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MODEL HIR-A HIGH TEMPERATURE CLAUS REACTOR INFRARED PYROMETER

INSTALLATION AND OPERATION INSTRUCTIONS
WITH RECOMMENDED SPARES LIST

MODEL NUMBER: HIR-A - _____ - _____ - _____ - _____ - _____
(RANGE) (HOUSING) (CABLE LENGTH) (FLANGE) (OPTION)

SERIAL NUMBER: _____

PROCESS CONNECTION SIZE & TYPE: _____ **RANGE:** _____

SENSOR / ELECTRONICS HOUSING: _____

FIBER OPTIC CABLE LENGTH: _____ **OPTIONS:** _____

CUSTOMER: _____

PURCHASE ORDER NUMBER: _____

TAG NUMBER(S): _____

RECOMMENDED SPARE PARTS:

NONE

MODEL HIR HIGH TEMPERATURE

INFRARED PYROMETER

I. GENERAL DESCRIPTION

The model HIR is an infrared temperature transmitter specifically designed to measure the refractory temperature of Claus Process thermal reactors.

Theory of Operation

The model HIR uses infrared pyrometry to measure temperature. All materials radiate energy as a function of their absolute temperatures. The Model HIR "looks" into the reactor and senses the amount and spectrum of the infrared energy being emitted by the hot face of the refractory. The sensed energy is converted into a signal, which can be used to accurately display the refractory operating temperature.

Considerations when using Infrared Pyrometry to measure Claus Thermal Reactor Temperature

In order to effectively measure temperature, the instrument needs a clear, unobstructed view into the vessel. The infrared energy must pass through the reacting gases without being absorbed by them. The instrument must "look" through those same gases without seeing them or sensing their high temperatures. This feat is accomplished by the use of optical bandpass filters. The selected sensing spectrums avoid errors due to absorption, reflection, etc.

A potential problem of using infrared pyrometry in a Claus thermal reactor is that sulfur or other solids can accumulate on the window or in the nozzle, blocking the infrared radiation, requiring expensive maintenance to clean the window and optical path. The Model HIR is designed to be nearly maintenance free; When properly installed and operated, it maintains the lens, sighting window, and nozzle at a sufficiently high temperature to avoid sulfur buildup and the need for periodic cleaning.

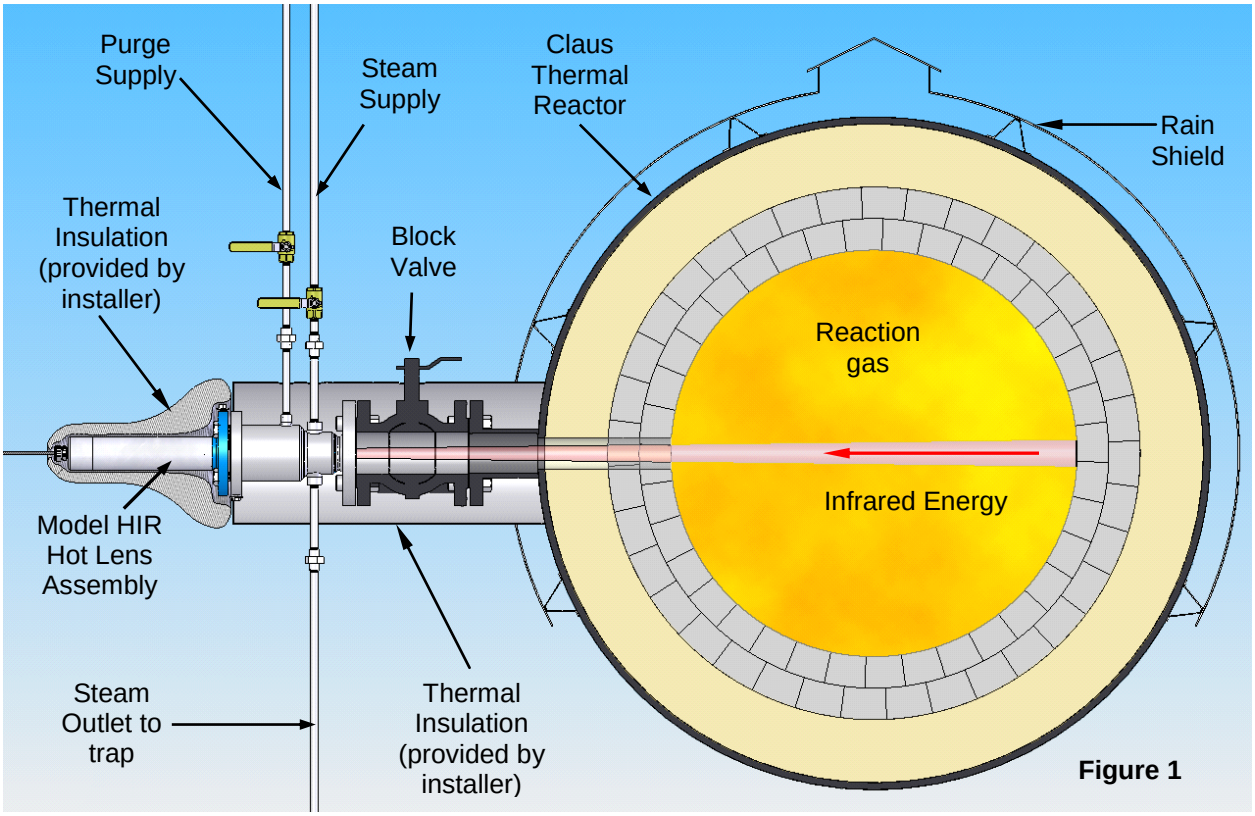

Figure 1

2. INSTALLATION

Figure 2 shows a typical installation. The HIR features a unique “Hot Lens” assembly that is mounted directly to the block valve, which is mounted on the vessel nozzle flange. The Hot Lens assembly is normally furnished in either a 2” or 3” flanged process connection size. Check to see that the size and type flange on the nozzle block valve matches the hot lens-mounting flange received. If the connections do not match, contact Delta Controls to secure a unit with the necessary nozzle connection size and type.

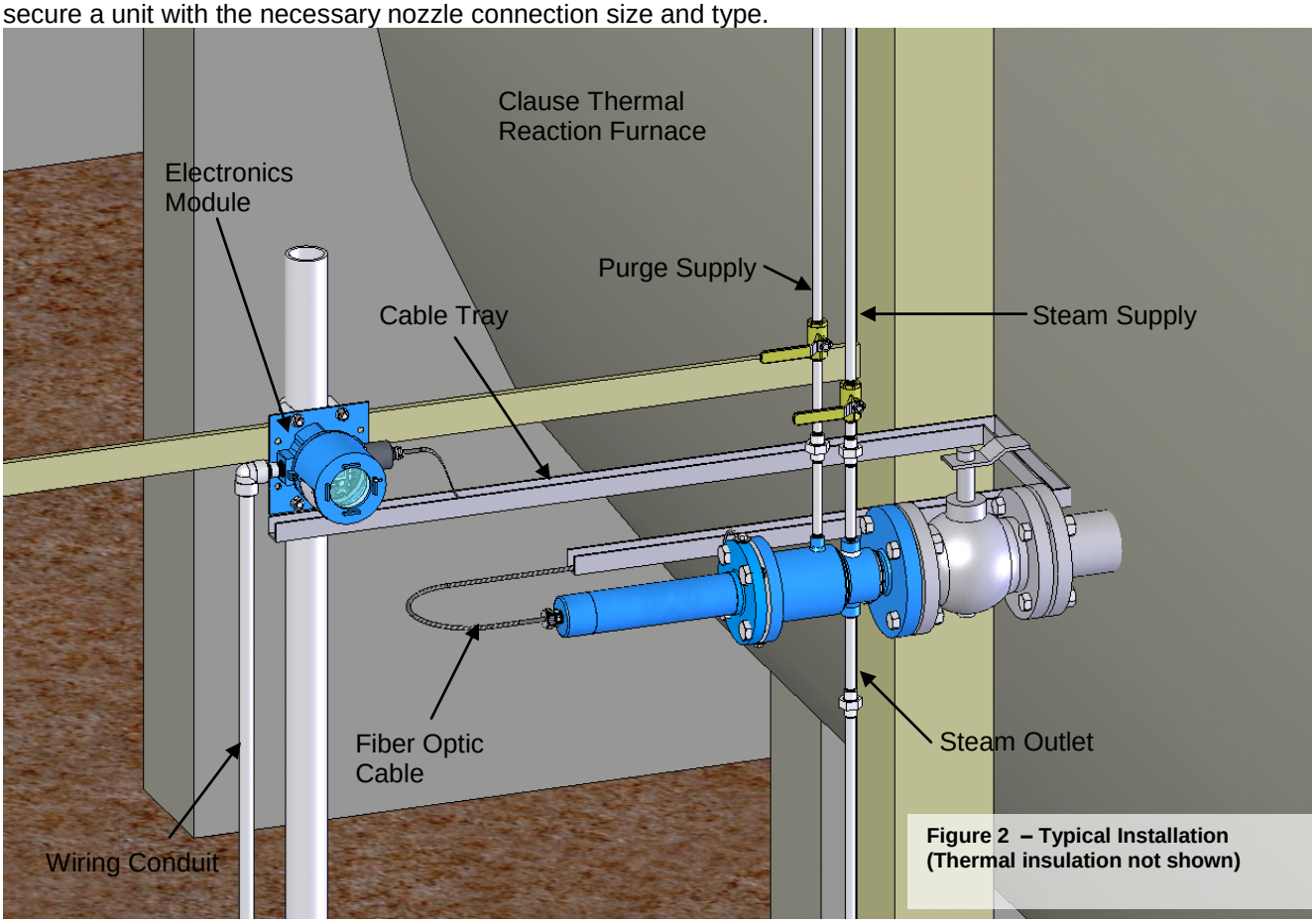

Figure 2 – Typical Installation (Thermal insulation not shown)

2.1 Mounting the Hot Lens Assembly

Check the operation of the block valve mounted on the vessel nozzle while the unit is down. Insure that it operates smoothly and properly. Replace the valve if it appears to bind or if, there is any indication that it may leak. Close the valve (it will be opened after the reactor reaches operating temperature of over 300°C (1472ºF).

Bolt the flange of the Hot Lens Assembly to the valve flange with the 1/8” NPT purge port at the top.

2.1.1 Steam Supply

Long-term reliability of this instrument requires the use of steam to maintain the temperature of the window and nozzle above the melting point of sulfur. Failure to maintain a high enough temperature can allow sulfur to solidify and build up on the window and nozzle surfaces, blocking the light and causing inaccurate temperature readings. Connect the steam lines (in accordance with the best practices of your plant) to the upper (inlet) port and connect a bucket type steam trap to the lower (outlet) port of the assembly. The standard steam port connections are 1/4” NPT. Insulating the steam lines is recommended, though not shown in Figure 1.

2.1.2 Lens Purge

Figure 3 HFI Flush Gas Control Station

A 60 SCFH (28L/min) flow of purge gas to the Hot Lens Assembly is required. Insure that the supply of purge gas is clean, oil free and dry. Any moisture or hydrocarbons in this purge gas may cause the inside of the lens window to coat. A coating will prevent some of the infrared energy from reaching the sensor, causing a low temperature reading to occur, and window cleaning to be required. Use a rotameter with a needle control valve suitable for a flow rate of approximately 10 – 90 SCFH air (.03-2.5 m^3/h). Connect the purge gas supply to the 1/8" NPT fitting on the top of the Hot Lens Assembly. Regulate the purge supply to 15 PSIG (1 Bar). Delta Controls recommends using the Model HFI (Figure 3) as it provides a conveniently packaged assembly of the necessary purge supply components. Connection of the Model HFI is shown in Figure 4.

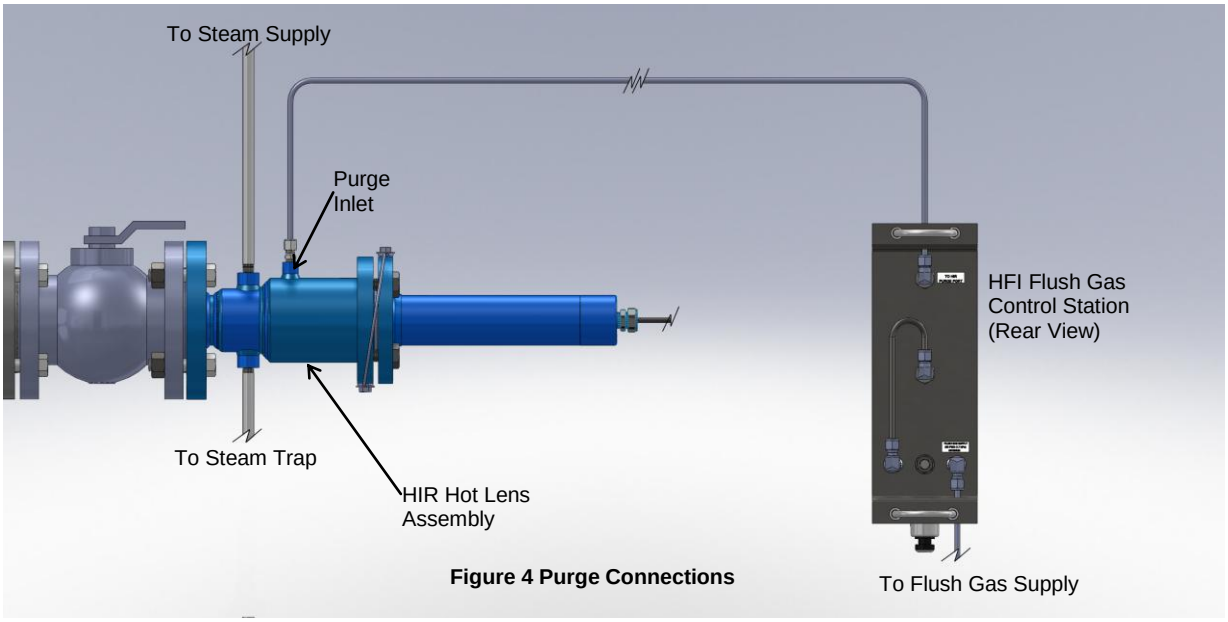

Figure 4 Purge Connections

2.2 Thermal Insulation

To prevent sulfur from plugging the optical path, it is important that a temperature above 250˚F (121˚C) be maintained on the nozzle, block valve, and hot lens assembly. In most cases, the heat from the reactor and steam body are not sufficient to keep the temperature of the valve and lens assembly above this temperature unless they are insulated. It is important, therefore, that insulation be installed around the nozzle, valve, and lens assembly, as shown in Figure 1, in accordance with the best practices of your plant. Adequacy of the insulation should be tested by verifying that the lens assembly flange and the block valve body are above 250˚F (121˚C) under the most unfavorable conditions (wind, rain, snow, etc.)

2.3 Installing the Electronics Housing

A mounting location must be provided nearby for the electronics module. Choose a location that is protected from the heat of the reactor, such that the maximum ambient temperature of the electronics is not exceeded. For convenience in performing optical alignment, the electronics display should be visible to an operator standing at the hot lens assembly.

2.3.1 Remote Sensor mounting – Option RS

Under some circumstances, it is impractical to mount the electronics close to the lens body. Extending the fiber optic cable is not possible, due to losses that would occur in a longer fiber. However, it is possible to mount the electronics housing farther from the lens body by mounting the fiber optic adapter (Figure 5) at the end of the 10' (3m) fiber optic cable, and extending the sensor wires back to the remotely mounted electronics housing, as shown in Figure 6.

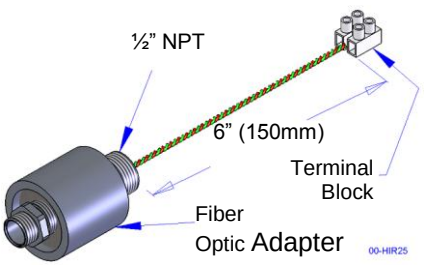

Figure 5 Fiber Optic Adapter

The following considerations should be observed when remotely mounting the fiber optic adapter:

- The fiber optic adapter must be mounted in a location with an ambient temperature of 0 to 185˚F (-20 to +85˚C)
- The recommended maximum extension is 25 ft. (8m). Further extension should be possible, but has not been tested.
- Run a single twisted pair between the fiber optic adapter and the electronics housing. The twisted pair MUST be run through metallic conduit.
- Do not run other wires in the same conduit with the sensor wires.
- Conduit should be appropriate for the area classification. Seals should be installed near the electronics housing, in accordance with governing code.

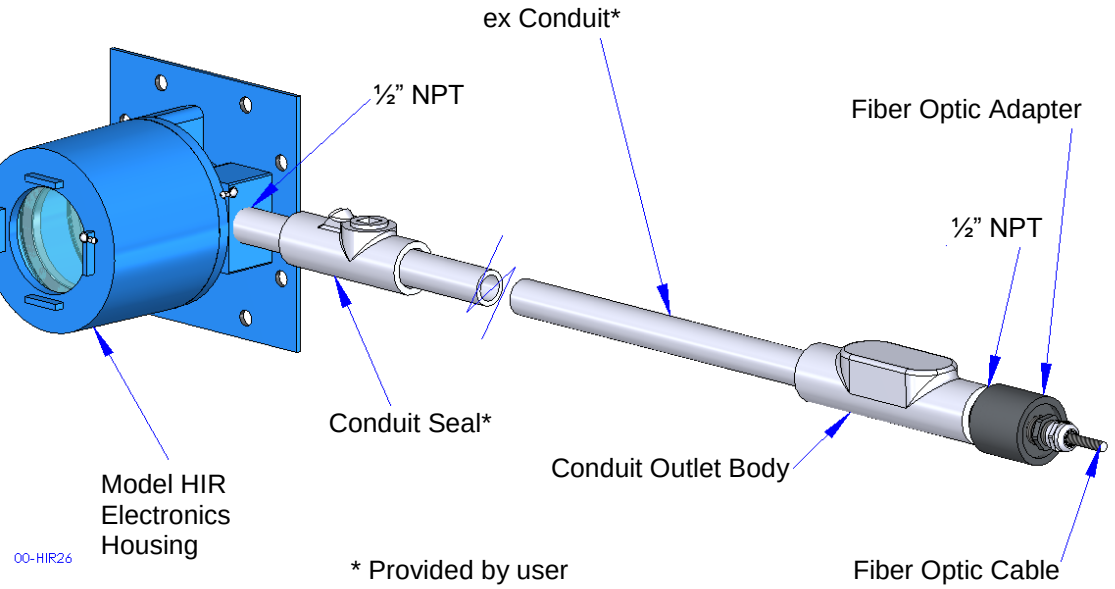

Figure 6 Typical Installation of Remote Fiber Optic Adapter

Unless stated on the cover page of this manual, the loop wiring conduit connection on the model HIR is ¾" NPT. Unless the 'RS' option is specified, the fiber optic adapter is normally factory installed in a ½" NPT opening in the housing. A ¾" NPT connection is located on the bottom of the housing, covered by the pipe stand mounting plate. This connection is normally plugged and not used.

Wire the electronics module in accordance with local governing code.
A green external earthing screw is located near the threaded conduit entry. An internal green earthing screw is also provided inside the housing. To connect to the internal earthing screw, you must first move the electronics module out of the way by removing the two screws holding the module down. Replace the module and hold-down screws after connecting the earth ground conductor.

Note: If, for any reason, the fiber optic adapter must be unscrewed from the electronics housing, first make sure the fiber optic adapter sensor wires are disconnected from the electronics module terminals.

2.3.2 Flameproof Installation

When type 'd' flameproof protection is employed, wire the HIR as shown in Figure 7 or Figure 8. Use certified cable glands and conduit seals for all flameproof installations.

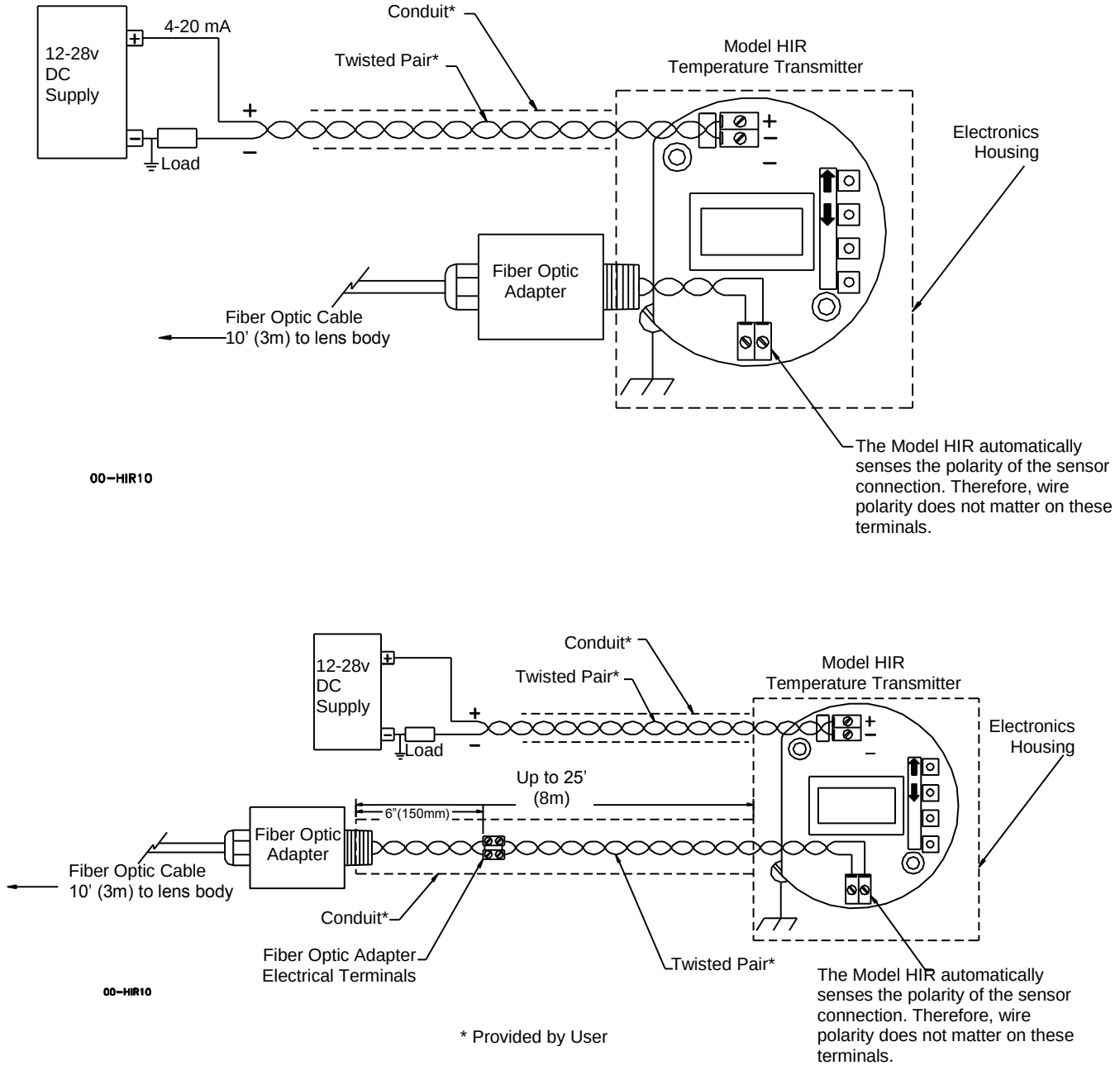

Figure 8 Typical Wiring - Remote Sensor, option RS

2.4 Connecting the Fiber Optic Cable

Use care in handling the fiber optic cable. Even though it is armored, sheathed, and sealed for durability, individual glass fibers within the cable can be damaged my mishandling. Avoid dropping, shocking, kinking, pulling, or sharply bending the cable. When routing the fiber optic cable, it is important to observe the minimum bend radius specification. Bending the fiber optic cable more sharply than specified can result in low temperature readings due to excessive infrared energy losses in the cable.

The fiber optic cable is connected to a sensor in the fiber optic adapter as shown in Figure 9:

1. Insert the cable into the fiber optic adapter. The cable must be inserted all the way to the bottom of the adapter hole in order for the cable grip to seat and to avoid calibration errors.

2. Tighten the cable grip to seal the cable against moisture.

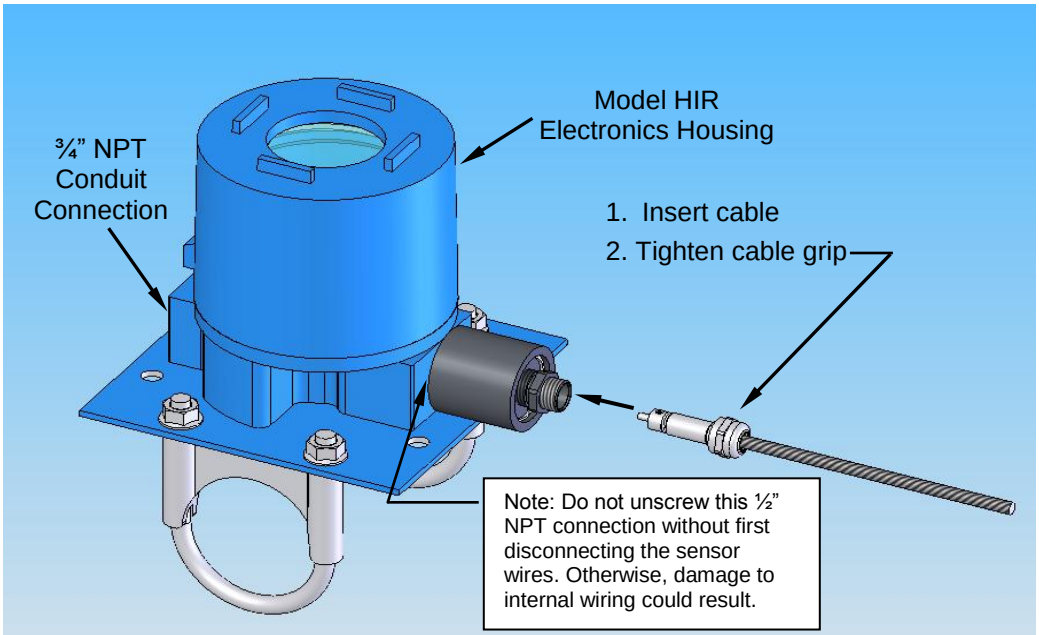

Figure 9 – Inserting the Fiber Optic Cable

2.5 Optical Alignment

The fiber optic lens is aligned at the factory to look straight down the bore of the nozzle. Because a variety of installation issues can cause misalignments of the lens with the nozzle, the alignment should be visually checked prior to relying on the instrument. This alignment check is only possible when there is light inside the reactor vessel, either with the vessel opened and lighted prior to operation, or from the light from the reaction after startup.

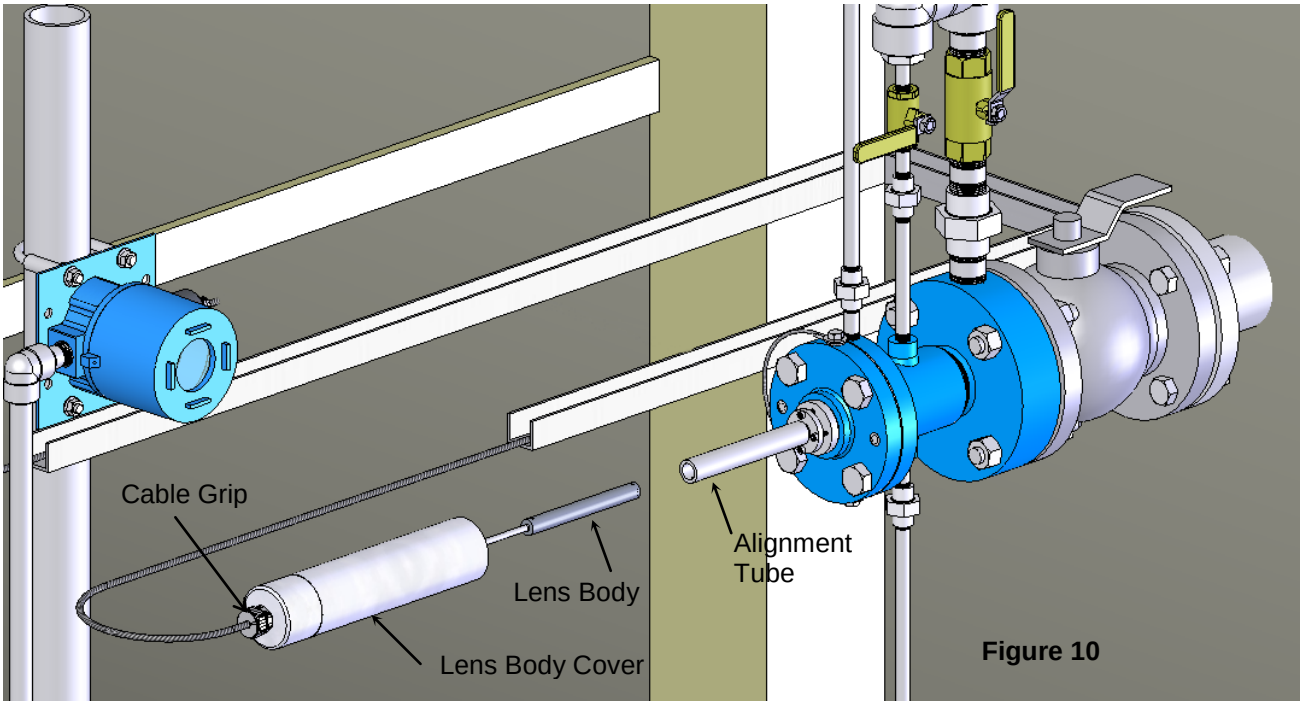

Figure 10

To view the optical path:

1. Loosen the cable grip holding the fiber optic cable.
2. Unscrew the lens body cover and slide it down the fiber optic cable. Be careful not to allow the weight of the cover to damage the fiber optic cable.
3. Loosen the hex setscrew that holds the lens body in the alignment tube.
4. Slide the lens body and fiber optic cable out of the alignment tube.
5. Open the block valve.
6. You can now sight down the alignment tube and through the window into the reaction chamber.

The light from the reaction vessel should appear centered in the alignment tube. If it is not, the alignment tube should be aligned as follows:

7. Loosen the four hex screws that hold the alignment ball.
8. Manually adjust the alignment tube until the light from the reaction chamber is centered.
9. Tighten the four hex screws holding the alignment ball.
10. Re-check the alignment to make sure the tube didn't move while tightening the alignment ball screws.

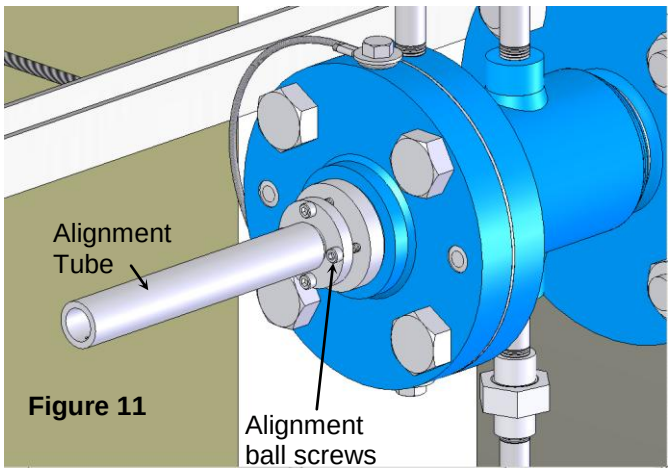

Figure 11

3 OPERATION

Caution: When used with type 'd' flameproof protection, do not open the cover when circuits are energized and hazardous gasses might be present.

The Model HIR user interface consists of an LCD display and 4 setup pushbuttons. The temperature characteristics of the display are such that you should only calibrate the unit when the ambient temperature is between 0°F and 140°F. Outside this temperature range, the transmitter will operate properly, but the display may be difficult to read.

Pushbuttons

↑ Pressing the UP button causes the value displayed to be incremented. Holding the button down causes the value to continue upward at an ever-increasing rate.

↓ Pressing the DOWN button causes the value displayed to be decremented. Holding the button down causes the value to continue downward at an ever-increasing rate.

NEXT Pressing this button shifts the display to the next setup parameter.

SAVE Pressing the SAVE button saves all calibration values and setup parameters. The display will indicate "Saving..." to verify that the values are being saved.

3.1 Setup Parameters

IR Temp	This parameter displays the temperature as measured by the infrared sensor. While displaying this parameter, use the up and down arrows to increase or decrease the displayed temperature. Adjusting this value automatically calculates a new emissivity value. Press Save to save any adjustments that have been made. Note: Beginning in revision 1.9J, In order to prevent inadvertent changes to the calibration, you must first unlock the adjustment feature by pressing and holding the NEXT button while simultaneously pressing the DOWN button.
Units	This parameter sets the units of measure for temperatures. Use the up or down arrows to toggle between degrees Celsius and degrees Fahrenheit .
4mA =	This is the zero scale temperature, i.e., the temperature corresponding to 4.00mA loop current
20mA	This is the full scale temperature, i.e., the temperature corresponding to 20.00mA loop current
The following parameters are normally used only during factory setup. They can only be accessed by pressing and holding the NEXT button while simultaneously pressing the UP arrow. **CAUTION:** accessing these parameters can result in at least momentary disruption of the transmitted 4-20mA signal as described below under Zero Adj and Span Adj.	
Version	Software/Hardware Revision number
IR Raw	Factory Use only
IR Volts	Factory Use only
Cal T1	Factory Use only
Cal V1	Factory Use only
Cal A	Factory Use only
Cal B	Factory Use only
Em Corr	Emissivity correction factor. This value also corrects for other factors that can attenuate the light received by the detector. This value can be adjusted with the up and down arrows, but it is also automatically calculated whenever the "IR Temp" parameter is adjusted.
Filter	This parameter is used to adjust the dampening or averaging of the temperature measurement. A value of 1 provides no filtering. Higher values increase the amount of filtering.
Sensor	Sensor Type –C,D, or E. Note: changing this value will **erase** the factory calibration.
LowCutoff	Temperature below which the unit will not read.
Zero Adj	When this parameter is accessed, the instrument immediately transmits a value corresponding to 0 scale or 4 mA. Adjust this parameter up or down until the device measuring the output current indicates exactly 4.00 mA **CAUTION:** Accessing this parameter will cause the transmitter to stop transmitting temperature and instead transmit Zero Scale. Be sure that any equipment connected to this transmitter is prepared for the disruption in the temperature signal level before accessing this parameter.
Span Adj	When this parameter is accessed, the instrument immediately transmits a value corresponding to full scale or 20 mA. Adjust this parameter up or down until the device measuring the output current indicates exactly 20.00 mA. **CAUTION:** Accessing this parameter will cause the transmitter to transmit Full Scale Temperature. Be sure that any equipment connected to this transmitter is prepared for the disruption in the temperature signal level before accessing this parameter.
MemCmd	Factory Use only

3.2 Initial startup

- Make sure the nozzle block valve is closed. This will prevent any foreign matter from collecting on the viewport window during refractory dry out, curing and hydrocarbon firing.
- Establish steam flow to the hot lens assembly and insure that the trap is functioning properly. This assures that condensation will not accumulate on the viewport during refractory dry out and unit startup.
- After verifying that the hot lens assembly is up to temperature, Open the Block Valve. It is important to keep the block valve closed until operating temperature is reached in order to prevent sulfur from condensing and solidifying on the window.
- Turn the purge gas pressure on. Set the purge rotameter needle control valve at approximately 60 SCFH (1.7 m^3/h) of gas to the hot lens assembly.
- Apply power to the electronics module. The “IR Temp” value will be displayed.
- Press NEXT. The “Units” parameter will be displayed
- Press the UP or Down Arrow to toggle between degrees Celsius or Degrees Fahrenheit as desired.
- Press NEXT. The “4mA=” parameter will be displayed
- Press the UP or DOWN arrows to set the temperature corresponding to 4.00mA loop current.
- Press NEXT. The “20mA=” parameter will be displayed.
- Press the UP or DOWN arrows to set the temperature corresponding to 20.00mA loop current.
- Press SAVE to save all changes. The display will briefly indicate “Saving…”
- Press NEXT. The Temperature will be displayed.

3.3 Emissivity Adjustment

Claus Thermal reactors behave very much like what physicists refer to as ‘black bodies’. As such, the emissivity of a Claus thermal reactor at uniform temperature should ideally be very nearly 1.0. In practice, many system variables can reduce the infrared energy sensed by the instrument, resulting in lower than expected temperature readings.

The model HIR can easily be adjusted to compensate for these factors, whether they are caused by emissivity changes or other conditions in the system. This should only be done when the actual temperature in the reactor is known, usually by comparison to a thermocouple or other temperature sensor in the reactor.

To adjust the instrument reading, simply press the UP or Down button while displaying the ‘IR TEMP’ parameter. A new emissivity value will be calculated to match the displayed temperature. When the temperature is reading correctly, press SAVE to save the new emissivity value. **Note:** Beginning in revision 1.9J, In order to prevent inadvertent changes to the calibration, you must first unlock the adjustment feature by pressing and holding the NEXT button while simultaneously pressing the DOWN button.

3.4 Preventive Maintenance

The Model HIR is designed to give years of trouble-free operation without the need for service. In most cases, to achieve this performance, the only requirement is that the optical path (nozzle, valve, window) temperature be maintained above the freezing point of sulfur, and that the window purge be maintained to keep the window free of particulates. Thus, a preventive maintenance schedule should include periodic inspections to verify:

1. that the steam supply is on, the steam trap is functioning, and steam is heating the lens body,
2. that the window purge is flowing at the recommended flow rate (60SCFH),
3. and that the thermal insulation as shown in Figure 1 is in place and in good condition.

If it is determined that the optical path temperature or purge has been compromised, the window should be inspected to see if it needs to be cleaned. (refer to “viewing the optical path” in section 2.5 Optical Alignment)

3.5 Calibration

It is recommended that the calibration be checked after 1 year and every 2 years after that, or any time an anomaly is suspected. The easiest way to check the calibration or recalibrate the instrument is with a ClausTemp model HIP handheld pyrometer. See www.claustemp.com/00-hip01.htm

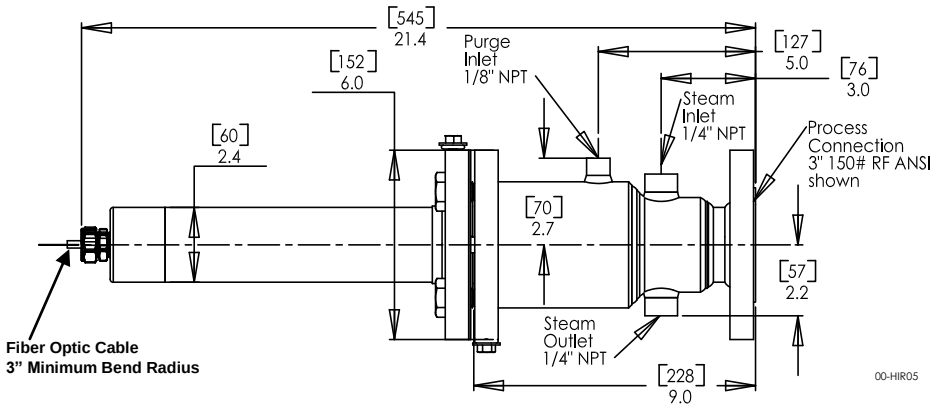

Figure 12 - Dimensions – Hot Lens Assembly

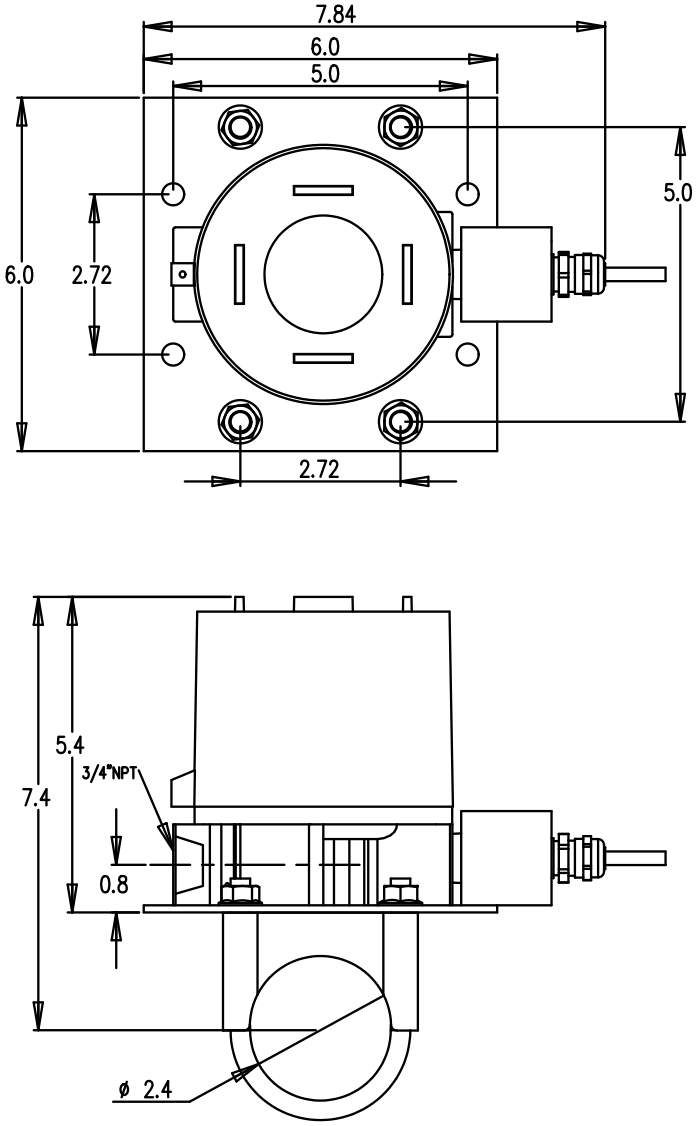

Figure 13 - Dimensions – Electronics Housing

4 SPECIFICATIONS

Range	
“C” Range	800ºC to 1700ºC (1472ºF to 3092ºF)
“D” Range	300ºC to 1700ºC (572ºF to 3092ºF)
“E” Range	400°C to 1700°C (752°F to 3092°F)
Accuracy	0.5% of reading or ±5ºC (20°F), whichever is greater
Repeatability	0.1% of full scale span
Warm-Up Time	60 seconds
Readout:	High Contrast LCD Display;
Output Signal:	4-20 mADC, 2 wire loop
Hazardous Location Rating	II 2 G Ex d IIC T6 when installed per section 2.3.1 IP65
Fiber Optic Cable:	Flexible PTFE over SS armor; 3M (10’) is the standard length.
Minimum Bend Radius	7.5cm (3 inch)
Hot Lens Mounting:	On a flanged nozzle; steam jacketed 3” ANSI is standard: other types and sizes available
Ports:	
Steam Jacket in and out	For 50-100psi (344-690kPa) steam to heat the hot lens assembly
Nitrogen Purge	60SCFH (28L/min) typical
Housing Mounting:	On a vertical surface or a 2” pipe stand with vertical or horizontal orientation
Housing Conduit Connection	¾” NPT on side, another ¾” NPT on back is normally plugged.
Ambient Temperature Limits:	
Fiber Optics & Lens	-30°C to 200°C (-20°F to 400°F)
Fiber Optics Adapter	-20°C to 85°C (-4°F to 185°F)
Electronics:	-20°C to 70°C (-4°F to 158°F)
Maximum Process Pressure	150psi (1000kPa)

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