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Introduction

The INVALCO Model 780 is a level interface control designed specifically for the detection of hydrocarbon and water interfaces without being affected by contaminants such as paraffin, iron sulfide and asphaltines. The unit is provided with both point level and continuous outputs, as well as LED visual indicators to reflect the status of each.

Features

- **Excellent Sensitivity and Repeatability** - means precision control even with difficult applications.
- **Non-Fouling Probe** - for continuous, reliable use.
- **Convenient Operator Interface** - provides visual status indication and greatly reduced set-up time.
- **Individually Adjustable Dual Outputs with Time Delay** - allows the flexibility needed to change and customize control of your system.
- **Approved for use in hazardous locations.**

Specifications

Electronic's Temperature Limit

-20°F to 160°F

Probe Temperature Limit

250°F

Temperature Drift

0.009 pf per degree F

Power

110/220 AC, 50/60 Hz at 50 mA or 24 VDC 6 watts

Maximum Working Pressure

350 PSIG

Outputs

Continuous: 4-20 mA

Relay Contact: DPDT 10 amps at 120 VAC & 30 VDC
non-inductive

Fail-Safe Mode

Low Level

Sensitivity

0.3 pf max.

Response Time

0.75 seconds or less

Enclosures

Weatherproof: NEMA 4X with silicon rubber seal

Explosion-proof: Class I, Groups C&D

Certification for Use in Hazardous Areas

Probe is certified for use with either W.P. or X.P. housed control unit. X.P. housed control unit is certified for use in hazardous areas.

cUL and UL approved

File: E215164

Type: Class 1, Groups C & D

Cable Length

500 feet max.

Applications

Petroleum and Gas

Separators
Heater Treaters
Desalters
Free-water Knock-out

Other Industrial Liquid Processing

Storage Tanks
Extraction Units
Separation Equipment

Terms and Definitions

The following terms are used throughout this manual.

- **Interface** - The layer where the two liquids meet and undergo some amount of emulsification.
- **Point Level** - An instantaneous reaction from the control unit due to the detection of a pre-selected interface level.
- **Continuous** - A 4 to 20 mA output that is directly proportional to the span of the interface.

IMS Model 780

The Model 780 is designed to provide both a continuous (throttling) and snap-acting (on/off) output mode.

The snap-acting selector is a 10-position switch. The zero position is normally used when the Model 780 is used to detect a gas/liquid interface. Positions 1-9 are used to detect ever-increasing concentrations of water-in-oil.

Position 1 is nearest 100% oil, position 9 is nearest 100% water.

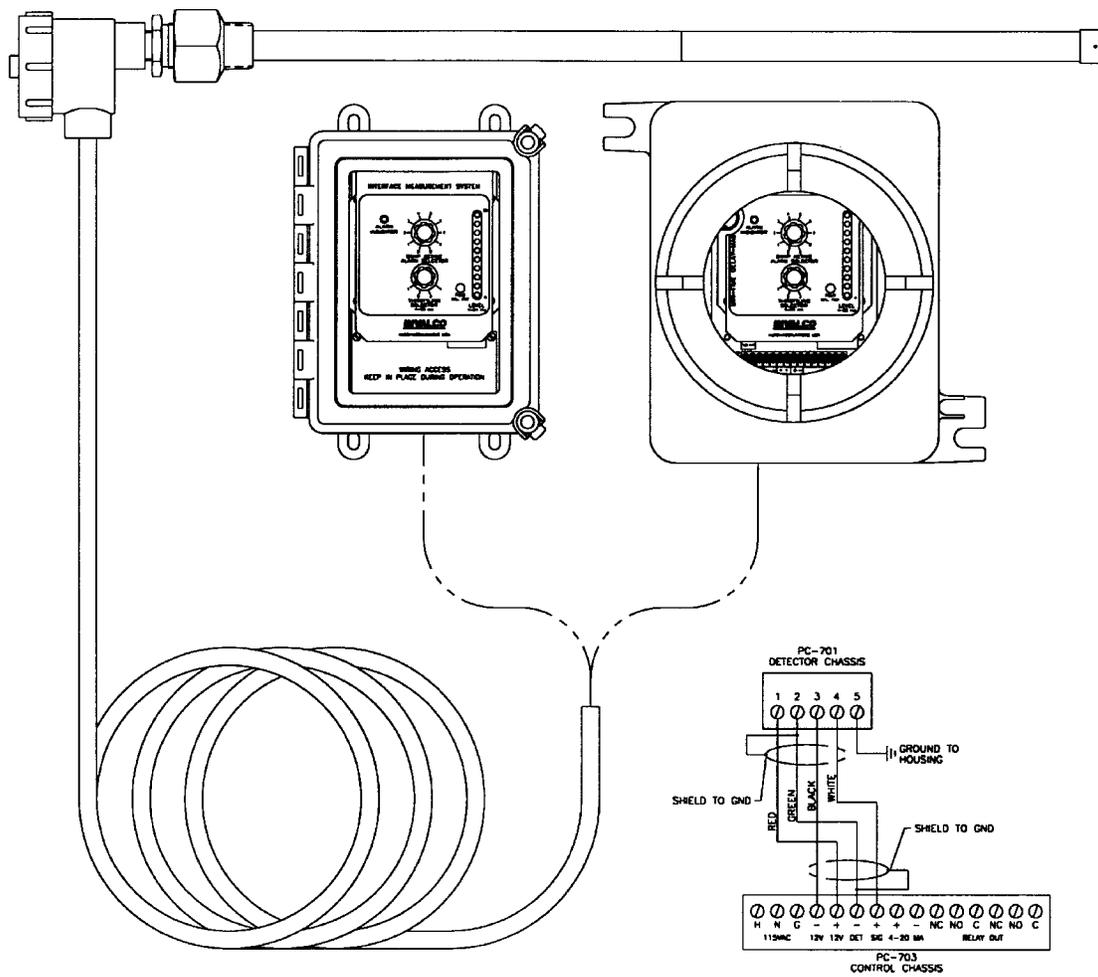
The Model 780 is also capable of developing a 4-20 mA throttling output which is particularly effective when applied to free-water knock-outs, treaters (crude oil dehydrators), wash tanks (gun barrels), skim tanks, three-phase separators, and other process vessels where an interface level must be maintained at a reasonable constant level.

The throttling selector has four positions marked 1, 2, 3, and 4. These positions correspond with the instruments overall span with respect to the water content of the oil at the interface.

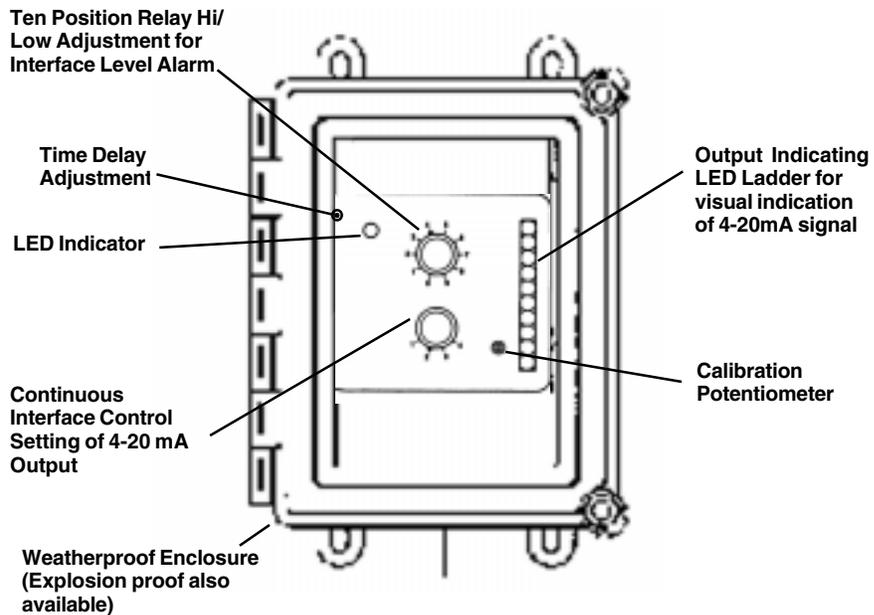
Though actual water concentrations corresponding to the four positions vary with the different characteristics of oil and water, the general ranges follow:

Position 1	0-25% Water
Position 2	0-50% Water
Position 3	0-75% Water
Position 4	0-100% Water

Dimensions/Features



Model 780 Interface Measurement System



Note: Dimensions -- Inches to the nearest tenth (millimeters to the nearest whole mm), each independently dimensioned from respective engineering drawings.

Theory of Operation

The INVALCO IMS Model 780 works on the principle of measuring an electrical value, called capacitance, that exists from its probe to ground. It does this by measuring the dielectric constant (dk) value of the material surrounding the probe and the distance from the probe to the nearest, and largest, ground plane which normally is the conductive water below the oil/water interface. The capacitance value will increase if the material dk increases, or if the water moves closer to the probe. Conversely, the capacitance will decrease if the material dk decreases, or if the water moves away from the probe. The main, dominating, factor is the distance from the probe to the water which thereby allows the IMS 780 to be a superior level indicator/control device. The unit is sensitive to extremely small changes (+/- 0.3 pf) and with a horizontally mounted probe, can be set to measure a clean interface as much as 24 inches away, depending upon fluid characteristics.

The use of capacitance to detect interface levels in many applications has always been complicated by the electrical conductivity of the fluids and the buildup of conductive materials on the probes. These cause changes in conductivity which are mistaken for changes in capacitance, resulting in a misinterpretation of the interface level, or instrument failure. Interference caused by changes in conductivity are virtually eliminated by the use of high frequencies in the INVALCO IMS detection circuit design. Normally, high frequency requires the use of special cable (coaxial) to carry the signal which introduces other complications. The high frequency oscillator and detection circuitry in the INVALCO IMS are mounted in the probe and overcome the need for special cable. The control unit can be remotely mounted up to 500 feet away.

Installation and Start-up

The Model 780 probe may be installed horizontally, vertically, or at an angle. A horizontally mounted probe will be able to detect an interface further away than a vertical or angle mounted probe due to the area of the probe which is parallel to the interface. A horizontally mounted probe will have the entire length and width of the probe's electrode parallel to and "looking down" to the interface while a vertical, or angle mounted probe will have only the circular area of the end of the probe electrode "looking down" to the lower interface.

Normally a horizontally mounted probe is used when it is desired to control an interface below the probe while a vertical, or angle mounted probe is used when it is desired to control the interface on the probe electrode proper. **For maximum safety, depressurize the vessel before installing or removing the probe.**

A single screwdriver calibration potentiometer is adjusted to set up the instrument.

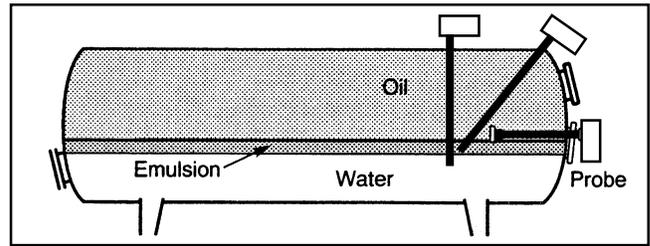


Figure 1 Various Probe Locations

The unit is composed two components:

1. The probe and detector unit, housed in an explosion proof conduit, mounted on the process vessel.
2. The control unit, housed in either a weather proof or an explosion proof housing, mounted remotely.

These two components are wired together with a four conductor, shielded cable. The length of this cable can be as long as 500 feet and may be altered to fit the conduit run.

Warning: Never perform electrical connections with power circuit live. To prevent personal injury and damage to the 780 electronics make all connections with 120 VAC power off.

Electrical Installation

The 780 requires 120 volts AC, 50 or 60 Hz, 50 mA at 6 watts. Connect the Hot wire to the "H" terminal and the Neutral wire to the "N" terminal on the control unit. Connect earth ground to the "G" terminal located next to the "N" terminal. (Figure 1)

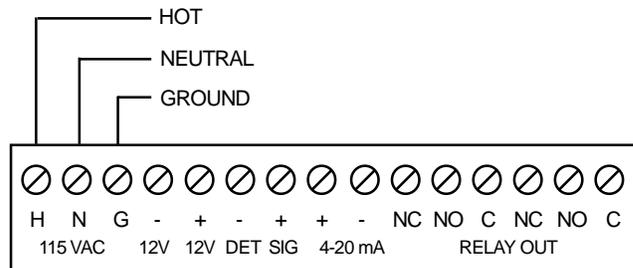


Figure 1

A monitoring device capable of accepting 4 to 20 mA can be connected to the output labeled "4-20 mA."

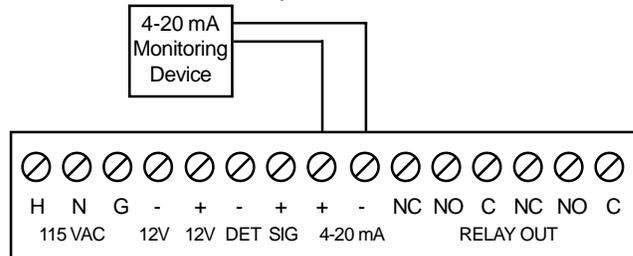


Figure 2

Two sets of Form C contacts are available for point level indication. Connect the indicating or control circuitry to the Common "C" and Normally Closed "NC" or the Normally Open "NO" terminals to get the desired output.

Caution: Do not make the probe to the 780 electronic connections while circuit is live. Remove power, connect probe and then reapply power.

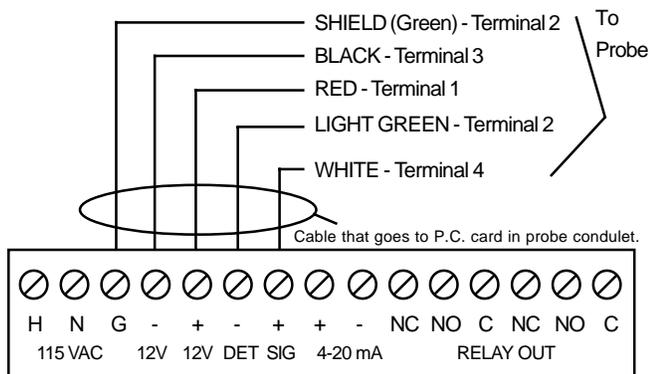


Figure 3

The cable connections are:

Color	Control Unit	Probe
Red	+12 Volts	Terminal 1
Light Green	Det. Sig. -	Terminal 2
Black	-12 Volts	Terminal 3
White	Det. Sig. +	Terminal 4
Green	G (Shield) or Det. Sig. -	Terminal 2

Caution: On some early IMS 780 Models, the -12 volt and the +12 volt terminals were opposite of those shown in this illustration. ALWAYS observe the polarity as marked below the terminal strip on the 780 instrument when connecting wires to the probe P.C. card.

Field Calibration

Field calibration is simple and easy. The reason for doing the field calibration is to "zero" out any electrical influence caused by piping, wires, etc. which may be locating internally in the vessel near the probe.

To Calibrate

1. Install probe into vessel per instructions on page 7 and 8.
2. Cover the probe with the upper material that it will "see" in operation.
 - (a) If the probe is going to be used as a liquid level control with air/gas above the liquid being measured, then the probe should be suspended in the air/gas above the liquid.
 - (b) If the probe is to be used to control an oil to water interface, then the probe should be covered with the oil.
3. Set both the Snap Acting Alarm Selector Switch and the 4-20mA Throttling Selector switch to position number one. Now take a small screwdriver and turn the field calibration pot (located on the lower right of the readout unit panel) until the Alarm

Indicator LED just goes off. Turning the field calibration pot counter clockwise will cause the LED's to come on. Turning the calibration pot clockwise will cause the LED's to go off. If using the 4-20mA output, you can use the bottom LED on the 4-20mA LED ladder instead of the alarm LED. Turn the pot until the bottom LED goes out and then turn the pot counter clockwise to make the bottom LED come on.

Unit is now calibrated. Use the snap acting and throttle switch to select the operating range desired.

Operation

The 780 can output in either the continuous mode, point level mode, or both depending on how it is wired.

Point Level Set Point (Snap Acting)

The point level selector is a 10 position switch. The 0 position is used for factory calibration and should be used when the 780 is detecting a low vessel level. Positions 1 through 9 are used to set the level of the control to sense the change in the interface, or as the liquid changes from one type to another. In the case of a Hydrocarbon-Water interface, position 1 is nearest to 100 percent hydrocarbon and position 9 is nearest 100 percent water.

To set the unit to measure an interface, observe the following instructions:

1. From the materials that need to be detected, select the material with the highest dielectric constant (Dk).
2. Adjust the material level until the probe is covered with the material selected in Step 1.
3. Adjust the Point Level Selection Switch until the Point Level LED Indicator goes off, then turn the switch back the opposite direction one position.
4. Turn the relay time delay adjusting knob, located in the upper left corner of the front panel in the direction as marked by the arrows to change the length of delay desired for relay actuation after the level reaches the preset actuation point. This feature is useful to eliminate false relay actuation, or chattering, due to liquid wave actions in the vessel.

It is possible to adjust the level that will trip the unit by just adjusting the point level switch up or down. Using this idea, it is possible to have a "High" or "Low" Level Alarm.

Any position on the Point Level switch that is lower number than is currently set is the "Low Level Alarm" and any number higher than the current setting is the "High Level Alarm." In the case where a "Low Level Alarm" is selected, the Point Level LED Indicator will normally be on and will go off when the level drops below the probe. In the case where a "High Level Alarm" is selected, the Point Level LED Indicator will normally be off and will come on when the level covers the probe. When the instrument is installed, the wiring will need to be done to provide these effects.

Continuous Range 4-20 mA (Throttle)

The continuous range selector is a 4 position switch that allows for the selection of one of four continuous ranges.

Position	Span	Percent Water
Position 1	10-1	0-25%
Position 2	20-1	0-50%
Position 3	30-1	0-75%
Position 4	40-1	0-100%

The continuous ranges are expressed in ratios of the dielectric constant (Dk) of the two materials to be measured or the percent water in the hydrocarbon.

Example:

- Liquid A has a Dk of 2 and Liquid B has a Dk of 20, then the span is 10 to 1 which corresponds to Position 1.
- If Liquid A has a Dk of 2 and Liquid B has a Dk of 40, then the span is 20 to 1 which corresponds to Position 2.
- If Liquid A has a Dk of 2 and Liquid B has a Dk of 45, then the ratio is slightly more than 20 to 1, but less than 30 to 1, so the switch position stays at Position 2.

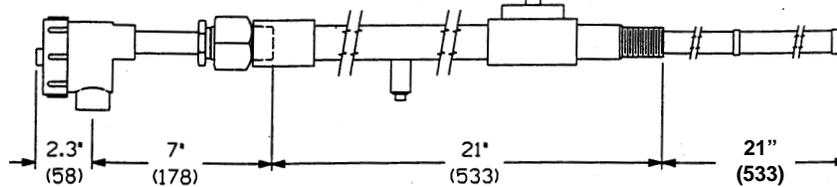
If unsure of the dielectric constants of the liquids, use trial and error to select the switch position that gives the desired outputs.

NOTE: Both the Point Level and the Continuous select switches can be matched to span from 100 percent hydrocarbon to 100 percent water. By setting the Point Level selector to position 10, and the Continuous selector to position 4, both span over the 0 to 100 percent water in hydrocarbon range simultaneously. The row of LED's indicate the increasing water in hydrocarbon concentration from bottom to top. As the top LED indicates the approach of the full continuous span (approximately 100 percent water), the control will generate the full 20 mA continuous and point level output signal at the same instant.

IMS 780 Probe

with Extension Pipe, Full open ball valve and drain port

p/n P514019



Note: Dimensions – Inches to the nearest tenth (millimeters to the nearest whole mm), each independently dimensioned from respective engineering drawings.

Warning: For maximum safety, depressurize the vessel before installing or removing the probe.

Installation of Probe

Installation Procedures for Probe (p/n P51409) with Extension Pipe and Shut-Off Valve

1. Mount 1" collar for probe on vessel at desired location.
 2. Loosen packing follower from hex-headed mounting hub. Slide packing follower back to probe conduit. See Figure A on page 4.
 3. Unscrew mounting hub from collar.
 4. Remove piping assembly from probe. Screw piping assembly into collar on vessel. Be sure drain connection is pointed downward after installation.
 5. Pull probe backward through mounting hub until front retaining ring contacts front of mounting hub.
 6. Open ball valve. Then insert probe into piping assembly. Tighten mounting hub into collar.
 7. Slide probe completely into vessel until rear retaining ring (not shown) contacts the inside of the mounting hub thus preventing probe from going further into vessel. After checking to be sure the conduit is oriented as desired, screw packing follower tightly into mounting hub.
- Note:** The use of flexible conduit is recommended for probe hook-up so probe can be easily removed from piping assembly in future if needed for inspection, cleaning, etc.
8. Probe should now be ready for field calibration and to be put into service.

To remove probe p/n P51409

If possible, vessel should be depressurized. Please note that the inserted probe has a cross-sectional area of approximately .5 square inch. Vessel pressure will be trying to push the probe out by a force equal to almost 50% of the vessel pressure. Example: A vessel pressure of 100 lbs. will create an ejection force of almost 50 lbs. on the probe end. Caution and discretion should be used. Stand to side of probe. DO NOT stand directly behind the probe during removal. DO NOT loosen mounting hub.

1. Loosen packing follower. If vessel is pressurized, watch to see if probe is exiting by vessel pressure or if you need to pull it out. In either case, the probe should be extracted until the front safety retaining ring contacts the front of the mounting hub.
2. Now close the ball valve, thus isolating the probe and portion of piping behind the ball valve from the vessel. Slowly unscrew the drain plug to release any trapped pressure and to drain any fluid in piping.
3. After all pressure is vented and fluid drained out, you can unscrew the mounting hub from the collar and remove the probe from the piping assembly. Cleaning, inspection, etc. of the teflon covered sensing element of the probe can now be done.
4. To reinsert/install probe back into the vessel-
 - a) Slide mounting hub toward teflon covered electrode until hub hits front safety ring.
 - b) Screw mounting hub securely into collar on probe piping assembly.
 - c) Screw drain plug tightly into drain.
 - d) Slowly open ball valve to full open position.
 - e) Slide/push probe into vessel until rear safety ring contacts inside of mounting hub. Screw packing follower into hub to secure probe. Remember, vessel pressure will be opposing you as you push the probe back into the vessel.

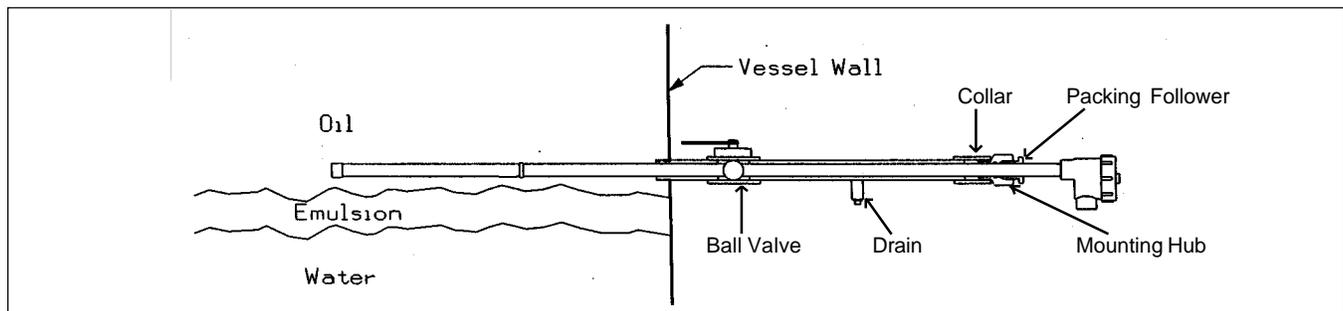
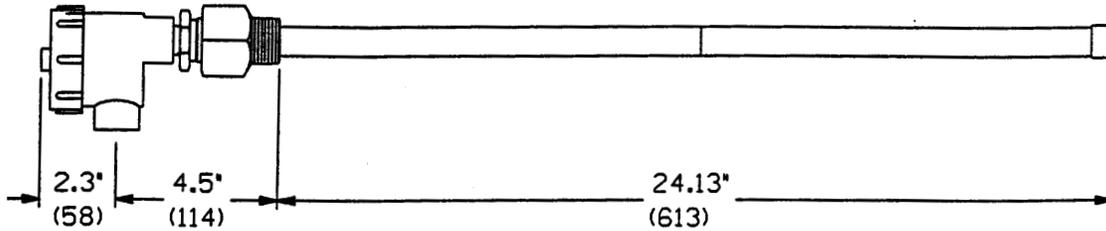


Figure A
Probe Mounting on Vessel Wall Through a 1" NPT Ball Valve

IMS 780 Probe
without extension pipe
p/n 81001059



Warning: To prevent possible injury or damage never install or remove probe while vessel is pressurized.

Installation of Probe (p/n 81001059) that does not have the extension piping assembly.

1. Mount 1" collar on vessel at the desired location.
2. Install a 1" full opening valve onto collar.
3. Unscrew packing follower (on probe) from mounting hub.
4. Pull probe backward through mounting hub until stainless steel ring on end of teflon covered element contacts front side of mounting hub.
5. Screw mounting hub into valve previously attached to vessel.
6. Push probe into vessel until safety retaining ring (on probe s/s tubing) contacts rear of mounting hub.
7. Slide packing nut forward and screw securely into rear of mounting hub.
8. Probe should now be ready for field calibration and to be put into service.

Notes:

1. The use of flexible conduit is recommended for probe hook up so the probe can be easily removed in the future, if needed, for cleaning, inspection, etc.
2. The probe has a cross sectional diameter of almost .5 sq. in. This means that approximately 50% of vessel pressure will be trying to push the probe out at all times. This pressure will be bucking you when you install the probe and will be trying to eject the probe when you are removing it. So use caution.

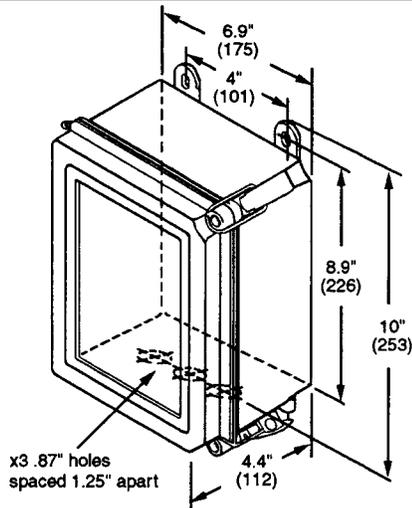
Do not stand behind the probe during installation or removal.

Do not unscrew the packing nut from the mounting hub until you have secured the probe, if the vessel is pressurized.

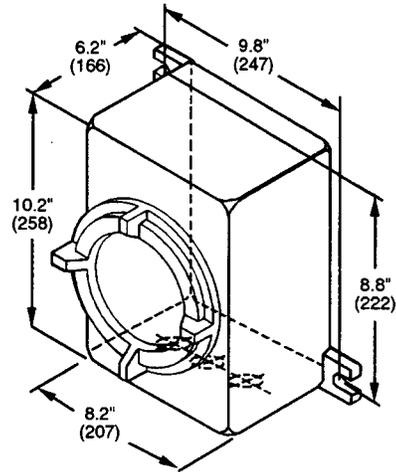
For safety purposes, INVALCO recommends depressurizing the vessel during installation or removal of the probe.

Dimensions

Inches (mm)



NEMA 4X Weatherproof Housing



NEMA 7 Explosion-Proof Housing

System with Probe without Extension Pipe Assembly

Model No.	110VAC 50/60 Hz	Part Number
Model 780-XP	Interface Measurement System - Explosion-proof - NEMA 7, w/Probe and 20 ft. of Cable	81001055
Model 780-WP	Interface Measurement System - Weatherproof - NEMA 4X, w/Probe and 20 ft. of Cable	81001057
	Probe Assembly c/w PC701 Detector Card	81001059

Model No.	220VAC 50/60 Hz	Part Number
Model 780-XP	Interface Measurement System - Explosion-proof - NEMA 7, w/Probe and 20 ft. of Cable	81001052
Model 780-WP	Interface Measurement System - Weatherproof - NEMA 4X, w/Probe and 20 ft. of Cable	81001053
	Probe Assembly c/w PC701 Detector Card	81001059

Model No.	24 VDC	Part Number
Model 780-XP	Interface Measurement System - Explosion-proof - NEMA 7, w/Probe and 20 ft. of Cable	81001054
Model 780-WP	Interface Measurement System - Weatherproof - NEMA 4X, w/Probe and 20 ft. of Cable	81001152
	Probe Assembly c/w PC701 Detector Card	81001059

Chassis	110 VAC 50/60 Hz includes Relay LED Ladder	81001050
Chassis	220 VAC 50/60 Hz includes Relay LED Ladder	81001049
Chassis	24 VDC includes Relay LED Ladder	81001151
Probe	Std. Probe Only, No Detector Card, No Extension Pipe	81001060
Detector	PC701 Detector Card Fits All Probes	49020038

System with Probe with Extension Pipe Assembly

Model No.	110 VAC 50/60 Hz	Part Number
Model 780-XP-E	Interface Measurement System - X.P. NEMA 7 w/Probe with Ext. Pipe, Valve, 20' Cable	P514037
Model 780-WP-E	Interface Measurement System - Weatherproof - NEMA 4X, w/Probe and 20 ft. of Cable	P514987
	Probe Assembly c/w extension pipe, valve, drain, and PC701 Detector Card	P514019

Notes on probe P/N P514019:

- The extension pipe is one inch, complete with a full opening one inch ball valve (for isolation purposes) and a 1/4" drain with plug.
- The probe used with the extension pipe has two welded on safety rings, one on each end, to preclude the expulsion of the probe by pressure. The probe is removed from the vessel by loosening the packing nut behind the mounting hub and pulling the probe out until the front safety ring hits the forward end of the mounting hub. The ball valve is then closed and the drain opened. After pressure is released, and fluid drained out, the mounting hub is unscrewed from the collar on the extension pipe allowing the probe to be removed.

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The specifications contained herein are subject to change without notice and any user of said specifications should verify from the manufacturer that the specifications are currently in effect. Otherwise, the manufacturer assumes no responsibility for the use of specifications which may have been changed and are no longer in effect.

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