INSTALLATION, OPERATION and MAINTENANCE MANUAL

Model RF83
Flow Switch/Monitor

Doc. No. 003147 **Rev. B**

U.S. Patent Numbers 3,898,638 and 4,449,403

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Appendix C contains a detailed explanation of the FCI customer service policy on returns, adjustments, in-field or factory repair, in- or out-of-warranty.

Reserved for Domestic Rep Map

Reserved for International Rep Map

Contents

Figures

Tables

Symbols

The following symbols are used throughout the manual to draw attention to items or procedures that require special notice or care.

Warning: Warns of possible **personal danger** to those handling the equipment.

Caution: Cautions against possible **equipment damage**.

Note: Contains important information.

1. General Information

Description

This document explains the operating principle of the Model RF83 Flow Switch. The following pages also present the recommended procedures for the installation, operation, maintenance, and troubleshooting of the Model RF83.

The Model RF83 is an instrument that is capable of detecting bi-directional liquid or gaseous flow environments. The instrument has field adjustable alarm set points for control of the media.

Flow Element

The operational parts of the flow element are the sensing points. The sensing points consist of four thermowells (hollow tubes). There is two pair of thermowells welded together. The thermowell pairs have a heater in one thermowell and a Resistance Temperature Detector (RTD) in the other thermowell. The thermowell pairs (sensing points) are placed on opposite sides of a flow media barrier. There is a baffle placed around the sensing points to direct the flow across the up-stream sensing point. As the flow media flows from sensing point B to sensing point A (as shown in Figure 1-1) the flow media removes heat from the up-stream, heated RTD. There is no effect on the heated RTD A. A delta R (DR) exists between the two RTD's that the electronics measures. If the flow reverses RTD A looses heat and not RTD B.

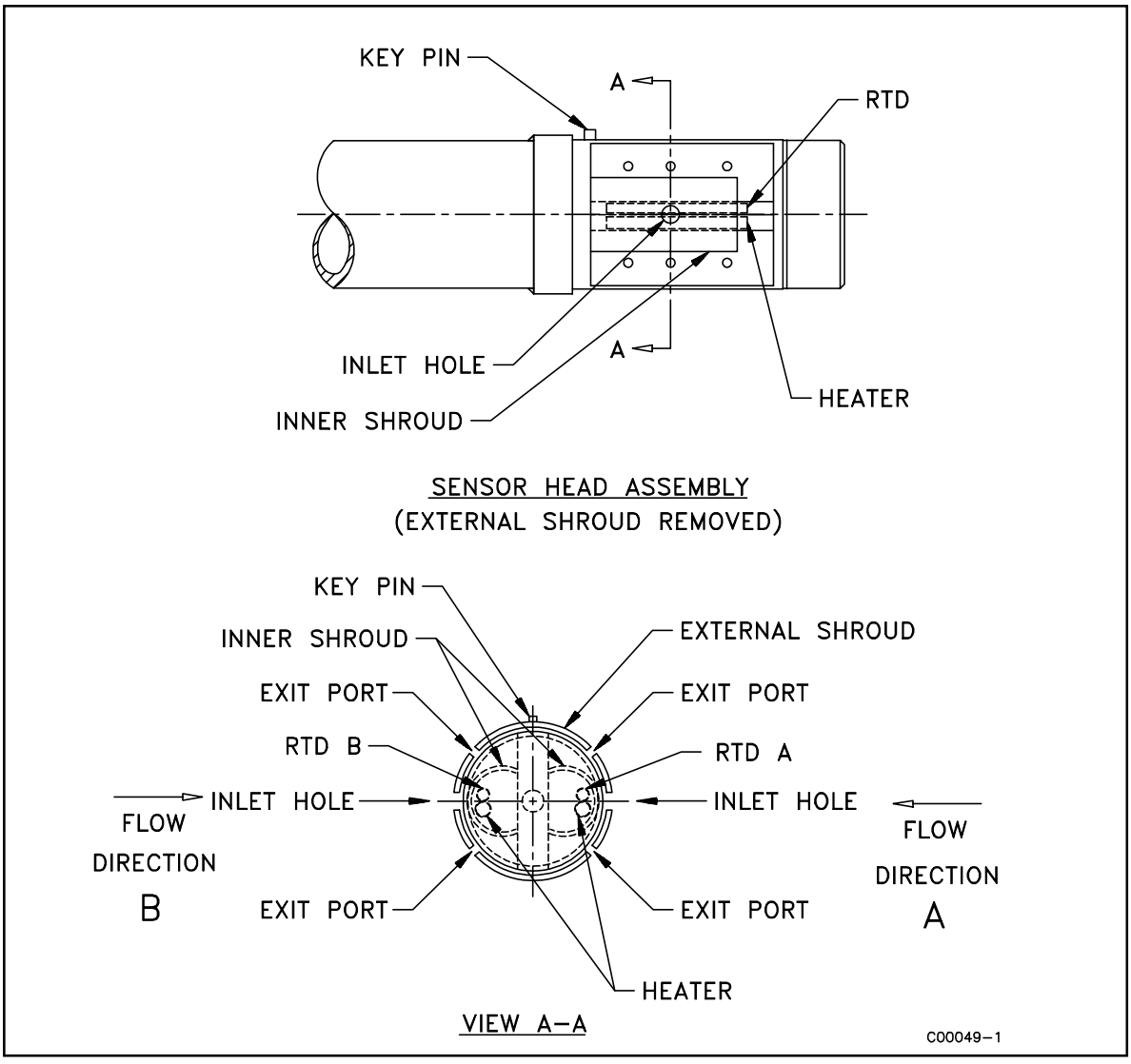


Figure 1-1. Process Installation Showing the Sensing Point

Control Circuit

The basic functions of the control circuit are to provide power to the flow element, measure the DR between the two RTDs, condition the sensing point signals, and provide relay alarm contacts for customer uses.

Single pole double throw (SPDT) or double pole double throw (DPDT) relays are available in the instrument for connections to the customer alarm systems. The relay outputs can be set for either open or closed contacts when there is either flow or no flow of the process media.

The place where the relays change state will vary depending on the type of media as well as air or liquid turbulence. Therefore the instrument has field adjustable alarm set points.

Specifications

- **Process Connections:**

  1 inch male NPT, 1-1/4 inch male NPT, or larger flanged connections.

- **Insertion Length:**

  2 inch (50mm) U-length, standard. Customer specified U-length optional.

- **Material of Construction:**

  All wetted surfaces are 316 series stainless steel with nickel braze per process specifications AMS 4777. Optional wetted surface material customer specified.

- **Alarm Set Points:**

  Setable to any value within the indicated flow range. 5mV hysteresis. All units are preset with set-points at mid-range in water. Factory certified alarm set points available.

- **Time Response:**

  5 to 150 seconds.

- **Flow Rate:**

  From: 1 - 40 f/s (.3 - 12m/s) in air
  To: .05 - .5 fps (.15 - 150 mm/s) in water.

- **Electrical Connection:**

  1 inch female NPT

- **Relay Rating:**

  SPDT contacts rated at 6A at 115 Vac or 24 Vdc resistive, relay coil de-energized at no-flow (standard option). Optional contact and/or coil arrangements are customer specified.

- **Power Input:**

  100-132 Vac, 50/60 Hz, 6 watts maximum (standard option). 24 Vac. 24 Vdc or 230 Vac are customer specified.

- **Electrical Enclosure:**

  Electrical components mounted in a NEMA 7 BCD electrical enclosure. NEMA 4 and NEMA 4X enclosures customer specified.

- **Operating Temperatures:**

  Flow element: -100° to +350°F (-73° to +177°C).
  Control circuit: -40° to +140°F (-40° to +60°C).

- **Operating Pressure:**

  To 4000 psig (276 bar).

- **Options:**

  Retractable probe and packing gland assemblies.

- **Approvals:**

  FM, CSA, CENELEC, JIS and SAA for hazardous locations.

2. Installation

Receiving/Inspection

- Unpack carefully.
- Verify that all items in the packing list are received and are correct.
- Inspect all instruments for damage or contaminants prior to installation.

If the above three items are satisfactory, proceed with the installation. If not, then stop and contact a customer service representative.

Packing/Shipping/Returns

These issues are addressed in Appendix C - Customer Service

Required Materials

Appropriate wire, cable, conduit, and a mating flange on the vessel.

Note: Potting Y's for all the interconnecting wires are recommended when installing the instrument. Other requirements may vary based on local wiring codes. An appropriate mating surface on the vessel is also required.

Pre-Installation Procedure

Warning: Only qualified personnel should install this instrument. Install and follow safety procedures in accordance with the current National Electrical Code. Ensure that power is off during installation. Any instances where power is applied to the instrument will be noted in this manual. Where the instructions call for the use of electrical current, the operator assumes all responsibility for conformance to safety standards and practices.

Caution: The instrument is not designed for weld-in-place applications. Never weld to process connection or a structural support.

Damage resulting from moisture penetration of the local or remote (optional) enclosure is not covered by product warranty.

The control circuit contains electrostatic discharge (ESD) sensitive devices. Use standard ESD precautions when handling the control circuit. See below for ESD details.

Use Standard ESD Precautions

Use standard ESD precautions when opening an instrument enclosure or handling the level transmitter. FCI recommends the use of the following precautions: Use a wrist band or heel strap with a 1 megohm resistor connected to ground. If the instrument is in a shop setting there should be static conductive mats on the work table and floor with a 1 megohm resistor connected to ground. Connect the instrument to ground. Apply antistatic agents to hand tools to be used on the instrument. Keep high static producing items away from the instrument such as non-ESD approved plastic, tape and packing foam.

The above precautions are minimum requirements to be used. The complete use of ESD precautions can be found in the U.S. Department of Defense Handbook 263.

Verify Serial Numbers (For Remote Applications Only)

Verify that the flow element serial number matches the control circuit serial number. A tag indicating the serial number is located on the local and remote enclosures. The serial number is also found on the control circuit.

Verify Installation Location

Prepare the vessel for installation, or inspect the already prepared location to ensure that the instrument will fit into the system. Prepare the necessary sealants or gaskets to provide a leakproof installation for the application if required. The location that should have been prepared at the time of order should be at least 20 pipe diameters downstream and 20 pipe diameters upstream from any bends or interference in the process pipe or duct to achieve the greatest accuracy.

Flow Element Installation

Install the flow element in the process piping at the desired location. FCI recommends that the A side of the flow element be placed so it is on the up-stream side of the normal flow direction. Verify that the flat area machined into the flow element is flat, up and level. The flat is machined on the flow element near where it is screwed into the enclosure. "FLAT UP & LEVEL" is also etched on the flat surface.

Threaded Mounting

Apply a lubricant/sealant compatible with the process to all threads. Use a pipe wrench for 1-1/4 inch (32mm) NPT and larger connections (including exotic materials of construction), or an open-end wrench for 1-1/4 inch (32mm) NPT and smaller connections. All connections should be tightened firmly. To avoid leaks, do not overtighten or cross-thread connections. The figures in Appendix A and Figure 2-1, show this configuration.

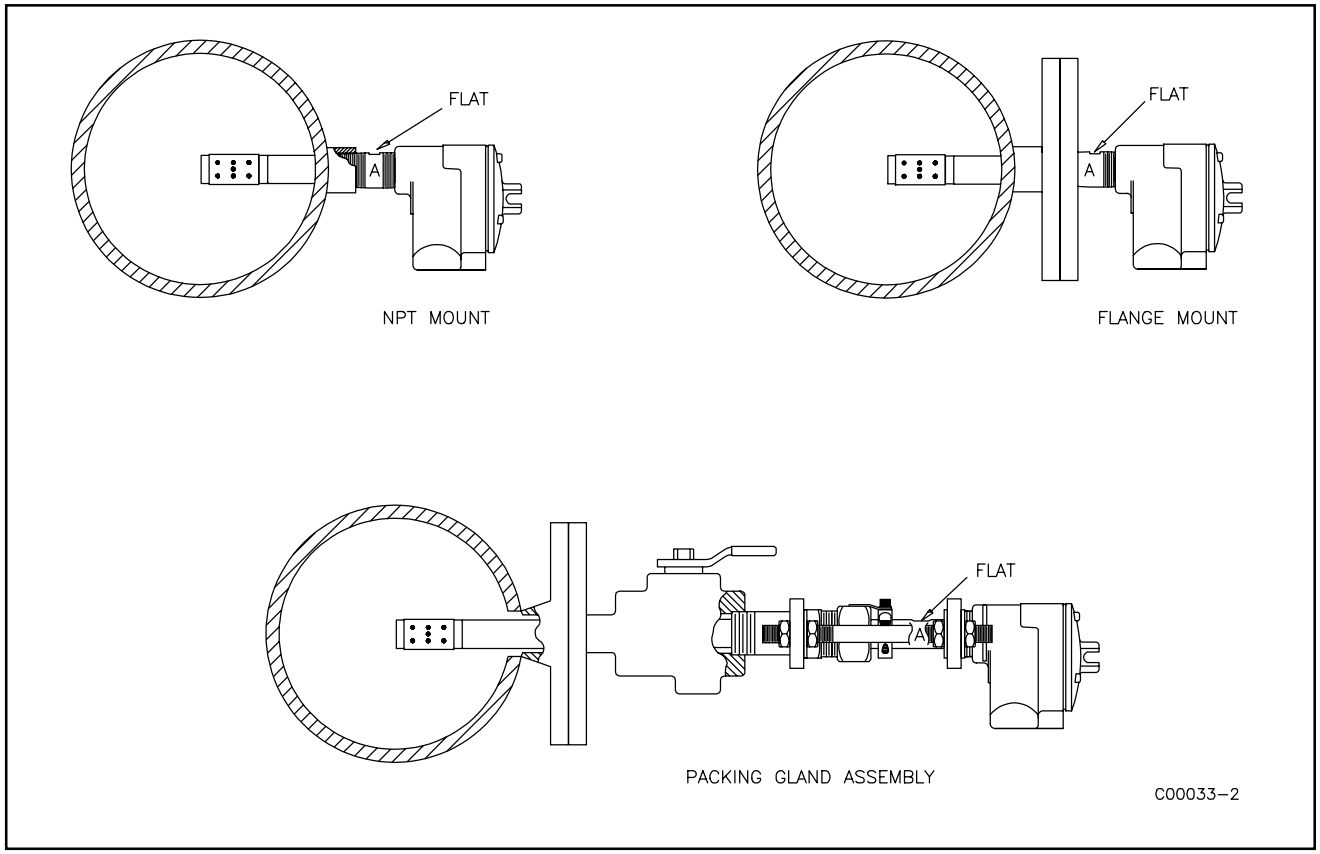


Figure 2-1. Pipe, Flange and Packing Gland Assemblies

Flanged Mounting

As appropriate, use flange-face gaskets and sealants that are compatible with the process. Use the correct size mounting bolts and tighten firmly. See Figures 2-1 and Appendix A for the mounting details.

Packing Gland Assembly

If used, the customer supplies a ball valve with the appropriate connection. Follow the threaded or flanged mounting procedure as applicable.

Hand tighten the packing nut until the internal packing material is tight enough to prevent process media leakage, but not enough to prevent the flow element shaft from sliding.

If used, open the valve. Check for process media leakage. Push or jack the flow element into the process pipe. Tighten the packing nut 1/2 to 1 turn, torque to approximately 65 - 85 ft-lbs (88 to 115 N·m).

Rotate the split-ring locking collar to lineup with the connecting strap welded to the packing nut. Tighten two 1/4-28 hex socket cap screws on the split-ring locking collar. See Figures 2-1 and Appendix A for mounting details.

Control Circuit Installation

The standard configuration (see Appendix A, Figure A-7) of the instrument is with the control circuit already installed in the local enclosure (the control circuit is physically mounted with the flow element). If the application requires an optional remote operation (an operation where the control circuit is mounded separately from the flow element), then continue with the following instructions.

Select a location for the remote enclosure within a 1000 feet (305 m) of the flow element. This location should be easily accessible with enough room to open the remote enclosure. Secure the remote enclosure solidly to a vertical surface capable of providing support. Use appropriate hardware to mount the remote enclosure. The outline dimensions of a typical remote enclosure is shown in Appendix A.

Wiring Installation

Conduit Routing

All socket and/or terminal block connections are to be made through the 1 inch female NPT openings in the enclosure(s). FCI strongly recommends that all electrical cables be run through an appropriate conduit for the protection of the instrument and personnel.

Protection of the control circuit from moisture is an important consideration. Keep the entry of the conduit into the enclosures in the downward direction so condensed moisture that collects in the conduit will not drain into the enclosure. The local enclosure may be turned not more than 180° using the threads on the flow element stand pipe to gain an acceptable orientation. In addition, FCI recommends sealing off the conduit with a potting Y or other sealing method to prevent moisture from entering the enclosure.

Minimum Wire Size

Table 2-1 shows the smallest (maximum AWG number) copper wire that is to be used in the electrical cables used for connecting the instrument to the customer alarms and power. Use a lower gauge of wire for less of a voltage drop. Contact FCI concerning greater distances than those listed in the table.

Table 2-1. Interconnecting Cable Size (AWG)

Connection	Maximum Distance for AWG					
	10 ft. (3m)	**50 ft. (15m)**	**100 ft. (31m)**	**250 ft. (76m)**	**500 ft. 152m)**	**1000 ft. (305m)**
AC Power	22	22	22	20	18	16
Relay (2A)	28	22	20	16	12	10
Relay (10A)	22	16	12	8	6	Not Recommended
Flow Element Wires for Remote Option*	24	24	24	22	22	18
*Requires a shielded cable which is connected to the control circuitry terminal block.						

Cable Connections

Caution: In order to prevent circuit or component damage, remove the signal conditioner from the remote enclosure (if present) prior to the pulling of conduit wire.

Note: The installation of an AC line switch between the AC power source and the instrument is recommended. This facilitates easy power disconnection and is an added safety feature.

Connect the cable wires per the applicable wiring diagram in Appendix A. Use the tag found on the instrument or packing list to match the control circuit description with the modules that call out the wiring diagrams. The modules are also found in Appendix A. The part of the tag description that denotes the control circuit is found between two forward slashes (/...../) and starts with a circuit board name, e.g. /0018-...../. The code that follows corresponds to the modules. The lack of a full code denotes that the control circuit has a standard configuration. Standard configurations are denoted on the modules with the abbreviation STD.

The cable used to connect the flow element to the control circuit must be shielded. The shield drain wire is terminated at the control circuit socket (terminal 7). The other end of the shield is left floating (no connection to the terminal block). The standard cable provided has a shield and is 22 AWG wire.

Connect the relay outputs to the customer alarms. Also connect the power to the instrument power input. See Appendix A for the appropriate connection information.

3. Operation

Caution: The control circuit contains electrostatic discharge (ESD) sensitive devices. Use standard ESD precautions when handling the control circuit. See Chapter 2, Installation for ESD details.

Factory Calibrations

The RF83 Flow Switch is delivered in its standard factory set point form unless a custom factory calibration was specified. The standard factory setting is mid-range between no flow and full flow. See Figures 3-1 and 3-2.

If the order included custom factory calibrations and alarm set points, keep all settings unchanged. The instrument is ready for service without changes.

Field Calibrations for Flow Applications

If the factory calibrations were not ordered then follow one of the procedures below based on the particular instrument purchased. If precise measurement is desired, FCI recommends that a FM71 Monitor/Calibrator be used. Then the precise measurement of the signal voltage versus flow rate can be calculated for the alarm set points.

Alarm Set Point Adjustments By Observation or By Measurement

Alarm set points can be adjusted by observation or by precision measurements. The following procedure is adjustment by observation. If adjustment by measurement is desired, obtain an FCI FM71 Calibrator/monitor and follow the instructions found in the FM71 manual. For the highest accuracy,balancing the control circuit and creating a calibration curve should be performed. These subjects are addressed later in this chapter.

Alarm A Set Point Procedure

1. Flow the pipeline at the desired flow direction and rate of flow.
2. Apply power to the instrument and allow 15 minutes for the sensing elements to become active and stabilize.
3. Locate the potentiometer (R5) and the red LED on the control circuit. (See Figure 3-3 or 3-4.)
4. Choose A or B.

A. Detecting No Flow or Decreasing Flow Rate

If the LED is off, turn the potentiometer clockwise until the LED turns on. If the LED is on, turn the potentiometer counterclockwise until the LED turns off, then turn the potentiometer clockwise until the LED just turns on. With the LED on, turn the potentiometer slowly counterclockwise until the LED just turns off. Turn the potentiometer one-half turn past the point at which the LED just turns off. Be aware that the potentiometer may have up to one quarter turn of hysteresis. If the mark is overshot, the procedure should be repeated. See Figures 3-1and 3-2 for potentiometer position and curve results.

B. Detecting Maximum Flow or Increasing Flow Rate

If the LED is on, turn the potentiometer counterclockwise until the LED turns off. If the LED is off, turn the potentiometer clockwise until the LED turns on, then turn the potentiometer counter clockwise until the LED just turns off. With the LED off, turn the potentiometer slowly, clockwise until the LED just turns on. Turn the potentiometer one-half turn past the point at which the LED just turns on. Be aware that the potentiometer may have up to one quarter turn of hysteresis. If the mark is overshot, the procedure should be repeated. See Figures 3-1 and 3-2 for potentiometer position and curve results.

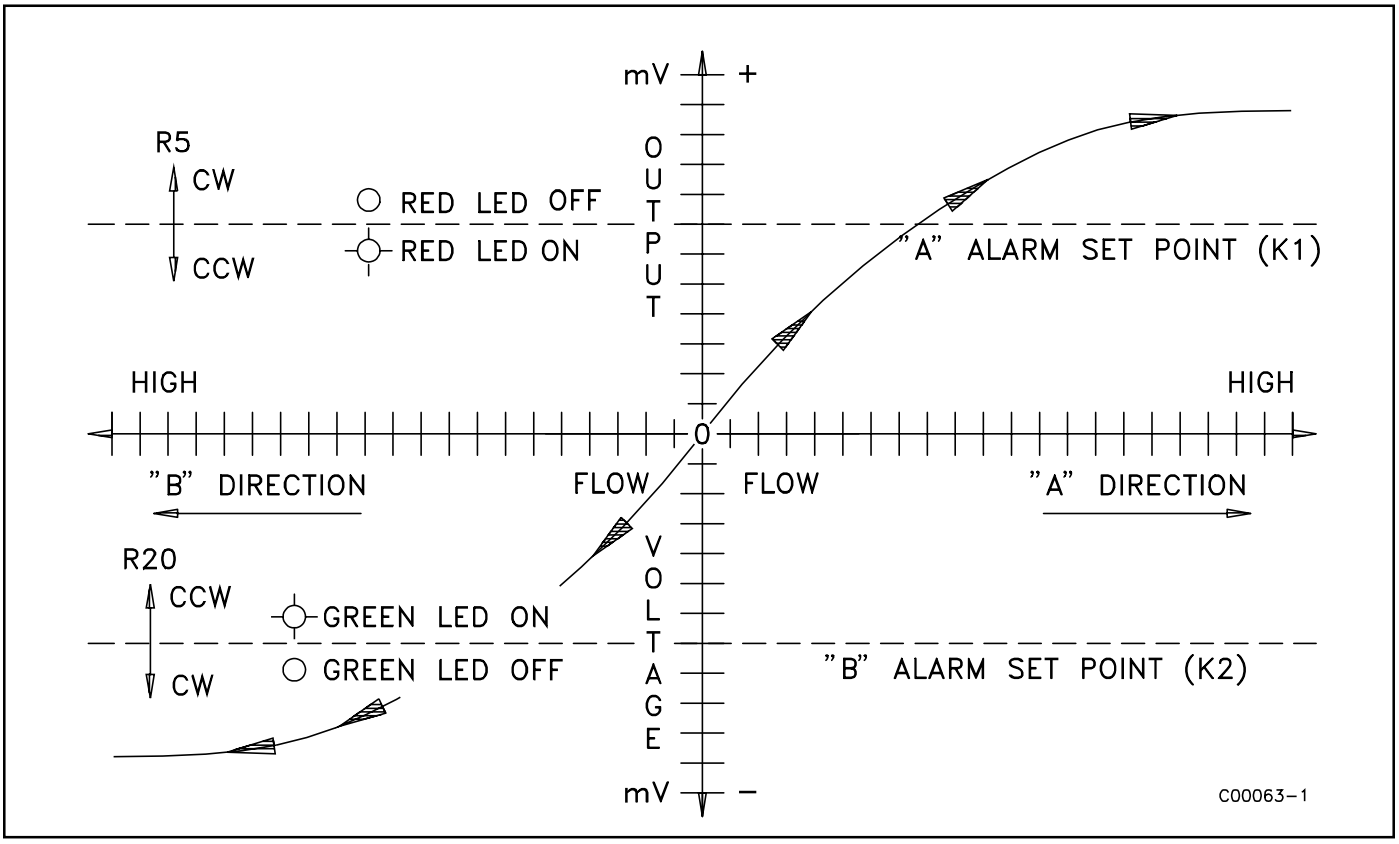


Figure 3-1. Setting Forward and Reverse Alarm Switch Points

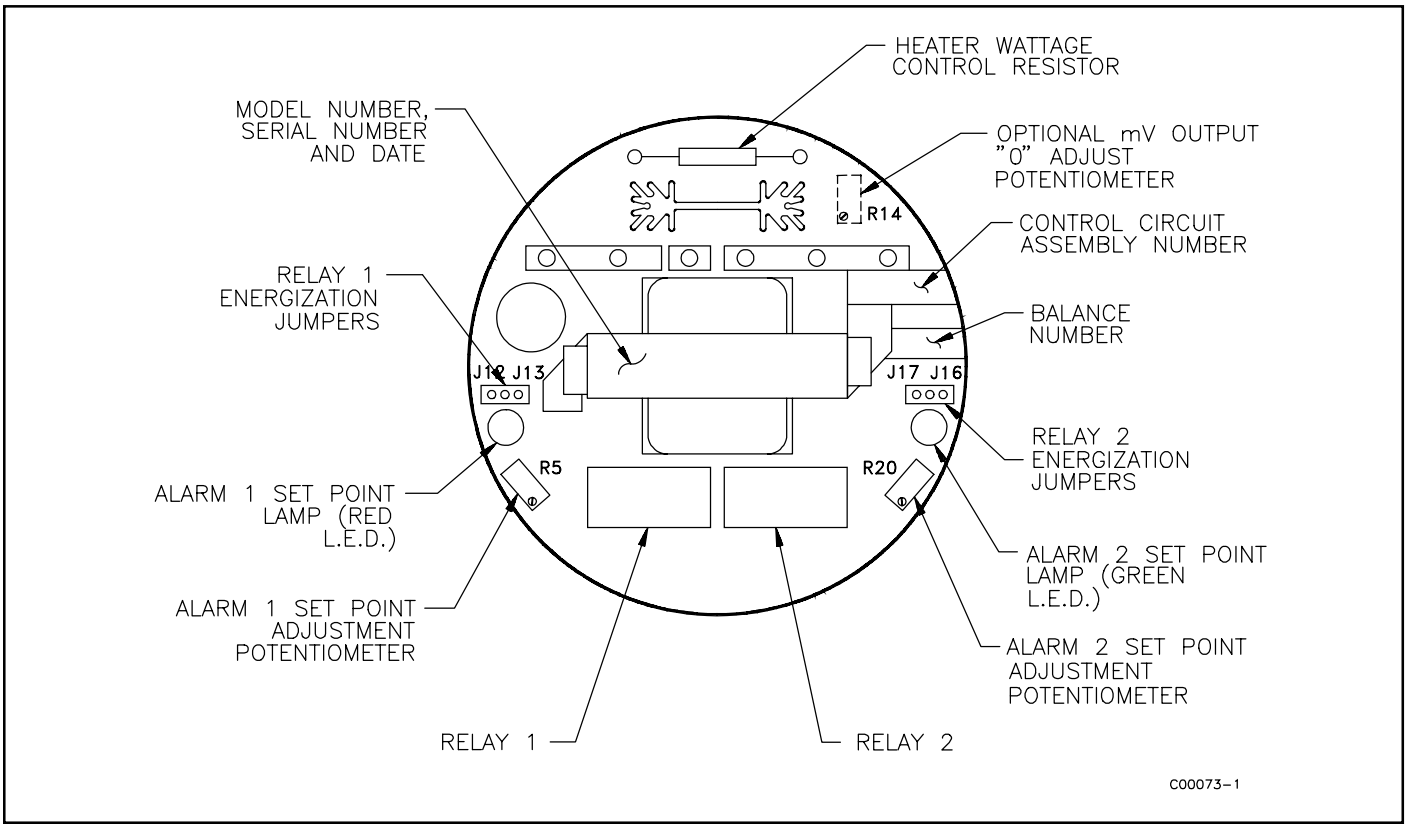


Figure 3-2. Control Circuit Outline Drawing

Alarm B Set Point Procedure

1. Flow the pipeline at the desired reverse rate of flow.
2. Apply power to the instrument and allow 15 minutes for the sensing element to become active and stabilize.
3. Locate the potentiometer (R20) and the green LED on the control circuit. See Figure 3-1 for the potentiometer location.
4. Choose A or B.

A. Detecting Reverse No Flow or Reverse Decreasing Flow Rate

If the LED is off, turn the potentiometer clockwise until the LED turns on. If the LED is on, turn the potentiometer counterclockwise until the LED turns off, then turn the potentiometer clockwise until the LED just turns on. With the LED on, turn the potentiometer slowly counterclockwise until the LED just turns off. Turn the potentiometer one-half turn past the point at which the LED just turns off. Be aware that the potentiometer may have up to one quarter turn of hysteresis. If the mark is overshot, the procedure should be repeated. See Figures 3-1 and 3-2 for potentiometer position and curve results.

B. Detecting Maximum Flow or Increasing Flow Rate

If the LED is on, turn the potentiometer counterclockwise until the LED turns off. If the LED is off, turn the potentiometer clockwise until the LED turns on, then turn the potentiometer counter clockwise until the LED just turns off. With the LED off, turn the potentiometer slowly, clockwise until the LED just turns on. Turn the potentiometer one-half turn past the point at which the LED just turns on. Be aware that the potentiometer may have up to one quarter turn of hysteresis. If the mark is overshot, the procedure should be repeated. See Figure 3-1 and 3-2 for potentiometer position and curve results.

BALANCING

The balance number is the resistance difference between the two RTDs (A and B) when the heaters are disconnected. The balance number is recorded on the edge of the control circuit on a white block with the lettering "BALANCE NO." written above it.

Generally it is not necessary to obtain the balance number for an application which requires only a switch. However, for detecting flow direction a precise balance is required since either a small positive or negative voltage output is used as the indicator.

Balancing is usefull to obtain a calibration curve for the instrument, it is essential to balance the control cirucit. The accuracy of the calibration is dependent on an accurate balance number. Balancing is also needed if the instrument switch points are going to be adjusted by numerical values.

Balance the instrument when the balance number can not be found or if the accuracy seems to be incorrect.

Delta R, the difference between the sensor A and sensor B RTDs is used for balancing. Balancing the voltage (Ohm's law V=I x R) to zero is accomplished by making the difference between the two RTDs zero.

Determining The Balance Number:

Setup Required

FCI FM71D Calibrator

Sensor immersed in process media at zero flow

Power source to power up the switch circuit board

1. Verify the sensor mounting in the process line is correct. Insure there is a no-flow condition in the process line.
2. Verify the correct wiring configuration and then disconnect the heater circuits.
3. Connect the FM71D calibrator (terminal 7,8 and 9 which is labeled on the FM71D calibrator) to the control circuit, apply power to the instrument.

5. Dial the bridge balance dial to the balance number on the control circuit.
6. Allow the FM71D display to stabilize (at least 10 minutes) at a certain millivolt (the voltage may vary +/-1 mV). If the reading is zero, balance is OK and FM71 may be removed and heaters reconnected. If the reading is not zero, a new balance number must be generated by the following steps:
7. Dial the bridge balance dial to produce a zero on the FM 71D calibrator readout. The number should be stable over a 10 minute period (it may vary +/- 1 mv).
8. Read the new balance number of the bridge balance dial and record it on the face of control circuit.

Note: The balance number is not permanently fixed into the instrument. When the calibrator is used for that same instrument, then re-enter the balance number recorded earlier. It is necessary to enter the balance number or verify the balance of the circuit board to the calibrator each time the FM 71D is used.

Creating a Calibration Curve Using the Millivolt Output Option

The zero adjust procedure should be performed before the instrument calibration curve is measured. Millivolt points in between the actual measurement points may be used for indicating the corresponding flow.

1. Apply power to the instrument and establish a constant flow rate in the pipe for the first data point to be taken. Let the instrument stabilize for 10 minutes.
2. With a high impedance DMM measure the voltage from terminal pin 8 (+) to 11 (-). Record the flow rate versus the meter readout.
3. Repeat steps 1 and 2 at different flow rates. Record enough flow points to be able to make a millivolt versus flow curve.

Creating a Calibration Curve Using an FM71 Calibrator

1. Apply power to the instrument and establish a constant flow rate in the pipe for the first data point to be taken. Let the instrument stabilize for 10 minutes.
2. Attach an FM71 meter to the control circuit. Dial in the balance number found near the edge of the control circuit. The read out /calib. switch should be in the readout position. Record the flow rate versus the meter readout.
3. Repeat steps 1 and 2 at different flow rates. Record enough flow points to be able to make a millivolt versus flow curve.

To set a switch point using numerical values, use the instructions that come in the FM71 manual.

4. Maintenance

Warning: To avoid hazards to personnel, ensure that all environmental isolation seals are properly maintained.

Caution: The control circuit contains electrostatic discharge (ESD) sensitive devices. Use standard ESD precautions when handling the control circuit. See Chapter 2, Installation for ESD details.

The instrument requires very little maintenance. There are no moving parts or mechanical parts subject to wear.

Maintenance

Without detailed knowledge of the environmental parameters of the application, surroundings, and process media, FCI cannot make specific recommendations for periodic inspection, cleaning, or testing procedures. However, some suggested general guidelines for maintenance steps are offered below. Use operating experience to establish the frequency of each type of maintenance.

Alarm Set Point Verification

Periodically verify the alarm set point(s).

Enclosures

Periodically verify that the moisture barriers and seals of the local and/or remote enclosures are adequate and that no moisture is entering the enclosure(s).

Electrical Wiring

Periodically inspect the power, flow element, and output wiring for signs of corrosion or deterioration.

Electrical Connections

Periodically inspect wire connections on the socket and terminal block (if present). Verify that terminal connections are tight and physically sound with no sign of corrosion.

Process Connection

Periodically verify that all seals are performing properly and that there is no leakage of the process media. Check for deterioration of the gaskets and environmental seals used.

Flow Element

Periodically remove the flow element for inspection based on historical evidence of debris, foreign matter, or scale buildup and appropriate plant shutdown schedules and procedures. Check for corrosion, stress cracking, and/or buildup of oxides, salts, or foreign substances. The heater and RTD thermowells must be free of excessive contaminants and be physically intact. Any debris or residue buildup could cause inaccurate switching. Clean the flow element, as necessary, with a soft brush and available solvents (compatible with stainless steel).

5. Troubleshooting

Warning: Only qualified personnel should attempt to test this instrument. The operator assumes all responsibilities for safe practices while troubleshooting.

Caution: The control circuit contains electrostatic discharge (ESD) sensitive devices. Use standard ESD precautions when handling the control circuit. See Chapter 2, Installation for ESD details.

Tools Needed

Digital Multimeter (DMM)

Quick Check

Check the jumper positions of J12, J13, J16 and J17. Jumper J12 and J17 energize the relays at flow or wet. Jumpers J13 and J16 energize the relays at no flow.

Check that the control circuit is firmly seated into it's socket.

Check if power is present and customer fuses are good, if they are used.

Follow the trouble shooting flow chart in Figure 5-1 near the end of this chapter.

Non-maintenance Observations

At this point, observe the system setup to verify operation. No disassembly or testing is required at this time.

Check Serial Numbers

Verify that the serial number of the flow element and the control circuit are the same when the instrument is used with the remote enclosure option. The flow element and the control circuit are a matched set and cannot be operated independently of each other.

Check Input Power

Verify that the correct power source is turned on and connected.

Check the Instrument Installation

Review the information on instrument installation in Chapter 2 to verify correct mechanical and electrical installation.

At the time of order the flow element placement should have been determined. However, if not, the flow element should be mounted at least 20 diameters downstream and 20 diameters upstream from any bends or interference in the process pipe or duct.

Check for Moisture

Check for moisture on the control circuit. Moisture on the control circuit may cause intermittent operation.

Check for moisture on the flow element. If a component of the process media is near its saturation temperature it may condense on the flow element. Place the flow element where the process media is well above the saturation temperature of any of the process gases.

Check Application Design Requirements

Application design problems may occur with first time application instruments, although the design should also be checked on instruments that have been in operation for some time. If the application design does not match field conditions, errors occur.

1. Review the application design with plant operation personnel and plant engineers.
2. Ensure that plant equipment such as pressure and temperature instruments conform to the actual conditions.
3. Verify operating temperature, operating pressure, line size, and gas medium.

Control Circuit Dash Number Specification

Verify that wiring is connected per the correct wiring diagram. To find the correct diagram look at the control circuit dash number printed on the instrument name plate. Compare the dash number to Appendix A, Figure A-10. The figure will then guide the user to find the appropriate wiring diagrams. If there is a space within the dash number there is a standard option associated with the blank. See Note 4 in Figures A-10.

Verification of Flow Element Resistance

The measurements are based on a standard (4K ohm RTD at 70°F, or 21°C) flow element. Variation of ±100 ohms from nominal is to be expected, depending on temperature. The maximum allowable difference in resistance between matched RTD's is 1% at ambient temperature (immersed in water). The heater resistance should be 430±5 ohms for each heater. The heaters are connected in parallel, therefore the combined parallel resistance is 215 ohms. Be sure to subtract the cable resistance to get the true resistance.

Note: When the flow element is connected to a remote enclosure control circuit, a shielded cable is to be used. Be sure that the cable shield is ONLY connected to the control circuit socket, terminal number 7. The other end of the shield should be left floating.

1. Turn off the operating power to the instrument.
2. Gently remove (pull straight out) the control circuit from the socket. Using a DMM, measure the resistance of sensor A and sensor B sensing elements.
3. Measure the resistances as found in Table 5-1 to determine if the flow element is functional.

   For remote instruments, if there is a faulty reading at the control circuit socket, (control circuit pulled out) make the resistance measurements found in Table 5-2.

For the remote configuration (the control circuit is in a separate enclosure from the flow element), if an open circuit exists for one RTD and a value of twice the resistance exists for the other RTD then there is probably a miswiring or mislabeling problem.

For the local configuration (the control circuit is in the same enclosure as the flow element), if there is an indication of an open or short in the RTD, the flow element will need to be replaced.

After replacing the flow element, it will be necessary to follow the set point adjustment procedures found in the Operation Chapter before returning the instrument to service. If a millivolt output option is provided on the control circuit, the zero adjustment procedure must be performed.

If the flow element resistance is correct, proceed to the voltage verification test.

Table 5-1. Local Flow Element Resistances In Ohms (control circuit enclosure)

From Terminal (Pin)	To Terminal (Pin)	Expected Ohms*
Heater (7)	Heater (10)	215
Sen A (9)	Com Sen (8)	4000
Sen A (9)	Sen B (7)	8000
Sen B (7)	Com Sen (8)	4000

Table 5-2. Remote Flow Element Resistances in Ohms (flow element enclosure when separate from the control circuit enclosure)

From Terminal (Pin)	To Terminal (Pin)	Expected Ohms*
At Local Enclosure For Remote Option (3)	At Local Enclosure For Remote Option (4)	5000
At Local Enclosure For Remote Option (3)	At Local Enclosure For Remote Option (5)	10000
At Local Enclosure For Remote Option (5)	At Local Enclosure For Remote Option (4)	5000
At Local Enclosure For Remote Option (1)	At Local Enclosure For Remote Option (2)	215

*Resistance varies with temperature. These values should be ±5 ohms at 70 °F (21 °C).

Verification of Flow Element Voltage

If the above resistance checks are good, plug in the control circuit and apply power. Measure the voltages in Tables 5-3 and 5-4. If the voltages are not correct, then remove and replace the control circuit.

Table 5-3. Local Flow Element Voltages (control circuit enclosure)

From Terminal Pin	To Terminal Pin	Voltage Expected**
9 (+)	7 (-)	22VDC
7 (+)	8 (-)	12VDC
9 (+)	8 (-)	10VDC
10 (+)	7 (-)	22VDC (2 Watt Heater) 15VDC (1 Watt Heater) 19VDC (1.5 Watt Heater) 11VDC (0.5 Watt Heater)

Table 5-4. Remote Flow Element Voltages (flow element enclosure when separate from the control circuit enclosure)

From Terminal Pin	To Terminal Pin	Voltage Expected**
At Local Enclosure For Remote Option 3 (+)	At Local Enclosure For Remote Option 5 (-)	22VDC
At Local Enclosure For Remote Option 5 (+)	At Local Enclosure For Remote Option 4 (-)	12VDC
At Local Enclosure For Remote Option 3 (+)	At Local Enclosure For Remote Option 4 (-)	10VDC
Heater Option 1 (+)	Heater Option 2 (-)	22VDC (2 Watt Heater) 15VDC (1 Watt Heater) 19VDC (1.5 Watt Heater) 11VDC (0.5 Watt Heater)

**Voltages are dependent on temperature.

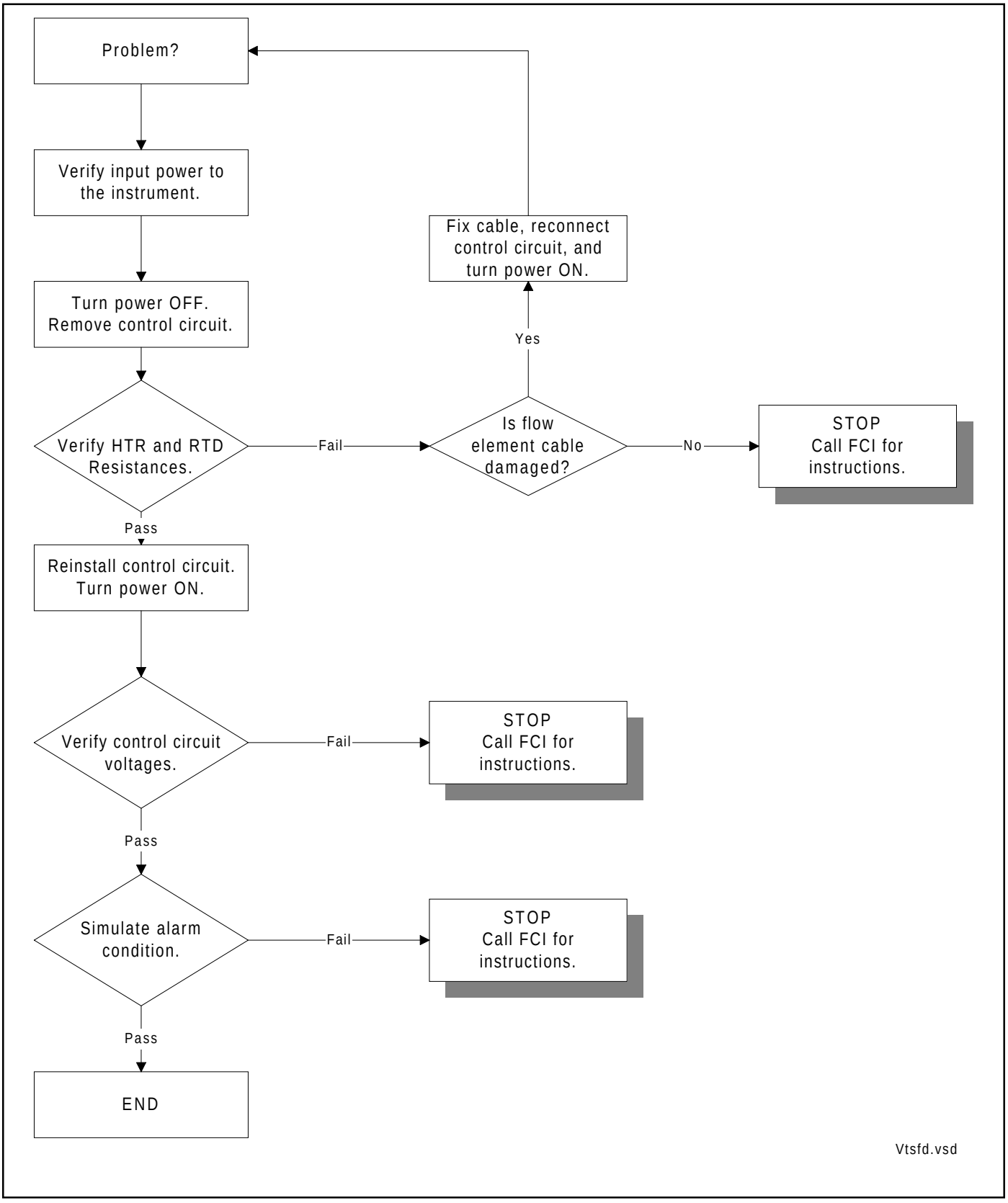


Figure 5-1. Troubleshooting Flow Chart

Spares

FCI recommends that one control circuit be kept as a spare. Check the Order Information Sheet that was filled out at the time of order for the correct part and dash number. Contact FCI for specific recommendations.

Defective Parts

Before returning any equipment to FCI, obtain an return authorization (RA) number for authorization, tracking, and repair/replacement instructions. If a return is required, remove the defective part or instrument, replace it with a spare, calibrate, and then return the defective part or instrument to FCI freight prepaid for disposition.

Customer Service

1. In the event of problems or inquiries regarding the instrument, please contact the Regional or Country Authorized FCI Field Agent. There is an extensive list of these representatives at the front of this manual.
2. Before contacting the FCI representative, be sure that all the applicable information is near so that a more effective, efficient and timely response may be provided.
3. Refer to Appendix C for specific Customer Service policy provisions.

Appendix A. Drawings

Inches [mm]

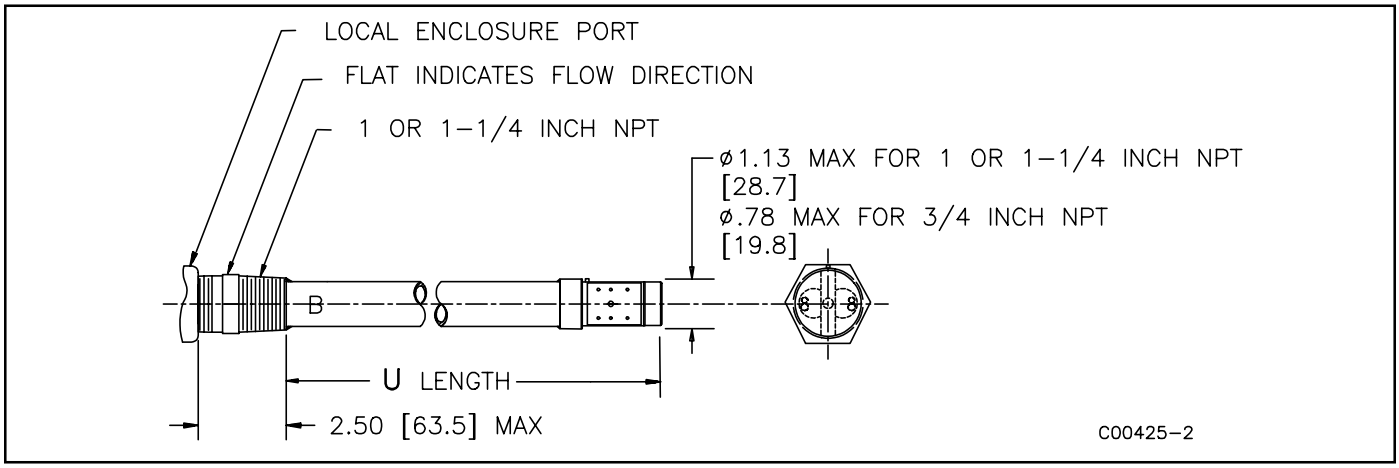


Figure A-1. Threaded Process Connection

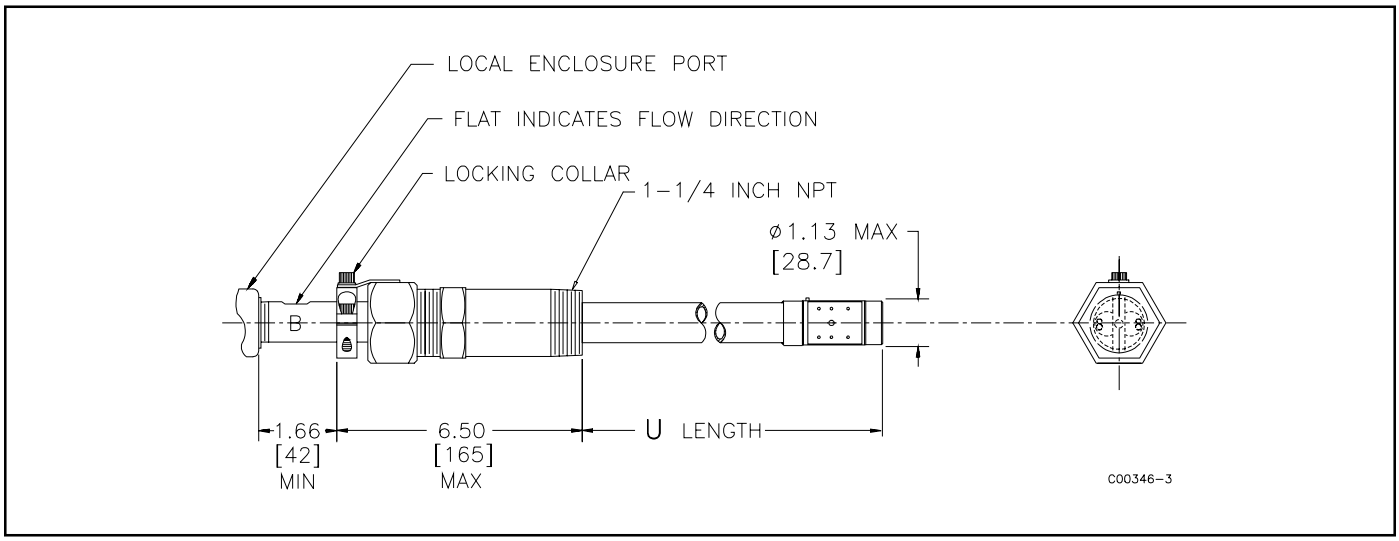


Figure A-2. Threaded Low Pressure Packing Gland

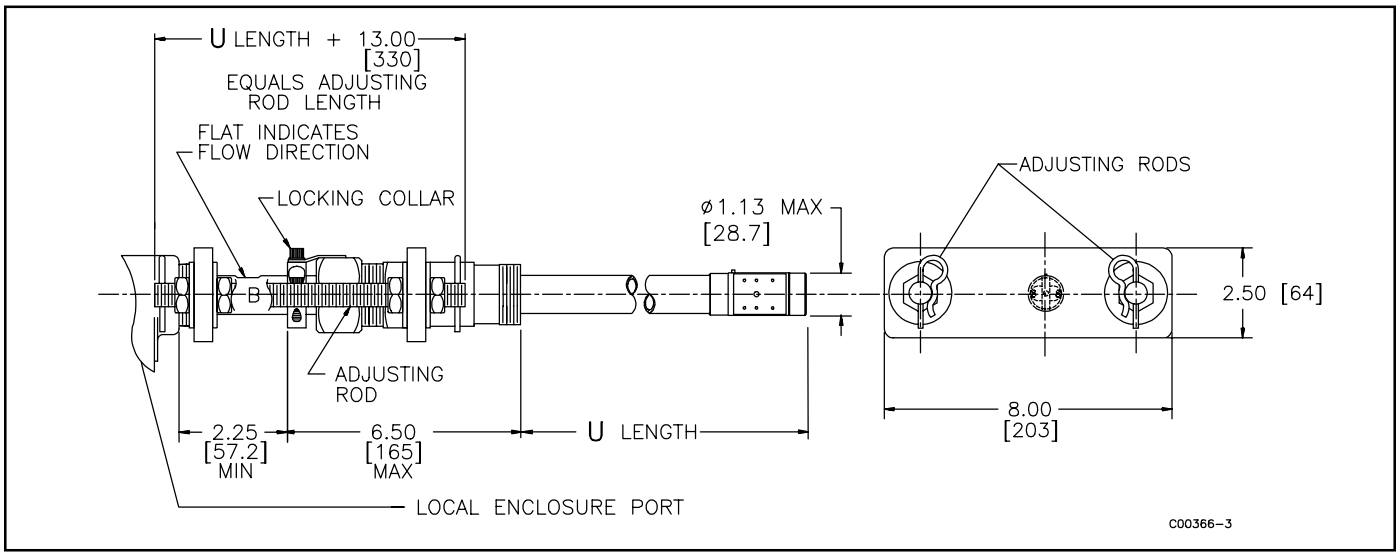


Figure A-3. Threaded Medium Pressure Packing Gland

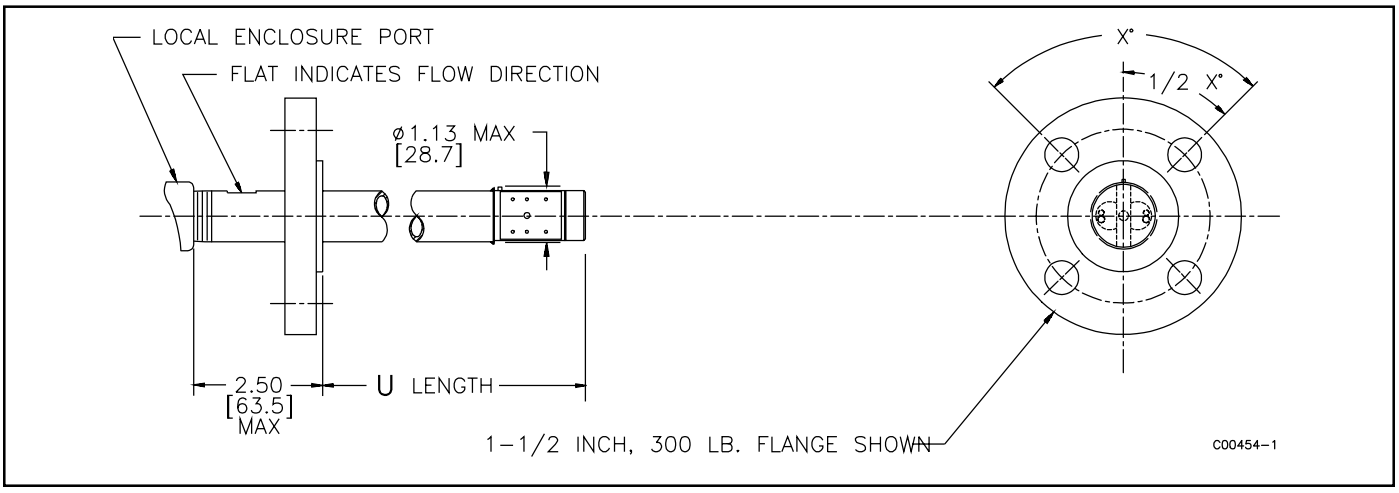


Figure A-4. Flanged Process Connection

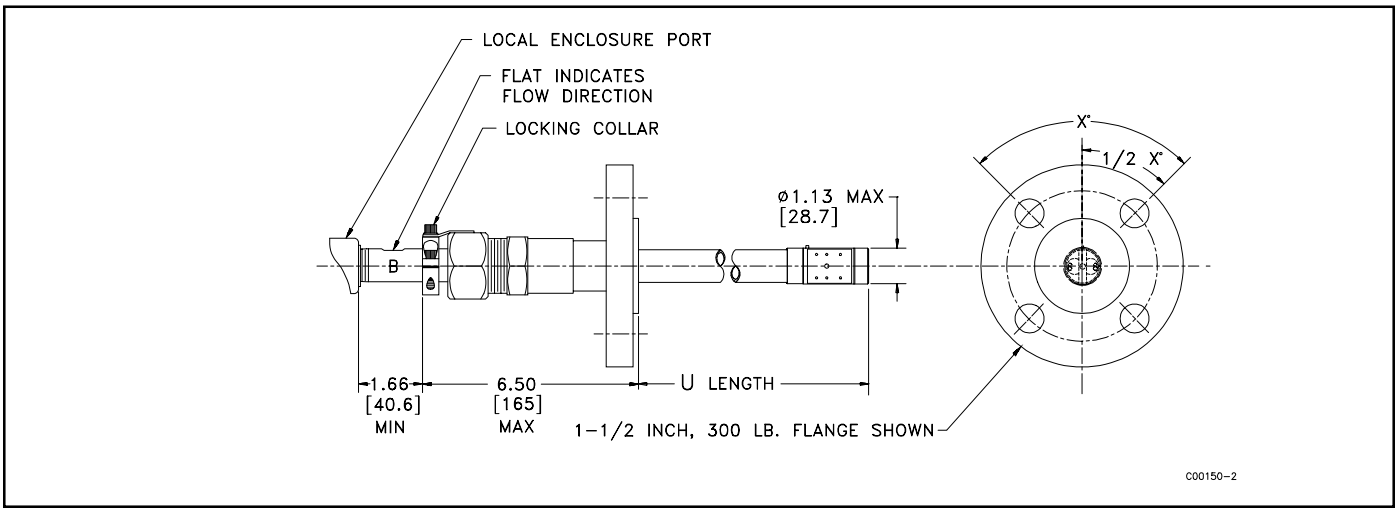


Figure A-5. Flanged Low Pressure Packing Gland

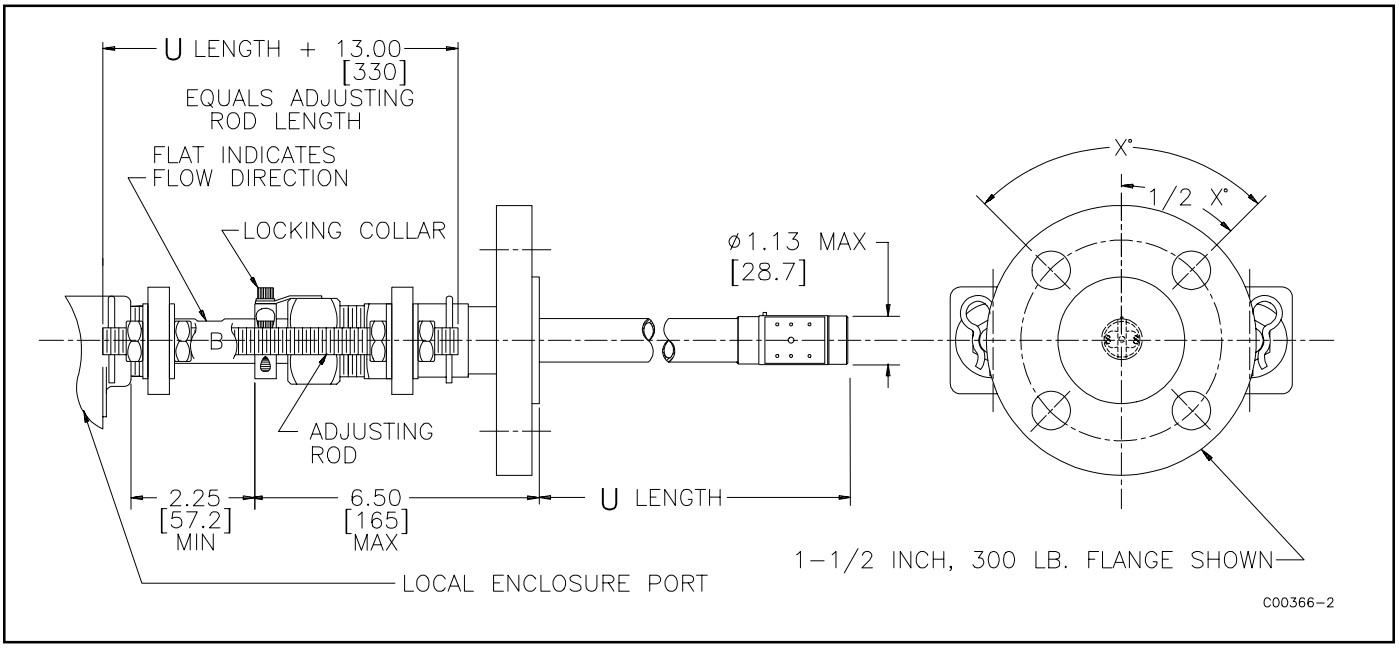


Figure A-6. Flanged Medium Pressure Packing Gland

Inches [mm]

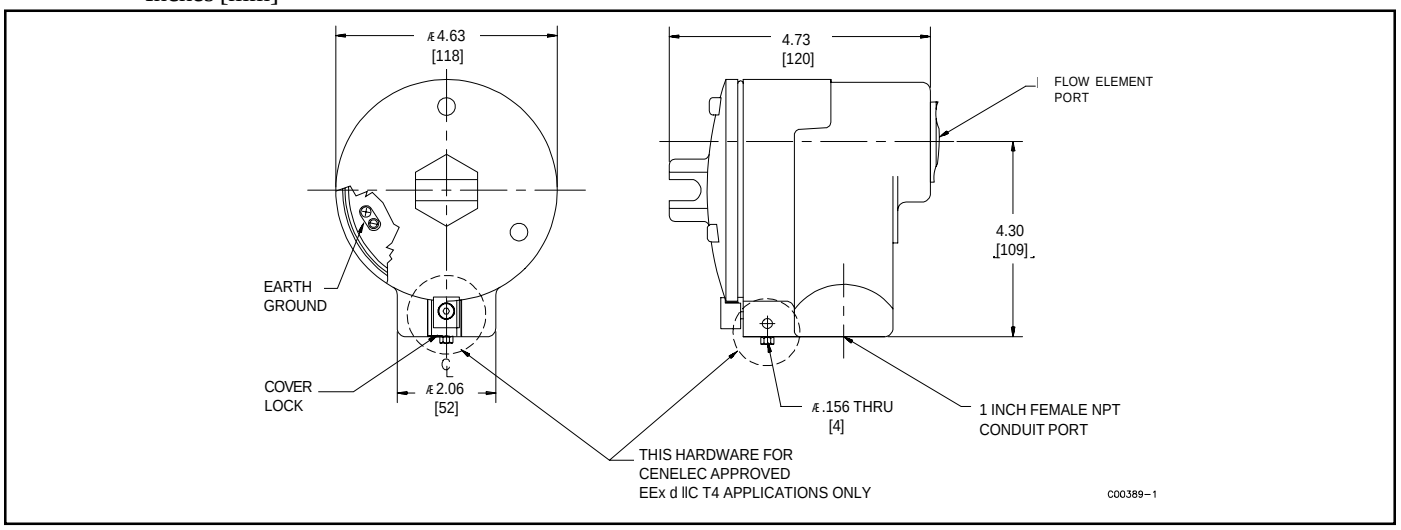


Figure A-7. Local Enclosure NEMA Type 4X and 7 Hazardous Location (Aluminum and 300 Series Stainless Steel Enclosures Shown. Feraloy ® Enclosures are Slightly Smaller)

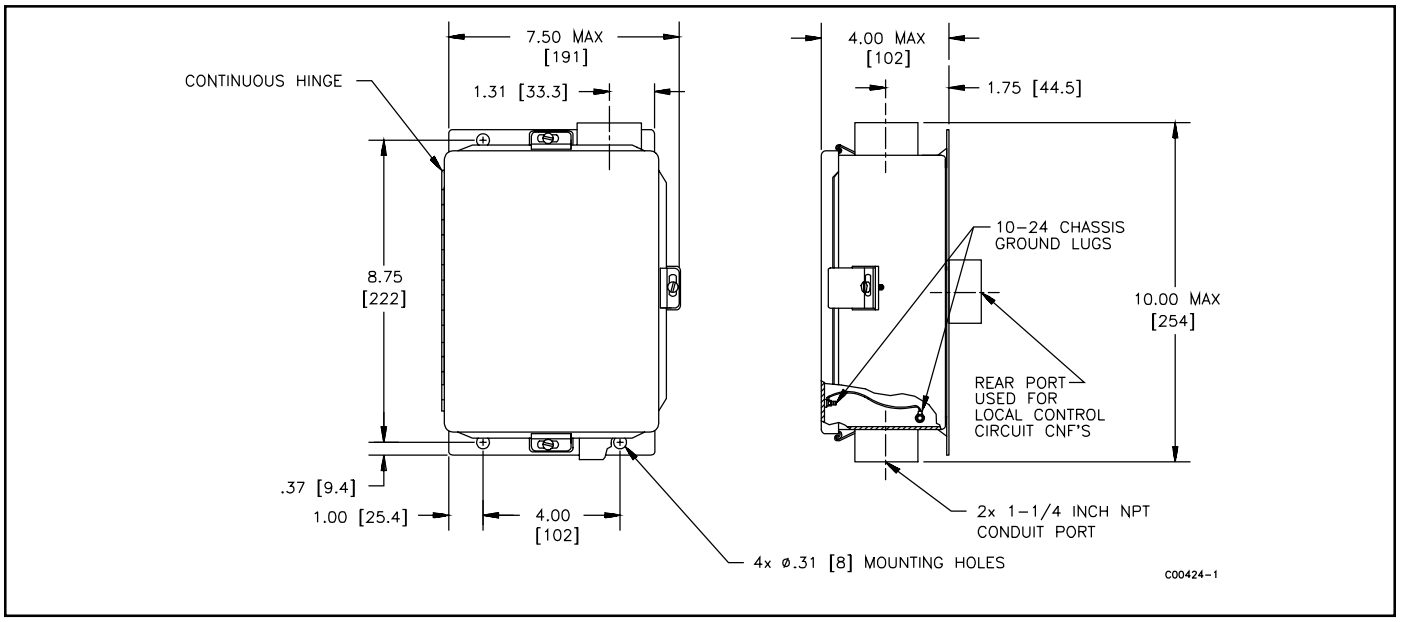


Figure A-8. Remote Enclosure NEMA Type 4 (Carbon Steel Epoxy Coated)

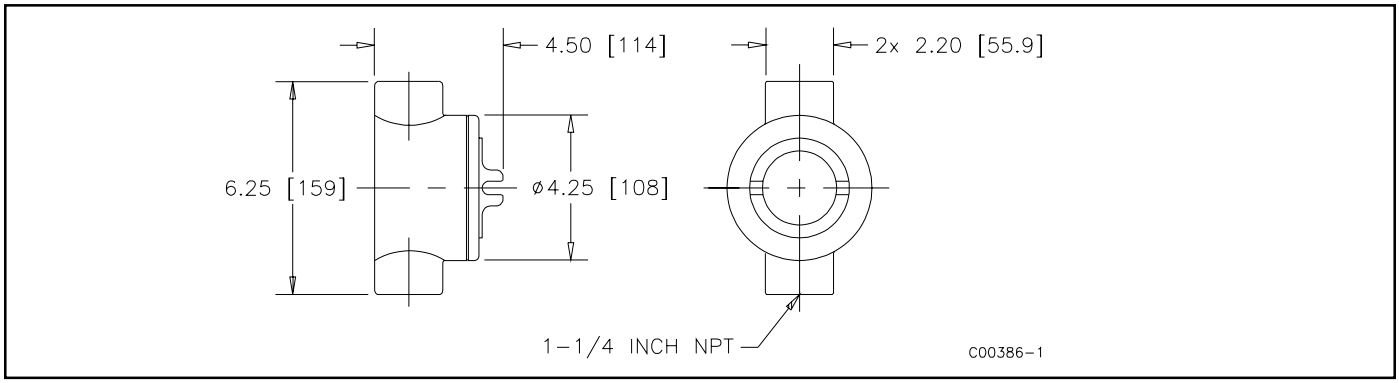


Figure A-9. Remote Enclosure NEMA Type 4 and 7 Hazardous Location (Feraloy® Epoxy Coated)

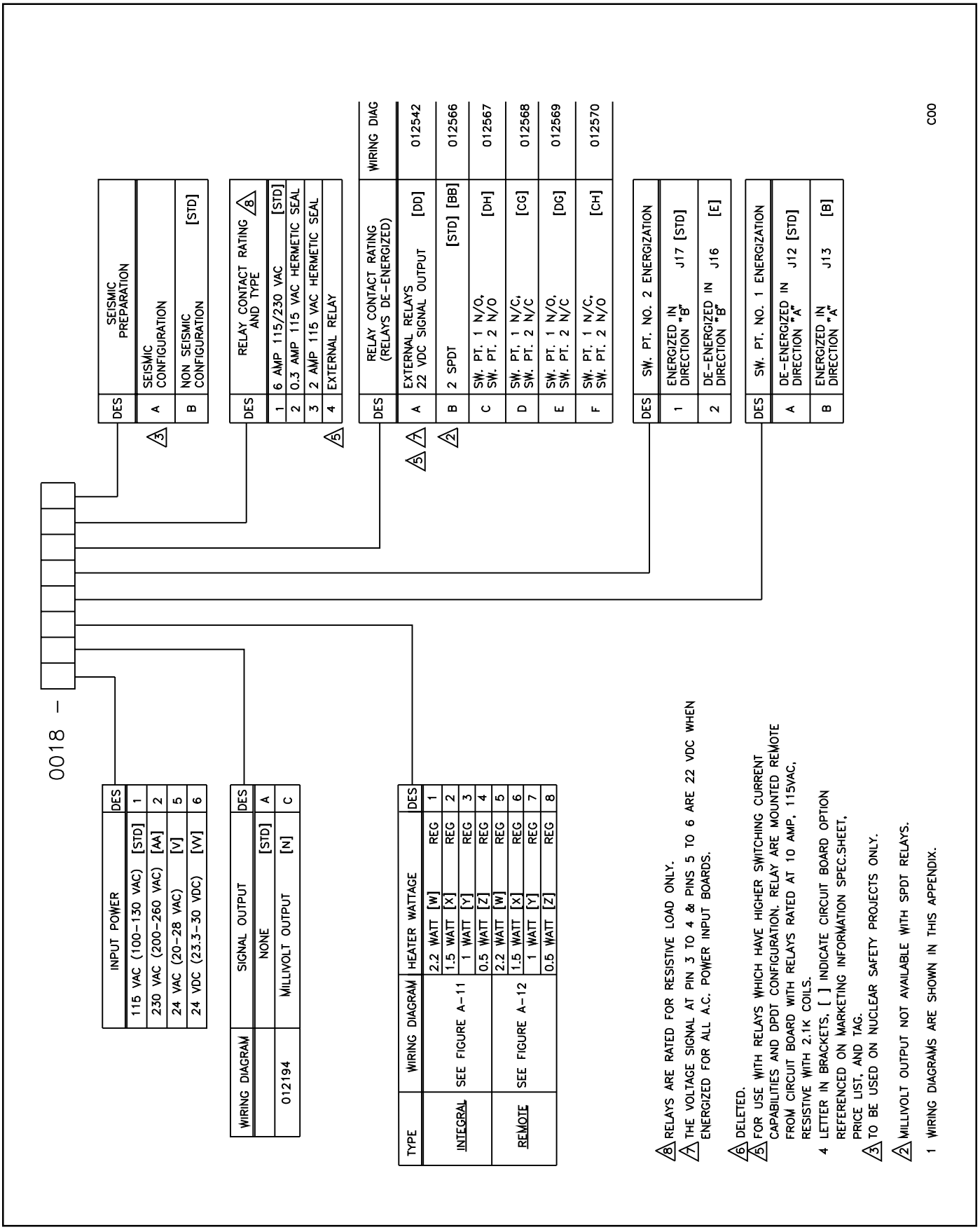


Figure A-10. Control Circuit Module

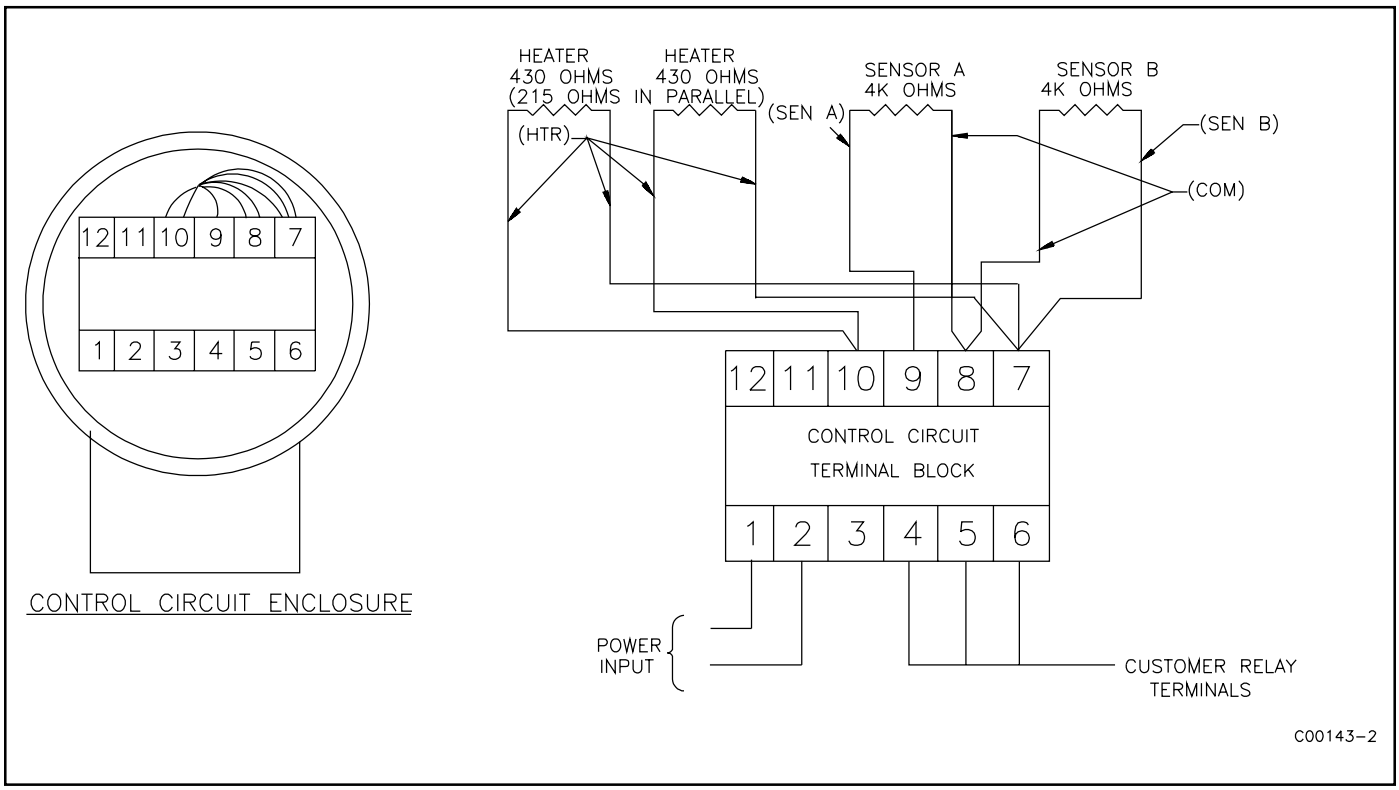


Figure A-11. Wiring Diagram Local Enclosure, Regulated Heater

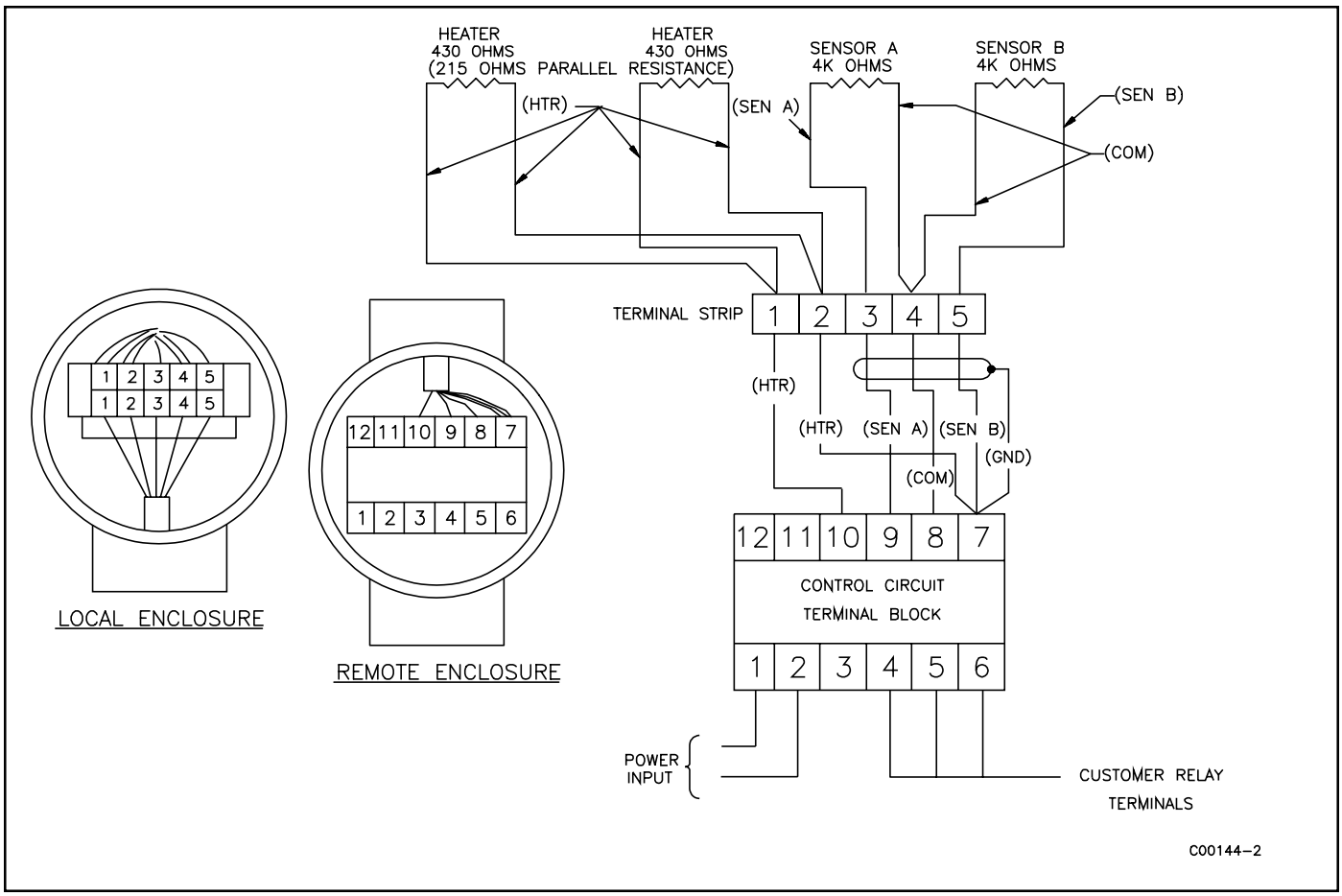


Figure A-12. Wiring Diagram Remote Enclosure, Regulated Heater

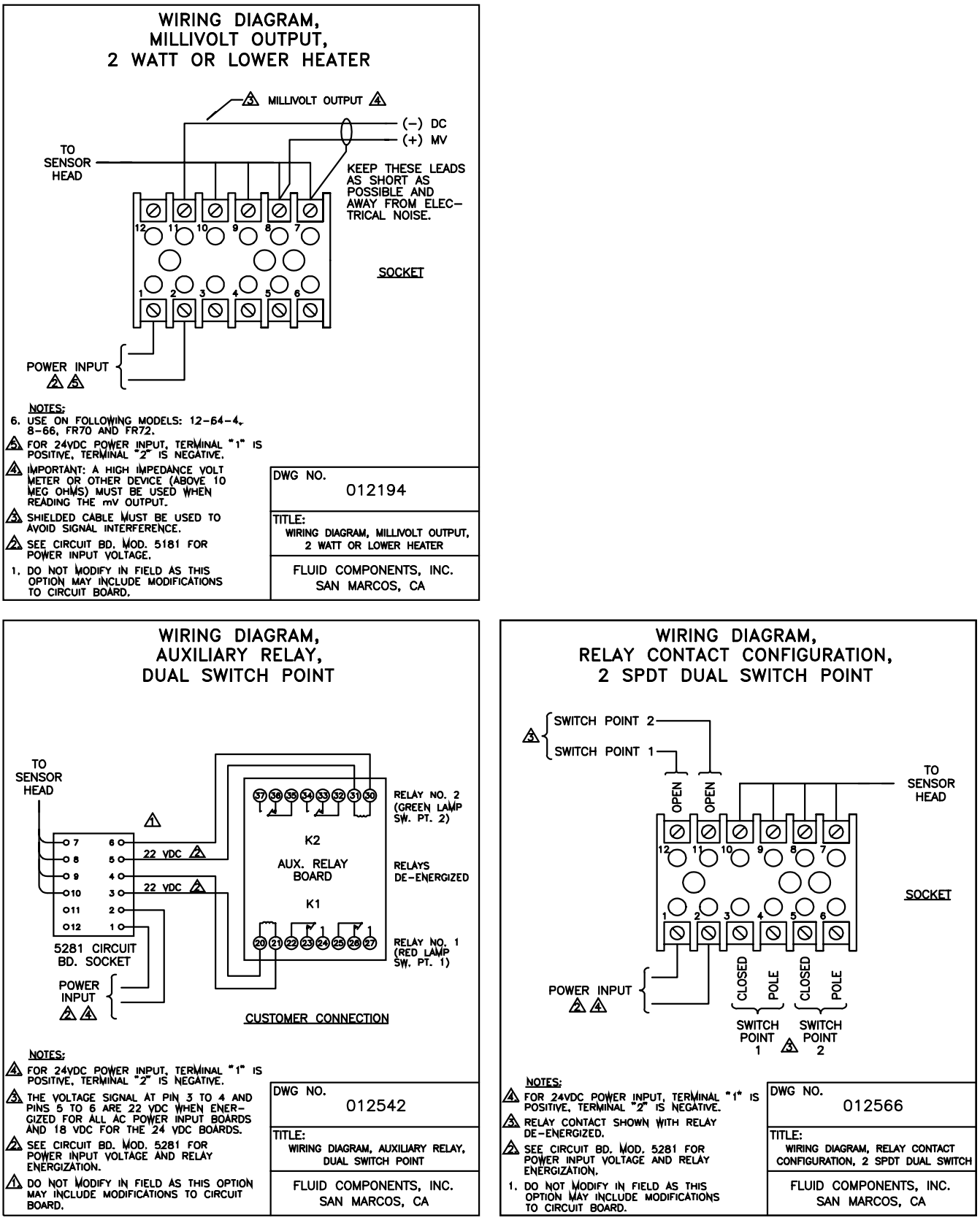


Figure A-13. Control Circuit Options - Wiring Diagrams

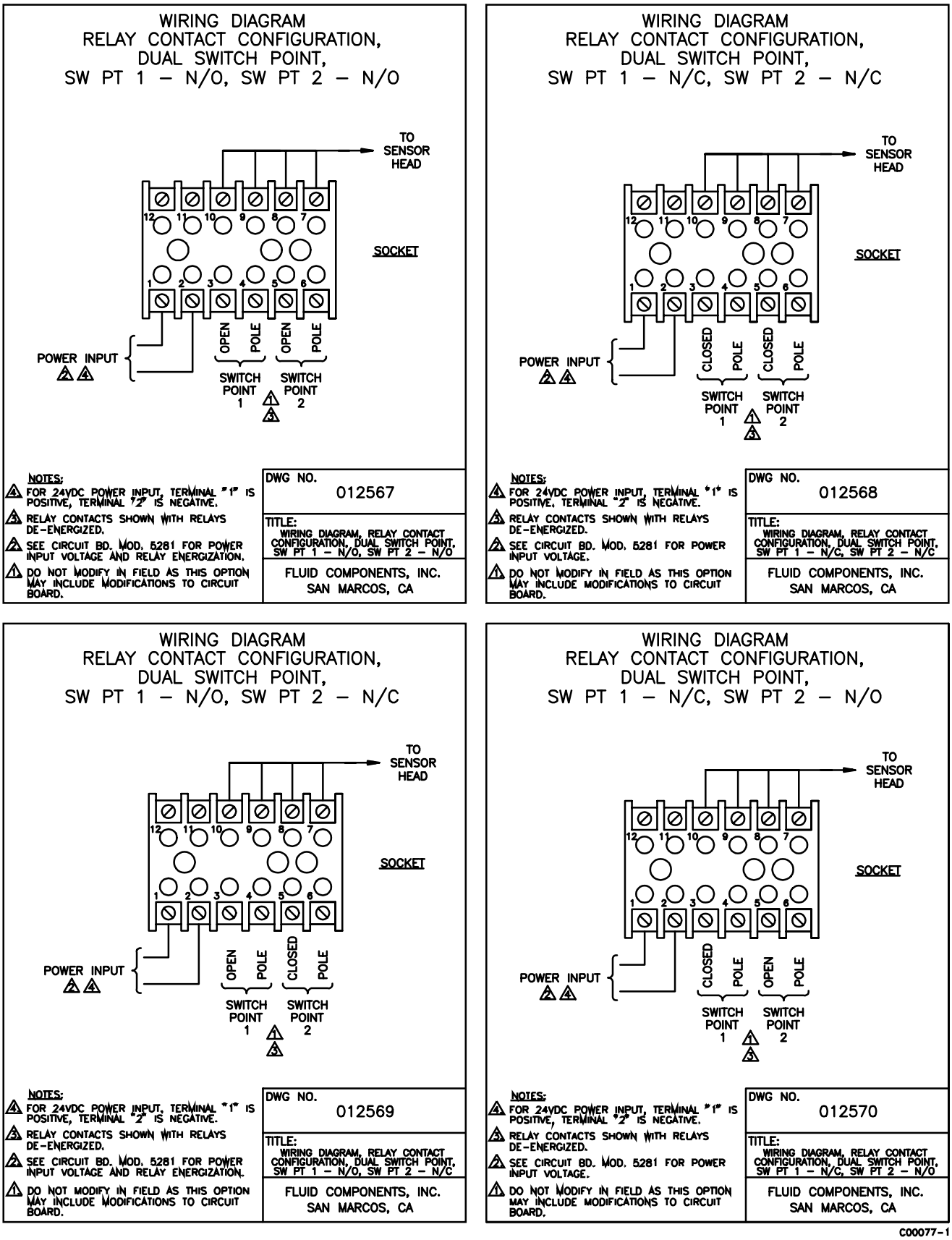
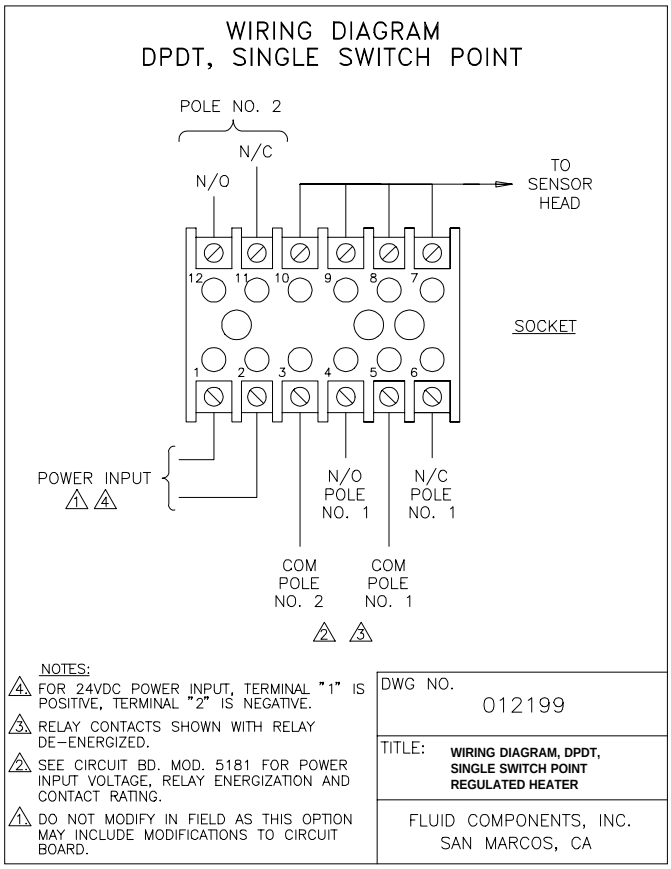
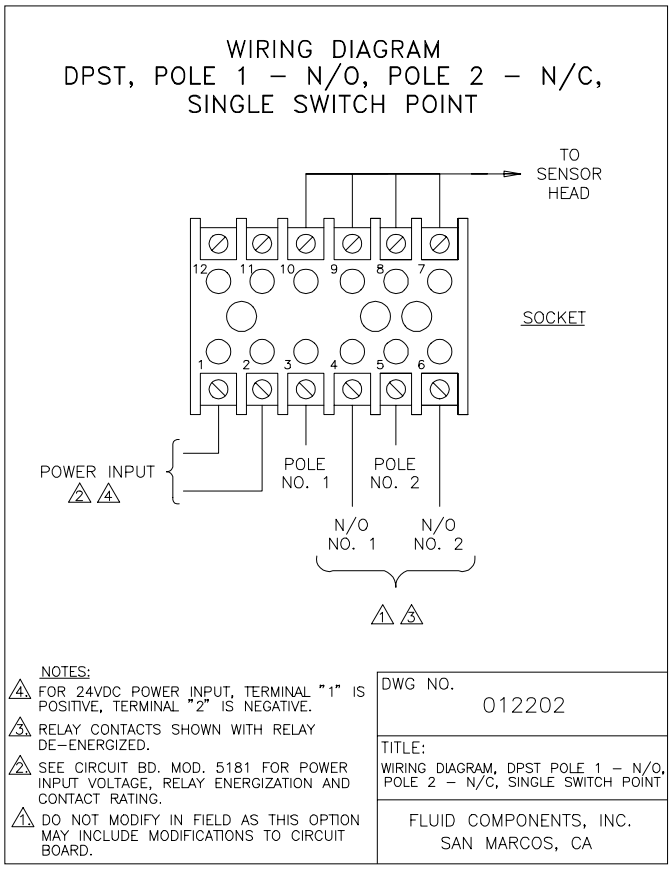


Figure A-14. Control Circuit Options - Wiring Diagrams





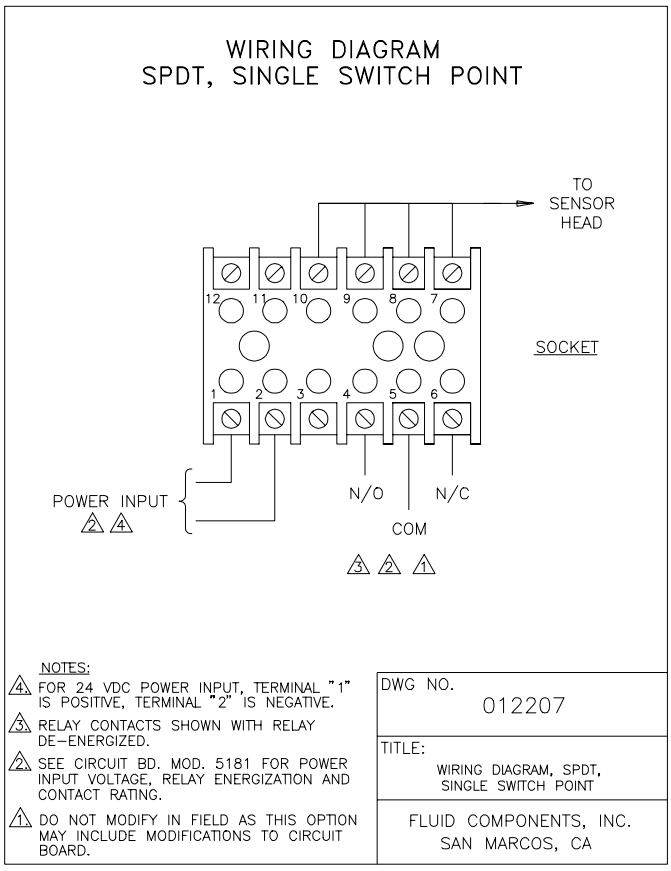


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Figure A-15. Control Circuit Options - Wiring Diagrams

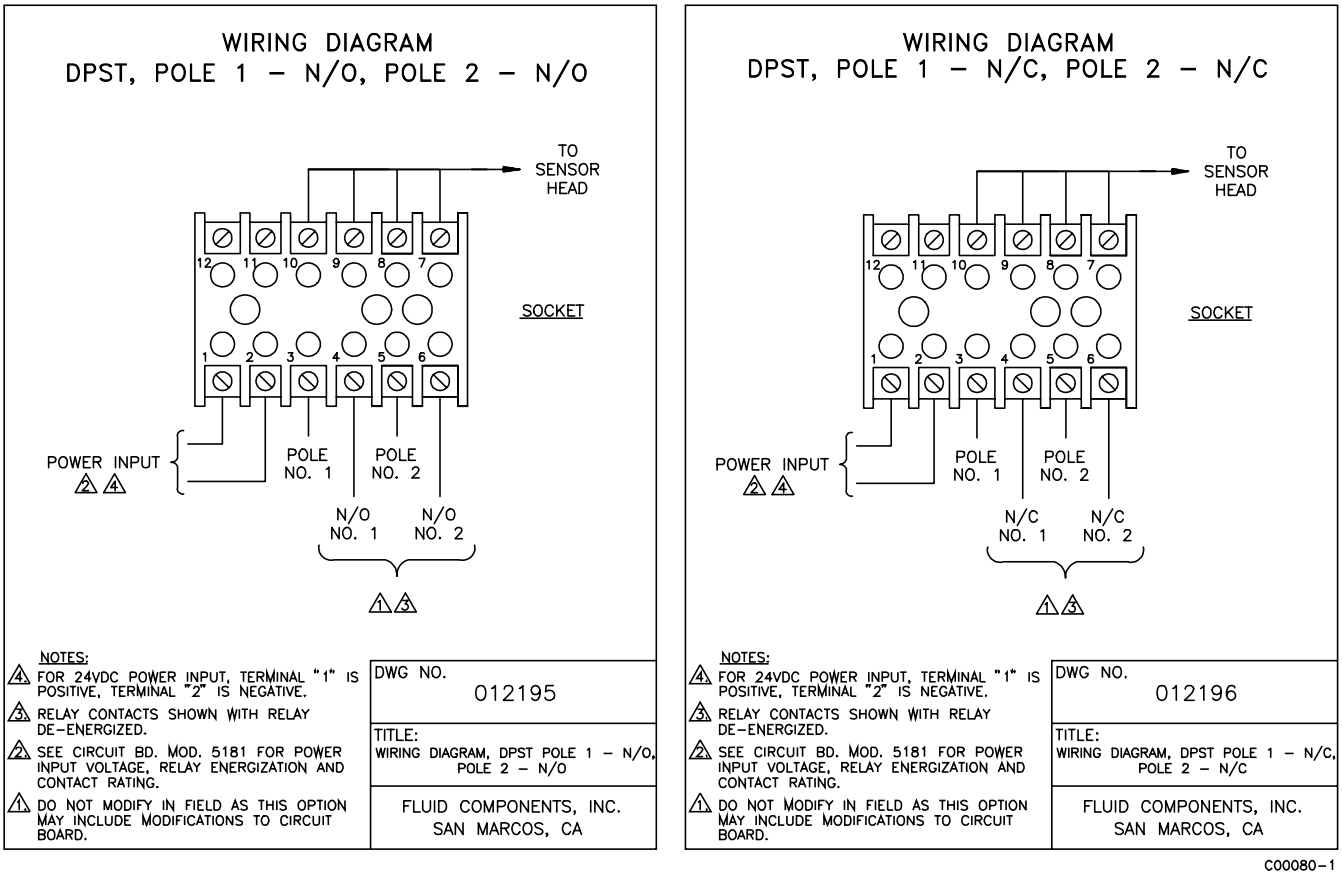

Figure A-16. Control Circuit Options - Wiring Diagrams

Appendix B. Glossary

ABBREVIATIONS

Delta R (ΔR)	Differential Resistance
Delta T (ΔT)	Differential Temperature
DMM	Digital Multimeter
FCI	Fluid Components Intl
HTR	Heater
LED	Light Emitting Diode
RA	Repair Authorization
RTD	Resistance Temperature Detector

DEFINITIONS

Active RTD	The flow element part that senses the fluid flow rate.
Balance	A number that is used to balance or match the active and reference RTDs when the heater is off.
Control circuit	The portion of the flow switch that conditions, converts, and scales the flow element signal.
Differential resistance Delta -R (ΔR)	The flow element signal.
Differential temperature Delta -T (ΔT)	The difference in temperature between the active and reference RTDs.
Flow element	The portion of the flow switch that contains the thermowells, RTDs, and produces a signal with a defined relationship to the flow rate.
Heater (HTR)	The flow element part that heats the active RTD.
Local enclosure	The enclosure attached to the flow element (contains the wiring terminal block when a remote enclosure is used).
Reference RTD	The flow element part that senses the fluid temperature.
Remote enclosure	The enclosure that contains the control circuit, and is connected to the local enclosure by an electrical cable.
Resistance Temperature Detector (RTD)	A sensor whose resistance changes proportionally to detector temperature changes.
Thermowell	The flow element part that protects the heater and RTD's from the process fluid.

Appendix C. Customer Service

Point of Contact

Your point of contact for service, or return of equipment to FCI is your authorized FCI service representative (see list in the front matter of this manual).

Reference Documents

Return Authorization Request/Certificate of Non-Contamination (Document 1)
Warranties (Document 2)
Documents 1 and 2 are included in this appendix.

Hardware Return Procedure

1. Complete a Return Authorization (RA) Request/Certificate of Non-Contamination form (Document 1) and mail or fax it to the FCI customer department. After FCI issues you an RA number, complete the following steps.
2. Thoroughly clean the hardware.
3. Package each instrument with protective packing material similar to the original FCI shipment cartons indicated below. **All damage occurring in transit is the customer's responsibility.**
    a. Instruments weighing less than 25 pounds each are to be covered with protective wrap, i.e. bubble wrap or surrounded with "popcorn". Instruments weighing greater than 60 pounds or extending more than four feet should be secured in wooden crates by bolting the sensing element assembly in place.
    b. Protect the sensing element with a cardboard tube or other sturdy wrapping.
    c. Do not pack more than four small instruments in each carton.
    d. Packages weighing in excess of 70 pounds or with a combined length and girth of more than 138 inches cannot be shipped by United Parcel Service. Larger packages or crates should be shipped by carriers who specialize in the transport of industrialized instrumentation.
    e. The RA number should be noted on the packing list and marked clearly on the outside of the box.
4. Prepay freight to the FCI receiving door.

Shipping/Handling Charges

All Shipping (Warranty and Nonwarranty Repairs or Returns)

The customer prepays all shipping, freight, duty/entry and handling charges from the customer site to the FCI door. If the customer does not prepay, FCI will invoice the customer for the charges that appear on the freight bill. Address the return equipment to :

FLUID COMPONENTS INTL

1755 LA COSTA MEADOWS DRIVE

SAN MARCOS, CA. 92069

ATTN: REPAIR DEPT.

RA NUMBER: _____

Warranty Repairs or Returns

FCI prepays ground transportation charges for return of freight to the customer's door. FCI reserves the right to return equipment by the carrier of our choice.

International freight, handling charges, duty/entry fees for return of equipment are paid by the customer.

Nonwarranty Repairs or Returns

FCI returns repaired equipment to the customer either collect or prepaid and adds freight charges to the customer invoice.

Return to Stock Equipment

The customer is responsible for all shipping and freight charges for equipment that is returned to FCI stock from the customer site. These items will not be credited to customer's account until either all freight charges are cleared or until the customer agrees to have any freight costs incurred by FCI deducted, along with applicable return to stock charges, from the credit invoice. (Exceptions are made for duplicate shipments made by FCI.)

If any repair or return equipment is received at FCI, freight collect, without prior factory consent, FCI bills the sender for these charges.

Field Service Procedures

Field Service Requests

Contact your FCI field representative to request field service.

A field service technician is dispatched to the site from either the FCI factory or one of the FCI representative offices. After the work is complete, the technician completes a preliminary field service report at the customer site and leaves a copy with the customer.

Following the service call, the technician completes a formal, detailed service report. The formal report is mailed to the customer within five days of the technician's return to the factory or office.

Rates

All field service calls are billed at the prevailing rates as listed in the FCI Price Book unless specifically excepted by the FCI Customer Service Manager. FCI reserves the right to bill for travel times at our discretion.

Customers are charged for shipping costs related to the transfer of equipment to and from the job site. They are also invoiced for field service work and travel expenses by FCI's Accounting Department.

Document 1.

FCI RETURN AUTHORIZATION REQUEST

Customer Information

Name of Company Returning Hardware _____

Contact Name: _____ Phone # _____ Fax # _____

Customer Bill to Address: _____ Ship to: _____

_____ _____

_____ _____

_____ _____

Purchase Agent Contact: _____ Phone # _____ Fax # _____

Product Information

Model Number(s) _____ Serial Number(s) _____

Sending: Electronics only ☐ Sensor only ☐ Complete unit ☐ Number of units ____

Failure Symptoms _____

_____

Troubleshooting done in the field by FCI representative ☐ or by Customer ☐ : _____

_____

Action to be taken by FCI _____

(Note: Re-calibration/Re-certification requires the completion of a new Application Data Sheet)

Process Flow Media: _____

Who is your FCI factory technical contact: _____

Note: FCI will charge a **$100 minimum** handling fee on all non-warranty evaluations.

Have you contacted your local FCI representative for assistance? _____ yes _____ no

Decontamination Information

Exposure to hazardous materials is regulated by Federal, state (California), County and City laws and regulations. These laws provide FCI's employees with the right to know the hazardous materials with which they come in contact while handling our products. Consequently, our employees must have access to data regarding the hazardous materials which the equipment has been exposed to in your process(es). Accordingly, prior to returning your instrument for repair, please sign the certification below and thoroughly comply with the instructions, if applicable.

I certify that the item(s) has (have) been thoroughly and completely cleaned and if the item(s) has (have) been exposed to or contacted by a hazardous material, hazardous substance or toxic materials or substances that the undersigned can assure the returned item(s) has (have) been thoroughly and completely decontaminated and neutralized of such substances and contamination. I have also attached a Material Safety Data Sheet (MSDS) which covers all hazardous material, hazardous substance or toxic materials or substances exposed to or contacted by the instrument. Furthermore, I understand that this Certificate, or providing a MSDS, shall not waive our responsibility to provide a neutralized, decontaminated, and clean product for repair to FCI.

Authorized Signature _____ Date _____

Cleanliness of a returned item or the acceptability of the MSDS shall be at the sole discretion of FCI.
Any returned item which does not comply with these instructions shall be returned to you at your expense.

Document 2. Warranties

Warranties

Goods furnished by the Seller are to be within the limits and of the sizes published by the Seller and subject to the Seller's standard tolerances for variations. All items made by the Seller are inspected before shipment, and should any of said items prove defective due to faults in manufacture or performance under Seller approved applications, or fail to meet the written specifications accepted by the Seller, they will be replaced or repaired by Seller at no charge to Buyer provided return or notice of rejection of such material is made within a reasonable period but in no event longer than three (3) years for non-calibration defects and one (1) year for calibration defects from date of shipment to Buyer, and provided further, that an examination by Seller discloses to Seller's reasonable satisfaction that the defect is covered by this warranty and that the Buyer has not returned the equipment in a damaged condition due to Buyer's or Buyer's employees', agents', or representatives' negligence and Buyer has not tampered, modified, redesigned, misapplied, abused, or misused the goods as to cause the goods to fail. In addition, this warranty shall not cover damage caused by Buyer's exposure of the goods to corrosive or abrasive environments. Moreover, Seller shall in no event be responsible for (1) the cost or repair of any work done by Buyer on material furnished hereunder (unless specifically authorized in writing in each instance by Seller), (2) the cost or repair of any modifications added by a Distributor or a third party, (3) any consequential or incidental damages, losses, or expenses in connection with or by reason of the use of or inability to use goods purchased for any purpose, and Seller's liability shall be specifically limited to free replacement, or refund of the purchase price, at Seller's option, provided return or rejection of the goods is made consistent with this paragraph, and the Seller shall in no event be liable for transportation, installation, adjustment, loss of good will or profits, or other expenses which may arise in connection with such returned goods, or (4) the design of products or their suitability for the purpose for which they are intended or used. Should the Buyer receive defective goods as defined by this paragraph, the Buyer shall notify the Seller immediately, stating full particulars in support of his claim, and should the Seller agree to a return of the goods, the Buyer shall follow Seller's packaging and transportation directions explicitly. In no case are the goods to be returned without first obtaining a return authorization from the Seller. Any repair or replacement shall be at Seller's factory, unless otherwise directed, and shall be returned to Seller transportation prepaid by Buyer. If the returned goods shall prove defective under this clause they will be replaced or repaired by Seller at no charge to Buyer provided the return or rejection of such material is made within a reasonable period, but in no event longer than (1) year from the date of shipment of the returned goods or the unexpired terms of the original warranty period whichever is later. If the goods prove to be defective under this paragraph, the Buyer shall remove the goods immediately from the process and prepare the goods for shipment to Seller. Continued use or operation of defective goods is not warranted by Seller and damage occurring due to continued use or operation shall be for Buyer's account. Any description of the goods contained in this offer is for the sole purpose of identifying them, and any such description is not part of the basis of the bargain, and does not constitute a warranty that the goods will conform to that description. The use of any sample or model in connection with this offer is for illustrative purposes only, is not part of the basis of the bargain, and is not to be construed as a warranty that the goods will conform to the sample or model. No affirmation of that fact or promise made by the Seller, whether or not in this offer, will constitute a warranty that the goods will conform to the affirmation or promise. THIS WARRANTY IS EXPRESSLY IN LIEU OF ANY AND ALL OTHER EXPRESS OR IMPLIED WARRANTIES WITH RESPECT TO THE GOODS OR THEIR INSTALLATION, USE, OPERATION, REPLACEMENT OR REPAIR, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS OF PURPOSE; AND THE GOODS ARE BEING PURCHASED BY BUYER "AS IS". SELLER WILL NOT BE LIABLE BY VIRTUE OF THIS WARRANTY OR OTHERWISE FOR ANY SPECIAL, INCIDENTAL OR CONSEQUENTIAL LOSS OR DAMAGE RESULTING FROM THE USE OR LOSS OF USE OF THE GOODS.