

WATER SUPPLIES DEPARTMENT
STANDARD SPECIFICATION E-51-02
ELECTRIC ACTUATOR FOR VALVES AND PENSTOCKS

1. GENERAL

1.1 Requirements

This specification covers the requirements of electric actuator for valves and penstocks. While the term “valve” is used throughout the specification, the various requirements are equally applicable to penstocks. The actuator shall be supplied with motor, drive mechanism and gearing, integral reversing starter, setting tools and software for torque and position limit switches, local control facilities, terminals for remote control and indication connections etc. as specified.

1.2 Standards

Equipment supplied shall comply with the latest version of the relevant international standards.

1.3 Electricity Supply

The motorised valve actuator shall be suitable for electricity supply of 380V 3-phase 50Hz with voltage variation within +6% and -10% and frequency variation within 49-51Hz.

2. DESIGN AND CONSTRUCTION

2.1 Actuator Enclosure

The actuator shall have a double-sealed enclosure with an ingress protection rating of IP68 to IEC 60529 and 3 metre submersion for 48 hours. The cable terminal compartment shall be sealed and separated from the inner electrical and mechanical components of the actuator.

A type test certificate from an independent approved testing authority to endorse the enclosure rating shall be submitted with the offer. The actuator casing including the end-cap shall be of die cast metal of robust construction. The reversing starter, control transformer and local controls shall be integrated with the actuator and suitably housed

to prevent the build-up of condensation.

Actuators shall be protected against C3 environments or better under ISO 12944-2.

2.2 Handwheel

A handwheel of suitable size shall be provided for safe and efficient manual operation. The manual operation shall be independent of the motor drive and gear, i.e. the motor operation shall not cause the handwheel to rotate, and the operation of the handwheel shall not cause the motor to rotate. The changeover from motor operation to handwheel operation shall be accomplished by an auto or manual declutching device. The handwheel or the declutching device if equipped shall be padlockable or else an external locking facility shall be provided to prevent unauthorised manual operation of the handwheel.

The total manual force exerted on the rim of the handwheel shall not be greater than 250N for seating or unseating the valve. The handwheel shall have an arrow with wording "OPEN" or "CLOSE" to indicate the required direction of rotation.

2.3 Local Electrical Control

Local selector and control switches shall be provided on the actuator for selection of "Local/Off/Remote" control modes and local open/stop/close functions. The "Local/Off/Remote" selector switch shall be padlockable.

2.4 Local Position Indicator

The actuator shall be fitted with a back-lit local indicator showing the valve position in terms of percentage opening.

2.5 Drive Coupling

The actuator shall have output drive coupling conforming to BS EN ISO 5210 or BS EN ISO 5211 as appropriate for interfacing with the driven equipment such that the actuator can be removed without disturbing the valve position. The coupling shall have a sealed bearing and shall withstand the thrust reaction experienced in valve operation.

2.6 Performance on Loss of Main Power Supply

The actuator shall remain in the position attained immediately after the loss of a.c. mains power supply.

The actuator shall be fitted with an internal battery such that the actuator can still perform the following functions when the a.c. mains power supply is lost and the valve is being manually operated by the handwheel:

- (a) Refreshing of the output signals for actuator status and position limit switches.
- (b) Displaying of the valve position, actuator status and alarm messages on the back-lit display.

The battery supplied shall be of leak-proof lithium type with a replacement cycle longer than 5 years for normal operation of the actuator. The actuator shall periodically monitor the battery status and provide a 'low battery' indication on the back-lit display when battery replacement is required.

When specified, an auxiliary d.c. power supply shall be provided to the actuator, such that the actuator shall be able to perform the functions (a) and (b) mentioned above and maintain its fieldbus connection when the a.c. mains power supply is lost. In that case, the requirement of backup battery is not necessary.

2.7 Actuator Protection

Integral protection shall be provided to cut out the motor under the following conditions:

- (a) Overheating as sensed by the motor winding embedded temperature detector as specified in Clause 3.2 of this Standard Specification.
- (b) Over-travel of the valve in either direction as sensed by the position and/or torque limit switches as specified in Clause 3.7 of this Standard Specification.

Protection shall also be provided to prevent the motor from starting when any phase of the 3-phase a.c. mains power supply is lost.

Rotation direction of the motor shall be corrected automatically if the 3-phase a.c. mains power supply is incorrectly wired.

2.8 Rating Plate

A rating plate made of stainless steel or other non-tarnishing weather resistant material with a black background and bare metal lettering shall be provided for the actuator.

The following information shall be provided on the rating plate:

- (a) actuator size and type
- (b) serial number
- (c) a.c. mains power supply ratings
- (d) output speed

- (e) torque rating
- (f) enclosure protection rating
- (g) year of manufacture

2.9 Duty Performance

The actuator shall comply with the following duty ratings:

Actuator application	Actuator duty class to ISO 22153
On-off / inching	Class A or Class B
Modulating	Class C

3. ELECTRICAL COMPONENTS

3.1 Starter

Reversing contactor type starter to BS EN 60947-4-1, utilisation category AC4, intermittent duty class 0.3, 30 operating cycles per hour shall be provided. For valve specified for modulating control duties, the operating cycles shall be 1200 per hour.

The starter forward and reverse contactors shall be mechanically and electrically interlocked to prevent inadvertent short-circuit or excessive current surges during travel reversal. Where solid state controls are employed, provision shall be made to prevent inadvertent valve operation due to noise and transients in the system.

3.2 Actuator Motor

The actuator motor shall be of class F insulated, low inertia, high torque squirrel cage type suitable for operating on 380V, 3-phase, 50Hz supply. The rated torque and starting torque of the actuator shall be greater than 100% and 200% of the required maximum unseating torque of the valve respectively.

For on-off/inching application, the actuator motor shall be able to operate at duty cycle similar to S2 or S4 30% under IEC 60034-1. It shall be rated not less than 15 minutes or 2 times the valve stroke time, whichever is longer, based on an average load of at least 30% of the rated torque with ability to transmit 100% of the rated torque for at least 10% of the time.

For modulating application, the actuator motor shall be able to operate at duty cycle similar to S4 50% under IEC 60034-1 for 1200 starts per hour based on an average load of 50% of the rated torque.

The motor shall be provided with embedded temperature detectors to protect the stator

winding against overheating.

3.3 Control Transformer

The primary winding of the control transformer shall be protected by easily replaceable cartridge type fuses.

3.4 Internal Wiring

The control wiring inside the actuator shall be tropical grade PVC insulated cable. Each wire shall be identified by a unique colour code. Terminal numbers where numerals are printed at both the terminal and component ends will be accepted as an alternative if full circuit and wiring diagrams are provided by the manufacturer.

3.5 Monitor Function

A monitor relay or similar device with volt-free changeover contacts shall be provided to monitor the condition of the actuator and wired to the terminal block for external connections. It shall be arranged for “fail-safe” operation and shall trip and generate a fault signal when any of the following conditions occurs:

- (a) Loss of one or more phases of the a.c. mains power supply when the motor is not running.
- (b) Loss of control circuit power supply.
- (c) Motor winding temperature high thermostat trip.
- (d) Wrong phase sequence (where applicable).

If one or more phases of the a.c. mains power supply phases is/are lost when the motor is running, a fault signal shall be generated when the motor is stopped. The motor shall be inhibited from starting until the fault is cleared.

Alarm icons or messages for indicating problems of the valve and actuator shall be incorporated into the local back-lit display of the actuator to identify the potential area of the problems and facilitate fault attendance in dim light condition.

3.6 Valve Motor Running Indication

A pair of normally open volt-free auxiliary contacts shall be wired to the external connection terminal blocks for the initiation of remote “Valve motor running” indication.

3.7 Torque and Position Limit Switches

Setting of the torque and position limit switches of the actuator shall not require the opening of the actuator enclosure, i.e. it shall be non-intrusive. The settings shall be adjustable via local control buttons and/or a remote control setting tool with password protection. If setting can only be performed via a remote control setting tool, a minimum of one set of the tool shall be provided per each project location. If setting can be performed via a computer, the software shall be supplied with licence-free installation to a personal computer.

The actuator shall be provided with reliable non-volatile storage devices for keeping all settings during a.c. mains power supply failure.

The following table summarises the limit switches to be provided for the actuator for external connections:

VALVE AUXILIARY LIMIT SWITCH POSITION CHART				
Switch	Open	Intermediate	Closed	Function
LS-1			█	closed interlock/indication
LS-2	█	█		control interlock 1
LS-3	█			open interlock/indication
LS-4		█		control interlock 2
LS-5	←→	█		control interlock 3
LS-6	←→	█		control interlock 4
LS-7	←→	█		control interlock 5

Notes:

- (a) “ ←→ ” represents the switch operation is adjustable to any intermediate position.
- (b) “ █ ” represents the contact to be made for the limit switch.
- (c) Limit switches LS-5, LS-6 and LS-7 shall be able to be set to make or break at any position of valve travel.
- (d) The limit switches shall be wired to the terminals for external cable connections. Limit switch contact shall be rated at 5A 120V a.c. or 30V d.c.

3.8 Remote Control

The terminal block shall receive the following remote control signals in the form of volt-free contacts:

- (a) Open valve
- (b) Close valve
- (c) Stop valve

The actuator shall be configurable for the following modes of control:

- (a) Open/close push to run control
- (b) Open/close maintained control with mid travel reversal
- (c) Open/stop/close maintained control
- (d) Overriding emergency shut-down to close (or open)

The circuit associated with remote control and monitoring functions shall be optically isolated from the remote control signal inputs.

3.9 Termination and Connection

The actuator shall make provision for bottom entry, glanding and termination of one 6 mm² 3-core and one 1.5 mm² 27-core XLPESWAPVC copper cables. Provision shall be also made for the entry of two or four communication cables for dual redundant fieldbus connections.

Terminations shall be so positioned to allow connection or disconnection of external wiring without disturbing internal connections. Terminations shall be clearly and durably marked.

Terminals for the power supply cables shall be shrouded by a plastic cover and separated effectively from control wire terminals.

All unused cable gland holes shall be sealed up with screw plugs with an ingress protection rating of IP68 to IEC 60529.

3.10 Position Transmitter (Optional)

When specified, the actuator shall be fitted with a position transmitter or an equivalent device, which outputs a signal of 4-20mA d.c. in proportion to the percentage of valve opening. Its accuracy shall be within $\pm 2.5\%$ of the full scale. It shall be capable of driving a load with an impedance of 500 ohms when the power supply to the position transmitter is derived from the actuator. It shall operate at 24V d.c. when an external power supply is used.

3.11 Position Controller (Optional)

When specified, an electronic control unit shall be provided to enable the modulating actuator to position the valve in proportion to an analogue d.c. input signal of 4-20mA. The minimum variation of the input signal to initiate a change of valve position (deadband) shall be adjustable from 0% to 5%. The accuracy shall be better than 2.5% of the full scale.

3.12 Fieldbus Connection

Digital communication format shall be supported and fieldbus module shall be provided with the actuator and meet the following requirements:

- (a) It shall be suitable for direct serial communication to an industrial standard programmable logic controller (PLC) and shall support Modbus or Profibus protocol.
- (b) It shall take power supply from the actuator.
- (c) It shall support a data rate of 9,600 baud for communication distance up to 1,200 metres without repeaters.
- (d) It shall have surge protection devices to protect the actuator from high voltage transients on the fieldbus cables.
- (e) If the actuator fails, is powered down, or is detached from the fieldbus network, all other devices connected to the same network shall not be affected and be able to operate normally without any need to rewire the fieldbus cables.

When optical fibre connection is specified for an installation vulnerable to lightning strikes such as at a service reservoir, the actuator shall be fitted with a Profibus module for interfacing with the external electro-optical converter provided by others. The use of other communication protocols complying with IEC 61158 or equivalent shall be subject to approval.

Dual redundant fieldbus connection shall be provided. The actuator shall be accessible by the PLC using the other network without any reconfiguration or re-wiring of the actuator if any one of the fieldbus networks fails.

4 Information to be Provided in the Particular Specification

The following information, if required, shall be provided in the Particular Specification in addition to this Standard Specification.

Section of this Standard Specification	Requirements to be specified in the Particular Specification
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Clause 2.6 Performance on Loss of Main Power Supply	Provision of an auxiliary d.c. power supply to the actuator
Clauses 2.9 and 3.2 Actuator application	Intended application of the actuator (on-off/inching or modulating)
x	
Clause 3.10 Position Transmitter	Provision of a position transmitter in the actuator
Clause 3.11 Position Controller	Provision of a position controller for modulating control in the actuator

- End of this Specification -