# RP 62-1

# GUIDE TO VALVE SELECTION

**November 1998**

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Document Title

# GUIDE TO VALVE SELECTION

**APPLICABILITY**

Regional Applicability: **International**

Business Applicability: **All Businesses**

**SCOPE AND PURPOSE**

This document presents guidelines for the selection of isolating, check and diverter valves for applications commonly met in the petroleum, petrochemical and associated industries.

This Recommended Practice is intended for use in the modification or expansion of the existing facilities and in the conceptual, front end and detailed engineering development of new projects. It is applicable to onshore, offshore and subsea requirements as defined in the Scope.

It should be recognised that valves are an extensive and complex subject and it is not possible to cover all applications, services and duties in the initial issue of this Practice. While international in applicability, this document makes extensive reference to British Standards as substitutes for or supplements to international industry standards.

**AMENDMENTS**

| Amd | Date | Page(s) | Description |
|---|---|---|---|

**CUSTODIAN** (See Status List for Contact)

**Valves**

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**CONTENTS**

Section Page

# FOREWORD

## Introduction to BP Group Recommended Practices and Specifications for Engineering

The Introductory volume contains a series of documents that provide an introduction to the BP Group Recommended Practices and Specifications for Engineering (RPSEs). In particular, the 'General Foreword' sets out the philosophy of the RPSEs. Other documents in the Introductory volume provide general guidance on using the RPSEs and background information to Engineering Standards in BP. There are also recommendations for specific definitions and requirements.

## Value of this Recommended Practice

This BP Group Recommended Practice has been written to collate and disseminate information on valve selection and application, as an aid to reduce maintenance and operational problems and costs, in response to the needs of valve users in BP.
The results of a survey of valve experience throughout the BP Group and the findings of an on-going Valve Testing Programme by BP Research, Sunbury have been used of improve guidelines for selection of valves.

## Application

Text in italics is Commentary. Commentary provides background information which supports the requirements of this Recommended Practice, and may discuss alternative options. It also gives guidance on the implementation of any 'Specification' or 'Approval' actions; specific actions are indicated by an asterisk (*) preceding a paragraph number.

This document may refer to certain local, national or international regulations but the responsibility to ensure compliance with legislation and any other statutory requirements lies with the user. The user should adapt or supplement this document to ensure compliance for the specific application.

Valves intended for use on BP Chemical Sites or new projects shall follow:-
minimum HSE and environmental requirements for the site and as specified herein; those specifications which are most appropriate to or have been specifically developed for that site or business.

Projects associated with existing BP Chemicals sites shall follow local requirements. Projects for new BP Chemical sites may use the appropriate specification or contractors generated specifications subject to BP Chemicals approval.

**Principle Changes from Previous Edition**

This document is an update of RP 62-1 (April 1992) edition. The foreword and Appendix G have been modified to fully cover BPC requirements and Appendix G has been updated.

**Feedback and Further Information**

Users of BP RPSEs are invited to submit any comments and detail experiences in their application, to assist in their continuous improvement.

For feedback and further information, please contact Standards Group, BP Engineering or the Custodian. See Status List for contacts.

# 1. SCOPE

## 1.1 Scope

This Recommended Practice gives guidance on the choice of common types of isolating (block), check and diverter valves for the petroleum, petrochemical and associated industries, both at onshore and offshore locations, including subsea applications. Valves for plants, pipelines and fire protection systems are included.

The following range is covered:-

| | | |
|---|---|---|
| (a) | Line Size Range | ½ in. to 36 in. NPS (DN 15 to DN 900). |
| (b) | Line Pressure Range | 150 lb to 2500 lb class rating to ANSI B16.5/B16.34 125 lb to ANSI B16.1 and CL.800 API |
| (c) | Design Temperature Range | -196°C to 650°C. |
| (e) | Fluid Range | Clean and dirty service (applications with entrained solids). |

It excludes valve actuators, modulating control valves, safety and relief valves, choke valves for drilling production, valves for marine, road and rail tankers and building services.

## 1.2 Application

1.2.1 Whilst this Code uses the duty to guide the selection of valves, the user is required to pay particular attention to all aspects of the application involving process, metallurgical and mechanical considerations.

1.2.2 Section 2 provides a means of determining the most suitable valve type (or types) for a particular application given basic information about the service conditions. Information relating to valve types, function, service characteristics etc. is included in Sections 1 to 5.

Appendices D to F are supplementary commentary that include further details for those seeking more information.

The following Appendices give advice on:-

Appendix G - Materials

Appendix H - Flow and Resistance

# 2. VALVE SELECTION

## 2.1 Introduction

Valve selection in this Recommended Practice is made from a knowledge of:-

(a) Valve function
(b) Service characteristics

The selection of valves requires consideration of the many factors in addition to the guidelines given in this Practice. Past experience for particular applications shall always be taken into consideration. Many of the factors involved can be simplified by an early evaluation of valve requirements and preparation of procurement specifications that adequately define particular requirements. This approach can be of benefit in modifying existing plant; is of considerable importance on new projects and may be of overriding importance where valve development is required for special application.

General technical factors that must be taken into account include:-

(a) Weight
(b) Space
(c) Ease of maintenance

There will also be commercial factors which influence valve choice in most circumstances.

## 2.2 Valve Function

Typical valve types for various operating functions are given in the following table. More details of these and other functions are given in Section 3.

| VALVE FUNCTION | TYPICAL VALVE TYPES |
|---|---|
| Isolation | Gate Valve<br>Ball Valve<br>Butterfly Valve<br>Plug Valve<br>Diaphragm/Pinch Valve<br>Globe (Stop) Valve |
| Flow Diversion | Plug Valve<br>Ball Valve<br>Globe Valve |
| Prevention of Flow Reversal | Swing Check Valve<br>Lift Check Valve<br>Diaphragm Check Valve |
| Flow/Pressure Control<br>(not covered by this Practice) | Globe Valve<br>Ball Valve (v port)<br>Plug Valve<br>Butterfly Valve<br>Diaphragm/Pinch Valve |

## 2.3 Service Characteristics

Appropriate valve selection is dependent on complete knowledge of the service characteristics, in particular:-

(a) Fluid Type

The fluid being handled should be classified as liquid; gas; two phase mixture; steam; slurry or solids.

(b) Fluid Characteristics

The fluid may be attributed with one or more of the following characteristics: clean, dirty (including abrasives), containing large, suspended solids, liable to solidification, viscous, corrosive, flammable, fouling or scaling, of a searching nature. These characteristics are discussed more fully in Section 4.

(c) Pressure, Temperature Limitations and Chemical Resistance

Valves are normally allocated a rating according to the maximum operating pressure and temperature or the ratings of the piping system and flanges. The temperature also limits the materials used in the valve construction, particularly the internals, trims, seals, linings or lubricants.

*Appendix G gives a general guide to the application of metallic and non-metallic materials. The materials required may vary with the pressure, temperature, fluid concentration and condition. Metallurgical advice shall always be sought where doubt exists.*

Irrespective of chemical resistance properties, cast iron, copper alloy or plastic valves shall not be used on hydrocarbon, toxic or other hazardous service.

(d) Operation and Maintenance Requirements

Operational and maintenance requirements can influence selection and design. Consideration should be given to:-

Fire resistance.
Operability.
Leak tightness (internal and external).
Maintainability.
Weights and dimensions (construction handling).
Storage and Commissioning.
Location (e.g. seabed valves.)
Pipeline requirements (e.g. ability to pass cleaning pigs).

These requirements are discussed in more detail in Section 5.

## 2.4 Selection of Valve Types

To assist in the rapid selection of probable valve types for the majority of general services the following tables may be used:-

| | |
|---|---|
| Table 1 - | Selection of Isolation (Block) Valves - Service Conditions |
| Table 2 - | Selection of Isolation (Block) Valves - Service Conditions |
| Table 3 - | Selection of Isolation (Block) Valves - Features |
| Table 4 - | Selection of Isolation (Block) Valves - Available Materials |
| Table 5 - | Selection of Isolation (Block) Valves - Achievable Leakage Rates |
| Table 6 - | Selection of Check and Diverter Valves - Service Conditions |
| Table 7 - | Selection of Check and Diverter Valves - Service Conditions and Sizes |
| Table 8 - | Selection of Check and Diverter Valves - Available Materials |

These tables are for guidance only and the users shall ascertain that the service conditions are within the valve manufacturers recommendations.

Tables 1 to 3 and 6 to 7 may be used to obtain a recommendation for a valve or valves based on the appropriate conditions or required size and features selected.

Tables 4 and 8 give guidance on materials availability and Table 5 indicates the degree of standard leak tightness to be expected from new valves.

In some cases the tables will suggest that a variety of valve types are suitable, the user may consider past experience for the service together with other factors e.g. if slow or quick opening/closing action is required (gate or ball valves). Further assistance can be obtained from more detailed information given elsewhere in this Recommended Practice.

| Valve types | | Wedge gate | | | | Parallel gate | | | | | | Ball metal seat | | | Ball soft seat | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | VALVE DESCRIPTION / CONDITIONS | Solid Wedge | Flexi-wedge | Split-wedge | Rubber lined | Conduit Slab Gate | Parallel double disk gate | Conduit split gate | Parallel slide (steam/feed) | Knife gate | | Floating ball | Trunnion mounted ball | Eccentric ball | Floating ball | Trunnion Mounted ball | Eccentric ball |
| Resistance to flow | Very low resistance required (<3) | | | | | | | | | | | | | | | | |
| | Low resistance required ((3-10) | | | | | | | | | | | | | | | | |
| | Moderate resistance tolerable (10-30) | | | | | | | | | | | | | | | | |
| | High resistance tolerable (>30) | | | | | | | | | | | | | | | | |
| | Piggable (Yes/No) | N | N | N | N | Y | N | Y | N | N | | Y | Y | Y | Y | Y | Y |
| Fluid | Liquid (and two phase) | | | | | | | | | X | | | | | | | |
| | Gas | | | | | | | | | X | | C | | | | | |
| | Steam | D | | | X | X | X | X | | X | | X | R | R | X | X | X |
| | Slurry | X | X | X | C | X | X | X | X | | | C | C | | C | C | |
| | Solids (Powder etc.) | X | X | X | C | X | X | X | X | | | C | C | X | X | X | X |
| Fluid Condition | Clean | | | | | | | | | | | | | | | | |
| | Dirty (Abrasive) | E | E | E | E | | X | X | X | E | | | | | X | X | X |
| | Large Susp. Solids | X | X | X | X | X | X | X | X | | | | | X | X | X | X |
| | Solidifying | J | J | J | X | X | X | X | X | J | | J | C | J | X | X | C |
| | Viscous | | | C | | | C | C | X | | | | | | | | |
| | Corrosive | L | L | L | L | L | L | L | L | L | | L | L | L | L | L | L |
| | Flammable | | | | X | | | | X | X | | N | N | N | M | M | M |
| | Fouling scaling | X | X | X | X | | X | X | X | X | | | | | X | X | X |
| | Searching | P | P | P | X | X | C | C | X | X | | X | X | X | P | P | P |

| Valve types | | Plug taper | | | | | Plug parallel | | | Diaphragm | | | | Globe | | | | Butterfly | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | VALVE DESCRIPTION / CONDITIONS | Non-lubricated (sleeved) | Non-lubricated (lined) | Lubricated | Lubricated (balanced plug) | Lifting plug | Expanding plug | Eccentric plug | Lubricated | Full bore | Weir | Pinch | Iris | Straight | Angle | Oblique ('Y' type) | Needle | Concentric, metal disk/seat | Concentric, rubber lined | Concentric other lining | Eccentric, metal disk/seat | Eccentric, rubber lined | Eccentric, soft seat |
| Resistance to flow | Very low resistance required (<3) | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| | Low resistance required ((3-10) | | | | | | | | | | X | X | X | X | X | X | X | A | A | A | A | A | A |
| | Moderate resistance tolerable (10-30) | | | | | | | | | | | | | X | X | | X | | | | | | |
| | High resistance tolerable (>30) | | | | | | | | | | | | | | | | | | | | | | |
| | Piggable (Yes/No) | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N |
| Fluid | Liquid (and two phase) | | | B | B | | | | B | | | | X | | | | | | | | | | |
| | Gas | | | | | | | | | | | X | X | | | | | X | | C | C | | |
| | Steam | X | X | X | X | X | X | X | X | X | X | X | | | | | | | X | X | C | X | X |
| | Slurry | | | X | X | C | X | C | X | | X | | X | X | X | X | X | | | | C | | C |
| | Solids (Powder etc.) | C | C | X | X | X | X | X | X | | X | | | X | X | X | X | C | C | C | C | C | C |
| Fluid Condition | Clean | | | | | | | | | | | | | | | | | | | | | | |
| | Dirty (Abrasive) | E | E | E | E | | F | F | F | | | | | G | G | G | G | H | H | H | I | I | H |
| | Large Susp. Solids | E | E | | | C | X | X | | C | X | C | X | X | X | X | X | X | X | X | X | X | X |
| | Solidifying | C | X | C | C | C | X | X | C | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| | Viscous | | | | | | | | | | X | | X | G | G | G | G | | | | | | |
| | Corrosive | L | L | L | L | L | L | L | X | K | K | K | L | L | L | L | L | L | L | L | L | L | L |
| | Flammable | N | N | N | N | N | M | M | X | X | X | X | X | | | | | X | X | X | | X | M |
| | Fouling scaling | | | G | G | C | X | X | X | X | X | X | X | X | X | X | X | | X | X | | X | X |
| | Searching | P | P | X | X | P | C | C | X | K | K | K | X | P | P | P | P | X | X | X | X | X | P |

Notes on Flow Resistance

Valve flow resistances are presented as multiples of the resistance of a plain piece of pipe where this is equivalent to 1 (the figures are approximate).

Reduced port (venturi) gate and ball valves may have up to twice the flow resistance of full bore valves.

KEY

Suitable

X Not suitable/not recommended
A Some butterfly valves may fall into the "low resistance" category.
B Depends on liquid. Unsuitable for use with solvents etc.
C May be suitable. Consult manufacturer.
D Flexi-wedge more suitable for this service in large sizes.
E May be used subject to nature of fluid. Sharp particles may be trapped in cavities and damage soft seats.
F No information available but unlikely to be suitable.
G Not normally recommended.
H Variable performance. Moderate service life.
I Can perform well. Depends on Manufacture.
J Must be full bore. Steam jacket/trace heating required.
K Must have secondary stem seal.
L Satisfactory subject to appropriate choice of materials. Careful attention should be given to design of internal parts etc.
M Fire tested type required.
N Fire tested or fire resistant gland required. Plug valve sleeves and linings may be resistant to fire but do not provide shut-off capability after destruction.
P Use bellows sealed versions in smaller sizes where available. Helium leak test and double block and bleed for hydrogen service.
R Only suitable if all plastic/rubber components eliminated.

## TABLE 1

## SELECTION OF ISOLATION (BLOCK) VALVES (SERVICE CONDITIONS)

| Valv+B41e types | | Wedge gate | | | | Parrallel gate | | | | | | Ball metal seat | | | Ball soft seat | | | Plug taper | | | | | Plug parallel | | | Diaphragm | | | | Globe | | | | Butterfly | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VALVE DESCRIPTION / CONDITIONS | | Solid Wedge | Flexi-wedge | Split-wedge | Rubber lined | Conduit Slab Gate | Parallel double disk gate | Conduit split gate | Parallel slide (steam/feed) | Knife gate | | Floating ball | Trunnion mounted ball | Eccentric ball | Floating ball | Trunnion Mounted ball | Eccentric ball | Non-lubricated (sleeved) | Non-lubricated (lined) | Lubricated | Lubricated (balanced plug) | Lifting plug | Expanding plug | Eccentric plug | Lubricated | Full bore | Weir | Pinch | Iris | Straight | Angle | Oblique ("Y" type) | Needle | Concentric, metal disk/seat | Concentric, rubber lined | Concentric other lining | Eccentric, metal disk/seat | Eccentric, rubber lined | Eccentric, soft seat |
| Press-ure | VACUUM | J | J | J | X | X | J | X | X | X | | X | X | X | J | X | J | J | J | X | X | J | J | J | X | X | X | X | X | J | J | J | X | X | K | K | X | K | K |
| | LOW < CL.150 | | | | | | | | B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | MED. CL 300/600 | | | | | | | | | X | | | | | | | | | | | | | | X | | X | X | X | X | | | | | | | | | | |
| | HIGH CL. 900/2500 | | | | X | | | | | X | | | | | C | | | X | X | X | | | | X | X | X | X | X | X | | | | | X | X | X | X | X | X |
| | CLASS 800 | | | | X | X | X | X | | X | | | X | X | | X | X | X | X | X | | X | X | X | X | X | X | X | X | | | | | X | X | X | X | X | X |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Temp. | CRYOGENIC | | | | X | X | X | X | X | X | | X | X | X | | | X | X | X | X | X | X | X | X | X | X | X | X | X | | | X | | X | X | | | X | |
| | MED/LOW-50 deg C/200 deg C | | | | A | | | | | | | | | | A | A | A | | | A | A | | A | | A | A | A | A | | | | | | | A | A | | A | A |
| | HIGH 200 deg C/450 deg C | | | | X | A | A | A | | X | | A | A | A | X | X | X | X | X | X | X | | X | X | X | X | X | X | X | | | | | | X | X | | X | X |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Size | ≤1.5" NS (40DN) | | X | X | X | | X | X | | X | | | X | | | X | | | | | | | X | | X | | | | X | | | | | X | X | X | X | X | X |
| | 2" TO 8" NS (50 TO 200DN) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | E | | | | | | |
| | 10" TO 16" NS (250 TO 400DN) | | | | | | | | | | | X | | F | X | | F | F | F | | | F | F | | | F | F | | | | | | X | | | | | | |
| | > 16" NS (400 DN) | | | | | | | | | | | X | | F | X | | F | X | X | | | F | F | | | X | X | X | X | X | X | X | X | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Iso-lation | BUBBLE TIGHT (GAS) | H | H | H | | X | H | H | X | X | | X | X | H | G | G | | | | X | X | H | | | X | | | X | X | H | H | H | H | X | | X | X | | |
| | DROP TIGHT (LIQUID) | H | H | H | | X | H | H | X | H | | X | X | | G | | | | | I | I | | | | I | | | | X | H | H | H | H | X | | | | | |
| | VERY LOW LEAKAGE PERMITTED | | | | | X | | | | H | | X | X | | | | | | | I | I | | | | I | | | | X | | | | | X | | | | | |
| | SOME LEAKAGE PERMITTED (NORMAL COMMERCIAL STD.) | | | | | | | | | H | | | | | | | | | | | | | | | | | | | X | | | | | X | | | | | |
| | COURSE ISOLATION ONLY | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Notes

The degree of isolation quoted is that which is consistently and readily achievable and can be maintained in service.

It should be noted that most metal seated valves can be produced to achieve a greater degree of leak tightness than that shown in this table. This will require greater expenditure of time and effort but the degree of isolation thus achieved is likely to be maintained for longer than that more readily available by use of soft seated valves.

KEY

| | |
|---|---|
| (shaded) | Suitable/Available/Achievable |
| X | Not suitable/Available/Achievable |
| A | Temperature range may be limited by soft seats/seals/linings etc. |
| B | Relies on differential pressure for seal, poor sealing at very low pressures. |
| C | < 2" NB only |
| E | Not recommended in sizes larger than 2" NB |
| F | Limited size range depending on pressure rating |
| G | May not be achievable at low pressures |
| H | Usually only achievable by soft seated valves |
| I | Leak tightness depends on efficiency of sealant |
| J | Soft seated valves preferred. Consult manufacturer re seat finishing, cleaning. Consider bellows seal. Helium leak test recommended. |
| K | May be suitable - consult manufacturer. |

## TABLE 2

## SELECTION OF ISOLATION (BLOCK) VALVES (SERVICE CONDITIONS AND SIZES)

| Valve types | | Wedge gate | | | | Parrallel gate | | | | | | Ball metal seat | | | Ball soft seat | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | VALVE DESCRIPTION / CONDITIONS | Solid Wedge | Flexi-wedge | Split-wedge | Rubber lined | Conduit Slab Gate | Parallel double disk gate | Conduit split gate | Parallel slide (steam/feed) | Knife gate | | Floating ball | Trunnion mounted ball | Eccentric ball | Floating ball | Trunnion Mounted ball | Eccentric ball |
| Gland Pack-ing | STD STUFFING BOX | | | | | | | | | X | | B | B | | B | B | |
| | O' RINGS | B | B | B | B | B | B | B | A | X | | | | X | | | X |
| | POLYMER SEALS | A | A | A | A | | | | A | X | | | | | | | |
| | FIRE TESTED | X | X | X | X | X | X | X | X | X | | | | | | | |
| | EXTENDED BONNET (L.T.) | | B | A | X | A | A | A | A | X | | A | A | A | | | A |
| | BELLOWS SEAL | C | X | X | X | X | A | A | A | X | | X | X | X | C | C | X |
| Lin-ings | RUBBER | | X | X | | X | X | X | X | X | | X | X | X | X | X | X |
| | PTFE | A | A | A | X | X | X | X | X | X | | X | X | X | | | |
| | OTHER POLYMERS | B | A | A | X | B | B | B | X | X | | X | X | X | B | B | B |
| | GLASS | X | X | X | X | X | X | X | X | X | | X | X | X | X | X | X |

| Valve types | | Plug taper | | | | | Plug parallel | | | Diaphragm | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | VALVE DESCRIPTION / CONDITIONS | Non-lubricated (sleeved) | Non-lubricated (lined) | Lubricated | Lubricated (balanced plug) | Lifting plug | Expanding plug | Eccentric plug | Lubricated | Full bore | Weir | Pinch | Iris |
| Gland Pack-ing | STD STUFFING BOX | B | A | A | A | | | | A | X | X | X | X |
| | O' RINGS | A | A | | | A | A | A | A | B | B | B | X |
| | POLYMER SEALS | | | B | B | B | A | | | X | X | X | X |
| | FIRE TESTED | | | | | A | | | A | X | X | X | X |
| | EXTENDED BONNET (L.T.) | X | X | X | X | X | X | X | X | X | X | X | X |
| | BELLOWS SEAL | X | X | X | X | X | X | X | X | X | X | X | X |
| Lin-ings | RUBBER | X | X | X | X | | X | | X | | | | X |
| | PTFE | X | | X | X | A | D | A | X | A | | A | X |
| | OTHER POLYMERS | X | B | X | X | A | D | | X | A | | A | X |
| | GLASS | X | X | X | X | X | X | A | X | | | X | X |

| Valve types | | Globe | | | | Butterfly | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | VALVE DESCRIPTION / CONDITIONS | Straight | Angle | Oblique ('Y' type) | Needle | Concentric, metal disk/seat | Concentric, rubber lined | Concentric other lining | Eccentric, metal disk/seat | Eccentric, rubber lined | Eccentric, soft seat |
| Gland Pack-ing | STD STUFFING BOX | | | | | | A | A | | A | |
| | O' RINGS | B | B | A | | | | | | | |
| | POLYMER SEALS | C | C | C | C | A | A | A | | | |
| | FIRE TESTED | X | X | X | X | | X | X | | X | |
| | EXTENDED BONNET (L.T.) | | | X | | | X | A | | X | |
| | BELLOWS SEAL | C | B | B | C | X | X | X | X | X | X |
| Lin-ings | RUBBER | X | X | X | X | X | | X | X | | X |
| | PTFE | D | D | D | D | X | X | | X | X | |
| | OTHER POLYMERS | B | D | B | D | X | X | | X | X | |
| | GLASS | X | X | X | X | X | X | X | X | X | X |

KEY

(shaded) Available

X Not Available/Applicable
A Not normally available
B Limited availability
C Available sizes may be limited.
D Not known

## TABLE 3

## SELECTION OF ISOLATION (BLOCK) VALVES (FEATURES)

| Valve types | | Wedge gate | | | | Parallel gate | | | | | Ball metal seat | | | Ball soft seat | | | Plug taper | | | | | Plug parallel | | | Diaphragm | | | | Globe | | | | Butterfly | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | VALVE DESCRIPTION / CONDITIONS | Solid Wedge | Flexi-wedge | Split-wedge | Rubber lined | Conduit Slab Gate | Parallel double disk gate | Conduit split gate | Parallel slide (steam/feed) | Knife gate | Floating ball | Trunnion mounted ball | Eccentric ball | Floating ball | Trunnion Mounted ball | Eccentric ball | Non-lubricated (sleeved) | Non-lubricated (lined) | Lubricated | Lubricated (balanced plug) | Lifting plug | Expanding plug | Eccentric plug | Lubricated | Full bore | Weir | Pinch | Iris | Straight | Angle | Oblique ('Y' type) | Needle | Concentric, metal disk/seat | Concentric, rubber lined | Concentric other lining | Eccentric, metal disk/seat | Eccentric, rubber lined | Eccentric, soft seat |
| Body, Bon-net etc. | CARBON STEEL | | | | | | | | | | | | | | | | | | | | | | | | B | B | | | | | | | | | | | | |
| | CHROME MOLY STEEL | | | | X | A | | A | | X | A | A | A | X | X | X | X | X | A | A | A | A | A | A | X | X | X | X | | | | | B | X | X | B | X | X |
| | AUST. STAINLESS STEEL | | | | X | | B | B | B | | | | | | | | | X | | | | | | | B | | X | A | | | | | | X | X | | X | |
| | NICKEL ALLOYS | B | B | A | X | | B | B | B | | | | | | | | | X | A | A | B | B | | B | A | A | A | A | B | B | B | B | | A | A | B | X | A |
| | ALUMINIUM BRONZE | B | B | A | X | A | A | A | X | A | X | X | A | B | B | A | A | A | A | A | A | A | A | A | A | A | A | A | C | C | C | C | B | X | X | B | X | B |
| | BRONZE/GUNMETAL | | | A | X | A | A | A | | A | A | A | A | | | A | A | A | | A | A | A | | A | | | A | A | | | | | B | X | X | B | X | X |
| | ALUMINIUM | B | A | A | X | A | A | A | A | A | A | A | A | | A | A | A | A | A | A | A | A | | A | A | A | A | A | C | C | C | C | B | X | X | B | X | X |
| | CAST IRON | | | A | X | A | A | A | | B | A | A | A | | A | A | | | | | | | | | | | | D | | | | | | | | | | |
| | PVC | B | X | X | X | X | X | X | X | X | X | X | X | | X | X | X | X | X | X | X | X | X | B | D | | D | D | D | | D | D | X | X | | X | X | |
| | CUPRO-NICKEL | | | A | X | A | A | A | A | A | A | A | A | | | A | | | A | A | A | A | A | A | A | A | A | A | C | C | C | C | B | X | X | B | X | X |
| | GLASS | X | X | X | X | X | X | X | X | X | X | X | X | | A | X | X | X | X | X | X | X | X | | X | X | X | X | X | | | X | X | X | X | X | X | X |
| Trim | 13%Cr, (410) S.S. | | | | | A | A | A | A | A | X | X | X | | | A | A | A | A | A | | A | A | | X | X | X | X | | | | | A | A | A | A | A | A |
| | 13%Cr, NI FACED | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | X | X | X | X | B | B | B | B | A | A | A | A | A | A |
| | 13% Cr, HARD FACED | | | | X | | | | | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | X | X | X | X | B | B | B | B | A | A | A | | A | A |
| | AUSTENITIC S.S. | A | A | A | A | A | | | A | | A | A | A | | | | | A | | | | | | | X | X | X | X | | | | | | | | | | |
| | AUST.S.S. HARD FACED | | | | A | | | | | B | | | | B | B | | A | A | A | A | A | A | A | A | X | X | X | X | | | | | A | A | A | | A | A |
| | C.S. HARD FACED | A | | A | X | | | | | A | A | | A | A | A | A | X | X | X | X | X | X | X | X | X | X | X | X | B | B | X | X | X | X | X | X | X | X |
| | MONEL/INCONEL | | | A | A | A | A | A | | | A | A | | | A | | | A | A | A | A | A | | A | X | X | X | X | B | B | B | B | | B | B | | B | B |
| | CHROME PLATED | A | A | A | A | B | B | B | A | B | A | | A | | | A | A | A | A | A | B | | A | B | | | | | A | A | A | A | B | B | B | | B | B |
| | ENP | A | A | A | A | | B | B | A | B | A | | A | | | A | X | X | | A | | | | | X | X | X | X | A | A | A | A | | A | A | | A | |
| | CAST IRON | | A | A | | A | A | A | A | A | A | A | A | A | A | A | | | | | | | | | X | X | X | X | | | A | A | | | | | | |
| | BRONZE | | A | A | A | A | A | A | | A | A | A | A | | B | A | A | A | C | A | A | B | | B | X | X | X | X | | | | | | B | B | | B | |

KEY:

[grey box] Available

X Not available
A Not normally available
B Limited availability
C Available sizes may be limited
D Not Known

EXAMPLES OF CARBON & ALLOY STEEL AVAILABLE

Carbon Steel
Carbon Steel (low temperature)
Carbon/molybdenum steel

1¼ Cr - ½Mo
2¼ - 1 Mo
3 Cr - 1 Mo
5 Cr - ½Mo
9 Cr - 1 Mo
2 Ni
3½ Ni

EXAMPLES OF CORROSION RESISTANT ALLOYS AVAILABLE

| Alloy | Description |
|---|---|
| 18 Cr - 10 Ni | 304 Austenitic Stainless Steel |
| 18 Cr - 10 Ni - 2 Mo | 316 Austenitic Stainless Steel |
| Ni - Cr - Fe | Inconel |
| Ni - Cu | Monel |
| Ni - Cu | Hastelloy B |
| Ni - Mo - Cr | Hastelloy C |

Other materials (eg. duplex s.s., titanium) may be available to special order.

For acid and other non-fibre hazardous, non-hydrocarbon services, plastic or rubber lined valves may be considered.
Note that, in some cases, valve trim may consist of a combination of several materials.
For information on application of materials see supplement.

## TABLE 4

## SELECTION OF ISOLATION (BLOCK) VALVES (AVAILABLE MATERIALS)

| Valve types | | Wedge gate | | | | Parrallel gate | | | | | | Ball metal seat | | | Ball soft seat | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CONDITIONS | VALVE DESCRIPTION | Solid Wedge | Flexi-wedge | Split-wedge | Rubber lined | Conduit Slab Gate | Parallel double disk gate | Conduit split gate | Parallel slide (steam/feed) | Knife gate | | Floating ball | Trunnion mounted ball | Eccentric ball | Floating ball | Trunnion Mounted ball | Eccentric ball |
| Liquid | ISO 5208 RATE 3 | B | B | B | | X | B | B | X | B | | X | X | | A | | |
| | ISO 5208 RATE 2 | | | | | X | | | | B | | X | X | | | | |
| | ISO 5208 RATE 1 | | | | | | | | | B | | | | | | | |
| | API 598 | C | C | C | | C | C | C | C | B | | D | D | D | A | | |
| | MSS-SP-61 | | | | | | | | | B | | | | | | | |
| | BS6755 PART 1 RATE C | | | | | | | | | B | | X | | | | | |
| | | | | | | | | | | | | | | | | | |
| Gas | ISO 5208 RATE 3 | B | B | B | | X | B | B | X | X | | X | X | B | A | A | |
| | ISO 5208 RATE 2 | B | B | B | | X | B | B | X | X | | X | X | | A | | |
| | ISO 5208 RATE 1 | | | | | | | | | X | | X | | | | | |
| | API 598 | B | B | B | | X | B | B | X | X | | D | D | D | A | | |
| | MSS-SP-61 | | | | | | | | | X | | X | | | | | |
| | BS6755 PART 1 RATE C | | | | | | | | | X | | X | A | | A | | |
| | | | | | | | | | | | | | | | | | |

| Valve types | | Plug taper | | | | | Plug parallel | | | Diaphragm | | | | Globe | | | | Butterfly | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CONDITIONS | VALVE DESCRIPTION | Non-lubricated (sleeved) | Non-lubricated (lined) | Lubricated | Lubricated (balanced plug) | Lifting plug | Expanding plug | Eccentric plug | Lubricated | Full bore | Weir | Pinch | Iris | Straight | Angle | Oblique ('Y' type) | Needle | Concentric, metal disk/seat | Concentric, rubber lined | Concentric other lining | Eccentric, metal disk/seat | Eccentric, rubber lined | Eccentric, soft seat |
| Liquid | ISO 5208 RATE 3 | | | F | F | | | | A | | | | E | B | B | B | B | E | | X | X | | |
| | ISO 5208 RATE 2 | | | F | F | | | | F | | | | E | | | | | E | | | | | |
| | ISO 5208 RATE 1 | | | | | | | | | | | | E | | | | | E | | | | | |
| | API 598 | | | | | | | | C | | | | E | C | C | C | C | E | | X | D | | |
| | MSS-SP-61 | | | | | | | | | | | | E | | | | | E | | | | | |
| | BS6755 PART 1 RATE C | | | F | F | | | | F | | | | E | | | | | E | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| Gas | ISO 5208 RATE 3 | | | X | X | B | | | X | | | X | E | B | B | B | B | E | | X | X | | |
| | ISO 5208 RATE 2 | | | X | X | B | | | X | | | X | E | B | B | B | B | E | | X | X | | |
| | ISO 5208 RATE 1 | | | | | | | | | | | | E | | | | | E | | | | | |
| | API 598 | | | X | X | B | | | X | | | X | E | B | B | B | B | E | | X | D | | |
| | MSS-SP-61 | | | | | | | | | | | | E | | | | | E | | | | | |
| | BS6755 PART 1 RATE C | | | F | F | | | | F | | | X | E | | | | | E | | X | X | | |
| | | | | | | | | | | | | | | | | | | | | | | | |

KEY

Consistently achievable

X Not normally achievable

Note: By expenditure of sufficient time and effort, it is usually possible to achieve a high degree of eat leak tightness with most types of valve. In general, however, it is not good practise to specify leakage rates which are unnecessarily stringent compared to actual process requirements.

A May not be achievable at low pressures.
B Usually only achievable by soft seated valves.
C Valves 2" NB and less may need to be soft seated.
D Leak rates are determined by agreement with the purchaser.
E Valve not intended for tight shut-off on liquid or gas service.
F Leak tightness depends on efficiency of sealant.

| Test Medium | LEAKAGE RATES (ml/min/mm DN) | | | |
|---|---|---|---|---|
| | ISO 5208 Rate 3<br>BS6755 Pt 1 Rate A | ISO 5208 Rate 2<br>BS 6755 Pt 1 Rate B | BS 6755 Pt 1 Rate C | ISO 5208 Rate 1<br>BS 6755 Pt 1 Rate D<br>MSS-SP-61 |
| Liquid | No visually detectable leakage for the duration of the test. | 0.0006 | 0.0018 | 0.006 |
| Gas | No visually detectable leakage for the duration of the test | 0.018 | 0.18 | 1.8 |

- API 598 leakage rates are not directly comparable but the following may be used as a guide.
- For soft seated valves, leakage rate corresponds to ISO 5208 Rate 3.
- For metal seated gate, globe and plug valves liquid leakage rate approximately corresponds to ISO 5208 Rate 3 for valves ≤2" NB, ISO 5208 Rate 1 for sizes between 2" and 12" NB and is between BS 6755 Rate C and ISO 5208 Rate 2 for valves ≤ 14" NB, Gas leakage rate is approximately half that of ISO 5208 Rate 2.
- For Metal seated ball and butterfly valves leakage rates are by agreement with the purchaser.

Note: A leakage rate of one drop of liquid corresponds to 0.0625 ml.
A leakage rate of one bubble (from ¼" dia. tube) corresponds to 0.15ml. (ANSI B16 104).

## TABLE 5

## SELECTION OF ISOLATION (BLOCK) VALVES (ACHIEVABLE LEAKAGE RATES)

| Valve Types | | Check Valves: Lift | | | | | | | | Check Valves: Swing | | | | | | Check Valves: Other | | | | Diverter Valves | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CONDITIONS | VALVE DESCRIPTION | Ball | Disk | Piston (Axial) | Ball (Spring Loaded) | Piston (Spring Loaded) | Plate (Spring Loaded) | Lift Type with Dash Pot | Lift Type - Angle Pattern | Swing with Long Arm | Swing - Standard Pattern | Wafer Pattern | Tilting Dish | Swing - Spring Loaded | Dual-Disk - Spring Loaded | Foot Valves | Screw-down Stop & Check | Axial Flow anti-slam | Diaphragm | 3 & 4 Way Taper Plug (Sleeved) | 3 & 4 Way Taper Plug (Lubricated) | 4 Way Lifting Plug (Taper) | 4 Way Expanding Plug (Parallel) | 3 Way Ball (Metal seated) | 3 Way Globe Valve |
| Resis- tance flow | LOW RESISTANCE REQD (<30) | X | X | X | X | X | X | X | X | | | X | | | | X | X | | X | | | | | | X |
| | MODERATE RESISTANCE TOLERABLE (20-50) | X | X | | X | | X | X | | | | X | | | | | X | | | | | | | | X |
| | HIGH RESISTANCE TOLERABLE (<50) | | | | | | | | | | | | | | | | | | | | | | | | |
| | PIGGABLE | X | X | X | X | X | X | X | X | A | A | X | X | A | X | X | X | X | X | X | X | X | X | X | X |
| Fluid | LIQUID (AND TWO PHASE) | | | | | | | | | | | | | | | | | | | | J | | | | |
| | GAS | | | | | | | | | | | | | | | X | | | X | | | | | X | |
| | STEAM | | | | | | | | | | | | | | | X | | | X | X | X | X | X | X | |
| | SLURRY | X | X | X | X | X | X | X | X | | | | X | X | X | X | X | X | | | X | C | X | | X |
| | SOLIDS (POWDER ETC.) | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | C | X | X | X | | X |
| Fluid Con- dition | CLEAN | | | | | | | | | | | | | | | | | | | | | | | | |
| | DIRTY (ABRASIVE) | B | B | X | B | X | X | X | B | B | B | B | B | B | | B | X | X | | K | K | C | C | | P |
| | LARGE SUSP. SOLIDS | X | X | X | X | X | X | X | X | C | C | X | X | C | X | X | X | X | D | C | | X | X | | X |
| | SOLIDIFYING | F | X | X | F | X | X | X | F | F | F | F | X | F | F | E | X | X | X | X | C | C | X | | X |
| | VISCOUS | | F | F | | F | X | F | F | F | F | F | F | F | F | F | F | F | F | | | | | | P |
| | CORROSIVE | G | G | G | G | G | G | G | G | G | G | G | G | G | G | G | G | G | G | L | L | L | L | L | L |
| | FLAMMABLE | H | H | H | H | H | H | H | H | H | H | H | H | H | H | X | H | H | X | M | M | M | M | M | M |
| | FOULING/SCALING | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | E | | X | C | X | | X |
| | SEARCHING | I | I | I | I | I | X | I | I | I | I | I | I | I | I | X | I | | X | N | X | N | N | X | N |

Notes on Flow Resistance
Valve flow resistances are presented as multiples of the resistance of a plain piece of pipe where this is equivalent to 1 (the figures are approximate).

There are no designs of check valve offering the very low flow resistance of ball and gate valves. If minimum flow resistance is the dominating criterion of selection, the axial flow, anti-slam valve should be chosen.

KEY

(shaded) Suitable

X Not suitable/not recommended
A Can be pigged provided valves specially designed.
B Hard particles may prevent complete closure of valve. Valves not in fully open position may suffer wear of hinge pins etc.
C Consult manufacturer. Seats may suffer damage and sealing ability may be impaired.
D Depends on type
E Check valves not really suitable for this service and likely to give poor performance.
F Consult manufacturer. Steam jacketing/trace heating may be required. Valves without spring assistance likely to be sluggish in operation.
G Satisfactory subject to appropriate choice of materials. Careful attention should be given to design of springs and other internal parts.
H Valves incorporating soft sealing components may need to be fire tested.
I Some leakage likely, even with soft seat materials. Helium leak test for hydrogen service.
J Depends on liquid. Unsuitable for use with solvents etc.
K May be used subject to nature of fluid. Sharp particles may be trapped in cavities and damage soft seats.
L Satisfactory subject to appropriate choice of materials. Careful attention should be given to design of internal parts etc.
M Fire tested or fire resistant gland required.

## TABLE 6

## SELECTION OF CHECK AND DIVERTER VALVES (SERVICE CONDITIONS)

| | Valve Types | Check Valves | | | | | | | | | | | | | | | | | | | | | Diverter valves | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lift | | | | | | | | | Swing | | | | | | | Other | | | | | | | | | | |
| | VALVE DESCRIPTION / CONDITIONS | BALL | DISK | PISTON ( AXIAL ) | BALL ( SPRING LOADED ) | PISTON ( SPRING LOADED ) | PLATE ( SPRING LOADED ) | LIFT TYPE WITH DASH POT | LIFT TYPE-ANGLE PATTERN | | SWING WITH LONG ARM | SWING-STANDARD PATTERN | WAFER PATTERN | TILTING DISK | SWING-SPRING LOADED | DUAL-DISK - SPRING LOADED | | FOOT VALVES | SCREW-DOWN STOP & CHECK | AXIAL FLOW ANTI-SLAM | DIAPHRAM | | 3 x 4 WAY TAPER PLUG ( SLEEVED ) | 3 x 4 WAY TAPER PLUG ( LUBRICATED ) | 4 WAY LIFTING PLUG ( TAPER ) | 4 WAY EXPANDING PLUG ( PARALLEL ) | 3 WAY BALL ( METAL SEATED ) | 3 WAY GLOBE VALVE |
| | VACUUM | X | X | X | B | B | B | X | X | | X | X | X | X | X | B | | X | X | B | B | | X | X | B | B | X | B |
| | LOW ≤ CL.150 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Press- | MED. CL 300/600 | | | | | | | | | | | | | | | | | X | | | X | | G | G | | X | | |
| ure | HIGH CL. 900/2500 | C | D | | C | C | | C | C | | | | D | | X | | | X | C | | X | | X | X | G | X | D | |
| | CLASS 800 | | X | | | | X | | | | E | | X | E | X | X | | X | X | X | X | | X | X | X | X | X | X |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | CRYOGENIC <-50 deg C | F | F | F | X | X | X | F | F | | X | F | X | F | X | X | | X | X | | X | | X | X | X | X | E | |
| | MED/LOW -50 deg C/200 deg C | | | | | | | | | | | | | | | | | | | | A | | | | | | | |
| Temp. | HIGH 200 deg C/450 deg C | | | | | | | | | | | | X | | | | | | | X | X | | X | X | X | B | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | ≤1.5" NS (40DN) | | | | | | | | | | X | X | X | X | X | X | | X | | X | X | | | | X | X | E | |
| | 2" TO 8" NS (50 TO 200DN) | | D | | D | | | | | | | | | | | | | | | | | | | | | | | |
| Size | 10" TO 16" NS (250 TO 400DN) | G | X | E | X | E | G | D | D | | | | | | | | | | E | | | | X | X | G | | E | D |
| | > 16" NS (400 DN) | X | X | X | X | X | X | X | X | | | | | | | G | | | X | | D | | X | X | X | | X | E |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | BUBBLE TIGHT (GAS) | H | H | H | H | H | H | H | H | | X | X | X | X | X | H | | X | H | H | X | | | X | | | X | A |
| | DROP TIGHT (LIQUID) | H | H | H | H | H | H | H | H | | X | X | X | X | X | H | | X | H | H | | | | K | | | X | H |
| Iso- | VERY LOW LEAKAGE PERMITTED | I | I | I | I | I | I | I | I | | I | I | I | I | I | I | | | I | | | | | K | | | X | |
| lation | SOME LEAKAGE PERMITTED (NORMAL | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | COMMERCIAL STD.) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | COURSE ISOLATION ONLY | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | PULSATING FLOW | X | X | X | | | J | | | | X | X | X | X | X | X | | | | | | | | | | | | |
| Oper- | UNSTABLE FLOW | X | X | X | X | X | X | X | X | | X | X | X | | X | X | | X | X | | X | | | | | | | |
| ration | SUDDEN FLOW | | X | X | | | | | | | X | | X | | | | | | | | | | | | | | | |
| | SUDDEN FLOW REVERSAL | X | X | X | | | | | X | | X | X | X | | X | | | | X | | | | | | | | | |

# TABLE 7

## DIAPHRAGM VALVES

## TYPES OF CONSTRUCTION

**KEY**

| | |
|---|---|
| (shaded) | Suitable/Available/Achievable |
| X | Not suitable/Available/Achievable |
| A | Temperature range may be limited by soft seats/seals/linings etc. |
| B | Soft seated valves only. Few check valves are suitable for sealing against vacuum. Helium leak test recommended. |
| C | Small size only |
| D | Limited availability |
| E | Not normally available |
| F | Consult manufacturer. Special design required |
| G | Limited pressure rating |
| H | Usually only achievable by soft seated valves |
| I | May not be achievable at low pressures except by soft seated valves. Even at higher pressures, metal seated valves are likely to require special effort to achieve this. |
| J | Compressor discharge valves only. |
| K | Leak tightness depends on efficiency of sealant |

## TABLE 7

## DIAPHRAGM VALVES

## TYPES OF CONSTRUCTION

| Valve Types | | Check Valves – Lift | | | | | | | | Check Valves – Swing | | | | | | Check Valves – Other | | | | Diverter valves | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CONDITIONS | VALVE DESCRIPTION | BALL | DISK | PISTON ( AXIAL ) | BALL ( SPRING LOADED ) | PISTON ( SPRING LOADED ) | PLATE ( SPRING LOADED ) | LIFT TYPE WITH DASH POT | LIFT TYPE-ANGLE PATTERN | SWING WITH LONG ARM | SWING-STANDARD PATTERN | WAFER PATTERN | TILTING DISK | SWING-SPRING LOADED | DUAL DISK -SPRING LOADED | FOOT VALVES | SCREW-DOWN STOP & CHECK | AXIAL FLOW ANTI-SLAM | DIAPHRAM | 3 x 4 WAY TAPER PLUG ( SLEEVED ) | 3 x 4 WAY TAPER PLUG ( LUBRICATED ) | 4 WAY LIFTING PLUG ( TAPER ) | 4 WAY EXPANDING PLUG ( PARALLEL ) | 3 WAY BALL ( METAL SEATED ) | 3 WAY GLOBE VALVE |
| Body, bon-net, Etc | CARBON STEEL | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | B | ▨ | ▨ | ▨ | ▨ | B | ▨ |
| | CHROME MOLYSTEEL | A | ▨ | A | A | ▨ | ▨ | ▨ | ▨ | A | ▨ | A | ▨ | A | A | X | ▨ | X | X | X | X | X | X | B | ▨ |
| | AUST. STAINLESS STEEL | ▨ | ▨ | ▨ | A | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | A | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | A | A | ▨ | ▨ |
| | NICKEL ALLOYS | X | B | B | X | A | A | A | A | A | B | A | A | X | B | X | X | B | X | ▨ | A | A | A | ▨ | B |
| | ALUMINIUM BRONZE | X | A | A | X | A | X | A | A | X | B | ▨ | X | X | ▨ | X | X | ▨ | X | A | A | X | X | A | B |
| | BRONZE / GUNMETAL | X | ▨ | ▨ | X | A | A | ▨ | ▨ | X | ▨ | A | A | X | B | ▨ | ▨ | X | ▨ | A | X | X | X | X | ▨ |
| | ALUMINIUM | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | A | X | X | X | X | A |
| | CAST IRON | X | ▨ | A | X | X | ▨ | X | X | B | ▨ | ▨ | X | X | ▨ | ▨ | ▨ | X | ▨ | ▨ | ▨ | X | X | X | ▨ |
| | P.V.C | ▨ | X | X | X | X | X | X | ▨ | X | X | X | X | X | X | ▨ | X | X | X | X | X | X | X | X | C |
| | CUPRO-NICKEL | X | C | X | X | C | X | C | C | X | B | X | X | X | B | X | X | X | X | ▨ | A | A | A | A | B |
| | GLASS | ▨ | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | C |
| Trim | 13 % Cr ( 410 ) S.S | ▨ | ▨ | ▨ | ▨ | X | X | ▨ | ▨ | ▨ | ▨ | ▨ | X | X | ▨ | X | X | X | X | | | | | | |
| | AUST. STAINLESS STEEL | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | A | ▨ | ▨ | ▨ | ▨ | ▨ | | | | | | |
| | HARD FACED | ▨ | ▨ | ▨ | ▨ | ▨ | B | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | A | X | ▨ | A | X | | | | | | |
| | MONEL / INCONEL | X | B | B | X | ▨ | X | A | A | A | B | A | A | X | B | X | B | B | X | | | | | | |
| | ALUMINIUM BRONZE | X | A | A | X | A | X | A | A | X | B | ▨ | X | X | ▨ | X | X | ▨ | X | | | | | | |
| | BRONZE / GUNMETAL | X | ▨ | ▨ | X | A | X | ▨ | ▨ | X | ▨ | A | A | X | B | ▨ | ▨ | X | X | | | | | | |
| Lin-ings | RUBBER | ▨ | X | X | X | X | X | X | X | X | X | ▨ | X | X | ▨ | X | X | X | ▨ | | | | | | |
| | PTFE | ▨ | ▨ | ▨ | X | X | X | X | X | X | X | ▨ | X | X | X | X | X | X | X | | | | | | |
| | OTHER POLYMERS | X | ▨ | ▨ | X | X | X | X | X | X | X | ▨ | X | X | ▨ | X | X | ▨ | X | | | | | | |
| | GLASS | ▨ | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | | | | |

KEY:

▨ Available

X Not available / not applicable

A Not normally available

B Limited availability

C Not known

## TABLE 8

## SELECTION OF CHECK AND DIVERTER VALVES

## (AVAILABLE MATERIALS)

## 3. VALVE TYPES, FUNCTION AND APPLICATIONS (GENERAL)

### 3.1 Valve Function

3.1.1 The configuration of the flow path through a valve and the method used to control flow determine a valve's characteristics and influence the selection of a type of valve for a particular function.

3.1.2 The method of flow control can be important in valve selection, especially when considering valves for block functions with dirty fluids.

3.1.3 Valves may be grouped according to the method by which the closure member (gate, ball, disc, plug or piston) moves to open or close the valve. The movement relative to the valve seat may be sliding, closing or flexing and the path of travel may be linear or rotary. Valves are often described as linear action (or multiple turn if screw operated) and rotary action (or more commonly quarter turn).

3.1.4 The different methods of flow regulation are as follows:-

(a) Sliding Method

The closure member slides across the valve seat face to open or close the valve.

Linear action valves using the sliding method are parallel gate valves.

Rotary action valves that use this method are ball valves and plug valves which have the additional feature of rotating about a central axis normal to the flow path through the valve.

(b) Closing Method

The closure member moves away from or towards the valve seat to open or close the valve by moving either against the seat face or by projecting into the seat orifice.

Linear action valves using the closing method are globe valves. Valves of the lift check type also use this method, e.g. ball check, disc check and piston check valves.

*Note that most safety and relief valves use this method.*

Rotary action valves using the closing method are butterfly valves. Check valves of the swing check type (flapper and split (double) disk) and tilting disc type also use this method.

(c) Flexing Method

The method of opening or closing the valve is by flexing a resilient membrane within the valve body.

Linear action valves using this method include diaphragm and pinch valves. The closure member is external to the fluid flow and may be mechanical or fluid operated. Check valves of the diaphragm type also use this method.

Rotary action valves using this method are sometimes found but are relatively uncommon. Iris valves in which a flexible membrane of tubular shape is rotated into a conical shape for closure are an example.

3.1.5 Combinations of these methods and linear/rotary action are not uncommon. The widely used wedge gate valve is an example of a linear action valve which appears to employ the sliding method but actually uses the closing method to wedge the gate into the tapered seats. The lifting taper plug is an example of combined linear/rotary action.

## 3.2 Valve Types for Isolation (Block) Duty

3.2.1 Block valves for starting and stopping flow are generally selected to provide:-

(a) Low resistance (pressure drop) to flow by means of a straight through flow configuration which also facilitates line clearing.

(b) Shut off with the flow or pressure from either direction, i.e. bi-directional sealing.

3.2.2 Block valves are the most widely used valve type. Operation is normally by manual intervention either directly or indirectly, e.g. powered actuators.

Many types of valves are used and include:-

| | | | |
|---|---|---|---|
| Gate valves | - | Wedge/Parallel Gate | (most common) |
| Ball valves | - | Floating, Trunnion | |
| Butterfly valves | - | ‘High Performance’/Rubber Lined | |
| Plug valves | - | Taper/Parallel, Lubricated, Non-Lubricated, Lined | |
| Diaphragm valves | - | Weir/Full Flow, Pinch | |
| Globe valves | - | Straight/Angle/Oblique/Needle/Piston/ Stop and Check | (least common) |

*Further information on these valve types may be found in Appendices D & F.*

**3.3 Valve Types for Prevention of Flow Reversal (Check)**

3.3.1 Check valves are required to permit forward flow and prevent reverse flow. This is achieved through linear or rotary (angular) motion of a closure member which, with forward flow is kept open by flowing fluid pressure. When the flow is reduced towards zero or reversed the closure member is closed against its seat by forces due to its weight, supplementary springs and back pressure.

* 3.3.2 Common types of lift check are ball, piston and disk and body styles may include globe type, angle pattern and in-line. Swing check valve types most commonly met with are standard pattern, tilting disk and spring loaded dual disk.

In addition, there are several special designs deriving from the basic types e.g. the axial flow, 'anti-slam' valve and the screw-down stop check.

3.3.3 A position indicator mechanism is not usual and may be incorporated only on swing check valves and dual plate wafer type check valves.

3.3.4 Only swing type check valves are suitable for pigging, and then only to special design.

3.3.5 Many types of valves are used and include:-

Lift Check - normally small disk, piston and ball types
Swing Check - Normally 2 NPS and above, swing disk
Diaphragm Check - Utilises flexible diaphragm
Piston Type - Normally 2 NPS and below
Screw-Down Stop and Check - Globe and swing types with provision for manual closure
Wafer Check Valve - A narrow valve style for installation between flanges
Spring Operated Non-Slam Check Valve - Axial flow type for pulsating flow
Foot Valves - Pump suction valves

*Further information on these valve types may be found in Appendices E & F.*

## 3.4 Valves for Special Applications

3.4.1 General

(a) The use of high temperature packings (e.g. carbon/graphites or similar) or other special packing materials may be required. In this case, the use of martensitic stainless steel (e.g. 13% Cr) valve stems should be avoided. If this is not possible, inhibited packing should be used.

* (b) Soft seated valves (e.g. ball, plug and butterfly valves) used in hazardous areas where they could be subjected to fire shall be of a fire tested design or approved by BP. Metal seated valves may require a ‘fire safe’ gland (e.g. a carbon gland packing) and fire resistant joint gaskets.

(c) For particularly hazardous service or high pressure (class 1500 and above) additional volumetric and surface examination tests may be specified for the pressure retaining boundary. ANSI B16.34 provides guidance on the areas which should be considered and EEMUA Publication 167 specifies quality levels for steel valve castings.

(d) Electrical isolation of valve flanges may be necessary when mating with valves or flanges of dissimilar materials. Similarly electrical continuity and earthing may be required in fully lined piping systems where static discharge may be a problem, particularly where gasses are flowing at high velocities (especially when liquid droplets and solid particles are present) or with low conductivity liquids.

(e) Services such as oxygen, cryogenic and other special process applications may require valves to be thoroughly degreased, cleaned and assembled in a ‘clean room’.

* (f) Valves required for searching duties (e.g. hydrogen) may be subject to a helium leak test, or to a test using a mixture of air or nitrogen plus helium, to prove a high degree of leak tightness. Details of the test shall be subject to agreement with the valve manufacturer and approval by BP.

(g) Materials for valves for sour and/or chloride service shall comply with NACE Std MR-01-75 and BP Group GS 136-1.

(h) Wellhead equipment should comply with BP Group GS 162-5 and 162-6.

* (i) Valves for services such as sulphur and applications where the fluid may solidify may require steam jacketing, or trace heating. The details of such arrangements shall be subject to approval by BP.

3.4.2 Bellows Sealed Valve

A valve specified for applications where escape of fluid to the atmosphere is undesirable for health, safety or economic reasons. A bellows provides the primary sealing of the stem during opening and closing, a gland may be provided for secondary sealing in some designs. The bellows is housed in an extended bonnet (see Fig H7) which may be welded or bolted to the valve body.

Bellows are normally used in linear action valves of the gate and globe design size 6 in. and smaller, but are also used in special ball valve designs.

3.4.3 Cryogenic Service

Valves for cryogenic applications (below -50°C) should comply with BS 6364 and, unless otherwise approved by BP, be provided with extended glands.

Valves normally employed are gate, globe, ball or butterfly types manufactured in stainless steel, monel, bronze or cupro-nickel.

The extended bonnet allows a reasonable temperature gradient up to the gland and point of operation. The extended stem includes a column within which a liquefied gas may reach a vaporising temperature. The column should provide means of venting any excess pressure build up, should this be necessary.

Leakage rates normally acceptable in conventional application are not acceptable for cryogenic service where leakage could freeze affecting the plant balance. Stem leakage may result in stem seizure and packing failure.

Seats and seals are normally manufactured in KEL-F, PTFE and similar materials and need careful selection for temperatures below -65ºC.

Ball valves with soft seats or other valves having a closed body cavity may require facilities for relieving overpressure caused by thermal expansion of fluids.

Valves should normally be installed with stems vertical or at 45 degrees to the vertical to maintain a low conductivity vapour lock in the bonnet.

High energy shocks may occur in liquid oxygen systems dislodging debris from valve seats. Material should be chosen to eliminate fire risk. Stainless steel materials usually acceptable for oxygen service may not be suitable. Bronze or monel body and trim materials are recommended to prevent a spark occurring during high energy mechanical impact.

All valves for cryogenic service should be cleaned to a high standard and free of moisture and grease.

Cryogenic liquids are generally non-lubricating and therefore galling may occur between relatively soft metal mating parts. Bronze stem bushing, KEL-F, PTFE or hard seats, special coatings and solid film lubricants are recommended to prevent this.

Guidance on valves which are subject to sub-zero, but not cryogenic, conditions is provided in EEMUA Publication 192.

### 3.4.4 Vacuum Service

For vacuum service soft seated valves may be specified, including high performance butterfly valves. For extremely high vacuum metal to metal closing mechanisms may be required.

Valve stems shall be truly round and parallel and have a smooth finish of 0.4 micrometers or better. Similar attention needs to be given to the stuffing box bore.

Valve packing shall be suitable for 25 mm Hg absolute pressure.

Bellows stem seals may be specified provided the cycle life is compatible with the application. Secondary packing should be specified in such cases.

### 3.4.5 Deluge Valves

These valves are used on firewater deluge service. Proprietary deluge valves are preferred to process control valves for this service because:-

(a) They operate virtually instantaneously. A process control valve can require several seconds to operate.

(b) They fail safe despite damage to the pneumatic detection or actuation system. This may not be true in the case of process control valves.

(c) Process control valves are liable to seize when they stand inactive for extended periods of time as in deluge service. Proprietary deluge valves are designed to avoid this problem.

(d) For any given line size, the deluge valve saves space and weight when compared with actuated process valves.

3.4.6 Excess Flow Valves

Excess flow valves are designed to close automatically when the flow through them exceeds the specified rate. They may be installed where fluid leakage through a defect in the line would cause serious damage.

They incorporate a spring-loaded valve disk which will only close when the forward flow of fluid through the valve generates sufficient force, or differential pressure, to overcome the power of the spring holding it open. Each valve has a closing rate in GPM or CFH.

Each excess flow valve is designed for a specific flow rate. The effect of piping, fittings and valves downstream of the valve must be taken into account when evaluating flow. The valve should be installed as near as possible to the protected cylinder or tank.

Valves should be selected with a closing flow rate of at least 10% to 15% greater than the anticipated normal flow. Valves having a rated closing flow near the normal flow may chatter or slug closed when surges in the line occur during normal operation, or due to the rapid opening of a control or quarter turn valve.

The closure speed of larger sized valves may be reduced by the addition of a dashpot which utilises the working fluid. This is recommended only on large liquid lines, to avoid shock associated with sudden closure.

A downstream break in piping or hoses may not provide sufficient flow to close the valve. Therefore, as an alternative, supply lines may be fitted with a remote operated shut-off valve, operable from a number of points located at some distance from the line, such that access to at least one point is possible irrespective of wind direction and prevailing conditions.

3.4.7 Float Operated Valves

Float operated valves are used for liquid level control in non-pressurised containers. Valves may be to BS 1212 Parts 1, 2, 3 or to manufacturer's standards.

Valves to BS 1212 are small bore, sizes 3/8 in. to 2 in. NB, with threaded male end, specified with an orifice sized to accommodate various conditions of the pressure and flow. To enable the correct orifice size to be determined, the computed flow through each orifice at given heads is tabulated in Part 1. Available orifice sizes are:-

(a) Part 1: 1/8 in. - 1 ¼ in.
(b) Parts 2 & 3: 1/8 in. - 3/8 in.

Valves to BS 1212 Parts 2 and 3 have the outlet positioned above the body, rather than below as in Part 1, enabling the attachment of a discharge assembly to prevent back siphonage of the fluid.

Valves to manufacturer's standards range from the small threaded valve in the sizes covered by BS 1212, to flanged valves up to 18 in. NB, pressure balanced to equalise the hydraulic forces on the moving element and giving greater sensitivity to changes in water level throughout the inlet pressure range.

Valves to manufacturer's standard may be either in-line or angle type. Designs are available for high pressure applications, having a streamline flow pattern which provides smooth handling of high velocities, minimising vibration, erosion and noise.

Surface turbulence, for instance in a break tank, can cause oscillatory action of the valve. This may be prevented by installing a separate float tank, or baffle plate.

This type of valve should always be backed up by some independent means of overfilling, because of the valves low reliability even on low hazard duties.

* 3.4.8 Flush Bottom Outlet Valves

A flush bottom valve is a 'Y' pattern valve which controls the flow of liquid or slurry from the bottom of a vessel to a valve discharge angled at 45 degrees to the vertical and is generally to manufacturer's standards.

The valve may have a disk and seat, or be of seatless design with a piston, plunger or mushroom type disk. It may be selected for either flush bottom or penetrating operation.

A flush bottom valve allows removal of precipitate which may have bridged the vessel outlet and, when fitted to a dished end, allows complete draining of the vessel.

When heavy sediment may be deposited in the vessel, a piston or plunger type valve should be selected. On closing, the piston penetrates the deposit, allowing the vessel to drain when the valve is next opened.

Since the seat in a disk type valve is part of the vessel outlet nozzle, the valve must be provided before the vessel is fabricated. Disk type valves may not seat properly when used with liquids containing solids in suspension.

The valve requires a considerable vertical distance under the vessel bottom for installation and operation. Operation may be manual or remotely controlled.

A variation of the piston design is used for sampling.

3.4.9 Iris Valve

A valve in which the closure member moves towards the valve bore, mainly used for controlling powder media. There are several designs:-

(i) A flexible cylinder is rotated at one end, closure being effected by closing of the neck midway along the cylinder.

(ii) The closure member is in the form of flat petals hinged and rotated to close (like a camera diaphragm).

(iii) The petals are curved like a cone and hinged to close together; this design is used for quick shut off on hydraulic systems where leakage is allowable.

3.4.10 Rotary Valve

A valve consisting of a spindle or hub to which several blades are attached, the whole being housed in a fabricated or cast body. Rotation of the spindle causes a measured quantity of product (power or pellet) to be transferred from storage vessels to conveying lines. Valves are usually motorised and are not intended to be liquid or gas tight. A specialised design of ball valve is also used for this duty.

3.4.11 Emergency Shutdown Applications

Valves intended for ESD service must achieve the highest degree of reliability and integrity and are usually affected by legislation. In the case of offshore applications the Certifying Authority should be involved at all stages of the procurement process and specialist assistance should be sought. Subsea isolation valves (SSIV) are covered by a separate Recommended Practice which is supplementary to this document.

# 4. SERVICE CHARACTERISTICS

## 4.1 Fluid Characteristics, General

4.1.1 The characteristics and condition of fluids and slurries require careful identification since these are often the most significant factors in selecting the correct type of valve. Clean fluids generally permit a wide choice of valve types, for dirty fluids the choice is often restricted and may require specific types of valves. A fluids characteristics may fit one or more of categories of service.

4.1.2 The hazardous nature of the service, its flammability, toxicity and searching nature requires consideration to be given to the engineering requirements, e.g. leakage to atmosphere and past valve seats.

## 4.2 Clean Service

4.2.1 Clean service is a term used to identify fluids free from solids or free from contaminants to meet product quality requirements. Some fluids may require a special high degree of cleanliness such as oxygen service where thorough degreasing is necessary, assembly in a clean room and special attention given to packing.

4.2.2 A number of fluids are normally defined as ‘clean’, these include instrument air, nitrogen, potable water, potable and treated (demineralised) water, steam, lube oil, diesel oil and many chemicals including dosing chemicals used for injection into fluids systems for which there are no special clean requirements. Valves for fluids such as oxygen, hydrogen peroxide and sometimes treated water or lube oil require special attention to cleanliness of the valve. Valves for potable water must meet water board regulations.

4.2.3 Fluids that are subject to processing may also be defined as clean subject to the consideration of conditions at each stage of processing.

4.2.4 Clean services are generally less damaging to valves resulting in long term performance and reliability. Selection from a range of valve types may be possible for some applications allowing greater freedom of choice.

4.2.5 If the fluid service is basically clean, attention should be given to protecting valves selected for clean service. During construction this may require the removal of valves until the piping system is clean, i.e. after flushing, pigging and drying.

## 4.3 Dirty Service

4.3.1 Dirty service is a general term used to identify fluids with suspended solids that may seriously impair the performance of valves unless the correct type design is selected. This type of service is often of major significance since many valves are very sensitive to the presence of solids. Dirty service may be further classified as abrasive or sandy.

## 4.4 Abrasive Service

4.4.1 Abrasive service is a term used to identify the presence of abrasive particulate found in piping systems and includes the presence pipe rust, scale, welding slag, sand and grit which are damaging to many valves. These materials can damage seating surfaces and clog working clearances in valves often resulting in excessive force required to operate valves, sticking, jamming and leakage through the valve. Such damage may be caused by particulate for quite low concentrations and of small size, typically 10 microns.

Abrasive conditions are commonly found during construction, continuing into production. Valves can be irreversibly damaged requiring early overhaul, unless adequate steps are taken to prevent damage.

4.4.2 Where abrasive conditions continue for indeterminate period during production, a valve suitable for dirty services should be selected. Typical conditions include naturally occurring particulate in the process fluid e.g. sand from production wells, corrosion products from pipe surfaces which could be caused by the change in the nature of the fluid or the injection of dosing chemical during service, or the release of pipe scale following drying out of piping system as in gas systems.

## 4.5 Sandy Service

4.5.1 Sandy service is a term identifying severe abrasive and erosive conditions and is used in oilfield production to identify the production of formation sand with reservoir crude oil or gas.

4.5.2 Valves for this service are often required to have their performance qualified by means of the sand slurry test specified in API 14D.

**4.6 Fouling Service**

4.6.1 Fouling or scaling services are general terms used to identify liquids or elements of liquids that form a deposit on surfaces. Such deposits may vary widely in nature, with varying hardness, strength of adhesion and rates of build up. Valves for these services require careful selection particularly where thick, hard, strongly adhesive coatings occur. The temperature of the fluid may be a vital factor and in some cases valves may need tracing or be steam jacketed or of purged design.

**4.7 Slurry Services**

4.7.1 Slurry service is a general term used to define liquids with substantial solids in suspension. often the product is the solid and the fluid is primarily the means of transportation, e.g. coal slurries and catalyst services. Slurries vary widely in nature and concentration of solids. hard abrasive solids of high concentration can cause severe abrasion, erosion and clogging of components. Soft, non-abrasive solids can cause clogging of components. Differential expansion at elevated temperatures also requires careful consideration in valve designs for slurry services. In certain chemical processes polymerization may block the cavities preventing valve operation.

**4.8 Solids**

4.8.1 There are many other conditions where solids may be present in the form of hard granules, crystals, soft fibres or powders. The transporting media may be liquid or gas. Air or fluidised bed systems may be used for some particulates. Specialised valves are available for many of these services but development work may sometimes be necessary.

**4.9 Hazardous Service**

* 4.9.1 Where the term ‘hazardous service’ is used in this document, this will be defined by BP for each specific case but will always include the following:-

(a) Liquids above their auto-ignition temperature (AIT), or 210º if the AIT is not known.

(b) Flammable liquids flashing on leakage to form a substantial vapour cloud. This shall include LPG, LNG and NGL condensate and others where specified by BP.

(c) Fluids liable to cause a hazard by blockage due to hydrate formation or solids deposition.

(d) Toxic substances, but only as specified by BP (e.g. chlorine, hydrofluoric acid, hydrogen sulphide, C0, phenol etc.).

(e) Hydrogen service - defined as service in contact with hydrogen or gaseous mixtures containing hydrogen in which the partial pressure of hydrogen is 5 bar (abs), (72.5 psia) or more.

(f) Flammable fluids at class 900 flange rating and above.

(g) Highly corrosive fluids such as acids and caustic alkalis to be defined by BP.

(h) Scalding fluids e.g. hot boiler feed water, steam above Class 300.

## 4.10 Flammable Service

4.10.1 Fluids with an auto-ignition temperature (AIT) above 210°C, fluids which will flash off an inflammable vapour cloud.

## 4.11 Searching Service

4.11.1 Searching service is a term used to identify fluids with enhanced leakage capacity that require special attention in valve design and manufacture to prevent leakage through pressure containing components (body-bonnet joints etc.) and through seats and seals. Particular attention is usually given to surface finish of sealing surfaces, see reference to flange finish in BP Group GS 142-2.

4.11.2 Gasses of low molecular weight such as hydrogen and helium and liquids of low viscosity such as Dowtherm are of a very searching nature.

## 4.12 Solidifying Service

4.12.1 Solidifying service is a general term used to identify fluids that will change from liquid to solid unless maintained at the correct conditions of temperature, pressure and flow. It is a term generally associated with fluids such as liquid sulphur and phthalic anhydride where valves of steam jacketed design may be required or heavy fuel oil where valves often require tracing to maintain temperature and operability.

**4.13 Corrosive Service**

4.13.1 Corrosive service is a term generally used to identify clean or dirty fluids containing corrosive constituents that, depending on concentration, pressure and temperature may cause corrosion of metallic components.

Corrosive fluids include sulphuric acid, acetic acid, hydrofluoric acid (HFA), wet acid gas (wet $C0_2$), wet sour gas (wet $H_2S$) and chlorides. Many chemicals are highly corrosive including concentrations of some corrosion inhibitors.

4.13.2 Both dirty and clean services may contain corrosive fluids, e.g. a dosing chemical service with corrosion inhibitor could be nominally defined as clean.

The choice of suitable corrosion resistant materials for valve pressure containing components (body bonnet) and trim is necessary to avoid corrosion that can impair the integrity or performance of the valve.

Types of corrosion that need to be considered when selecting valve materials and designs include:-

(a) Acid corrosion resulting in general wastage typical with wet $C0_2$.

(b) Crevice corrosion.

(c) Galvanic corrosion between dissimilar materials.

(d) Pitting corrosion.

(e) Stress corrosion cracking of components typical with wet H2S and chlorides depending on concentration, pressure and temperature.

(f) Sour service - materials for sour ($H_2S$) service and chlorides are required to conform with the requirements of BP Group GS 136-1 which includes the requirements of NACE Standard MR-01-75.

### 4.14 Viscous Service

4.14.1 Viscous service is a term that generally identifies a wide range of dirty or clean fluids with pronounced thickness and adhesive properties that, for the range of operating conditions (pressure, temperature and flow) may require high operating torques and cause a sluggish response affecting seating. Fluids include high viscosity oils (lube and heavy fuel oil) and non-newtonian fluids e.g. waxy crude, gels and pastes.

4.14.2 The choice of valves for viscous service can vary depending on fluid properties. Special attention should be given to check valves where sluggish response may cause operating difficulties and even hazardous conditions.

### 4.15 Vacuum Service

4.15.1 Vacuum service is a term used to identify systems where the pressure is permanently or intermittently below atmospheric. Valve selection needs to pay particular attention to sealing capability of glands etc.

4.15.2 In the case of systems which have the potential to create an unwanted vacuum (e.g. condensing, tanks etc.) it is often necessary to fit a vacuum breaker valve which functions in such a way as to admit air automatically whenever a vacuum occurs.

## 5. VALUE OPERATION & ISOLATION

### 5.1 Fire Resistance

* 5.1.1 BP may specify certain areas of an installation as presenting a special fire risk. This will influence such factors as the fire testing of soft seated valves and the fire protection of all type of valves.

In these areas, BP may specify certain valves to be on critical duties; such valves are anticipated to be few in number on conventional onshore installations, but will probably be much more numerous on compact plants such as certain modular or offshore installations.

* 5.1.2 Valves in special fire risk areas, shall be identified as being on (a) critical or (b) non-critical duty.

(a) Valves on critical duty that require to remain operable during any fire shall be capable of remote operation from outside the fire risk area. The complete valve assembly including motor, actuator and cabling shall be fire protected by a method approved by BP (see BP Group RP 24-2).

Valves on critical duty that require to remain closed during any fire shall have either:-

(i) Metal to metal, or non-decomposing primary seats,

or

(ii) If fitted with soft primary seats, shall be fire protected or fire tested. Fire testing shall be to BS 5146 or API Std 607.

(b) For valves on non-critical duties, fire testing and associated documentation will not be a standard BP requirement.

### 5.2 Operability

5.2.1 Manual valves shall be closed by turning a handwheel, wrench or geared handwheel in a clockwise direction. Wrench operated valves shall be provided with limit stops to prevent overtravel.

Handwheels and wrenches shall be constructed of steel, malleable or nodular iron. Pressed or stamped handwheels and wrenches shall not be used.

Butterfly valves with wrench operators shall be designed to hold the disk in at least five equally spaced intermediate positions between closed and fully open.

Handwheel keys should only be used in emergencies or where handwheels are known to be inadequately sized.

If handwheel keys are employed, they should be used with caution. Increased operating torque is usually indicative of a problem which needs to be addressed.

5.2.2 The effort required to operate a valve will depend upon its design, operating conditions and size. When the effort to operate the handwheel exceeds 350 N geared operators shall be provided.

All gear operators shall be totally enclosed and suitable for the site conditions (e.g. onshore, offshore and subsea). Any lubricants used shall be suitable for use at the site ambient temperatures.

350 Newtons is a figure accepted in many British Standards of operation of manual valves.

Manually operated valves are normally expected to be provided with gear operators for the following sizes and above, subject to the manufacturers recommendations.

| ***Class*** | ***150*** | ***300*** | ***600*** | ***900*** | ***1500*** | ***2500*** |
|---|---|---|---|---|---|---|
| *Valve* | *Wedge Gate 14 NB* | *10 NB* | *8 NB* | *6 NB* | *4 NB* | *2 NB* |
| *Type* | *Globe8* | *8* | *6* | *4* | *3* | *2* |
| | *Ball 8* | *8* | *6* | *6* | *6* | *2* |
| | *Butterfly 8* | *8* | *-* | *-* | *-* | *-* |
| | *Plug 6* | *6* | *6* | *4* | *4* | *2* |

5.2.3 Parallel slide valves for steam services are normally provided with integral by-pass connection in size 8 NPS and above to equalise pressure on the disc before opening. The requirement for a by-pass is subject to the operating pressure and the manufacturers recommendations. The by-pass pipe shall meet the same specification as the associated piping specification.

5.2.4 Chainwheel operators shall not be used unless approved by BP and shall not be used for valves in screwed lines, or for any valve smaller than 2 in. NB. Extended spindle operator may also be used but should be avoided if possible.

* 5.2.5 Details of ancillary mechanical devices, e.g. locks, linkages, chain wheels and extended spindles shall be subject to approval by BP.

*Approval is required for quality of design, standardisation on plant and assessment of location (e.g. access/obstruction etc.).*

5.2.6 Pneumatic or electric valve actuators shall comply with the requirements of BP Group RP 30-1 Section 9.

5.2.7 The position of the valve closure member and direction of closure shall be clearly indicated.

**5.3 Isolation**

5.3.1 Positive Isolation

5.3.1.1 Recommendations for isolation of piping systems are specified in BP Group RP 42-1 and where leakage cannot be tolerated for safety or contamination reasons isolation is made by removal of spools, blanking or the use of line blinds.

5.3.2 General Isolation

5.3.2.1 Soft seated block valves, such as ball valves, line plug valves, soft seated gate and butterfly valves can provide a good tight shut off for most clean services.

5.3.2.2 Metal seated valves may also give tight shut off (when new and on test) but their efficiency may vary with pressure, temperature and after use for a period of time, their leak tightness cannot always be guaranteed. For high pressures/temperatures and dirty abrasive service they may be the only option and are the preferred type.

5.3.2.3 Metal to metal plug valves have good isolation characteristics but require regular lubrication and maintenance.

5.3.2.4 For steam services parallel slide valves shall be fitted to the main steam distribution system, at battery limits or as section isolating valves within any process unit where any section may be taken out of service for maintenance while the unit remains in operation. Wedge gate valves may be used as an alternative for general isolation duty or where good, low pressure leak tightness is required.

5.3.2.5 There are many variations on the solid wedge gate valve using split and self aligning wedges for which various claims for improved sealing and wedge alignment are made. Solid wedges are normally specified for general service.

5.3.2.6 Butterfly valves vary greatly in design of varying degrees of leak tightness, good results can be obtained from ‘high performance’ type using offset discs.

5.3.2.7 Double block valves are recommended for services such as hydrogen service where leakage of a highly flammable searching media is undesirable.

5.3.3 Block and Bleed

This term describes the provision of a tapping point, either integral with the valve or located in the downstream pipework, which permits any leakage past a block valve to be bled off.

5.3.4 Double Block and Bleed

5.3.4.1 This term is used to describe the provision of two isolation points (either two separate block valves or a single block valve having two seats, each of which makes a seal) with a tapping point located between them. The arrangement is used in two different ways:-

(a) Where the two valves or valve seats seal against a single source of flow or pressure. Any leakage from the first valve or valve seat is bled off through the tapping point, thus ensuring the integrity of the second seal.

(b) Where the two valves or valve seats seal against two separate sources of flow or pressure which are applied from opposite directions. Any leakage from either source is off through the tapping point, so preventing contamination or mixing of the two sources.

5.3.4.2 When a single valve is used for this duty it should ideally be of a type where the seat load is applied mechanically so that it is independent of variations in line pressure. Suitable valve types include the parallel double disk gate valve with expanding wedge, the expanding plug valve and high integrity versions of the wedge gate valve (e.g. soft seated). Such valves (when provided with appropriate tappings) are suitable for either of the two applications described above although arrangements for pressure relief of the valve cavity must be made where liquids subject to temperature increase are likely to be trapped.

5.3.4.3 Both trunnion mounted ball valves and through conduit slab gate valves can be used in single valve arrangements where sealing against both upstream and downstream pressure is required. It should be noted that these designs rely on the line pressure to make an effective seal and the use of springs etc. to provide supplementary mechanical loading at low pressure is not always effective.

5.3.4.4 Through conduit slab gate valves can also be used where a double seal against upstream pressure is required and have the advantage that the pressure load applied to the upstream seat is transmitted, through the floating gate, to the downstream seat. Trunnion mounted ball valves with double piston effect seats are suitable for double block applications but must not be used for single valve double block and bleed duty.

5.3.4.5 Butterfly, globe and conventional plug valves are not suitable for double block or double block and bleed duty where a single valve is required.

5.3.4.6 Certain applications (e.g. hydrogen service) require that two separate valves are provided in double block or double block and bleed arrangements.

5.3.5 Cavity Relief

5.3.5.1 Some ball valves or special plug valves may have a body cavity sealed in both the open and closed positions. When open the valve may have a sealed cavity between the ball or plug and the body. Any fluid of high thermal expansion may cause the pressure in the cavity to rise to an unacceptable level and must be relieved.

Relief can be achieved by a drilled hole in the ball or plug from the cavity to the upstream side or in some cases a drill hole through a seat ring. Ball valves with floating seats should be self relieving.

## DEFINITIONS AND ABBREVIATIONS

### Definitions

Standardised definitions may be found in the BP Group RPSEs Introductory volume.

| | |
|---|---|
| contractor: | a contractor undertaking to purchase equipment covered by this practice. |
| supplier: | the manufacturer, or authorised agent of the manufacturer, of equipment covered by this practice. |

### Abbreviations

| | |
|---|---|
| ABS | Acrylonitrile Butadiene Styrene |
| ANSI | American National Standards Institute |
| API | American Petroleum Institute |
| ASME | American Society of Mechanical Engineers |
| ASTM | American Society for Testing and Materials |
| BHRA | British Hydromechanics Research Association |
| BS | British Standard |
| BSI | British Standards Institute |
| CAF | Compressed Asbestos Fibre |
| CFH | Cubic Feet Per Hour |
| DN | Nominal Diameter |
| EEMUA | Engineering Equipment and Materials Users Association |
| EPDM | Ethylene Propylene (Diene Modified) |
| FPM | Viton (Vinylidene Fluoride and Hexafluoropropylene) |
| GPDM | Ethylene Propylene |
| GPM | Gallons Per Minute |
| HRC | Hardness, Rockwell, Scale C |
| IP | Institute of Petroleum |
| ISA | Instrument Society of America |
| ISO | International Standards Organisation |
| LNG | Liquefied Natural Gas |
| LME | Liquid Metal Embrittlement |
| LPG | Liquefied Petroleum Gas |
| MSS | Manufacturers Standardisation Society of the Valves and Fittings Industry |
| NACE | National Association of Corrosion Engineers |
| NB | Nominal Bore |
| NGL | Natural Gas Liquids |
| NPS | Nominal Pipe Size |
| OCMA | Oil Companies Materials Association |
| PP | Poly Proplene |
| PTFE | Polytetrafluorethylene |
| PVC | Poly Vinyl Chloride |

| | |
|---|---|
| PVDF | Polyvinylidene Fluoride |
| UPVC | Unplasticised Poly Vinyl Chloride |

## LIST OF REFERENCED DOCUMENTS

A reference invokes the latest published issue or amendment unless stated otherwise.

Referenced standards may be replaced by equivalent standards that are internationally or otherwise recognised provided that it can be shown to the satisfaction of the purchaser's professional engineer that they meet or exceed the requirements of the referenced standards.

### International Documents

| | |
|---|---|
| ISO 5208 | Industrial Valves - Pressure Testing for Valves |

### American Documents

| | |
|---|---|
| ASME Boiler & Pressure Vessel Code Section I | Power Boilers |
| ASME/ANSI B16.1 | Cast Iron Pipe Flanges and Flanged Fittings, Classes 25, 125, 250 and 800. |
| ASME/ANSI B16.5 | Pipe Flanges and Flanged Fittings. |
| ASME/ANSI B16.34 | Valves - Flanged and Butt-Welding End. |
| API 6A | Specification for Wellhead and Xmas Tree Equipment. |
| API 6D | Pipeline Valves, End Closures, Connectors and Swivels. |
| API 14D | Specification for Pipeline Valves (Steel Gate, Plug, Ball and Check Valves). |
| API 594 | Wafer-Type Check Valves. |
| API 597 | Steel Venturi Gate Valves, Flanged and Butt-Welding Ends. |
| API 599 | Steel Plug valves, Flanged and Butt-Welding Ends. |
| API 600 | Steel Gate Valves, Flanged and Butt-Welding Ends. |
| API 602 | Compact Steel Gate Valves. |
| API 603 | Class 150, Cast Corrosion Resistant, Flanged End Gate Valves. |
| API 606 | Compact Carbon Steel Gate Valves (Extended Body). |
| API 607 | Fire Test for Soft Seated ball Valves. |

| | |
|---|---|
| API 609 | Butterfly Valves, Lug Type and Wafer Type. |
| API 941 | Steels for Hydrogen Service at Elevated Temperatures and Pressures in Petroleum Refineries and Petrochemical Plants. |
| NACE Std MR-01-75 (1990 Revision) | Material Requirements - Sulphide Stress Cracking Resultant Metallic Material for Oil Field Equipment. |
| MSS SP 67 | Butterfly Valves. |
| MSS SP 81 | Stainless Steel, Bonnetless, Flanged, Wafer, Knife Gate Valves. |

**United Kingdom Documents**

| | |
|---|---|
| BS 759 Pt. 1 | Specification for Valve Mountings and Fittings. |
| BS 1212 | Specification for Float Operated Valves. |
| BS 1414 | Steel Wedge Gate Valves (Flanged and Butt-Welding Ends) for the Petroleum, Petrochemical and Allied Industries. |
| BS 1868 | Steel Check Valves (Flanged and Butt-Welding Ends) for the Petroleum, Petrochemical and Allied Industries. |
| BS 1873 | Steel Globe and Globe Stop and Check Valves (Flanged and Butt-Welding Ends) for the Petroleum, Petrochemical and Allied Industries. |
| BS 5150 | Cast Iron Wedge and Double Disk Gate Valves for General Purposes. |
| BS 5146 | Inspection and Testing of Valves. |
| BS 5152 | Cast Iron Globe & Globe & Check Valves for General Purposes. |
| BS 5153 | Cast Iron Check Valves for General Purposes. |
| BS 5155 | Specification for Butterfly Valves. |
| BS 5156 | Screw Down Diaphragm Valves for General Purposes. |
| BS 5157 | Steel Gate (Parallel Slide) Valves for General Purposes. |
| BS 5158 | Cast Iron and Carbon Steel Plug Valves for General Purposes. |

| | |
|---|---|
| BS 5163 | Double Flanged Cast Iron Wedge Gate Valves for Water Works Purposes. |
| BS 5351 | Steel Ball Valves for the Petroleum, Petrochemical and Allied Industries. |
| BS 5352 | Specification for Steel, Wedge Gate, Globe and Check Valves 50 mm and smaller for the Petroleum, Petrochemical and Allied Industries. |
| BS 5353 | Specification for Plug Valves. |
| BS 6364 | Specification for Valves for Cryogenic Service. |
| BS 6755 Pt. 1 | Specification for Production Pressure Testing Requirements. |
| BS 6755 Pt. 2 | Specification for Fire Type-Testing Requirements. |
| EEMUA Publ. No. 167 | Specification for Quality Levels for Carbon Steel Valve Castings. |
| EEMUA Publ No. 192 | Guide for the Procurement of Valves for Low Temperature (Non-Cryogenic) Service. |

**BP Group Documents**

The BP Group RPs and GSs replace the former BP Codes and Standards, for which the old document numbers are given in brackets.

| | |
|---|---|
| BP Group RP 42-1 | Piping Systems. |
| BP Group RP 24-2 | Passive Fire Protection of Structures and Equipment. |
| BP Group GS 162-5<br>BP Group GS 162-6 | Wellhead and Xmas Tree Gate Valves. |
| BP Group GS 136-1 | Materials for Sour Service to NACE Standard MR-01-75 (1990 Revision) |
| BP Group GS 142-7 | Gaskets and Jointing. |
| BP Group GS 142-9 | Bolting for Flanged Joints. |
| BP Group GS 142-2 | Pipe Flanges and Fittings. |
| BP Group RP 30-1 | Instrumentation and Control, Design and Practice. |

# WELLHEAD GATE VALVES

## C1. General

C1.1 This appendix provides a quick guide to assist in the selection of wellhead gate valves and considers features of various types. It is intended to help identify equipment during tender assessments and for equipment replacement, it is not intended to give field specific information which will be specified in a technical specification. For BP general requirements refer to BP Group GS 162-5 and 162-6.

## C2. Valve Types

There are three principle types of gate valve which may be considered for use as wellhead gate valves:-

Floating seat - The seats are spring loaded from the body such that both upstream and downstream seats are always in contact with the gate. In this design both the seat to gate and seat to body seals are dynamic seals.

Fixed seat/Floating gate - The seats are fixed relative to the valve body, the body to seat seal being provided by a static seal. Cavity pressure, forces the gate to float and seal against the downstream seat. A floating connection is required between gate and stems. It is also possible to have the best of both designs and use a fixed seat for the downstream seat and a floating seat for the upstream seat.

Split gate - In this design the gate is effectively spring loaded so as to contact both seats, the seats will generally be of the fixed variety. There are two basic types of split gate design:-

(a) Spring loaded gate maintaining seat to gate contact.

(b) Spring retained wedge design - where the gate is constructed from two wedge halves. The wedges are forced to ride up each other in the closed and open position thus forcing the gate to form an interference fit with the seats and hence a seal.

## C3. Valve Selection

The selection of an appropriate type valve for a particular service must take account of the following aspects.

C3.1 Actuation Method

Valves which maintain seat to gate contact shall be designed to prevent cavity locking effects, i.e. an increase in cavity pressure which generated sufficient opposing force to prevent actuation. In general, this should be achieved by the use of a balance stem arrangements, i.e. an equal diameter stem on both sides of the gate. In this design a pressure assist force valve closure can be generated by supplying upstream pressure behind the balance stem.

The spring retained wedge design will require the generation of very high actuation forces to operate the valve, this generally means the use of a manual actuator or a double acting actuator (rather than a spring return fail safe closed device). For the latter reason this type of valve should not generally be used where closure is required when control system pressure is lost.

Unbalanced cavity valve designs (i.e. single stem of two stems with different diameters) can produce a pressure assist force to assist in valve closure, reducing the size of actuator return spring required. unbalanced cavity valve designs should vent any potential change of pressure due to cavity volume changes to the process bore.

C3.2 Sandy Service

Valves which maintain seat to gate contact are preferable for sandy service, fully fixed seat designs can also be considered if the gate float tolerance is minimised.

Sandy service valves should feature sufficient debris seals and scrapers to prevent sand ingress into the gate, seat and stem sealing faces.

C3.3 Valve Requirements

C3.3.1 General

The valve should be of minimum complexity.

The valve should either have a proven track record or have been previously rigorously tested.

* C3.3.2 The chosen supplier should operate a proven and BP approved QA system.

C3.3.3 Valve Stem Seals

Stem seals shall in general consist of:-

(a) A scraper to remove debris from the stem.

(b) A primary seal which should be metallic. The scraper and metal primary seal may be incorporated as one device.

(c) A backup seal which should be constructed from a material highly resistant to chemical attack and explosive decompression damage. Typically the backup seal should be constructed from glass reinforced PTFE and incorporate a spring energiser for low pressure sealing.

Many valve designs incorporate a stem arrangement where a profile on the stem can contact against a mating face in the bonnet in order to form a high pressure seal. This arrangement is beneficial in two ways:-

It forms a further seal, possibly allowing changeout of the stem primary and backup seal whilst still under pressure.
It prevents ejection of a disconnected stem out through the bonnet.

The use of elastomeric materials for stem seals is undesirable due to their relative poor resistance to explosive decompression and chemical attack from chemicals such as methanol and scale inhibitor. The stem seal material shall be carefully selected in order to avoid attack from any specified or likely process fluid.

The process fluid temperature and pressure will have a major effect on stem seal selection. PTFE glass reinforced stem seals are generally suitable up to temperatures of 120ºC combined with pressures up to 15000 psi, a metal seal could be suitable service above this limit. An extended bonnet design may be adopted in order to locate the stem seal in a lower temperature area more remote from the high temperature fluid.

Fire tested valves will require to have stem seals which are of a suitable high temperature material (i.e. metal) or the seal will need to be shielded from the high temperature effects.

The stem itself should be hard coated to avoid any scoring from debris and galling damage with the scraper or metal stem seal.

C3.3.4 Seat to Body Sealing

Floating or fixed seat designs are generally acceptable.

Gate to seat sealing both high and low pressure should be effected by metal to metal contact only. The gate to seat contact pressure shall be in the region of 3 times that of the process fluid. Sealing systems with insert seals in the seat sealing face are not to be used, such seals have only limited life and can often function as debris traps impairing valve sealing and causing erosion.

The gate and seat surface finish and flatness shall comply with the following if low pressure sealing down to 80 psi is required:-

(a) Be flat to better than 3 light bands using a helium laser source.

(b) Have a surface finish of better than 8 CLA.

In the case of process fluid containing debris a sandy service type design of valve should be utilised. The design shall prevent damage from any particles being trapped between the downstream seat to gate sealing surface. This prevention can either be achieved by:-

(a) Adopting spring loaded seats which always maintain contact with the gate.

(b) Minimising the gate float in the case of a floating gate design and using hard gate/seat materials.

(c) Adopting a split spring loaded gate design.

Note: Chamfers on the seat OD shall be avoided. They can act as debris traps and cause scoring damage of the gate and seats.

C3.3.5 Seat to Body Sealing

The seat to body sealing should avoid the use of any elastomeric seal. A metal to metal seal is preferred in this location for high and low pressure sealing.

In the case of a floating seat design the seal used shall be capable of accepting repeated compression and expansion due to the seat movement. The sealing faces shall also be protected by debris or scraper seals to prevent build up of debris which could impair the float or sealing integrity.

C3.4 Materials

Material requirements will be covered in a technical specification (particularly in reference to the fluid class) and in BP Group GS 162-5 and 162-6.

In general, the following material guidelines are provided in reference to the API fluid classes (latest Edition API 6A).

| **Fluid** | **Body/Bonnets** | **Valve Gate** | **Seats** | **Gasket** |
|---|---|---|---|---|
| AA | Alloy Steel + Inlayed Pockets/Seal Preps | Alloy Steel + Tungsten Carbide Overlay | Solid Carbide or Stellite | 316 SS |
| BB | Alloy Steel + Inlayed Pockets/Seal Preps | Alloy Steel + Tungsten Carbide Overlay | Solid Carbide or Stellite | 316 SS |
| CC | Alloy Steel with Inconel Cladding | Inconel + Tungsten Carbide Overlay | Solid Carbide or Stellite | Nickel Alloy |
| DD | Alloy Steel + Inlayed Pockets/Seat Preps | Alloy Steel + Tungsten Carbide Overlay | Solid Carbide or Stellite | 316 SS |
| EE | Alloy Steel + Inlayed Pockets/Seat Preps | Alloy Steel + Tungsten Carbide Overlay | Solid Carbide or Stellite | 316 SS |
| HH | Alloy Steel with Nickel Alloy Cladding | Nickel Alloy + Tungsten Carbide Overlay | Solid Carbide or Stellite | Nickel Alloy |

The need for hard gate and seat materials shall however be reinforced. Typically gate and seats in the order to 50 HRC should be utilised, with a differential hardness of approximately 5 HRC between seats and gate. These hardness values will provide long term wear resistance and avoid abrasion damage.

The stems shall be constructed from a wear and corrosion resistant material to avoid damage from hard particles and to prevent any galling action with metal stem seals. Typically a tungsten carbide coating will be required on top of a corrosion resistant substrate material.

C3.5 Supporting Calculations

The manufacturer shall provide:-

(a) Calculations showing the sealing pressure developed by the seat to gate contact.

(b) Calculations of the maximum gate drag, stating what seat to gate coefficient of friction is used.

(c) Calculations of the stem buckling load showing that buckling will not occur.

(d) Calculations justifying pressure retaining boundary.

C3.6 Previous Testing

Evidence of previous satisfactory testing of the valve design shall be given. These tests shall include:-

High pressure hydrostatic tests

Low pressure hydrostatic tests

Low pressure air tests at 80 psi

API 14D test for sandy service conditions (if sandy service is required)

## *BLOCK VALVE TYPES*

*This Commentary relates to clause 3.2.*

### *D1. Ball Valves*

*D1.1* *A low torque quarter turn valve, with low resistance to flow, suitable for many on-off utility and process services. It has a straight through configuration typical of the sliding method of closure. It is not generally used for throttling applications in its standard form because of the potential for seat damage and cavitation. There are several designs including the floating ball, eccentric ball and trunnion mounted ball types. Most designs are double seated but there are some special single seated designs.*

*The majority of valves have soft seats, usually PTFE which limits the maximum working temperature and makes the valve unsuitable for abrasive service. Graphite seats are also available. Metal to metal seated designs can however be purchased and these are suitable for abrasive service. Reduced bore valves are not recommended for very high velocities of fluids containing solids. Where scaling may take place on the ball surface, metal seats with a scraping action to clean ball should be specified.*

*Soft seated ball valves are excellent for clean service but lips of soft seals are easily damaged by hard particles, solids can also become trapped in body cavities. When the fluid is dirty, or hard particles are present, hard faced balls and seats may be recommended together with a block and bleed facility (e.g. export oil/sandwash). Plated balls should be avoided. Gate valves may be preferred for some of these services.*

*D1.2* *The body design features vary and can be defined as follows:-*

*(a) One Piece:-*

*(i) Axial entry (ball fitted through body ends).*
*(ii) Top entry.*
*(iii) Bottom entry.*
*(iv) Sealed type.*

*(b) Split-Body:-*

*(i) Two Piece - (Comprising of body and body connector)*

*(ii) Sandwich - (Comprising of body and two body connectors) enables body to be removed from line leaving body connectors attached to mating pipework. Has additional joints which could leak. The body connectors usually retain ball seals, the removal and replacement of body could affect seal loading.*

*(iii) Constrained - (Comprises of a body and two ends) arranged such that the body cannot be removed without significant displacement of the pipe.*

*D1.3 Valves may be characterised by the method used to support the ball:-*

*(a) Seat Supported and Floating Ball Type*

*These are designed to support the ball with two seats in the valve body on up and down stream sides. The upstream pressure presses the ball on the downstream seat, compressing the seal and shutting off fluid flow. Some valves have pre-compressed seats providing a double block and bleed function, these should have features to allow relief of the body cavity pressure. Seat supported valves are generally used in small bore piping or low pressure clean service classes 150-300. Larger sizes and higher pressures result in high seat loads and operating torques.*

*(b) Trunnion Supported Type*

*These have the ball mounted on trunnions supported in body bearings above and below the ball. Sealing is achieved by a spring loaded seat inserted in a retainer which shuts off flow using line pressure. This provides automatic cavity relief. Can be used for double block and bleed only when pressure acts from opposite directions.*

*Trunnion supported designs are available in the larger sizes and used for higher pressure service, they have lower operating torque requirements than seat supported types.*

*D1.4 Where soft seats are specified, shrouded designs with a large contact area are recommended to minimise seat damage.*

*D1.5* *For high temperature service, graphite or metal to metal seats should be specified.*

*D1.6* *Soft seated socket or butt weld end valves for sizes up to 1 ½ NPS should be provided with end nipples welded in place by the manufacturer prior to valve assembly, the valves having an overall length of 400 mm. The carbon content of socket or butt-welding components shall be limited to 0.25%.*

* *D1.7* *Valves with Chromium plated balls shall not be used. Subject to BP approval, nickel plating may be used (see para G6.1). For abrasive service balls and seats faced with Stellite 6 or equivalent should be used. The material and method of deposition shall be subject to approval by BP.*

*D1.8* *Valves with welding ends shall only be specified for sizes up to and including 1 ½ NPS, above this size flanged valves shall be used except where external leakage is totally unacceptable. Flange valves sizes 1 ½ NPS and below shall normally only be used on equipment connections, tank nozzles and header branches.*

*D1.9* *Where Class 150 short pattern valves sizes 12 NPS and 16 NPS are specified rather than long pattern types the ball may protrude beyond the body end flange faces when the valve is closed. Such valves cannot be used where spading is envisaged, cannot be easily removed when in the closed position and should be avoided.*

*D1.10* *Steel ball valves shall comply with BS 5351 or API Spec. 6D and, where specified with soft seats, shall be a fire safe design to BS 6755 Part 2 or API 607 and fitted with an anti-static device.*

*The requirement for fire tested valves may be waived for valves used in areas not defined as fire risk. For important isolation duties in fire risk areas, external protection may also be specified by the purchaser.*

* *D1.11* *Pressure/temperature ratings shall comply with the requirements BS 5351 or API Spec. 6D. These ratings may require to be limited subject to the manufacturers recommendations and details of the seat material. High ratings based on the manufacturers recommendations shall only be used subject to the approval of BP. Valve designs to API Spec. 6D shall be subject to approval by BP.*

*D1.12* *Valves which rely on sealant injection to seal damaged seating surfaces shall not be used on dirty services.*

*D1.13* *Cam action stem valves having a single seat with inserts are not suitable for scaling services. This type of valve is usually used on high* *or low temperature gas service. They are not generally recommended for pigged lines, but if used on this duty the pig and valve manufacturers should be consulted. Some of these valves may require studs instead of stud bolts in end flanges, and reference should be made to manufacturer's catalogue. Metal seated valves may have a substantially higher differential pressure capability than conventional soft seated ball valves.*

*D1.14* *Where rapid closure of the valve could cause water hammer, gear operated valves shall be used.*

## ***D2. Butterfly Valves***

*D2.1* *A low torque, quarter turn, rotary action valve with a straight through flow configuration in which the disk is turned through 90 degrees, closed to open position, in axial trunnion bearings and is used as a control or block valve. It is of compact design and may be obtained with or without flanges and linings. Seating arrangements may be soft (use of body lining, trapped 'O' ring etc.) or metal to metal.*

*They generally do not provide the lowest resistance to flow, especially as the size decreases, due to the increasing intrusion of the disc in the flow path, but may be used where resistance to flow is not critical. The configuration also imposes pressure limitations. The closing method can provide good shut off and various degrees of seat leak tightness, dependent on the design. Butterfly valves are generally suitable for bi-directional sealing but some designs have a preferred direction of flow.*

*Seating arrangements may be soft (use of body lining, trapped 'O' ring etc.) or metal to metal.*

*Butterfly valves have the following disadvantages:-*

*(a) Line cannot be pigged.*

*(b) Create higher pressure drop than full bore gate or ball valves.*

*(c) Require to be withdrawn from line for maintenance.*

*(d) Block and bleed facility not available unless two valves or double disk type are installed.*

*D2.2* *Butterfly valve designs available are:-*

*(a) Conventional type supplied to BS 5155 generally suitable for:-*

(i) *ANSI B16.1 class 125 iron flanges.*

(ii) *ANSI B16.5 class 150 steel flanges.*

(iii) *Maximum shut-off pressure: generally 14 bar. Refer to manufacturer's catalogues.*

(iv) *Tight shut-off generally below 120°C, dependent on resilient lining. Refer to manufacturers' catalogues.*

(v) *Shut-off, with allowable seat leakage, to 425°C for metal seated valves.*

(vi) *On-off or control service. (Notes: when used for control, butterfly valves exhibit high pressure recovery downstream and are thus susceptible to generating cavitation in liquid service.)*

(vii) *Non-demanding corrosive service.*

(viii) *Large flows of gases, liquids, slurries, liquids with solids in suspension.*

(ix) *Fire safe application.*

*Body Patterns available are:-*

(a) *Double flanged - having flanged ends for connection to pipe flanges by individual bolting.*

(b) *Wafer - primarily intended for clamping between pipe flanges using through bolting with a body of one of the following patterns:-*

  (i) *Single flange or lug type - incorporating drilled or tapped holes.*

  (ii) *Flangeless - fitted inside the bolt circle.*

  (iii) *U-Section - with flanges, but generally may not be assumed suitable for individual bolting of each flange to the pipework.*

(c) *'High performance' type. This refers to valves with offset disk/seats which are suitable for higher pressures to BS 5155 and API Std. 609. The term does not exclude conventional* *form having a high performance within their pressure/ temperature range.*

*'High performance' valves are suitable for:-*

*(i) ANSI B16.5 class 150-600 steel flanges. (Note that there are limited suppliers of class 600 valves).*

*(ii) Pressure/temperature ratings to ANSI B16.34 and differential pressure to full flange rating except where restricted by resilient seat material.*

*(iii) Tight shut-off, using resilient seats, to 260ºC.*

*(iv) Shut-off, with allowable seat leakage, to 538°C for metal seated valves.*

*(v) On-off or control service. (See (a) (vi) page 45).*

*(vi) Large flows of gases, liquids, slurries, liquids with solids in suspension.*

*(vii) Fire safe application.*

*(viii) Cryogenic Service*

*Body patterns available are normally restricted to single flange/lug type or flangeless wafer type.*

*D2.3 Conventional butterfly valves are supplied with iron or steel bodies, iron valves shall not be used for process duties hazardous service or where freezing is a possibility. The valve stem is generally mounted through the vertical axis of the disk. For tight closure the disk/seat interface must be suitably designed, particularly around the stem. Tight closure can be achieved by mounting the disk eccentrically on the stem/shaft providing an uninterrupted 360 degrees seal.*

*D2.4 'High performance' butterfly valves are supplied with steel or alloy bodies, with stem mounted eccentrically on the disk.*

*D2.5 Single flange (lug) type valves with replaceable seats may not be suitable for dead-end service without the use of a downstream companion or blind flange. The manufacturer shall state in his quotation the suitability of valve for dead-end service.*

*D2.6 A wafer type butterfly valve in which the resilient seat is extended to serve also as a line gasket should only be installed between weld neck or socket weld pipe flanges. Slip-on or threaded flanges may not provide an adequate seal.*

D2.7 *Vulcanised linings are difficult to renew, and are not recommended.*

D2.8 *Lined valves should not be specified for sticky fluid services, but may be specified on gritty services for proven designs.*

* D2.9 *A valve in which the gasket contact area is reduced by counterbored or countersunk holes for retaining screws, used to secure seat ring assemblies in the valve body, shall not be used unless approved by BP. When specified, it shall be used only with the gasket manufacturer's recommended gasket, contact area, and surface finish. Spiral wound gaskets shall not be used on such valves.*

D2.10 *As the distribution of static fluid pressure on the disk may produce a strong closing torque, larger size valves should be equipped with self-locking gearing or other substantial stem restraints.*

D2.11 *On liquid service, manually operated valves located such that rapid closure could produce water hammer shall be gear operated. Alternatively, if suitable, a gate valve may be specified.*

D2.12 *The user should ensure the disk, when fully or partly open, will not foul adjacent valves, fittings or connected pipework particularly when assembled with cement or rubber lined pipe.*

D2.13 *Flangeless wafer type valves with long exposed bolts, may leak when subject to high or low temperatures and if exposed to fire due to expansion of the bolts.*

* D2.14 *Flangeless wafer type valves shall not be used for flammable or toxic service without approval by BP. Where such valves are used, a light gauge stainless steel shroud shall be wrapped around the valve and exposed bolts irrespective of service. Alternatively, lug type valves may be considered subject to approval by BP.*

*In order to limit flange seal leakage in toxic service or where fire hazard exists, bolting should be kept as short as possible.*

* D2.15 *Wafer-type valves shall not be used where it is required to dismantle a pipeline leaving the valve at the end of the pressurised line. Valves having tapped holes shall not be used in this application without approval of BP.*

*Bolts may become rusted in bodies and difficult to remove, nuts can be cut or burnt off.*

*D2.16* *Butterfly valve standards are:-*

*(a)* *BS 5155 -* *Specifies requirements for double flanged and wafer types of metal seated, resilient seated, and lined cast iron and carbon steel valves.*

*These valves are supplied to ANSI class 125, 150 and 300 and ratings PN25 and PN40. Refer to Standard for pressure/temperature ratings.*

*(b)* *API Std. 609 -* *Specifies requirements for wafer type and lug type valves of cast iron, ductile iron, bronze, carbon steel or alloy steel construction. Valves may be metal seated, resilient seated, or lined. Conventional type valves and high performance type valves are covered: conventional to ANSI class 125 and 150 with a maximum pressure differential of 14 bar, and high performance valves to ANSI class 600.*

*(c)* *MSS-SP 67 -* *Specifies requirements for double flanged and wafer types of metal seated, resilient seated, and lined cast iron, carbon steel, bronze valves to ANSI class 125, 150 and 300.*

*D2.17* *Valves to different standards may not be interchangeable because of differing face-to-face dimensions, where necessary care in specifying standards may be required to restrict inventory.*

## *D3. Gate Valves*

*D3.1* *Gate valves are used for on/off operation on non-vibrating hydrocarbon, general process and utilities service for all temperature ranges. They have straight through configurations which are typical of the sliding method.*

*Gate valve types are:-*

*(a)* *Wedge*
*(b)* *Parallel Double disk (internal wedge)*
*(c)* *Parallel Slab/Conduit*
*(d)* *Parallel Slide*
*(e)* *Knife-edge*
*(f)* *Venturi*
*(g)* *Corrosion resistant*
*(h)* *Compact*

*D3.2 Gate valves should not be used for:-*

*(a) Installation in horizontal lines transporting heavy or abrasive slurries where sediment may become trapped in the pocket below the valve seat, preventing closure. (Except for reverse acting conduit or knife-edged types).*

*(b) Throttling duties generally, as erosion of seats and disk may cause leakage. However, gate valves may be used for control valve bypass duty on class 150-600 sizes 10 in. n.b. and over, and class 900-2500 sizes 8 in. NB and over.*

*D3.3 Gate valves have the following stem arrangements:-*

*(a) Inside screw: rising or non-rising stem*

*(b) Outside screw: rising or non-rising stem*

*D3.4 An outside screw, rising stem valve is easier to maintain, allowing access for lubrication of the thread. In marine environments the rising stem and threads should be protected against corrosion, or corrosion resistant material should be specified.*

*D3.5 Where headroom is limited, a non-rising stem type valve may be specified. As the stem thread is within the body and is exposed to the line fluid, this type is unsuitable for corrosive or slurry service where excessive wear may occur on threads, or for high temperature applications where expansion and contraction may cause thread binding. BS 5352 restricts carbon steel valves of this type to a maximum temperature of 425°C.*

*D3.6 When quick and frequent operation is necessary, and taking account of water hammer, ball valves or in some instances plug valves, having quarter turn operation, are preferred rather than a relatively slower operated gate valve.*

*D3.7 Wedge Gate Valve*

*(a) Steel wedge gate valves are classified by wedge type: plain solid wedge, flexible solid wedge; split wedge. A flexible solid wedge may more easily accommodate misaligned seats and minimise galling of sealing surfaces. A plain solid wedge may be more difficult to grind to an accurate fit.*

*(b) Solid wedge gate valves are good general block valves offering a good sealing capability with low pressure drop. A 100%*

*shut-off capability cannot always be relied upon however, and slight leakage may occur with variations in temperature and pressure after being in service sometime. For hydrogen service, double (two) wedge gate valves should be used for shut-off applications. Extended bonnets are available for cryogenic service.*

(c) *Wedge gate valves are prone to 'thermal wedging' when subjected to temperature changes after closure. In these and similar conditions, where the valve body may deform following a change in process conditions, a split wedge type valve to API Standard 600 may be specified. This has a two-piece gate which can adjust to changes in seat angle whilst maintaining a good seal.*

(d) *Wedge gate valves may have seating problems on dirty service due to material collecting on seats or in base of valve but may give a better life than soft seated ball valves. Services with abrasive particles or applications where wire drawing is possible will require hard faced wedges and seats. Conduit or parallel gate types give increased service lift when used with fluids containing solid particles because the gate cleans the seat and there is less chance of solids entering body cavities.*

(e) *Some special rubber seated designs have good sealing characteristics when used on applications containing solids but have limited pressure and temperature range, other soft seats may be damaged by hard particles.*

(f) *Flat sided designs are economical in terms of space and cost but their use should be restricted to the low pressure ratings.*

(g) *Steel valves below 2 in. NB have plain solid wedges and shall comply with BS 5352 or API Standard 602.*

(h) *Steel valves size 2 in. NB and above shall comply with BS 1414 or API Standard 600. The standard steel wedge gate valve 2 in. NB and above normally has outside screw and yoke, rising stem, non-rising handwheel, and bolted bonnet.*

(i) *Cast iron valves shall not be used except for underground water services where freezing is not a possibility and shall comply with BS 5150 or BS 5163.*

*D3.8 Parallel Double Disk Gate Valve (Expanding Wedge)*

*(a) This valve has parallel seats and an internal spreading device which forces the two disks against the body seats at point of closure, providing a tight seal for liquid or gas service without the assistance of fluid pressure.*

*(b) Should not be used on steam service, as the increased differential pressure resulting from condensate forming between the disks may result in leakage.*

*(c) Steel valves shall comply with API Standard 600 or API Spec. 6D.*

*(d) Cast iron valves - see CM3.3.7 (i).*

*D3.9 Parallel/Conduit Gate Valve*

*(a) This valve has a single parallel faced slab gate, incorporating an aperture the same diameter as the valve bore. When the gate rises to the fully open position it allows free and uninterrupted flow. The body cavity is sealed off by the gate when the valve is fully open or closed. Valves may have rising or non-rising stem, can be obtained with a reduced bore, and are available in reverse acting version where the gate rises to close the valve.*

*(b) The seats are usually pressure energised onto the gate and double block and bleed designs are available. Metal seated versions of the valve are amongst the most suitable for dirty or abrasive service.*

*(c) The basic design is suitable for use on a wide range of applications e.g. well head isolation, large diameter piping, storage tanks, and on pipeline service where pigs may be passed through the line.*

*(d) Steel valves for process applications shall comply with API Spec. 6D.*

*D3.10 Parallel Slide Valves*

*(a) The design feature of parallel slide valves is to maintain a high degree of fluid - tightness without the aid of a wedging action. This is normally achieved by two sliding discs maintained in close contact with the seats with a non-corrodible spring when not under pressure. Effective closure is obtained by pressure*

*of fluid forcing the downstream disc against the mating body seat. Because of this, the valve will not provide tight shut-off at very low or zero differential pressure.*

*(b) On opening, the discs slide over the seat faces completely clear of the bore giving full flow through the valve.*

*(c) Sealing capability and operability are virtually unaffected by wide temperature variations.*

*(d) These valves are recommended for applications where good shut-off characteristics are required for steam headers, steam isolation, feed water and blowdown applications (where they are used in tandem with a sacrificial globe valve).*

*(e) Flanged steel valves class 150-600 shall comply with BS 5157, except that blowdown service valves are to manufacturer's standards, but complying with BS 759 Part 1 or ASME Power Boiler Code Section 1.*

*(f) Socket-weld and butt-weld valves for all classes are to the manufacturer's standards.*

*D3.11 Knife-Edge Gate Valve*

*(a) This valve has a bevel or knife-edged gate, and is designed to handle slurries etc. liable to obstruct a wedge gate. The knife-edge pushes aside or cuts through solids in the flow.*

*(b) The valve is generally designed to manufacturer's standard. A stainless steel bonnetless version is available to MSS-SP-81.*

*(c) Body materials suitable for most corrosive services are stainless steel types 304, 316 or 347.*

*D3.12 Compact Carbon Steel Gate Valve (Extended Body)*

*(a) These are small (1 ½ in. n.b. max.) valves having one end extended to permit direct threaded or welded attachment to the pipe and a threaded or socket weld female connection on the other end. Otherwise the valve characteristics match those of API Standard 602.*

*(b) The valve may be used as a primary isolator for pressure measurement, vents or drains. use of the valve eliminates a pipe nipple and weld joint where applicable.*

*(c)* *The valve shall comply with API Standard 606.*

*D3.13* *Venturi Gate Valve*

*(a)* *In this valve the seat openings are smaller than the end ports. The pressure drop through the valve can be up to twice that of a full bore valve but is generally negligible in relation to the whole piping system.*

*(b)* *The advantages of this valve compared to the full bore type are: lighter weight, lower cost, and easier operation.*

*(c)* *When valves are installed in horizontal pipe runs line drainage may be necessary.*

*(d)* *Wedge gate type valves shall comply with API Standard 597.*

*(e)* *Parallel slide type valves shall comply with BS 5157.*

*D3.14* *Corrosion-Resistant Gate Valve*

*(a)* *Class 150 valves may be specified to API Standard 603.*

*(b)* *Valves above class 150 should be specified to BS 1414 or API Standard 600.*

***D4. Globe or Screw-Down Stop Valves***

*D4.1* *The globe or screw-down stop valve is used for flow regulation or as a block valve where resistance to flow is not critical and a positive closing action is required. They have a tortuous configuration which is typical of the closing method and results in a higher resistance to flow compared with other valves. The configuration of the flow path is normally only suitable for uni-directional flow. High un-balance forces on single seated disc or plug designs tend to prevent opening with reverse flow but may be reduced in double seated designs.*

*D4.2* *The types are:-*

*(a)* *Globe*

*(b)* *Oblique*

*(c)* *Angle*

*all of which can be provided in needle pattern. The oblique and angle type have much lower flow resistance than the straight-through globe.*

*D4.3* *Steel valves below 2 in. NB shall comply with BS 5352.*

*D4.4* *Steel valves 2 in. NB and above shall comply with BS 1873.*

*D4.5* *Cast iron valves shall comply with BS 5152.*

*D4.6* *Globe, oblique or angle valves may be used to advantage for frequent on-off operation on gas or steam service because of a relatively short disk travel. For this operation the following disk are suitable:-*

*(a)* *Flat seat disk: with a metal-to-metal seat or a soft seal ring incorporated in the disk or seat ring. A soft seal ring type may be specified where foreign matter might prevent tight closure or score seating surfaces of metal-to-metal seats. The soft seal may be easily replaced. Soft seal rings are limited to their maximum allowable temperature.*

*(b)* *Types where the disk has a tapered or spherical seating surface, and provides a narrow contact against a conical seat. The narrow contact area tends to break down hard deposits that may form on the seat.*

*D4.7* *Oblique type valves have a relatively straight flow path, and are suitable for on-off or throttling duty on abrasive slurry or highly viscous services. Globe valves are not recommended for these services.*

*D4.8* *Angle type valves, when fitted at a change in direction of piping, save one bend or elbow and have the advantage of a smaller pressure drop than that for a globe valve. These valves are not extensively used because:-*

*(a)* *The 90 degrees bend in process piping may subject the valve to considerable stress at operating temperature.*

*(b)* *The handwheel may be placed in only one position with respect to the piping.*

## *D5. Plug Valves*

*D5.1* *Plug valves have quarter turn operation, plugs are tapered or parallel plugs, and are suitable for most on-off clean process and utility services, including non-abrasive slurries. They have straight through configurations typical of the sliding method. When used for throttling, special trim is necessary. Full bore, round port valves only are suitable for pigging, and when required for this duty the manufacturer* *shall be consulted. While plug valves are generally cheaper than ball valves, in the longer term, for some designs excessive operating torque and unacceptable leakage (on lubricated types) may make them less economic. Lubricated types require regular maintenance and PTFE sleeved and lined designs have temperature limitations.*

*Certain designs of fully lined or sleeved plug valves have excellent leakage performance, both down the line and to atmosphere and are specifically used for caustic, chlorine and similar services. 'Fire safe' glands are available from some manufacturers. The method of fitting or keying in the sleeve of PTFE sleeved valve is important to prevent creep of the sleeve and to maintain a low operating torque.*

*Lubricated types have been traditionally used for caustic, towns gas and sometimes for maintenance compressed air service. Valves for chlorine service shall have a drilling to vent plug and any body cavity to upstream port.*

*Fire tested glands can be obtained for sleeved valves. A fire tested plug valve cannot seal down the line once the sleeve is damaged. However, plug valve sleeves take longer to suffer damage than ball valve seals.*

*On dirty service the seats will normally be wiped clean. There are no cavities for trapping solids. The sleeves can sustain some damage before eventually leakage occuring. Dirty service could increase the already high operating torque.*

*D5.2* *Plug valves are made in four patterns, with port shapes and areas as follows:-*

*(a)* *Round opening pattern:* *full bore round ports in both body and plug (API Std. 6D, API Std. 599).*

*(b)* *Regular Pattern:* *substantially full area seat ports of rectangular or similar shape.*

*(c)* *Venturi Pattern:* *reduced area seat ports or round, rectangular or similar shape. Less expensive, with lower operating torque requirements than a regular pattern valve; recommended for use in larger sizes.*

(d) *Short Pattern:* *substantially full area or reduced area seat ports of rectangular or similar shape, with face-to-face dimension corresponding to wedge gate valves. Not recommended in larger sizes because the short length results in a small port area with abrupt change of throat shape between the flanges and plug.*

*D5.3* *Plug valve types are:-*

(a) *Lubricated plug:* *lubricant is injected under pressure between the plug face and body seat to reduce friction, provide port sealing, and to permit sealant jacking action to unseat the plug when it is tapered. Available in parallel and taper versions.*

(b) *Non-lubricated plug:* *incorporates mechanical design features to reduce friction between the plug face and body seat during operation by lifting the plug, or, in the split plug type valve, by contracting the plug. Fully PTFE lined or PTFE sleeved valves are also available.*

*Plug surfaces may be:-*

(i) *Hard faced or hardened by heat treatment to prevent galling.*

(ii) *Provided with an elastomeric coating.*

(iii) *Provided with soft seats.*

*D5.4* *Sleeved plug valves are of the tapered design and incorporate a polymeric sleeve (usually PTFE) in the body. Normally only available in the lower pressure ratings, they can provide good leak tightness.*

D5.5 *Expanding plug valves are of the parallel design and incorporate a split plug with an internal wedge mechanism which is used to force the plug halves against the seats on closure and to release them on opening. Soft seal rings are usually employed and the design is capable of excellent sealing. These valves are suitable for use in double block and bleed applications.*

D5.6 *Lifting (or wedge) plug valves are of the tapered design and utilise an operating mechanism whereby the plug is lifted from the seat prior to turning open or closed, the object being to reduce operating torque whilst maintaining good sealing capability.*

D5.7 *Eccentric plug valves are of the parallel design utilise a cam action to drive a half-plug onto the downstream seat. Designs are limited to the lower pressure ratings and lined versions are available.*

D5.8 *Lined plug valves are of the tapered design and are fully lined (plug and body) for chemical resistance.*

D5.9 *Parallel plug valves relying on lubrication to seal and protect the seats may be subject to through leakage. For bubble tight service, parallel plug valves should be to a soft seated design rather than a lubricated type.*

D5.10 *Lubricated plug valves are not generally recommended because:-*

*(i) Requires a lubrication programme to be maintained. The current lubricant must be used to suit the fluid.*

*(ii) Is subject to the temperature limitations of the lubricant.*

*(iii) Is unsuitable for throttling duty.*

*(iv) Lubricant may be washed from the plug face to contaminate the process stream.*

*(v) Some process fluids of very low lubricity may dissolve the lubricant from the plug so that the valve may tend to gall.*

*(vi) Unsuitable for dirty or abrasive service.*

D5.11 *Tapered plug valves have the following disadvantages:-*

*(i) May be difficult to free after prolonged setting in one position.*

*(ii) Unsuitable for dirty or abrasive service.*

*(iii)* *High operating torque (although this may be alleviated by using a lift type valve, a low friction coating or a lined or sleeved valve).*

*(iv)* *Some designs of PTFE sleeved plug valves have a high operating torque.*

*(v)* *Is subject to temperature limitation of elastomer/polymer sleeve or plug coating.*

*Pressure balanced valves are not recommended for abrasive service.*

*D5.12* *Soft seated valves shall be fitted with an anti-static device.*

*D5.13* *Soft seated lift type plug valves may be considered for tight shut-off applications. For abrasive service a metal-to-metal seat lift type plug valve is available, but may require seat flushing. Metal seated ball valves are preferred.*

*D5.14* *When used on liquid service, manually operated valves located such that rapid closure could produce water hammer shall be gear operated. Alternatively, if suitable, specify a gate valve.*

*D5.15* *Multiple port plug valves are available. These may simplify piping layout, reduce the number of valves required, and eliminate elbows or tees.*

*D5.16* *Multiple port arrangement may be such that one channel closes before another begins to open, preventing mixture of fluids or loss of pressure. Alternatively, some valves have greater port width so that in turning the plug, a new channel begins to open before the former channel is completely closed. This alternative may be used where it is necessary to carry out switching operation without stopping the flow at any time.*

*D5.17* *Multiple port valves can only provide closure when the operating pressure holds the plug against the body port which has to be shut off from the higher pressure. Leakage may occur when the operating pressure tends to push the plug away from the body port which has to be shut off. For vacuum applications ensure that the vacuum tends to hold the plug against the body port which has to be shut off.*

*D5.18* *4-way valves are intended for directional control only, and cannot be expected to hold high differential pressure without leakage from one side of the valve to the other.*

*D5.19* *For corrosive services lined valves may be specified.*

*D5.20* *Cast iron straight-way plug valves shall comply with BS 5158.*

*D5.21* *Steel straight through plug valves shall comply with BS 5353, API Standard 599 or API Spec. 6D.*

*D5.22* *Cast iron or steel multiple port valves are supplied to manufacturer's standard but shall be generally in accordance with the requirements of BS 5158, BS 5353, or API Standard 599.*

## *D6. Diaphragm Valves*

*A valve used for block and control functions. The closure is a resilient diaphragm seating in the valve body. The diaphragm also provides the joint between the body and bonnet and often the stem seal as well. Diaphragm valves are either manually operated by a handwheel closing device or by fluid pressure, normally air. Manually operated valves are typically of multi-turn operation.*

*Diaphragm valves have straight through flow or weir configurations employing the flexing method and may be used for low pressure chemical plant process for on/off or regulating operation of most gases and liquids, e.g. slurries, viscous fluids and fluids which are chemically aggressive. They are supplied with various types of diaphragms and linings. Standard valves are normally supplied with mallable iron bodies which are not acceptable for petrochemical duties. Steel valves are available, diaphragms are subject to wear and frequent maintenance may be required for regularly used valves. The pressure/temperature limitations are severely restricted by the limits of the membrane.*

*The standard body configurations are:-*

*(a)* *Weir type valve*

- *(i)* *Tight shut-off is obtained with comparatively low operating force and short diaphragm movement.*
- *(ii)* *Longer diaphragm life, reduced maintenance.*
- *(iii)* *Better throttling device than straight-through type, although flow control is poor at very low flow rates.*

*(b)* *Straight-through type valve*

- *(i)* *Better than weir type when handling viscous fluids, thick slurries, and fluids containing deposits.*

*(ii)* *Longer diaphragm movement, which decreases diaphragm life, increases maintenance and, requiring more flexible diaphragm, limits the material to elastomers.*

*Valves have operating temperatures limited by the material used for the diaphragm or body lining.*

*Diaphragm valves generally do not require packing, and having only three main parts - body, diaphragm, and bonnet assembly, may be quickly dismantled for maintenance. Diaphragms may be changed in place.*

*For very corrosive or toxic service a special bonnet, with packing box to prevent leakage in the event of diaphragm failure, shall be specified.*
*Valves shall comply with BS 5156.*

*Their operating temperature is normally between -65°C to 200°C depending on the diaphragm material and any linings.*

## *D7. Pinch Valves*

*D7.1* *Pinch valves have straight through configurations and are basically a reinforced rubber or elastomer tube or sleeve in a housing which is pinched for closure.*

*D7.2* *The sleeve may be exposed with flanged ends but generally it is encased in a metal body. It is suitable for both pneumatic or hydraulic control. An enclosed valve may also be used for vacuum service subject to the manufacturers approval.*

*D7.3* *Pinch valves are suitable for fine control or on-off operation on abrasive slurries, fluids with suspended particles, powders or corrosive chemicals.*

*D7.4* *Valves are easily maintained with occasional replacement of sleeve.*

*D7.5* *Pressure and temperature ratings are restricted by sleeve material.*

*D7.6* *Valves are supplied to manufacturer's standards.*

## *D8. Sampling Valves*

*D8.1* *Sampling valves are small bore valves generally similar to flush bottom valves, designed to draw off fluids from process streams, and* *are screwed into a half coupling or threadolet type fitting welded to a vessel or pipe.*

*D8.2* *Valves are suitable for use with liquids or slurries, and because they are flush bottomed create a minimum of turbulence.*

*D8.3* *Valve design assures a free flowing sample, because the piston takes up the whole interior of the valve in the closed position so that sediment cannot accumulate.*

*D8.4* *The piston travels through a PTFE seal which may allow leakage unless the gland packing is compressed correctly. With too much compression the seal will flow inward, preventing reinsertion of the piston.*

*D8.5* *As operation of the valve requires long piston travel, it will be slow to open or close.*

*D8.6* *Sampling valves described above should only be used when the conventional valving arrangement is not suitable, e.g. where plugging can occur.*

*D8.7* *Other types of sampling valves are available, generally as small bore instrument manifold blocks.*

### ***D9. Diverter Valves***

*(Other terms in use include multi-port or switching valve; also changeover valve).*
*The principal function is to divert one or more flow streams whilst preventing intermixing.*

*Diverter valves can replace several block valves but are not commonly used except in chemical process applications. Multi-port designs may vary from three to five ports according to requirements. Operation is normally by manual intervention either directly or indirectly, e.g. powered actuators.*

*Types of valves that are suitable for diverting flow are limited and include:-*

*Plug valves (most common)*
*Ball valves*
*Globe valves*

## *VALVE TYPES FOR PREVENTION OFFLOW REVERSAL (CHECK)*

*This Commentary relates to clause 3.3.*

### ***E1. General***

*E1.1 Installation & Process Design Considerations of Check Valves*

*E1.2 The self-acting (or self-operating) principle introduces dynamic response as well as static (e.g. flow configuration) considerations and valve characteristics should be selected that provide:-*

*(a) Free and unrestricted movement of the closure member, which, under normal operating conditions should be kept fully open against its stop. Oversizing should be avoided since this can lead to partial opening which may result in chatter of the valve against its seat or disk stop and excessive wear of active components. Manufacturers sizing data should be consulted when sizing check valves.*

*(b) Full closure under back pressure conditions with adequate seat loading to minimise through leakage. In some cases, particularly where pressures are very low and sizing only provides a partial solution, it may be necessary to consider supplementary loading. This can be achieved in some designs by additional weighting or stronger spring loading of the closure member.*

*(c) Closure response that is of sufficiently short duration to prevent back flow problems (e.g. reverse rotation of pumps or compressors) and avoids shock loading (valve slam or water hammer) that could otherwise cause excessively high pressure surge and possibly result in damage to the valve, piping system and ancillaries, e.g. pump and compressors. In general, surge should be considered when normal fluid velocities exceed 4.5m/sec for liquids or 27.5 m/sec for gases and whenever operating pressures are close to the design pressure of the piping system. Note that:-*

*(i) Comparison of predicted against required speed of valve closure, duration and closing force to prevent excessive back flow and surge pressure*

*may be qualitatively assessed or subject to detailed analysis if very critical. Calculations should be based on process data and manufacturers valve data. In general terms, a valve that closes at a mean velocity equal to or less than the normal flow velocity should avoid excessive surge pressure.*

*Lower closing velocities may be acceptable under certain conditions, e.g. on single pump systems for long pipelines where the terminal back pressure and maximum elevation are low. High closing velocities may be necessary on parallel pumping systems to prevent back flow into a failed pump. Supplementary loading can improve the response of some valves.*

*(ii) Generally, check valves with a short displacement and low inertia of the closure member, supplemented by spring loading, provide the most rapid response and lowest shock loading at closure. Smaller sizes of valves generally provide the fastest closing response.*

*(d) Stable operation to avoid rapid fluctuation in movement of the closure member due, for example, to large variations in operating pressure or smaller variations with pulsing flow, which can lead to valve chatter, excessive wear and poor reliability. Damping devices such as dashpots can be fitted to some designs to improve valve stability.*

*Note that damping at final closure may also be required to prevent shock loading by slamming of the valve onto its seat. This may be a requirement in systems where extremely rapid flow reversals occur, e.g. with compressible fluids.*

*In addition it may also be necessary to consider the following:-*

*(e) Frequency of flow reversal occurrences, which, if numerous, may have an adverse affect on wear and reliability of valve components in some designs.*

*(f) Flow resistance (pressure drop). Resistance to flow varies widely in different designs and also generally increases with smaller valve sizes. Low resistance is achieved in some designs by alternate valve patterns in which the closure member and seats are inclined towards rather than normal to the flow path. Generally, designs which provide easiest pigging etc. are most susceptible to inducing pressure surges and flutter.*

*(g) Location of the valve bore in either the horizontal or vertical plane. A vertical location can adversely affect the response of some types of check valves, depending on the pattern and should be avoided if possible. The direction of normal flow may also affect closing force requirements. Generally, flow in an upward direction is preferred and flow in a downward direction should be avoided. Swing check valves should never be used with downward flow. The manufacturer should always be advised of the intended valve location and, if vertical, the direction of flow.*

## *E2. Valve Categories*

*E2.1 Check valves may be broadly divided into three main categories. These comprise the lift check valve, based on linear motion of the closure member; the swing check valve, based on rotary (angular) motion of the closure member and the diaphragm check valve which operates by flexing of a membrane. There are a number of variations in design of all three types. Characteristics of each design vary considerably and should be considered in selecting valves for particular requirements.*

## *E3. Lift Check Valves*

*E3.1 A lift check valve is one in which the check mechanism incorporates a disk, piston or ball. Lift type check mechanisms are:-*

*(a) Disk: the mechanism is, or incorporates a disk.*

*(b) Piston: the mechanism consists of a piston and cylinder which provide a cushioning effect during operation.*

*(c) Ball: the mechanism is a ball.*

*E3.2* *Free and unrestricted movement of the closure member may be difficult to achieve with lift check valves since the majority of designs depend on close guiding of the closure member. The ingress of dirty or viscous fluids can result in slow response or even jamming unless considered in the design, especially of piston and disc check valves. Ball check valves tend to be less affected due to freer guiding of the ball. For gritty liquids composition disks are available. Most designs cause a relatively high pressure drop.*

*Full closure under back pressure conditions is often provided by supplementary spring loading due to weight limitations of closure members for most lift check valves, e.g. ball, disc and piston check valves. Sizing of ball and piston check valves tends to be limited to about 2 in. NB due to the limited weight of ball and piston.*

*E3.3* *Closure response of lift check valves is potentially fast due to the inherent characteristic of a short travel (lift) compared with other types of check valve and the low inertia of the closure member due to its light weight. Thus, the ball, disc and piston type check valves are suitable for many applications which could result in surge problems for other types of valves.*

*E3.4* *Stable operation to avoid rapid fluctuations in movement of the closure member cannot be provided by ball check valves which should not be used with widely varying pressures, pulsing flow and frequent flow reversals. Piston and disc check valves may perform better but under severe conditions it may be necessary to consider a damping device.*

*E3.5* *Low resistance to flow is not a characteristic of lift check valves of the ball, disc and piston type due to their tortuous configuration. However, where low resistance is required special patterns of 'Y' or oblique type are available that can substantially reduce the resistance to flow.*

*E3.6* *Location of the valve bore in horizontal or vertical plane requires careful consideration with lift check valves of the ball, disc and piston type which depend on the force of gravity acting on the closure member. Spring-loaded types may operate at any orientation. Consequently these are the only type of lift check valve which can be used in vertical pipes.*

E3.7 *Consideration should be given to the use of nozzle check valves where the normal range of check valves are found to be unsuitable, e.g. in preventing excessive pressure surge or providing adequate stability with wide pressure variations, pulsing flow and frequent flow reversals.*

*This design is typically selected for onerous duties, providing a rapid closure by spring loading. Stability is claimed to be improved by additional forces to open the valve through use of the venturi principle in the design of flow passages through the body. Sliding parts are largely shrouded from the flowing process fluid by the central housing. A low pressure drop is claimed and the valve can be mounted either horizontally or vertically. Although uncommon several manufacturers produce this design to high standards.*

E3.8 *Plate check valves which use flexible metallic plates or membranes are normally fitted to compressors. This type of valve provides a very fast closing response and is particularly suited to pulsing flow with compressible fluids. The frequency of flow pulsations may require special consideration of design to avoid plate flutter. Generally, designs are limited to a low differential pressure across the valve. Designs are suitable for mounting either horizontally or vertically.*

## E4. Swing Check Valves

E4.1 *A check valve in which the mechanism incorporates a disk which swings on a hinge, the free and unrestricted movement of the disk is, in general, easily achieved. The bearing assemblies for the hinge and disc are better shrouded from the flow stream and thus dirty and viscous fluids are less able to obtain ingress and hinder rotation of the closure member.*

*Swing check valves are used over a much larger size range than lift check valves. Typically swing check valves are available from 2 in. NB up to 24 in. NB and greater but weight and travel of the disc may become excessive in very large sizes and may require special designs for satisfactory operation.*

E4.2 *Swing check valves may be specified for horizontal or vertical upward flow on low velocity or highly viscous fluids. Composition disks are available for gritty fluids or positive shut-off at low pressure.*

*They are unsuitable for frequent flow reversal or pulsating flow, when installed in a system sensitive to sudden flow* *reversal. A balance weight or dashpot should be specified. A balance weight may be required when valve has to open under minimum pressure.*

*E4.3* *Full closure under back pressure conditions may be supplemented in the conventional and tilting disc designs by additional weighting of the disc or by an external weighted lever arm or spring attached to a shaft extension through the body. The latter introduces the additional complication of a gland to seal the extension arm and may result in excessive closing force (shock loading) unless a damper is fitted.*

*E4.4* *Closure response of swing check valves is generally slower compared with lift check valves. This is mainly due to the long travel of the disc during rotation from fully open to closed and is also subject to the inertia of the closure member, depending on the mass (weight) and moment arm of the disc and hinge arm.*

*E4.5* *Conventional type swing check valves have the slowest response due to the high inertia of the disc and swing arm, usually hinged outside the main flow stream. Although widely used, they are generally best suited to gravity flow and pumped (liquid) systems where flow velocities are relatively low. Improved operating characteristic result from reducing the travel by inclining the seat and disc towards each other and whenever possible the angle between the seat and the fully open position of the disk should be restricted to 65 degrees. Another method of reducing inertia is by locating the hinge axis at the edge of the disc.*

*E4.6* *Tilting disc check valves incorporate a disk which swings on a hinge and is parallel to, but above the horizontal axis of the piping. They are a variant of the conventional type and have a faster response by virture of a shorter path of travel of the disc centre of gravity and reduced inertia of the disc. The flow resistance however is greater than that of conventional valves. Tilting disk check valves are generally used as 'non-slam' valves, since closure at instant of reversal of flow is most nearly attained.*

*E4.7* *Split disc valves also provide a fast response due to a short path of travel of the half disc centre of gravity, the low inertia resulting from the light weight (low axis) and short moment arm of the half disc allied to the use of closing springs. Split disc check valves are better suited than the conventional type to high flow velocities, e.g. compressible flow.*

*Swing check valves of the split disc type depend on internal spring loading for closure and supplementary loading can be provided by stronger springs if required.*

*E4.8* *Timing of closure cannot alleviate all shock conditions at a check valve, typical applications being:-*

*(i)* *Cessation of pressure at the valve inlet produces flashing of the decelerating fluid downstream from the valve.*

*(ii)* *Stoppage of flow is caused by a sudden closure of a valve some distance downstream from the check valve, and the stoppage is followed by returning water hammer.*

*For these applications slower closure may be necessary, in which case the tilting disk valve should be equipped with an external dashpot.*

*They are suitable to use in viscous service and have less pressure drop at low velocities and more pressure drop at high velocities than a swing type valve.*

*E4.9* *Stable operation to avoid rapid fluctuations in movement of the closure member can be a problem with swing check valves. Stability of conventional and tilting disc check valves may be improved by fitting an external damping device (dashpot) via an external shaft extension through the body with the additional complication of a gland. A damping device is sometimes required to prevent shock loading (water hammer) during seating of the closure. Split disc check valves are more difficult to damp, particularly since external methods cannot be employed to control the floating action of the split discs.*

*Generally, swing check valves should be avoided where unstable conditions are likely, e.g. wide velocity variations, pulsing flow and frequent flow reversals. Under certain conditions fretting at hinge axis and even mechanical failure may occur.*

*Check valves are extremely sensitive to upstream piping features and elbows, valves etc. located immediately upstream can have a disastrous effect on performance. Such features should never be nearer to the check valve than three pipe diameters.*

E4.10 *Low resistance to flow is a particular advantage of swing check valves due to the straight through flow configuration, depending on the angle of opening at operating conditions. The conventional flapper valve in some special designs may also be suitable for pigging due to hinging of swing arms outside the valve bore. Split disc valves tend to have a greater resistance to flow as the size decreases due to the obstruction of the body centre web (sealing each half of the split discs) which reduces the area of flowpath.*

E4.11 *Location of the valve bore is generally best suited to the horizontal plane. Location in a vertical plane requires careful consideration. Conventional and tilting disc valves must always be located with flow in an upward direction but the design must prevent the disc from reaching a stalling position when fully open. It should also be recognised that in the fully open vertical position the disc/swing arm has a very small closing moment, further reducing response unless supplementary loading is used with possible complication of damping. Split disc check valves are more suited to vertical applications but preferably with flow in an upward direction. They may be considered for downward flow applications when stronger springs can be selected to suit the operating conditions.*

E4.12 *Swing check valves may also be provided in the following additional types:-*

*(a) Screw-Down Stop and Check*
*(b) Wafer*
*(c) Spring Operated Non-Slam*
*(d) Foot*

E4.13 *The preferred sizing of check valves is such that at minimum normal sustained flow the check mechanism will be held against the stop in the fully open position. Applications in gas or steam lines, or in liquid lines with low or unsteady flow should be fully described in the purchase specification so that the manufacturer can evaluate the suitability of the valve design. The non-slam characteristics of check valves in compressor piping systems shall be compatible with the compressor manufacturer's requirements.*

## *E5. Diaphragm Check Valves*

*E5.1 Although less commonly used than conventional lift or swing check valves, the diaphragm check valve has a number of characteristics and should be considered with the pressure and temperature limitations or restrictions of the flexible membrane that forms the closure member.*

*E5.2 Free unrestricted movement, full closure and fast closure response are all characteristics of the diaphragm check valve. They also have the ability to handle viscous or abrasive fluids and slurries more reliably than other types of check valve. Small sizes are usually of the cone type and larger sizes are typically of the nozzle type. The design can also provide stable operation with pressure variations, pulsing flow and frequent flow reversals, but care is required in the selection of suitable durable materials for reliability of the membrane.*

*Location may be either with the bore horizontal or vertical. Data on flow resistance is not currently available.*

## *E6. Piston Type Check Valves*

*E6.1 The designs available include straight through and oblique patterns, pilot pressure energises the piston to open or close during a reversal situation. The seating load to hold the closure (i.e. a piston) shut may be supplied from a system pressure via a pilot, an external load or a combination of both.*

*General features are as follows:-*

*(a) Generally used on line sizes below 2 in. NPS. This valve has a dashpot.*

*(b) Causes relatively high pressure drop.*

*(c) Spring loaded type may operate at any orientation, other types should be installed so that the piston will close by gravity.*

*(d) Suitable for frequent, but not sudden, flow reversal and pulsating flow duties.*

*(e) Unsuitable for gritty or dirty fluid service.*

*(f) Is equipped with an orifice to control the rate of movement of the piston. As the orifice used on a liquid*

*service is considerably larger than an orifice for a gas service, a valve designed for gas service should not be used in liquid service unless the orifice in the piston is changed.*

## *E7. Screw-Down Stop and Check Valves*

*E7.1 A valve in which the disc is held closed by a valve stem which can also be retracted to permit free movement of the disc. Generally used in steam generation by multiple boilers, where a valve is installed between each boiler and the main steam header. These are normally of the globe type, but swing type are also available (para. E3.12(a)). Other varieties are also*

*available (e.g. check feed valves).*

## *E8. Wafer Check Valves*

*E8.1 General features are as follows:-*

*(a) A check valve that is installed between pipe flanges and in which the mechanism consists of a single or dual plate swinging on a hinge.*

*(b) Reduced bore type generally available, in line sizes 2 in. NPS and above.*

*(c) Single plate type causes high pressure drop, and is unsuitable for use on low flow and low pressure gas services.*

*(d) Dual plate type utilises a spring to effect closure rather than reverse flow pressure and may be used to minimise water hammer. For faster response a higher torque spring may be specified, in which case account should be taken of the resulting higher pressure drop.*

*(e) Dual plate type may be installed for flow in any direction, including vertically downward for certain sizes - confirm with manufacturer.*

*(f) Dual plate type generally suitable for use on liquid or vapour service, but not recommended for slurry service.*

*(g) Requires to be removed from line for repair.*

*(h) A wafer check valve shall not be used in flammable or toxic service due to the possibility, in the event of fire, of expansion of the bolts and subsequent flange leakage. When a wafer check valve is used and a fire hazard exists, a light gauge stainless steel shroud shall be wrapped around the valve and exposed bolts, irrespective of service.*

*(i) It is essential to ensure that the plates do not foul adjacent valves or connected pipework.*

### *E9. Spring Operated Non-Slam Check Valves*

*E9.1 This is an axial flow valve, used specifically on compressor discharge lines subject to pulsating or low flow conditions where a tilting disk type valve may 'chatter'.*

*E9.2 This valve may be used on liquid systems, as an alternative to tilting disk type valves. It offers the least resistance to flow of any check valve type.*

### *E10. Foot Valves*

*E10.1 Generally installed at suction inlet of a pump to maintain prime. Valve may be fitted with a strainer to keep dirt and other foreign matter from entering the pump suction.*

### *E11. Check Valve Standards*

*(a) Steel swing check valves shall comply with BS 1868 or API Spec. 6D. Full port valves are specified to BS 1868 or API Spec. 6D, regular port valves are specified to API Spec. 6D.*

*(b) Cast iron swing check valves shall comply with BS 5153.*

*(c) Steel lift check valves below 2 in. NB:-*

*(i) Classes 150 to 800 shall comply with BS 5352.*

*(ii) Class 1500 shall comply with BS 5352 or be to manufacturer's standard.*

*(iii) Class 2500 shall comply with BS 1868 or be to manufacturer's standard.*

*(d)* *Steel lift check valves size 2 in. NB and above shall comply with BS 1868 or be to manufacturer's standard.*

*(e)* *Steel screw-down stop and check valves below 2 in. NB.*

*(i)* *Classes 150 to 800 shall comply with BS 5352.*

*(ii)* *Class 1500 shall comply with BS 5352 or be to manufacturer's standard.*

*(iii)* *Class 2500 shall comply with BS 1873 or be to manufacturer's standard.*

*(f)* *Steel screw-down stop and check valves sizes 2 in. NB and above shall comply with BS 1873 or be to manufacturer's standard.*

*(g)* *Wafer check valves shall comply with API Standard 594.*

*(h)* *Tilting disk check valves are to manufacturer's standard.*

*(i)* *Spring operated non-slam check valves are to manufacturer's standard.*

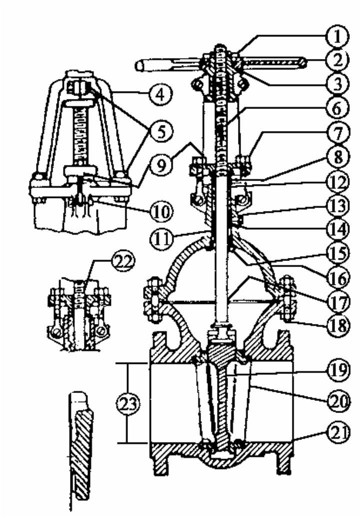
***APPENDIX F***

## *TYPES OF CONSTRUCTION*

*This Commentary relates to clauses 3.2 and 3.3.*

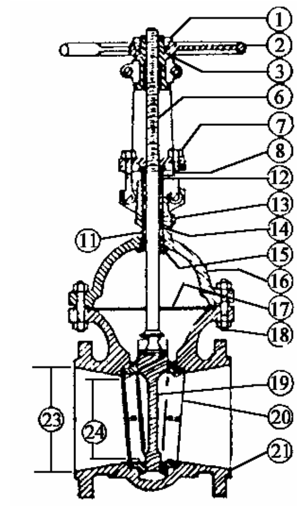
*List of figures illustrating individual valve types*

| | |
|---|---|
| *F7 : Diaphragm Valves:* | *Weir Type Diaphragm*<br>*Straight-through Diaphragm* |
| *F8 : Special Purpose Valves:* | *Pinch Valve*<br>*Flush Bottom Valve*<br>*Sampling Valve*<br>*Air Vent Valve*<br>*Deluge Valve*<br>*Float Operated Valve*<br>*Bellows Sealed Globe* |
| *F9: Special Purpose Valves:* | *Diverter Valve (globe type)*<br>*Excess Flow Valve* |
| *F10:* | *Port and Stop Arrangements*<br>*Multiple Port Valves* |

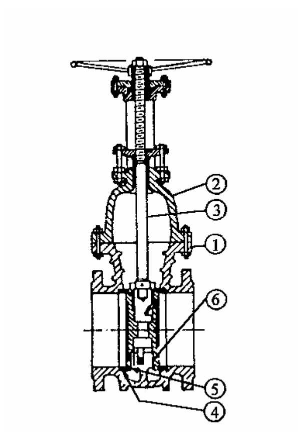



WEDGE GATE

| Ref | Name of part |
|---|---|
| 1 | Handwheel nut |
| 2 | Handwheel |
| 3 | Stem nut |
| 4 | Yoke |
| 5 | Yoke bolting |
| 6 | Stem |
| 7 | Gland flange |
| 8 | Gland |
| 9 | Gland bolting or gland eyebolts and nuts |
| 10 | Gland lug bolts and nuts |
| 11 | Stem wiper packing |
| 12 | Stem packing |
| 13 | Plug |
| 14 | Lantern |
| 15 | Backseat bushing |
| 16 | Bonnet |
| 17 | Bonnet gasket |
| 18 | Bonnets bolts and nuts |
| 19 | Gate |
| 20 | Seat ring |
| 21 | Body |
| 22 | One piece gland (alternative) |
| 23 | Valve part |
| 24 | Seal opening |

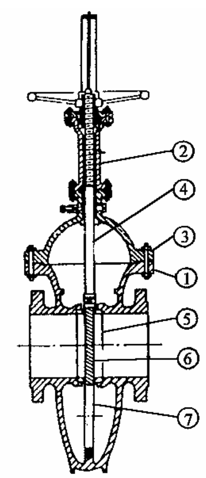



VENTURI GATE




DOUBLE DISK GATE

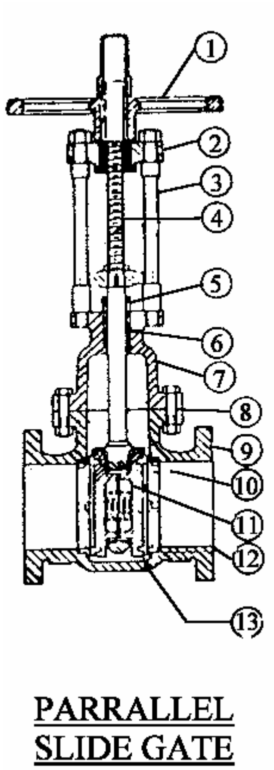
| Ref | Name of Parts |
|---|---|
| 1 | Body |
| 2 | Bonnet yoke and cover |
| 3 | Spindle |
| 4 | Seat |
| 5 | Disk |
| 6 | Wedge |



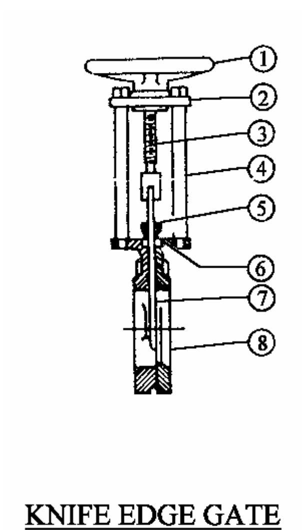

CONDUIT GATE

| Ref | Name of Parts |
|---|---|
| 1 | Body |
| 2 | Yoke |
| 3 | Cover |
| 4 | Spindle |
| 5 | Seat |
| 6 | Plate |
| 7 | Conduit ring |

**FIGURE F1 (part 1 of 2 ) GATE VALVES**

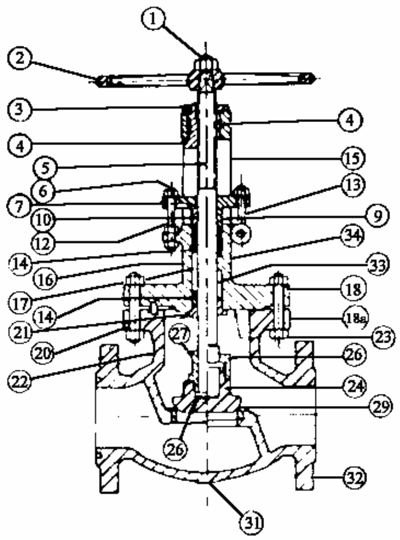



| Ref | Name of parts |
|---|---|
| 1 | Handwheel |
| 2 | Bridge |
| 3 | Piller |
| 4 | Stem |
| 5 | Gland |
| 6 | Gland packing |
| 7 | Bonnet |
| 8 | Bonnet gasket |
| 9 | Body |
| 10 | Body seal ring |
| 11 | Disk |
| 12 | Disk spring |
| 13 | Disk facing ring |

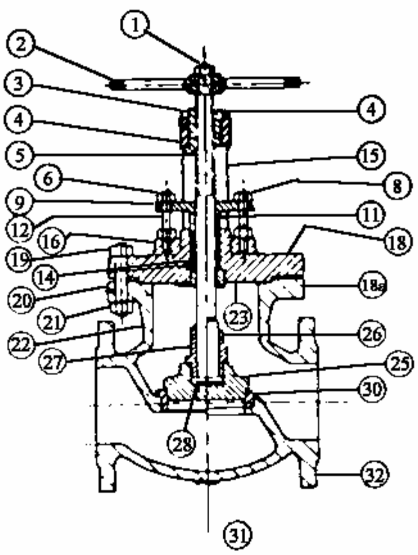



| Ref. | Name of part |
|---|---|
| 1 | Handwheel |
| 2 | Bridge |
| 3 | Stem |
| 4 | Piller |
| 5 | Gland |
| 6 | Packing |
| 7 | Knife |
| 8 | Body |

**FIGURE F1 ( part 2 of 2 ) GATE VALVES**



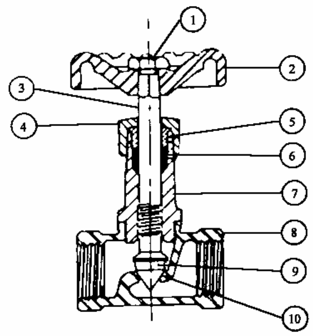
GLOBE ( BOLT TYPE DISK )



GLOBE ( PLUG TYPE DISK )

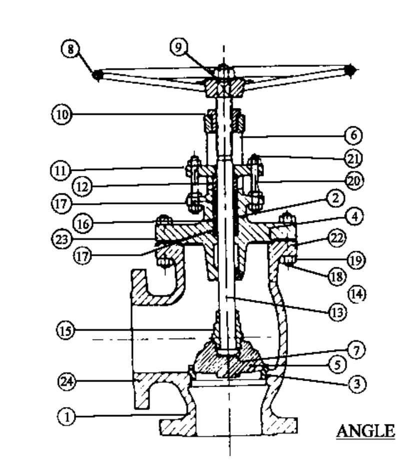
| REF | Name of parts |
|---|---|
| 1 | Handwheel retaining nut |
| 2 | Handwheel |
| 3 | Yoke bush nut |
| 4 | Yoke bush |
| 5 | Stem |
| 6 | Gland stud bolt nut |
| 7 | Gland flange |
| 8 | Gland end piece bushed type |
| 9 | Gland end piece type |
| 10 | Gland follower |
| 11 | Gland bush |
| 12 | Gland stud bolt |
| 13 | Gland bolt hinged type |
| 14 | Gland packing |
| 14a | Wiper rings |
| 15 | Yoke |
| 16 | Bonnet |
| 17 | Lantern ring |
| 18 | Bonnet flange |
| 18a | Body/bonnet flange |
| 19 | Bonnet stud bolt nut |
| 20 | Bonnet stud bolt |
| 21 | Back seat bushing |
| 22 | Body |
| 23 | Bonnet gasket |
| 24 | Disk ball type |
| 25 | Disk plug type |
| 26 | Disk nut |
| 27 | Disk nut back seat type |
| 28 | Disk thrust plate |
| 29 | Seat ring shoulder seated |
| 30 | Seat ring bottom seated |
| 31 | Body boss |
| 32 | End flange |
| 33 | Condensing chamber |
| 34 | Pressure relief plug boss |

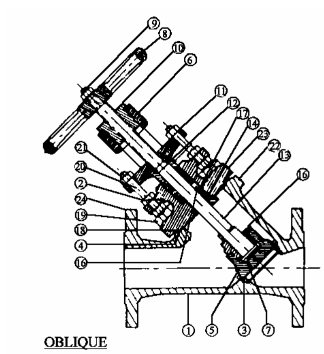
**FIGURE F2 ( PART 1 0F 2 ) GLOBE VALVES**



GLOBE ( NEEDLE TYPE DISK )

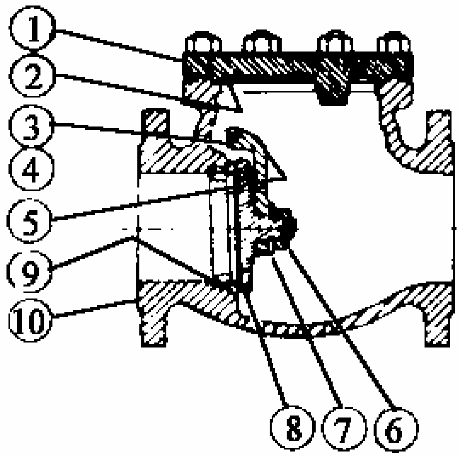
| Ref | Name of parts |
|---|---|
| 1 | Hand wheel nut |
| 2 | Hand wheel |
| 3 | Stem |
| 4 | Gland nut |
| 5 | Gland |
| 6 | Packing |
| 7 | Bonnet |
| 8 | Body |
| 9 | Needle disk |
| 10 | Seat |



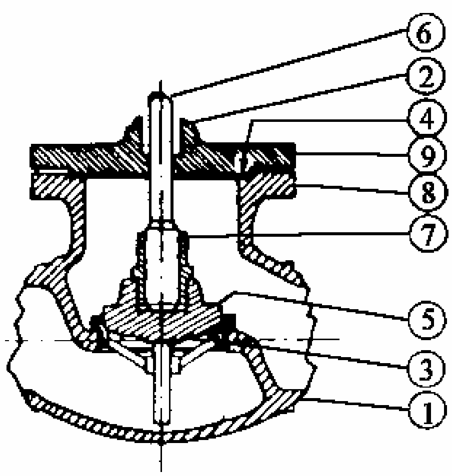

| Ref | Name of part |
|---|---|
| 1 | Body |
| 2 | Bonnet |
| 3 | Body seat ring |
| 4 | Bonnet gasket |
| 5 | Disk |
| 6 | Yoke |
| 7 | Disk thrust plate |
| 8 | Handwheel |
| 9 | Handwheel retaining nut |
| 10 | Yoke bush |
| 11 | Gland flange |
| 12 | Gland follower |
| 13 | Stem |
| 14 | Back seat bushing |
| 15 | Disk nut |
| 16 | Lantern ring |
| 17 | Stem packing |
| 18 | Bonnet stud bolt |
| 19 | Nut for gland stud bolt |
| 20 | Gland stud bolt |
| 21 | Nut for gland stud bolt |
| 22 | Body/bonnet flange |
| 23 | Bonnet flange |
| 24 | End flange |

**FIGURE F2 ( PART 2 OF 2 ) GLOBE VALVES**




SWING

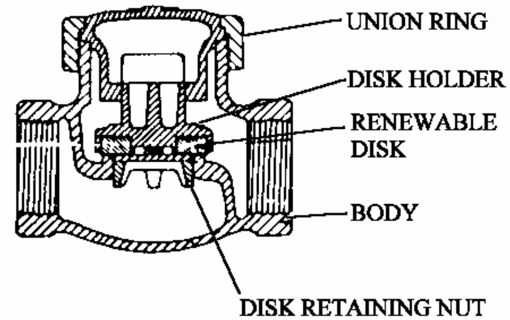
| Ref | Name of part |
|---|---|
| 1 | Cover |
| 2 | Cover gasket |
| 3 | Hinge pin |
| 4 | Pipe plug ( not shown ) |
| 5 | Hinge |
| 6 | Disk retaining nut |
| 7 | with pin |
| 8 | Seat ring |
| 9 | Body |
| 10 | |



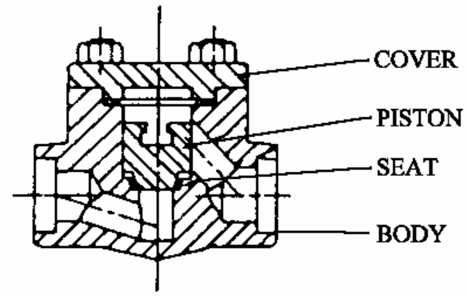

SCREW-DOWN STOP & CHECK

| Ref | Name of part |
|---|---|
| 1 | Body |
| 2 | Bonnet |
| 3 | Body seat ring |
| 4 | Bonnet gasket |
| 5 | Disk |
| 6 | Stem |
| 7 | Disc nut |
| 8 | Body/bonnet flange |
| 9 | Bonnet flange |

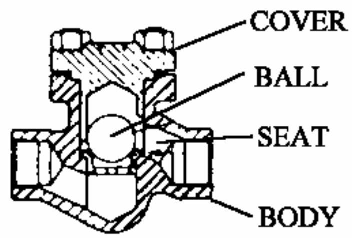
**FIGURE F3 (PART 1 0F 3 ) CHECK VALVES**



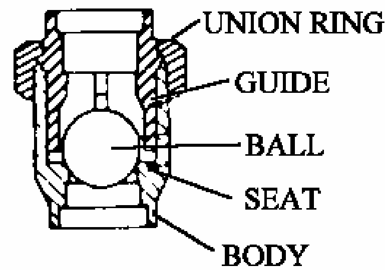

LIFT (DISK)



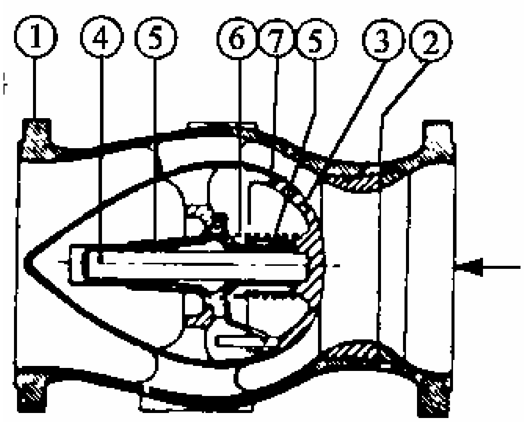

LIFT (PISTON)




LIFT (BALL-HORIZONTAL)



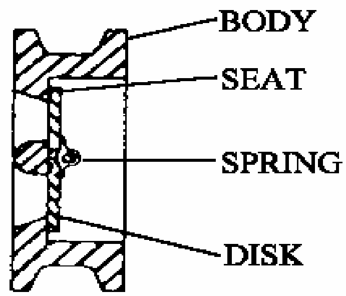

LIFT (BALL-VERTICAL)



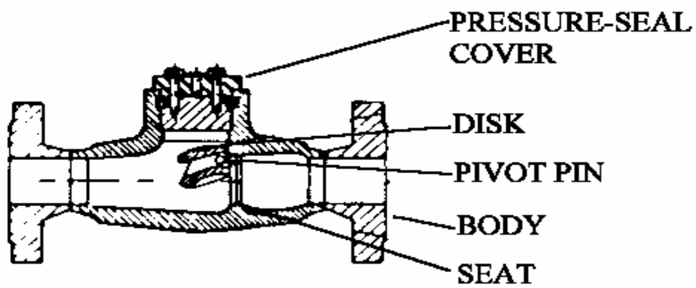

| Ref | Name of part |
|---|---|
| 1 | Body |
| 2 | Seat |
| 3 | Valve disc |
| 4 | Stainless steel rod |
| 5 | P.T.F.E bearing |
| 6 | Spring |
| 7 | Soft seal ring |

AXIAL FLOW

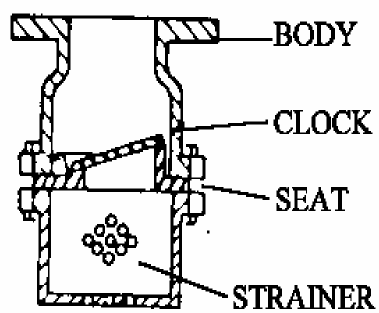
**FIGURE F3 (PART 2 0F 3 ) CHECK VALVES**




WAFER (DUAL DISK)

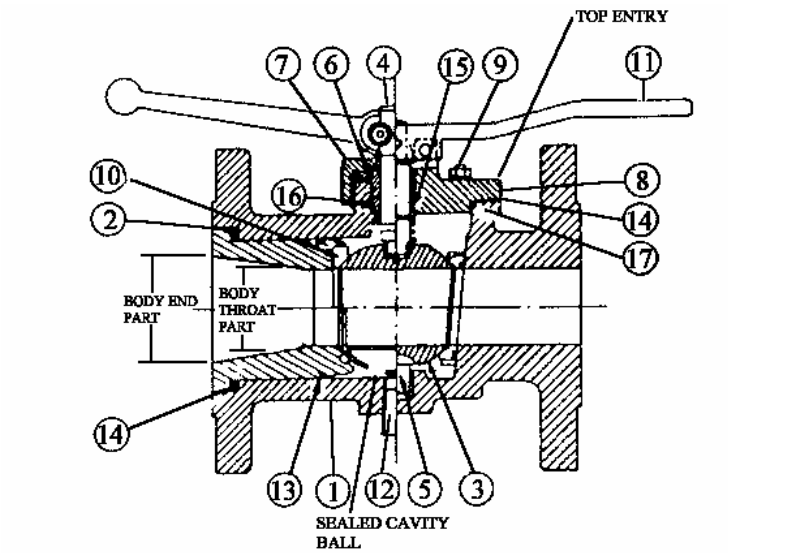



TILTING DISK



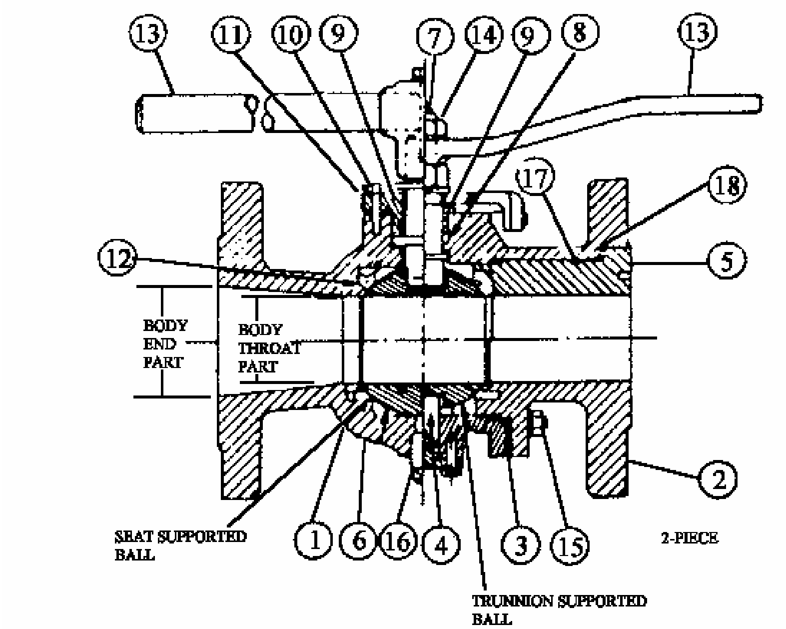

FOOT (WITH STRAINER)

**FIGURE F3 (PART 3 OF 3) CHECK VALVES**




ONE PIECE BODY (END OR TOP ENTRY)

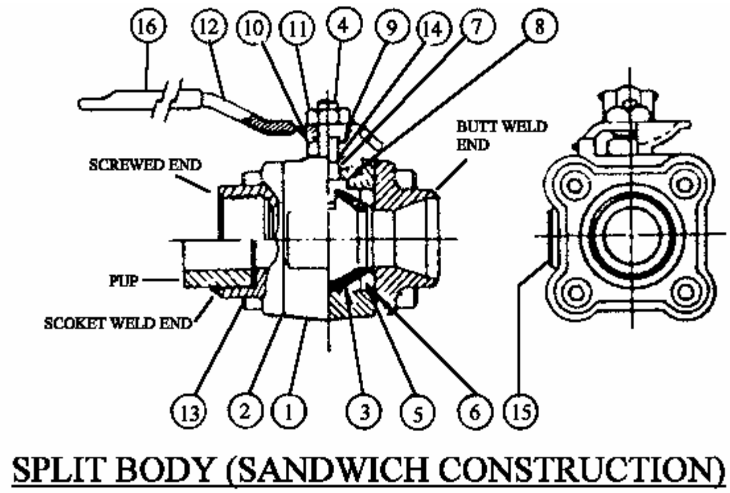
| Ref | Name of part |
|---|---|
| 1 | Body |
| 2 | Insert |
| 3 | Ball |
| 4 | Stem |
| 5 | Trunnion |
| 6 | Gland |
| 7 | Gland nut |
| 8 | Cover |
| 9 | Cover bolting |
| 10 | Body seat rings |
| 11 | Wrench |
| 12 | Body plug |
| 13 | Insert seal |
| 14 | Fire safe gasket |
| 15 | Stem seal |
| 16 | Gland packing |
| 17 | Cover seal |




SPLIT BODY (END ENTRY)

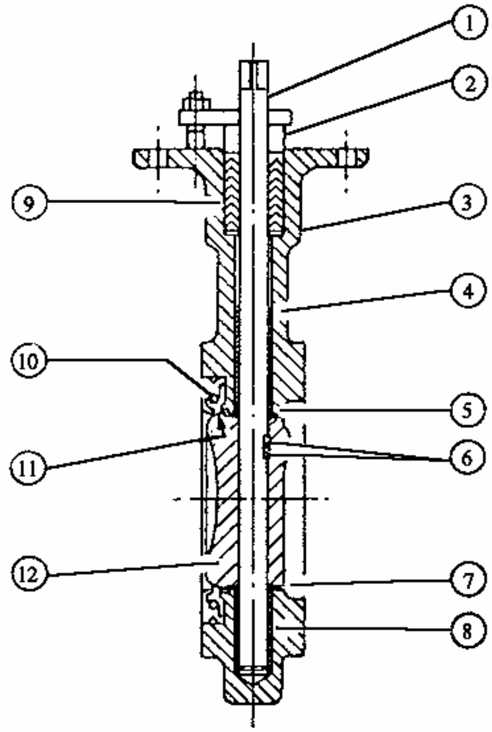
| Ref | Name of part |
|---|---|
| 1 | Body |
| 2 | Body connector |
| 3 | Body connector gasket |
| 4 | Trunnion |
| 5 | Insert |
| 6 | Ball |
| 7 | Stem |
| 8 | Stem seal |
| 9 | Gland |
| 10 | Gland bolts |
| 11 | Indicator |
| 12 | Body seal rings |
| 13 | Wrench |
| 14 | Wrench nut |
| 15 | Body connector bolting |
| 16 | Body plug |
| 17 | Insert seal |
| 18 | Fire safe gasket |

**FIGURE F4 BALL VALVES (PART1 OF 2 )**



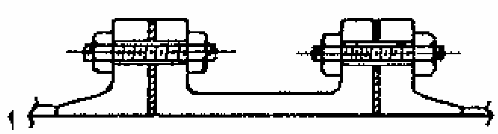

| Ref | Name of part |
|---|---|
| 1 | Body |
| 2 | Body connector |
| 3 | Ball |
| 4 | Stem |
| 5 | Body seal ring |
| 6 | Body connector seal |
| 7 | Gland packing |
| 8 | Stem seal |
| 9 | Gland |
| 10 | Gland nut |
| 11 | Wrench nut |
| 12 | Wrench |
| 13 | Body connector bolting |
| 14 | Disk spring |
| 15 | Body marking plate |
| 16 | Wrench sleeve |

**FIGURE F4 BALL VALVES PART 2. OF 2 )**

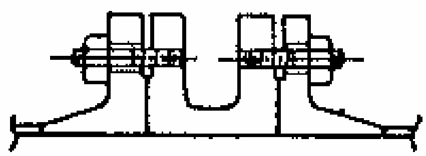



TYPICAL ASSEMBLY
HIGH PERFORMANCE VALVE

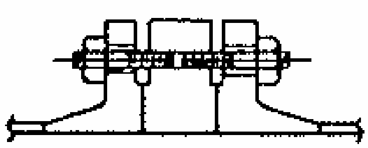
| Ref | Name of part |
|---|---|
| 1 | Stem |
| 2 | Gland |
| 3 | Body |
| 4 | Bearing |
| 5 | Thrust washer |
| 6 | Stem/disk pin |
| 7 | Thrust washer |
| 8 | Bearing |
| 9 | Packing |
| 10 | Seal spring |
| 11 | Seal |
| 12 | Disk |



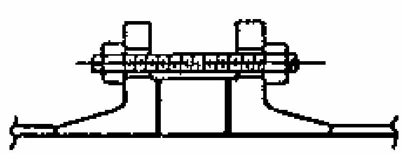
DOUBLE FLANGE



U - SECTION

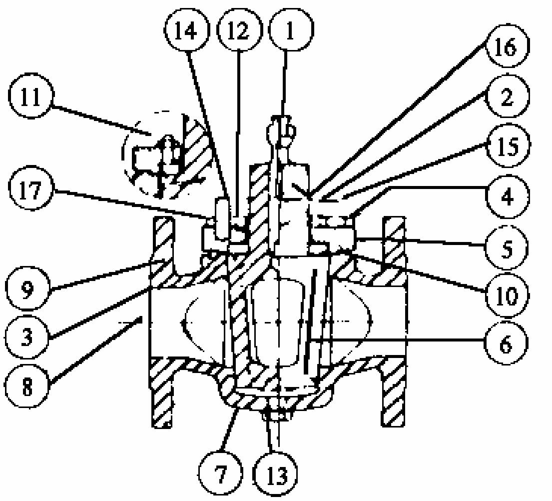


SINGLE FLANGE
OR LUG TYPE



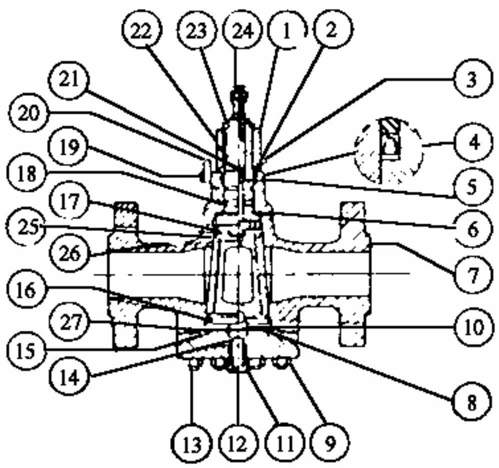
FLANGELESS

**FIGURE F5 BUTTERFLY VALVES**




STANDARD LUBRICATED TAPER PLUG

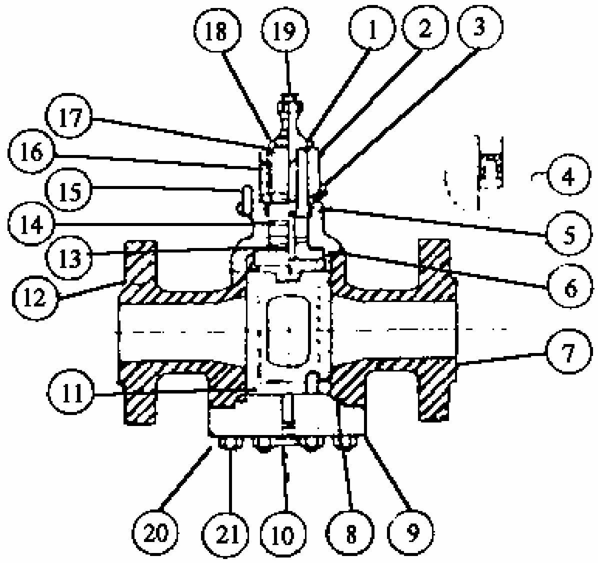
| Ref | Name of part |
|---|---|
| 1 | Combinator lubricant screw |
| 2 | Check valve |
| 3 | O ring |
| 4 | Bolts |
| 5 | Top cover |
| 6 | Taper plug |
| 7 | Body |
| 8 | Gasket |
| 9 | Flexible Plate |
| 10 | Press ring |
| 11 | Adjustable screw |
| 12 | Nut |
| 13 | Bottom screw |
| 14 | Stop |
| 15 | Stop plate |
| 16 | Snap ring |
| 17 | Sealing Ring |




PRESSURED BALANCED PLUG
( INVERTED LUBRICATED PLUG )

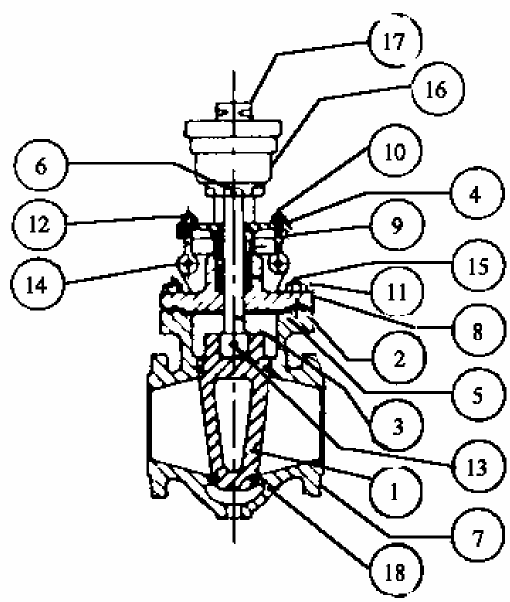
| Ref | Name of part |
|---|---|
| 1 | Operating Square |
| 2 | Stem bearing |
| 3 | V - ring |
| 4 | Sealing ring |
| 5 | Gasket |
| 6 | Thrust plate |
| 7 | Body |
| 8 | Ball seat |
| 9 | Bottom cover |
| 10 | Ball |
| 11 | Pressure screw |
| 12 | Bottom screw |
| 13 | Studs |
| 14 | Retaining ring |
| 15 | Diaphragm |
| 16 | Plug |
| 17 | Equaliser ring |
| 18 | Operating stem |
| 19 | O ring |
| 20 | Stop |
| 21 | Check valve |
| 22 | Parallel key |
| 23 | Nut for stem |
| 24 | Lubricant screw |
| 25 | Spring |
| 26 | Ball |
| 27 | Diaphragm |

**FIGURE F6 PLUG VALVES ( PART 1 OF 2 )**




LUBRICATED PARALLEL PLUG

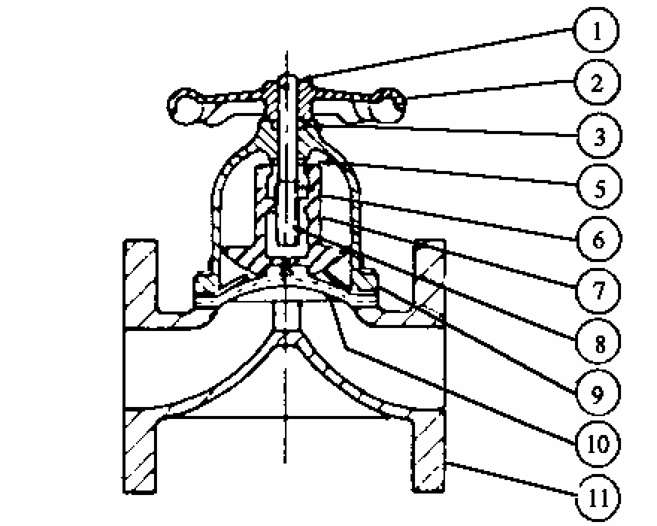
| Ref | Name of part |
|---|---|
| 1 | Operating square |
| 2 | Stem bearing |
| 3 | V ring |
| 4 | Sealing ring |
| 5 | Gasket |
| 6 | Thrust plate |
| 7 | Body |
| 8 | Gasket |
| 9 | Bottom cover |
| 10 | Bottom screw |
| 11 | Plug |
| 12 | Equailser ring |
| 13 | Operating stem |
| 14 | O ring |
| 15 | Stop |
| 16 | Check valve |
| 17 | Parallel key |
| 18 | Nut for stem |
| 19 | Lubricant screw |
| 20 | Nuts |
| 21 | Stud |



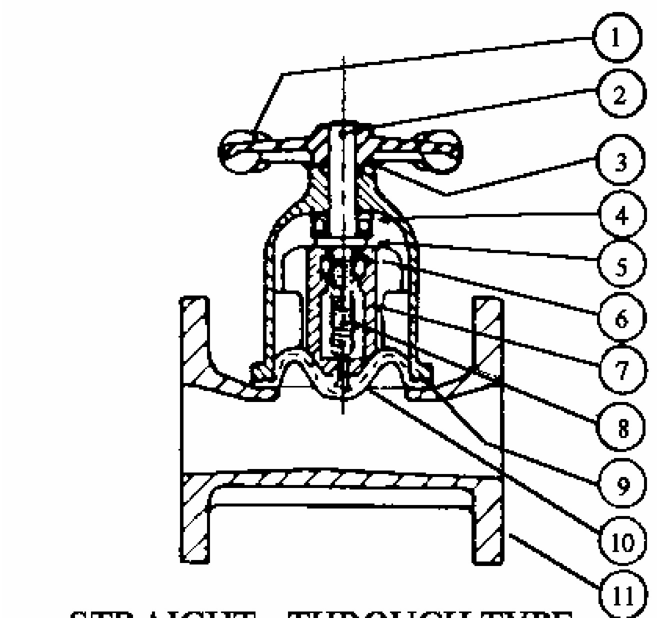

NON-LUBRICATED LIFT PLUG

| Ref | Name of part |
|---|---|
| 1 | Plug |
| 2 | Yoke bonnet |
| 3 | Stem |
| 4 | Pkg, gland flange |
| 5 | Bonnet gasket |
| 6 | Indicator keeper pin |
| 7 | Body |
| 8 | Bonnet stud nut |
| 9 | Packing gland |
| 10 | Eyebolt |
| 11 | Bonnet stud |
| 12 | Eyebolt nut |
| 13 | Plug key |
| 14 | Eyebolt keeper pin |
| 15 | Packing |
| 16 | Lubricating fitting |
| 17 | Operating nut |
| 18 | O ring |

**FIGURE F7 DIAPHRAGM VALVES ( PART 1 OF 2 )**



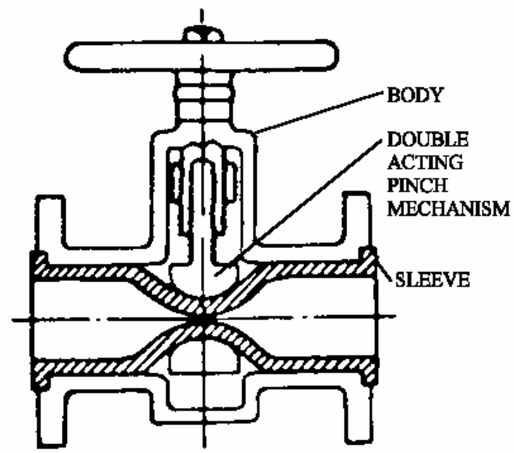

WEIR TYPE



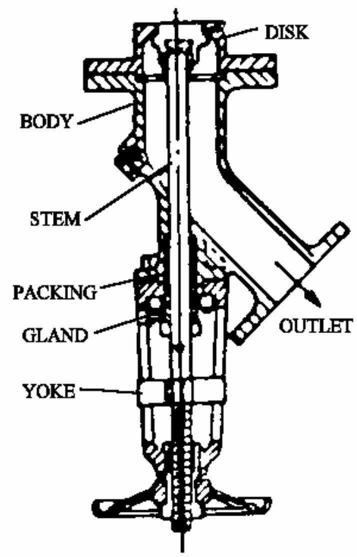

STRAIGHT - THROUGH TYPE

| Ref | Name of part |
|---|---|
| 1 | Handwheel |
| 2 | Handwheel pin |
| 3 | Felt washer |
| 4 | Thrust race |
| 5 | Washer |
| 6 | Spindle nut |
| 7 | Compressor |
| 8 | Spindle |
| 9 | Bonnet |
| 10 | Diaphragm |
| 11 | Body |

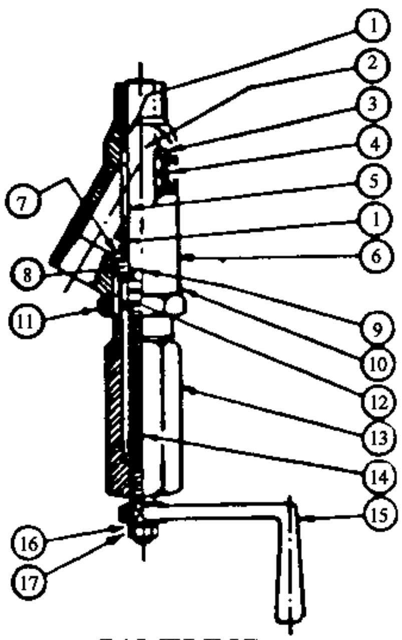
**FIGURE F7 DIAPHRAGM VALVES ( PART 2 OF 2 )**




PINCH



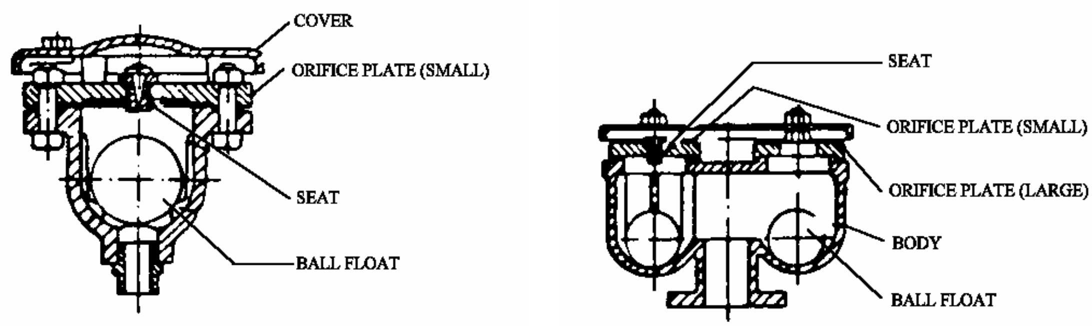

FLUSH BOTTOM




SAMPLING

| Ref | Name of part |
|---|---|
| 1 | Seal ring |
| 2 | Plunger |
| 3 | Comp. ring |
| 4 | Index ball |
| 5 | Lower gland |
| 6 | Body |
| 7 | Upper gland |
| 8 | Springcones |
| 9 | Washer |
| 10 | Lock washer |
| 11 | Lock nut |
| 12 | Coupling |
| 13 | Bonnet |
| 14 | Spindle |
| 15 | Handle |
| 16 | Washer |
| 17 | Nut |

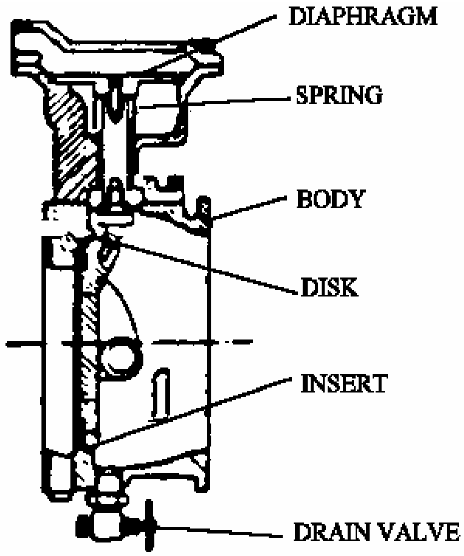
**FIGURE F8 ( PART 1 OF 2 ) SPECIAL PURPOSE VALVES**




SINGLE VALVE

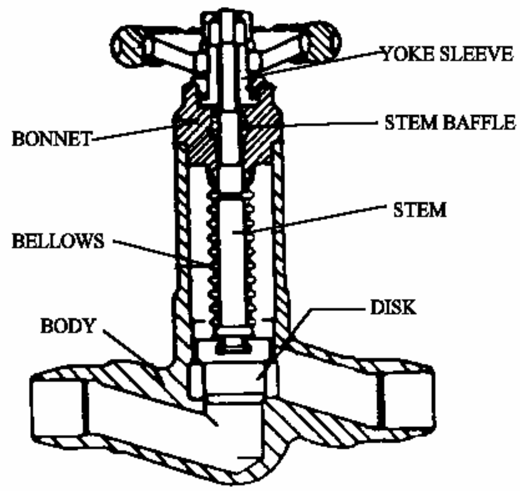
DOUBLE VALVE

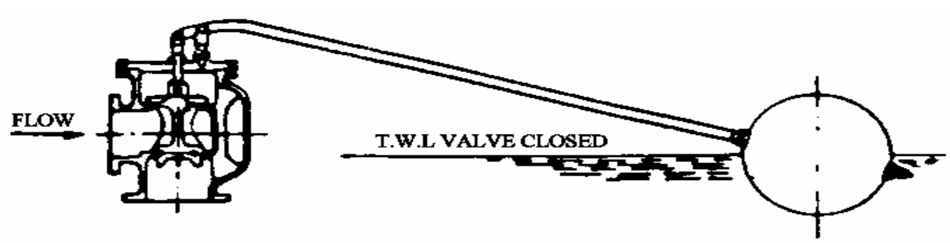
AIR VALVES




DELUGE VALVE

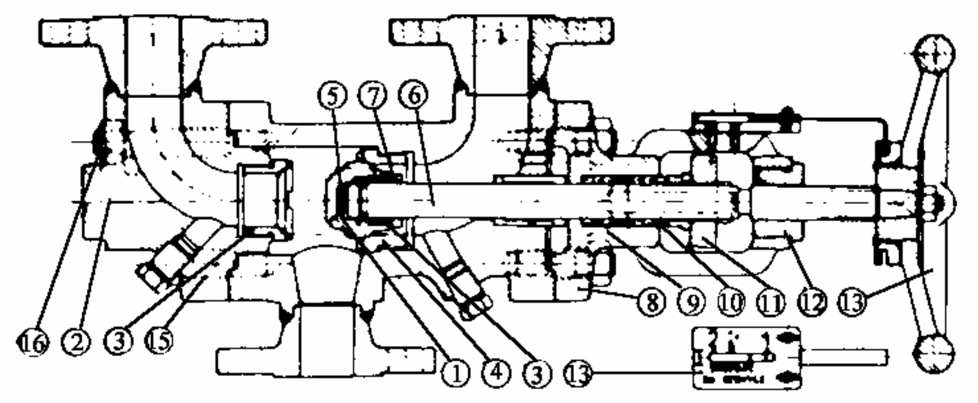
BELLOWS SEALED VALVE



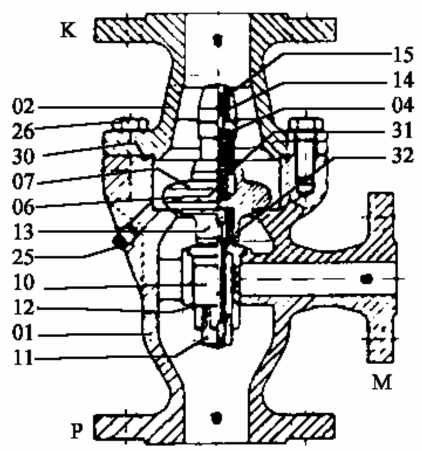

FLOAT OPERATED

**FIGURE F8 ( PART 2 OF 2 ) SPECIAL PURPOSE VALVES**




DIVERTER VALVE

| Ref | Name of part | Ref | Name of part |
|---|---|---|---|
| 1 | Body | 9 | Packing |
| 2 | Body | 10 | Gland |
| 3 | Seat | 11 | Gland flange |
| 4 | Disc | 12 | Yoke brushing |
| 5 | Disc pad | 13 | Indicator |
| 6 | Stem | 14 | Hand wheel |
| 7 | Disc nut | 15 | Stud bolt |
| 8 | Bonnet | 16 | Nut |




EXCESS FLOW VALVE

| Ref | Name of part |
|---|---|
| 01 | Body |
| 02 | Bonnet |
| 04 | Guide bushing |
| 06 | Spring |
| 07 | Disc |
| 10 | Vortex bushing |
| 11 | Control brushing |
| 12 | Stem |
| 13 | Adjustment bolt |
| 14 | PIN |
| 15 | Ball |
| 25 | Drainplug |
| 26 | Hex screw |
| 30 | O-ring |
| 31 | TEC ring |
| 32 | TEC ring |

**FIGURE F9 SPECIAL PURPOSE VALVES**

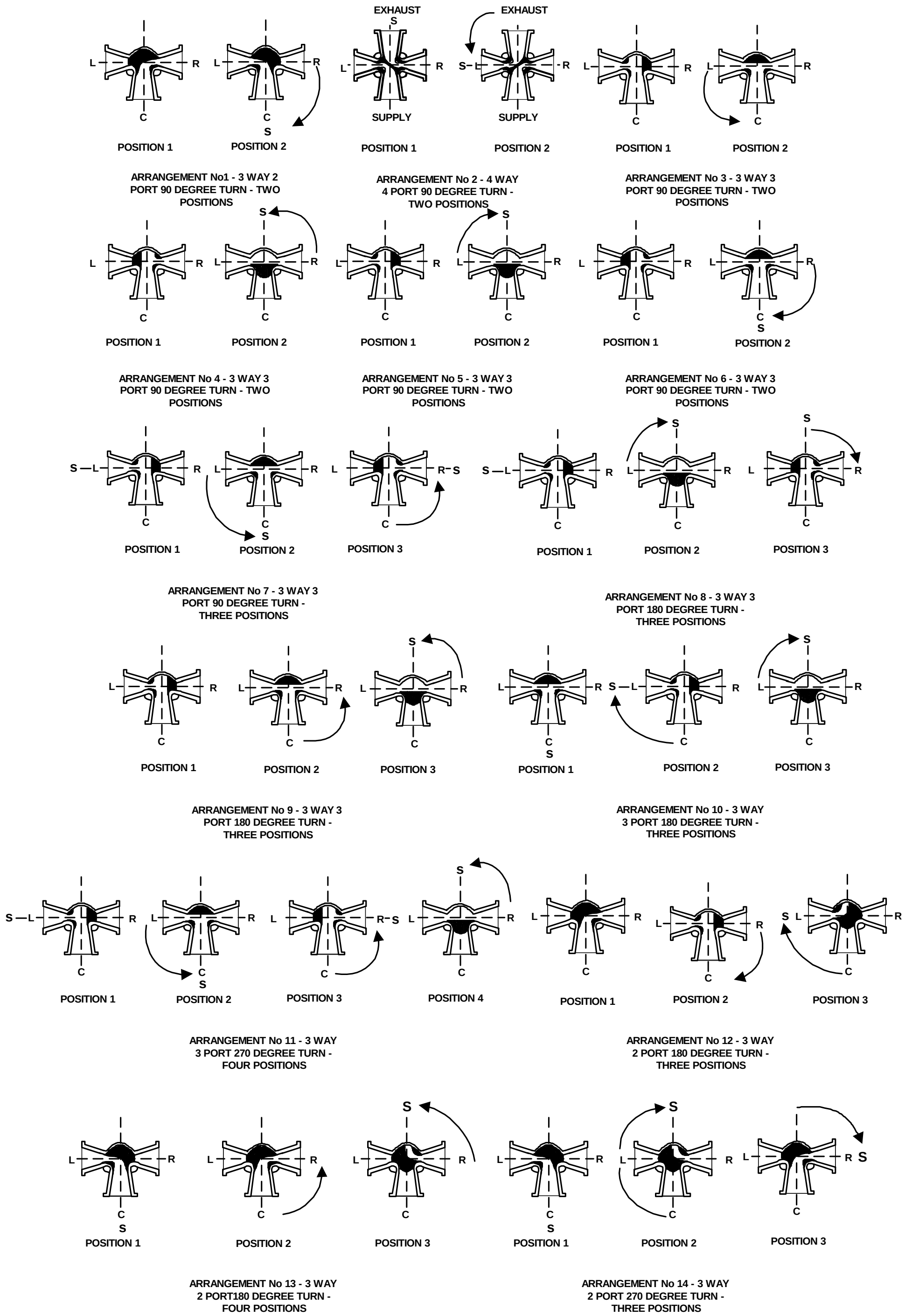
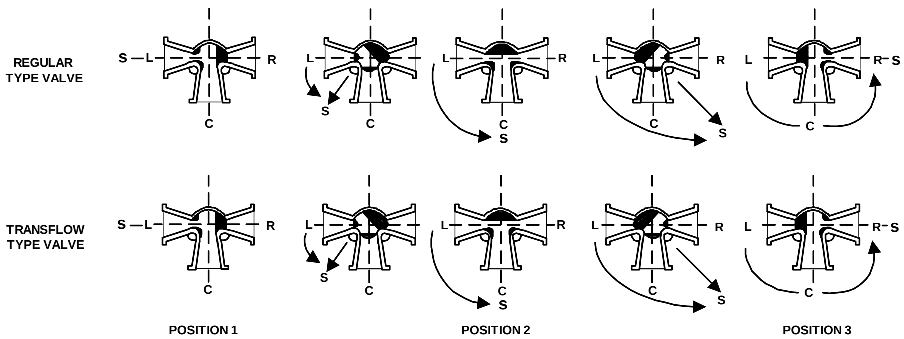



**FIGURE F10 PORT AND STOP ARRANGEMENTS (PAGE 1 0F 2) MULTIPLE PORT VALVES**

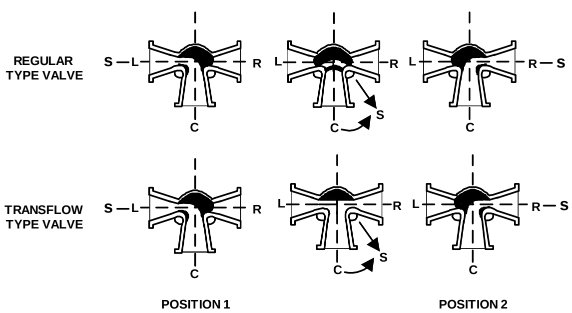
HOW TO ORDER - WHEN ORDERING MULTIPLE PORT VALVES, SPECIFY THE SIZE, FIGURE NUMBER AND THE PORT AND STOP ARRANGEMENT, ( WHEN MULTIPLE PORT VALVES ARE INVERTED, THE ARRANGEMENT REVERSES.)

COMPARISION OF REGULAR AND TRANSFLOW MULTIPLE PORT VALVES
REGULAR PATTERN - FOR SWITCHING WITH CUT-OFF BETWEEN POSITIONS
TRANSFLOW PATTERN - FOR SWITCHING WITHOUT CUT-OFF BETWEEN POSITIONS

3 - WAY, 3 - PORT




3 - WAY, 2 - PORT




POSITIVE SHUT OFF

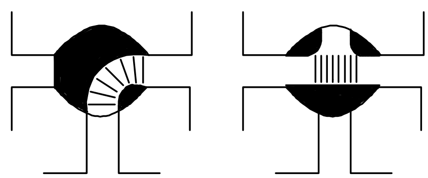


FIG 1 FIG 2

NEGATIVE SHUT OFF

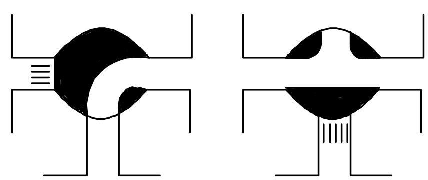


FIG 3 FIG 4

**FIGURE F10 PORT AND STOP ARRANGEMENTS (PAGE 2 0F 2) MULTIPLE PORT VALVES**

## *MATERIALS*

*This Commentary relates to clause 1.2.*

### *G1. General*

*G1.1 For most applications and non-corrosive duties, carbon steel is normally used for the pressure retaining boundary. For high temperature applications creep resisting steel may be specified. Alloy steel, stainless steel, nickel alloys, plastics, rubber lined or other special materials may be required on corrosive services or where there are clean or other special requirements.*

*G1.2 Materials for low temperature service (down to -50°C) may be carbon or alloy steel with impact test requirements. Aluminium or stainless steel may be specified for cyrogenic service (-50°C to -196°C). Further requirements for low temperature applications are provided in Appendix X of BP Group RP 42-1.*

* *G1.3 Cast iron valves should not be used except for underground water services, subject to the approval of BP.*

*G1.4 Materials used for valve trim should be suitable for exposure to the line fluid. Seating components may require to be manufactured from, or faced with, a hard material (e.g. nickel alloy, tungsten carbide, stellite etc.), to withstand wear, erosion and wire drawing. Performance of hard facings may depend on the suitability of the substrate material particularly at low temperatures. Materials for valve stems should be chosen with a view to avoiding galling when in contact with glands, trunnion bearings etc.*

### *G2. Materials for Fire Hazard Areas*

*G2.1 Where fire is a possibility the following materials should not be used for valve components in flammable or toxic service:-*

*(a) Cast, malleable, wrought or nodular iron.*

*(b) Brittle or low melting point materials such as aluminium, brass or plastics.*

*Note: Plastic linings and seals may only be used in fire hazardous areas subject to approval by BP, where the nature of the fluid prohibits the use of fire resistant materials.*

*G2.2* *When choosing materials care should be taken to avoid galvanic action between dissimilar materials.*

## *G3. Elastomers and plastics*

*G3.1.* *Some elastomers and plastics may be subject to swelling when used with particular fluids (e.g. nitrile rubber is not suitable in de-ironised water, nylon may swell with water).*

*G3.2* *Elastomeric materials in contact with gaseous hydrocarbons shall be of a type not prone to high gas permeation rates resulting in failure when subject to a sudden pressure drop (explosive decompression). Materials appear to be most sensitive to rapid pressure reductions occurring below 70 bar when pressures have previously been higher. Harder materials (e.g. 90 durometer) are more resistant than soft materials and special, explosive decompression resistant grades have been developed for this service. Note that, because of defects inherent in the manufacturing process, it is difficult to make any elastomer resistant where the section size exceeds 5.33 mm.*

*G3.3* *Valve pressure-temperature ratings are limited when non-metallic materials (PTFE, nylon, rubber) are used for seats, seals, linings and gaskets. For example Virgin PTFE is normally limited to a maximum operating temperature of 200°C. (Note that this may be increased marginally by the use of a suitable filler, e.g. glass. A guide to temperature limits can be found in BP Group GS 142-7 and most valve manufacturers publish pressure/temperature rating curves for their valves.*

## *G4. High Temperature Service*

*G4.1* *For high temperature (generally above 400ºC) power station steam services 2 ¼% Cr 1% Mo or ½% Cr, ½% Mo, ¼% Vanadium steels are often chosen. The seats and disks will require hard facing with alloys of cobalt, chromium and tungsten and a difference between the hardness of the disk and seat is recommended to avoid galling.*

## *G5. Low Temperature Service*

*G5.1* *For low temperature service (less than 0°C) most ferrous alloys suffer a reduction in notch impact strength and require charpy impact testing to demonstrate adequate toughness. The following is a useful guide to the minimum Charpy V-notch impact energy values which should be expected:*

*Average (Joules) = [min. specified yield (or 0.2% proof) strength (MN/m2) / 10]*

*Individual (Joules) = 0.75 x Average*

*G5.2* *Where materials are to be welded it is recommended that the average impact energy value be increased by 10 Joules.*

*G5.3* *Most non-ferrous materials such as copper, copper alloys and nickel alloys are suitable for low temperature service. 2 ½% nickel steels may be used down to -57°C and austenitic stainless steels retain acceptable properties even under cryogenic conditions.*

*G5.4* *Cast iron should not be used for low temperature service.*

## *G6. Anhydrous Ammonia Service*

*G6.1* *Copper and copper based materials should not be used in this service. Steels should have a maximum yield strength 350 N/mm2 (i.e.. low strength steel) and all welds in steel components should be stress relieved.*

## *G7. Chloride service and Environments*

*G7.1* *Stainless steels may be susceptible to stress corrosion cracking in chloride containing environments at temperatures above 60°C. depending on the concentration and stress level. For purposes of hydrostatic testing, chloride content of the test water should be limited to 30 ppm - lower if evaporation and concentration is likely.*

## *G8. Sour service*

*G8.1* *Materials for sour service should comply with BP Group GS 136-1 which includes the requirements of NACE Standard MR-0175. This limits the hardness of carbon steels, requires* *austenitic steels to be solution annealed and provides special requirements for bolting, welding, etc.*

### *G9. Hydrogen Service*

*G9.1 Carbon steel may be used for hydrogen service up to a maximum of 230°C. The material shall be selected in accordance with API Std. 941 (Nelson Curves); the choice depends upon the mixture of free hydrogen and other fluids at particular hydrogen partial pressures and temperature*

### *G10. Wet $Co_2$ and Chlorine Service*

*G10.1 When choosing materials for wet $C0_2$ or wet chlorine service specialist advice should be sought.*

### *G11. Material Composition of Welding End Valves*

*G11.1 The chemical composition (by ladle analysis) of valve bodies with butt weld or socket weld ends should be restricted as follows:-*

*(a) Carbon and carbon-maganese steels*

*Carbon .... 0.25% max. (forgings and castings)*
*Carbon equivalent (C.E.)1 .... 0.42% max.*

*where*

$$(C.E.)1 = C + \frac{Mn}{6}$$

*It is recommended that the steelmaker be required to confirm that regular production checks show that the carbon equivalent (C.E.)2 does not exceed 0.45%.*
*where*

$$(C.E.)2 = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Cu + Ni}{15}$$

*Note:- If necessary, in order to achieve minimum specified strengths, it may be permissible to increase the specified maximum maganese contents, as given in the referenced specification, up to a maximum of 1.6% provided the maximum permitted C.E. is not exceeded.*

*(b) Chromium-molybdenum steels*

*Steels with 2% Cr and less:*
*Carbon Max. = 0.20% (forgings and castings)*

*Steels with more than 2% Cr:*
*Carbon max. = 0.15%*

*Residual elements:*

| | |
|---|---|
| *Copper ..............* | *0.30% max.* |
| *Nickel ..............* | *0.40% max.* |
| *Tungsten ..............* | *0.10% max.* |
| *Tin ..............* | *0.03% max.* |

*G11.2* *Austenitic stainless steel valves which are to be welded should be manufactured from a low carbon grade (e.g. 304L, 316L) or stabilised grade (e.g. 321) in order to avoid corrosion resulting from the sensitization of the material.*

### *G12. Plated Components*

*G12.1* *When specifying valves (especially ball valves) for corrosive service (e.g. produced water) it is necessary to take into account the fact that plating is usually porous so that, if problems are to be avoided, the base material must be corrosion resistant (e.g. stainless steel). The following guidelines are suggested for electroless nickel plate:-*

*(a)* *minimum plating thickness should be 0.08 mm;*
*(b)* *plating should be free of porisity;*
*(c)* *phosphorous content should be at least 10%;*
*(d)* *plating should have a maximum of 0.5% of elements other than nickel and phosphorous;*
*(e)* *the heat treatment should be conducted in accordance with a written procedure;*
*(f)* *the base material should be compatible with the plating to ensure adequate bonding;*

*G12.2* *Plating is rarely effective where the service is abrasive and overlaid or sprayed coatings (e.g. tungsten carbide) are generally preferred.*

### *G13. Ball Valve Components*

* *G13.1* *Ball valves should normally be supplied with stainless steel balls. Chrome plated carbon steel balls should not be used. Electroless nickel plated carbon steel balls may be considered for non-corrosive service in which case the recommendations of G14 apply.*

*G13.2* *Balls and seats for abrasive service should be coated with tungsten carbide, stellite or other appropriate material.*

## *G14. Gland Packings and Stem Seals*

*G14.1* *Compression packings consist of deformable materials such as exfoliated graphite and carbon or polymer filament/yarn woven into a braid. The material is typically in the form of a box section, supplied in a continuous coil or as separate pre-formed ring elements. The latter are preferred since density can be more carefully controlled but coils can also be cut to provide individual rings. Compression by the gland follower urges the packing against the valve stem and stuffing box wall to provide a seal. Such packings traditionally suffer from relaxation of the load over time leading to leakage in service. To combat this, and where sealing integrity is of prime importance, techniques such as live (spring) loading and specially shaped packing rings may be employed.*

*G14.2* *Graphite packing containing even small amounts of impurities can cause corrosion of martensitic stainless steel valve stems in the presence of water (e.g., after hydrostatic testing). To avoid this, such material should be supplied with a corrosion inhibitor having a passivating or sacrificial action (the former is preferred).*

*G14.3* *A common cause of leakage is overlong stuffing boxes with too many packings rings such that the load applied by the gland follower never reaches the lower rings. Reducing the length of such arrangements (e.g. by replacement of superfluous packing by a rigid spacer) can often be beneficial.*

*G14.4* *Chevron packings generally consist of 'V' shaped rings of PTFE and reinforced polymers which are preloaded by the gland and pressure energised by the process media. They are most frequently used in applications where friction must be minimised (e.g. control valves).*

*G14.5* *'O' ring seals consist of round section elastomer rings fully retained in properly designed housings and sealed by pressure energy from the process fluid. Materials must be carefully selected to suit the fluid being handled. Diametric clearances must be minimised if extrusion is to be avoided and, at higher pressures, rigid plastic backing rings may be used. Specially filled elastomers are available for use in gas service where explosive decompression is a possibility.*

*G14.6* *Reinforced lip seals consisting of an outer sheath of polymer (e.g., PTFE) with internal nickel or stainless steel spring are also pressure energised at higher pressures. When pressure is low, the spring is intended to provide sufficient force to make a seal between the polymer sheath and the wall of the housing or stem. They can be very effective but will leak if scratched across the sealing face. They may also leak during temperature changes where these occur relatively quickly.*

*G14.7* *Thrust packings are packing rings or washers of polymeric reinforced materials mounted on shoulders in the bonnet and on the salve stem; initial sealing may be required by a compression packing. They are only used with quarter turn valves.*

*G14.8* *Diaphragm seals of diaphragm valves are used to isolate the valve stem from the process medium. Various designs are employed including bellows diaphragms of elastomeric or polymeric materials. It is important to realise that, unless a secondary seal (e.g., 'O' ring) is provided on the stem, diaphragm rupture will result in leakage to atmosphere.*

*G14.9* *BP Chemicals in it's drive to reduce both existing and future potential fugitive valve stem emissions from it's plants has implemented Environmental Management of it's wedge gate, globe and check valve population. Existing and new projects should use the technology and current BP Chemical agreements to achieve good long term environmental performance. For further details of the technology and agreements contact BP Chemicals Engineering Technology Manager, Vessels and Piping.*

*Non-compliance with the technology and agreements could be detrimental in terms of plant fugitive emission performance and financial penalties to BP Chemicals.*

*In the case of ball valves BP Chemicals accepts the industry standard to meet it's fugitive emission objectives.*

*BP Chemicals has a preferred technology for parallel slide valves. For further details of the technology and agreements contact BP Chemicals Engineering Technology Manager, Vessels and Piping.*

## *G15. Bolts, Nuts and Screws*

*G15.1* *Material for bolts, studs, screws, and nuts should be selected to suit the flange materials and conditions of service and should generally comply with BP GS 142-9.*

*G15.2* *For sour service 'M' grade bolting will be required where contact with the working fluid is expected (e.g. insulated joints where leakage may occur).*

*G15.3* *For low temperature applications, impact tested alloy steel material (L grade) should be specified. For cryogenic service, austenitic stainless steel is frequently used but it should be remembered that this material is much weaker than alloy steel, so bolt load may be restricted where a direct substitution is made without redesign of the joint.*

*G15.2* *Bolts for use on offshore applications should be zinc or cadmium plated. PTFE coating has limited effectiveness unless it is applied on top of plating since, if the coating is ruptured, corrosion may be accelerated.*

*TABLE G1 - VALVE BODY AND BONNET/COVER MATERIALS (Part 1of 2)*

| **Material** | **Typical Specifications** | | **Typical Application** |
|---|---|---|---|
| | **Forgings** | **Castings** | |
| *Carbon Steel* | *BS 1503-221-490<br>ASTM A105* | *BS 1504-161-480<br>ASTM A216<br>Gr. NCB* | *Non corrosive process hydro- carbons, produced water, slurries deaerated sea water, water air, steam* |
| *Chromium-Moly<br>1 ¼ Cr.<br>½ Mo.* | *BS 1503-621-960<br>ASTM A182- Gr.F11* | *BS 1504-621<br>ASTM A 217<br>Gr. NC6* | *H.P steam and process good resistance to sulphur and hydrogen, good mechanical properties at elevated temperatures* |
| *Chromium-Moly<br>5 Cr - ½ Mo* | *BS 1503-625-590<br>ASTM A1820-Gr. F5* | *BS 1504-625<br>ASTM A217-Gr. C5* | |
| *Stainless Steel<br>Type 304* | *BS 1503-304-S40<br>ASTM A182<br>Gr. F304* | *BS 1504-304-C15<br>ASTM A351 -<br>Gr. CF8* | *Corrosive service, low temp. service, services requiring cleanliness, unsuitable for sea water service. Not to be used where chlorides exceed 30 ppm* |
| *Stainless Steel<br>Type 316* | *BS 1503-316-S31/<br>S33<br>ASTM A182 -<br>Gr. F316* | *BS 1504-316-C16<br><br>ASTM A351 -<br>Gr. CF8M* | *Highly corrosive service. Not recommended for sea water. Not to be used where chlorides exceed 30 ppm* |
| *Carbon Steel<br>(Impact Tested)* | *BS 1503-221-Gr. 490<br>LT 50 ASTM A350-<br>Gr. LF2* | *BS 1504-161-Gr. 480<br>LT 50 ASTM A352-Gr.<br>LCB* | *Low temperature service* |

### *TABLE G1 - VALVE BODY AND BONNET/COVER MATERIALS (Part2 of 2)*

| Material | Typical Specifications | | Typical Application |
|---|---|---|---|
| | Forgings | Castings | |
| Bronze | -<br><br>- | BS 1400<br>Gr. LG2<br>ASTM B62<br>Alloy B36 | Black sewage, brine, fire water, air, steam, water leaded bronze has poor resistance to sea water |
| Aluminium<br>Bronze | - | BS 1400 Gr. AB2 | Sea water, black sewage, brine, fire water. Good for high velocities. Unsuitable for sulphide polluted water |
| Titanium | ASTM B348 Gr. 2 | | Sodium hypochlorite and ferritic chloride solutions |
| Grey Cast Iron | | BS 1452 Gr. 220<br>ASTM A126<br>Class B | Land locations, water aqueous solutions, non-volatile chemicals. Do not use for hydrocarbons or hazardous service. Should not be used where freezing may occur. May be used for underground water service but otherwise should be avoided |
| Spheroidal<br>Graphite Cast<br>Iron | | BS 2789<br>ASTM A395 | As grey cast iron but may be used at higher pressures and temperatures |
| Monel 400 | | ASTM A494 or<br>A744-M-35-1 | Sea water, brackish water, brine. Good resistance to all acids except oxidising types |
| Hastelloy Alloy C | | ASTM A494 or<br>A744-CW-12M | Hypochlorites, acetic acid chlorine, hydrogen |
| 13% Chrome Steel; | BS 1503-541- S21 ASTM A182-F60 | BS 1504-420 C29 ASTM A217-CA15 | Natural gas + $C0_2$<br>(Hardness limited to 22RC max) |
| Super Duplex<br>Stainless Steel | | | Sea water service Natural gas + extreme $C0_2$<br>Extreme sour service |
| UPBV<br>PVDF<br>PP<br>ABS | | | Land locations or inside modules only Non-fire hazardous services water and process services |

## *TABLE G2 - TYPICAL APPLICATION OF METALLIC TRIM MATERIALS*

| *MATERIAL* | *NOTES* |
|---|---|
| *13% Chrom. Steel* | *General services, gases, oil, steam. Normally supplied with body materials LBC, WCB, WC1, WC6, WC9, C5 and C12. Note: Stems may be subject to graphitic attack* |
| *13% Chrom. with Nickel Alloy Facing* | *General services, steam, water, air, gas, fuel oil non-lubricating, non-corrosive low viscosity oils. Normally supplied with WCB body material.* |
| *13% Chrom. Steel, Hard Faced* | *General services, steam, gas, oil and oil vapour. Supplied with body materials LCB, WCB, WC1, WC6, WC9 and C5.* |
| *Hard Faced Trim (e.g. Stellite, Tungsten Carbide)* | *Steam, wire drawing applications, dirty service etc. Normally supplied with body materials WCB, WC1, WC6, WC9 C5, C12, CF8, CF8M and CF8C.* |
| *Stainless Steel 18-10-2 with or without Hard Facing* | *Corrosive services. Normally supplied with body materials, LC3, LC2, LC1, LCB, WCB, CF8, CF8M and CF8C.* |
| *Bronze* | *Cold, hot water, marine applications and low temp. service. Normally supplied with WCB body material* |
| *Aluminium bronze* | *Sea water, brine, firewater unsuitable for sulphide polluted water.* |
| *Super Duplex Stainless Steel* | *Sea water, sour service.* |
| *Hastelloy Alloy C* | *Hypochlorites, chlorine, hydrogen sulphide, sea water, brine* |
| *Monel and Inconel* | *Corrosive Services* |
| *Electroless Nickel Plating* | *Used for ball valves* |
| *Cast Iron* | *Not used where freezing is likely to occur* |
| *Titanium* | *Sodium Hypochlorite* |

***TABLE G3 -TYPICAL APPLICATION OF NON-METALLIC MATERIALS***

(FOR FURTHER INFORMATION SEE BP GROUP GS 142-7)

| ***MATERIAL*** | ***APPLICATION*** |
|---|---|
| *Butyl Rubber* | *Cold water and process service, good wear resistance* |
| *Chlorinated Polyether (Penton)* | *Process service (good resistance to acids and solvents). If softening can be tolerated can be used to 125°C.* |
| *Chlorosulphonated Polyethylene (Hypalon)* | *Good resistance to chemical attack (e.g. acids, alkalis, oxidizing agents, minerals and vegetable oils), poor resistance to aromatic and chlorinated hydrocarbons* |
| *Ebonite* | *Good chemical resistance, most grade soften above 70°C. Becomes brittle at low temperatures* |
| *Ethylene Propylene (EP DM)* | *Good mechanical properties, good resistance to phosphate ester based hydraulic fluids and minerals. Some grades can be considered for wellhead and hot water applications (See BP Group GS 142-7)* |
| *Natural Rubber* | *Suitable for cold water and some chemical and abrasive service. Has low resistance to solvents, oils and sunlight* |
| *Neoprene* | *Suitable for some process services, high oil resistance with some grades. Good resistant to sunlight and weather suffers from compression set when hot* |
| *Nitrile* | *Good general service material, good resistant to oil, solvents and chemicals, subject to swelling when used with de-ionised water. Shall not be used for sour service. Poor resistance to sunlight and weather* |
| *Nylon* | *Insoluble in hydrocarbons, good resistance to alkalis, will absorb water and swell, good frictional properties* |
| *Polypropylene* | *Good resistant to chemical attack, similar to polythene. Not so subject to stress cracking as polythene* |
| *Polyethylene* | *Good resistance to mineral acids, alkalis and solvents. Suffers embrittlement when subject to polar solvents, esters, alchols and keytones* |
| *Polyurethane* | *Excellent resistance to oils, solvents, fats, grease, petrol, ozone sunlight and weather. Good properties at low temperatures. Some reduction in properties at high temperatures, susceptible to hydrolysis should not be used with hot water or acid* |
| *PTFE (Virgin)* | *Excellent for most process services. Some grades may be used at -180°C. Max temp. limits (200°C) may be increased by adding fillers. Max. allowable temperature depends on seal/valve design. Low friction properties, subject to creep and cold flow under moderate loads.* |
| *PVC* | *Can be supplied plasticised or in rigid form. Good chemical resistance. Can suffer from creep.* |
| *Silicone Rubber* | *Poor physical properties, lack of resistance to chemical attack. Not resistant to acids or alkalis. Aromatic and chlorinated solvents and petrol cause swelling* |
| *Fluoroelastomer (Viton)* | *Water and process service. Good resistance to some acids, petrol and solvents. Should not be used with esters and keytones. Poor flexibility at low temperatures. Viton A has poor methanol resistance, Viton GF has better methanol resistance but poor explosive decompression resistance* |

*	*Viton and EPDM elastomers (ethylene diene) may be used for wellhead seals. The grade selected shall be suitable for the process conditions and resistant to explosive decompression and subject to approval by BP.*

*Most elastomers are subject to swelling when used with de-ionised water, particularly nitrile rubber. Viton and neoprene elastomers should not be considered for hot water applications because they are susceptible to blistering, but may be used for hot oil application. EPDM (peroxide cured) may be considered for hot water applications up to 130°C. It is recommended that the use of viton is limited to 180°C for pressurised systems and 200°C for non-pressurised systems.*

### *G16. Material Temperature Limitations*

*The maximum and minimum operating temperatures given below are a general guide only for non-corrosive conditions. The corrosive nature or condition of the fluid may restrict the allowable operating temperature range and service life of the material. Where any doubt of the material suitability exist, a materials specialist must be consulted.*

### *TABLE G4 - BODY AND BONNET/COVER MATERIALS*

| *Materials* | *Temperature C Min* | *Max* | *Notes* |
|---|---|---|---|
| *Carbon Steel* | *- 29* | *425* | |
| *Chromium Moly (1 ¼ Cr, ½ Mo)* | *- 29* | *593* | *1, 2* |
| *Chromium Moly (5 Cr, ½ Mo)* | *- 29* | *593* | *1* |
| *Stainless Steel Type 304* | *-196* | *538* | |
| *Stainless Steel Type 316* | *-196* | *538* | |
| *Carbon Steel (Impact Tested)< LT50/LF2* | *- 50* | *343* | |
| *Bronze* | *- 30* | *260* | |
| *Aluminium Bronze* | *- 30* | *260* | |
| *Titanium* | *- 30* | *315* | |
| *Grey Cast Iron* | *-* | *204* | |
| *Spheridal Graphite Cast Iron* | *-* | *343* | |
| *Monel 400* | *-196* | *425* | |
| *Hastelloy C* | *-196* | *425* | |
| *13 Chrome Steel* | *- 50* | *600* | |
| *Duplex Stainless Steel* | *- 50* | *315* | |

*Notes:-*

1. *Class 150 flanges valves 540℃ max.*

2. *Scaling may occur above 565℃.*

*All valve temperature limits may be reduced to suit trim and materials.*

## *TABLE G5 - TRIM MATERIALS*

| *Materials - Metallic* | *Temperature ℃ Min* | *Max* | *Notes* |
|---|---|---|---|
| *13% Chromium Steel* | *-50* | *600* | |
| *13% Chromium with Nickel Alloy or other Hard Facing* | *-50* | *450 to 600* | *(depending on facing material)* |
| *Stellite or Tungsten Carbide Hard Facing* | *-196* | *650* | |
| *Stainless Steel 18-10-2 with or without Hard Facing* | *-196* | *450* | |
| *Bronze* | *-196* | *288* | |
| *Aluminium Bronze* | *-196* | *260* | |
| *Monel* | *-196* | *425* | |
| *Inconel* | *Dependent on Grade* | | |
| *Duplex Stainless Steel* | *-50* | *315* | |
| *Hastelloy Alloy C* | *-196* | *425* | |

| *Materials - Non-Metallic* | *Temperature ℃* Min* | *Max* |
|---|---|---|
| *Butyl Rubber* | *-50* | *120* |
| *Chlorinated Polyether (Penton)* | | *90* |
| *Chlorosuphonated Polyethylene (Hypalon)* | *-15* | *200* |
| *Ebonite* | *0* | *57/149 (depends on grade)* |
| *Perfluoroelastomer (kalrez etc.)* | *0/35* | *230/260 (depends on grade)* |
| *PEEK* | *-10* | *250 (depends on grade)* |
| *Ethylene Propylene (EPDM)* | *-30* | *150* |
| *Natural Rubber* | *-50* | *70* |
| *Polychloroprene (neoprene)* | *-20* | *100* |
| *Nitrile rubber (NBR)* | *-20* | *120* |
| *Polyproplene* | *0* | *100* |
| *Polyurethane* | *-30* | *90* |
| *Polyethylene* | *0* | *60* |
| *PVC* | *-40* | *60* |
| *Silicone Rubber* | *-80* | *170* |
| *Virgin PTFE* | *-190* | *260#* |
| *Fluoroelastomer (Viton)* | *(-5 to - 35)* | *200 (depends on grade)* |
| *Hydrogenated nitrile (HNBR)* | *-20* | *150* |

**For continuous exposure. Most materials will withstand brief excursions to 5° lower and 10/20° higher. For marginal applications specialist advice should be sought.*
*#If fully contained. Note: this material tends to extrude*

## *G17. Chemical Resistance Charts - Table G6 and 7*

*The following charts are a guide only for choosing valve materials. The choice is influenced by a number of factors such as fluid concentration, temperature, line velocity, presence of impurities, abrasion, possibility or stress corrosion cracking etc. Where any doubt exists, a BP materials specialist must be consulted.*

### *TABLE G6 - CHARACTERISTICS OF COMMON ELASTOMERS*

| Property | Elastomer Natural Rubber | Neoprene | Nitrile | Butyl | Hypalon | EPDM | Viton |
|---|---|---|---|---|---|---|---|
| Abrasion Resistance | A | B | B | BC | B | AB | B |
| Gaseous Permeability | C | B | B | A | B | C | B |
| Tear Resistance | AB | B | C | B | B | AB | B |
| Cold Resistance | B | B | B | B | BC | AB | BC |
| Resilience | A | A | BC | D | C | BC | C |
| Flame Resistance | D | B | D | D | B | D | B |
| Ozone Resistance | C | A | C | A | A | A | A |

*Key:* A = Excellent, B = Good, C = Fair, D = Poor

## *SIZING AND RESISTANCE TO FLOW*

*This Commentary relates to clause 1.2.*

### *H1. General*

*Depending on the type involved, valves can be a major source of pressure loss in a piping systems.*

### *H2. Incompressible (liquid) Flow*

*H2.1 There are four commonly used methods of stating a valve's resistance to flow:-*

*(a) Loss coefficient, K*

*This is the most convenient form for use in piping system design since it can be added to the loss coefficients of other piping components and the pipe itself to produce an overall loss coefficient for the system. Pressure or head loss can be calculated as follows:-*

$$\text{Head loss } dH = \frac{K\,V^2}{2g}$$

$$\text{Pressure loss } dH = \frac{K\,pV^2}{2}$$

*Wher V = Velocity of flow in pipe*
*p = Density of fluid*
*g = acceleration due to gravity*

*(b) L/D Ratio*

*This is the equivalent length of pipe, L having internal diameter D which has the same resistance as the valve.*

$$\text{Loss coefficient, } K = \frac{f\,L}{D}$$

*Where f = Pipe friction coefficient*
*L = Pipe length*
*D = Pipe diameter*

*A valve resistance quoted in terms of L/D ratio implies that an assumption has been made regarding pipe roughness and Reynolds Number and hence the value or 'f'*

*(c) Valve flow coefficient, Cv*

*This is the flow of water (at 60ºF), measured in U.S gallon/min. Which can be passed by the valve when a pressure drop of 1 psi acts across it. Pressure drop under flowing conditions is then given by:-*

$$dp = \frac{Q^2 G}{Cv^2} \text{ 1bf per sq. in.}$$

*Where Q = Flow rate (U.S gall/min.)*
*G = Specific gravity of liquid.*

*Note: If Cv is quoted in Imperial gallons the flow rate will need to be adjusted accordingly and vice versa. If flow is not fully turbulent (e.g. highly vicous liquid) a viscosity correction factor must be applied to Cv.*

*(d) Metric valve flow coefficient, Kv.*

*This is the metric equivalent of Cv and represents the flow in cubic metres/hr which can be passed by the valve when a pressure drop of 1 bar (actually 0.981 bar) acts across it. Pressure drop under flowing conditions is then given by:-*

$$dP = \frac{Q^2 G}{Kv^2}$$

*Where Q = Flow rate (cubic metres/hr)*
*G = Specific gravity of liquid*

*The relationship between Cv and Kv is:-*

*Kv = 0.87 Cv (for Cv in U.S. galls)*
*Kv = 1.05 Cv (for Cv in Imperial galls)*

*The relationship between Cv and K is:-*

$$K = \frac{894 \; d^4}{Cv^2} \text{ (for Cv in US. galls)}$$

$$K = \frac{620 \; d^4}{Cv^2} \text{ (Cv in Imperial galls)}$$

*H2.2* *Table H1 provides guidance on the relative flow resistance of different valve types assuming fully turbulent flow. In specific cases, accurate information should always be obtained from the manufacturer.*

*H2.3* *The increase in velocity through a valve may result in the vapour pressure of the fluid being reached, causing cavitation when the pressure rises again with resulting erosion damage. Such situations should be avoided.*

### *H3. Compressible (Gas or Vapour) Flow*

*The situation here is much more complex than in the case of incompressible flow and there is less agreement on procedures. Valve manufacturers use a variety of different formulae for sizing many of which involve the use of empirically derived factors. The user is primarily interested in the total pressure drop across the valve but the condition within the valve itself (e.g. possible high pressure drop followed by recovery, choked flow etc.) must be taken into account in deriving this.*

*H3.2* *In the case of full bore, low pressure drop valves (ball, gate) such effects are unlikely to be significant, but in other cases it is recommended that accurate information is obtained from the manufacturer and that authoritative texts be consulted (e.g 'ISA Handbook of Control Valves' - J.W. Hutchinson; 'Compressible Internal Flow' - D.S. Miller (BHRA)).*

*The following formula is provided for guidance.*

*Loss Coefficient K (see $H_2$)*

$$K = \frac{(Aa)^2}{(Av)^2}$$

*where* $Av = 24 \times 10^{-6} \times Cv$ *[(or* $28 \times 10^{-6} \times Kv$*)]*

$Aa = 24 \times 10^{-3} \times Av \times C$ *(for inlet velocities of Mach 0.2 or less)*

*C = Gas flow factor from manufacturer (based on air tests with critical flow). This is sometimes combined with Cv and quoted as a gas sizing coefficient Cg.*

### *H4. Surge*

*Valves can be a source of surge phenomena such as 'water hammer' in a piping system. The usual cause is fast closure (e.g. a swing check valve slamming shut on flow reversal) but fast opening of a valve isolating a high energy line from a depressurised part of the system can also be problematic.*

*The effect is a rapid conversion of kinetic energy into strain energy (pressure rise and deformation of the piping system) and specialist assistance should be sought if such situations are likely to arise.*

*As an indication of where this might be necessary, valve closures occuring within the time taken for a pressure wave to travel from the valve to the other end of the pipeline and back (one wave cycle) must be regarded as occuring instantaneously.*

$$\text{Time for one wave cycle} = \frac{2L}{C}$$

*where L is the length of pipe and C is the wave velocity. As will be seen from the following table, the latter quantity is a function of pipe diameter and wall thickness as well as the fluid contained.*

### *TABLE H1 - LOSS COEFFICIENT K*

| *VALVE TYPE* | *APPROX. K VALUE* | |
|---|---|---|
| | *MIN.* | *MAX.* |
| *Globe and Lift Check 2 in. and above, Full Bore* | *4* | *10* |
| *Globe and Lift Check 1 ½ in. and below, Full Bore* | *5* | *13* |
| *Globe 45 degrees Oblique Type Full Bore* | *1* | *3* |
| *Globe Angle Pattern 2 in. and above, Full Bore* | *2* | *5* |
| *Globe Angle Pattern 1 ½ in. and below, Full Bore* | *1.5* | *3* |
| *Gate Valve Full Bore* | *0.1* | *0.3* |
| *Ball Valve Full Bore* | *0.1* | *-* |
| *Plug Valve (Rectangular Port) Full Open* | *0.3* | *0.5* |
| *Plug Valve (Rectangular Port) 80% Open* | *0.7* | *1.2* |
| *Plug Valve (Rectangular Port) 60% Open* | *0.7* | *2.0* |
| *Plug Valve (Circular Port) Full Bore* | *0.2* | *0.3* |
| *Butterfly Valve* | *0.2* | *1.5* |
| *Diaphragm (Wier Type)* | *2.0* | *3.5* |
| *Diaphragm (Straight Through Type)* | *0.6* | *0.9* |
| *Swing and Tilting Disc Check* | *1.0* | *-* |

## *TABLE H2 - K FACTORS FOR AXIAL FLOW CHECK VALVES*

*The following approximate K Factors may be used for axial flow, spring operated, non-slam check valves (See Figure F3).*

| *Size NPS* | *'K' Factor* |
|---|---|
| *2* | *1.9* |
| *3* | *1.7* |
| *4* | *1.6* |
| *6* | *1.4* |
| *8* | *1.3* |
| *10* | *1.2* |
| *12* | *1.2* |
| *14* | *1.1* |
| *16* | *1.1* |
| *18* | *1.1* |
| *20* | *1.0* |
| *24* | *1.0* |
| *28* | *0.97* |
| *30* | *0.95* |
| *32* | *0.94* |
| *36* | *0.92* |
| *40* | *0.89* |
| *42* | *0.89* |
| *48* | *0.86* |
| *52* | *0.85* |
| *60* | *0.82* |

***TABLE H3 - APPROXIMATE WALVE VELOCITIES FOR INSTANTANEOUS CLOSURE***

| $\frac{d}{t}$ | *C. WAVE VELOCITY* | |
|---|---|---|
| | ***ft/s*** | ***m/s*** |
| *20* | *4,300* | *1,310* |
| *40* | *4,000* | *1,219* |
| *60* | *3,800* | *1,158* |
| *80* | *3,600* | *1,097* |
| *100* | *3,400* | *1,036* |
| *150* | *3,100* | *945* |
| *200* | *2,800* | *853* |
| *250* | *2,600* | *792* |
| *300* | *2,400* | *732* |

*Where d = Pipe inside diameter (inches or mm)*
*t = Pipe wall thickness (inches or mm)*

## GLOSSARY OF VALVE TERMINOLOGY

This Section lists in alphabetical order many common terms used in vale specification and description.

| | |
|---|---|
| Angle Valve: | A globe valve design with valve ends at right angles to each other. Normally with the inlet in the vertical plane and the outlet in the horizontal plane. |
| Abrasion: | Damage to valve trim caused by hard particulate in the process fluid. |
| Actuator: | A powdered valve operator to open or close a valve, energised by pneumatic, electric or hydraulic power sources. |
| Air/Vacuum Relief Valve: | See pressure/vacuum safety valve. |
| Anti-Blowout stem: | A valve stem with a shoulder, positively retained by the body or bonnet. Typically, a requirement for ball valves. |
| Anti-Static Device: | A device providing electrical continuity between the valve body and internal components to prevent ignition of flammable fluids. |
| Angle Valve: | A globe valve design having valve ends at right angles to each other. Normally the inlet in the vertical plane and outlet in the horizontal plane. |
| Automatic Control valve: | A valve automatically regulating the flow, pressure or temperature of a fluid in response to a process signal from a sending element. |
| Axial Piston Valve: | An uncommon but effective valve of the globe type having a piston shaped closure with its polar axis in the line of flow. Generally used as a check valve, but with modification also used for control and block valve functions, (also known as a nozzle valve, inline globe or piston valve). |
| Back Seat: | A face on the valve stem, seating on the underside of the gland stuffing box, providing a metal to metal seat on a full open valve reducing gland leakage should this occur. Gland packings shall not be replaced with the back seat closed and under line |

| | |
|---|---|
| | pressure. Generally provided on gate and globe valves. |
| Back Pressure: | The pressure at the outlet, downstream of the valve. For safety valves back pressure is expressed as a percentage of the set pressure. |
| Balanced Safety Valve: | A safety valve in which the spring and closing forces due to back pressure are balanced (generally by means of a bellows). |
| Ball: | See Closure. |
| Ball Check Valve: | A lift check valve having a free or spring loaded ball closing on a spherical seat (see also check valve). |
| Ball Valve: | A quarter turn, rotary action valve with spherical closure and seats. Also called a ball plug valve for some design features (see Appendix D Section D1). |
| Bellows: | A convoluted, cylindrical component, usually metal, providing axial flexibility and pressure containment. used as a gland seal (in bellows sealed valves) or equalising back pressure in balanced safety valves. Specifically strong designs may be used for mechanical loading seats in some designs of ball and gate valves for high temperature or dirty services. |
| Bellows Sealed Valve: | A valve having a bellows sealed gland (see 3.4.2). |
| Bi-Directional Valve: | A valve designed to seal against flow or pressure from either direction. |
| Block Valve: | A general term for valves used to shut-off flow and pressure. Other terms used are isolation valve, shut-off valve and stop valve. |
| Blow Down: | A term which when applied to safety valves means the pressure difference between set pressure and reseating pressure, usually expressed as a percentage of set pressure. Blow down is also a term used in steam plant and process plant. |
| Blow Down Valve: | A valve, often specially designed for rapid depressurising of a high pressure system. Also called a blow-off valve. |

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| Body (Valve): | The main pressure containing component of a valve housing the working components. The body may be of a single piece construction or comprise of several segments. |
| Bolted Bonnet: | A term specifying that the bonnet is bolted to the body (not screwed or welded). |
| Bolted Gland; | A term specifying that the gland is bolted to the bonnet (not screwed or a union type). |
| Bonnet: | The pressure containing top cover containing the gland, applies to block, diverter and control valves. The term cover is used for check valve. |
| Bonnet Assembly: | The bonnet and valve operator. |
| Bonnetless Valve: | A term for a valves having all internal parts inserted into s one piece body (could be used for some bellows sealed valves). |
| Bonnet Packing: | See gland packing. |
| Bottom Flange: | A term used when a pressure containing plate covers an opening on the bottom of a valve. |
| Brass to Iron: | Specifies a valve with a brass closure and iron seat or vice versa. |
| Breakout Torque of Force: | The torque of force required at the valve stem to initially move the closure from the fully closed position. |
| Bronze Trim or Bronze Mounted: | Specifies that trim (internal components), e.g. closure, stem, seat ring are of brass or bronze. |
| Bubble Tight: | A typical requirement for manufacturers production test meaning no visible seat leakage (bubbles of air). |
| Built-Up Back Pressure: | A safety valve outlet pressure due to flow into a discharge line, normally expressed as a percentage of the set pressure. |
| Butterfly Valve: | A valve having a circular disk closure normally mounted on a shaft, rotation gives a wing like movement to close at right angles to the flow (see Appendix D section D2). |

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| By-Pass Valve: | A valve to divert flow around or past part of a system through which it normally passes. |
| Cage Trim: | A trim diverting fluid from components using the fluid internal energy to improve regulation of flow and minimise wear in control and choke valves. |
| Cavitation: | A phenomena which can occur in partially closed valves due to a reduction in static pressure in the downstream region of an increasing velocity. If the liquid vapour pressure is reached, vapour filled cavities form and grow around gas bubbles and impurities, increases in static pressure cause vapour bubbles to suddenly collapse or implode and can damage the valve trim. |
| Cavity Relief: | Relief to prevent pressure build up in valve body cavities due to temperature changes of trapped fluids internal relief may be provided by the seat design, external relief may be necessary in some designs requiring a body mounted relief valve with inlet to the cavity. |
| Chatter: | A safety valve term for rapid reciprocating motion of the closure (disk) contacting the seat. |
| Check Valve: | A self acting valve type allowing forward flow, preventing reverse flow (see Appendix E3). Other terms used include back pressure valve, non-return valve, reflux and retention valve. |
| Chlorine Service: | Valves designed for this service. |
| Choke Valve: | A control valve for flow and pressure, often in the choked mode. The design is similar to a globe valve, the closure being conical or plug shape seating in a circular orifice. Is generally used for drilling and production of oil and gas; also for water injection. |
| Clamp Gate Valve: | A gate valve having body and bonnet held together by a ‘U’ bolt clamp which facilitates stripdown for overhaul. |
| Class Rating: | See rating. |

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| Clean Service: | A classification used to denote that the process fluid and piping system are essentially clean. |
| Closing Torque or Force: | Torque or force required at the valve stem to closure on to the final seat position. |
| Closure: | A term for the operating components regulating the flow or pressure e.g. ball, disk, gate piston or plug. Other terms used include closure member and obturator. |
| Cock: | A small quarter turn, rotary action valve with a taper plug closure, generally used for low pressure instrumentation, drains and vents. |
| Combined Stop Check Valve: | See globe stop and check valve. |
| Compact Gate Valve: | A gate valve having compact dimensions, normally complying with API 602 may be supplied with one extended end for threaded or welded attachment (API 606). |
| Conduit Gate Valve: | A parallel gate valve having a continuous uninterrupted port through the valve when fully open. Also known as a through conduit gate valve. See also slab gate and split gate valves (see Appendix D para D3.9). |
| Control Valve: | A term for a valve that regulates flow, pressure or temperature. See also automatic control valve and manual control valve. Other terms include regulating valve and throttling valve. |
| Conventional: | A term used to describe the basic generic valve type, distinguishing it from specific variations e.g. butterfly valves are conventional or high performance, parallel gate valves are conventional or conduit, safety valves are conventional or balanced. |
| Conventional Butterfly Valve: | See rubber lined butterfly valve. |

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| Conventional Parallel Gate Valve: | A parallel gate valve with a gate or disk closure that does not seal the bottom of the body cavity when open. Also called the regular parallel gate valve. |
| Conventional Safety Valve: | A safety having a bonnet vented to discharge (outlet) from the valve. |
| Corrosion allowance: | An allowance on the practical thickness of pressure containing components subject to corrosive fluids. |
| Crawl: | A safety valve term for graduated adjustment of set pressure of spring loaded safety valve from below normal to normal after the spring temperature has been raised by discharged fluid. |
| Cryogenic Valve: | A valve designed to operate within the temperature range -50ºC to 196ºC. Typical valve types used include ball, butterfly glove, wedge gate and check valves (see para. 3.4.3). |
| Dashpot: | A device for dampening the movement of the closure member. Dashpots are used for swing check valves to reduce or eliminate surge in piping systems. |
| Diaphragm: | A flexible disk of metal (convoluted) or a membrane of resilient material (elastomers, polymers - often fabric reinforced) that provides limited movement for valve operation and seating/separation of fluids. Applications include diaphragm check valves, diaphragm control valves and diaphragm valves. |
| Diaphragm Check Valve: | A valve in which the closure is a specially shaped diaphragm allowing forward flow (see Appendix E Section E4). |
| Diaphragm Control Valve: | A control valve having actuation provided by a diaphragm or the actuation operated by a spring diaphragm arrangement, |
| Diaphragm Valve: | A block/control valve utilizing a resilient diaphragm as the closure, two types available, weir and straight through type (see Appendix para. D6 ). The valve is also known as a glandless valve (gland can be provided). Use for low pressure applications, limited temperature operating range. |

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| Differential Pressure: | The difference in pressure between any two points in a piping system. For valves usually the difference in pressure between the upstream (inlet) and downstream (outlet) of a fully closed valve. Also known as pressure differential. |
| Double Acting Safety Valve: | A safety valve having a directly loaded closure disk directly mechanically loaded (normally a spring) against its seat and actuated by the process fluid, see also safety valve. |
| Discharge Coefficient: | A safety valve term for the ratio of the measured releasing capacity to the theoretical releasing capacity related to the nominal flow area. |
| Dirty Service: | A classification used to denote that the process fluid and piping system contain particulate which may damage valves unless specially selected for the condition (e.g. conduit gate and metal seated ball valves for oil and gas production). |
| Diverter Service: | A process requirement to direct flow from one stream to one or more streams. Several block valves on one diverter valve may be employed. Where several valves are used, to avoid confusion they should be called block valves for diverter services (See also diverter valves). |
| Diverter Valve: | A valve with multiple ports to divert flow to one or more streams and preventing intermixing (see Appendix D para. D9). Also called multi-port valves, switching valves and change over valves. The term may also be used to describe several valves used in combination for directing flow streams. |
| Dual Plate Check Valve: | See split disk check valve. |
| Double Block: | The provision of double isolation either by means of two separate valves installed in series or by means of a single valve having two seats, each of which provides a seal. |
| Double Block and Bleed: | The provision of double isolation with the additional capability of being able to vent the space between the two isolation points. |

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| Double Block Valve: | A single valve having two seats, each of which provides a seal. The seats may isolate with the pressure differential acting in the same or in opposite directions, depending on the design. |
| Double Block and Bleed Valve: | A single valve incorporating two seats, each which provides a seal, and a means of venting the space between the seats. The seats may isolate with the pressure differential acting in the same or in opposite directions, depending on the design. |
| Double Disk Butterfly Valve: | An uncommon design having two disks to isolate flow and pressure usually provided with cavity bleed for double block and bleed. |
| Double Piston Effect: | A term used for trunnion mounted ball valves in which the line pressure energised seats are designed to seal with cavity pressure. The floating seat effectively a piston seating by pressure from each side. |
| Downstream Seated Valve: | A valve where the upstream line pressure loads the closure against the downstream seat with differential pressure across the valve. Typical valves include gate valves (wedge gate, parallel gate), floating ball valves, globe valves and high performance butterfly valves. |
| Drag Valve: | A control valve with a perforated cage trim for high pressure drop, low noise application. |
| Drop Tight: | A term specifying that droplets shall not be passed when a valve is closed. |
| Eccentric Ball Valve: | A quarter turn, rotary action valve. Closure is by a ball or spherical seating component pivoted off centre to provide cam action motion locking closure against seat. |
| End Entry Ball Valve: | A ball valve with a single piece body in which the ball is assembled from one end of the bore and held in position by a seat/retainer ring fastened to the body. |
| Erosion: | Damage to the valve/trim caused by high velocity flow of fluids. |

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| Excess Flow Valve: | A valve designed to close automatically when flow exceeds a specified rate. |
| Expanding Wedge: | A gate valve with split gates separated by an expanding wedge loading each gate against its fixed seat. This feature is used in certain types in conventional and conduit parallel gate valves and wedge gate valves. |
| Face to Face Dimensions: | The dimension from the end face of the inlet port to the end face of the outlet port of a valve or pipe fitting. |
| Facing: | The finish of the gasket contact surface of flanged end piping materials and valves. |
| Fire Fighting Valve: | Generally a globe valve specifically for fire hydrants having an outlet for a hose coupling. |
| Fire Safe: | A misleading and incorrect term used to describe a valve suitable for fire hazardous areas - see fire tested valve. |
| Fire Tested Valve: | A valve fire tested and certified in accordance with accepted national fire test standards. Fire test certification used for acceptance of valve for use in fire hazardous areas. |
| Fixed Seats: | Seats fixed to valve body, a term differentiating from valves with floating seat as supplied with floating ball valves and split gate valves. Parallel gate valves generally have fixed seats. |
| Flap Valve: | A low pressure swing check valve having hinged disk or flap, sometimes leather or rubber faced. |
| Flash Point: | The temperature at which a fluid first releases sufficient flammable vapour to ignite in the presence of a small flame or spark. |
| Flat Faced bonnet Joint: | The jointing surface between a valve body and bonnet when the bonnet is not recessed into the body but seated on a flat surface. |
| Flat Full Face Gasket: | A flat gasket covering the entire surface of parts to be joined. |

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| Flexible Wedge Gate Valve: | A valve having a slotted gate permitting flexing, improving seat alignment, reducing break out and closing force (torque) with high pressures and temperatures - see gate valve. |
| Floating Ball Valve: | A ball valve having a ball in supported by seat rings, without a bottom trunnion. Also called a seat supported ball valve. (See Appendix D para. D1.3 and also ball valve). |
| Floating Seats: | Valve seats having limited axial movement, energised by line pressure to seal against the closure. A term used to differentiate from fixed seats of ball and gate valves, e.g. trunnion mounted ball valves and slab parallel gate valves have floating seats. |
| Float Valve: | An automatic flow control valve of globe or piston type, usually operated by a float mechanism for regulating or maintaining liquid level in a tank. |
| Flow Coefficient Cv: | The flow capacity of a valve in US gallons per minute of water at a temperature of 60ºF that will flow through the valve with a pressure loss of one pound per square inch at a specific opening position. Typically used in sizing control valves. |
| Flutter: | Rapid reciprocating or oscillating motion of a disk during which the disk does not contact seat (applicable to safety and check valves. |
| Foot Valve: | A lift or swing check valve with an open inlet for total immersion on a pump suction line, always fitted with a filter or strainer. |
| Full Bore/Port: | A valve bore approximately equivalent to pipe bore - minimising pressure drop and facilitating pigging. |
| Full Bore Diaphragm Valve: | Diaphragm valve with straight through full bore. See diaphragm valve and weir diaphragm valve. |
| Full Bore Plug Valve: | Plug valve with full bore through valve as opposed to standard patterns having trapezoidal ports. |
| Full Lift Safety Valve: | A valve modulating open over a small portion of the lift and then opens rapidly to the fully open position. |

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| Galling: | The tendency to seizure of two metallic components in sliding contact, usually where there is insufficient difference in relative hardness. |
| Gate: | See closure and gate valve. |
| Gate Valve: | A linear action, multi-turn (when hand operated) valve, the closure is a gate or disk closing against flat seats (see Appendix D Section D3). |
| Geared Operation: | A gearbox fitted to a valve for manual or actuated operation to reduce operating effort and time. |
| Gland: | A flanged or screwed component fastened to the bonnet to compress and retain the gland packing. |
| Gland Follower: | An integral or separate gland component in direct contact with the packing. |
| Glandless Valve: | A valve not requiring a gland, e.g. a diaphragm valve or pinch valve. |
| Gland Packing: | See packing. |
| Globe Valve: | A linear action, multi-turn (when hand operated) valve with a disc on piston closure seating on a flat or shaped seat (see Appendix D Section D4.). |
| Globe Stop and Check Valve: | A valve combining the self acting operation of a check valve with the manual action of a globe valve also called a combination stop check valve. (See Appendix E Section E6.). |
| Hammer Blow Handwheel: | A handwheel designed to provide a sudden load to start opening of a valve where a plain handwheel is inadequate but a geared operator is not justified. |
| Handwheel: | The manually operated component used to open and close a valve. |
| Hard Faced Seats: | Seats or seating having a hard facing or coating to provide good sealing surfaces resistant to wear, wire drawing, galling and abrasion. Materials generally used - plating (electroless nickel, chromium) cobalt bearing alloys (stellite, colmonoy), carbides (tungsten, chromium). |

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| Hard Seated Valve: | A valve with primary seating of metallic, ceramic, composition (carbon/metal) or other non-resilient materials to provide hard wearing faces. |
| Hand Valve: | A term sometimes used to describe small bore valves of the instrument type. |
| (Valve) Height: | Usually the distance from bore centre line to top of valve handwheel or the top of a geared operation or powered actuator. nb: The overall height includes the distance below the valve bore centreline to the base of the valve. |
| High Performance Butterfly Valve: | A butterfly valve with the closure disk offset or double offset from the stem polar axis, permitting their use at higher pressure than conventional butterfly valves also called eccentric butterfly valves. |
| Hose End Valve: | A valve for utility services on which have fittings for connection to a hose. |
| Inlay: | A corrosion resistant coating of body internal wearing surfaces. |
| Inlet Port: | The port connected directly to the upstream pressure of a fluid system. |
| Inner Valve Seat: | See seat ring. |
| Inside Screen Non-Rising Stem: | A stem design in which the gate rises on a threaded portion of the stem within the valve body and below the gland packing. |
| Iris Valve: | A valve design in which the closure moves towards the centre of the valve bore to seat. |
| Isolation Valve: | See block valve. |
| Kicker Valve: | A specific term for the valve used on pig traps to start flow to initiate pig launching and to stop flow on pig reception. The valve is in effect a bypass valve. |
| Knife Gate Valve: | A valve having a narrow parallel gate with a shaped edge for cutting through glutenous media or slurries. Normally limited for low pressure, the gland normally seals directly onto the gate. |

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| Lantern Ring: | A metallic ring forming a chamber between upper and lower sets of compression packings in a stuffing box. A part from the bonnet connects with the lantern ring which may have several functions:-<br><br>(i) An injection chamber for gland sealant.<br>(ii) A pressure chamber for preventing external loss of process media.<br>(iii) A leakage collection chamber. |
| Lapping: | The process of rubbing and polishing surfaces (e.g. closure and seats) to obtain a smooth seating surface to minimise leakage. |
| Leak Tight: | A term confirming there is no leakage through to form a valve. |
| Lever Operated Valve: | A term for a lever operated, quarter turn, rotary action valve, e.g. ball, butterfly and plug types, usually small, low rated valves. |
| Lift Check Valve: | A check valve in which the closure is lifted from the seat during forward flow, e.g. ball, piston, nozzle check and foot valves. |
| Lifting Plug Valve: | A valve in which the plug is lifted clear of the seat during rotation from open to close to reduce operating torque. Purging of the exposed cavity by steam or other fluid may be used for some severe service. |
| Line Blind Valve: | A block using a plate arranged to rotate between flanges that are clamped against the plate to seat. Also called a goggle and spectacle valve. |
| Lined Ball Valve: | A ball valve with the body internally lined, typically PTFE that is used to seal valve, use for chemical applications. |
| Line Pressure: | The pressure in the piping system. |
| Lubricated Plug Valve: | A plug valve having grooved seating areas and passage ways for lubricant and sealant injection for lubrication and sealing. See pressure balanced plug valve. |

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| Lugged Pattern: | Term for butterfly valve of wafer pattern provided with lugs drilled for bolting to pipe flanges. Other terms - lugged wafer pattern and single flanged valve. |
| Manual Control Valve: | A valve for manually regulating flow or pressure either directly or indirectly e.g. powered actuator. Globe, needle, ball, butterfly and diaphragm valves are extensively used. |
| Manual Operation: | A valve supplied for manual operation by lever, handwheel or endless chain. |
| Manual Override: | Manual override is means of operation by handwheel of a powered actuator in the event of power failure and for setting of the actuator travel in relation to the valve. |
| Mechanically Seated Valve: | A valve designed to achieve primary seating by mechanical means e.g. split (parallel) gate valve with a mechanically expanding wedge between the gate, wedge gate valves and the expanding plug valve. |
| Mixing Valve: | A control valve, usually self operating using a control element to regulate flow input(s), multi-port designs e.g., globe type may be used to mix different fluids and sometimes called blending valves. Mixing valves are also used for temperature control in conjunction with a thermostat. |
| Modulating Safety Valve: | A valve designed to modulate between open and closed over the entire or a substantial portion of the valve lift. |
| Needle Valve: | A globe valve with a conical plug (needle) closing into a small seat. Used for flow metering and damping pressure fluctuations on instruments e.g. pressure gauges. Also called an instrument valve. |
| Nominal Bore: | The nominal or reference diameter of the bore of a pipe, fitting or valve. The actual bore may vary considerably from the nominal size. |
| Non-Lubricated Plug Valve: | A plug valve not depending on the injection of lubricant or sealant for operation and seating e.g., lined and sleeved plug valves and lifting plug valves. |

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| Non-Rising Stem: | See inside screw, non-rising stem. |
| Nozzle Check Valve; | See axial piston valve. |
| Oblique Pattern: | A valve body with the closure at an angle to the port reducing pressure drop. Used for linear action globe and lift check valves, also called a 'Y' pattern valve. |
| Outside Screw and Yoke (OS&Y): | A rising stem design for linear action valves (gate and globe). The threaded portion of the stem is isolated from the process media by the gland packing and the stem rises via a threaded nut in the yoke. |
| Outside Screw, Rising Stem: | See outside screw and yoke. |
| Overlay: | A hard facing of trim components (welded overlays as opposed to coatings and plating). |
| Overpressure: | A safety valve term for pressure increase above the set pressure (expressed as percentage of set pressure). |
| Packing: | The material used to seal the valve stem within the valve body (see Appendix G). |
| Packing Assembly: | The gland, gland follower, packing nut and packing components of a valve. |
| Packing Box Assembly: | The bonnet gland stuffing box and packing assembly used to seal against leakage from the valve body stem area. |
| Packing Nut without Gland: | A packing nut that is used to directly compress the packing in the valve stuffing box. |
| Parallel Gate Valve: | A gate valve with a parallel slide gate or disk closure. See conventional parallel gate, conduit parallel gate, slab gate and split gate valves. |
| Parallel Slide Valve: | A conventional parallel gate valve with a split spring loaded disk closure (see BS 5157) generally used for power generation and stem service applications. (See Appendix D Section D3.10). |
| Parallel Plug Valve: | A valve with a cylindrical plug closure, various methods of sealing are used i.e., lubricated, |

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| | expanding plug, eccentric and 'O' ring sealed designs. (See plug valves). |
| Particulate: | Small solid containments in the process media which may be abrasive and damaging to the valve performance. |
| Penstock Valve: | A gate valve with the gate mounted in a frame fixed to a wall or bulkhead. Used for handling large volumes of water. Also called a sluice valve. |
| Pig-Ball Valve: | A ball valve designed to hold and launch or receive pigs or spheres. |
| Pigging Valve: | A full bore block valve suitable for the passage of pigs and spheres. Valves used are trunnion mounted ball valves, conduit gate valves of slab and split wedge design. Double block and bleed designs are normally required. |
| Pilot Operated Safety Valve: | A valve comprising of a main valve and a pilot valve. The pilot valve senses the pressure of the system. |
| Pilot Operated Safety Valve with Restricted Loading: | A pilot operated safety valve in which the closure seat loading is restricted to permit the valve to fully open within the permissible overpressure should the pilot fail to remove the seat loading. |
| Pinch Valve: | A design of diaphragm valve in which the closure is a flexible tube, either exposed or enclosed in a body. The tube is pinched to close mechanically or by application of fluid pressure in the body. |
| Piston Check Valve: | A check valve with a free or spring loaded piston closure (see Appendix E Section E5.). |
| Piston Valve: | A globe valve in which a piston closure enters or withdraws from a seat bore to start, stop or regulate flow. The seat bore contains packing to effect a seal. In addition to the standard straight pattern design other variants are available, e.g., tank bottom outlet valves and sampling valves. |
| Plate Check Valve: | A valve having several metallic membranes allowing forward flow, but close to prevent reverse flow, used for air and gas compressors. |

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| Plug: | A valve closure which may be tapered or cylindrical in shape. |
| Plug Valve: | A quarter turn, rotating action valve the closure is a plug closing against a downstream seat (see Appendix D section D5.). |
| Poppet Valve: | A linear action valve in which the closure is a stem mounted disk often with an angled edge closing on an angled seat. |
| Port: | A passage through a component, e.g. the inlet and outlet through an open valve. Also called a valve seat opening. |
| Preferred Flow Direction: | A term for a design of valve where line pressure aids closure in one direction and tends to unseat from the other direction. Valves with preferred flow directions include high performance butterfly, eccentric ball, plug and split (parallel) gate valves. |
| Pressure Balanced Plug Valves: | A lubricated valve with internal passageways pressurised by the process fluid to lift a tapered plug. |
| Pressure Control Valve: | An automatic valve with a pressure sensing element to control pressure with inset limits (see pressure maintaining valve). |
| Pressure Differential: | See differential pressure. |
| Pressure Energised Seat: | A floating seat with limited movement that is energised by line pressure which provides the seating load against the closure. used for trunnion mounted ball valves and slab (parallel) gate valves. |
| Pressure Maintaining Valve: | A control valve that maintains the level of upstream line pressure. Also called a surplug valve, pressure retaining, pressure sustaining or pressure control valve. |
| Pressure Reducing Valve: | An automatic control valve that reduces the upstream line pressure to a set level downstream and maintains the reduced pressure irrespective of changes in upstream pressure. |
| Pressure Relief Valve: | See safety valve. |

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| Pressure Sealed Valve: | A valve in which the bonnet is in the form of a cover plate held in place by removable ring sections and sealed by a special taper ring that increases the sealing effect as internal pressure is increased. This design replaces the bonnet and body flanges with the benefit of saving weight and cost. |
| Pressure/Vacuum Safety Valve: | A valve that automatically releases excess pressure or admits pressure to prevent a vacuum forming when filling or emptying a pipeline or tank. |
| Quick Operation Gate Valve: | See lever gate valve. |
| Quick Operation Gate Valve: | See lever gate valve. |
| Raised Face Flange (RF Flange): | A pipe flange or valve body flange where the gasket contact face is raised proud of the flange face. |
| Raised Face Gasket (RF Gasket): | A gasket with dimensions matching a RF flange gasket face. |
| Reduced Bore: | A valve in which the nominal diameter of the valve bore is reduced in the central portion of the bore. Generally the reduction is to the next pipe size down by may be less if required. Reduced bore valves are used to save weight where the additional pressure drop across is acceptable. (See venturi valve). |
| Regular Pattern: | A term used for a valve design in common usage as opposed to less common designs. Also specifically used for plug valves in which the port commonly used is trapezodial and equivalent in area to a circular bore. Also known as a standard pattern (see conventional design). |
| Relief Valve: | In the UK, known as a safety valve. In the USA a design of safety valve that is direct acting and intended for liquid service only. Designs include a full lift relief valve and a modulating relief valve. |
| Reseating Pressure: | A safety valve term for the pressure at which the valve reseats after discharge. |
| Resistance Coefficient: | A coefficient defining the friction loss through a valve in terms of velocity head or velocity pressure. |

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| Reverse Acting Gate: | A term used for conduit gate valves in which the gate(s) is ported through the upper half so that the gate is raised to close. This design is used to minimum ingress of particulate into the body cavity where the process fluid cavity is dirty. It is also used to facilitate spring return to ease actuation. |
| Ring Type Joint Flange (RTJ Flange): | A pipe or valve body flange having a machined groove into which a ring type joint is fitted. |
| Ring Type Joint: | A metal ring joint of oval or octagonal section. |
| Rising Stem: | See outside screw, rising stem, outside screw and yoke and inside screw, rising stem. |
| Rotary Disk Valve: | A form of gate valve design in which an offset shaft rotates the closure across the valve seat to open or close. Designs include a single disk closure and a double disk closure in which the disks are separated by a spring to load the upstream disk against its seat. Upstream pressure loads the downstream disk against its seat via the desk assembly. Also called a rotary gate valve and a lever gate valve when manually operated by a lever. |
| Rotary Valve: | A general term sometimes used to describe valves with a rotary action, e.g., ball, butterfly, plug valves.<br><br>The term is also used specifically for a design of valve used to dose precise quantities of powders on liquids into a process stream. The closure is machined with a series of cups to hold the dose and may be continuously rotated through 360 degrees or partially rotated to provide dosing. A particular design is the cup ball valve typically used in chemical plants. |
| Rubber Lined Butterfly Valve: | A quarter turn rotary action valve of conventional design in which the rotational axis of the disk is concentric with the shaft axis. The rubber lining of the body forms the valve seat. The lining may be vulcanised to the body or be replaceable in the form of a lining or insert. Valve of this type are limited by pressure and temperature. |
| Rubber Seated Wedge Gate Valve: | A valve with a rubber coated wedge closure that seals against the valve port. This design eliminates |

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| | the cavity in the bottom of the valve but is limited by pressure and temperature. |
| Running Torque or Force: | The torque or force required to stroke a valve over the majority of its travel. The torque on force is always less than the breakout and closing torque/force. |
| Safety Valve: | In the UK a term for any automatic valve that relieves a pressure system when abnormal operating conditions cause the pressure to exceed a set limit and closes when pressure falls below the set limit.<br><br>In the USA it is specifically a full lift pressure-relief valve intended for gas service only. |
| Safety Relief Valve: | A term now obsolescent in the UK. See safety valve. In the USA it is specifically a direct acting pressure-relief valve intended for gas, vapour and liquid service. |
| Sampling Valve: | A globe valve for taking samples from a vessel or piping system. Usually mounted on the bottom of a vessel or pipe (see piston valve). |
| Screwed Bonnet: | A bonnet screwed into the valve body rather than flanged or bolted. Generally used on small bore low pressure valves for non-hazardous industrial applications. The bonnet is sometimes seal welded to prevent external leakage from the threaded portion. |
| Screwed End: | A valve (and pipe) with ends threaded, suitable for a screwed connection. |
| Screwed Gland: | A gland usually threaded internally and screwed into the bonnet stuffing box, rather than flanged and bolted. Generally used on small bore valve, e.g. instrument valves. A locking device is sometimes fitted to prevent rotation in service due to vibration or other cause. |
| Sealant Injection: | The injection through a non-return valve of a sealing component to seal the gland and/or seats of a valve either by design (lubricated by valve) or for use in an emergency (leaking valve). |
| Seat: | The part of a valve against which the closure is loaded to provide shut-off or through which process |

fluid flows and may be regulated by adjustment of the closure in relation to the seat. The seat may comprise one or more components of metallic and for non-metallic materials.

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| Seat Bush: | See seat ring. |
| Seat Holder: | A metallic component, usually corrosion resistant, with a seat insert of another material, e.g. a soft seat of elastomer or polymer. Specifically the term is used for valves with floating seat designs. The seat holder is tubular in shape permitting axial movement in a seat housing and free to move slightly by line pressure to load the seat and seal against the closure. The seat may then be a soft seat insert or an integral overlay of hard metal facing material. Seat holders are typically used in trunnion mounted ball valves and slab (parallel) gate valves. |
| Seat Housing: | The counter bone in the body of floating seat valve in which the seat holder is located. |
| Seat Insert: | A ring shaped seat element generally of soft material such as an elastomer or polymer that is fitted in a seat holder, seat ring or closure. The insert may be moulded in position. It may be a push fit such as an 'O' ring, a press fit and may be partially encapsulated. Also called an insert seat and soft seat insert. |

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| Seat Pocket: | A general term for the counterbore(s) within a valve body that house or located a seat holder or seat ring. Seat pockets may be left plain or overlaid in corrosion resistant materials when required. |
| Seat Ring: | A ring shaped metallic component usually corrosion resistant. One face forms the valve seat which may contain a seat insert. The reverse end is fastened to the body of the valve by a threaded portion or by swaging in small bore valves. Seat rings are typically used in valves of fixed seat design where seat replacement is required. |
| Seat Seating Pressure: | The pressure (per unit area) required to prevent leakage across the seating contact surface of a valve seat and closure. Sealing pressure is due to the loadings imposed by line pressure and/or mechanical force and is dependent on the seat material, surface finish and geometry of the valve trim. Also called seat contact pressure. |
| Seat Supported Ball Valve: | See floating ball valve. |
| Seat to Body Seal: | The seal preventing leakage from a valve body cavity to the line via the seat to body connecting interface. In fixed seat valves the seal usually depends on a screwed or swaged joint. In floating seat valves a dynamic seal is required to allow float of the seat assembly. This seal may be in the form of an 'O' ring(s) or a metal to metal facing employing a spring or bellows for preloading at low pressure. |
| Set Pressure: | A safety valve for full lift safety valves as the pressure at which the valve suddenly opens. |
| Short Pattern Valve: | Valve designed in which the face to face dimension is less than the standard dimensions specified in BSI and API national standards. Several BSI and API standards include short pattern dimensions for different types of valves. Generally, valves are of reduced bore. |
| Shut-Off Valves: | See block valves. |
| Single Entry Ball Valve: | A two or three piece body ball valve in which the ball is assembled via the bore of one of the body pieces. |

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| Single Flanged Valve: | Normally a wafer pattern valve provided with a single flange or lugs for bolting to pipe flanges. |
| Single Piece Ball Valve: | A ball valve with the body in one piece, the ball being assembled from one end and held by a retainer ring which may also include a valve seat. Generally used for small bore valves. |
| Size: | The size of a valve normally references the nominal internal diameter of connecting piping and a full bore valve e.g. 6" n.b. sometimes the actual internal diameter is given, typically for wellhead gate valves. Reduced bore/venturi valves normally reference the size of the reduced nominal internal diameter or its equivalent in terms of flow area, e.g. 6 in. x 4 in. NB (See also full bore/part and reduced bore). |
| Slab Gate Valve: | A conduit gate valve with a single parallel sided gate normally sealed by floating seats, line pressure energised with supplementary mechanical loading (springs) or low pressure. Fixed seats are sometimes used, generally for small bore valves, but for all sizes by certain manufacturers. |
| Slide Valve: | A general term for the knife gate valve and the parallel slide valve.<br><br>Specifically, the term is used for parallel gate valves of the lab design working at high temperatures, low pressure and equipped with purging facilities. This valve design is used for gas/catalyst service on cat cracking units in refineries. |
| Sleeved -Plug Valve: | As a lined plug valve except that the sleeve of PTFE or similar polymer material is machined and press fitted or keyed instead of moulded into the valve body. |
| Slurry: | A product consisting of solids mixed with liquid to assist transportation through piping systems. The solids vary widely and may be abrasive, non-abrasive, hard or fibrous materials. |
| Small Bore Valve: | A term generally used for valves of 2 in. NB and less. |

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| Socket Weld End: | A valve with counterbored end(s) into which piping is fitted and fillet welded to make a joint. |
| Soft Seat Insert: | See seat insert. |
| Soft Seated Valve: | A valve with primary seats manufactured from elastomers, polymers and similar resilient or semi-resilient materials. |
| Soft Seated Wedge Gate Valves: | A wedge gate valve in which primary soft seating is used. Seating may be a solid PTFE seat, a soft seat insert, either in the valve body or in the wedge gate closure. |
| Solenoid Valve: | A linear action block valve, generally of globe type, fitted with a solenoid for quick operation. |
| Solid Wedge Disc: | A disc or wedge of one piece. |
| S P: | An abbreviation for steam pressure. A number following the abbreviation is the maximum non-shock operating pressure in psi at a given temperature. |
| Split Wedge Gate: | Gate valve having a wedge, comprising of two parts in order to provide flexibility and resistance to thermal wedging. |
| Stop Check or Screw Down Non-Return Valve: | A valve which automatically closes when flow reverses and which can be screwed down into a stop or closed position. |
| Swing Check Valve: | A valve which has a swinging disc that opens with the pressure of the flow and closes automatically when the pressure drops. |
| Throttling: | Regulation of flow through a valve. |
| Trim: | Internal components isolating or regulating the flow (e.g. wetted parts) which include seating surfaces, closure members (gate, disc, ball, plug etc.), stem, bearings, guides and associated parts. |
| Uni-Directional Valve: | A valve designed to seal in one flow direction. |
| Upstream Seated Valve: | A valve that when closed, seals by line pressure acting on the upstream seat. |

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| Valve Closure Member: | That part of a valve which is positioned to close, open, or to control the amount of flow. |
| Valve Operator: | The valve part or parts through which a force is applied to move or position the seat valve closure member on seat. |
| Valve Operator, Manual: | A valve operator consisting of a hand lever, wheel or other manual devices. |
| Valve Operator, Mechanical: | A valve operator consisting of a cam, lever, roller, screw, spring, stem or other mechanical devices. |
| Valve, Pressure Reducing: | A valve whose primary function is to limit outlet pressure. |
| Valve Port: | A controllable opening between passage, that is one which can be closed, opened or varied. Sometimes refers to the inlet or outlet openings of the valve. |
| Valve, Shut-Off: | A valve designed to operate fully open or fully closed, and not at intermediate positions. |
| Venturi Throat Valve: | A valve having a reduced port opening at the seat with the body throat graded to produce a venturi effect to minimise the velocity head losses and pressure drop through the valve. |
| V Port Plug or Ball: | A type of valve closure member (plug or ball) having a 'V' shaped orifice; it has good throttling characteristics. |
| Wiper Ring: | A ring which removes material by a wiping action. |
| Yoke: | That part of a valve which connects the valve actuator to the valve body. |
| Y Type Globe Valve: | See 'Oblique Pattern'. |