

PETRONAS TECHNICAL STANDARDS

DESIGN AND ENGINEERING PRACTICE

MANUAL

CONTROL VALVES - SELECTION, SIZING AND SPECIFICATION

PTS 32.36.01.17

SEPTEMBER 2010



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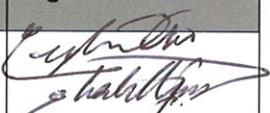
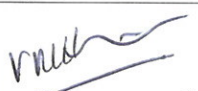
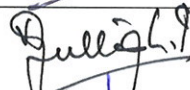
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This revision of **PTS 32.36.01.17– Control Valves – Selection, Sizing and Specification** has been updated incorporating PETRONAS Lessons Learnt, Best Practice and new information issued by relevant industry code and standards. All updates in the document are highlighted in *italic* font.

The previous version of this PTS (**December 2008**) will be removed from PTS binder/ e-repository from herein onwards.

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Revision History

Date	Version	Description of Updates	Author

Summary of Changes

Section	Description of Changes
3.1 GENERAL	Following was replaced (highlighted in bold): Control valves shall be installed with sufficient clearance around the actuator and valve body to allow the control valve actuator to be dismantled without the valve body being removed from the pipe.
3.3.2 ANGLE VALVES	Following were added (highlighted in bold): Angle valves should be considered for: • hydrocarbon services where coke may form; • erosive services, e.g. slurries; • flashing service; • applications where solid contaminants might settle in the body of a globe valve; • anti surge applications (use angle body for anti surge with gas inlet from bottom and the Cv of the valve shall be double of the Cv sized); • liquid service where high differential pressure prevails.
3.3.5 GATE VALVES	Following were added (highlighted in bold): Gate valves should only be considered for remotely operated on-off applications, where a fail-safe action is generally not required. Exceptions to fail-safe applications may be made for specific process applications, such as, fail-safe gate valves used in Surface Safety Valve (SSV) and Wing Valves (WV) at wellheads. They are normally equipped with an electric actuator (8.8) or hydraulic actuator (8.9). Typical applications are storage tank isolating valves, remotely operated on/off valves on blenders, pump suction shut-off services, and shut-off services on wellheads in oil and gas production facilities.
3.5 SOLENOID OPERATED VALVES	Following were added (highlighted in bold): Apart from their use in instrument air signal lines, solenoid operated valves (9.9) should only be considered for on-off control in hydraulic utility services, such as hydraulic control systems for loading arms, remotely operated valves, hydraulic turbine control and wellhead control units.
4.3 END CONNECTIONS	Adding "As a general Best Practice, the minimum flange rating for the control valve body should be ANSI 300 lbs."
4.6.1 GENERAL	Following were added (highlighted in bold): In order to comply with fugitive emission requirements, such as, for environmentally harmful process medium, the Manufacturer shall select appropriate gasket and packing materials in accordance with the requirements of PTS 31.38.01.11 and ISO15848.
5.1 SEAT LEAKAGE AND FLOW DIRECTION	Following were replaced, deleted and added (highlighted in bold): ~~Unless otherwise required, emergency shut-off valves should be specified and installed as "flow-tending-to-close".~~ For throttling applications with unbalanced valves trims, the direction should be "flow-tending-to-open" in order to avoid very large unstable forces in the virtually closed position.

Section	Description of Changes
	Depending on the application, the TSO requirement will apply for the forward direction, for reverse direction or for both. The leakage class and TSO direction shall be indicated on the PEFS. ~~Balanced-type single-seated control valves of the pilot-operated type shall not be used as TSO valves.~~ Cage-guided valves or balanced-type valves shall not be used for fluids that contain solid particles (e.g. coke). Balanced-type ~~control valves trims~~ shall be used only in clean services and in high differential pressure applications ~~(around 16 Barg or 220 psig)~~ (above 15 Barg or 200 psig) For seat leakage testing, reference is made to (11.6).
5.3 TRIM MATERIALS	Adding "For oxygen service, trim materials should be austenitic stainless steel. However, for severe services, exotic materials such as Monel or Inconel / Incoloy may be considered."
5.3 TRIM MATERIALS	Following were added in note (highlighted bold): "1) For choke valves and valves in other extremely erosive services, special materials such as tungsten carbide and ceramics may be used. However, for boiler feedwater (BFW) application, with the presence of Hydrazine that is used to treat the boiler feedwater, tungsten carbide shall not be used. The Cobalt binder in the Tungsten Carbide material is rapidly attacked by the hydrazine, allowing the carbide particles to fall away and thus exposed the bare metal to subsequent erosion/corrosion. Instead, the use of stainless steel SS 440C is recommended for BFW application where Hydrazine is present"
6.1.2 PILOT ASSISTED TRIMS	The whole 6.1.2 contents were deleted.
6.4 STEAM DESUPERHEATING VALVES	Adding "For desuperheating application, with dedicated quench water injection valve, the trim shall be able to withstand the severe service, including at start-up conditions, of high pressure drop and high exit velocity that could lead to potential cavitations and erosion, such as, by having multi-stage trims, etc."
6.5.1 GAS CHOKE VALVES FOR WELL	Following were replaced (highlighted in bold): d) The ~~plug and seat trims~~ should be stilted at least tungsten carbide.
6.5.2 LIQUID CHOKE VALVES	Following were replaced, deleted and added (highlighted in bold): For special applications, such as wellheads, the draining of high-pressure separators, a liquid choke valve should be considered. This valve shall be designed for liquids containing solid particles such as grit, sand and scale. ~~The trim of the valve consists of two discs: one fixed in the valve body and one that can be rotated by the actuator. Each disc has one or more eccentric holes and throttling is created by rotating the upper disc in such a way that the holes partly overlap each other. The major part of the pressure drop occurs across a bean downstream of the fixed disc. A built-in filter upstream of the rotating disc shall be fitted to protect the discs against large solid particles in the process fluid.~~

Section	Description of Changes
	The following shall apply: a) The valve shall be made up of a number of modular sub-assemblies, such as internals, bonnet, yoke, actuator, coupling, etc. b) To replace any of the sub-assemblies, it shall not be necessary to remove the valve body from the process line. c) The valve shall be ~~Class V or minimum~~ Class IV shut-off, in accordance with IEC 60534-4. d) The ~~discs and bean trim~~ shall be of at least tungsten carbide.
6.5.3 STEPPING ACTUATOR	The whole 6.5.3 contents were added.
6.6 FIRE SAFE DESIGN	Following were added (highlighted in bold): For requirements of certified fire safe valve bodies, see PTS 31.38.01.11 / PTS 80.47.10.30. The actuators, accessories and cabling for such valves may also need to be fire resistant.
7.1 LOW TEMPERATURE SERVICE	Following were replaced, deleted and added (highlighted in bold): ~~Control valves in services with a design temperature between 0°C and minus 50°C shall, in addition to the specification in the requisition, comply with MESC SPE 77/209.~~ Control valves in services with a lower design temperature below minus ~~50°C~~ 45°C shall, in addition to the specification in the requisition, comply with ISO 15848. Cryogenic refers to a service condition where the temperature is significantly below normal atmospheric temperature. Definitions vary with regards to the temperature defined as cryogenic. However, it is generally accepted that any temperature below minus 100°C is considered cryogenic.
8.1 GENERAL	Following were replaced, deleted and added (highlighted in bold): Piston-type actuators, if specified, should be of the ~~spring-opposed diaphragm or of the spring-opposed short-stroke type~~ spring return type or double-acting type. In the event of instrument air failure for double-acting piston type, the required valve action shall be achieved by ~~either automatic spring return long-stroke springless piston actuators~~ providing with lock-up valves, check valves and a local air buffer vessel.
8.4 ACTUATOR MATERIAL	Following were added (highlighted in bold): The diaphragm material shall be nylon-reinforced neoprene or Buna N rubber, unless the actuating medium is wet hydrocarbon gas, in which case Buna N shall not be used as diaphragm or seal material. In such cases, Viton or manufacturer's recommendation shall be considered.
8.5 ACTUATOR COLOUR CODING	Following were replaced and deleted (highlighted in bold): The colour of the actuator shall be in accordance with the Manufacturer's standard unless otherwise specified in the requisition. To identify that the valve is fail-safe, a colour code should be assigned to the actuator ~~(e.g. i.e. red for spring closing fail-close valves and green for spring opening fail-open valves), as specified in the requisition. For painting requirements, see section (10).~~

Section	Description of Changes
9.2 VALVE POSITIONERS	Following were replaced (highlighted in bold): The positioner shall not be provided with a bypass valve. The positioner shall have a weatherproof enclosure with a degree of protection of at least IP ~~55~~ 65 in accordance with IEC 60529.
9.2 VALVE POSITIONERS	Following were added (highlighted in bold): The control valve Manufacturer shall determine the tubing diameter so as to achieve the required stroking times. The minimum tubing diameter shall be 6mm (1/4 in). The tubing shall comply with the specification given in the requisition. Copper tubing shall not be used. For areas with a potential H₂S or acetylene atmosphere, or for offshore application, or other corrosive atmosphere locations, tubing and fittings shall be of stainless steel or other materials suitable for the stated atmospheric conditions and shall be subject to the Principal's approval. Use of low carbon, high nickel austenitic stainless steel alloy tubing material, such as, S31803 or better, is recommended to protect against hydrogen stress cracking environment.
9.2 VALVE POSITIONERS	Following were added (highlighted in bold): The valve positioner shall be provided with an identification plate, marked with the air supply pressure and input signal. For high vibration application and/or high temperature areas, the use of remote mounting positioner is recommended.
9.2 VALVE POSITIONERS	Following notes were added: Note: - Metric and imperial tubing sizes shall not be interchanged. - Every plant shall decide the usage of either metric or imperial sizes at the beginning of the project and shall maintain the same unit throughout the life of the plant.
9.6 LIMIT SWITCHES	Following were added and deleted (highlighted in bold): If limit switches are required, they shall be of the hermetically sealed proximity type. The proximitor(s) and initiator should be mounted inside a box for mechanical protection. The flying leads of the proximitor(s) shall terminate in an attached terminal box; alternatively, the protection box and the terminal box may be combined into one box. These boxes shall be suitable for the electrical hazardous area classification in which they are located with minimum IP65 against water/ dust ingress protection. If not armoured, the flying leads shall be protected against mechanical damage.
9.6 LIMIT SWITCHES	Following were deleted (highlighted in bold): The valve Manufacturer shall follow the mounting instructions supplied by the limit switch Manufacturer. The valve Manufacturer shall properly adjust the limit switches. ~~The vanes should approach the proximity switch perpendicular on its axis.~~
9.6 LIMIT SWITCHES	Following notes were added: Failure to install suitable interface proximity circuit will cause the IPS to be unstable and not able to recognize the very low input mA signal from the NAMUR type proximity.

Section	Description of Changes
9.10 FILTER REGULATORS	Following were added (highlighted in bold): Air-filter regulators shall be of metallic or metallic alloy. Plastic-type or glass (bowl-type) filter regulators shall not be used for outdoor environment.
11.1 EXTENT	Following were added (highlighted in bold): Valves used in services requiring a fugitive emission limitation, such as, environmentally harmful process medium.
11.4 FUNCTIONAL TEST	Following were added (highlighted bold): If the control valve is equipped with limit switches, they shall be checked for functional operation with a proximity tester. Limit switches shall also be loop tested with the IPS or DCS. If IPS or DCS is not available, limit switches signal compatibility with the IPS or DCS shall be verified with the relevant IPS or DCS vendor.
11.6 SEAT LEAKAGE TEST	Following were added (highlighted bold): The seat leakage test shall be in accordance with IEC 60534-4, as per Appendix IV with the acceptance criteria for the specified shut-off class; see (3.1) for TSO class V or VI. If the shut-off class is not specified, the following acceptance criteria shall apply:
11.9 ACTUATOR LEAKAGE TEST	Following were added (highlighted bold): All pneumatic fittings and actuator diaphragm chamber joints shall be tested for leak by using leak test solution while applying 1.1 times the rated air supply to the actuator, positioner and accessories, to ensure that there is no leak of instrument air supply and signal at the fittings & joints.
13. REFERENCES	Following PTSs were added as a references for these PTS: - Actuated Valve Management Strategy (PTS 32.36.01.19) - Assessment on the fire safety of onshore installations (PTS 80.47.10.30)
APPENDIX 2.1 SIZING CRITERIA	Following were added (highlighted bold): Unless otherwise specified, the calculation of the C_v value should be based on the maximum design flow with its relevant process data. Unless otherwise specified, the following should apply: the valve shall be sized for 110% of the maximum design flow rate (Q_d) in order to allow control at Q_d, i.e.: $Q_v = 1.10 \times Q_d$
APPENDIX 2.2 SELECTION OF C_v VALUE	Following were added (highlighted bold): As Best Practice, the valve opening at the specified maximum flow rate should not be more than : 80% for linear characteristics 90% for equal percentage characteristics As Best Practice, the valve opening at the specified minimum flow rate should not be less than : 10% for linear characteristics 30% for equal percentage characteristics If the above criteria cannot be met, this shall be taken up with Principal for approval.

Section	Description of Changes
	Trims shall be selected accordingly to the designed flow, Qs. However, in event of a bigger body size available with a reduced trim Vs. lower body size with full port, the first option should be selected.
APPENDIX 3.1 GENERAL	Following notes were added: Note: 1. Failure to consider all of above aspects may result in wrong selection and incorrect sizing of the control valve. 2. Due considerations shall be made for process mediums that comprising of multiple components with respect to changes in vapour pressures, molecular weights, compressibility, etc.
APPENDIX 4 SEAT LEAKAGE TEST	The whole Appendix 4 was added.

PREFACE

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They are based on the experience acquired during the involvement with the design, construction, operation and maintenance of processing units and facilities. Where appropriate they are based on, or reference is made to, national and international standards and codes of practice.

The objective is to set the recommended standard for good technical practice to be applied by PETRONAS' OPU in oil and gas production facilities, refineries, gas processing plants, chemical plants, marketing facilities or any other such facility, and thereby to achieve maximum technical and economic benefit from standardisation.

The information set forth in these publications is provided to users for their consideration and decision to implement. This is of particular importance where PTS may not cover every requirement or diversity of condition at each locality. The system of PTS is expected to be sufficiently flexible to allow individual operating units to adapt the information set forth in PTS to their own environment and requirements.

When Contractors or Manufacturers/Suppliers use PTS they shall be solely responsible for the quality of work and the attainment of the required design and engineering standards. In particular, for those requirements not specifically covered, the Principal will expect them to follow those design and engineering practices which will achieve the same level of integrity as reflected in the PTS. If in doubt, the Contractor or Manufacturer/Supplier shall, without detracting from his own responsibility, consult the Principal or its technical advisor.

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1. INTRODUCTION

1.1 SCOPE

This revised PTS specifies requirements and gives recommendations for the selection and specification of control valves with their actuators and accessories for throttling and on-off services. This includes the requirements for the design, construction, functioning and testing of control valves, as well as control valve sizing. Furthermore, this PTS includes the requirements for self-acting pressure regulators. ([Appendix 1](#)) of this PTS gives details on control valve sizing.

Emergency depressuring valves are outside the scope of this PTS and shall be in accordance with PTS 32.45.10.10.

This PTS is a revision of the PTS of the same title and number dated July 1997.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by PETRONAS, the distribution of this PTS is confined to companies forming part of PETRONAS or managed by a Group company, and to Contractors and Manufacturers/Suppliers nominated by them.

This PTS is intended for use in oil refineries, chemical plants, gas plants, exploration and production facilities and supply/marketing installations. When PTS are applied, a Management of Change (MOC) process should 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 may be more stringent than in this PTS, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable as regards safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this PTS 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 with the object of obtaining agreement to follow this document 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 work and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant, authorised to act for the Principal.

The word **shall** indicate a requirement.

The word **should** indicate a recommendation.

1.3.2 Specific definitions and abbreviations

For control valve terminology and related terms, refer to IEC 60534-1.

For definitions regarding control valve sizing, see ([Appendix 1](#)).

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

AISI	American Iron and Steel Institution
Blow-down or Depressuring	Reducing the pressure in process equipment at a controlled rate in emergency conditions or for operational purposes.
DCS	Distributed Control System
DN	Nominal Diameter
Emergency shut-off / shutdown	Shutting off a fluid flow in an emergency condition, e.g. as part of an IPF.
HAZOP	Hazardous Operability
IPF	Instrumented Protective Function : A function comprising the initiator function, logic solver function and final element function for the purpose of preventing or mitigating hazardous situations.
IPS	Instrumented Protective System : The electromechanical, electronic and/or programmable electronic Logic Solver component of the Instrumented Protective Function, complete with input and output equipment.
On-off	Changing to an open, closed or predetermined state when required, for example, by a sequence control system.
PEFS	Process Engineering Flow Scheme(s).
Piping class	A collection of piping components, suitable for a defined service and design limits in a piping system. Piping classes are compiled in PTS 31.38.01.10, PTS 31.38.01.12 and PTS 31.38.01.15.
PTFE	Polytetrafluoroethylene
Stroking time	The time required to move the valve over the full operational range in response to the command signal. For on-off commands, which include IPF actions, the stroking time should be taken as the time to travel from 100% (fully open) to 0% (fully closed) or vice versa. For manipulating commands, the stroking time should be taken as the time for the valve to travel from 0% to 95% or from 100% to 5% in response to a control signal change from 0% to 100% or from 100% to 0%. Stroking time may be further specified by minimum and/or maximum limitations, for valve opening and/or valve closing, for control signal changes and/or on-off IPF actions.
Throttling control	Continuously manipulating the stem/shaft of a control valve in order to obtain a desired process condition.
TSO	Tight shut-off (to Class V or Class VI, in accordance with IEC 60534-4).

1.4 CROSS-REFERENCES

Where cross references to other parts of this PTS are made, the referenced section number is shown in brackets. Other documents referenced in this PTS are listed in (13).

2. GENERAL

2.1 FUNCTION

The function of a control valve is to regulate flow and pressure.

There are several ways to achieve this function (e.g. by using variable speed drives) and these should be assessed before routinely deciding to use control valves.

2.2 REQUISITIONING

There are several commercial engineering design databases that allow the creation of intelligent requisitions and data sheets. If the engineering design is to be produced in paper form only, the following PTS requisitions should be used:

PTS 30.10.01.10 "Requisition"

The Manufacturer of the control valve and its accessories shall be selected from the "List of Selected Instrument Vendors", as agreed for the relevant project.

The Manufacturer shall:

- check the calculation of the selected C_v value for the given data;
- quote a C_v value for each valve in the fully open position;
- quote for control valves, meeting the requirements of the requisition;
- inform the Principal of any irregularities found in the relevant requisition;
- perform noise prediction calculations on all valves under all given process conditions.

The Manufacturer is responsible for the design and construction of the supplied control valves for the services and design conditions specified in the requisition.

If a control valve is provided with an actuator and/or accessories from another source, but supplied as part of the control valve requisition, the responsibility of the overall valve assembly (valve complete with actuator and/or accessories) shall be with one party. The responsible party (valve Manufacturer or actuator Manufacturer) shall be as indicated on the requisition.

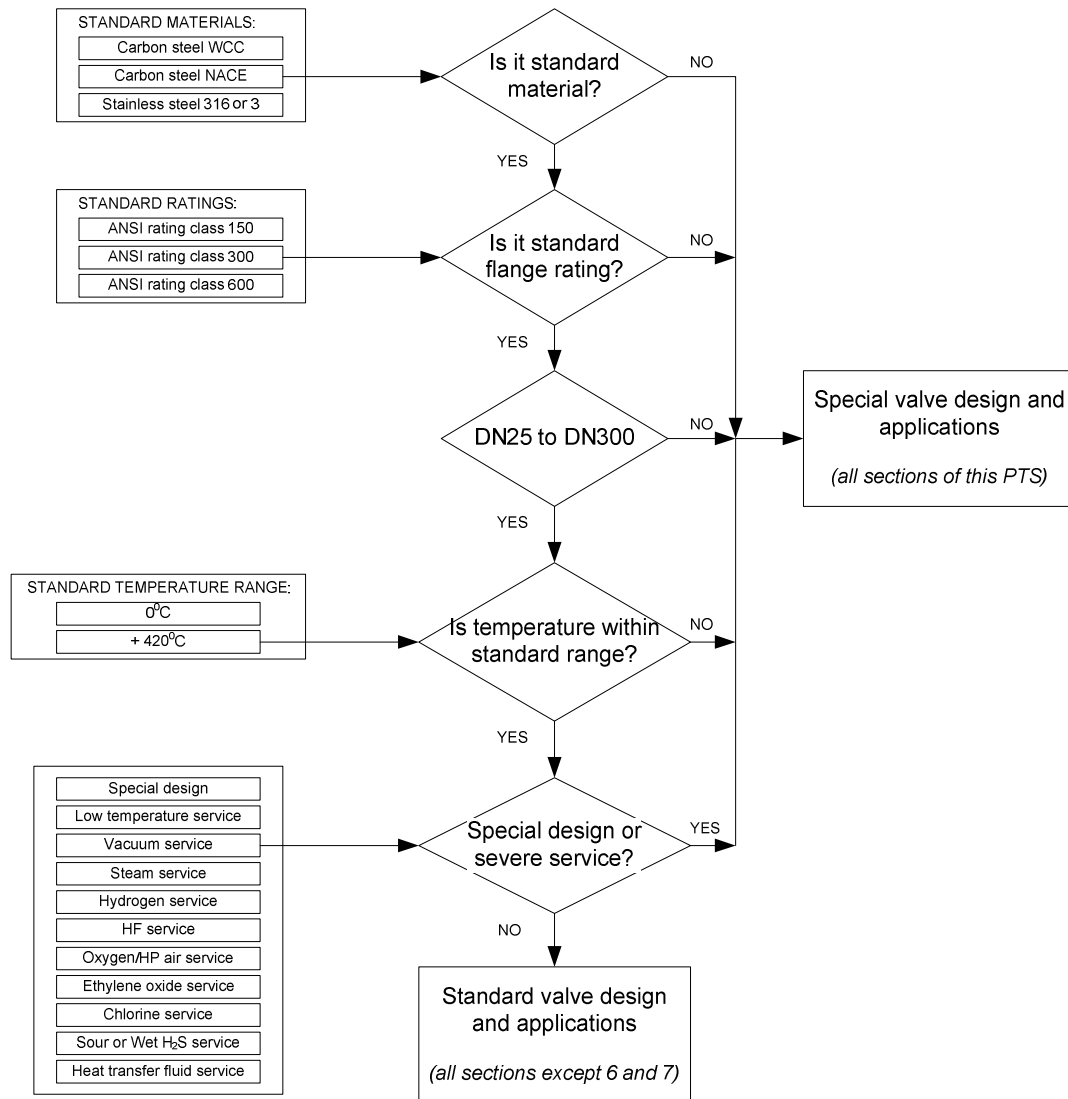
The variety of types and sizes of control valves and related accessories ordered under the requisition shall be minimised.

For economic reasons and for variety control, the Manufacturers' **standard** control valves should be used unless the process conditions, pressure, temperature, etc., are so severe that **special** control valves are needed.

Figure 1 illustrates the flow chart of this selection process. Figure 1 is typical only and may be amended by the Principal for a particular Manufacturer. The purpose of Figure 1 is to allow an early selection in order to concentrate effort on special valves. It is not intended to imply that off-the-shelf valves may be supplied if they do not meet this PTS.

If standard valves offered deviate from the requirements of this PTS, the approval of the Principal is required.

Figure 1: Control valve selection process



2.3 STRATEGY FOR PIPE FLUSHING

To prevent blockage, dirt collection and/or damage to the valve and its internals, control valves (except those with welded ends) should be installed after completion of the pressure testing and flushing of the piping system. A temporary spool piece should replace the valve to allow pressure testing and flushing.

Project timing and scope split between the parties involved should be based on the following sequence of events: spool piece installation, pressure testing, flushing, and replacement of spool pieces by control valves.

NOTE:

This requirement differs from the traditional and 'sharp' scope split and timing between the various parties involved: the construction Contractor's scope was typically defined to end at mechanical completion, i.e. with the control valves installed and functioning properly (dry test), while the commissioning party subsequently started pressure testing and flushing, which required the control valves to be removed again.

Depending on valve size, seat type (soft/metal) and trim construction, control valves may or may not be suitable for flushing. Furthermore, the installation of temporary filters might be considered. Only valves that will safely survive the flushing operation and for which the Principal has given his approval may be installed prior to pressure testing and flushing.

Control valves with welded ends can only be installed prior to pressure testing and flushing, but should be installed without trims at the construction stage, with a blind bonnet for temporary closure of the body. The trims shall only be installed after pressure testing and flushing. Only trims that will safely survive the flushing operation, and for which the Principal has given his approval, may be installed prior to flushing.

The flushing strategy and the resulting effect on project timing and scope splits should be defined in the project specification phase. The strategy should address pressure testing/flushing during commissioning of the new installation as well as during plant preparation for restart. The strategy should include a plan, defining:

- which non-welded valves shall be installed prior to pressure testing and flushing and which measures are required to keep the valves clean and fully open during pressure testing and flushing;
- which non-welded valves shall each be replaced by a temporary spool piece during pressure testing and flushing;
- for which welded valves the trim shall be installed prior to pressure testing and flushing, and what measures are required to keep the valves clean and fully open during pressure testing and flushing;
- for which welded valves the trim shall be installed after flushing and for which a temporary blind bonnet flange is required for body closure during pressure testing and flushing.

3. TYPES OF CONTROL VALVES AND THEIR APPLICATION

3.1 GENERAL

If the application allows, valves with a rotating spindle may be used in place of linear motion valves for reasons of:

- capacity;
- turndown.

Control valves and pressure regulators shall be selected in accordance with the requirements of the piping class.

Cadmium plating or galvanizing shall not be used for any component of the control valve assembly or its accessories.

In applications/locations where freezing may occur, valve stems, solenoid valves and other mechanical moving parts shall be protected against ice formation. The Principal shall approve the method of protection.

Linear motion valves shall be installed with their actuator stem in the vertical position.

Control valves shall be installed with sufficient clearance around the actuator and valve body to allow the actuator to be dismantled without the valve body being removed from the pipe.

There shall be sufficient clearance to lift and remove the valve. Control valves shall be located so that they are accessible for hoisting equipment where needed.

Throttling control valves should not be used if tight shut-off Class V or VI is required as per IEC 60534-4, since these shut-off classes cannot be maintained over a prolonged period. If a Class V or VI shut-off is required, a dedicated on-off TSO valve (e.g. ball or high performance butterfly valve) should be installed in series with the throttling control valve.

NOTE:

Some Manufacturers report good results for metal-seated rotary valves in throttling service, where TSO class V could be maintained over a prolonged period. Such valve designs may be considered for valves without IPF function.

The necessity of assigning such shut-off classes shall be examined with care. For shut-off class VI, rotary valves are preferred.

For depressuring services, two valves in series shall not be employed.

([Appendix 1](#), [Appendix 2](#) and [Appendix 3](#)) covers control valve sizing and noise prediction.