

DEP SPECIFICATION

CONTROL VALVES – SELECTION, SIZING, AND SPECIFICATION

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DESIGN AND ENGINEERING PRACTICE

DEM1



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1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the selection and specification of control valves, their actuators and accessories, using the latest industry practices and international standards where applicable. It includes self-acting regulators and the use of control valves as a final element for certain protective functions.

Outside the scope of this DEP are on/off valves solely intended for switching or protective functions.

This DEP is primarily intended for:

- Engineers who are involved in selection and specification of control valves as well as troubleshooting, adding new and replacing existing control valves;
- Engineering consultants and system integrators (Contractors) who are preparing requisitions and evaluating technical proposals on behalf of their Principal;
- Control valve vendors (Manufacturers/Suppliers) involved in the preparation of technical quotations, calculations and providing technical 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 DEP of the same title and number dated February 2011; 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 authorization 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.

1.3.2 Specific definitions

For control valve terminology and related terms, IEC 60534-1 applies, with the following amendments:

- *Section 4.1 Nominal size, add:*
Valve sizes may also be expressed in inches.
- *Section 4.2 Nominal pressure, add:*
Valve pressure rating may also be expressed in ASME classes.

For definitions regarding control valve sizing, see (Appendix A).

For the purposes of this DEP, the following definitions apply:

Term	Definition
FF	Foundation™ fieldbus
Highway Addressable Remote Transducer (HART)	Standard for sending and receiving digital information across analogue wires between smart devices and control or monitoring system.
HP	High pressure
Instrumented Protective Function (IPF)	Function comprising one (1) or more initiators, a logic solver and one (1) or more final elements whose purpose is to prevent or mitigate hazardous situations. An IPF is intended to achieve or maintain a safe state for the process, in respect of a specific hazardous event In IEC 61508 and IEC 61511, an IPF is referred to as a safety instrumented function (SIF)
Maximum Operating Pressure (MOP)	Maximum pressure allowed in a device or system. The design pressure (DP) is 110 % of the MOP.
NAMUR	An international user association of automation technology in process industries
NPS	Nominal pipe size
National Pipe Thread (NPT)	U.S. standard for tapered threads used on threaded pipes and fittings.
On/Off	Changing to an open, closed or predetermined state when required, for example, by an instrumented protective system, through the use of a solenoid-operated valve.
PAS	Process automation system
PEFS	Process engineering flow scheme
Smart Plant Instrumentation (SPI)	Instrument index complete with device specification sheets.

Term	Definition
Total Cost of Ownership (TcoO)	Cost of options evaluated against the lifecycle of the equipment (versus the initial upfront cost).
Throttling Control	Continuously manipulating the stem/shaft of a control valve in order to obtain a desired process condition. This is usually done through a valve positioned.

1.4 CROSS-REFERENCES

Where cross references to other parts of this DEP are made, the referenced section number is shown in brackets (). Other documents referenced by this DEP are listed in (15).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated February 2011.

Section	Change
All	Dual units have been added throughout the DEP; see also (1.7).
All	Reworded statements that could be interpreted in a manner that was different than the intent.
All	Reference new standard drawings as applicable to the section.
2.1	Changed text to "When a control valve is used as a protective element (through an SOV) this may not raise requirements to the control valve function such as stroke time and seat leakage".
3	Added "For general service, preference for rotary valves (eccentric plug or segmented ball) up to 10".
3.1	Changed some parameters to qualify severe service.
3.4	Table 2 - Changed some valve type selections.
4.2	Removed second process safety requirement as it was already including in the first requirement.
4.4	Added "Contractor to define orientation of control valves using a standard drawing".
13	Moved process safety requirement to Section 13.
5.2.1	Added additional process safety requirement.
6.2.2	Added "Request manufacturer to quote two options for low noise. One that stays within the noise limits without path treatment. And one that may generate up to 9 dB more noise, but that requires path treatment".
6.3	Modified requirements regarding downstream pipe length.
6.7.1	Removed second process safety requirement as it was covered already in the first requirement.
8.1.4	Added "Apart from an increased requirement of spring force (from 10 % margin to 20 % margin) a second requirement was added regarding force over friction, using the definition in ISA 75.25.01".
8.2.3	Revised text to state "Indicate on the actuator the maximum pressure and also why it is that value (casing MOP, diaphragm/linking strength or trim force)".
9.4	Changed limit switches to position feedback and added additional content

Section	Change
9.10.2	Added process safety requirement and associated content.
9.13	Removed section on relief valves as content was too prescriptive. Replaced with new content on lifting eyes.
11.1	Added "Hydrostatic test only allowed on components, not on assembled valves".
11.3	Changed the packing test to be mandatory for all valves.
11.8.1	Modified requirements for functional testing.
11.11	Added "Definition of stroking time to include dead time in electrical and pneumatic components".
11.18	Added Inspection and functional testing requirements.
12.5	Added details on documentation requirements.
Appendix A	Added content on Valve Authority. Revised text and drawings to reflect normal requirements (versus design requirements). Rewrote the valve sizing rules.

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://sww.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.

2. GENERAL

2.1 FUNCTION

The function of a control valve is to provide throttling control in response to signals from a control system, using an actuator and a positioner.

In case the control valve requires a bypass for operational reasons that bypass shall remain in place and, if necessary, be locked with a chain/padlock.

The use of a control valve as a final element of a protective function shall not affect the demands placed on the control valve in terms of material selection, flow capacity, characteristic, stroking time and allowable leak rate.

3. SELECTION OF CONTROL VALVES

The information listed in (12.3) shall be provided with the requisition for each control valve. This document is aligned with IEC 60534 and uses the standard control valve data sheet as included in IEC 60534-7:2010, Clause 6.3. Many of the required parameters for the specification of a control valve are described there. Throughout this document, reference is made to the standard control valve data sheet line numbers.

Note that if an instrument index (e.g., SmartPlant Instrumentation) is used for the project, the valve specifications sheets supplied with that instrument index shall be used. In this scenario, the IEC valve data sheet shall be used as a reference for information that shall be provided in the specification and purchase of a control valve. Additional information required for procurement of the valve shall be added in the notes section of the instrument index specification sheet.

The selection of control valves is done in a number of steps:

- Determine the basic process conditions and other details for the application (IEC 60534-7:2010, lines 1-30);
 - o During normal operating modes, at minimum, normal and maximum flow rate for each operating case;
 - o During abnormal operating modes, start-up, commissioning, test and emergency operations;
- Qualify the process conditions of the application as either 'General Service' or 'Severe Service' (3.1) and in case of severe service, gather additional information such as;
 - o Pump curves, piping details, line losses, elevations as shown in (Appendix A). This data will influence the controllability of the control valve and relates to the choice of trim characteristic for all services.
 - o Compressor anti-surge requirements;

NOTE: The vendor of the anti-surge system and vendor of compressor shall be consulted for all compressor anti-surge valve requirements.

This data will influence the controllability of the control valve and relates to the choice of trim characteristic for all services.

- Determine, based on the piping classes, whether the application requires any special valve designs (3.2) or end connections;
- For general service applications, rotary motion valves of the eccentric plug or segmented ball type should be considered as long as the controllability as a result of the inherent valve characteristic is not affected.
- Selection of technically accepted products and Suppliers (3.4).

The next steps will be the specification of the valve body (4), valve trim (5), actuator (8) and accessories (9).

Valves with special designs are covered in (6). Valves for special services are covered in (7).

3.1 QUALIFICATION OF SEVERE SERVICE CONDITIONS

In the early phases of a project limited information may be available and often a certain degree of uncertainty is associated to that knowledge.

However, the following information is generally reasonably known when the control valve selection is performed:

- Fluid state (liquid, gas, steam, slurries)
- Flow rate at max, normal and min conditions (Q) for each operating case
- Upstream pressure at max, normal and min conditions (P_1)
- Differential pressure at max, normal and min conditions (P_1-P_2) or (dP)
- Vapour pressure for liquids (P_v)
- Upstream temperature (T_1)
- Valve size (D), for this purpose taken as being one (1) size smaller than the line size.

With this information, a number of qualifiers can be calculated which will determine if a severe service condition exists for that control valve. It should be noted that the limits indicated in the table below are not very sharp but are merely indicating whether a potential for severity exist in the service conditions. The worst case may not necessarily exist at maximum conditions; often it is a combination of pressure drops and flow rates that may cause problems. It is required to calculate these qualifiers at least at minimum, normal and maximum conditions.

The severe service conditions shall be verified during detailed design through the use of computer programs that can model the piping and equipment around the valve and determine the behaviour of the control valve in the overall process. These programs will allow calculations to be performed at any flow rate, not just at minimum, normal and maximum flow and thus provide opportunities for trouble shooting and optimisation.

Table 1 Qualification of severe service conditions

Severe Service Condition	Calculation	Limit	Notes
Cavitating service	$dP/(P_1 - P_v)$	>0.38	Only for liquids
Flashing service	P_2/P_v	≤ 1.0	Only for liquids
High pressure drop ratio (choked flow)	dP/P_1	>0.6	
High turn-down ratio	Q_{max}/Q_{min}	>10	
High power conversion	$dP(\text{Pa}) \times Q$	$>100 \text{ Kw}$ (134 HP)	Q is volumetric flow
High noise	Noise $> 85 \text{ dB}$	$> 85 \text{ dB}$	
Erosive applications			Entrained solids

If any of these conditions violate the limits in Table 1, the application shall be considered as a 'severe service application' which requires the selection of control valves which have been specifically selected and qualified for severe service applications.

In addition to these criteria, severe service conditions always apply to:

- Compressor anti-surge/spillback valves;
- Minimum flow recycle valves;
- Choke valves for the control of well fluids;

- d. Liquid drain valves on HP separators and knock-out vessels;
- e. Boiler feed-water valves
- f. Valves that experience heavy out gassing (release of gases absorbed or dissolved in pressurised liquids).

If none of the above conditions apply (including start-up, commissioning and emergency conditions) the application can be met by a general service valve.

When it has been established that an application is qualified as severe service, this condition shall be indicated in the requisition (IEC 60534-7:2010, line 14) and additional process information shall be provided. Refer to (Appendix A).

The following service descriptions shall be used when selecting the control valve service:

3.1.1 Cavitating service

Cavitation potential exists when the pressure in the vena contracta of a control valve reaches the vapour pressure of the liquid based on the parameter $dP/(P_1 - P_v)$. Special measures are required to avoid material damage to the valve and downstream piping and equipment as well as noise and vibration. In case cavitation potential exists, a valve with a high numeric valve differential pressure ratio (X_r) shall be required. This is considered a severe service application.

3.1.2 Flashing service

In a flashing application, vapour will always be present downstream of the vena contracta of a control valve ($P_v \geq P_2$). The fraction of the vapour depends on many factors. Flashing is actually the first stage of cavitation but not all vapour returns to liquid. Control valves in a flashing application may also show material damage over time due to high valve outlet velocities, however, in most cases, this can be handled by selecting special hardened alloys.

3.1.3 High pressure drop ratio (choked flow)

Above a certain pressure drop ratio (dP/P_1) the flow rate does not depend on the downstream pressure anymore as the fluid velocity in the vena contracta reaches the velocity of sound. It only depends on valve opening and upstream pressure. This is called 'choked flow'. In certain applications, it is desirable to have the flow rate independent of downstream conditions. Choked flow in itself is not necessarily a problem but the effects associated to the very high velocities inside and at the outlet of the valve may require a severe service valve for these applications.

3.1.4 Turn-down ratio

The turn-down ratio of an application is the ratio between the maximum flow rate to the minimum flow rate that can be properly controlled by the control valve. This includes the effects of other devices in the flow path and is not the same as rangeability, which is a characteristic of a particular control valve.

3.1.5 High power conversion

The differential pressure across a control valve multiplied with the volumetric flow rate (equals velocity) provides an indication for the power conversion that takes place inside the valve. This energy conversion will be mostly from potential energy into thermal energy (heat), kinetic energy (velocity) and acoustic energy (noise). It is clear that this figure is an indicator for the intensity of the conversion that takes place inside the control valve. Examples of high power conversion valves are depressuring valves, recycle valves, wellhead choke valves, etc.

3.1.6 High noise

A control valve with a high noise level is an indication of a large dissipation of potential energy as acoustic energy. Accurate calculation of noise levels often requires more process and valve data than may be available during valve selection. These high noise valves shall be closely reviewed to ensure the appropriate valve design has been selected.

3.2 DETERMINATION OF SPECIAL VALVE DESIGN REQUIREMENTS

The piping class of the system in which the valve will be installed determines whether a control valve requires a special design. Based on the piping class, either a special valve design is required or the control valve can be considered as a standard valve.

3.2.1 Piping classes

A piping class is a collection of piping components, suitable for a defined service and design limits in a piping system. Piping classes are compiled in DEP 31.38.01.12 Gen. and DEP 31.38.01.15 Gen.

Although it should be recognised that Manufacturers generally do not have access to piping class details, reference to the applicable piping class shall be in the requisition (IEC 60534-7:2010, line 8). This will help consistency and avoid confusion and errors.

Control valves and self-acting regulators shall be specified in accordance with the requirements of the piping class. Based on those requirements, decide on the options for the following valve properties which shall be included in the requisition:

- a. Pressure class;
- b. Mechanical design limits, indicating the pressure ratings at coincident temperatures;
- c. Material selection of valve body (trim material shall be based on the application requirements and verified with the Manufacturer);
- d. Flange type and facing, end gasket type;
- e. Fugitive Emissions Class (IEC 60534-7:2010, remarks section).

These options shall be decided by the Contractor.

Providing a certain choice of the trim materials in the requisition (IEC 60534-7:2010, lines 48-49) allows the Manufacturer to be able to advise the most suitable material for the valve trim.

3.2.2 Selection process

Figure 1 illustrates the flow chart of the special design selection process. It is typical only and may be amended by the Principal for a particular Manufacturer. The purpose of Figure 1 is to enable an early selection in order to focus attention on valves that need special designs. Any special design requirements shall be indicated in the requisition (IEC 60534-7:2010, line 44).

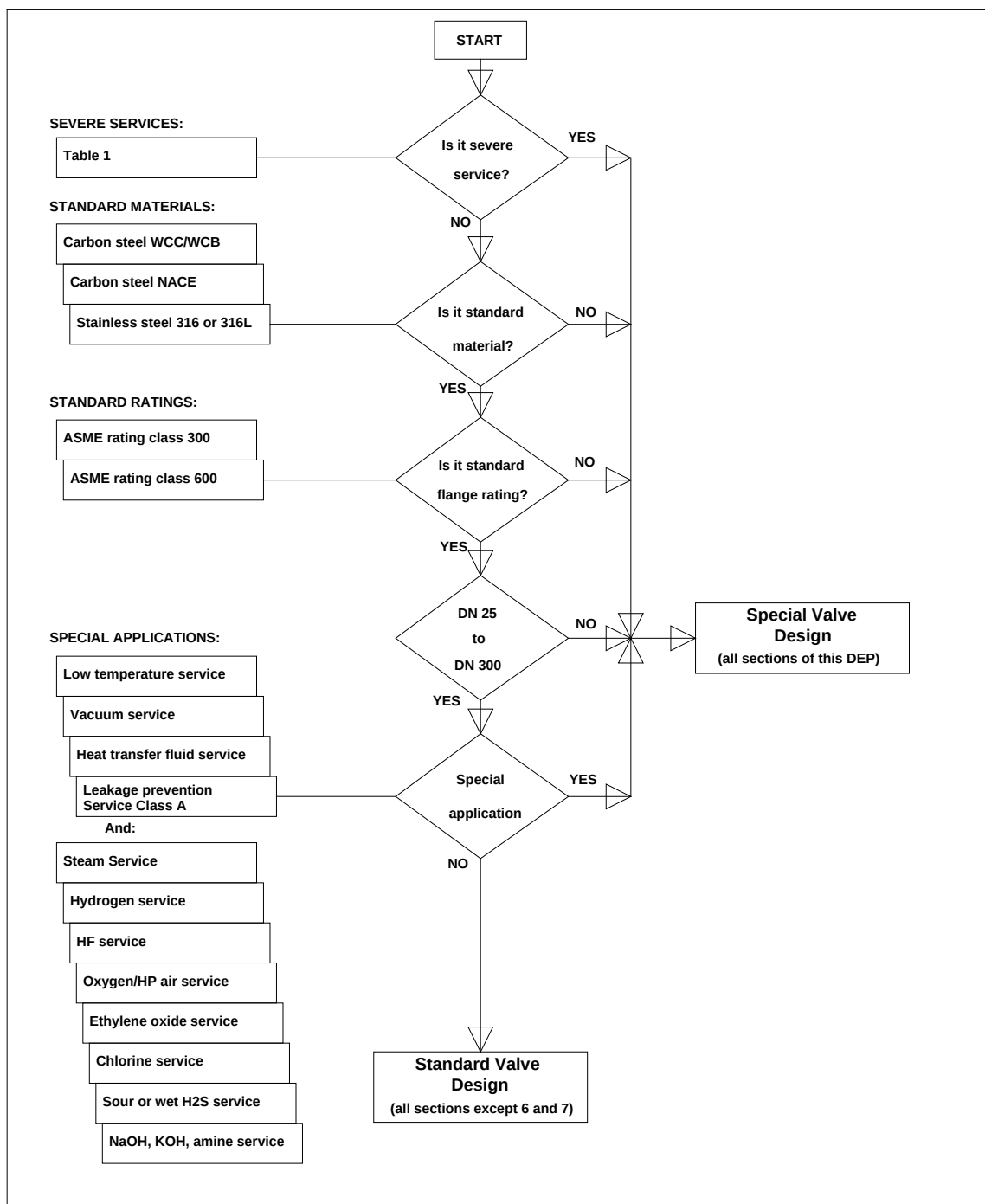


Figure 1 Selection process for special valve designs

3.3 SELECTION OF CONTROL VALVE TYPE

IEC 60534 splits control valve types by the motion of the valve stem. This is the first choice in the selection of a control valve. This choice is influenced by technical as well as economic reasons. The selection of valves for severe service applications shall be based on proven applications experience.

3.4 TECHNICALLY ACCEPTED PRODUCTS AND SUPPLIERS.

Products shall be technically qualified to the satisfaction of the Principal and shall be sourced from Manufacturers acceptable to the Principal.

IEC 60534-1:2005, Clause 3.1 provides a framework for different types of control valves which is depicted in Table 2. Use of this Table provides selection of types of valves that are acceptable to be used for a particular severe service condition. It should be understood that this selection is not 'absolute'. Local site experience should also be considered when selecting control valve types. The category of valve to be used for the tender shall be indicated in the requisition (IEC 60534-7:2010, line 46).

Only valve types from the same category shall be tendered in the same requisition.

NOTE: For this purpose Shell Companies may use the list of Technically Acceptable Manufacturers and Products maintained by Shell.

Table 2 Valve type selection table (an X indicates an allowed use of that valve type)

Sub-Group	Valve Sub-Sub-Group	General Service	Severe Service						
			Cavitating	Flashing	Hi-dP	Choked flow	Turn-down ratio	High Power	Erosive, solids,
Control Valve - Linear Motion	Diaphragm (IEC 60534-1:2005 Clause 3.1.1.1)	X							On/off only
	Gate (IEC 60534-1:2005 Clause 3.1.1.2)								
	Globe (IEC 60534-1:2005 Clause 3.1.1.3) Two-way post guided valve	X	X	X	X	X Note 1	X	X	X
	Two-way cage guided valve	X	X	X	X	X Note 1	X	X	
	Three-way valve	X							
	Axial flow valve			X	X	X Note 1	X	X	X
	Globe Angle (IEC 60534-1:2005 Clause 3.1.1.3)	X	X	X	X	X	X	X	X
Control Valve - Rotary Motion	Ball (IEC 60534-1:2005 Clause 3.1.2.1)	X	X						X
	Segmented Ball (IEC 60534-1:2005 Clause 3.1.2.2)	X	X	X			X	X	X
	Butterfly (IEC 60534-1:2005 Clause 3.1.2.3)	X	X Note 2						
	Plug (IEC 60534-1:2005 Clause 3.1.2.4)								X
	Eccentric Plug (IEC 60534-1:2005 Clause 3.1.2.5)	X	X	X					
Control Valve - Self-Acting	Pressure, Self-Acting	X							

Sub-Group	Valve Sub-Sub-Group	General Service	Severe Service						
	Temperature, Self-Acting	X							
	Tank blanketing/venting	X							
Control Chokes	Gas or liquid service	X			X	X		X	X

NOTES 1. Not for wellhead chokes.
2. Only as triple-eccentric.

3.5 LINEAR MOTION VALVES

The Sections below follow the structure and nomenclature of IEC 60534-1:2005, Clause 3.1.1. For certain valve types, qualifiers for service conditions have been added to the text which may differ from those used to qualify severe services. Users of this DEP may amend these figures based on site-specific experience. This will not require a deviation.

3.5.1 Diaphragm valves IEC 60534-1:2005, Clause 3.1.1.1

The use of diaphragm valves is common in waste water (water treatment) service. Use in any other service requires the approval of the Principal. These types of valves are not further covered in this document.

3.5.2 Gate valves IEC 60534-1:2005, Clause 3.1.1.2

These types of valves are not further covered in this document.

3.5.3 Globe valves IEC 60534-1:2005, Clause 3.1.1.3

Globe valves for throttling control shall only be considered if the higher pressure drop (when compared to a gate valve) can be tolerated. On larger sizes (greater than DN 150 (6 in)) globe valves typically require high thrust actuators when compared to other valves.

3.5.3.1 Two-way globe valves

Post guided valves:

Top guided parabolic plugs in modern "light weight" valves shall be selected with care to avoid stem vibration in sizes greater than DN 25 (NPS 1).

Cage guided valves:

Cage guided valves and balanced type valves, with the exception of double seated control valves, shall not be used in service where coke may form, where solids are present or where gluing effects may be present.

Balanced-type control valves shall only be used in clean services where Leakage class less than or equal to Class V applies. In case there is any potential for scaling, corrosion or contaminants, balanced-type control valves shall not be used.

3.5.3.2 Three-way globe valves

In case of a converging three-way globe valve, if the two (2) inlet streams are of different temperatures, it shall be confirmed that the resulting temperature stress is within the capabilities of the three-way globe valve. All process conditions shall be considered (start-up, shutdown, etc.) when confirming the temperature stress scenarios.

3.5.4 Axial flow valves

Axial flow valves shall be considered for anti-surge application. This is done to ensure smooth control, fast acting and to avoid unnecessary boosters (which affect and limit the control margin) to speed up the response.

3.5.5 Angle valves IEC 60534-1:2005, Clause 3.1.1.3

Angle valves for throttling control shall only be considered if one (1) or more of the following conditions are met:

- a. Hydrocarbon services where coke may form;
- b. Erosive services, e.g., slurries and solids carried in suspension;
- c. Severe flashing service;
- d. Cavitating services;
- e. Applications where solid contaminants might settle in the body of a globe valve, for instance vessel bottoms services;
- f. Liquid service with high differential pressures;
- g. Compressor anti-surge;
- h. Vent or blowdown valves;
- i. High temperature/desuperheating;
- j. Two (2) phase/multi phase flows;
- k. Wellhead fluid chokes.

3.6 ROTARY MOTION VALVES

The Sections below follow the structure and nomenclature of IEC 60534-1:2005, Clause 3.1.2. For certain valve types, qualifiers for service conditions have been added to the text which may differ from those used to qualify severe services. The users of this DEP may amend these figures based on site-specific experience. This will not require a deviation.

Cryogenic applications shall be reviewed for the requirement of a gas lock under the gland packing.

3.6.1 Ball valves IEC 60534-1:2005, Clause 3.1.2.1

Ball valves for throttling control shall only be considered if all of the following conditions are met:

- a. Cavitating potential <0.3
- b. Non flashing service
- c. Pressure drop $dP < 2500 \text{ kPa}$ (360 psi)
- d. Pressure drop ratio $dP/P_1 < 0.6$
- e. Turn down ratio <5
- f. Power conversion $<100 \text{ kW}$ (134 HP)

The controllability (installed characteristic) shall be checked over the whole range of the valve to ensure smooth control.

Ball valves without internals that are specially designed for throttling control require the approval of the Principal.

3.6.2 Segmented ball IEC 60534-1:2005, Clause 3.1.2.2

Segmented ball valves for throttling control shall only be considered if all of the following conditions are met (all pressures are in kPa (psi)):

- a. Cavitating potential <0.4
- b. Mild or non-flashing service
- c. Pressure drop $dP < 1000 \text{ kPa}$ (145 psi)

- d. Pressure drop ratio $dP/P_1 < 0.6$
- e. Turn down ratio < 10
- f. Power conversion $< 100 \text{ kW } 1340 \text{ HP}$

3.6.3 Butterfly valves IEC 60534-1:2005, Clause 3.1.2.3

Butterfly valves for throttling control shall only be considered if all of the following conditions are met (all pressures are in kPa):

- a. Valve size $> \text{DN } 100 \text{ (4 in)}$
- b. Pressure drop ratio $dP/P_1 < 0.2$
- c. Turn down ratio < 5
- d. Pressure drop $dP < 500 \text{ kPa (75 psi)}$
- e. Leakage Class $< V$,
- f. Non-erosive fluids.

3.6.4 Plug valves IEC 60534-1:2005, Clause 3.1.2.4

The Contractor shall specify plug valves in accordance with MESC SPE 77/107; which is an amendment of API 599.

3.6.5 Valves with eccentric plug IEC 60534-1:2005, Clause 3.1.2.5

Eccentric plug valves for throttling control shall only be considered if all of the following conditions are met (all pressures are in kPa (psi)):

- a. Cavitating potential < 0.6
- b. Pressure drop $dP < 2000 \text{ kPa (290 psi)}$
- c. Pressure drop ratio $dP/P_1 < 0.6$
- d. Turn down ratio < 10
- e. Power conversion $< 20 \text{ kW (27 HP)}$
- f. $\frac{\Delta p_{Open}}{\Delta p_{Closed}} > 0.15$

3.7 SELF-ACTING REGULATORS

Self-acting regulators shall only be used in clean fluid services and only in applications that need no operator intervention, like the changing of a set point or manual operations. All self-acting regulators shall meet local pressure code requirements.

The use of self-acting regulators requires the approval of the Principal.

3.7.1 Self-acting pressure-reducing regulators

Pressure reducing regulators in gas blanketing service shall not be provided with an internal self-relieving function because that would cause a constant bleed of gas. All components downstream of the pressure-reducing regulator shall be rated for the maximum upstream protected pressure or suitable pressure protection shall be provided.

3.7.2 Self-acting back-pressure regulators

All components downstream of the back-pressure regulator shall be rated for the maximum upstream protected pressure or suitable pressure protection shall be provided.

3.7.3 Self-acting differential-pressure regulators

The pressure containing components of the differential-pressure regulator shall be rated for the maximum upstream and downstream protected pressures or suitable pressure

protection shall be provided. Protected pressure is the maximum pressure allowed by a mechanical pressure protection device (e.g. relief valve, rupture disk).

3.7.4 Self-acting temperature regulators

Self-acting temperature regulators shall only be considered for simple heating applications where utilities (e.g. instrument air or gas) are not available.

4. SPECIFICATION OF BODY CONSTRUCTION AND MATERIALS

4.1 VALVE BODY

In general, valve body sizes are smaller than the piping size. However, the valve body size shall not be smaller than half the adjacent pipe size or two (2) nominal pipe sizes smaller, whichever is larger without approval from the Principal. Valves smaller than half the pipe size may require isolation from transmitted pipe stresses.

Oversized bodies (up to the size of the adjacent piping) with reduced trim sizes may be considered for economic reasons (e.g., to allow for foreseen capacity increase in the future) or may, for instance, be required to reduce the fluid outlet velocity.

The nominal sizes of control valve bodies should be selected from the following series:

DN 25, DN 40, DN 50, DN 80, DN 100, DN 150, DN 200, DN 250, DN 300 and larger (NPS 1, NPS 1 ½, NPS 2, NPS 3, NPS 4, NPS 6, NPS 8, NPS 10, NPS 12 and larger).

The use of body sizes smaller than DN 25 (NPS 1) shall only be used with the approval of the Principal.

The pressure class of control valve bodies shall be at least PN40 (ASME class 300). These bodies may be provided with 300# flanges and be machined to 150# flange dimensions and face-to-face dimensions in accordance with 150# bodies. The overall pressure rating of the valve shall then be dictated by the flange rating.

Control valve bodies shall not be fitted with bottom drain plugs or other process-wetted threaded connections.

Split-body globe valves shall only be used with the approval of the Principal.

Control valves shall be installed free of pipe stresses.

All pressure containing components shall meet the regulatory pressure registration requirements in compliance with local codes.

4.2 END CONNECTIONS

Control valves in hydrocarbon service SHALL [PS] be provided with one of the following options:

- Flanged
- Flangeless lug
- Welded ends

NOTE: A lug type valve has lugs that are used to pass the stud bolts between the connecting flanges. In case stud bolts are not possible at boltholes locations adjacent to the stem drive and tail ends, tapped holes shall be used on those boltholes only.

Wafer type valves that do not have attachment lugs shall not be used on hydrocarbon service and require approval of the Principal when used on non-hydrocarbon service.

The Contractor shall specify flanges (including review of the suitability of the valve bottom flange gasket material) and flange gasket contact surface finish in accordance with the piping class and this shall be indicated in the requisition (IEC 60534-7:2010, line 11).

4.3 FACE-TO-FACE AND END-TO-END DIMENSIONS

Face-to-face dimensions for control valves shall be in accordance with IEC 60534-3 as follows:

- IEC 60534-3-1 - Face-to-face dimensions for two-way, globe type, straight pattern and centre to face dimensions for two-way, globe type angle pattern control valves.
- IEC 60534-3-2 - Face-to-face dimensions for rotary control valves except butterfly valves (which means segmented ball and eccentric rotary control valves with or without flanges).
- IEC 60534-3-3 - End-to-end dimensions for butt-weld, two-way, globe-type, straight pattern control valves.

The Contractor shall select the basic series from EN 558 to be used in the above standards and indicate this in the requisition (IEC 60534-7:2010, line 41).

For control valves that fall outside the range of the IEC 60534-3, either ISA S75-3 or EN 558 shall be used as indicated in the requisition.

Wafer type control valves designed to ASME, shall meet ASME B16.10 face-to-face dimensions. Wafer type control valves designed to EN standards shall meet EN 558 face-to-face dimensions.

4.4 STEM ORIENTATION

The Contractor shall indicate the orientation of the valve and its actuator in relation to the piping and means of access using DEP Standard Drawing S 36.801 for linear motion valves and S 36.802 for rotary motion control valves.

As much as possible, linear motion valves on horizontal lines shall be installed with the actuator stem in the vertical position with the actuator on top. Wherever possible, butterfly valves shall be mounted with the valve stem in the horizontal position.

NOTE: Valve positioning for cryogenic applications shall be reviewed for the requirement of a gas lock under the gland packing.

The Manufacturer shall indicate whether or not the intended position, as indicated on the requisition, is acceptable. If supports are required, the Manufacturer shall provide details of the support requirements.

Control valves shall be installed with sufficient clearance around the actuator and valve body to allow for:

- Lifting and removal of the valve and actuator. Hoisting equipment shall be accessible.
- The removal of the valve top cover without the valve body being removed from the pipe. This may be required for trim replacement.

4.5 BODY MATERIALS

4.5.1 General

The material selected for the body (including bonnet and/or bottom flange), bolts, studs and nuts, etc. shall be in accordance with the requirements of the piping classes. The Contractor shall extract the material choice(s) from the piping classes and these choice(s) shall be indicated in the requisition (IEC 60534-7:2010, line 8). Standard body materials are carbon steel WCB/WCC, ISO 15156 or NACE MR0103 carbon steel and stainless steels 316/316L. The Manufacturer may propose an alternative material if this is economically attractive. All other materials shall be considered as a special design and shall be approved by the Principal.

4.5.2 Lining

Internal lining of the valve may be proposed for protection against corrosion or erosion as an alternative to resistant base materials. The use of internal lining shall be approved by the Principal.

Internal lining of the entire body shall be considered for valves in seawater services (such as for fire protection deluge valves).

4.6 BONNET AND STEM SEALING

Valve bonnets shall be of bolted construction with fully retained gaskets; exceptions shall be approved by the Principal. PTFE-like packing/seal materials are only allowed in case the design temperature as indicated in the requisition (IEC 60534-7:2010 line 10) is below 200 °C (390 °F).

The Manufacturer shall supply the torque values for bolted connections in pressure containing parts, e.g., body/bonnet, gland packing.

Based on the applicable piping class, the Contractor shall specify the requirements for packing/seal materials to be either:

- Compression packings
- Elastomeric seals, or
- Thermoplastic seals

Any other material requires an advice from a materials expert and approval by the Principal.

This choice shall be indicated in the requisition (IEC 60534-7:2010, line 55). In his proposal, the Manufacturer shall indicate his choice of packing or seal make and type.

The stuffing box shall be provided with an adjustable or spring-loaded bolted stem packing flange and gland follower. The valve shall arrive with the valve stem packing properly adjusted by the valve Manufacturer.

- NOTES:
1. An extended bonnet may also be required if the operating differential pressure across the valve could otherwise cause freezing of the packing/seal and/or ice formation on the yoke. This may, for example, be the case with compressor recycle (anti-surge) valves.
 2. On valves in cryogenic service, an extended bonnet shall be fitted to bring the packing/seal outside the thermal insulation, see also (7.1).
 3. An extended bonnet may also be required if the operating temperature of the process can exceed the temperature rating of the packing.
 4. Thermal insulation shall not cover the bonnet extension, because doing so will impair the heat transfer required to maintain the proper packing/seal temperature. The limit of the insulation shall be marked on the bonnet extension.

4.6.1 Compression packings

Two (2) choices are available for compression packings:

- MESC SPE 85/203 Graphitic packing material, which are amendments to ASTM F2168, or
- MESC SPE 85/204 Packing material, graphite and carbon braided yarn, which are amendments to ASTM F2191.

Packing requiring external lubrication or grease shall not be used. Any deviation from the above requires approval by the Principal.

4.6.2 Elastomeric seals

Toroidal O-rings shall be validated according to MESC SPE 85/301 which are amendments/supplements to NORSOK M-710 type test practices.

4.6.3 Thermoplastic seals

Thermoplastic seal materials shall be selected in accordance with the applicable piping classes. If the applicable piping class does not contain isolation valves fitted with thermoplastic seats/seals, the proposed thermoplastic material shall be approved by the Principal.