



GS 130-6

Guidance for Specification 130-6

ACTUATORS FOR SHUTOFF VALVES

July 1993

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ACTUATORS FOR SHUTOFF VALVES			
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This Guidance for Specification is to be used for the purchase of pneumatic and hydraulic actuators for shutoff (on-off) valves. The document is not intended to be used for actuators for more specialised valves such as chokes or normally modulating valves. The purpose of this document is to act as a guide to the design engineer in the correct specification of actuators and their accessories as well as a 'check list' in vetting vendors proposal.			
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Engineering Practices Group, BP International Limited, Research & Engineering Centre Chertsey Road, Sunbury-on-Thames, Middlesex, TW16 7LN, UNITED KINGDOM			
Tel: +44 1932 76 4067		Fax: +44 1932 76 4077	Telex: 296041

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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 Guidance for Specification

This is a new Guidance for Specification giving requirements for actuators and ancillary equipment for shut off valves. It is not applicable to the selection and use of control and shutoff valves.

In the past many have been incorrectly sized, incorrectly installed on the associated valve and supplied with unreliable ancillary equipment.

It allows actuators to be sized and selected to suit the specific application in order to reduce capital cost, weight and commissioning and operational problems.

It is intended that this General Specification is applied in the detailed engineering stages of new projects and relevant modifications or expansion of existing facilities. It is applicable to onshore, offshore and subsea installations.

Application

This Guidance for Specification is intended to guide the purchaser in the use or creation of a fit-for-purpose specification for enquiry or purchasing activity.

Text in *italics* is Commentary. Commentary provides background information which supports the requirements of the Specification, 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.



Specification Ready for Application

A Specification (BP Spec 130-6) is available which may be suitable for enquiry or purchasing without modification. It is derived from this BP Group Guidance for Specification by retaining the technical body unaltered but omitting all commentary, omitting the data page and inserting a modified Foreword.

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 International or the Custodian. See Quarterly Status for contacts.



1. ACTUATOR DESIGN

1.1 Torque/Thrust Characteristics

- 1.1.1 The torque/thrust characteristics of the actuator in its line application including static and dynamic pressure effects shall be determined to be compatible with the valve manufacturers quoted torque/thrust curves, taking into account the following:-

Size of valve, valve stem size and type, rating and construction.

The valve torque/thrust characteristic shall be traceable to actual tests and exclude the manufacturers own safety factors.

In the case of rotary valves the valve reseating torque on closure shall be taken as not less than the corresponding breakout from close position.

The following torques should be provided by the valve manufacturers for rotary valves:-

Running torque

Re-seat torque

Break to open torque

Break to close torque

Stem yield torque

For linear valves the maximum required thrust at maximum operating differential pressure is required in both directions.

For gate valves the disk/seat coefficient of friction is also required.

A check should be made of what safety factors, if any, have been added by the valve manufacturers. Multiple conservatism should be avoided.

A suitable contingency should be included in the torque/thrust characteristic to cater for normal wear & tear and to overcome stiffness due to seal wear, dirt accumulation and/or long periods of non-operation. For this reason it is necessary to specify the process and operation requirements of the valve initially.

- 1.1.2 The actuator shall be capable of driving the valve from fully open to fully closed and vice versa, within the specified time limits, against the maximum differential pressure acting across the valve.

For offshore pipeline ESDV's in the UK speed of closure should be in accordance with [SI 1029](#).

For hydraulic or pneumatic linear actuators the standard speed of operation is 1 inch/second. For electric actuators the standard speed is 24 rev/min.



Where necessary the control system shall include speed control facilities to limit the speed of operation and avoid surge.

- 1.1.3 The valve torque/thrust characteristic shall be established for a valve in new condition for the maximum differential pressure to which it will be subjected under operational conditions.

Some block valves are fitted with by-passes and are therefore not required to open against full differential pressure. Gas pipelines, for example, are pressurised downstream before opening the valve so the valve opens against a minimal differential pressure.

- 1.1.4 The operating pressure range, operating temperature, ambient temperature and type of fluid shall also be taken into account when determining the torque/thrust characteristics.

- 1.1.5 For ESD applications of ball valves the actuator design torque/thrust shall be capable of delivering twice the valve requirement throughout its stroke at minimum supply pressure/voltage.

For other valves and non-ESD applications the actuator design torque/thrust shall be capable of delivering 1.5 times the valve requirement throughout its stroke at minimum supply pressure/voltage.

Gate valve operation force is more predictable and excessive conservatism increases stem dia. and therefore operating load.

In abrasive or dirty service it may be necessary to apply larger safety factors. The design of the valve and seat type should also be considered.

The torque/thrust requirement should be for the valve in application and include where possible static and dynamic pressure effects.

- 1.1.6 All items in the load path between valve seat and actuator shall be capable of withstanding the maximum torque/thrust produced by the actuator without exceeding allowable stresses or being subjected to unacceptable deflections.

- 1.1.7 Allowance shall be made for spring relaxation when calculating 'end' torque for spring return actuators.

The actuator manufacturers normally quote a minimum end torque which allows for spring relaxation. Ideally springs should be scragged so there is no relaxation in service.

Spring Scragging

Springs shall be scragged by compressing rapidly to solid 6 times.

The last two scraggings shall reveal no increase in spring rate.



The results of these tests shall be included in the certification provided with the actuator.

1.1.8 Careful consideration shall be given to the actuator mechanism required for quarter turn valves i.e. scotch-yoke, rack-and-pinion or crank arm.

Where rotating mechanisms are required, e.g. for ball or butterfly valves, three types of mechanism can be used, there are:-

- (a) *Scotch-yoke - This transforms linear movement of a piston into a 90 deg rotating movement. A Scotch-yoke mechanism produces a torque curve that most closely matches the requirements of valve actuators when converting linear to rotary motion. It produces greater torque at the beginning and end of each stroke of the piston.*

The efficiency of this torque output allows use of a smaller piston, shorter moment arm and lower operating pressures to achieve the same amount of break torque as other mechanisms.

It should be recognised that the torque output of Scotch Yoke actuators is 10% less than the final end torque at 5 degrees from the end of travel. Ball valves are generally closed at this point and peak operating torques are likely to be encountered.

- (b) *Rack-and-pinion - This mechanism produces a constant torque throughout the piston stroke.*

- (c) *Crank arm - This mechanism produces less torque at the beginning and end of each stroke, which is where the greatest torque will be encountered.*

For operation of gate, globe and other linear valves a linear or a multiturn actuator is required. Electric actuators are generally used for multiturn mechanisms.

1.2 Supply Pressure

1.2.1 Pneumatic actuators shall be sized to operate from the available air supplies.

Careful definition of the supply pressure is necessary as under-specifying could result in an oversized actuator and over-specifying could result in longer closure times and juddering as there will not be enough power to close smoothly, or the valve may fail to close.

If the minimum supply pressure required for the actuator is higher than the minimum pressure specified, then volume tanks should be provided to maintain the pressure. This, however, should be avoided wherever possible.

1.2.2 The minimum supply pressure shall correspond to the low supply pressure alarm which should be equal to or greater than the minimum actuator operating pressure.



- 1.2.3 The supply pressure used for sizing pneumatic or hydraulic actuators shall be the pressure below which the supply is deemed to have failed.
- 1.2.4 The maximum supply pressure shall correspond to the upper limit at which the actuator shall be required to operate.
- 1.2.5 The actuator and pressure containing components shall be capable of withstanding without damage an over-pressure equivalent to the greater of:-
- 100% supply relief pressure.
OR
150% Maximum supply pressure.
- Where this is not achievable local pressure regulation and separate pressure relief must be fitted.

1.3 Calculations

- 1.3.1 Manufacturers shall supply the following calculation data where specified:-

Maximum & minimum stroking times at specified operating pressures.
Break out torque against full DP.
Running torque.

Valve stem min. dia. - Maximum allowable stress vs. actual applied stress.

Spring sizing.

Sizing of all torque transmitting parts (e.g. couplings and mounting bolts.) - Maximum allowable stress vs. actual applied stress.

Calculations which demonstrate the torsional strength of the output shaft and coupling.

Calculated values of fatigue life of all components.

Mean time between failure (MTBF) for complete actuator assembly based on the MTBF of the individual components that make up the actuator and their past service history.

Maximum torque/thrust produced by the actuator.

Stroke/torque characteristic.

Calculations which demonstrate adequacy of pressure retaining parts.

The majority of the above will be required for ESD applications but may not be needed in all cases.

- 1.3.2 Design calculations shall consider the effect on the valve/actuator of being left closed or open for long durations prior to operation and also the effect of high or low temperature service.



- 1.3.3 All actuator components shall be shown to be strong enough to withstand the maximum calculated loads.

1.4 Electric Actuators

- 1.4.1 Electric motor actuators shall be in accordance with BP Group [GS 112-2](#).

2. BACK-UP SUPPLIES

2.1 General

- 2.1.1 Double-acting actuators, when used, shall be provided with control units and volume tanks or accumulators to provide failure to the required pre-determined failure position.

- 2.1.2 For double acting actuators the reservoir shall be connected such that it is dedicated for the supply of the fail-safe mode of operation. It shall be charged via a non-return valve or valves which feature positive closure on zero differential. For critical applications the pressure of the reservoir shall be monitored.

- 2.1.3 Pneumatic volume tanks or hydraulic accumulators shall be mounted on or close-coupled to their actuators i.e. located a maximum distance of 2 metres from the valve stem. Fittings between the two should be kept to a minimum in order to reduce the number of leak paths. Where compression fittings are used they should be of the double seal type.

- 2.1.4 Volume tanks and accumulators shall be sized to allow for the required number of operations of the actuator when the volume tank is charged at the minimum operating pressure. - An operation is defined to be a single direction movement of the actuator over the full travel of the valve.

- 2.1.5 Design calculations shall be produced to establish adequate sizing of accumulator banks and volume tanks.

Unless correctly specified reserve supplies may be undersized leading to loss of performance/compromise of safety margins or oversized leading to greater cost/weight/space requirement.

- 2.1.6 The initial charge pressure of the reservoir shall be calculated taking into account the resulting size of the reservoir, actuator and volume tanks.

Unacceptable consequences will arise if inadequate consideration is given to supply pressures. If too low a pressure is chosen as the initial charge pressure of the reservoir, then oversizing of the actuator and/or reservoir will result. On the



other hand, too high a value will mean that adequate pressure may not be available when required.

2.2 Hydraulic

- 2.2.1 For hydraulic actuators the actuator supplier shall be responsible for the design, manufacture, test and supply of any dedicated standard hydraulic packages integral with the valve/actuator assemblies.

The hydraulic power system shall comprise of pumps, reservoirs, accumulators, strainers, controls and all other necessary equipment to provide a permanent supply of hydraulic liquid at a maintained pressure for movement of the isolation valves. The pumps and hydraulic oil used should be as stated in BP Group [GS 134-1](#) Hydraulic power supplies.

- 2.2.2 Hydraulic accumulators shall be in accordance with BP Group [GS 134-1](#).

- 2.2.3 Accumulators shall be provided with a pressure relief valve.

- 2.2.4 Bladder type accumulators should be nitrogen charged to [BS 5045](#) part 1. The bladder shall be low-permeability according to [BS 903](#) part A30.

- 2.2.5 Isolation may have to be provided on hydraulic systems (for maintenance purposes). In such cases the valve open position shall be clearly indicated and should be capable of being locked and control room indication provided if specified. In such cases continued plant safety will be dependent on the preparation and use of suitable site procedures.

- 2.2.6 Careful consideration shall be given to the type of accumulator specified i.e. piston or bladder.

Of the two types of accumulator available, piston and bladder, bladder type accumulators have been more commonly specified. This type of accumulator, suffers from the major drawback that the condition of the bladder is difficult to ascertain without either discharging the system or overhauling.

The piston accumulator, although more expensive, is easier to maintain and troubleshoot with the use of piston position indicators. Piston type accumulators can operate at higher discharge pressures, reducing the volume, requirements and display superior fluid delivery qualities than the bladder type.

- 2.2.7 For hydraulic accumulators (bladder type) at least three (50% duty) accumulators shall share the duty so in the event of one being unserviceable there remains adequate stored volume to produce the two times maximum valve torque after one actuator stroke. Careful attention to the setting of the nitrogen precharge pressure is required.



Each bladder type accumulator used should contain 50% of the actuator requirements so that it can function fully with one accumulator off-line for maintenance.

The pre-charge pressure of hydraulic accumulators is typically chosen (following manufacturers guidelines), to be 90% of the pressure that needs to be guaranteed. This results in there normally being stored fluid equivalent to approximately three strokes.

Care should be taken in setting the pre-charge pressure. If it is too high then the quantity of stored fluid available is reduced. Having a precharge pressure which is too low is less serious: it will reduce the pressure output after fluid usage but requires a significant error to be critical.

If the temperature in service differs from the temperature at which the pre-charge was set this would alter the effective pre-charge pressure. This may be significant if there is a large temperature variation e.g. in the Middle East: it is recommended that the pre-charge pressure is based on the highest service temperature.

2.3 Pneumatic

- 2.3.1 Pneumatic reservoirs shall be in accordance with [BS 5500](#) category 2 and BP Group [GS 146-1](#) and [146-3](#) and [ASME VIII](#).

Standby pneumatic supplies should be charged from the local air supply system via non return valves. As the integrity of the non return valves is vital, further protection may be provided on the back-up vessel inlet. This can be achieved by means of a pilot operated isolation valve, closing on falling upstream pressure.

- 2.3.2 A low pressure switch shall be fitted, where specified, to pneumatic reservoirs, to give sufficient warning of failure of the back-up supply.

3. MATERIALS OF CONSTRUCTION

- 3.1.1 Materials of construction of the actuator and associated pipework shall be selected to prevent galvanic corrosion.

No materials which will exhibit a significant electrochemical potential difference in service should be in electrical contact while exposed to process media or the external environment and cause corrosion due to galvanic action.

- * 3.1.2 Carbon steel shall be used for all pressure retaining parts of the actuator such as cylinders, pistons, air reservoirs and hydraulic accumulators.

The material used for all parts of the actuator shall be subject to approval by BP.

As there are different grades of Carbon steel available, the grade used should be subject to approval by BP.



3.1.3 All materials in contact with the hydraulic fluid shall be compatible with the fluid and any additives contained within it.

3.1.4 The vendor shall identify all material used in the construction of the actuator.

The use of Aluminium alloys in the construction of actuators, regardless of location or service must be approved by the purchaser. Where the use of aluminium alloys is permitted the alloy must contain less than 6% magnesium. This is due to the fact that Aluminium can cause sparks when in contact with rusty surfaces and although it burns at high temperatures it burns at much lower temperatures if magnesium is present.

Grey Cast Iron shall not be used as it is vulnerable to shock loading and has a low impact strength.

Malleable iron has a better impact strength due to the heat treatment, but it is not possible to establish whether heat treatment has been effective without destroying the component.

Plastic shall not be used due to its low melting point. It may, however, be used for seals in pneumatic and hydraulic actuators.

Brass and copper alloys shall not be used offshore. Copper tubing and brass fittings may, however, be used onshore.

PH stainless steel and aluminium bronze are acceptable when used as a bearing material in scotch yoke mechanisms.

* 3.1.5 The material used for solenoids and all other accessories such as filters, regulators, pilot valves shall be subject to approval by BP.

For the offshore environment solenoids and all pneumatic accessories such as filters, regulators, pilot valves shall be manufactured from 316 stainless steel or use epoxy painted cast iron.

All brackets, fittings and fixings shall be fabricated from 316 stainless steel.

Control cabinets and tubing should also be fabricated from 316 stainless steel. All tubing shall be to [ASTM A269](#), TP316.

3.1.6 Bolting shall be to [ASTM A193](#) grade B7. Nuts shall be to [ASTM A194](#) grade 2H. Exceptions shall be subject to approval by BP.

e.g. - Exceptions for Low Temperature Applications.

3.1.7 Field mounted instruments shall be weather-proof to a minimum of IP 55 to [IEC 529](#). Associated electrical junction boxes shall be to a minimum of IP 55 or the [NEMA](#) equivalent.



For offshore applications junction boxes should be to a minimum of IP 67.

- 3.1.8 For Scotch-yoke actuators all components in sliding or rotating contact i.e. the yoke pin and yoke pin rollers should be of a suitable material or heat treated to ensure good bearing properties and long life.

Bearing surfaces, including piston rods, yoke, yoke pin and yoke pin rollers shall be coated with a lubricant which includes a corrosion inhibitor.

- 3.1.9 Actuator and accumulator pistons should be fitted with PTFE wear rings to prevent cylinder scoring and promote seal life.

- 3.1.10 Actuator cylinders and other pressure retaining parts shall be designed and manufactured in accordance with [ASME VIII](#) or [BS 5500](#).

All welding (including casting repair) shall be performed in accordance with written procedures and by welders qualified in accordance with [ASME IX](#) or [BS 4870](#).

4. ACTUATOR/VALVE INTERFACE

- 4.1.1 The vendor on whom the order is placed shall be responsible for the mechanical compatibility and provision of mechanical coupling between the valve and actuator.

The actuator shall be fully compatible with the valve with regard to torque/thrust figures, inertial stresses on the valve stem and mechanical stresses on the valve topworks.

Particular care shall be taken to ensure the actuator/valve interface coupling is machined accurately to afford a correct fit on the valve stem taking valve stem tolerances into account.

- 4.1.2 Where a rectangular alloy steel key is provided to fit between the actuator drive coupling and the valve stem for each unit, it should be capable of transmitting the stall force/torque of the actuator. Shear keys shall not be supplied.

- 4.1.3 The design of additional support brackets necessary to support the weight of the actuators on the valve body shall be subject to the valve manufacturers approval.

- 4.1.4 The assembly mounting used to hold the valve and actuator together should be capable of withstanding any stresses placed upon it by any movement of the valve and actuator. Valve bonnet bolts shall not be used to secure the actuator.



- 4.1.5 Wherever possible mechanical coupling between the valve and actuator should be to an acceptable national standard such as [BS 5840](#) parts 1 & 2 or the equivalent ISO when it is published.
- 4.1.6 Shear loads shall not be reacted by bolting. The bolts shall not hold or transmit torque or thrust.
- 4.1.7 Consideration should be given to the mechanical locking of bolts and screwed parts to prevent movement in areas of high vibration.

5. ACCESSORIES

5.1 Mechanical Stops

- 5.1.1 Externally adjustable mechanical stops shall be fitted to adjust individually the opening and closing stroke.

In order to compensate for the manufacturing tolerance of both valve and actuator to limit actuator travel independently from valve stops.

5.2 Filters

- 5.2.1 Pneumatic and hydraulic actuators shall be fitted with in-line filters and any pressure regulation equipment necessary to suit the specified fluid supply, complete with pressure indicator and pressure relief device.
- 5.2.2 Air filters and liquid catch pots should be included for the air system feed to the actuator system.

5.3 Manual Control

- 5.3.1 Manual operators shall not be used for pneumatic or hydraulic actuators on ESD duty.

Electric actuators shall be supplied with handwheels. If specified, Hydraulic actuators shall have a facility for local manual control via a hand pump which can be locked out when not in use.

For pneumatic or hydraulic actuators it is easy to override the supply with a manual operator, therefore, they should not be used unless they are necessary. When used they should be lockable and have remote alarms to ensure they are not left in the override position.

Electric actuators however, are generally supplied with handwheels and these are acceptable as they require some sort of mechanical coupling to put into operation.

Electric actuators are more commonly used in terminals, offsite areas and for multiturn valves.



For linear actuators three types of manual override are available:-

- (a) *Declutchable - This is designed to provide manual operation of the actuator/valve assembly when a supply medium is not available. The override is engaged by simply pushing in the engage knob and pulling the same knob to disengage. When the override is engaged the actuator and valve assembly can be positioned anywhere between full open and full closed by operating of a handwheel.*
- (b) *Hydraulic - This override is operated to provide manual operation of the actuator/valve assembly when the supply medium is not available. The override is made operational by means of a control valve position knob, hand pump and cylinder by-pass.*
- (c) *Jack screw - This override is not normally used, it is capable of providing the required override capabilities on an infrequent basis. If frequent override capabilities are expected then one of the previously described systems should be selected.*

5.3.2 Handwheels where fitted, shall be engagable in any position and readily actuate the valve without fluid assistance. Means of venting the actuating cylinder shall be provided where required to enable manual operation. The handwheel shall not interfere with the operation of the actuator when not engaged.

When specified handwheels shall conform to the following:-

- (a) May be integral or attached by bolts or clamps.
- (b) May be locking or de-clutching type.
- (c) Operating force required shall be limited to 350N on the rim of the handwheel.
- (d) The handwheel diameter shall be no greater than 750 mm.
- (e) If necessary, gearing shall be employed to achieve (c) and (d).
- (f) Shall indicate direction of opening/closing.

5.4 Solenoid Valves

5.4.1 Solenoid valves shall be supplied such that the actuator is driven to the agreed failure position on power failure. Manual electrical, pneumatic or mechanical resets shall be included, if specified, on the solenoid valves.

Check that the failure mode of the solenoid valve is compatible with that required for the main valve.



- 5.4.2 Solenoid valves shall be certified for use in all hazardous areas by a nationally recognised authority. A conservatively rated anti-surge diode shall be fitted. Solenoid valves shall be full ported spring return type. Supplier shall confirm that all valve port sizes and impulse tubing are consistent with the required actuator operating times.

A BASEEFA certificate or national equivalent is required in all areas where there is potential for an explosive environment.

- 5.4.3 Solenoid valve bodies and trim shall be made from a material suitable for use in the operating environment.

For offshore installations solenoid valve bodies and trim shall be of AISI 316 stainless steel and coil housing shall be made from a material for use in an exposed marine environment. The degree of protection for the solenoid housing shall comply as a minimum with IP 56 in accordance with [IEC 529](#).

- 5.4.4 For valves used for shutdown and emergency isolation duties there shall be two solenoids. The valves shall be piped in series and each valve shall be wired to its own individual junction box for interfacing to the separate systems. ESD shall take preference.

- 5.4.5 The solenoid valves shall be provided with integral termination facilities or be provided with a certified junction box with environmental protection to IP 55.

For offshore use where there is periodic operation of the deluge system protection to IP 67 may be required.

5.5 **Speed Control**

- 5.5.1 Where necessary to avoid surge from the valve closing too quickly, speed control facilities shall be included in the actuator. These shall be arranged such that the risk of causing blockage of the flow of fluid shall be minimised.

All actuators should be fitted with speed control valves and end-of-travel dampers if not integral parts of the actuator.

Pneumatic actuators shall be fitted with [AISI 316](#) stainless steel adjustable snubbers or needle valves with vernier scales to control the speed of operation if necessary.

Hydraulic actuators shall be fitted with calibrated variable restrictor on supply and return lines, to control the speed of operation. The restrictor shall be [AISI 316](#) stainless steel.

- 5.5.2 It shall not be possible to fully close the speed controlling devices fitted to either pneumatic or hydraulic actuators, thereby preventing valve operation.

5.6 Limit Switches

- 5.6.1 Where specified the actuator shall be fitted with two limit switches, one at each end of the fully open and fully closed positions. The switches shall be such that they are closed when the valve is in the appropriate position. Each switch shall operate within 3% of the valve travel from the respective open and closed limits. Mechanical protection shall be fitted to prevent disturbance/malfunction of the limit switches.

For pneumatic/hydraulic actuators proximity type are preferred for reliability reasons.

- 5.6.2 Limit switches shall be designed such that their normal failure mode leads to an alarm condition.

- 5.6.3 Proximity sensors shall be mounted inside a junction box for mechanical protection, the flying leads of the proximity sensors shall terminate in this junction box. External linkage to the actuator stem or the rotary spindle and vane shall not be used.

- 5.6.4 The junction box enclosure shall be weather-proof to IP 55 as a minimum, and must be IP 56 or above for offshore applications.

- 5.6.5 Where necessary limit switches shall be certified for use in the designated area by a nationally recognised certification authority applicable in the country of use (e.g. in the UK two such bodies are BASEEFA and SIRA).

Electrical protection should be provided against any hazards according to the plant philosophy e.g. in Europe certification according to [BS 5501](#) or the [CENELEC](#) equivalent is required in all areas where there is potential for an explosive environment.

Electric actuator limit switches shall be used where provided but consideration shall be given to additional provision of stem activated switches for safety related valves.

5.7 Pressure Gauges

Pressure gauges shall be fitted to the control system to indicate all key pressures in the system, such as:-

- (a) incoming air supply
- (b) actuator control supply (hydraulic or pneumatic).
- (c) all regulated pressures in the control system.

For remote applications pressure switches may be used instead.

Any additional pressure measurement points considered to be of use during performance monitoring or failure diagnosis shall be fitted with hand valves and capped outlets.

- 5.7.2 Pressure gauges shall be in accordance with BP Group [GS 130-4](#).

5.8 Local Controls

- 5.8.1 Local controls plus associated system components shall be located in a suitable enclosure mounted preferably on the actuator.

Controls shall be grouped, colour coded and labelled in a manner to avoid confusion in response, particularly for action required in an emergency.

- 5.8.2 All accessories shall be supplied rigidly mounted, piped and wired by the supplier in one compact assembly. Mounting arrangements shall take account of vibration.

- 5.8.3 All electrical components shall be weather-proof to [IEC 529](#) classification IP 55 minimum. All other non-electrical components shall be protected to IP 55 minimum.

- 5.8.4 Intrinsically safe (IS) equipment shall be certified Ex(ia) in accordance with [EN 50 039](#) or other nationally equivalent standard.

Flameproof equipment shall be certified Ex(d) in accordance with [EN 50 018](#) or other nationally equivalent standard.

Junction boxes and cable glands shall be certified in accordance with [BS 5501](#) or the [CENELEC](#) equivalent or the relevant national standard in the country of use.

5.9 Scotch Yoke Actuators

- 5.9.1 Scotch Yoke type actuators, hydraulic and pneumatic, shall be provided with 'Telltale' pressure relief visual indicator to display pressure build-up in the actuator central housing - when so specified.

5.10 Lifting Eyes

- 5.10.1 Where specified actuators shall be fitted with certified and tested lifting eyes. Alternatively, slinging points should be clearly identified such that over-stressing of the assembly does not occur during lifting and control components are not damaged.

EEC Directive [90/269/EEC](#) on 'The minimum health and safety requirements for the manual handling of loads where there is a risk of back injury to workers' requires that hazardous manual handling should be avoided where possible.

5.11 Test and Override Equipment

- 5.11.1 Where specified test and override equipment shall be installed to enable testing of the actuator control system.

6. ENVIRONMENTAL PROTECTION

6.1 General

- 6.1.1 The inside surface of air cylinders shall have nickel plating or some other approved corrosion resistant layer suitable for the environment at the point of installation.

Exposed metal surfaces e.g. cylinder liners, piston rods shall have a corrosion resistant layer, suitable for the environment at the point of installation.

Particular attention shall be given to avoiding corrosion in chambers that are normally freely vented.

When the valve and actuator are coated to prevent corrosion it is necessary to take into account all applicable conditions (e.g. salt, spray, humidity, temperature, spillage, line leaks). Electrical earthing and bonding should not be impaired by the coating.

- 6.1.2 The actuator enclosure shall provide ingress protection to [IEC 529](#) designation IP 54 as a minimum.

- 6.1.3 External surfaces shall be prepared and painted in accordance with BP Group [GS 106-2](#). Alternative coatings are subject to BP approval.

- 6.1.4 Materials of construction of the valve and actuator shall be suitable for prolonged service in the environment at the point of installation.

The choice of materials (inherent qualities and electrolytic compatibility), the actuators design and the protective systems shall provide a high resistance to corrosion, consistent with the environment and expected operational requirements.

The actuators may be used in exposed locations in the offshore environment and will be subject to seawater deluge and hosing down. It is therefore essential that the actuator is designed such that the level of ingress protection is sufficient to prevent corrosion within the actuator, particularly on the springs, bearings, guides and cylinder surfaces. In addition, protective compounds and coatings shall be used to prevent corrosion in the event of water condensing inside the various housings.



- 6.1.5 The design shall include protection against water penetration of screw threads.
- 6.1.6 Where cathodic protection is employed, the structure shall be electrically continuous throughout. This may be provided by cable bonding or welding.
- 6.1.7 When isolating valves are installed in locations susceptible to seismic disturbance, all components shall be suitable for the anticipated bending loads and deflections.

7. FIRE PROTECTION

- 7.1 Passive fire protection where fitted shall be easily removable to enable inspection and testing of the valve and actuator.
- 7.2 Account shall be taken of the reduced heat loss of actuators with passive fire protection fitted. This may cause increased temperatures at the actuator.

Fire protection for offshore pipeline ESDV's in the UK shall be in accordance with SI 1029.

8. QUALITY ASSURANCE AND QUALITY CONTROL

- 8.1.1 For the North Sea, Pipeline ESDV's and their installations shall be subject to the approval of a certifying authority. The supplier shall ensure that all material and equipment supplied against this Specification meets the requirements of [SI 1029](#).

Verification of the vendor's quality system is normally part of the pre-qualification procedure, and is therefore not specified in the core text of this specification. If this is not the case, clauses should be inserted to require the vendor to operate and be prepared to demonstrate the effectiveness of their quality system to the purchaser.

9. INSPECTION AND TESTING

9.1 General

- 9.1.1 The supplier shall maintain up-to-date documentation at all times reflecting the inspection/testing status of the equipment. However, the submittable documentation shall not be regarded as the total requirement. The purchaser may wish to inspect retained documentation such as internal test results, equipment logs and fault/correction records.



- 9.1.2 All testing to be carried out in accordance with written procedures.
- 9.1.3 Certificates shall be issued recording satisfactory completion of all tests and signed by manufacturers/purchases quality representative.

9.2 Actuators

- 9.2.1 The supplier shall devise and execute a test programme during all stages of fabrication. Results of such testing shall be fully documented.
- 9.2.2 A torque/thrust test at the stated air/hydraulic pressures shall be carried out on the actuator prior to leaving the actuator suppliers premises witnessed by BP or the purchaser.
- 9.2.3 The cylinders shall be pressure tested according to their manufacturer's procedures to verify the sealing of pistons and piston rods.
- 9.2.4 Hydrostatic testing shall be carried out on all pressure retaining components such as cylinders, accumulators and pipework at 1.5 times maximum working pressure.

9.3 Valve/Actuator Assembly

- 9.3.1 The valve/actuator assembly shall be tested as one complete unit. Operation of the assembly shall be checked by stroking the actuator via its solenoid valve and observing the limit switch status. This shall be carried out with the full differential pressure alternately applied to each side of the valve. Manual reset function on the solenoid valve shall be checked for correct operation on loss of electrical power to the solenoid valve. The speed of operation for the valve actuator assembly shall be confirmed against specification.
- 9.3.2 The purchaser shall witness a factory acceptance test prior to releasing the equipment. The supplier shall be responsible for conducting the test and providing all necessary facilities, equipment and personnel. The supplier shall present for the factory acceptance test a fully assembled and integral valve/actuator unit complete with all accessories.

The factory acceptance test should comprise of, as a minimum, the following:-

- (a) *Each actuator to be checked for piston seal leakage commensurate with pressure requirements.*
- (b) *Each actuator to be operated at least 5 consecutive times in each direction using maximum and minimum pressures.*



A torque-time curve shall be established at a specified actuating pressure, the actuator to be timed with varying valve differential pressures from maximum rating.

An actuating pressure - time curve shall be established i.e. at zero valve differential, the actuator to be timed with varying actuator pressures from 20% to 100%.

- (c) *Each actuator shall operate its valve in both directions with minimum actuating supply pressure and maximum differential at either side of the valve.*
- (d) *Each rotary actuator to be inspected to verify a minimum of 90 degree rotation.*
- (e) *Where mechanical locking has been specified each actuator to be inspected to verify actuator's stop screws are at least one screw diameter extension in length beyond the stop screw jam nut.*
- (f) *In addition to the tests listed above, spring return actuators shall have the following measurements checked.*

Spring force at beginning of stroke.

Spring force at end of stroke.

Spring force at beginning and end of return stroke.

- (g) *All accessories must be installed at the time of testing and shall be functionally tested. The results of these tests shall be recorded on the test certificate.*
- (h) *The double acting actuator system shall be tested and the valve operated three times with reservoir pressure only, after the actuating supply has been off for a minimum period of 6 hours. This test shall be required to prove the capacity requirements and shall be carried out at the normal reservoir pressure.*
- (i) *Each actuator shall be tested at the maximum available working pressure for leakage at the following locations:-*
 - Adapter flange to housing.*
 - Stop screw seals.*
 - Yoke O-ring seals.*
 - Cylinder to flanges - both end and adapter gaskets.*
- (j) *The range of speed controls to be established at the normal operating conditions.*
- (k) *Where applicable inching facilities shall be fully functional tested for correct operation at simulated process conditions.*

9.4 Test Equipment

- 9.4.1 All test equipment used shall have a current certification of accuracy from an approved test authority.



- 9.4.2 All test equipment used to measure the performance of the actuator shall be calibrated and used in accordance with the suppliers QA system.

10. SUBSEA ACTUATORS

10.1 General

- 10.1.1 The power unit and accessories shall be in accordance with BP Group [GS 134-1](#) or BP Group [GS 112-2](#).
- 10.1.2 The actuator package shall be separately mountable/dismountable from the valve body as build up assemblies. To facilitate removal and replacement, provision should be made for the use of actuator handling frames.
- 10.1.3 The actuator should be pressure compensated using a balance device to equalise pressures inside and outside the actuator.
- The actuator internal pressure should be slightly higher than the surrounding water pressure so, if there is any leakage, hydraulic fluid leaks out rather than water leaking in.
- 10.1.4 Removal of the actuator package shall not compromise the pressure containing integrity of the valve. All chambers without pressure compensation shall utilise pressure relief systems to avoid over pressurisation.
- 10.1.5 The actuator calculations shall take into account the pressure containment requirements at the rated and shallow water depths.
- The actuator shall be designed for 1.5 times the operational water depth.
- 10.1.6 The actuator piston rod to valve stem connection shall be shown to be strong enough to react to all possible load cases.
- 10.1.7 The actuator should move the subsea isolation valve to the fully closed position in the time specified, without imposing any unacceptable stresses in the valve and actuator mechanism and unacceptable surge pressures in the pipeline.
- 10.1.8 Where specified, the actuator shall be provided with remote position status indication in the adjacent platform central control room. The actuator should also incorporate a position indicator for the safe and

convenient verification by diver or remotely operated vehicle of the valve status in poor visibility conditions.

- 10.1.9 The actuator shall be provided with the facility for cylinder flushing subsea (by the diver) and incorporate a hydraulic override device to enable operation of the valve by attachment of a hydraulic 'hot line'.
- 10.1.10 For gas pipelines the effect of low temperatures on pipeline rupture due to Joule-Thompson effects on the required valve closure torque shall be taken into account for actuator sizing.
- 10.1.11 Coupling with valve including any adaptors shall be sealed and provided with venting arrangements to permit depressurisation prior to dismounting should valve stem seal leakage have occurred.
- 10.1.12 The actuator shall be capable of assembly to valve in only one position.
- 10.1.13 The actuator shall be maintenance free for specified life.

10.2 Materials

- 10.2.1 The actuator seal material shall be specified so it has an expected life at least equal to the full operational life of the actuator, and not less than 20 years.
- 10.2.2 The pressure chamber and housing shall be constructed from a suitable alloy steel. The hydraulic sealing surfaces shall be overlaid with a corrosion and wear resistant material, which shall be resistant to sea water contaminated control fluid. Electrolytic nickel plating is not normally considered as acceptable on corrigible steel and shall only be used subject to approval by BP. Chrome plating, cast iron or aluminium components shall not be used.
- 10.2.3 The piston stem shall be constructed from a corrosion and wear resistant material. The material selected shall be such as to ensure that galling between the piston rod seal and the stem does not occur.
- 10.2.4 The material for all surfaces in contact with the pressure fluid shall be corrosion resistant with respect to the fluid.

10.3 Testing

- 10.3.1 The actuator cylinder and piston shall be subjected to a hydrostatic test with a minimum single hold period of 15 minutes.

This test shall be carried out prior to any plating being applied to the cylinder or piston.



The acceptance criteria is that zero leakage and no permanent deformation is found.

- 10.3.2 After the actuator has been installed onto the assembly an actuator seal pressure test shall be applied. (The seal leakage tests will be carried out at 20%, 80% and 100% supply pressure).
- 10.3.3 A test shall be carried out to prove assembly/disassembly using methods practicable in a sub-sea environment.

11. IDENTIFICATION & FINISHING

11.1 Identification Marks

- 11.1.1 The 'open' and 'close' positions shall be clearly identified on the actuator. For sub-sea valves easy identification shall be possible in poor visibility.
- 11.1.2 The hydraulic override on the actuator shall be clearly marked.
- 11.1.3 The actuator will be identified by the Company Order Number, Manufacturer's Model and Serial Number using low stress stamps. These numbers shall appear on all drawings and correspondence and shall be stamped on the manufactures standard nameplate. The same numbers shall be stencilled on all packing cases.

11.2 Painting and Coatings

11.2.1 External

The actuator shall be painted in accordance with BP Group [GS 106-2](#) - Painting of Metal Surfaces.

Preparation Blast clean to [BS 4232](#), 2nd Quality

Priming 1 coat: Red Oxide two pack epoxy primer
 - 50 microns dry film thickness

Finishing 3 coats: Two pack epoxy finish suitable for subsea
 exposure, in the following sequence

Yellow: [BS 4800](#) Shade 08-E-51

White: [BS 4800](#) Shade 00-E-55

Yellow: [BS 4800](#) Shade 08-E-51

125 microns per coat dry film thickness

Total dry film thickness 425 microns.



Alternative paint procedures may be proposed by the Supplier, but shall be subject to BP approval.

Full technical data of the proposed paint manufacturers' products is to be provided by the Supplier with his Tender.

The actuator shall be painted after completion of the pressure tests.

11.2.2 Internal

Full details of internal coatings applied to valve and actuator internals for permanent and temporary protection during manufacture, assembly, testing and subsequent storage are to be provided by the Supplier.



ACTUATOR DATA SHEET

VALVE DATA			
TO BE COMPLETED BY PURCHASER		TO BE COMPLETED BY VALVE MANUFACTURER	
Manufacturer		Stem diameter	
Type		Stem type	
Size		Flange type	
Required stroke time		Break torque (rotary)	
Operating media		Running torque (rotary)	
Max. DP		Re-seat torque (rotary)	
Max. Fluid Temperature		End to open torque (rotary)	
Hyperbaric pressure (Subsea)		Break to close torque (rotary)	
Water depth (Subsea)		Stem shear torque (rotary)	
ACTUATOR DATA		Max. operating torque (rotary)	
Type		No. turns (multi-turn)	
Required safety factor		Friction factor (gate valves)	
Min. supply pressure		Max. Thrust (linear)	
Max. supply pressure		ACTUATOR DATA TO BE COMPLETED BY MANUFACTURE	
Space/weight constraints		Actual Stroke time	
Controls and accessories		Max. operating torque	
Special paint requirement		Minimum reservoir pressure (pneumatic)	
Accumulator precharge pressure (hydraulic)		Type of mechanism	

For electric actuator data sheet see BP Group [GS 112-2](#).



DEFINITIONS AND ABBREVIATIONS**Definitions**

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

Abbreviations

AISI	American Iron and Steel Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing Materials
BASEEFA	British Approvals Service for Electrical Equipment in Flammable Atmospheres
BS	British Standard
CENELEC	European Committee for Electrotechnical Standardisation
DP	Differential Pressure
EN	Euro Norm.
ESD	Emergency Shut Down
ESDV	Emergency Shut Down Valve
IEC	International Electrotechnical Commission
ISO	international Standards Organisation
NEMA	National Electrical Manufacturers Association
PTFE	Polytetrafluorethylene
SI	Statutory Instrument (UK)
UK	United Kingdom

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 Standards

[IEC 529](#) Degrees of protection provided by enclosures (IP Code)
(Equivalent of [BS 5490](#))

[ISO 5210 & 5211](#) Multi-turn valve actuator attachment

American Standards

[ASME VIII](#) Boiler and pressure vessel code.

European Standards

[CENELEC](#) equivalent of [BS 5501](#) parts 1-9, Electrical apparatus for potentially explosive atmospheres:-

EN 50 014
EN 50 015
EN 50 016
EN 50 017
EN 50 018
EN 50 019
EN 50 020
EN 50 021
EN 50 028
EN 50 039

British Standards

BS 903 part A30	Physical testing of rubber
BS 5045	Transportable gas containers
BS 5490	Specification for classification of degrees of protection provided by enclosures.
BS 5500	Specification for unfired fusion welded pressure vessels.
BS 5750	Quality systems.
BS 5781	Measurement and calibration systems



[BS 5840](#) parts 1&2

Valve mating details for actuator operation.

[SI 1029](#)

Offshore installations (emergency pipe-line valve) regulations.

BP Group Documents

BP Group [GS 106-2](#)

Painting of Metal Surfaces (replaces BP Std 141)

BP Group [GS 112-2](#)

Electric Motor Operated Valve Actuators for Intermittent Operation of Isolation Valves
(replaces BP Std 152)

BP Group [GS 130-4](#)

Pressure Gauges
(replaces BP Std 177)

BP Group [GS 134-1](#)

Hydraulic Power Supplier.
(replaces BP Std 115)

BP Group [GS 146-1](#)

Vessels to [BS 5500](#)
(replaces BP Std 194 Pt 1)

BP Group [GS 146-2](#)

Vessels not Exceeding 20 mm Thick
(replaces BP Std 194 Pt 3)

