MI 021-137
February 1993

Instruction

2800 Series
Flanged Magnetic Flowtubes
ptfe, Polyurethane, and Neoprene Lined,
14- through 36-inch Sizes

Flowtube Installation
Style C

MODEL 2814 WITH ptfe LINING SHOWN

A Siebe Group Company

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Introduction

The 2800 Series Magnetic Flowtubes have been designed to operate in harsh in-plant or outdoor environments and are suitable for installation in most hazardous area locations. A selection of High Humidity/Condensate, General Purpose NEMA 4X, and Accidental Submergence Housings are offered.

The stainless steel flowtube is lined with a choice of ptfe, polyurethane, or neoprene lining. Together with the choice of lining materials, a selection of electrode metals and electrode shapes enables these flowtubes to handle a wide variety of liquids such as water, slurries, and sticky, abrasive, and highly corrosive processes.

All flowtubes are wet calibrated to verify their specified accuracy with traceability to the U.S. National Institute of Science and Technology (NIST).

The 2800 Series Magnetic Flowtubes can be calibrated for use with either ac or pulsed dc coil excitation. These flowtubes, together with an E96 (ac) Magnetic Flow Transmitter or an 896 (pulsed dc) Magnetic Flow Transmitter, combine to form an easy-to-use, versatile magnetic flowmeter that measures the volumetric flow rate of virtually any conductive liquid. The transmitter converts the low level, high impedance signal from the flowtube to a standard transmission signal that is proportional to flow rate.

This instruction relates to the installation of the flowtube portion of the magnetic flowmeter system. For installation, wiring, operation, configuration, and maintenance details relating to the flowmeter system, refer to the applicable transmitter documents.

Reference Documents

PSS 1-6B5 E	2800 Style C Magnetic Flowtubes, 14 to 36 in Sizes
PSS 1-6C1 A	E96 Series Transmitter, Product Specifications
PSS 1-6C2 A	896 Series Transmitter, Product Specifications
DP 021-137	2800 Series Flanged Flowtubes, 14 to 36 in, Dimensions
MI 021-333	E96P and E96S Magnetic Flow Transmitters - Instructions
MI 021-334	E96R Magnetic Flow Transmitters - Instructions
MI 021-350	896P and 896S Magnetic Flow Transmitters - Instructions
PL 008-544	2800 Series Flanged Flowtubes, 14 to 36 in, Parts List
TI 27-71f	Magnetic Flowtube Materials Selection Guide
TI 027-072	Magnetic Flowmeter Liquid Conductivity Tables

Principle of Operation

The principle of operation of the magnetic flowtube is based on Faraday's law of electromagnetic induction: the voltage ($V_{O)}$ induced in a conductor of length (D_E) moving through a magnetic field (T) is proportional to the velocity (v) of the conductor.

$$V_O = (D_{E)}(v)(T)$$

In this application of Faraday's law, the process fluid is the conductor. The process fluid passes through the magnetic field induced by coils built around a section of the metering tube. The

process fluid is electrically insulated from the flowtube by the lining in the tube. Two metallic electrodes are mounted in the flowtube, and a voltage is developed across these electrodes which is directly proportional to the average velocity of the fluid passing through the magnetic field. The 2800 Series Magnetic Flowtube can use either ac (from an E96 Magnetic Flow Transmitter) or pulsed dc (from an 896 Magnetic Flow Transmitter) coil excitation. The voltage signal is screened (shielded) from interference, amplified and demodulated into a standard dc current signal by a magnetic flow transmitter.

Standard Specifications

Ambient Temperature

Normal Operating Condition Limits -10 and +50°C (20 and 120°F)
Operative Limits -30 and +60°C (-20 and +140°F)

Nominal Line Sizes

350, 400, 450, 500, 600, 750, and 900 mm (14, 16, 18, 20, 24, 30, and 36 in)

Electrodes

Tantalum, 316 ss, Hastelloy C, platinum, or titanium. 316 ss and Hastelloy C electrodes are also offered in conical shaped configurations. Refer to TI 27-71f for process-wetted materials selection guide.

Metering Tube

AISI Type 304 stainless steel.

Process Fluid Conductivity

The minimum process fluid conductivity required is 2 μS/cm when used with an E96 Transmitter, and 5 μS/cm when used with an 896 Transmitter.

Signal and Coil Driver Cable Length

Using Foxboro cable Part Number R0101ZS, the maximum allowable cable length is 300 m (1000 ft) between flowtube and transmitter when used with an 896 Transmitter. When used with an E96 Transmitter, the maximum cable length varies with the conductivity of the liquid, as shown in Figure 11.

Minimum and Maximum Upper Range Values and Nominal Calibration Factors

Minimum and maximum upper range value (URV) flow rates and nominal calibration factors are shown in Table 1 and Table 2 for the different tube sizes and linings.

Table 1. Lined Metal Flowtubes with 896 Transmitter Pulsed dc Coil Excitation

Nominal Line Size		Flowtube Type(a)	Upper Range Limits				Nominal Calibration Factor	
			Minimum		Maximum			
mm	in		L/m	US gpm	L/m	US gpm	mV/(L/m)	mV/US gpm
350	14	A	102	430	54 500	14 400	0.0000977	0.00037
		N and T	106	440	54 500	14 400		
400	16	A	136	570	72 000	19 000	0.0000501	0.00019
		N and T	136	580	72 000	19 000		
450	18	A	174	730	91 000	24 000	0.0000449	0.00017
		N and T	178	740	91 000	24 000		
500	20	A	432	1815	114 000	30 000	0.0000250	0.000095
		N and T	440	1840	114 000	30 000		
600	24	A	932	3900	162 000	43 000	0.0000142	0.000054
		N and T	955	4000	162 000	43 000		
750	30	A	1482	6200	258 000	68 000	0.0000058	0.000022
		N	1505	6300	258 000	68 000		
900	36	A	2153	9000	374 000	99 000	0.0000034	0.000013
		N	2198	9200	374 000	99 000		

(a) A=Polyurethane Lined Metal
N=Neoprene Lined Metal
T=ptfe Lined Metal

Table 2. Lined Metal Flowtubes with E96 Transmitter ac Coil Excitation

Nominal Line Size		Voltage and Coils(a)			Power		Lining	Upper Range Value				Nominal Calibration Factor	
								Minimum		Maximum			
mm	in	Hz	V	Coils	W	VA	(b)	L/m	US gpm	L/m	US gpm	mV/(L/m)	mV/US gpm
350	14	60	120	P	120	720	A	6810	1800	54 500	14 400	0.000145	0.000 55
			240	S			N and T	6810	1800			0.000148	0.000 56
			240	P	550	2880	A	3410	900			0.000291	0.001 10
							N and T	3410	900			0.000291	0.001 10
		50	120	P	150	900	A	5680	1500			0.000174	0.000 66
			240	S			N and T	5680	1500			0.000174	0.000 66
			220	S	120	720	A	6810	1800			0.000145	0.000 55
							N and T	6810	1800			0.000148	0.000 56
			220	P	550	2880	A	3410	900			0.000291	0.001 10
							N and T	3410	900			0.000291	0.001 10
400	16	60	120	P	150	840	A	9080	2400	72 000	19 000	0.000111	0.000 42
			240	S			N and T	9080	2400			0.000111	0.000 42
			240	P	675	3360	A	4540	1200			0.000219	0.000 83
							N and T	4540	1200			0.000219	0.000 83
		50	120	P	180	1050	A	7570	2000			0.000132	0.000 50
			240	S			N and T	7570	2000			0.000132	0.000 50
			220	S	150	840	A	9080	2400			0.000111	0.000 42
							N and T	9080	2400			0.000111	0.000 42
			220	P	675	3360	A	4540	1200			0.000219	0.000 83
							N and T	4540	1200			0.000219	0.000 83
450	18	60	120	P	180	960	A	11400	3000	91 000	24 000	0.0000871	0.000 33
			240	S			N and T	11400	3000			0.0000871	0.000 33
			240	P	805	3840	A	5680	1500			0.000174	0.000 66
							N and T	5680	1500			0.000174	0.000 66
		50	120	P	220	1200	A	9460	2500			0.000106	0.000 40
			240	S			N and T	9460	2500			0.000106	0.000 40
			220	S	180	960	A	11400	3000			0.0000871	0.000 33
							N and T	11400	3000			0.0000871	0.000 33
			220	P	805	3840	A	5680	1500			0.000174	0.000 66
							N and T	5680	1500			0.000174	0.000 66
500	20	60	120	P	215	1080	A	14400	3800	114 000	30 000	0.0000713	0.000 27
			240	S			N and T	14400	3800			0.0000713	0.000 27
			240	P	960	4320	A	7190	1900			0.000140	0.000 53
							N and T	7190	1900			0.000140	0.000 53
		50	120	P	260	1300	A	11900	3150			0.0000845	0.000 32
			240	S			N and T	11900	3150			0.0000845	0.000 32
			220	S	215	1080	A	14400	3800			0.0000713	0.000 27
							N and T	14400	3800			0.0000713	0.000 27
			220	P	960	4320	A	7190	1900			0.000140	0.000 53
							N and T	7190	1900			0.000140	0.000 53

Table 2. Lined Metal Flowtubes with E96 Transmitter ac Coil Excitation (Continued)

Nominal Line Size		Voltage and Coils(a)			Power		Lining	Upper Range Value				Nominal Calibration Factor	
								Minimum		Maximum			
mm	in	Hz	V	Coils	W	VA	(b)	L/m	US gpm	L/m	US gpm	mV/(L/m)	mV/US gpm
600	24	60	120	P	265	1260	A	22700	6000	162 000	43 000	0.0000475	0.000 18
			240	S			N and T	22700	6000			0.0000475	0.000 18
			240	P	1150	5040	A	11400	3000			0.0000977	0.000 37
							N and T	11400	3000			0.0000977	0.000 37
		50	120	P	320	1550	A	18900	5000			0.0000581	0.000 22
			240	S			N and T	18900	5000			0.0000581	0.000 22
			220	S	265	1260	A	22700	6000			0.0000475	0.000 18
							N and T	22700	6000			0.0000475	0.000 18
			220	P	1150	5040	A	11400	3000			0.0000977	0.000 37
							N and T	11400	3000			0.0000977	0.000 37
750	30	60	120	P	330	1650	A	34100	9000	258 000	68 000	0.0000306	0.000 116
			240	S			N	34100	9000			0.0000306	0.000 116
			240	P	1465	6240	A	17000	4500			0.0000610	0.000 231
							N	17000	4500			0.0000610	0.000 231
		50	120	P	400	1900	A	28400	7500			0.0000367	0.000 139
			240	S			N	28400	7500			0.0000367	0.000 139
			220	S	330	1650	A	34100	9000			0.0000306	0.000 116
							N	34100	9000			0.0000306	0.000 116
			220	P	1465	6240	A	17000	4500			0.0000610	0.000 231
							N	17000	4500			0.0000610	0.000 231
900	36	60	120	P	420	1800	A	47300	12 500	374 000	99 000	0.0000211	0.000 080
			240	S			N	47300	12 500			0.0000211	0.000 080
			240	P	1680	7200	A	23700	6250			0.0000422	0.000 160
							N	23700	6250			0.0000422	0.000 160
		50	120	P	500	2200	A	39700	10 500			0.0000253	0.000 096
			240	S			N	39700	10 500			0.0000253	0.000 096
			220	S	420	1800	A	47300	12 500			0.0000211	0.000 080
							N	47300	12 500			0.0000211	0.000 080
			220	P	1680	7200	A	23700	6250			0.0000422	0.000 160
							N	23700	6250			0.0000422	0.000 160

(a) P = Parallel Connected, S = Series Connected
(b) A = Polyurethane, N = Neoprene, T = ptfe

Process Liquid Earth (Ground)

IF CONNECTING PIPING IS UNLINED METAL

System grounded through flange bolts and ground straps. Ground straps are provided with flowtube sizes 350 mm (14 in) or greater.

IF CONNECTING PIPING IS LINED METAL OR NONMETALLIC

Systems grounded using earthing (grounding) rings at each end of the flowtube. Grounding rings (i.e., orifice plates) are available from Foxboro, if needed.

Process Pressure and Temperature Limits

See Table 4, Table 5, and Table 6.

Enclosure Construction

Housing is fabricated from fiberglass reinforced plastic (FRP), and gaskets are used to seal all joints. Offered for high humidity, NEMA 4X, or accidental submergence applications, as specified.

Enclosure Finish

Polyurethane paint.

Electrical Connections

The housing has two 3/4 NPT tapped holes for power conduit fittings and one 1/2 NPT tapped hole for an optionally provided 3/4 NPT signal cable seal.

Mounting Position

The flowtube can be mounted in any orientation provided that during normal flow, it remains full of process liquid, and the electrodes are in the horizontal plane.

End Connection

ANSI Class 150 and 300, AWWA Class D; Metric PN 6, 10, 16, 25, and 40 flanges.

Product Safety Specifications

Refer to Table 7 for Electrical Classifications.

Approximate Mass

Refer to Table 3.

Table 3. Approximate Flowtube Mass

Flowtube Size		Approximate Flowtube Mass	
mm	in	kg	lb
350	14	170	375
400	16	195	425
450	18	215	475
500	20	285	625
600	24	410	900
750	30	545	1200
900	36	660	1450

Table 4. Process Pressure and Temperature Limits - ptfe-Lined Flowtubes - 2814 - 2824 Sizes Only

Flange Rating	Flowtube Model (Line Size)	Process Pressure Limits		Process Temperature Limits	
		Lower Limit	Upper Limit	Lower Limit	Upper Limit
ANSI Class 150	2814 and 2816	Zero (No Vacuum)	1.38 MPa (200 psig)	-18 °C (0 °F)	82 °C (180 °F)
	2818 to 2824	Zero (No Vacuum)	1.03 MPa (150 psig)		
Metric PN 6	2814 to 2824	Zero (No Vacuum)	0.62 MPa (90 psig)		
Metric PN 10	2814 to 2824	Zero (No Vacuum)	1.03 MPa (150 psig)		

Table 5. Process Pressure and Temperature Limits - Polyurethane-Lined Flowtubes

Flange Rating	Flowtube Line Size	Process Pressure Limits		Process Temperature Limits	
		Lower Limit	Upper Limit	Lower Limit	Upper Limit
ANSI Class 150	2814 and 2816	Full Vacuum	1.38 MPa (200 psig)	-18 °C (0 °F)	71 °C (160 °F)
	2816 to 2824	Full Vacuum	1.03 MPa (150 psig)		
Metric PN 10	2814 to 2824	Full Vacuum	1.03 MPa (150 psig)		
	2830	Full Vacuum	0.69 MPa (100 psig)		
	2836	Full Vacuum	0.62 MPa (90 psig)		
Metric PN 6	2814 to 2824	Full Vacuum	1.03 MPa (150 psig)		
	2830	Full Vacuum	0.69 MPa (100 psig)		
	2836	Full Vacuum	0.62 MPa (90 psig)		
AWWA Class D	2830	Full Vacuum	0.69 MPa (100 psig)		
	2836	Full Vacuum	0.62 MPa (90 psig)		

Table 6. Process Pressure and Temperature Limits - Neoprene-Lined Flowtubes

Flange Rating	Flowtube Model (Line Size)	Process Pressure Limits		Process Temperature Limits	
		Lower Limit	Upper Limit	Lower Limit	Upper Limit
ANSI Class 150	2814 and 2816	Full Vacuum	1.38 MPa (200 psig)	-18 °C (0 °F)	82 °C (180 °F)
	2818 to 2824	Full Vacuum	1.03 MPa (150 psig)		
AWWA Class D	2830	Full Vacuum	0.69 MPa (100 psig)		
	2836	Full Vacuum	0.62 MPa (90 psig)		
Metric PN 6	2814 to 2824	Full Vacuum	0.62 MPa (90 psig)		
Metric PN 10	2814 to 2824	Full Vacuum	1.03 MPa (150 psig)		
	2830	Full Vacuum	0.69 MPa (100 psig)		
	2836	Full Vacuum	0.62 MPa (90 psig)		

Table 7. Electrical Classifications

Testing Laboratory, Types of Protection and Area Classification	Conditions of Certification	Electrical Certification Specification(a)
CSA certified for use in Ordinary Locations and Class I, Groups A, B, C, and D, Division 2 hazardous locations.	Models 2814 through 2824, Temperature Class T3.	CS-E/CN-A
FM approved for use in Ordinary Locations and Class I, Groups A, B, C, and D, Division 2 hazardous locations.	Models 2814 through 2824. Temperature Class T3.	CS-E/FN-A
Foxboro(b) certified for use in Ordinary Locations.	Models 2830 and 2836. Temperature Class T3.	CS-E/CG-F
Foxboro(c) certified for use in Ordinary Locations and Class I, Groups A, B, C, and D, Division 2 hazardous locations.	Models 2814 through 2836. Temperature Class T3.	CS-E/FN-F

(a) Refer to Electrical Certification Specification on data plate for classification of flowtube.

(b) Certified to CSA standards.

(c) Certified to FM standards.

Flowtube Identification

The flowtube can be identified by a data plate located on the housing surface of the flowtube. A typical data plate is shown in Figure 1. For a breakdown of the Model Code, refer to PL 008-544. Refer to the applicable transmitter instruction for information regarding transmitter data plates.

NOTE: Do not remove flowtube from shipping carton without first reviewing the "Unpacking and Handling Procedures" section that follows.

Figure 1. Flowtube Data Plate

Unpacking and Handling Considerations

Unpacking for Inspection

The Foxboro magnetic flowtube is built to be durable, but it is also part of a calibrated precision system and should be handled as such. Avoid dropping or otherwise subjecting it to impact, particularly at the flange faces.

The flowtube is shipped from the factory in a sturdy carton and cradled between flange covers for protection. Before removing it from the carton, move it as close as possible to its installation point. If the flowtube must be removed for receiving inspection, REINSTALL THE END COVERS AFTER INSPECTION. This is particularly true with ptfe-lined flowtubes.

Lift flowtube out of carton with rope falls, chain hoist, etc. as shown in the "Flowtube Handling" sections that follow. In some instances it may be more convenient to insert bolts into the flange bolt holes and use hooks around the bolts for lifting (rather than tying slings around the flowtube). NEVER PUT ANYTHING THROUGH THE FLOWTUBE TO LIFT IT, SINCE THIS WILL CAUSE DAMAGE TO THE LINING.

After removing flowtube from its shipping carton, inspect it for visible damage. If any damage is observed, notify the carrier immediately and request an inspection report. Obtain a signed copy of the report from the carrier.

AVOID TOUCHING ELECTRODES WITH FINGERS OR MATERIALS THAT CAN CONTAMINATE ELECTRODES. Deposit on electrodes will result in high impedance boundary between electrodes and conductive fluid. If electrodes have been touched, clean them with isopropyl alcohol.

General Precautions

1. Leave end covers installed over flanges any time flowtube is put in storage. Do not cut or remove flowtube lining.

NOTE: In ptfe-lined flowtubes, the white material extending over the flanges is the ptfe lining, not packaging material. DO NOT ATTEMPT TO REMOVE OR CUT THE FLOWTUBE LINING.

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2. Check that cable length between flowtube and transmitter is within limit for specified system accuracy.
3. Good piping practice should be used for the installation of all magnetic flowtubes. Gaskets are recommended. Select a gasket material which is compatible with the process liquid.
4. The flowtube lining extends outward and over the raised face of the flange.

CAUTION: To avoid damage to the lining extension, do not exceed torque values specified when tightening flange bolts.

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5. The flowtube lining (especially polyurethane) is susceptible to damage from excessive heat. Avoid such heat sources (such as welding adjacent piping).

CAUTION: To avoid possible loss of accuracy with a flowtube, it is recommended that the flowtube be connected in a straight section of pipe at least five pipe diameters upstream from the center line of the flowtube and three pipe diameters downstream. The center line of the flowtube is the same location as the electrode location.

To avoid excessive lining wear (especially with ptfe), it is recommended that five pipe diameters of straight section of pipe be connected from the flowtube flange end. If this recommendation cannot be met, it is suggested that a protective device (i.e., grounding ring) be installed on the upstream end of the flowtube.

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6. For flowtubes with polyurethane lining and ac coils, the temperature of the lining can rise above the upper temperature limit if flow is stopped for a period of time and power is left on.

CAUTION: To avoid possible damage to the polyurethane lining from excessively high temperatures, disconnect (turn off) ac power from the coils whenever flow is stopped for more than about one hour.

Lifting Flowtube for Mounting

Care should be taken in lifting the flowtube into the pipeline position required for horizontal or vertical mounting. In order to prevent damage to the flowtube lining, housing, or the tube's structural integrity, it is important to reiterate flowtube handling precautions.

1. Never put anything through the flowtube to lift it.
2. Do not use the housing to support or lift the flowtube. Figure 2 and Figure 3 show correct and incorrect methods for lifting the flowtubes. Note that in Figure 2 (horizontal lifting), the suggested approach is to place the lifting rope between the flange and flowtube body. For vertical lifting, shown in Figure 3, the use of eye bolts in the flange to which the lifting rope is attached is the preferred method. This ensures that the lifting force is applied to the eye bolts as nearly straight upward as possible.

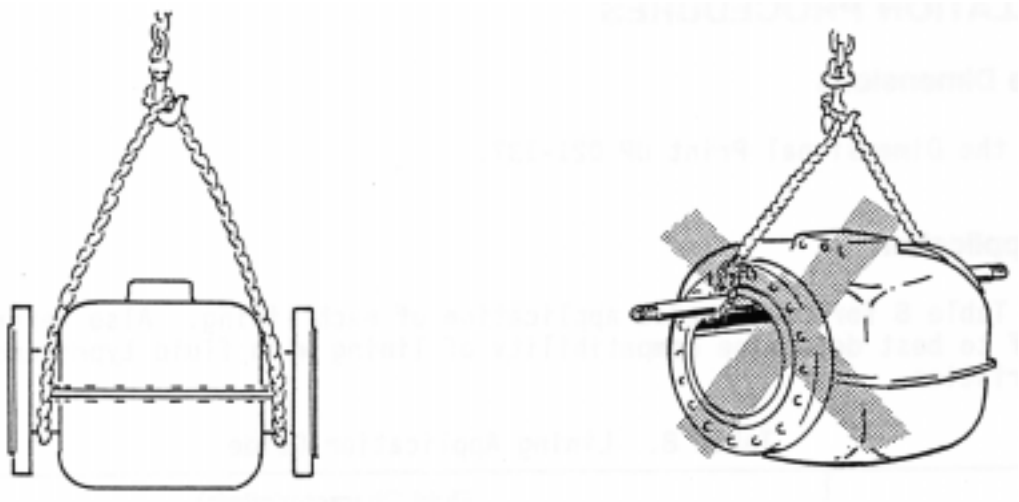

Figure 2. Lifting Flanged Flowtube for Horizontal Mounting (14 to 36 in Size Shown)

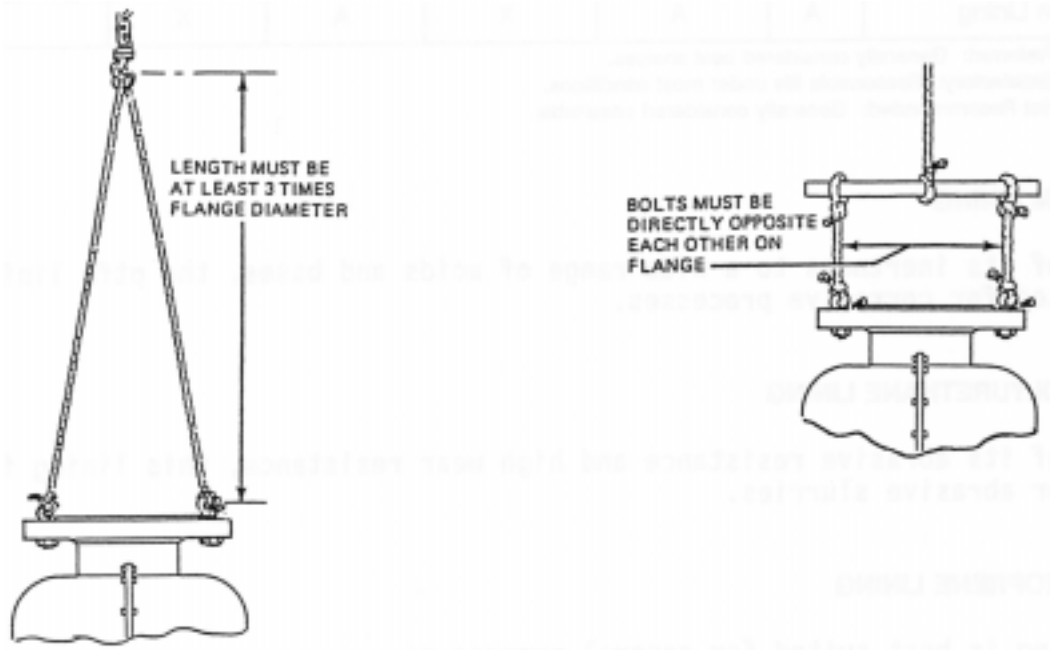

Figure 3. Lifting Flanged Flowtube for Vertical Mounting (14 to 36 in Size Shown)

Installation Procedures

Flowtube Dimensions

Refer to the Dimensional Print DP 021-137.

Lining Application

Refer to Table 8 for recommended application of each lining. Also refer to TI 27-71f to best determine compatibility of lining with fluid types and fluid characteristics.

Table 8. Lining Application Guide

Flowtube Construction	Fluid Characteristic(a)					
	Clean	Mild Corrosion	Severe Corrosion	Mild Abrasion	Severe Abrasion	Mild Corrosion and Abrasion
ptfe Lining	A	A	A	B	X	B
Polyurethane Lining	A	B	X	A	A	B
Neoprene Lining	A	A	X	A	X	A

(a) A = Preferred: Generally considered best choices.
B = Satisfactory: Reasonable life under most conditions.
X = Not Recommended: Generally considered unsuitable.

Use of ptfe Lining

Because of its inertness to a wide range of acids and bases, the ptfe lining is best suited for corrosive processes.

Use of Polyurethane Lining

Because of its abrasive resistance and high wear resistance, this lining is best suited for abrasive slurries.

Use of Neoprene Lining

This lining is best suited for general purpose use.

CAUTION: Do not use hydrocarbon defoamers, such as kerosene or sulfonated oils, with the neoprene lining as they cause neoprene to swell.

Pre-Startup Flowtube Cleaning

If possible, make up a flanged “spool piece” the same length as the flowtube. Insert it in the line before startup. On startup, any foreign objects in the line, such as pieces of wood or metal, should be located and removed before the flowtube is installed. This greatly lessens the possibility of accidental damage to the flowtube. Refer to Table 9 for end-to-end dimensions of the different flowtube sizes.

Table 9. End-to-End Dimensions, Flanged End Connections

Flowtube Size		Flanged End Flowtubes with the Following Linings		
mm	in	ptfe	Polyurethane	Neoprene
350	14	726 mm (28.6 in)	711 mm (28.0 in)	711 mm (28.0 in)
400	16	772 mm (30.6 in)	762 mm (30.0 in)	762 mm (30.0 in)
450	18	879 mm (34.6 in)	864 mm (34.0 in)	864 mm (34.0 in)
500	20	879 mm (34.6 in)	864 mm (34.0 in)	864 mm (34.0 in)
600	24	980 mm (38.6 in)	965 mm (38.0 in)	965 mm (38.0 in)
750	30	–	1067 mm (42.0 in)	1067 mm (42.0 in)
900	36	–	1219 mm (42.0 in)	1219 mm (42.0 in)

Mounting Positions

The flowtube can be mounted in any position: vertical, horizontal, or at an angle, as long as both electrodes are in constant contact with the measured liquid (see Figure 4). However, for accurate measurement, the flowtube must be completely full. Vertical installation with flow in an upward direction, as shown in Figure 5, is generally recommended. This is particularly so in slurries with abrasive solids. If mounting flowtube in other than a vertical position, it is recommended that it be turned about the flow axis shown in Figure 8 so that electrodes are in a horizontal plane. Electrodes should be in a horizontal plane to avoid contacting bubbles (at top) or sediment (at bottom) inside metering flowtube.

NOTE: Figure 5 and Figure 6 also show the recommended length of straight piping upstream and downstream from the center of the flowtube. Five pipe diameters is the upstream length, and three pipe diameters is the downstream length. Refer to the sections that follow for earthing (grounding) and mounting procedures.

Flow through the flowtube can be in either direction. However, if it is installed with the “direction-of-flow” arrow pointing upstream, it will be necessary to reverse the signal wires if used with an E96 Transmitter, or the coil drive wires if used with an 896 Transmitter. Wiring details are given in the System Wiring section of the applicable transmitter installation instructions.

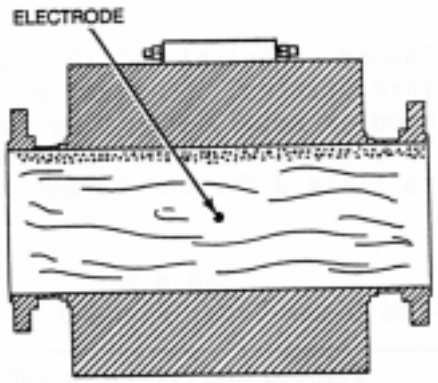

Figure 4. Horizontally Mounted Flowtube Showing Correct Relationship of Electrodes

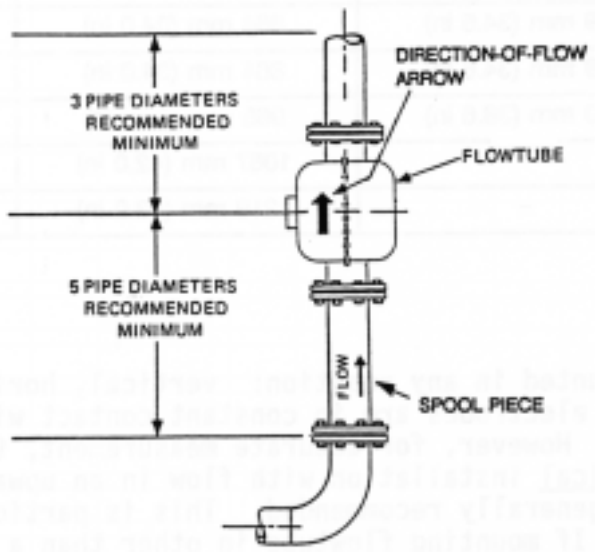

Figure 5. Flanged Body Flowtube Mounted Vertically

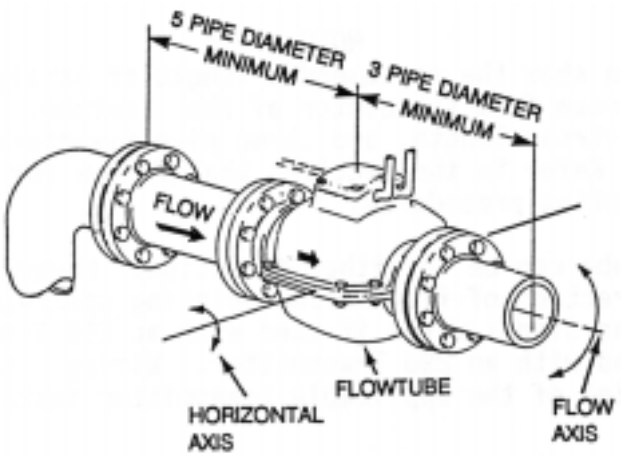

Figure 6. Flanged Body Flowtube Mounted Horizontally

Flowtube Earthing (Grounding)

Continuity between flowing liquid and metal metering tube is required to provide a reference for the measurement signal. With unlined metal pipe connected to the flowtube flange, continuity is provided by the pipe, the flange bolts, and the ground straps. Refer to the System Wiring section of the applicable transmitter installation instructions for earthing (grounding) details between the transmitter, flowtube, and earth.

Installations in which non-metal or lined metal pipe is used require installation of earthing rings (grounding rings) on each flowtube flange as shown in Figure 7. To provide continuity, connect one ground strap to each grounding ring. Ground rings can be made from orifice plates. Inside diameters of the grounding rings should be slightly less than the inside diameter of the flowtube liners. This reduced grounding ring inside diameter will provide positive contact with the process liquid and protect the leading edge of the flowtube liner from abrasives. Refer to Table 10 for the inside diameter of the flowtube liners.

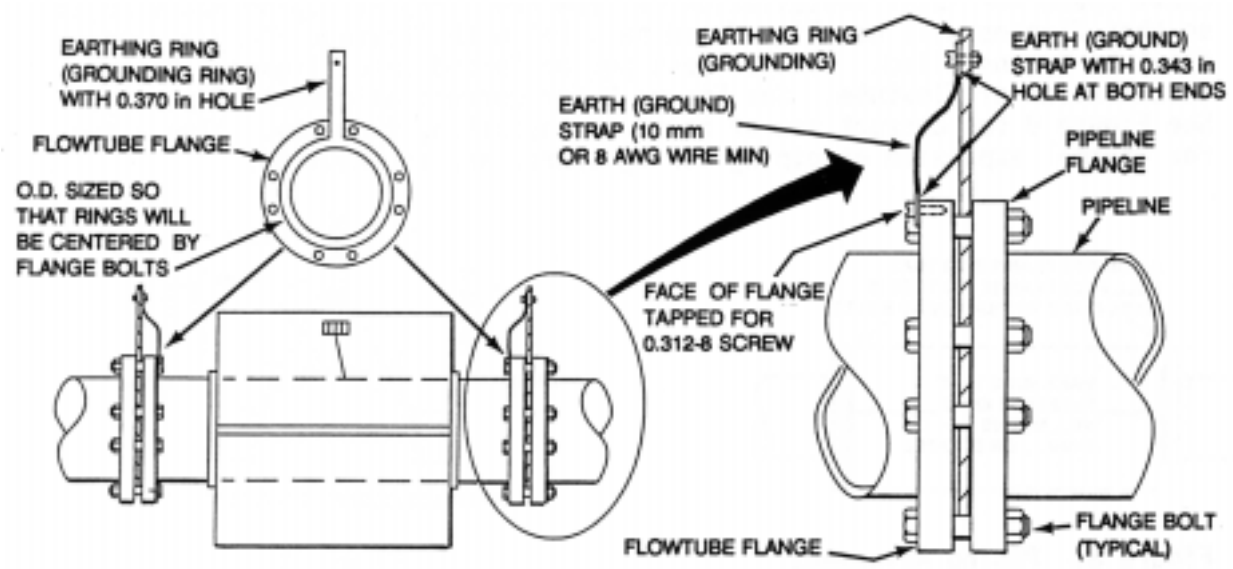

Figure 7. Use of Earthing (Grounding) Rings with Flanged End Flowtubes

Table 10. Flowtube Lining Inside Diameters

Flowtube Size		Inside Diameter of Following Lining					
		ptfe		Polyurethane		Neoprene	
mm	in	mm	in	mm	in	mm	in
350	14	341	13.4	338	13.3	340	13.4
400	16	391	15.4	387	15.3	391	15.4
450	18	441	17.4	438	17.3	442	17.4
500	20	491	19.3	489	19.3	492	19.4
600	24	592	23.3	584	23.0	594	23.4
750	30	N/A	N/A	737	29.0	746	29.4
900	36	N/A	N/A	889	35.0	899	35.4

Mounting Procedure - Flanged End Flowtubes

CAUTION: Excessive forces during installation and operation of flowtube can crush extended ends of flowtube lining. Some causes of these forces are excessive bolt torque, weight of vertical pipeline, thermal expansion of pipeline, and misalignment of flanges. To minimize these forces, adhere to the following procedure.

1. Before installing flowtube, install and adequately support the piping. If flowtube is being mounted vertically, add piping supports above and below flowtube to avoid strain to flanges and to avoid damaging lining. Also, for horizontal mounting, do not rest flowtube on floor as this can cause undue flange alignment and stresses. The pipeline can support the flowtube adequately by merely using piping supports.

   Leave space for later installation of flowtube. Adjust piping and flanges so that flanges will be aligned and parallel with flowtube flanges when flowtube is installed. Flanges must <u>not</u> be forced into alignment during installation of flowtube. See Figure 8 for correct alignment of piping. See Figure 9 for correct use of hoist in installing flowtube. Also allow for thermal expansion of piping during operation, as required.

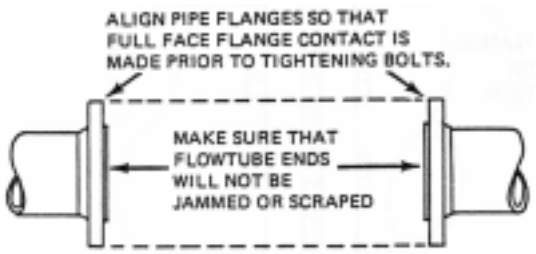

Figure 8. Piping Alignment for Flanged End Flowtube

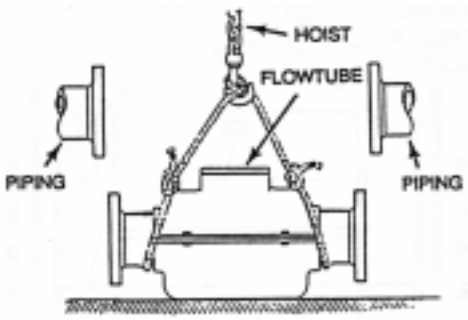

Figure 9. Hoisting Flowtube into Place

CAUTION: Piping supports must be firm enough so that addition of process fluid will not disrupt alignment of flowtube and adjacent piping.

2. Locate and remove all foreign objects from the piping. If possible, make up and install a section of pipe (spool piece) in the space provided for the flowtube. Start up the process to help locate any foreign objects.
3. To install the flowtube into the pipeline, proceed as follows:
   a. Hoist flowtube into place (see Figure 9).
   b. Refer to Figure 10. Spring back piping to allow clearance as necessary to insert flowtube without causing damage to lining.
   c. Install gaskets and grounding rings (as applicable) adjacent to flowtube flanges. (For details of grounding rings, see "Flowtube Earthing" section.)
   d. Align flanges, install bolts, and position piping into place.
   e. Tighten flange bolts alternately and uniformly to torque values given in Table 11.

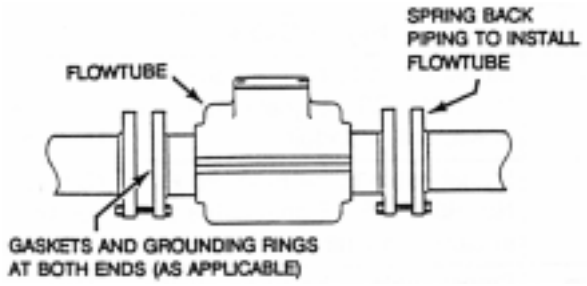

Figure 10. Installing Flowtube into Pipeline

Table 11. Flange-Bolt Torque Values for Flanged-End Flowtubes

Flowtube Size		Number of Bolts in Flange	Flange-Bolt Torque for All Linings	
mm	in		N•m	lb•ft
350	14	12 16	135 110	100 80
400	16	16	135	100
450	18	16 20	170 135	125 100
500	20	20	170	125
600	24	20	200	150
750	30	24 28	200 200	150 150
900	36	28 32	240 240	175 175

Cable Length and Process Fluid Conductivity

With the 896 (Pulsed dc) Transmitter

The maximum allowable cable length is a function of the cable type, process fluid conductivity, and whether the cables are in the same or separate conduits. Standard system accuracy (896 Transmitter with the 2800 Series Flowtubes) will be maintained when the installations are in accordance with Table 12.

Table 12. Maximum Cable Length vs. Fluid Conductivity for 2800 Series Flowtube with 896 Transmitter

Maximum Cable Length		Minimum Fluid Conductivity	Signal and Coil Driver Cable Description	
m	ft		Signal Cable	Driver Cable
300	1000	5 µS/cm	Signal cable to be Foxboro Part No. R0101ZS. Signal cable to be in separate conduit.	Driver cable consists of two 2.5 mm^2 or 14 AWG wires. Driver cable to be in separate conduit.
225	750	5 µS/cm	Signal cable to be Foxboro Part No. R0101ZS. Signal cable to be in same conduit as driver cable.	Driver cable consists of two 2.5 mm^2 or 14 AWG wires. Driver cable to be in same conduit as signal cable.
150	500	20 µS/cm	Signal cable to be good quality twisted shielded pair, preferably no smaller than 1.0 mm^2 or 18 AWG for mechanical considerations.(a) Signal cable may be in same conduit as driver cable.	Driver cable consists of two 2.5 mm^2 or 14 AWG wires. Driver cable may be in same conduit as signal cable.

(a) Belden 8760 or 9318, Alpha 5610/1801 or 5611/1801, or equivalent.

With E96 (ac) Transmitter

Using the graph in Figure 11, the maximum signal-cable length for specified system accuracy (E96 Transmitter with 2800 Series Flowtube) can be determined. Note that the graph is valid only for Foxboro cable, Part No. R0101ZS, or Foxboro cable and connector assembly, Part No. N0136CC (used with E96 Transmitter only). Maximum cable length depends on size of flowtube, conductivity of liquid, and type of instrument to which flowtube is connected.

Example:

Determine the maximum permissible signal-cable length for a 350 mm (14 in) flowtube to be used with an E96 Transmitter if the process fluid has a conductivity of 2800 µS/m (28 µmho/cm).

Refer to dotted lines on graph below.

a. Draw a vertical line at a fluid conductivity of 2800 µS/m (28 µmho/cm) intersecting the flowtube reference line.

b. From this intersection, draw a horizontal line to the E96 Transmitter standard performance line.

c. From this intersection, draw a vertical line to the cable length scale where approximately 130 ft (40 m) is read.

NOTE: The graph can be used to solve the above problem in reverse, using a desired cable length of 40 m (130 ft) with a 350 mm (14 in) flowtube to determine minimum conductivity of 2800 µS/m (28 µmho/cm) at specified system accuracy.

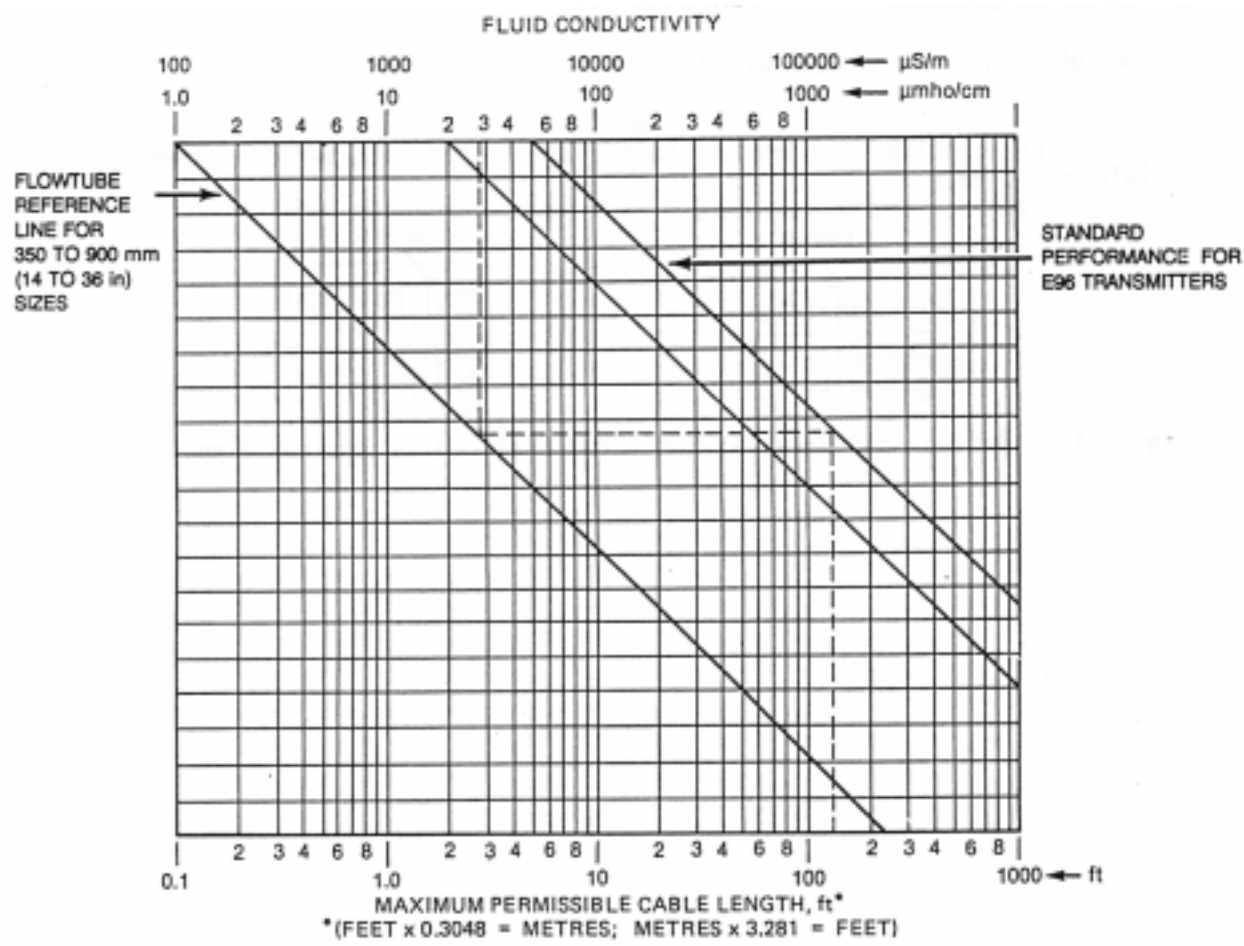

Figure 11. Maximum Signal Cable Length vs. Fluid Conductivity of E96 Transmitter with 2800 Series Flowtube

Flowtube Field Coil Connections

For ac Systems

The flowtube coils may be wired either in series or in parallel as shown in Figure 12. Refer to data plate for voltage, coil connections, and mV/factor.

Table 13 defines the use of transmitter terminals 1, 2, and GND for both E96 and 896 Transmitters.

Table 13. Transmitter Terminals 1, 2, and GND

Transmitter Model	
E96 Transmitter (ac)	896 Transmitter (pulsed dc)
1 = Live 2 = Neutral GND = Power Earth (Ground)	1 = C1 2 = C2 GND = Connect to Earth (Ground) or to Transmitter Earth (Ground) Terminal

For Pulsed dc Systems

The flowtube coils are always wired in series as shown in Figure 12.

NOTE: Again, all dc pulsed 896 Transmitters must be used with series-connected field coils only.

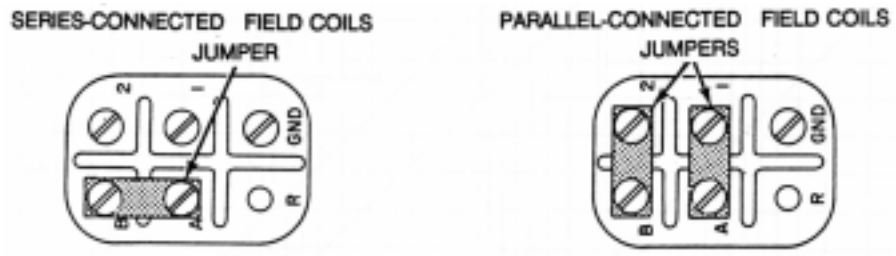

Figure 12. Series- and Parallel-Connected Field Coils Showing Jumper Position

Transmitter Installation and System Wiring

Transmitter installation and system wiring (flowtube and transmitter) are described in the applicable transmitter installation instructions. Refer to the “Reference Documents” section for the applicable transmitter document.

Maintenance

If a fault is suspected in the flowtube, first make exterior checks for wire continuity and rusted or corroded flanges, flange bolts, and/or ground straps. Rusted flanges, ground straps, and/or bolts can result in a poor process earth (ground). Use ultrasonic cleaner or low-voltage cleaning procedure, if the flowtube is so equipped, to clean electrodes.

If it becomes necessary to clean flowtube, avoid damaging the tube interior. Do not exceed temperature or pressure limits of flowtube.

System fault location and maintenance information are described in the instruction book shipped with the applicable transmitter. For flowtube parts, refer to the applicable flowtube parts list in the “Reference Document” section.

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