ENGLISH

Model HTS

INSTALLATION, OPERATION & MAINTENANCE MANUAL

Delta Controls CORPORATION

00-HTS Rev F
16 April 2024

Before installation and operation, please read this manual and take note of all safety instructions. Wear required personal protective equipment during installation, operation, and maintenance. Use this product only if it is in good condition. Delta Controls Corporation is not liable for damage caused by improper or non-designated use.

Delta Controls Corporation reserves the right to modify technical data without prior notice.

Engineered Reliability

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SPECIFICATIONS

1. Components of the HTS Claus Thermal Reactor Thermocouple System

Failure to utilize these components will reduce the life of the HTS and may cause failure.

The following listed components are required for proper installation of the HTS.

HTS	HNP	HFS
		
Thermocouple for Sulfur Processing Service, Compact	Refractory Nozzle Packing Kit	Flush Gas Station (usually shipped separately)
Thermocouple assembly with mounting flange, body, flush connections, terminal enclosure housing and primary thermowell.	Rigid and compressible disks for proper insulation of the nozzle, and is designed to prevent the buildup of sulfur in the nozzle.	Includes flow meter with needle control valve, pressure regulator, filter, and gauge on stainless steel panel with mounting hardware.

2. Pre-Installation

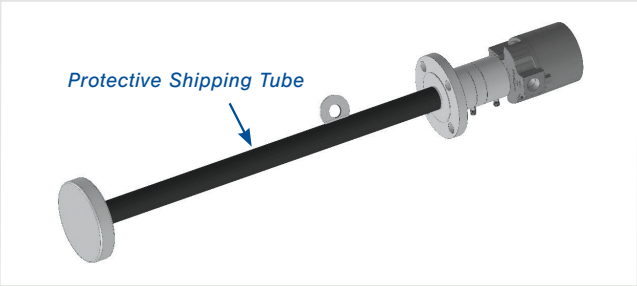
2.1 Transportation

When carrying, moving, and shipping the HTS thermocouple, it is important to use caution. A significant portion of the HTS is constructed of ceramic. Ceramics are very brittle and easily damaged; along with being damaged from exposure to ambient temperatures and mechanical shock.

CAUTION

The ceramic primary thermowell can easily break.

The unit is packaged with a sand-filled protective shipping tube before shipping from the factory. The tube and sand should be left in place until time for the unit install, and for which the HTS can be inserted and the flange can be assembled.



Retention of the shipping tube and shipping crate is recommended for re-shipment and storage of the HTS assembly.

2.2 Storage

Store equipment in a clean and dry location. It is recommended the equipment remain packaged until ready for installation, to protect it from being damaged and securing components from misplacement.

When storing a unit or preparing it for shipment, the shipping tube should be filled with clean, fine #1 blasting sand, and replaced on the unit.

2.3 Handling

Unit(s) are constructed with ceramic material which is susceptible to damage from rough handling. Whenever possible, the unit(s) should only be handled with the protective shipping tubes in place, and in the original shipping containers, when transported to/from the installation site in their original shipping containers.

2.4 Site Installation Survey

A. Confirm the vessel nozzle location is relative to the specific instrument tag number, the temperature transmitter, and the installation location planned for the Delta Controls Flush Gas Control Station.

> **NOTE**
>
> The thermocouple transmitter is not supplied by Delta Controls.

B. Confirm the compatibility of the transmitter and thermocouple with the thermocouple element type(s).

C. Confirm the proper type thermocouple extension leadwire is available for connection of the transmitter. A separate cable is required for each thermocouple element. The type of cable is determined by the type(s) of elements in the thermocouple assembly, as specifically ordered.

D. Secure the flange bolts, studs and required flange gasket.

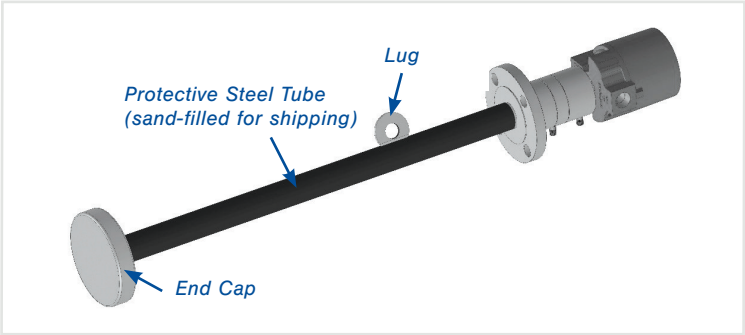
2.5 Thermocouple and Accessories Inspection

A. Open the carton and carefully remove the top layer of the packing materials.

B. Inspect the HTS Assembly for damage.

C. The protective steel tube attached to the flange surrounds the ceramic primary thermowell. This tube is filled with sand to support and protect the primary thermowell during shipping. Carefully remove the thermocouple from the carton, move it to an area where the sand can be safely emptied.

D. Remove the end cap flange from the end of the steel protective shipping tube. Turn the thermocouple upright to pour out the sand into a container.



E. Insert the tip of a large screwdriver or other similar tool into the lug, which is welded to the protective tube and use as a lever. Twist the tube to loosen it, but do not remove. This will permit easy removal by hand at the installation site. Occasionally, the use of a pipe wrench may be required to loosen the tube.

> **NOTE**
> Leave the protective shipping tube in place until the thermocouple is to be inserted into the vessel nozzle.

F. Inspect inside the end of the tube and gently touch the tip of the primary thermowell to be certain it is not “loose”. If loose, the thermocouple is broken and must be repaired prior to installation. The shipping tube and custom built protective shipping carton are reusable.

G. If any parts appear to be damaged, contact Delta Controls immediately.

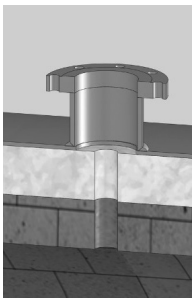
2.6 Nozzle Inspection

Because the “as-built” dimensions of the refractory and nozzle can (and often do) differ from the design specifications, it is important to verify these dimensions before installing the thermocouple.

CAUTION

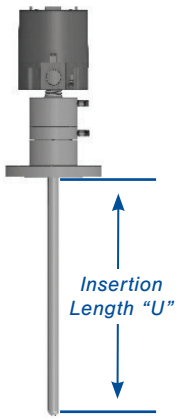
Installing a thermocouple that is not properly sized for the nozzle and refractory can result in breakage or inaccurate measurements.

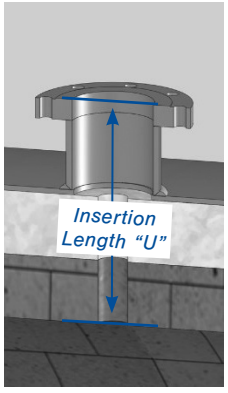
A. **Inspect the inside of the vessel nozzle.** The inside of the nozzle should be clean; free from debris and welding slag. The bored hole through the refractory should be clean, centered in the nozzle, and relatively aligned perpendicularly to the nozzle flange face. *(If the hole does not meet the above criteria, the thermocouple can become broken shortly after start up as refractory begins to shift.)*



B. **Verify the nozzle and refractory dimensions.**
To ascertain Insertion Length “U”, lay a straight edge across the flange face and measure from the inside surface (hot face) of the refractory, inside the vessel, up to the straight edge. Confirm the measurement matches the length of the thermocouple primary thermowell, as measured from the thermocouple flange to the tip of the thermowell.

(If the thermocouple primary thermowell is too long, it will extend into the gas space, making it read erroneously high and making it susceptible to breakage from thermal shock. If the thermocouple is too short, it may read erroneously low.)





2.7 Resolving Dimensional Problems

Carefully measure the nozzle and refractory dimensions and compare them to the dimensions on the front cover of this manual. Dimensional discrepancies are commonly caused by the following conditions:

A. **Nozzle height is not as specified** – If the nozzle is too tall, the thermocouple will not extend all the way into the vessel and may report erroneously low temperatures. If the nozzle is too short, the thermocouple may extend too far into the thermal reactor, which may also cause erroneous temperature reports. Invalid temperature reports could make it susceptible to damage from thermal shock.

B. **Incorrectly specified thermocouple dimensions** – The design intent is for the thermocouple element tip to be positioned even with the refractory hot face. If these conditions are not met, it may cause be inaccurate measurements and/or breakage due to thermal shock

C. **Refractory is not installed at the specified thickness** – If the overall refractory is thicker than specified, the thermocouple will not extend all the way into the vessel and may report erroneously low temperatures. If the refractory is thinner than specified, the thermocouple will extend past the refractory hot face. This could increase the possibility of breakage due to thermal shock.

D. **Refractory firebrick has separated from the insulating castable** – It is not uncommon for the firebrick to sag and form a gap between the firebrick and the castable or insulating brick. However, thermal expansion will cause this gap to close when the furnace reaches an operating temperature. If this is the only cause of dimensional discrepancy, thermocouple installation may proceed.

E. **Refractory has separated from the vessel shell** – Although this condition is not common, it is possible for a gap to appear between the insulating refractory and the vessel shell. This occurrence of the thermocouple not extending far enough into the vessel to reach the refractory hot face, would result in reporting of erroneously low temperatures. In general, this gap will not close up at operating temperatures. The thermocouple must be re-sized to account for the gap.

In the event any dimensional discrepancies occur, contact Delta Controls to arrange for the replacement of a properly sized thermocouple to be ordered for the installation.

3. Installing the Thermocouple

3.1 Mounting

A. Carefully remove the protective tube from the thermocouple and place it in a safe location.

B. Install nozzle packing disks onto the ceramic thermowell, filling the nozzle completely.

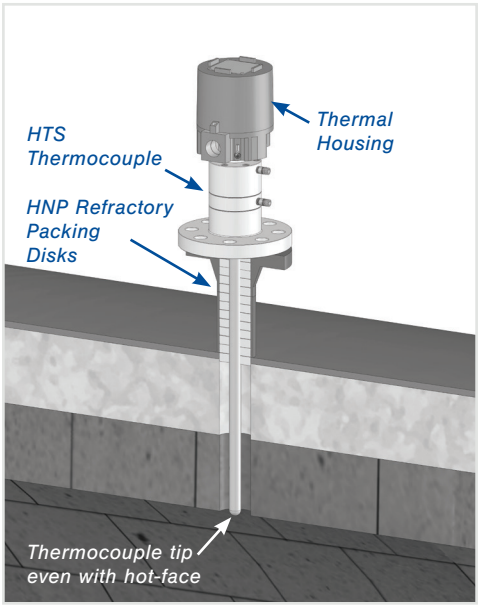
C. Place gasket onto the flange.

D. Carefully insert the thermocouple into the nozzle.

E. Rotate the thermocouple to the desired position to attach conduit and tubing.

F. Install and tighten flange studs to recommended torque standard appropriate for flange size.

G. Install conduit and flush tubing.



After installation and before reactor startup, perform the **Flush Gas /Primary Thermowell Integrity Test** on page 13. This will verify the primary thermowell was not broken during installation, and no problems exist with the connections.

Performing this test as soon as possible prior to reactor startup, will allow time to obtain replacements in the event of primary thermowell breakage. In general, replacement is not possible while the reactor is running. A thermocouple with a broken primary thermowell or which is improperly flushed will only operate for a short time before failing.

3.2 Wiring

The conduit connection to the terminal enclosure should be equipped with a union and a flexible conduit for ease of maintenance and to reduce strain on the terminal enclosure.

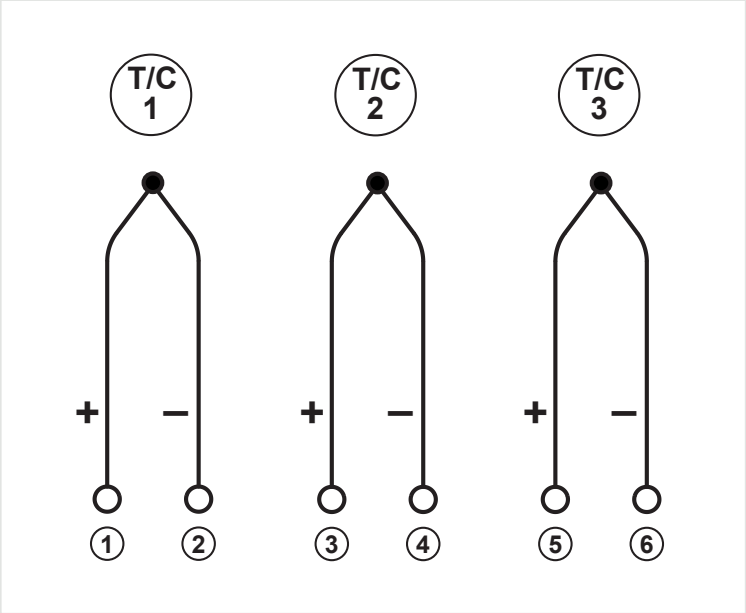
Verify that the insulation on thermocouple extension lead wire is rated for 400°F (200°C) continuous service.

Installation shall be in accordance with EN60079-14 and/or other governing codes.

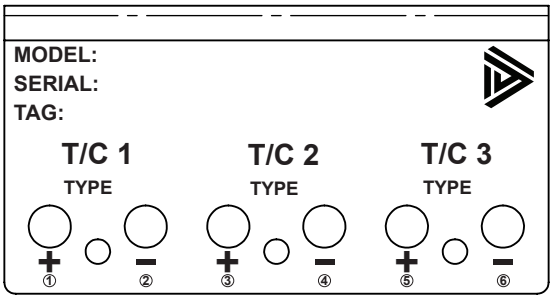
The thermocouple elements are terminated on the connecting blocks, which are mounted inside the thermocouple head. The block positions are marked “T/C 1”, “T/C 2”, and “T/C 3” to designate which thermocouple is connected at each set of two terminal points. The standard arrangement is:

- T/C 1: The T/C 1 thermocouple; usually a type “R”, “S” or “B” platinum/rhodium.
- T/C 2: The T/C 2 thermocouple; refer to markings for type.
- T/C 3: The T/C 3 thermocouple; supplied as an option on some models.

Wiring Diagram



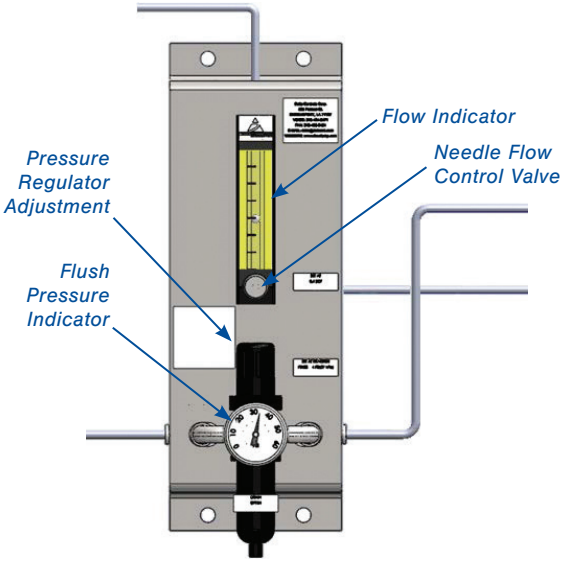
Terminal Block Diagram



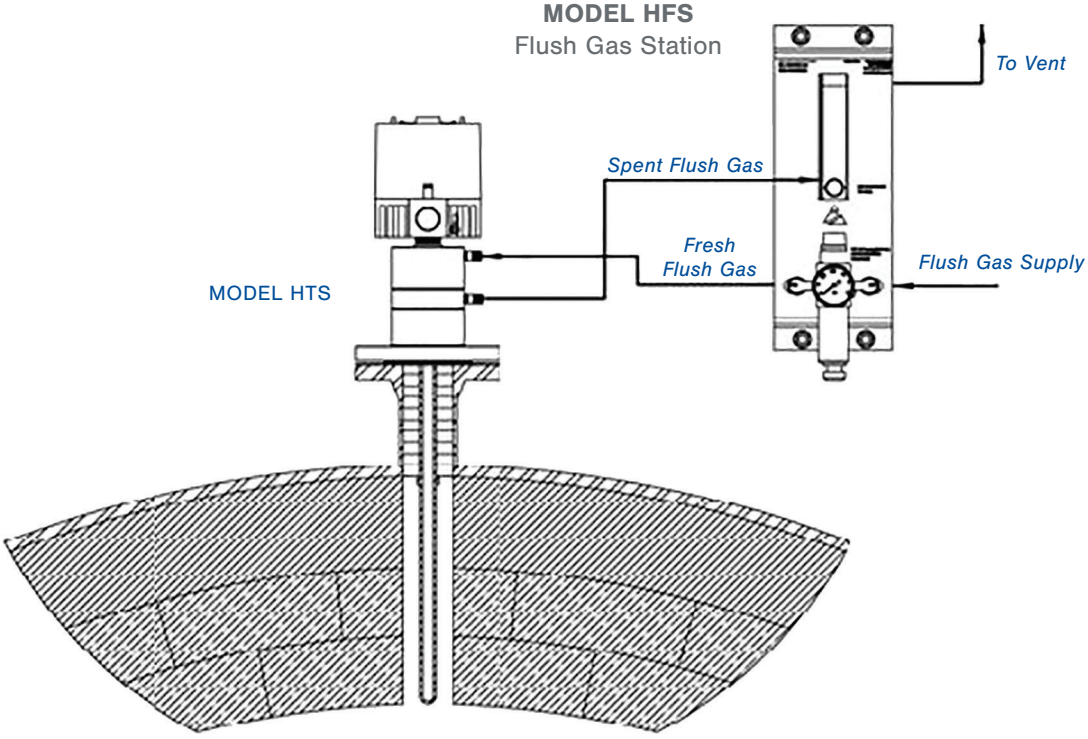
3.3 Flush Gas Connection

The use of nitrogen as a flush gas is strongly recommended. Ensure the supply of flush gas is clean, oil free and dry. The Delta Controls Model HFS Station provides a convenient and effective means to properly control the flush gas pressure and flow rate. Consult document *http://claustemp.com* for details.

- Connect flush gas tubing to HTS thermocouple as shown. Regulated, filtered gas enters the top flush gas connection and exits the lower flush gas connection.
- Set flush pressure to 5 psi (0.35 bar) above maximum thermal reactor operating pressure.
- Adjust needle flow control valve for a flow rate of 11 L/h as indicated on flow meter. This provides sufficient flow to protect the thermocouple without significantly cooling the thermocouple elements.



MODEL HFS
Flush Gas Station



3.4 Flush Gas/Primary Thermowell Integrity Test

The following procedure should be performed after thermocouple installation to identify installation problems, and to verify that the thermowell was not broken during installation. It should also be performed periodically (suggested weekly or bi-weekly) as routine preventative maintenance.

A. **Pressure Setting** – Verify that the flush pressure is at least 5 psi above the maximum operating pressure of the reactor [normally 15 to 20 psig (1.0 to 1.3 bar) is suitable]. Adjust if necessary.

B. **Flow Setting** – Verify the flush flow rate is correct: 11 L/h as indicated on the flow indicator. Adjust if necessary.

C. **Check for Flush Integrity** - Elevate the pressure on the HFS regulator by approximately 10 to 15 psig (0.68 to 1.0 bar). Verify the flow rate on the flow indicator does increase. Reduce the pressure to its previous setting and verify the flow rate returns to its previous value.

> **NOTE**
> Depending on the increased amount of flow rate, cooling of the thermocouple by the gas could show up as an apparent drop of a few degrees in reported temperature.

Failure of the flow indicator to respond to changes in flush pressure can indicate:

- **Leaks** – which will allow the flush gas to escape to atmosphere and not return to the flow indicator.
- **Breakage of the primary thermowell** – which allows gas to escape into the reaction vessel and allows reaction gases to contact the thermocouple element, leads to increasing inaccuracy and ultimately complete failure from contamination and corrosion.
- **Plugging of the flush lines** – usually, is due to primary thermowell breakage. Sulfur condenses in the tubing and plugs them. Such a condition is often accompanied by a visible yellow Sulfur deposit on the inside surface of the glass flow indicator.

4. Using Multiple Thermocouples within the HTS

Model HTS can be equipped with up to 3 independent thermocouples in the same thermowell. It is common for the thermocouples to be of different types, offering different temperature measurement ranges. For example it is common for one thermocouple to be a type R or S and another to be type B. This will allow the maximum possible range of measurement, since type R or S can measure down to ambient temperatures, and Type B can survive temperatures higher than types R or S, though type B cannot be used below about 100 °C. A third thermocouple can also be provided for redundancy.

5. Pre-Commissioning/Commissioning Procedure (Startup)

- Verify the flush gas is properly supplied to the thermocouple prior to reactor startup.
- Use the pressure regulator adjustment on the HFS to set the pressure to approximately 5 psi above the maximum operating pressure of the reactor.
- Using the flow control valve on the HFS and adjust the flow rate to 11 L/h as shown on the flow indicator.

6. Shutdown

Continue purging the thermocouple during shutdown until the reactor has cooled and reaction gases are no longer present in the reactor.

7. Operation

The thermocouple has no adjustments or controls. Operation consists of maintaining flush gas flow to the thermocouple.

8. Maintenance

No periodic maintenance is required on the thermocouple. It is recommended the Flush Gas/Primary Thermowell Integrity Test, on page 13, be performed on a weekly or bi-weekly basis. Routine maintenance, as recommended, will ensure the retention of gas flow to the thermocouple and also enable detection of any thermowell breakage exposing it to corrosive gases and subsequent failure.

The HTS is not intended to be repaired by unqualified persons. Do not open disassemble the HTS, as it may compromise its reliability and safety.

9. Troubleshooting

For assistance with diagnostic procedures, go to the Delta Controls website, “HTP & HTX Troubleshooting” page at *www.deltacnt.com*.

10. Specifications

Absolute Maximum Ratings:		
Maximum Process Pressure:		150 psig (10 bar)
Maximum Nitrogen Flush Pressure		30 psig (2 bar)
Maximum Process Temperature:		+3272 °F (+1800 °C)*
Maximum Process Temperature: (measured at Process Flange)		+650 °F (+343 °C)
Maximum Rate of Temperature Change:		+200 °C / hr
Minimum Operating Temperature:		-4 °F (-20 °C)
Maximum Process Flange Temperature:		+446 °F (+230 °C)
Maximum Terminal Enclosure Temperature:		+383 °F (+195 °C)
Ingress Protection:		IP65
Terminal Housing Hazardous Location Rating:		Class I, Groups B, C and D; Class II, Groups E, F and G; Class III; Encl 4X
Hazardous Location Rating:		II 2 G Ex db IIB+H2 T3 Gb
Applied Hazardous Location Standard(s)	IECEx:	IEC 60079-0:2017 Ed. 7
		IEC 60079-1:2014 Ed. 7
	ATEX:	EN 60079-0:2018
		EN 60079-1:2014
	EAC:	TR CU 012/2011
T/C Types:		B,S,R,K,T (“C” non-standard)
Materials:		
Main Body:		316 Stainless Steel
Process Flange:		316 Stainless Steel
Terminal Housing:		Aluminum or Stainless Steel
Trim/Bolting/Seats:		Stainless Steel
Thermowell:		Blended Alumina, Ceramic
Gas Requirements:		Dry Nitrogen, 0.4scfh (11l/h)

* Type ‘B’ thermocouple. Maximum operating temperature is limited by the thermocouple melting point.

Model Numbering System

MODEL EXAMPLE	MODEL	-	T/C 1	-	T/C 2	-	T/C 3	-	INSERTION LENGTH	-	PROCESS CONNECTION	-	OPTIONS
	HTS	-	R	-	R	-	O	-	15.0	-	2"150RY	-	AA

MODEL	DESCRIPTION
HTS	Thermocouple, Sulfur Processing Service, Compact, ATEX, IECEx

T/C [1]	DESCRIPTION	RANGE [1]
B	(-) platinum +6% rhodium / (+) platinum +30% rhodium	+212 °F to +3270 °F (+100 °C to +1799 °C)
R	(-) platinum / (+) platinum +13% rhodium	+32 °F to +3200 °F (0 °C to +1760 °C)
S	(-) platinum / (+) platinum +10% rhodium	+32 °F to +3200 °F (0 °C to +1760 °C)
O	None (T/C 2, T/C 3 only)	

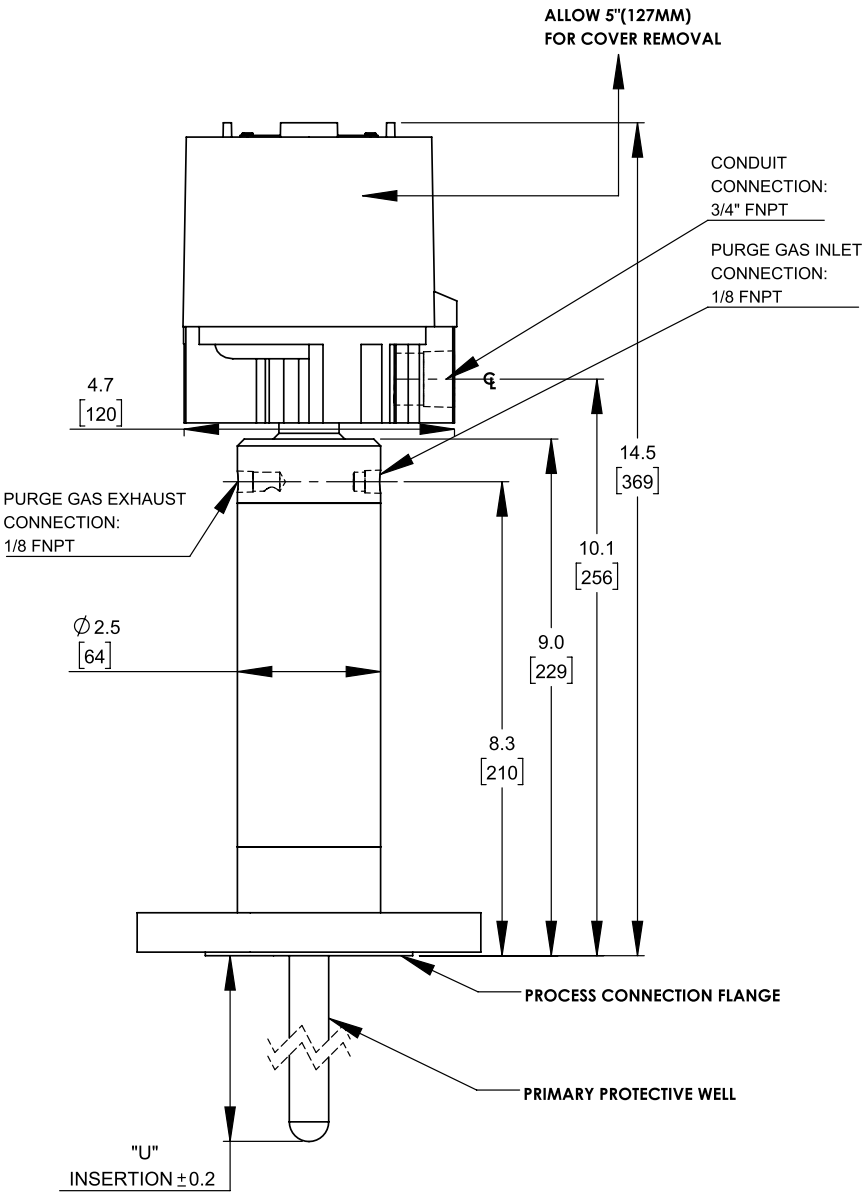
INSERTION LENGTH	DESCRIPTION
**.*	**.* in from flange face to inside face of the refractory

PROCESS CONNECTION	DESCRIPTION
2"MPTY	2 in male pipe thread, 316 Stainless Steel
2"150RY	2 in Class 150 raised face flange, 316 Stainless Steel
2"300RY	2 in Class 300 raised face flange, 316 Stainless Steel
3"150RY	3 in Class 150 raised face flange, 316 Stainless Steel
3"300RY	3 in Class 300 raised face flange, 316 Stainless Steel
3"MPTY	3 in MPT, 316 Stainless Steel
4"150RY	4 in Class 150 raised face flange, 316 Stainless Steel
4"300RY	4 in Class 300 raised face flange, 316 Stainless Steel
6"150RY	6 in Class 150 raised face flange, 316 Stainless Steel
6"300RY	6 in Class 300 raised face flange, 316 Stainless Steel

OPTIONS	DESCRIPTION
AA	None
XPB	300 grade stainless steel housing
T**.*	Temperature Extension (**.* in)

Notes:
[1] Temperature shown is the maximum recommended for continuous service

Model HTS Dimensional Drawing



Contact Us

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