

WATER SUPPLIES DEPARTMENT

STANDARD SPECIFICATION E-83-03

ELECTRO-MAGNETIC FLOWMETER

I N D E X

	Page No.
1. GENERAL	1
2. DESIGN	1-4
3. CONSTRUCTION	
3.1 Flow Detector Head	4
3.2 Flow Converter	5
4. ACCESSORIES	5
5. CALIBRATION AND TESTING	5
6. IN-SITU VERIFICATION EQUIPMENT	6
7. INFORMATION FOR ASSESSMENT	6

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ELECTRO-MAGNETIC FLOWMETER

1. GENERAL

This standard outlines the technical requirements of flowmeters which operate on the principle of electro-magnetic induction. The flowmeter shall consist of an in-line flow detector head and a separately mounted flow converter / transmitter for producing a current and pulse output directly proportional to the liquid flow rate. The design, operation and calibration of the flowmeter shall comply with the latest version of relevant standards as listed below or other international standards currently enforced on the date of tender invitation where applicable:

ISO 17025	General requirements for the competence of testing and calibration laboratories
ISO 6817	Measurement of conductive liquid flow in closed conduits - Method using electromagnetic meters
IEC 60529	Degree of protection provided by enclosures (IP code)
BS 6920	Suitability of non-metallic materials and products for use in contact with water intended for human consumption with regard to their effect on the quality of the water.

2. DESIGN

The flowmeter shall meet the following design requirements:

(a) Overall Performance

Accuracy : Better than $\pm 1.2\%$ for flow rate ranging from 10% to 20% of the total flow of the flowmeter (for all applications when flow velocity is at least 0.3 m/sec.)

Better than $\pm 0.5\%$ for flow rate ranging from 20% to 100% of the total flow of the flowmeter (for potable water, sea water, raw water and chemical solution applications as specified in the Particular Specification)

Better than $\pm 1.0\%$ for flow rate ranging from 20% to 100% of the total flow of the flowmeter (for slurry and sludge flow applications)

Linearity error : Better than $\pm 0.2\%$ of the span

Repeatability : Less than $\pm 0.1\%$ of the span

Total power consumption	Nominal pipe size (mm diameter)	Total power consumption (VA)
	< 1000	< 30
	≥ 1000	< 80

(b) Standard Flow Range

Unless otherwise specified, the flowmeter shall be calibrated to work in the following flow range :

Flowmeter size (mm)	Standard Flow Range(MLD)
40	0.3
50	0.5
80	1.5
100	2
150	5
200	8
250	15
300	20
350	25
400	35
450	40
500	50
600	75
700	100
800	120
900	160
1,000	200
1,200	300
1,400	400
1,600	500
1,800	700
2,000	800

(c) Flow Detector Head

Enclosure rating : IP68 to IEC 60529 for continuous 8 hours submersion at 5 m depth

Field excitation : Pulsed d.c. field from flow converter

Metering tube : Stainless steel of Grade 304 unless otherwise

specified in the Particular Specification

- Lining material : Elastomer or other approved material suitable for use in potable water applications, and Hard Rubber or PTFE (Teflon) or other approved material suitable for use in salt water, chemical solution and sludge applications as specified in the Particular Specification
- Electrode material : Stainless steel of Grade 316 for potable and raw water, Hastelloy 'C' or Titanium or other approved material for sea water and chemical solution as specified in the Particular Specification
- Pressure effect : Less than 0.15% over the operating range of flowmeter
- Temperature effect : Less than $\pm 0.05\%$ of flow rate per 10°C
- Compliance to BS 6920 series : All non-metallic materials direct in contact with the measured medium shall comply with BS 6920 series and suitable for use in potable water with temperature up to 35°C or higher.

(d) Flow Converter / Transmitter

- Enclosure rating : IP 66 or better
- Input signal : Induced e.m.f. from flow detector head
- Output signals
- (i) current : 4 - 20 mA d.c. for load up to 500 ohms
 - (ii) pulse : 24V/200 mA d.c. pulses with pulse rate up to 10 pulses/sec. suitable for driving a pair of electromechanical counters each with coil resistance of 430 ohms nominal
- Low flow signal cut off : Automatic output signal cut off at less than 1% of the full scale flow range with resumption of normal measurement at flow above 2%
- Signal averaging time : Field adjustable between 0-5 sec
- Supply voltage effect : Less than $\pm 0.1\%$ of the calibrated span per $\pm 10\%$ change in supply voltage
- Frequency effect : Less than $\pm 0.1\%$ of the calibrated span per $\pm 2\%$

change in supply frequency

- Temperature effect : Less than $\pm 0.15\%$ of flow rate per 10°C
- Power supply : 220V 50 Hz or 24V d.c. as detailed in the Particular Specification
- Zero and span settings : Auto or manual with password protection
- Diagnostic : Self monitoring with fault diagnostic functions including self calibrating the accuracy of signal processing including non-full-bore detection during normal running with alarms.
- Configuration programming : Socket provided capable of linking for interface to a laptop computer.
- Digital communication : HART protocol via hardwire. Other protocol shall be provided when specified in the Particular Specification.

3. CONSTRUCTION

3.1 Flow Detector Head

The flow detector head shall be flanged at both ends. It shall be suitable for installing in the pipeline between a fixed flange at the upstream end and a straight pipe edge at the downstream end by means of a flange adaptor. The detector head shall be constructed from non-magnetic material lined with a non-corrodible insulating material compatible with the liquid being measured and of the required pressure rating. The field excitation coil assembly shall be epoxy resin encapsulated. The complete housing, including cable termination, shall have a certified degree of protection to IEC 60529 IP 68 for continuous 5 metres water submersion for 8 hours or better. External cable connections for field excitation and signal transmission shall be made via a sealable die-cast termination box or water-tight plugs and sockets. The cable shall be screened with suitable mechanical protection.

Suitable earthing arrangements shall be provided on both sides of the detector head. Where the detector head is specified to be installed in a pipeline with cathodic protection, insulating flanges, bonding bars etc. shall be provided to avoid any electrical interference to the flowmeter. Resilient gaskets shall be supplied for fitting between the flanges of the detector head and the pipeline. The gasket material shall be chemically resistant to the measured liquid.

The design and construction of the electrode assembly shall prevent any ingress of water into the detector coil housing.

A liquid sensing electrode or an equivalent device shall be provided to nullify the flow

signal output when the metering tube is only partially filled with measured liquid.

3.2 Flow Converter

The enclosure of the flow converter shall be of IP 66 to IEC 60529. The electronics package shall be of the withdrawable type to allow easy access to the PCB for testing or fault diagnosis and with full firmware support and connectors for in-situ verification under operating conditions. Local flow rate indication and alarms shall be provided at the flow converter. Alarm contacts for high/low flow rate and partially filled metering tube shall be provided. Alarms, range, span and other parameters of the flowmeter shall be settable at the flow converter through local buttons.

Where the flowmeter is required for bi-directional flow measurement, separate analogue and pulse signal outputs for forward and reverse flow conditions shall be provided with a volt-free contact to indicate the reverse flow condition. Furthermore, the flanged adaptors at both ends of the flowmeter should be of adequate length to enable the measurement for forward and reverse flow conditions.

4. ACCESSORIES

Each flowmeter shall be provided with the following accessories:

- (a) One set of earthing attachment for each end of the flowmeter, and
- (b) 50m of screened cables for field excitation and signal transmission between the detector head and flow converter or otherwise specified in the Particular Specification.

5. CALIBRATION AND TESTING

Each flowmeter shall be tested and flow calibrated with certified testing apparatus at the manufacturer's works or other approved flow calibration facility with calibrated test equipment traceable to National or international standards. The following tests shall be conducted: -

- (a) Pressure test to 150% of the required working pressure for 30 minutes;
- (b) Flow calibration for the complete flow detector head and flow converter to verify the accuracy over 10% to 100% of the full flow range in accordance with ISO 6817 for flowmeter size up to 1000mm and to verify the accuracy from 10% of the full flow range to at least 200MLD for flowmeter size above 1000mm; for bi-directional flowmeters, separate tests shall be carried out with water flow in forward and reverse directions; and
- (c) All test result/certificates for the flowmeter shall be submitted to the Water Supplies Department prior to delivery of the equipment.

6. IN-SITU VERIFICATION EQUIPMENT

Where specified, portable in-situ verification equipment shall be provided. The verification equipment shall be battery-powered and readily connectible to the flow converter without removal of the flowmeter from the installed position. The verification equipment shall be equipped with firmware and program to facilitate automatic verification and validation of the flowmeter conditions.

The verification equipment shall test the integrity of the flowmeter by altering a number of flow measurement parameters and measuring the values returned from the flowmeter. Test results shall be displayed on the LCD of the verification equipment and a report shall be generated to display and verify the performance of the system by comparing with the results of factory tests on the flowmeter including:

- (a) Insulation and integrity tests of the entire flowmeter system including the cables.
- (b) Transmitter gain, linearity and zero point tests.
- (c) Test of sensor magnetic properties.
- (d) Digital output test.
- (e) Analog output test.

The handheld verification equipment shall have a storage capacity for storing at least 20 sets of test results. Connection cables and software compatible with Microsoft Windows of the latest version shall be provided for downloading the test results to the computer for storage and analysis.

The calibration certificate of the verification equipment shall be provided together with the test results on the flowmeters supplied.

7. INFORMATION FOR ASSESSMENT

The following information shall be submitted for assessment upon request:

- (a) Type test reports/certificates shall be submitted to prove the degree of protection of the flow detector head to IEC 60529 IP 68.
- (b) Details of the flow calibration test including the flowmeter test rig arrangement, flow capacity and calibration method.
- (c) Relevant testing certificates shall be submitted for compliance with BS 6920 series for non-metallic materials direct in contact with potable water having temperature up to 35°C or higher.