

DEP SPECIFICATION

SELECTION AND PROCUREMENT OF ACTUATORS FOR ON-OFF VALVES

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DESIGN AND ENGINEERING PRACTICE

DEM1



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TABLE OF CONTENTS

1..	INTRODUCTION	5
1.1	SCOPE	5
1.2	DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS	5
1.3	DEFINITIONS	6
1.4	CROSS-REFERENCES	8
1.5	SUMMARY OF MAIN CHANGES.....	8
1.6	COMMENTS ON THIS DEP	8
1.7	DUAL UNITS.....	8
1.8	NON NORMATIVE TEXT (COMMENTARY).....	8
2.	REQUIREMENTS	9
2.1	GENERAL	9
2.2	ACTUATOR DESIGNATION AND CLASSIFICATION	9
2.3	PNEUMATIC ACTUATORS	11
2.4	ELECTRIC ACTUATORS.....	13
2.5	HYDRAULIC ACTUATORS	13
2.6	ACTUATOR DESIGN	14
2.7	ENVIRONMENT	16
2.8	ACTUATOR CONSTRUCTION	18
2.9	ACTUATOR COMPONENTS, MATERIALS AND FINISH	23
3.	ACTUATOR ACCESSORIES	26
3.1	GENERAL	26
3.2	ACCESSORIES INTEGRAL TO THE ACTUATOR.....	26
3.3	POSITION CONTROL AND FEEDBACK ACCESSORIES.....	28
3.4	PNEUMATIC ACCESSORIES.....	33
3.5	OTHER ACCESSORIES	37
4.	ACTUATOR SIZING.....	39
4.1	TORQUE REQUIREMENTS AND SAFETY FACTORS	39
4.2	OPERATING TIME	44
5.	PRODUCTION INSPECTION, CERTIFICATION AND TESTING	45
5.1	WITNESSING	45
5.2	SCOPE OF THE PRODUCTION TESTING	45
5.3	ACTUATOR COMPONENTS	46
5.4	BARE ASSEMBLED ACTUATOR	49
5.5	AUTOMATED ACTUATOR	50
5.6	BARE VALVE.....	51
5.7	INTEGRATED VALVE ASSEMBLY.....	51
6.	DOCUMENTATION REQUIREMENTS.....	55
7.	PACKING AND SHIPPING	55
7.1	ACTUATOR ONLY	55
7.2	VALVES	56
8.	PROCUREMENT – SUPPORTING INFORMATION	56
8.1	INFORMATION TO BE SUBMITTED WITH THE REQUISITION	56
8.2	INFORMATION TO BE PROVIDED BY THE MANUFACTURER/SUPPLIER.....	57
9.	ENDURANCE TESTING	57
9.1	GENERAL	57
9.2	QUALIFICATION RANGE	58
9.3	SCOPE OF THE TYPE TESTING	58
9.4	PRE AND POST TEST INSPECTIONS	58
10.	REFERENCES	63

APPENDICES

APPENDIX A SAFETY FACTOR VALIDATION 68

1.. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for pneumatic, electric and hydraulic actuators for on-off valves and their accessories, for use in both General Service Applications and Protective Applications.

This DEP does not cover actuators installed on control valves, valves in subsea service and valves on distribution pipeline systems.

This DEP covers the selection, specification, requisitioning, procurement and Endurance Testing of actuators and integrated valve assemblies.

This DEP mainly deals with pneumatic actuators and some of the listed requirements may not apply to hydraulic or electric actuators. At the same time, not all relevant aspects of hydraulic and electric actuators have been included.

This DEP is intended for:

- the Principal's control and automation engineers that are involved in the selection and testing of actuators, as well as in trouble shooting, for both new and replacement actuators;
- engineering consultants and system integrators (Contractors) who prepare requisitions and evaluate technical proposals on behalf of the Principal;
- actuator and valve Manufacturers that prepare technical quotations and calculations and provide support to sites.

This DEP contains mandatory requirements to mitigate process safety risks in accordance with Design Engineering Manual (DEM) 1 – Application of Technical Standards.

This DEP is a revision of the same number dated February 2016; see (1.5) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI, the distribution of this DEP is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them. Any authorised access to DEPs does not for that reason constitute an authorisation to any documents, data or information to which the DEPs may refer.

This DEP is intended for use in facilities related to oil and gas production, gas handling, oil refining, chemical processing, gasification, distribution and supply/marketing. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process shall be implemented; this is of particular importance when existing facilities are to be modified.

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

1.3 DEFINITIONS

1.3.1 General definitions

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

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

The **Principal** is the party that initiates the project and ultimately pays for it. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The capitalised term **SHALL [PS]** indicates a process safety requirement.

The word **should** indicates a recommendation.

The word **may** indicates a permitted option.

1.3.2 Specific definitions

Term	Definition
Actuator	An electric, pneumatic or hydraulic powered device bolted or otherwise attached to the valve to apply torque or thrust for the opening and closing of a valve.
Fail safe	A property of a device that, in the event of failure or loss of signal or supply, responds in a pre-determined safe way.
General Service Applications	Applications of an actuator on a valve with an on/off service not considered being HSSE critical equipment.
HSSE Critical Equipment	Equipment whose failure could release a Hazard with a RAM red Risk (and yellow 5A and 5B Risks for Asset Integrity – Process Safety) or whose purpose is to prevent or limit the Consequences of the release of a Hazard with a RAM red Risk (and yellow 5A and 5B Risks for Asset Integrity – Process Safety).
Maximum Operating Pressure (MOP)	The maximum pressure allowed in a device or system. With respect to use of this definition relating to actuators, the MOP is the maximum pressure allowed in the actuator which produces the torque/thrust for which the mounting kit has been designed.
Mechanically Loaded Parts	Parts that are designed to provide the generation and/or transmission of torque/thrust.
On-Off Valve	A valve that is not intended for throttling control in a partially-opened position. It is intended to be either fully open or fully closed.
Pressure-Containing Parts	Parts whose failure to function as intended results in a release of contained fluid into the environment.
Protective Applications	Applications of an actuator on a valve which is HSSE Critical Equipment as defined in the HSSE Control Framework Glossary, such as final elements of an IPF SIL1 or higher.

1.3.3 Abbreviations

ISO 12490 lists a number of relevant definitions and abbreviations that have not been repeated below.

Term	Definition
AET	Air End Torque
ART	Air Running Torque
AST	Air Start Torque
ENP	Electroless Nickel Plating
GSA	General Service Application
IDT	Insulation Displacement Terminal
MAST	Maximum Allowable Stem Torque
MAT	Maximum Air Torque
MOP	Maximum Operating Pressure
MST	Maximum Spring Torque
MWDr	Mild warm dry
NDE	Non-Destructive Examination
NPT	National Pipe Thread
PA	Protective Application
PFD	Probability of Failure on Demand
PST	Partial Stroke Test
RMS	Root Mean Square (of the material roughness in the context of this DEP)
SET	Spring End Torque
SIA	Secured Instrument Air
SIL	Safety Integrity Level
SIS	Safety Instrumented System
SRT	Spring Running Torque
SST	Spring Start Torque
VEOT	Valve End-to-Open Torque
VNBT	Valve Net Breakout Torque

Term	Definition
VRST	Valve Re-Seat Torque
VRT	Valve Running Torque
VSCT	Valve Start-to-Close Torque

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section or clause number is shown in brackets (). Other documents referenced by this DEP are listed in (10).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated February 2016. The only changes are to DEP cross-references to reflect changes in the DEP library in 2017.

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be submitted to the Administrator using one of the following options:

Shell DEPs Online (Users with access to Shell DEPs Online)	Enter the Shell DEPs Online system at https://www.shelldeps.com Select a DEP and then go to the details screen for that DEP. Click on the "Give feedback" link, fill in the online form and submit.
DEP Feedback System (Users with access to Shell Wide Web)	Enter comments directly in the DEP Feedback System which is accessible from the Technical Standards Portal http://www.shell.com/standards . Select "Submit DEP Feedback", fill in the online form and submit.
DEP Standard Form (other users)	Use DEP Standard Form 00.00.05.80-Gen. to record feedback and email the form to the Administrator at standards@shell.com .

Feedback that has been registered in the DEP Feedback System by using one of the above options will be reviewed by the DEP Custodian for potential improvements to the DEP.

1.7 DUAL UNITS

This DEP contains both the International System (SI) units, as well as the corresponding US Customary (USC) units, which are given following the SI units in brackets. When agreed by the Principal, the indicated USC values/units may be used.

1.8 NON NORMATIVE TEXT (COMMENTARY)

Text shown in italic style in this DEP indicates text that is non-normative and is provided as explanation or background information only.

Non-normative text is normally indented slightly to the right of the relevant DEP clause.

2. REQUIREMENTS

2.1 GENERAL

1. The requirements in this Section apply to all General Service Applications. In case additional requirements or restrictions apply to Protective Applications, this is specifically mentioned in the text.

2.2 ACTUATOR DESIGNATION AND CLASSIFICATION

2.2.1 Actuator movement

Actuators can be divided in the following movements:

- *part-turn actuator that transmits torque to the valve for a rotation of one revolution or less;*
- *multi-turn actuator that transmits torque to the valve for a rotation of more than one revolution;*
- *linear actuator that transmits thrust to the valve for a defined linear stroke*

2.2.2 Actuator type

Actuators can be divided in the following types:

- *pneumatic actuator, comprised of pneumatic cylinder(s) or another shape, appropriate gearing and travel stops;*
- *electric, self-contained actuator, typically comprised of an electric motor, reduction gearing, limit and/or torque switches, and a motor control package, which may be integral or external to the actuator;*
- *hydraulic actuator, comprised of hydraulic cylinder(s) or another shape, appropriate gearing and travel stops.*

2.2.3 Actuator configuration

Actuators can be divided in the following configurations:

- *Single acting actuator, with supply energy that is active in one direction only, and with the return stroke driven by an alternative form of stored energy, such as a spring;*
 - *Double acting actuator, requiring the application of supply energy to operate the actuator output in both directions.*
1. For Protective Applications, one of the following configurations SHALL [PS] be used:
 - a. A single acting actuator using a return spring;
 - b. A double acting hydraulic actuator.

2.2.4 Action on loss of supply energy

1. Upon loss of supply energy, the valve shall be automatically driven to, or remain in, a predetermined position. These positions can be as follows:
 - a. Fail to open;
 - b. Fail to close;
 - c. Fail last (also known as stay-put).
2. Fail last (using lock-up valves) should be considered in case of a temporary drop in supply energy pressure or voltage.

2.2.5 Actuator designs

Actuators are available in many different designs. The most common designs for pneumatic and hydraulic actuators are as follows:

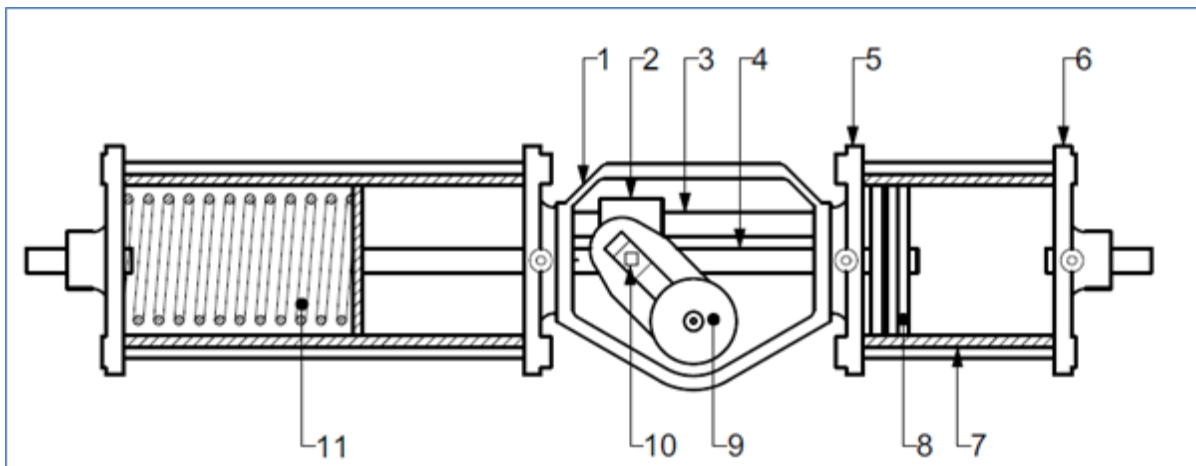
- *scotch-yoke*, a mechanism that converts the linear motion of a slider/piston into rotational motion of the output shaft;
- *rack and pinion*, a pair of gears that convert linear motion into rotational motion. the circular pinion on the output shaft engages teeth on the rack (a flat bar);
- *vane*, an arm-like component that is moved by fluid pressure causing rotation;
- *helix*, a piston with a helical groove that rotates when it is moved by fluid force, also called a *helical-spline*, *piston and helix*, and *sliding spline*;
- *linear*, a piston that transmits linear thrust to the valve.

Other actuator designs are described in ISO 12490.

1. For Protective Applications, only designs that have passed the endurance test as described in (9) shall be used. The endurance test is based on:
 - a. EN 15714-3 Table 1 for pneumatic actuators;
 - b. EN 15714-4 Table 2 for hydraulic actuators.

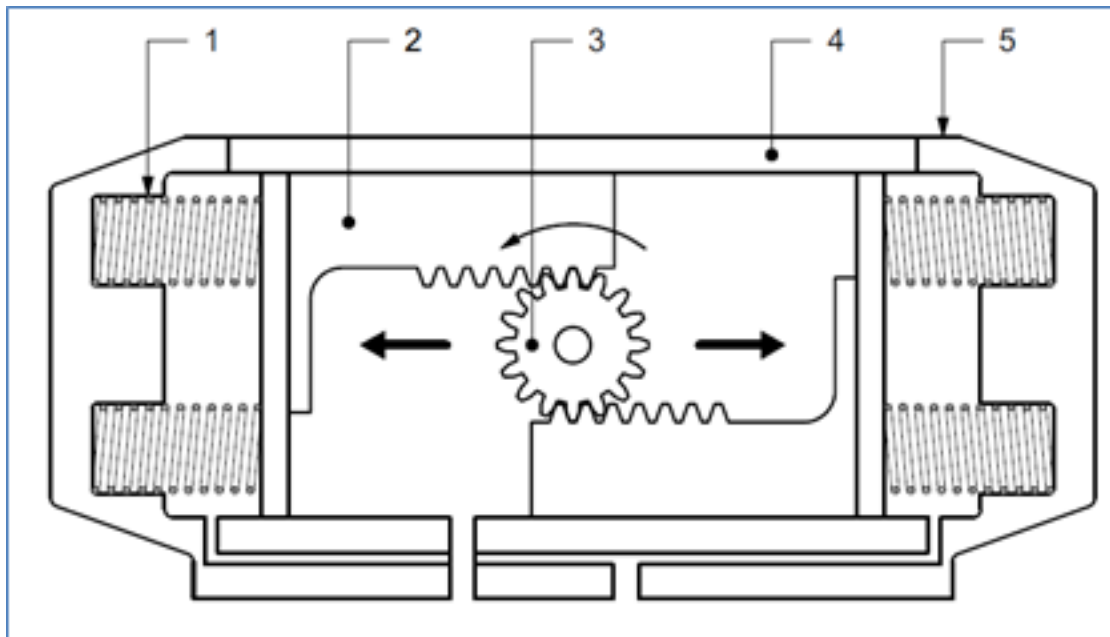
The endurance testing requirements in EN 15714 does not cover linear motion actuators.

Figure 1 Scotch-yoke mechanism (shown in actuated position)



- 1 housing
- 2 guide block
- 3 guide bar
- 4 piston rod
- 5 inner cap
- 6 outer cap
- 7 cylinder
- 8 piston
- 9 yoke and output shaft
- 10 yoke pin
- 11 spring

Figure 2 Rack and pinion mechanism (shown in actuated position)



- 1 spring
- 2 piston and rack
- 3 pinion
- 4 housing
- 5 end cap

2.3 PNEUMATIC ACTUATORS

2.3.1 Operating medium

1. The operating medium for pneumatic actuators shall be compressed air, unless otherwise specified.
2. Refer to DEP 31.37.00.11-Gen. for the requirements regarding compressed air.

2.3.2 Alternatives to compressed air

1. Use of any compressed gas other than air requires approval of the Principal. Refer to DEP 31.37.00.11-Gen. for the requirements regarding alternatives to compressed air.
2. The gas shall be clean, dry, oil free, "not very toxic" (as defined in DEP 01.00.01.30-Gen.).
3. If a "very toxic-acute", "very toxic-chronic", or "very toxic-environment" gas is used, the area around the actuator, solenoid-operated valve and other pneumatic accessories shall be ventilated so that personnel are not exposed to harmful levels of gases.
4. Pneumatic exhaust ports shall be located and oriented such that the release does not affect personnel near the valve.
5. The Principal shall specify the chemical composition of the gas, the hydrocarbon dew point and the water dew point.
6. Based on the gas composition, the Manufacturer shall propose materials that are compatible with the gas at the specified operating conditions, for approval by the Principal.

2.3.3 Pneumatic operating medium

1. The pneumatic actuator shall meet the service limits described in (2.6.5) with the compressed air purity classes specified below supplied to the tie-in point of the actuator.
 - a. For actuators that use a solenoid-operated valve to control their position ISO 8573-1:2010 Class 7 3 4, i.e.:
 - i. Solid particle Class 7, i.e. particle size $\leq 40 \mu\text{m}$ (1.6 mils), concentration $\leq 10 \text{ mg/m}^3$;
 - ii. Humidity Class 3, i.e., pressure dew point $\leq -20^\circ\text{C}$ (-4°F);
 - iii. Oil Class 4, i.e., concentration total oil $\leq 5 \text{ mg/m}^3$.
 - b. For actuators also fitted with diagnostic positioner or other pneumatic accessories ISO 8573-1:2010 Class 6 2 3, i.e.:
 - i. Solid particle Class 6, i.e. particle size $\leq 5 \mu\text{m}$ (0.2 mils), concentration $\leq 5 \text{ mg/m}^3$;
 - ii. Humidity Class 2, i.e. pressure dew point $\leq -40^\circ\text{C}$ (-36°F);
 - iii. Oil Class 3, i.e. concentration total oil $\leq 1 \text{ mg/m}^3$.
2. In regions with climate types colder than mild warm dry (MWDr) as defined in IEC 60721-2-1 where the ambient temperature can frequently be below -10°C (14°F), Contractor shall specify a tighter specification for humidity class and water class.
3. The Contractor shall specify the air quality at the site where the actuator will be installed.

2.3.4 Pneumatic supply pressure

All pneumatic pressures are given in gauge pressure.

1. The Contractor shall specify the pneumatic supply pressure available at the point where the pneumatic supply line connects to the pneumatic system of the actuator:
 - a. Minimum available pressure to supply at the actuator (default is 550 kPa (ga) (80 psig)),
 - b. Normal available pressure to supply the actuator (typically 700 kPa (ga) (100 psig)),
 - c. Maximum available pressure to supply at the actuator (default is 900 kPa (ga) (130 psig)),
 - d. Relief valve setting on instrument air system (default is 1000 kPa (ga) (145 psig)).
2. In case no site-specific values for the pneumatic supply are specified, the default values mentioned in (2.3.4, item 1) shall be used for sizing and selection purposes.
 - a. In that case the actuator design pressure (DP) shall be at least 1100 kPa (ga) (160 psig).

Specifying an excessively wide range of pneumatic supply pressures (ratio max/min available pressure > 1.6) can result in onerous design requirements, with consequential cost implications.

3. For some applications, a maximum allowed operating time for the working stroke in the non-fail safe direction has been specified (4.2, item 2). In those cases the normal available supply pressure given by the Contractor should include the pressure loss in the tubing between the air supply header/distribution point and the point where the pneumatic supply line connects to the pneumatic system of the actuator during the working stroking of the actuator.

2.4 ELECTRIC ACTUATORS

2.4.1 Duty classification

The duty classification of electric actuators as provided in EN 15714-2 is given below:

Class A: On-off – The actuator is required to drive the valve through its entire travel from the fully open position to the fully closed position or vice-versa.

Class B: Inching/positioning – The actuator is required to occasionally drive the valve to any position (fully open, intermediate and fully closed). Class B is not covered by this DEP.

Class C: Modulating – The actuator is required to frequently drive the valve to any position between fully open and fully closed. Class C is not covered by this DEP.

Class D: Continuous modulating – The actuator is required to continuously drive the valve to any position between fully open and fully closed. Class D would typically be used on a control valve and is not covered by this DEP.

In this DEP, only Class A electric actuators are covered.

2.4.2 Electrical power supply

1. The Contractor shall specify the following:
 - a. Voltage, phase, frequency;
 - b. Voltage variation and frequency variation. Unless otherwise specified, this should be in accordance with Zone B as described in Figure 12 of IEC 60034-1;
 - c. Number of consecutive valve strokes;
 - d. Number of starts per hour. Unless otherwise specified, this should be in accordance with Table 6 and Table 7 of EN 15714-2.

2.4.3 Actuator duty performance

1. Unless otherwise specified by the Contractor, the duty performance class shall be Class A (on/off) as specified in clause 4.7.2 of EN 15714-2.

2.5 HYDRAULIC ACTUATORS

2.5.1 Hydraulic operating medium

1. The Contractor shall specify the type of hydraulic fluid used to provide the supply energy.
2. The flashpoint shall be not less than 93 °C (200 °F) for pressures below 1 MPa (ga) (145 psig) and 157 °C (315 °F) for pressures above 1 MPa (ga) (145 psig).
3. The Manufacturer shall ensure the internal parts used in the actuator and its accessories are compatible with the hydraulic fluid specified.
4. For the supply of the hydraulic operating medium refer to DEP 31.36.10.30-Gen.

2.5.2 Hydraulic fluid quality

1. Unless otherwise specified, the actuator shall be capable of operating reliably and sustainably with hydraulic fluid which has a contamination level class 19/17/14 per ISO 4406.

2.5.3 Hydraulic supply pressure

1. The Contractor shall specify the hydraulic supply pressure available at the point where the hydraulic supply line connects to the hydraulic system of the actuator in terms of:
 - a. Minimum available pressure to supply at the actuator;
 - b. Normal available pressure to supply the actuator;
 - c. Maximum available pressure to supply at the actuator;
 - d. Relief valve setting on hydraulic supply unit.
2. Hydraulic actuators shall be designed to operate with one of the maximum allowable pressure ratings as specified in clause 4.3.1 of EN 15714-4.

2.6 ACTUATOR DESIGN

2.6.1 Design code

1. Pressure-containing parts, such as the cylinder heads and cylinder, shall be designed in accordance with one of the following design codes:
 - a. PD 5500, Construction category 2;
 - b. ASME BPVC Section VIII, Division 1 or Division 2;
 - c. EN 13445-3;
 - d. EN 13445, Testing Group 1;
 - e. Other internationally recognized design codes or standards by agreement between the Manufacturer and the Principal.
2. The Manufacturer shall indicate the design code.
3. Pressurised actuator enclosures shall be designed with minimum safety factors as given in Table 1 (taken from EN 15714-3 Table 6) or the safety factors following from the selected design code, whichever is the highest.

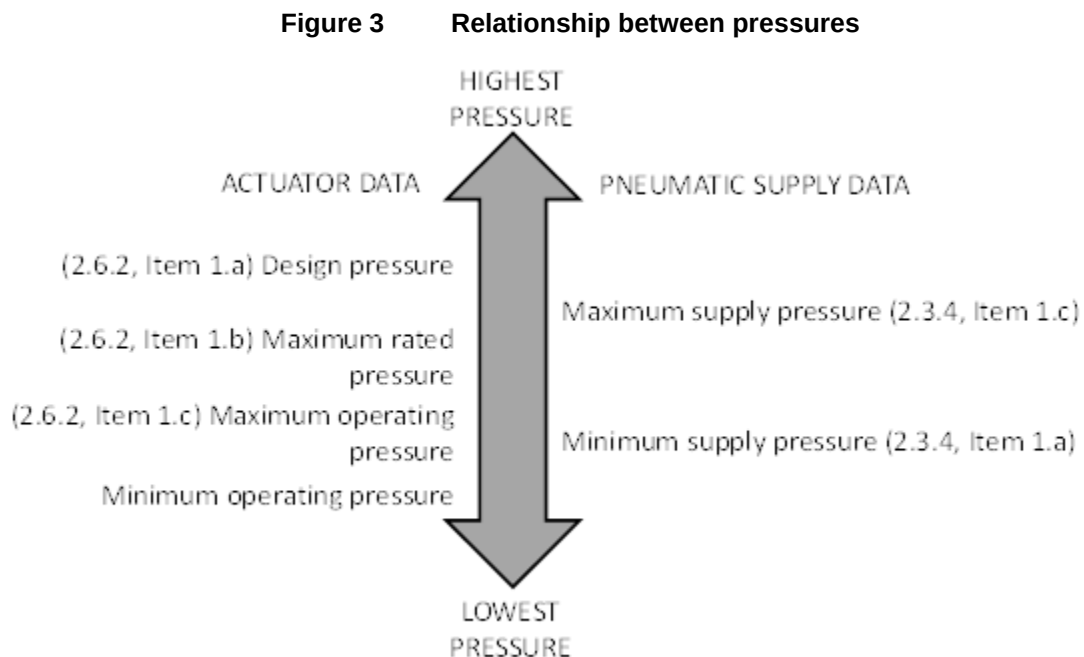
Table 1 Minimum design safety factors

Material	Proof strength as appropriate	Tensile Strength
Ferritic Steel	$R_{p0.2}/1.5$	$R_m/2.4$
Austenitic stainless steel, A5 > 30 %	$R_{p1.0}/1.5$	----
Austenitic stainless steel, A5 > 35 %	$R_{p1.0}/1.2$	$R_m/3$
Cast steel	$R_{p0.2}/1.9$	$R_m/3$
Aluminium	$R_{p0.2}/1.5$	----
Aluminium (non hardenable)	$R_{p0.2}/1.5$	$R_m/2.4$
Other materials	Calculations shall utilize the values appropriate to the properties of the material.	
Note: 1. $R_{p0.2}$ is the amount of stress that will result in a plastic strain of 0.2 % (non-proportional elongation) 2. R_m is the tensile strength at which the material tears under pressure (the maximum tensile stress).		

2.6.2 Design pressure

1. Based on the maximum available pressure to supply, the Manufacturer shall specify:
 - a. The design pressure which is used for the design of the pressure-containing parts consisting of the end caps, barrel, tie rods and nuts of the power cylinder.
 - b. The maximum rated pressure which is the pressure in the power cylinder that produces the maximum rated torque in static conditions, i.e. at the mechanical limits of the yoke, the housing and the travel stops.
 - c. The maximum operating pressure which is the pressure in the power cylinder that produces the maximum allowable operating torque in dynamic conditions.

These actuator pressure relationships are illustrated in Figure 3.



2.6.3 Actuator – valve attachment

1. The mechanical interface between the actuator and the valve shall be specified by the Contractor in accordance with one of the following:
 - a. ISO 5210 for multi-turn actuators;
 - b. ISO 5211 for part-turn actuators;
 - c. MSS SP-101-1989 (R 2001);
 - d. MSS SP-102-1989 (R 2001).
2. The output drive of part-turn actuators may be an integral part or a removable component to allow it, when necessary, to be machined to suit the driven component of the valve.
3. For linear actuators, the dimensions of the valve attachment should be in accordance with clause 4.3.3 of EN 15714-2.
4. In case the actuator is ordered as a part of an integrated valve assembly, the flange size should be provided by the valve Supplier.

2.6.4 Accessories mounting interface

1. For accessories connected to the shaft/stem of pneumatic actuators, the mounting interface should be in accordance with clause 4.6.1 of EN 15714-3 and for hydraulic actuators in accordance with clause 4.12.1 of EN 15714-4.

2.6.5 Service limits

1. The Contractor shall specify the following service limits:
 - a. Anticipated design life (years) prior to actuator replacement (default shall be 25 years);
 - b. Anticipated number of actuator cycles per year (minimum shall be 300 per year).
2. The Manufacturer should describe the maintenance requirements based on a six-year turn-around interval and indicate which activities require removal of the actuator from the valve.

2.7 ENVIRONMENT

2.7.1 Environmental conditions

1. Actuators and accessories shall be suitable for continuous use in the environmental conditions specified.
2. For the location where the actuator will be installed:
 - a. The Contractor should determine the climate type based on IEC 60721-2-1.
 - b. Climatic conditions for that climate type should be based on IEC 60721-3 taking into account the possible influence of a very cold or very hot process.
3. Unless otherwise specified, equipment shall be suitable for installation and use in outdoor locations Class D as specified in IEC 60654-1.
4. Unless otherwise specified, equipment shall be suitable to be used in an ambient temperature range from -20 °C to 60 °C (-4 °F to 140 °F) and with relative humidity up to 80 %.

2.7.2 Corrosion protection

1. Unless otherwise specified, corrosion protection of external components and housings of the actuator and mounting kit shall be in accordance with corrosion category C5-M (very high, marine) per ISO 12944-2.

This corrosion category is designed for exposure to corrosive, aggressive, industrial, coastal environments. 316 stainless steel does not require corrosion protection.
2. The recommended paint system is:
 - a. Zinc rich epoxy primer – 60 µm (2.4 mils);
 - b. High build epoxy mid-coat – 180 µm (7.2 mils);
 - c. Polyurethane topcoat – 60 µm (2.4 mils).
3. The total minimum nominal dry film thickness (NDFT) shall be 300 µm (12 mils).
4. Unless otherwise specified, the coating shall be the Manufacturer's standard colour and paint specification. If a coating other than the Manufacturer standard is used, the Contractor shall specify the RAL colour and paint specification.
5. In addition to the protection of external parts, protective compounds and durable materials and coatings shall be used to prevent corrosion in the event of condensation inside the housing, spring module and power cylinder.

6. Closed loop breathing systems in accordance with Standard Drawing S 36.601 that protect the cylinder from ingress of outside air shall be used in the following cases:
 - a. Actuator configurations where the return spring is located inside the power cylinder,
 - b. All actuators used in a marine environment.
7. Blasting as a preparation for painting shall only be done on components before assembly. Blasting after assembly of the actuator shall be subject to the approval of the Principal.
8. In case the valve is painted after mounting of the actuator, the valve stem or spindle and gasket-contact surface of flanges as well as nameplate and warning plates shall be protected against paint.
9. The flange face between the actuator and the valve shall be protected against corrosion, for instance, with peelable varnish or Shell Ensio Fluid grade S, T or V or equivalent.

2.7.3 Ingress protection

1. The ingress protection class of actuators shall be IP66/IP66M in accordance with IEC 60529, as a minimum. This excludes the effect of pressurisation of components by pneumatic operating medium.
2. For actuators in a marine environment, the ingress protection class shall be IP67/IP67M, as a minimum.
3. For Protective Applications, the ingress protection class of actuators shall be IP67/IP67M, as a minimum.
4. For pneumatic and electric accessories, including position control devices, junction boxes and electrical enclosures, the ingress protection class shall be IP66, as a minimum, regardless of the environment and application.

2.7.4 Hazardous areas

1. Electric actuators intended for use in hazardous areas shall be designed and certified in accordance with the requirements of the applicable regulations.
2. The Contractor shall specify the following details in accordance with IEC 60079-0:
 - a. Area classification;
 - b. Gas group;
 - c. Temperature class.
3. The Contractor shall specify the preferred method of protection for use of electrical equipment in a potentially hazardous atmosphere.
4. For use in a Zone 1 hazardous area the method of protection shall be Ex'e' for non-sparking equipment and Ex'd' for sparking equipment.
5. For use in a Zone 2 hazardous areas the method of protection shall be Ex'n' or Ex'e' for non-sparking equipment and Ex'd' or Ex'p' for sparking equipment.

2.7.5 Electrical

2.7.5.1 General

1. Cable entry in enclosures should be M20 x 1.5 mm (female ISO 724) or ½ in NPT (ANSI/ASME B1.20.1). Power supply cables to electrical actuators may require other sizes.
2. Unsupported individual wires or cables inside limit switch boxes, valve position transmitters and diagnostic positioners shall be terminated in a junction box with screw terminals or insulation displacement terminals (IDTs).

2.7.5.2 External circuits

1. For electrical actuators, the relay, circuit breaker and contactor coils shall be provided with de-coupled networks consisting of one of the following protection circuits:
 - a. A reverse diode for DC supplied coils;
 - b. An RC network (e.g., a 100 ohm resistor in series with a 100 nF capacitor) for AC supplied coils;
 - c. A varistor for AC or DC supplied coils.
2. Electrical isolation shall be provided between such protection circuits and field wiring terminations at the actuator.

2.7.6 Orientation

1. The Contractor shall specify the installed orientation of the actuated valve assembly and the direction from which local access is required, including pipeline direction, valve stem direction and actuator orientation, preferably using the coding as shown on S 36.803.
2. The valve stem shall not be loaded by lateral forces which are caused by the weight of the actuator.
3. The forces resulting from the actuator's weight and applied torque shall not be carried by the valve stem.
 - a. *Actuator supports, where specified, should allow for sliding/horizontal movement and only take the majority of the vertical load away from the mounting kit.*
4. The following information is required as a minimum:
 - a. Orientation of pipeline in which the valve is installed (horizontal, vertical, other);
 - b. Axis orientation of valve shaft (horizontal, vertical, other);
 - c. Orientation of actuator with respect to valve (parallel or transverse to the valve centreline);
 - d. Orientation of accessories in order to ensure convenient access for maintenance and operation.
5. The default orientation is pipeline horizontal, valve stem vertical, and the actuator axis parallel to the pipeline (orientation code 22 on S 36.803).

2.8 ACTUATOR CONSTRUCTION

2.8.1 General (applies to all actuator types)

The Principal will advise the language or languages to be used on warning labels and nameplates.

1. The design of spring return actuators shall permit the safe mounting on and removal from the valve.
2. All moving components of the actuator, including the housing but excluding the mounting kit, stem extension and accessories such as position feedback and position indicator, shall be of fully enclosed design to avoid the possibility of injury to personnel during operation.
3. The housing cover, when applied, shall be bolted and easily removable to allow access to the internal linkages without disassembling the entire unit or removing the unit from the valve.
4. In case the actuator has a cover as an integral part of the housing or a cover that supports the shaft, then the cover shall be provided with a clearly visible label, indicating "do not operate the actuator when cover is removed".

5. The Contractor shall specify whether in-situ servicing of the actuator is required.
6. Bolted joints between valve, mounting kit and actuator shall be protected from lateral loads, e.g. by means of dowel pins or by controlled assembly procedures in the Installation, Operation and Maintenance manual.
7. Fasteners shall be selected and installed in a manner to ensure bolt tightness is maintained under all operating conditions (such as the influence of temperature, vibration).
8. For Protective Applications, the housing of scotch-yoke actuators shall be provided with a removable cover in order to facilitate in-situ maintenance and repair.

2.8.2 Mounting kit

The mounting kit forms the mechanical interface between the actuator and the valve. It transmits the mechanical loads from the actuator to the valve.

1. The mounting kit may be comprised of combinations of the following:
 - a. An intermediate support (an open bracket, a closed flanged spool, adaptor);
 - b. A coupling (drive adaptor, drive tube, drive shaft);
 - c. Optional drive key(s) connecting the coupling to the valve shaft;
 - d. A dowel pin fixing the intermediate support to the valve body or bonnet;
 - e. Bolting.

An open bracket enables easier visual identification of leaks and prevents product from entering the actuator.
2. The mounting kit design and manufacturing tolerance shall ensure the following:
 - a. Parallelism of the intermediate support mounting faces;
 - b. Concentricity of the pitch circle diameter of the bolting of the intermediate support;
 - c. Alignment of the valve stem, coupling and the actuator drive.
3. The design basis for the mounting kit shall be one of the following:
 - a. Stress-based using the design code selected in (2.6.1) (e.g., ASME BPVC Section VIII-2);
 - b. Based on documented previous experience, including validation testing and approval by the Principal.
4. The mounting kit shall be designed to transfer all torque/thrust from the actuator to the valve to a minimum of 1.1 times the highest of the following:
 - a. Torque/thrust generated by actuator at maximum operating pressure or as limited by relief valve or other pressure-limiting device, for pneumatic/hydraulic actuators;
 - b. Torque/thrust generated by maximum compressed spring force, for spring return actuators;
 - c. 100 % Torque/thrust switch setting, for electric actuators.
5. The Manufacturer of the mounting kit and the coupling shall determine the Maximum Allowable Coupling Torque (MACT).
6. Incorrect angular orientation or improper assembly of actuator to valve shall be prevented, e.g., by means of a dowel pin or fitted bolt.
7. In case an open mounting kit is used, it shall be possible to identify the valve position without removing the actuator, e.g. by clear markings on the coupling.

8. If the mounting kit is a sealed compartment, it shall be fitted with safety relief devices, to ensure that, in the event of leakage from the valve stem seals, excessive pressure cannot build up in a compartment that is not designed to contain pressure.
9. The safety relief device shall be designed so that it cannot become inoperative as a result of environmental degradation (UV) or external corrosion.
10. The safety relief device shall be provided with a warning label indicating that it should not be painted.
11. The actuator shall be mounted on the valve so that, with the valve installed in the indicated orientation, the mounting kit and stem are not overstressed by the weight and torque of the actuator.
12. Any requirement for additional support of the actuator, other than that provided by the mounting kit, shall be clearly identified in the proposal.
13. The Manufacturer shall specify whether any special equipment or arrangements are required for mounting the actuator.

2.8.3 Pneumatic actuators

2.8.3.1 General

1. All joints between actuator components shall be sealed against environmental ingress and crevice corrosion.
2. The power cylinder and spring module or the spring/cylinder module of a scotch-yoke actuator shall be bolted to the housing.
3. The actuator internals shall be packed for life with suitable lubricants.

2.8.3.2 Springs

1. The spring(s) on spring return actuators shall be designed in accordance with internationally recognized design codes or standards.
2. If no equations exist for the spring type, a proprietary equation may be used provided it has been validated by cycle testing.
3. The spring design should be based on 10 times the number of cycles considered as quasi-static loading as described in EN 13906, but shall not be less than the number of cycles required for the endurance test as described in one of the following standards:
 - a. EN 15714-2 (2009) Table 2 for electrical actuators;
 - b. EN 15714-3 (2009) Table 1 for pneumatic actuators;
 - c. EN 15714-4 (2009) Table 2 for hydraulic actuators.
4. No rubbing or buckling of the springs shall occur.
5. Compression of the springs shall be limited so that it is not pressed to its solid height.
6. The Manufacturer shall provide procedures in the Installation, Operation and Maintenance manual for the safe removal of the spring and/or spring module.
7. In case the spring module is a unit that is welded closed while the spring is compressed, the Manufacturer shall provide procedures in the Installation, Operation and Maintenance manual for the safe decommissioning of the spring module.
8. Actuator designs that contain a spring inside the power cylinder shall only be used when the power cylinder is using a closed loop breathing system. Refer to S 36.601.
9. In case the spring is housed in a separate spring module, that module shall be O-ring sealed or non-breathing to prevent ingress of atmospheric air, sand and moisture.

2.8.3.3 Tie rods

1. Tie rods, when used, shall only be applied to retain the end caps/flanges on the spring module and/or the power cylinder.
2. Tie rods shall only be loaded by forces that are longitudinal.
3. Tie rods shall not be used to attach the power cylinder or the spring module to the housing.
4. Tie rod design shall be in accordance with the design code selected in (2.6.1), unless otherwise specified.
5. Failure of one tie rod shall not cause danger to personnel or interfere with the proper operation of the valve.
6. In-situ replacement of a failed tie rod should be possible without removing the pneumatic supply. For that reason, external tie rods are preferred.
7. In case in-situ replacement of a failed tie rod is not possible without removing the pneumatic supply, warnings shall be provided as a physical label attached to the actuator and warning in the Installation, Operation and Maintenance manual.

2.8.3.4 Pressure connections

1. Actuators shall have at least two pressure connections, one on either side, unless otherwise specified.
2. Pressure connections on double acting actuators should be clearly identified with numbers (2 and 4), in accordance with ISO 5599-2.
3. For single acting actuators, the port to be pressurised should be clearly marked.
4. As a minimum, the dimensions of these pressure connections/interface should be as specified in Table 3, Table 4, Figure 1 and Figure 2 of EN 15714-3.

2.8.4 Electric actuators

2.8.4.1 General

Actuator motors are designed as an integral part of the actuator. They are outside the scope of IEC 60034-1.

1. Asynchronous motor windings shall be protected against overheating by a suitable thermal protecting device.

For other types of motors, the protecting device is not mandatory.

2. The actuator gear mechanism shall be totally enclosed and lubricated. The method of lubrication (grease, oil and/or self-lubricating materials) shall suit the environmental conditions specified and the operation of the actuator when mounted in any orientation.
3. In case of oil lubrication, oil level checking shall be possible regardless of the orientation of the actuator.
4. In case of grease lubrication, injection and release nipples or plugs shall be provided.