

DEP SPECIFICATION

**CONTROL VALVES – SELECTION, SIZING, AND
SPECIFICATION**

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DESIGN AND ENGINEERING PRACTICE



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1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the selection, sizing and specification of control valves, their actuators and accessories, using the latest industry practices and international standards where applicable. Self-acting regulators and control valves used as final elements of an instrumented protective function are included.

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;
- Contractors who are preparing requisitions and evaluating technical proposals on behalf of the Principal;
- Manufacturers/Suppliers involved in the preparation of technical quotations, calculations and providing technical support to sites.

This is a revision of the DEP of the same number dated February 2013; see (1.5) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

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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 word **should** indicates a recommendation.

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

1.3.2 Specific definitions

Term	Definition
Depressuring	Reducing the pressure in process equipment at a controlled rate, either due to emergency conditions or for operational purposes.
Design Pressure	The gauge pressure at the most severe condition of coincident pressure (including coincident static head in the operating position) and temperature expected during normal operation. The design pressure is 110 % of the Maximum Operating Pressure.
Inherent Flow Characteristic	Relationship between the relative flow coefficient, Φ , and the corresponding relative travel, independent of the means of actuation. (from IEC 60534-1)
Instrumented Protective Function (IPF)	Function comprising one or more initiators, a logic solver and one 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)
MESC SPE	MESC SPEs are referred to in MESC buying descriptions and describe aspects that apply to many different types of equipment and are an important part of standardisation.
NAMUR	An international user association of automation technology in process industries.
National Pipe Thread (NPT)	U.S. standard for tapered threads used on threaded pipes and fittings (ANSI/ASME B1.20.1).
On/Off Valve	A valve that is controlled to an open or closed state when required, for example, by an instrumented protective system, through the use of a solenoid-operated valve.
Path Treatment	Measures to attenuate noise transmission from the source of the noise to the receiver of the noise (the ear).
Piping Class	A collection of piping components that are 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.
Pressure Containing	Description of a part whose failure to function as intended results in a release of contained fluid into the environment such as: body, bonnet, bonnet flange.
Pressure Retaining	Description of a part, such as seat and obturator, intended to prevent or permit the flow of fluids.
Severe Service Condition	Conditions that qualify a certain application as 'Severe Service', resulting in restrictions regarding the styles of control valves that may be selected.

Term	Definition
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 positioner.
Wetted	To be in direct contact with the process fluid.

1.3.3 Abbreviations

Term	Definition
NDE	Non-Destructive Examination
NPS	Nominal Pipe Size
SIA	Secured Instrument Air
SIF	Safety Instrumented Function (also referred to as IPF in Shell DEPs)

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 (13).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a full revision of the DEP of the same number dated February 2013. The following are the main, non-editorial changes.

Section/Clause	Change
All	Replaced references to IEC datasheet with references to DEP data/requisition sheet
All	Revised and SHALL [PS] that were covered in other DEPs or were not effective barriers to Major Accident Hazards
2.2	Changed several severe service condition qualifiers
2.3	Deleted Table 2 Valve type selection
2.3	Added preference for rotary motion valves
2.6	Added content on self-acting regulators
3	Added detailed references to piping classes and MESC specifications
3.2	Deleted requirement for minimum 300# pressure rating of valve body, changed allowable face-to-face dimensions, changed valve packing requirements
3.3	Changed requirements for packing materials
3.4.2	Added fire protection requirements
4.2	Added content on stem orientation
4.3	Changed seat leakage requirements and definition of flow direction
6	Added details on mandatory and special service requirements

Section/Clause	Change
7.1	Added details on actuator configurations, fail action and stored energy
7.1.6	Changed stroking time requirements
7.1.6	Updated actuator sizing requirements
8.3, 8.4	Referred to DEP 32.36.01.18-Gen. for solenoid-operated valves, limit switches and position transmitters
8.5	Added content on pressure gauges and measurement points
8.7	Added details on speed controlling devices
9.1	Added details on indication of flow direction
10	Added details on Inspection and Test Plan
10.2	Added details on visual inspection, functional test
10.2	Changed definition of stroking time
10.3	Added details on certification
11	Deleted reference to TAMAP and Positive Material Identification
12	Updated packing and packaging requirements

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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.

1.9 CONTROL VALVE TERMINOLOGY

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

- Nominal Valve sizes may also be expressed in inches.
- Nominal Valve pressure rating may also be expressed in ASME classes.

2. SELECTION OF CONTROL VALVES

2.1 GENERAL

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.

1. The use of a control valve as a final element of a SIF shall not affect the requirements on the control valve in terms of material selection, flow capacity, characteristic, stroking time and allowable leak rate.
2. The information listed in (11.2) shall be provided with the requisition for each control valve.

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

- *Determine the basic process conditions and other details for the application;*
 - 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' (2.2) 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 can influence the performance of the control valve.*
 - o *Compressor anti-surge requirements.*
- 3. For general service applications, rotary motion valves of the eccentric plug or segmented ball style should be considered as long as the minimum control valve authority can be met.

2.2 DETERMINATION OF SEVERE SERVICE CONDITIONS

2.2.1 General

In the early phases of a project, limited information might be available and often a certain degree of uncertainty is associated to that information. However, the following information will be known when the control valve style selection is performed:

- *Fluid state (e.g., liquid, gas, steam, slurries)*
- *Flow rate (Q) at maximum, normal and minimum conditions for each operating case in m³/s (ft³/s)*
- *Upstream pressure (P₁) at maximum, normal and minimum conditions in Pa (psi)*
- *Differential pressure (P₁-P₂) or (dP) at maximum, normal and minimum conditions in Pa (psi)*
- *Vapour pressure (P_v) for liquids in Pa (psi)*
- *Valve size (D), for this purpose taken as being one size smaller than the line size, in inches.*

With this information, a number of qualifiers can be calculated which will determine if a severe service condition exists for that application, regardless of the control valve style chosen. It should be noted that the limits indicated in Table 1 are indicative of whether a potential for severity exists in the service conditions. The worst case might not

necessarily exist at maximum conditions; often it is a combination of pressure drops and flow rates that may cause problems.

1. Severe service qualifiers shall be calculated at least at the minimum, normal and maximum conditions.
2. The severe service conditions shall be verified during detailed design (i.e., the Execute phase of the project) through the use of computer programs that 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
Cavitation potential	$dP/(P_1 - P_V) (= x_F)$	>0.4 >0.8	Only for water and aqueous solutions. Other liquids
Flashing service	P_2/P_V	≤ 1.0	
High pressure drop ratio (choked flow potential)	dP/P_1	>0.7	
High shaft loading	dP/D	>2000	Only for butterfly valves
High turn-down ratio	Q_{max}/Q_{min}	>10	
High power conversion	$dP \times Q_{norm}$	>100 kW (134 HP)	
Erosive applications Applications containing solids Applications that may form scale			Entrained solids

3. If any of the service conditions exceeds the limits in Table 1, the application shall be labelled as a "severe service" application which requires the selection of control valves that have been specifically designed, selected and qualified for severe service applications.
4. In addition to the criteria in Table 1, severe service conditions shall apply in all circumstances to each of the following:
 - a. Compressor anti-surge/spillback valves.
 - b. Minimum flow-recycle valves.
 - c. Choke valves for the control of well fluids.
 - d. Level control valves on high pressure separators and knock-out vessels.
 - e. Boiler feed-water valves.
 - f. Valves that may experience a release of gases absorbed or dissolved in pressurised liquids.

5. If none of the conditions in either Table 1 or (2.2.1, Item 4) apply (including for start-up, commissioning and emergency conditions), the application may be met by a general service valve.

2.2.2 Cavitation potential

Cavitation potential exists when the pressure in the vena contracta of a control valve approaches the vapour pressure of the liquid.

1. If cavitation potential exists, one or more of the following steps are required:
 - a. Review valve location and piping arrangements (e.g. lower temperature or higher back pressure), or
 - b. Select a valve with a high numeric value for the liquid pressure recovery factor F_1 (F_1^2 should be larger than xF).

This avoids or delays cavitation, thus reducing noise, vibration and material damage to the valve and downstream piping.

2.2.3 Flashing service

1. Control valves in a flashing application should use hard trim materials in order to avoid material damage over time due to high valve outlet velocities.

In a flashing application, vapour will always be present downstream of the vena contracta of a control valve ($P_v \geq P_2$).

2.2.4 High pressure drop ratio (choked flow)

1. The presence of choked flow conditions in a control valve may be delayed by selecting a valve with a high numeric value for the pressure differential ratio xT .

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. The flow rate only depends on valve opening and upstream pressure. This is called 'choked flow'.

2.2.5 High shaft loading

1. Butterfly valves should not be used for throttling control on applications where the pressure drop is high.

The shaft of a butterfly valve is loaded with a force determined by the differential pressure multiplied by the surface area of the blade (D^2). That shaft requires smooth rotation during control. The diameter of the stem is usually proportional to the diameter of the valve so the loading on the bearing surfaces is determined by the differential pressure multiplied by the diameter (D) of the valve. That poses restrictions on the maximum differential pressure for a given valve size.

2.2.6 Turn-down ratio

1. For applications with a high turn-down ratio a linear motion control valve style should be selected.

The turn-down ratio of an application is the ratio between the maximum flow rate to the minimum flow rate that require control by the control valve. Certain valve styles cannot control properly at very small openings and are not suitable for those applications.

2.2.7 High power conversion

1. For applications with a high power conversion a linear motion control valve style should be selected.

The differential pressure across a control valve multiplied by the volumetric flow rate 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). This figure is an indicator for the intensity of the conversion that takes place inside the control valve. Certain valve styles cannot handle applications with high power conversion and are not suitable for use on those applications.

2.3 SELECTION OF VALVE STYLE

This section lists criteria and limit values for the selection of control valve styles, based on the severe service conditions determined in (2.2). Where the severe service conditions allow, rotary motion valves of the eccentric plug or segmented ball style should be considered first.

Much of the content is recommendation and, based on site experience, users of this DEP can amend the criteria and limit values.

2.4 ROTARY MOTION VALVES

2.4.1 Ball valves to IEC 60534-1:2005, Clause 3.1.2.1

1. Ball valves should only be selected for throttling control if all of the following conditions are met:
 - a. Cavitating potential < 0.3 .
 - b. Non flashing service.
 - c. Pressure drop $dP < 2500$ kPa (360 psi).
 - d. Pressure drop ratio $dP/P_1 < 0.6$.
 - e. Turn down ratio < 5 .
 - f. Power conversion < 100 kW (134 HP).
 - g. $Q_o > 130$ % of Q_{max}
2. The use of ball valves without internals that are specially designed for throttling control shall be subject to the approval of the Principal.

2.4.2 Segmented ball valve to IEC 60534-1:2005, Clause 3.1.2.2

1. Segmented ball valves should only be selected for throttling control if all of the following conditions are met:
 - a. Cavitation potential < 0.4 .
 - b. Mild or non-flashing service.
 - c. Pressure drop $dP < 1000$ kPa (145 psi).
 - d. Pressure drop ratio $dP/P_1 < 0.6$.
 - e. Turn down ratio < 10 .
 - f. Power conversion < 100 kW (1340 HP).

2.4.3 Butterfly valves to IEC 60534-1:2005, Clause 3.1.2.3

1. Butterfly valves should only be selected for throttling control if all of the following conditions are met:
 - a. Valve size $> DN 100$ (NPS 4).
 - b. Pressure drop ratio $dP/P_1 < 0.2$.
 - c. Turn down ratio < 5 .
 - d. Pressure drop $dP < 500$ kPa (75 psi).
 - e. Leakage Class $< V$.
 - f. Non-erosive fluids.

- g. $Q_o > 130\%$ of Q_{max}

2.4.4 Eccentric plug valves to IEC 60534-1:2005, Clause 3.1.2.5

1. Eccentric plug valves should only be selected for throttling control if all of the following conditions are met:
 - a. Cavitation potential < 0.6 .
 - b. Pressure drop $dP < 2000$ kPa (290 psi).
 - c. Pressure drop ratio $dP/P_1 < 0.6$.
 - d. Turn down ratio < 10 .
 - e. Power conversion < 20 kW (27 HP).
 - f. Pressure ratio meets Equation 3.1

$$\frac{\Delta p_{Open}}{\Delta p_{Closed}} > 0.15$$

Eqn 3.1

2.5 LINEAR MOTION VALVES

2.5.1 Diaphragm valves to IEC 60534-1:2005, Clause 3.1.1.1

The use of diaphragm valves is common in general waste water service.

1. Use of diaphragm valves in any service other than waste water shall be subject to the approval of the Principal.

2.5.2 Globe valves to IEC 60534-1:2005, Clause 3.1.1.3

2.5.2.1 Top-guided globe valves

1. Top guided globe valves should be used for general service applications where stem vibration will not occur as a result of fluid velocities.

2.5.2.2 Cage-guided globe valves

1. Cage guided globe valves should be considered for severe service applications where anti-cavitation or noise reduction properties are required.
2. Cage guided valves shall not be used in the following applications:
 - a. Where coke could form;
 - b. Where solids could be present. Also refer to (5.1.1).

2.5.2.3 Top- and bottom guided globe valves

1. Top and bottom stem guiding shall be applied for double seated valves.

2.5.3 Angle pattern valves to IEC 60534-1:2005, Clause 3.1.1.3

1. Angle pattern valves in flow to close direction may be selected if any of the following conditions apply:
 - a. Applications where coke deposits may form.
 - b. Erosive services, e.g., slurries or solids carried in suspension.
 - c. Flashing service with outlet velocities > 50 m/s (165 ft/s).
 - d. Cavitating services.
 - e. Applications where solids might settle in the body of a globe valve.
 - f. Liquid service with differential pressures > 5000 kPa (725 psi).

2.6 SELF-ACTING REGULATORS

2.6.1 General

1. Self-acting regulators shall only be used in services that meet all of the following requirements:
 - a. Fluid services that are all of the following:
 - i. Clean;
 - ii. "Not very toxic" (as DEP 01.00.01.30-Gen.);
 - iii. Below its auto ignition temperature.
 - b. Permanent installations that require no operator intervention (e.g., changing of the setting).

Instrument air pressure regulators are not included in this clause.
2. The use of self-acting regulators shall be subject to Principal approval.
3. All components downstream of the pressure-reducing regulator shall meet one of the following:
 - a. Rated for the upper design pressure of the upstream piping, or
 - b. Provided with overpressure protection.
4. The actuator casing shall be designed for the upper design pressure of the upstream piping.
5. The pressure sensing line of self-acting regulators should be implemented in one of the following ways:
 - a. Using a connection internal to the valve, either inlet or outlet;
 - b. Using an external connection to a nozzle provided with a primary isolation valve.
 - i. In this case, use may be made of impulse lines and compression fittings such as those used for online instruments.
6. Self-acting regulators shall be engineered as control valves and follow the requirements placed on control valves with the following exceptions:
 - a. May use a split-body design subject to (3.1, Item 6);
 - b. May use non-standard face-to-face dimensions subject to (3.2.6, Item 2);
 - c. May use non-standard bonnet style and stem packing (3.2.7).
7. The following exceptions may be applied for self-acting regulators:
 - a. Stroking time (7.1.4) rules do not apply.
 - b. Actuator sizing rules (7.1.5) do not apply;
 - c. Actuator may be driven by process fluids other than air or hydraulic fluid;
 - d. Materials alternative to those in (7.2.4) may be used for the actuator and diaphragm.
8. Self-acting regulators shall not be provided with an internal relief valve.
9. External reliefs or vents shall not be provided other than a breathing connection on the non-pressurised side of the actuator.
10. Adjustments to the setpoint of self-acting regulators shall only be possible with a tool such as a wrench or spanner and not by hand.

2.6.2 Pressure-reducing regulators

1. Pressure reducing regulators should be used to control the pressure downstream of the regulator.

These valves are fail to open. The actuator casing is connected to the outlet pressure, so in case of control failure the downstream piping and actuator casing will be exposed to the inlet pressure.

The non-pressurised side of the actuator normally has a breathing connection which, in case of diaphragm failure will pass process fluid to atmosphere.

2.6.3 Back-pressure regulators

1. Back-pressure regulators should be used to control the pressure upstream of the regulator.

These valves are fail to close. The actuator casing is exposed to the upper design pressure of the upstream piping.

The non-pressurised side of the actuator normally has a breathing connection which, in case of diaphragm failure, will pass process fluid to atmosphere.

2.6.4 Differential-pressure regulators

1. The pressure retaining components of the differential-pressure regulator shall be rated for the upper design pressure of the upstream and downstream piping, whichever is the highest.

2.6.5 Tank blanketing regulators

Tank blanketing regulators are used to feed blanket gas into a tank when the pressure in the tank drops, for instance when the level is dropping.

Tank pressure relief valves are not covered by this DEP.

1. External pressure sensing lines of tank blanketing regulators should be installed with minimal bends and constant slope to allow for drainage back into the tank.
2. In fouling or dirty applications, the provision of a constant purge of gas into the tank should be considered.

2.6.6 Temperature regulators

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

3. VALVE DESIGN AND MATERIALS

3.1 PIPING CLASSES AND MESC SPECIFICATIONS

1. For the selection of the design and materials requirements for control valves, reference should be made to the following as applicable:
 - a. The project line list (see DEP 31.38.01.92-Gen.);
 - b. DEP 31.38.01.12-Gen.
 - c. DEP 31.38.01.15-Gen.
 - d. The MESC component database available from Shell Technical Standards Portal:
 - i. MESC_CAPS export file linking MESC components to Piping Classes;
 - ii. MESC Group 77 Specifications for Valves;
 - e. MESC SPEs that are referred to in MESC Group 77 Specifications for Valves

The project line list contains the design pressure and temperature and the piping class to be used for components in that line. For those piping classes the

MESC_CAPS export file contains MESC numbers of most valve styles and size, including generic component and material descriptions. Based on the selected valve style a specific MESC can be selected which can be used as the basis for the specification of a control valve.

2. The Contractor shall select the specific MESC in MESC Group 77 Specifications for Valves, determine the following valve properties and include them in the requisition:
 - a. Piping class (from the project line list)
 - b. Design pressure and temperature (from the project line list)
 - c. Pressure rating (3.2.2)
 - d. End connections type and size (3.2.3) and (3.2.4)
 - e. Flange facing and finish (3.2.5)
 - f. Basic series to determine face-to-face dimensions (3.2.6)
 - g. Material options for bolts, nuts and gaskets (3.3.2)
 - h. Material options for body and bonnet (3.3.3)
 - i. Packing type, material and fugitive emissions class (3.2.7) and (3.3.4)
 - j. Material options for trim and stem/shaft (4.5)
 - k. Mandatory requirements (6.2)
 - l. Special service types (6.3)

Providing a certain choice of the body and trim materials allows the Manufacturer/Supplier to be able to advise the best material for the valve trim.

3. Control valves shall not be fitted with bottom drain plugs or packing lubricators.
4. Control valves shall not use process-wetted threaded connections.
5. Valve assemblies weighing more than 25 kg (55 lb) should be provided with facilities or instructions so they can be lifted and handled without damaging the equipment.
6. Use of split-body globe valves shall be subject to the approval of the Principal.

3.2 VALVE DESIGN

3.2.1 General

1. Unless otherwise specified in the MESC Group 77 Specifications, the bonnet shall be bolted to the body with fully retained gaskets.
2. The Manufacturer/Supplier shall supply the torque values for bolted connections in pressure containing parts, e.g., body/bonnet, gland packing.

3.2.2 Pressure rating

1. The pressure rating of control valves shall be the same as the pressure rating of the adjacent piping.
2. The use of Special Class ratings shall be subject to Principal approval.

Special classes are defined in ASME B16.34.

3.2.3 End connection size

1. The body size of a control valve shall not be less than the minimum listed in Table 2.

Table 2 Minimum valve body size

Upstream line size	NPS	1	1 ½	2	3	4	6	8	10	12	14	16	18	20	24	28	30	32	36
	DN	25	40	50	80	100	150	200	250	300	350	400	450	500	600	700	750	800	900
Minimum valve body size	NPS	1	1	1	1 ½	2	3	4	6	8	10	12	14	16	18	20	24	28	30
	DN	25	25	25	40	50	80	100	150	200	250	300	350	400	450	500	600	700	750

2. If the flow capacity of the valve would lead to a body size that is two or more sizes smaller than the pipe size, a body that is one size larger should be selected together with a reduced trim to allow for future capacity increase and to reduce fluid velocity.
3. The use of body size of control valves smaller than DN 25 (NPS 1) shall be subject to Principal approval.

3.2.4 End connections type

3.2.4.1 General

1. Control valves shall be provided with one of the following types of end connections:
 - a. Flanged;
 - b. Lug;
 - c. Welded ends.

The type of end connections is determined by the piping class.

3.2.4.2 Flanged

1. Unless otherwise specified by the Principal, end flanges shall be raised-face in accordance with one of the following:
 - a. ASME B16.5 for sizes through DN 600 (through NPS 24);
 - b. ASME B16.47 Series A flanges for sizes DN 650 through DN 1500 (NPS 26 through NPS 60).
2. Flange bolt holes shall straddle the normal centrelines of the pipe.

3.2.4.3 Lug

A valve with lug type end connections has lugs that are used to embed the stud bolts in the body of the valve. They save on weight and size of the equipment.

1. Lug type valves shall only be applied on valves based on API 609 design specification.
2. Threaded holes on lug type valves shall only be applied on those positions on the body where a studbolt would interfere with the bonnet or bottom flange.

3.2.4.4 Welded ends

1. The use of welded ends on control valves shall be subject to Principal approval.
2. Control valves with welded ends shall be based on a design which allows for in-situ maintenance and testing of the valve including for the following:
 - a. Cleaning and machining of the bolting and gasket surfaces;
 - b. Performing stem packing tests;
 - c. Performing seat leakage test.

3.2.4.5 Wafer

A valve with wafer-type end connections does not have lugs that embed the stud bolts.

1. Wafer-type end connections shall only be used for non-flammable products.

3.2.5 Flange facing and finish

1. Unless otherwise specified by the Principal, the flanges shall have raised face.

2. Unless otherwise specified by the Principal, the flange surface finish shall be in accordance with ASME B16.5.

3.2.6 Face-to-face dimensions

1. The Contractor should select the basic series from EN 558 as represented in Table 3 to be used for the face-to-face dimension of the control valve and indicate this in the requisition.

EN 558 recommends face-to-face dimensions for valves based on a large number of international and national standards, grouped in basic series.

Not all valve styles are available in all pressure ratings.

The basic series options are listed in the order of preference of their use.

2. The selection of a valve that does not follow face-to-face dimension from one of the basic series in Table 3 shall be subject to Principal approval.

Not all valves are available in each basic series. Some Manufacturers/Suppliers offer valves that are not listed in the columns of a particular basic series.

Table 3 Basic series from EN 558

	Basic series from EN 558					
Pressure rating of end connections	150#	300#	600#	900#	1500#	2500#
Globe valves	37	38	39	55/105	55/105	56/105
Eccentric plug valves	36/37	36/38	36/39	(0)	(0)	(0)
Segmented ball valves	36	36/35/38	36/39	(0)	(0)	(0)
Butterfly valves	13	13	14	8	(0)	(0)
Ball valves	5/12	5/17	5	54	55	56
(0) indicates that no commonly used basic series is available for that combination of valve style and pressure rating.						

3.2.7 Packing

1. Control valve stem gland flange shall be provided with either:
 - a. A spring-loaded arrangement (preferred), or
 - b. An adjustable arrangement.
2. The Manufacturer/Supplier should document the torque values for bolted connections on the valve stem gland flange.

3.2.8 Extension bonnet

3.2.8.1 General

1. Extension bonnets may be used in order to locate the packing farther away from the valve body.
2. An extension bonnet shall be applied when indicated in MESC Group 77 Specifications.
3. Thermal insulation shall not cover the extension bonnet, because doing so will impair the heat transfer required to maintain the proper packing/seal temperature.
4. The limit of the thermal insulation shall be marked on the extension bonnet.

3.2.8.2 Low temperature and cryogenic service

1. Control valves for applications with design temperatures below -50 °C (-58 °F) shall be supplied with extension bonnets to maintain the stem packing at a temperature high enough to permit operation within the normal temperature range of the packing material.
2. An extension bonnet shall be provided on applications where the differential pressure across the control valve causes freezing and ice formation on the packing and the yoke (e.g., with compressor recycle valves).
3. The control valve should be installed with the extension bonnet in the vertical orientation to maximize heat transfer (vapor barrier).

3.2.8.3 High temperature service

1. A heat dissipation bonnet shall be applied when indicated in MESC Group 77 Specifications.
2. A heat dissipation bonnet may be used if the operating temperature of the process could exceed the temperature rating of the packing.
3. MESC SPE 77/212 shall be applied for valves with maximum design temperatures > 450 °C (842 °F) and ≤ 550 °C (1022 °F).

3.2.8.4 Bellows seal

1. A bellows seal should be applied when indicated as a special requirement in MESC Group 77 Specification for Valves.
2. The use of bellows seal on control valves shall be subject to Principal approval.

3.3 MATERIAL SELECTION

3.3.1 General

Manufacturers of control valves offer a limited choice of wetted and pressure retaining materials.

1. The Contractor shall specify the material, inspection and certification requirements in the requisition.
2. The use of alternative materials proposed by the Manufacturer/Supplier shall be subject to Principal approval.

3.3.2 Bolting

This section applies to the bolting used for:

- *Body to bonnet flange;*
 - *Valve stem gland flange.*
1. The material for bolting shall be selected from the options provided in MESC Group 77 Specifications for Valves, or an equivalent standard option available from the Manufacturer.
 2. Where galvanized bolts and nuts are specified, the requirements contained in MESC SPE 81/007 shall be met.
 3. Cadmium plating shall not be used on bolting or any valve component.
 4. The use of washers may be considered for the following cases:
 - a. Bolts that require accurate torqueing;
 - b. Bolts that may cause galling with the material of the nut bearing area;
 - c. Bolts that will be tightened after painting of the nut bearing area;
 - d. Bolts where the nut bearing area is unmachined.

5. Spring washers shall not be applied on pressure retaining bolts.

3.3.3 Valve body and bonnet

3.3.3.1 Body

1. The material for valve body and bonnet shall be selected from the options provided in MESC Group 77 Specifications for Valves, or an equivalent standard option available from the manufacturer.
2. Cladding of the body shall apply when indicated in MESC Group 77 Specifications for Valves.
3. The Manufacturer may propose cladding to be used as a protection against erosion and/or corrosion.

3.3.3.2 Valve bonnet

1. If MESC Group 77 Specifications for Valves does not include a specification for the bonnet material, the selection should be the same as or equivalent to the body material.

3.3.3.3 Body to bonnet gasket

1. The following details shall be selected from the options provided in MESC Group 77 Specifications for Valves, or an equivalent standard option available from the Manufacturer:
 - a. The type of body to bonnet gasket;
 - b. The material for the metallic parts of the body to bonnet gasket;
 - c. The material for the seal element of the body to bonnet gasket.

3.3.3.4 Valve lining

1. The material for the lining of the wetted parts of a valve shall be selected from the options provided in MESC Group 77 Specifications for Valves.

3.3.3.5 Valve covers

1. The material for the cover as used for the bonnet of a top entry ball valve or the bottom cover of a butterfly valve shall be selected from the options provided in MESC Group 77 Specifications for Valves.
2. The material of a valve cover valve may be taken as representative for the material of plate that is exposed to the process fluid.

3.3.4 Packing

3.3.4.1 General

1. The Contractor shall select the packing material based on a low-friction solution using PTFE based materials unless any of the following apply:
 - a. The design temperature of the application is above 200 °C (390 °F);
 - b. PTFE is incompatible with the process fluid.
2. The Manufacturer/Supplier shall propose a packing solution which meets the fugitive emissions requirements.
3. Packing systems requiring external lubrication or grease shall not be used.
4. A liveloaded packing should be considered if the valve will be subjected to thermal cycling, pressure cycling, or high vibration.

3.3.4.2 Bellows seal

1. The material for the bellows seal for a valve should be selected from the options provided in MESC Group 77 Specifications for Valves.