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Guidance on Practice for Control Valves and Pressure Regulators

GP 30-35

BP GROUP
ENGINEERING TECHNICAL PRACTICES

Foreword

This is the first issue of Engineering Technical Practice (ETP) BP GP 30-35. This Guidance on Practice (GP) is based on parts of heritage documents of the merged BP companies as follows:

British Petroleum

RP 30-1	Instrumentation and Control, Design and Practice.
RP 30-2	Instrumentation and Control, Selection and Use of Measurement Instrumentation.
RP 30-3	Instrumentation and Control, Selection and Use of Control and Shut-off Valves.

Amoco

A PC-CVPR-00-P	Process Control—Control Valves and Pressure Regulators—Supply Specification.
A PC-CVPR-00-C	Process Control—Control Valves and Pressure Regulators—Installation Specification.
A PC-CVPR-00-E	Process Control—Control Valves and Pressure Regulators—Selection Specification.
A PC-CVPR-00-G	Process Control—Control Valves and Pressure Regulators—Guide.

ARCO

ES 203-92	Ball Valve Procurement Specification.
ES 204-92	Butterfly Valves.
ES 206-90	Valve Procurement Specification.

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1. Scope

This GP provides guidance on practice for selection, application, and installation of control valves and pressure regulators, including actuators and accessories for both onshore and offshore applications.

2. Normative references

The following normative documents contain requirements that, through reference in this text, constitute requirements of this technical practice. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this technical practice are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies.

BP

GP 06-XX	Guidance on Practice for Protective Coatings CONFIRM
GP 12-60	Guidance on Practice for Hazardous Area Electrical Installations.
GP 12-70	Guidance on Practice for MOV Actuators. CONFIRM
GP 30-25	Guidance on Practice for Common Field Instrument Issues.
GP 30-30	Guidance on Practice for Field Communication Bus.
GP 30-80	Guidance on Practice for Safety Instrumented Systems - Implementation.
GP 30-90	Guidance on Practice for Certification, Testing, Acceptance, Installation, and Commissioning of C&I Systems.
GP 62-50	Guidance on Practice for Actuators for On/Off Valves. CONFIRM
GP 46-XXX	Title & Reference Number CONFIRM

American National Standards Institute (ANSI)

FCI 70-2	Control Valve Seat Leakage.
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American Petroleum Institute (API)

RP 553	Refinery Control Valves.
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ASME International (ASME)

B16.5	Pipe Flanges and Flanged Fittings.
B16.34	Valves - Flanged, Threaded, and Welding End.

British Standards Institute (BSI)

BS 6364	Specification for valves for cryogenic service.
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International Electrotechnical Commission (IEC)

60529	Degrees of protection provided by enclosures (IP Code).
60534	Industrial-process control valves.

International Organization for Standardization (ISO)

5208	Industrial Valves - Pressure Testing of Valves.
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NACE International (NACE)

MR0175

Sulphide Stress Cracking Resistant Metallic Material for Oilfield Equipment.

3. Symbols and abbreviations

For the purpose of this GP, the following abbreviations and acronyms apply:

AISI American Iron and Steel Institute.

B Inherent control valve pressure drop (PD) allowance.

C_v Control valve sizing coefficient.

DN Nominal diameter (metric).

dp Differential pressure across the valve.

DP Differential pressure.

ESD Emergency shutdown.

FCI Fluid Controls Institute, Inc.

H Static head (head difference between entrance and exit).

I/P Current-to-pressure.

HAP Hazardous air pollutants.

HAZOP Hazard and operability.

LVDT Linear variable differential transformers.

MOV Motor operated valve.

NPS Nominal pipe size.

PAS Process automation system.

P&ID Piping and instrumentation diagram.

PD Pressure drop.

PH Precipitation hardened.

Ra Roughness average, Surface finish (arithmetical mean deviation of the assessed profile).

VOC Volatile organic compound.

4. Control valve and pressure regulator application principles**4.1. General**

- a. Power actuated isolation valves shall comply with GP 62-50.



- b. Control valves and regulators should be specified using the Data Sheet.
ISA S20.50 and ISA S20.51 or IEC 60534-7 may be used as data sheets. Explanatory notes on these data sheets are used for reference purposes only.
- c. Control valve failure position, as shown on the P&IDs, shall be specified on the control valve Data Sheet.
- d. To confirm appropriate design of control system, valve failure position shall be reviewed by means of a Hazard and Operability (HAZOP) study or other appropriate hazard analysis methodology. Valve failure position options include “fail open”, “fail closed”, and “fail last”.

4.2. Emissions

In selecting control valves for volatile organic service, fugitive emissions of hazardous air pollutants (HAP) from control valve glands shall be minimised. Volatile organic service includes equipment that contains or contacts a stream containing at least 10% by weight of total organic compounds with a vapour pressure above 0,015 kPa (0.002 psi).

Volatile organic compounds (VOCs) are regulated in the US and may be regulated in other countries. US regulatory agencies maintain a listing of hazardous substances.

Containment of VOCs may require special low emission valve packing. If such packing is required, it could alter required size and type of actuator. Refer to 5.4.

1/4-turn valves are often specified to minimise emissions. Also, bellows seals may be used in place of packing for extremely hazardous streams (for example, auto ignite, toxic, or carcinogenic).

4.3. Design considerations

- a. Control valve pressure drop for process design, piping systems, and control valve sizing calculations shall be determined in accordance with Annex A. In addition:
 - 1. For globe type valves, pressure drop should be at least 70 kPa (10 psi). Globe type control valves in throttling service should be selected such that the valve normally operates between 15% and 80% of full open travel over the required control/throttling range of the system.
 - 2. For full flow type valves (for example, butterfly valves), pressure drops less than 35 kPa (5 psi) shall be subject to BP approval.
- b. Total dead band for a valve and actuator assembly should be less than 1%.
Dead band is the major cause of process variability in control loops. Control valves are often the major contributor to total dead band, due to causes such as friction, backlash, shaft windup, and positioner dead zone.
Ideally, valve dead band should be less than 0.25% for optimal control performance. Packing friction is often a major contributor to poor control loop performance.
- c. If installation area is susceptible to seismic disturbances, control valves or pressure regulators shall have components designed to withstand anticipated stresses and to function normally afterwards. In such cases, valve design shall be subject to BP approval.
- d. The following shall be specified in accordance with associated system or piping specifications for the line where the valve is to be installed:
 - 1. Minimum material.
 - 2. Pressure rating.



3. Size.

5. Control valves**5.1. Common design considerations****5.1.1. General**

- a. Lowest lifecycle cost control valve that complies with Data Sheet requirements should be selected. Factors that influence selection include:

1. Fitness for purpose.
2. Initial cost.
3. Reliability.
4. Expected life.
5. Standardisation.
6. Ease of repair.

- b. Valve sizing and selection assistance should be provided by control valve suppliers, who should be involved from beginning of a project.

In certain cases, it may be necessary for designer to select a valve (or certain valve features) rather than relying on supplier to provide a valve suitable for the service. Such cases include chemical processes that require special valve selections to address equipment reliability and full lifecycle cost considerations. Examples include:

- 1) Proprietary processes in which expected operating conditions are not disclosed.*
- 2) Severely corrosive or erosive services that require special metallurgy.*
- 3) Process control that is abnormally sensitive to valve selection.*
- 4) Replacement of a valve in an existing service.*
- 5) Selection of a new valve to match existing spare parts inventory within an operating facility.*

- c. Valve body sizes shall not be less than 2 pipe sizes smaller than inlet pipe size.
- d. Integral flanged valves are preferred. However, control valves with removable flanges by means of split rings may be used for alloy body valves.

Removable flanges may be specified to reduce cost.

- e. Carbon steel split body valves should not be used.

Split body valves are sometimes considered over high alloy valves to cut costs.

- f. If “through body bolted control valves” are used, the following should be considered:

1. Length of bolts.

For example, potential for misalignment or leakage with butterfly valves is not as great as for valves of significantly greater face to face dimension.

2. Line size.

Through body bolted control valves have a risk of leakage if line size is large.

3. Fire risk in immediate area of control valve, and type of fire protection available.

Through body bolted control valves are sometimes considered to reduce control valve weight and cost, and sometimes because of space constraints. The main



concern with such control valves is that increased bolt length leads to increased potential for misalignment of valve flange faces. There is also increased potential for unintentional loss or relaxation of bolt tension leading to increased risk of product leakage. There is also added risk that a small, localised fire will increase potential for bolt expansion and further leakage. Alternatives could be lagged valves (where bolts are protected) or sheet steel physical protection.

5.1.2. Weld end control valves

- a. Weld end control valves should be considered in the following circumstances:
 - 1. High temperatures and pressures are expected.
 - 2. Controlled fluid is highly toxic.
- b. If used, weld end valves shall have body material that is suitable for welding to adjoining pipe material.
- c. Weld end control valves should not be used if valve removal may be required for maintenance purposes or process changes.

5.2. General requirements

5.2.1. Valve bodies (valve types)

5.2.1.1. Valve body selection

- a. For general process control applications, valves should be globe style bodies with either stem or cage guided plugs.

Although initial selection of control valves is usually indicated on data sheets, the manufacturer's engineers often make recommendations for difficult services or to reduce initial cost. Valve selection should be evaluated to ensure the valve complies with requirements and has lowest lifecycle costs.

Globe body is traditionally the most commonly used style. It offers a greater degree of internal (trim) and external (mounting) flexibility than other styles. Alternate valve designs are often recommended for larger sizes to reduce cost.

- b. For special control applications, valve body styles may be selected in accordance with Table 1.



Table 1 - Matching valve body style and application

Valve body style	Application
Globe stem guided	Throttling or on/off control.
Globe cage guided	Throttling or on/off control for clean liquids and gases.
Angle	Throttling or on/off control for: - Systems that require self-draining capability. - Liquids and gases that are gritty, sticky, or tend to produce solid particle buildup on internal valve parts. - Liquids and gases in high temperature or high pressure drop service.
Standard ball	On/off control.
Characterised ball (V notch)	Throttling or on/off control of liquids and gases, including those that are sticky or contain suspended particles, such as slurries and gritty fluids.
Butterfly	- Low pressure drop throttling applications. - Throttling or on/off control of steam. - Level control of large volume utility service tanks. - Process flow splitting. - Narrow rangeability requirements.
Eccentric disc	- Throttling or on/off control of liquids and gases in situations that require quick opening. - Throttling slurries. - Narrow rangeability requirements.
Pinch ¹	Throttling or on/off control of erosive slurries or fluids that carry greater than 70% suspended particles.
3-way	Mixing, convergent, or diverting flows.
Note 1: For many applications, the pinch valve body style is not sufficiently reliable and represents a potential safety hazard should the diaphragm or liner rupture. This style is not recommended for hydrocarbon service.	

- c. Cage guided valves should not be used with high viscosity fluids, fluids that contain solids, or in slurries.

Cage trim in cage guided valves can plug in dirty services.

- d. Angle valves should be considered for:

1. Slurries.
2. Prevention of solids accumulation.
3. Erosive service.

Angle valves are high capacity valves with outlet passages available and a venturi type liner that streamlines flow and reduces valve body erosion.

4. Flashing liquids.
5. Special piping configurations, including self draining piping systems.

Angle valves are used to facilitate piping (to provide an elbow) or if a self draining piping system is desirable.

- e. Full bore ball valves or characterised ball valves should be used to control large volume flows and high shutoff differential pressures.

A full floating ball pattern gives total shutoff, but requires high operating torque. Leakage for a characterised ball pattern is equivalent to good double seated globe design. A full bore ball pattern has poor low flow control ability, whereas a characterised ball pattern exhibits near equal percentage performance for the lower



half of its travel. Ball valves may be more prone to cavitation than global angle valves.

- f. V notch ball valves should be considered for:

1. Viscous fluids and slurries.
2. Erosive service.

V notch ball valves produce lower fluid velocity, which can result in less erosion.

3. Cavitating and flashing service, subject to BP approval.

- g. Butterfly valves or eccentric rotating plug valves may be used to achieve:

1. Large volume flow.
2. Low pressure drop.

For low to medium shutoff differential pressures, if a small leakage is acceptable, butterfly valves are an economic alternative to large globe and ball valves.

- h. Ball, butterfly, and disc valves should not be selected for cavitating service.

Higher recovery and downstream pressure causes vapour bubbles to collapse (implode).

5.2.1.2. Valve body specifications

- a. Globe valves should be flanged to ASME B16.5 (inch dimensions).
- b. Face to face dimensions for control valve bodies shall comply with IEC 60534 Part 3.
- c. Flange bolt holes shall symmetrically straddle vertical valve centreline.
- d. Steel flanges shall be raised face type and cast iron flanges shall be flat face type, unless otherwise specified.
- e. Direction of flow through valve shall be permanently marked on valve body or flanges. Such markings may be stainless steel flow arrows attached with drive screws or arrows cast into valve body.
- f. Pressure ratings of globe valves and ball valves with bodies up to DN 200 (NPS 8) shall be at least Class 300.

Class 300 minimum rating costs no more than Class 150 construction, yet offers significantly higher temperature/pressure ratings. (Refer to Standard Pressure-Temperature Ratings for ASME Class 150 and Class 300 Valves, ASME B16.34).

Class 300 control valve end connection rating offers greater lifecycle flexibility in terms of plant maintenance.

- g. Requirements for spiral wound gaskets and associated flange finish should be included on the Data Sheet. Recommended finishes are listed in Table 2.

Table 2 - Flange finish recommendations

Gasket type	Flange finish
Spiral wound gaskets	125-250 rms
Jacketed or metal clad gaskets	63-80 rms
Solid metal gaskets	63-80 rms

- h. Rotary valves shall have splined drive shafts to limit lost motion.

Lost motion is common to keyed shafts found in equipment designed for "on/off" applications in which limiting backlash is not important.

