ENGLISH

Model HTV

INSTALLATION, OPERATION & MAINTENANCE MANUAL

Delta Controls CORPORATION

00-HTV03 Rev E
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 HTV Claus Thermal Reactor Thermocouple System

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

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

HTV	HRW	HNP	HMB	HRG
				
Thermocouple for Sulfur Processing, Unpurged	Refractory Thermowell (for use with 4 - 6" nozzles)	Refractory Nozzle Packing Kit	Horizontal Mounting Bars (usually shipped separately)	Refractory Drilling System
Thermocouple assembly with mounting flange, body, terminal enclosure housing and primary thermowell.	The large refractory thermowell collar rests in the refractory and protects the primary thermowell.	Rigid and compressible disks for proper insulation of the nozzle, and is designed to prevent the buildup of sulfur in the nozzle.	Bars are used to reliably install thermocouple(s) in non-vertical nozzles.	Creates straight, centered, and perpendicular bore hole through the refractory.

2. Introduction

2.1 Model Overview

The Delta Controls Model HTV Unpurged Thermocouple is designed for the primary purpose of reliably protecting a vessel and its refractory lining from excessive temperatures. The HTV is intended for installations without access to a flush system.

The design of the HTV is the result of attention to detail and more than 50 years of experience in the sulfur processing industry. The thermocouple junction is isolated from the process gases by using a permeation resistant thermowell constructed of monocrystalline sapphire. The patent-pending QSeal™ design prevents trace amounts of process gases from leaking past the seals and accumulating inside the thermowell. In the event of thermowell breakage, multiple redundant seals prevent the release of process gases.

The HTV is built to meet each customer's specific installation requirements such as thermocouple type, operating temperatures, nozzle size, insertion length, and materials of construction. The HTV assembly is furnished complete with all necessary installation components. Installation tools are available, and recommended, to accurately produce the refractory bore hole in the correct size and alignment needed for the thermocouple assembly.

2.2 Theory of Operation

The Delta Controls QSeal™ system utilizes equilibrium sealing technology to protect the thermocouple elements from embrittlement, degradation, and sublimation. In harsh environments such as sulfur recovery, over years of service, it is inevitable that trace gases will permeate and accumulate in thermowells and sealing elements. QSeal™'s innovative design ensures the diffusion of permeating molecules is extrinsic to the thermocouple elements.

QSeal™ utilizes a monocrystalline sapphire thermowell as one of several components of this patent pending protection system. While monocrystalline lattice structures inhibit permeation, additional protection mechanisms are necessary to prevent molecular accumulation. Additional protection mechanisms include:

- Four primary seals and an isolated seal breather ensure proper molecular diffusion during normal operation as well as process containment in the event of thermowell damage. Each seal has a secondary redundant backup for added reliability and security. The sealing system provides for direct process protection, permeating gas protection, and containment isolation in the event of thermowell breakage.
- The QSeal™ design ensures permeating molecules accumulate in designated interior cavities instead of around and through sealing elements used in other designs. An isolated seal breather prevents molecular accumulation by maintaining interior equilibrium concentrations.
- A monocrystalline sapphire secondary thermowell significantly reduces permeation rates through its crystalline matrix. The silicon carbide primary thermowell provides robust thermal shock resistance with its strength and stability.

3. Pre-Installation

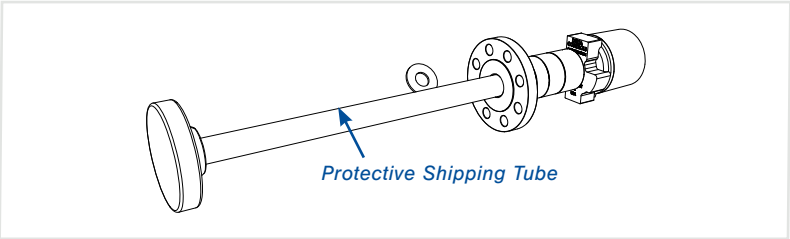
3.1 Transportation

Care should be used in carrying, moving, and otherwise transporting the Model HTV thermocouple. A significant portion of the HTV is constructed of ceramic. Ceramics are very brittle at ambient temperature and can be damaged by mechanical shock.

CAUTION

The ceramic primary thermowell can easily break.

At the factory, the unit is packaged with a sand-filled protective shipping tube. This tube and its sand packing should be left in place until which time the HTV can be inserted and the flange can be assembled.



The shipping tube and crate should be retained for re-shipment and storage of the assembly.

3.2 Storage

It is recommended that the equipment remain packaged until ready for installation to prevent breakage or misplacing of components. Store equipment in a clean, dry place.

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

3.3 Handling

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

3.4 Site Installation Survey

A. Confirm vessel nozzle location relative to instrument tag number and temperature transmitter. (Note: The thermocouple transmitter is not supplied by Delta Controls.)

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

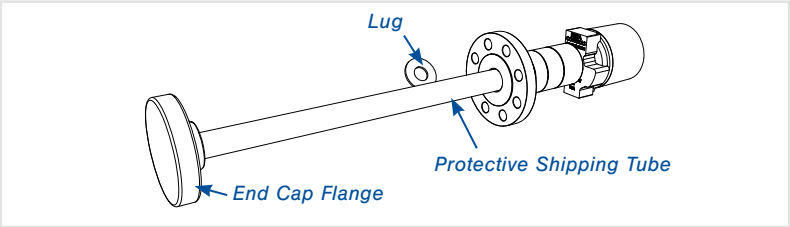
C. Confirm availability of proper type thermocouple extension leadwire for transmitter connection. A separate cable is required for each thermocouple element. The type cable is determined by type(s) of elements in thermocouple assembly as specifically ordered.

D. Have available flange studs, nuts and required flange gasket.

3.5 Thermocouple and Accessories Inspection

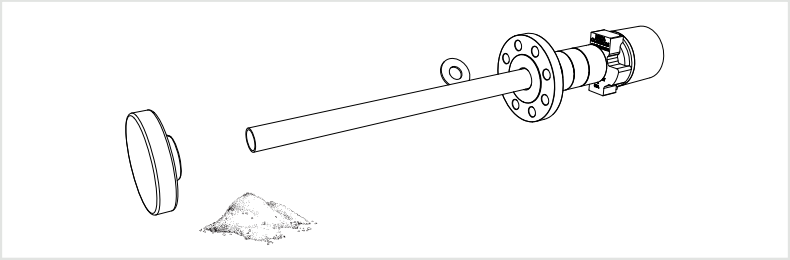
A. Open the carton and carefully remove the top layer of the packing materials.

B. Visually inspect the HTV assembly for damage.

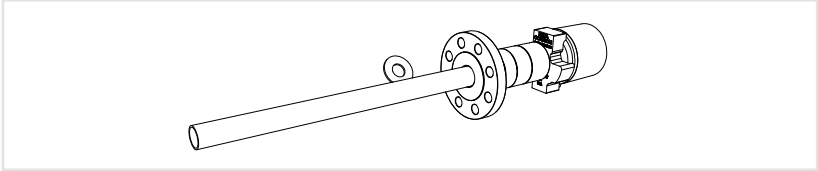


C. The protective shipping tube attached to the flange surrounds the primary thermowell. This tube is filled with sand to support and protect the primary thermowell, during shipping. Move to an area where the sand can be safely emptied and carefully remove the thermocouple from the carton.

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



E. Insert the tip of a large screwdriver or other similar tool into the lug welded to the protective shipping tube. Using it as a lever, twist the tube to loosen it for easy removal by hand at the installation site. **Leave the protective shipping tube in place until the thermocouple is to be inserted into the vessel nozzle**.



NOTE

Occasionally, use of a pipe wrench may be required to loosen the protective shipping tube.

F. The protective shipping tube and shipping carton are reusable and should be saved for storage or reshipment.

G. If the primary thermowell is loose, the thermocouple is broken and must be repaired prior to installation. If the primary thermowell or any other parts appear to be damaged, contact Delta Controls immediately.

NOTE

Leave protective shipping tube in place until ready to install thermocouple on vessel nozzle.

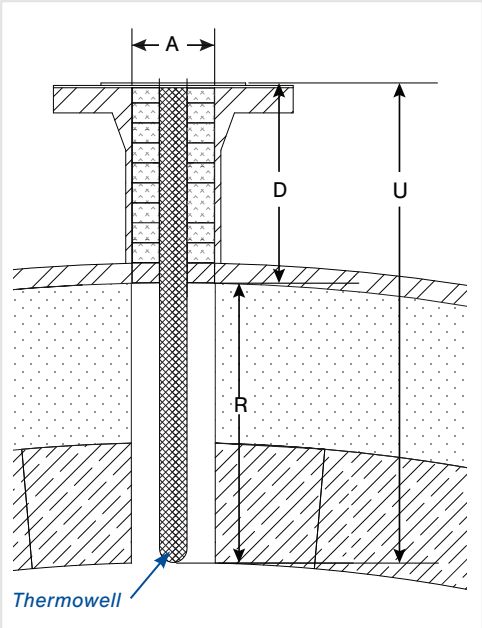
3.6 Nozzle Inspection

Verify refractory and nozzle dimensions match design specifications before installing the thermocouple.

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

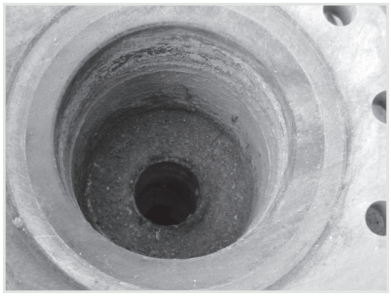
A. Verify nozzle and refractory dimensions.

- 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 measurement matches the primary thermowell length, as measured from the thermocouple flange to the tip of the thermowell.



B. Inspect inside of vessel nozzle. Inside of nozzle should be clean—free from debris and welding slag.

- The bored hole through the refractory should be clean, centered in nozzle, and perpendicular to the nozzle’s flange face.

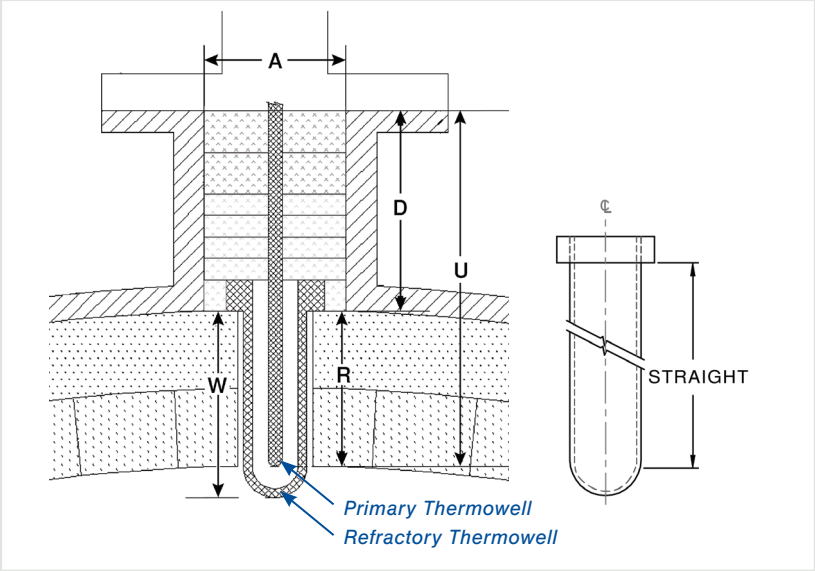


NOTE

If the above criteria is not met, the thermocouple can break shortly after start up as refractory begins to shift.

C. **For 4 inch and larger nozzles only:** Verify the refractory thickness with a measuring tape (Length “R”). Confirm that this dimension matches the length of the straight portion of the Model HRW Refractory Thermowell.

- If the HRW is too short, it will break when the thermocouple is inserted. If the HRW thermowell is too long, there is an increased possibility of breakage due to thermal shock.
- If there is a discrepancy of more than 0.5 inches (12 mm) on the above measurements, DO NOT install the thermocouple until the discrepancy is resolved.



NOTE

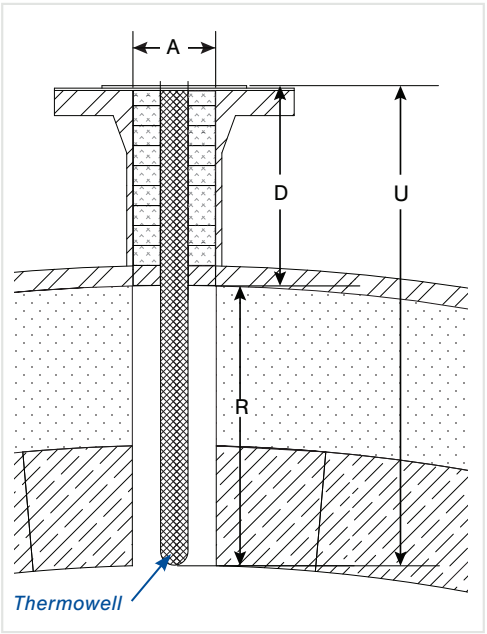
The HRW Refractory Thermowell is intended to protrude approximately 1 inch (25 mm) beyond the refractory hot face.

D. **For 4 inch and larger nozzles only:** Ensure the top of the refractory inside the nozzle is flat and not protruding upwards. Excess material can result in the HRW thermowell sitting too high and impacting the thermocouple ceramic thermowell.

3.7 Resolving Dimensional Problems

Carefully measure the nozzle and refractory dimensions and compare them to the dimensions on the specific order. In the event any dimensional discrepancies occur, contact Delta Controls to arrange for a properly sized thermocouple for the installation.

Dimensional discrepancies are commonly caused by the following conditions:



Reference for A - C

A. **Nozzle height is not as specified**

- If the nozzle is too tall, the thermocouple tip may not be positioned properly at the refractory hot face and may report erroneously low temperatures.
- If the nozzle is too short, the thermocouple tip may extend too far into the thermal reactor.

B. **Incorrectly specified thermocouple dimensions**

The design intent is for the primary thermowell tip to be positioned even with the refractory hot face.

- If these conditions are not met, it may cause be inaccurate temperature 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 to the refractory hot face and may report erroneously low temperatures.
- If the overall refractory is thinner than specified, the thermocouple will extend past the refractory hot face. This increases the possibility of breakage due to thermal shock.

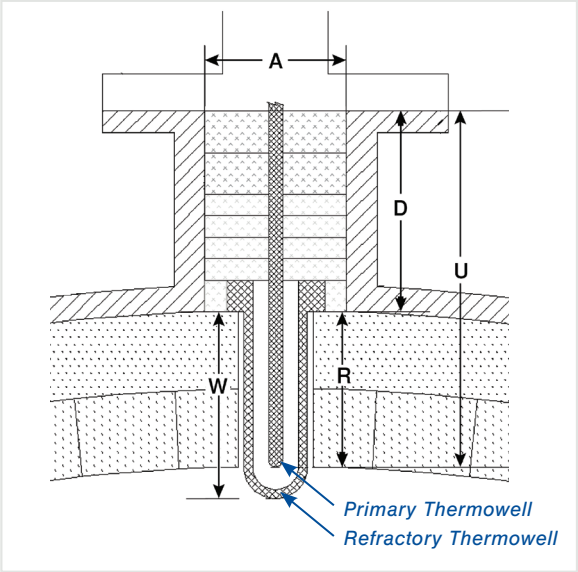
D. **Refractory has separated from the vessel shell**

Although this condition is not common, it is possible for a gap to appear between the insulating refractory and the vessel shell. If the thermocouple does not extend all the way to the refractory hot face, it would report 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.

The following conditions are for 4 inch or larger vessel nozzles:

Reference for E & F



E. **Nozzle inner diameter is not as specified**

If the nozzle inner diameter is too small, the rigid nozzle rings will not fit. These rings can be cut down to size. Contact Delta Controls for more information.

> **NOTE**
> To avoid breathing the dust, use a dust collector when cutting the rings.

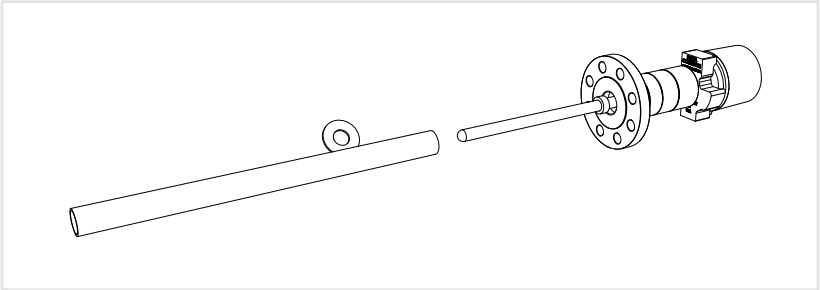
F. **Refractory has entered the base of the nozzle**

The top surface of the refractory should be even with the inside surface of the vessel shell. If it is not, the Refractory Thermowell will not rest at the proper position and may cause it to be broken when the thermocouple is inserted into the nozzle. If there is refractory material inside the base of the nozzle, it must be removed to restore a flat surface that is even with the inner surface of the vessel shell.

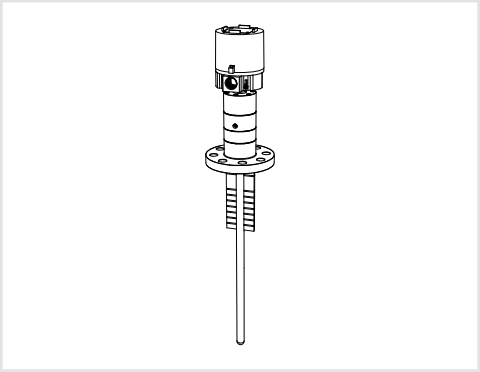
4. Installation in a 3 inch or Smaller Nozzle

4.1 Vertical Installation

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



B. Install the HNP rigid nozzle rings and compressible collar rings onto the ceramic thermowell, so as to fill the nozzle completely.

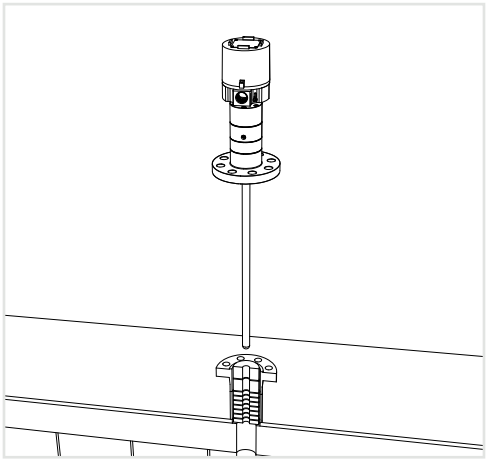


C. Place gasket onto the flange and center.

CAUTION

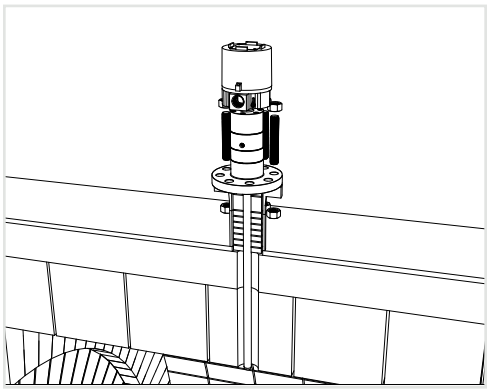
The ceramic primary thermowell can easily break. To prevent breakage, do not exert any sideways force on the ceramic thermowell.

D. Lift the Model HTV to a vertical position. Grasp the top housing to permit the unit to hang vertically plumb, and then center the primary thermowell on the borehole.



E. Carefully insert the thermocouple into the nozzle. The nozzle rings will compress as the thermocouple is positioned into place.

F. Keeping the unit centered on the flange, rotate the thermocouple to the desired position to attach conduit and tubing.



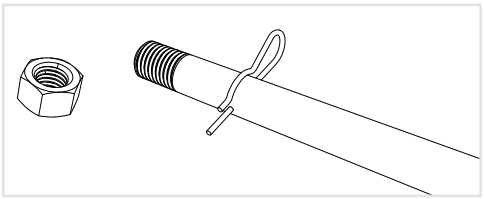
G. Install studs and nuts. Fully tighten the nuts.

4.2 Non-vertical Installation

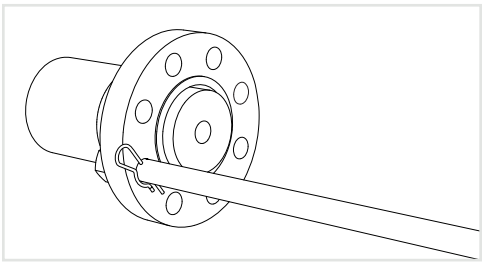
In non-vertical installations, inserting the thermocouple unit can be difficult. The installer must support the entire weight of the unit while fully inserting it into the centerline of the HNP rigid nozzle rings and compressible collar rings without resting the unit's weight on the primary thermowell.

The Model HMB Horizontal Mounting Bars provide an easy and safe means of inserting the heavy thermocouple in non-vertical nozzles. The use of the mounting bars minimize the risk of breaking the primary thermowell due to misalignment of the unit with the nozzle centerline while the HTV is being inserted into position. A video showing the use of the HMB mounting bars is available at *www.youtube.com/@claustemp*

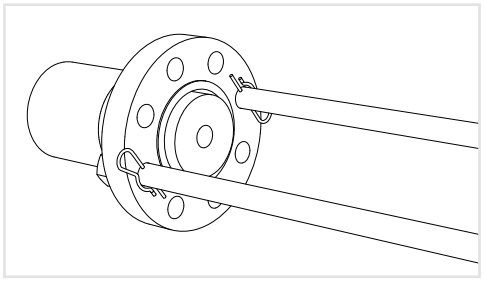
A. For Class 150 raised face flanges, insert an r-clip into the bolt hole nearest the threads on one of the mounting bars; for Class 300 raised face flanges, use the bolt hole farthest away from the threads.



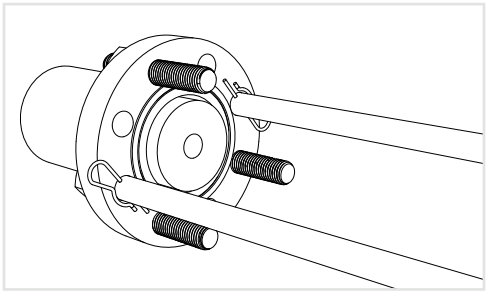
B. Place the threaded end of the mounting bar into a vessel nozzle flange bolt hole as shown. Secure the bar to the flange with the provided nut.



C. Repeat steps A and B to install the second mounting bar on the opposite bolt hole.

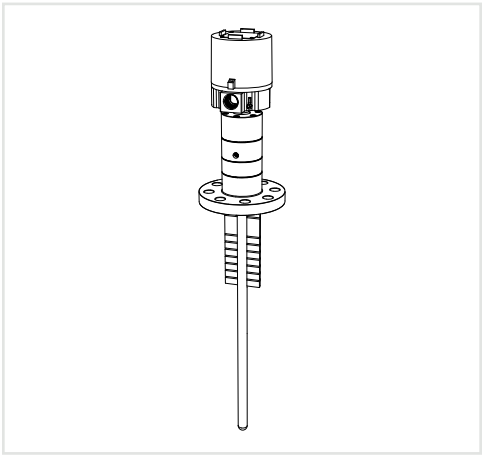


D. Install three studs as shown. Place the flange gasket in position. The studs will temporarily hold the flange gasket in position.



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

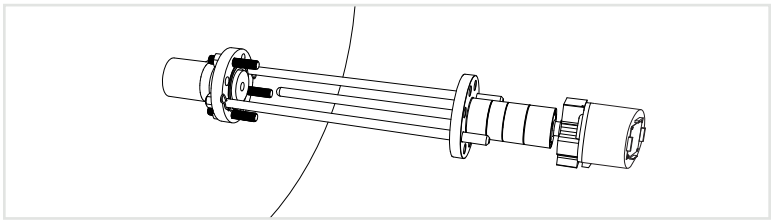
F. Install the HNP rigid nozzle rings and compressible collar rings onto the ceramic thermowell, so as to fill the nozzle completely.



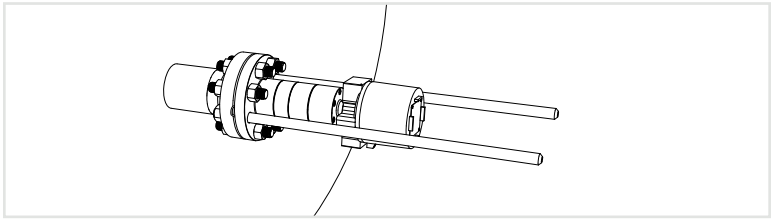
CAUTION

The ceramic primary thermowell can easily break. To prevent breakage, do not exert any sideways force on the ceramic thermowell. May require 2 or more people to install.

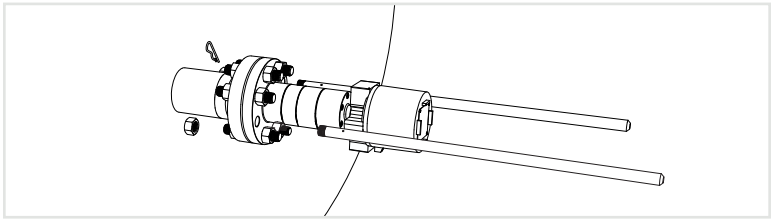
G. Confirm the thermocouple unit is correctly rotated so that the conduit and tubing are oriented in the desired direction. Place the thermocouple on the mounting bars and insert the thermowell tip into the borehole. Allow the mounting bars to support the weight of the thermocouple as it is carefully inserted flush to the flange gasket.



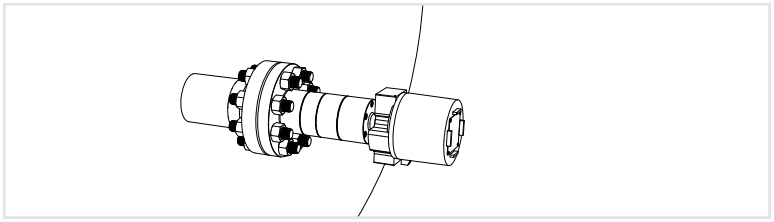
H. Install and hand tighten the stud nuts. Install remaining studs and stud nuts in all remaining holes to hold the thermocouple in place as the mounting bars are removed.



I. Remove the mounting bar nuts. Pull the r-clips and remove the mounting bars.



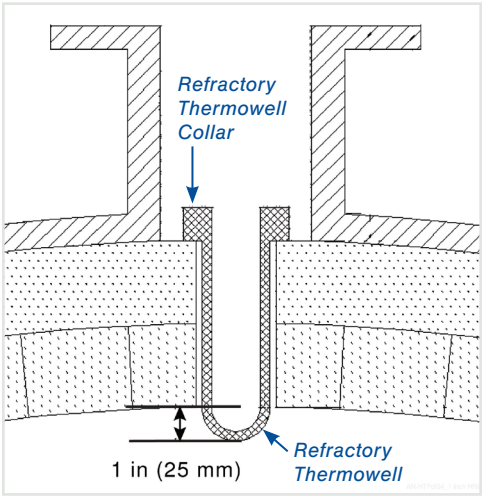
J. Install the last two studs and nuts. Confirm that the flange and gasket is centered. Fully tighten the nuts.



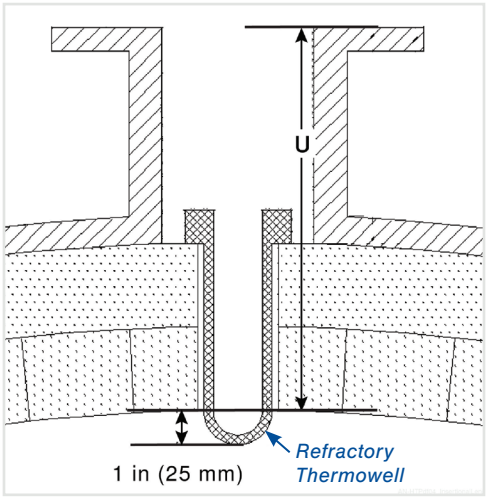
5. Installation in a 4 inch or Larger Nozzle

5.1 Vertical Installation

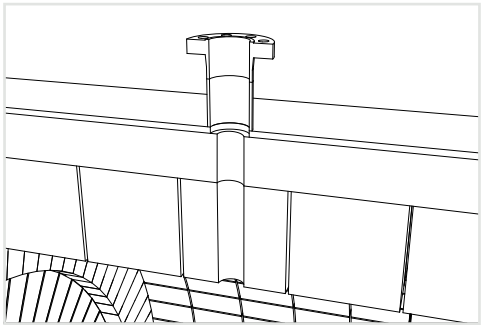
A. Carefully place Model HRW Refractory Thermowell on the hole in the refractory. Make sure HRW's collar is flat against the refractory surface, and the tip extends about 1 inch (25 mm) below the refractory into the reactor vessel. The fit should be slightly loose.



B. Verify the thermocouple's clearance. Measure from the HRW's inside tip to the flange face. The distance should be approximately 1 inch (25mm) longer than the primary thermowell's Insertion Length "U".

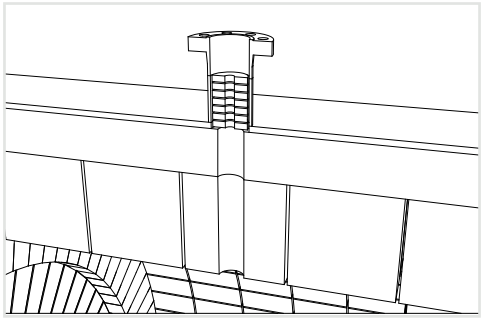


C. Place the two compressible **collar rings** from the HNP Nozzle Packing Kit around the HRW refractory thermowell's collar.



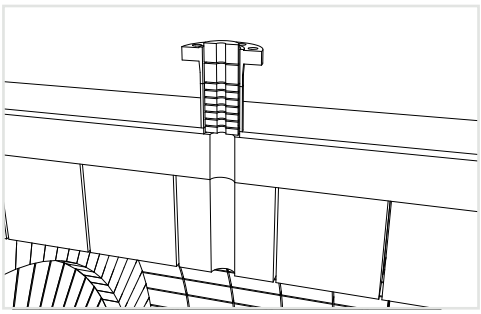
NOTE
Collar rings have a 2.75 inches (70 mm) inside diameter.

D. Place approximately 8 – 10 **compressible nozzle rings** on top of the two collar rings at the bottom of the nozzle. Align center holes.



NOTE
Compressible nozzle rings have a 0.75 inch (19 mm) inside diameter.

E. Place **rigid nozzle rings** on top of the soft compressible nozzle rings until half of the top ring is above the flange face. If needed, adjust the number of soft compressible nozzle rings to increase or decrease the height.

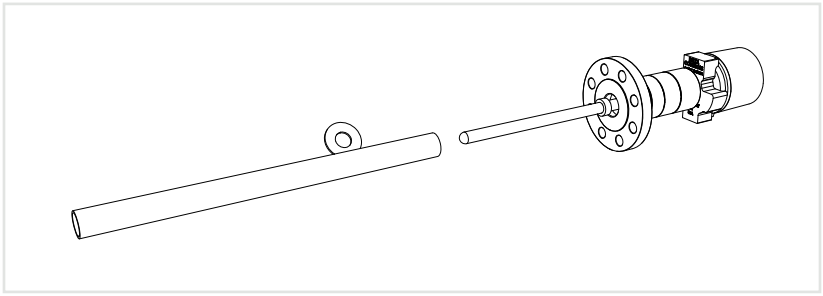


NOTE

A single rigid nozzle ring's height is 1.5 inches (38 mm).

F. Place the flange gasket on the nozzle flange and center.

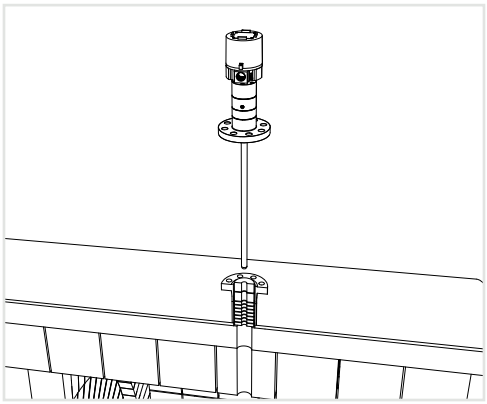
G. Carefully remove the protective shipping tube from the thermocouple and place it in a safe location.



CAUTION

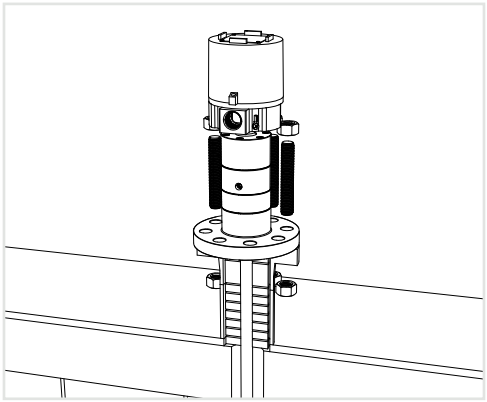
The ceramic primary thermowell can easily break. To prevent breakage, do not exert any sideways force on the ceramic thermowell. May require 2 or more people to install.

H. The first person picks up and turns Model HTV to a vertical position. The second person grasps the top housing to permit the unit to hang vertically plumb. The first person then centers the primary thermowell on the interior hole of the HNP Nozzle Packing rings.



I. Carefully insert the thermocouple into the nozzle. The nozzle rings will compress as the thermocouple is positioned into place.

J. Keeping the unit centered on the flange, rotate the thermocouple to the desired position to attach conduit and tubing



K. Install studs and nuts. Fully tighten the nuts.

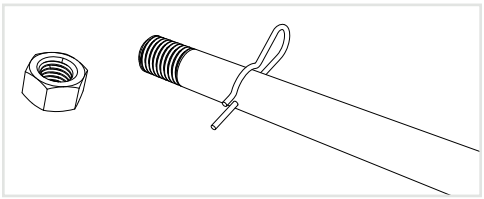
5.2 Non-vertical Installation

In non-vertical installations, inserting the thermocouple unit can be difficult. The installer must support the entire weight of the unit while fully inserting it into the centerline of the nozzle insulating materials without resting the unit's weight on the primary thermowell.

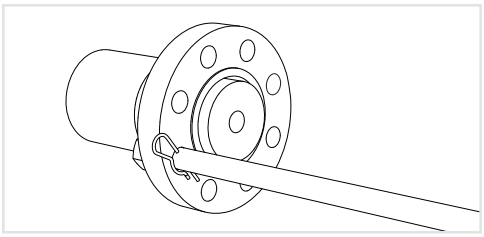
The Model HMB Horizontal Mounting Bars provide an easy and safe means of inserting the heavy thermocouple in non-vertical nozzles. The use of the mounting bars minimize the risk of breaking the primary thermowell due to misalignment of the unit with the nozzle centerline while the HTV is being inserted into position. A video showing the use of the HMB mounting bars is available at *www.youtube.com/@claustemp*

A. Install the nozzle packing rings as described in 4.1 Vertical Installation steps A-E.

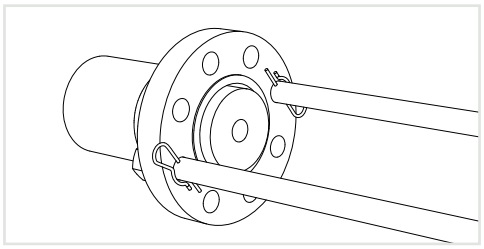
B. For Class 150 raised face flanges, insert an r-clip into the bolt hole nearest the threads on one of the mounting bars; for Class 300 raised face flanges, use the bolt hole farthest away from the threads.



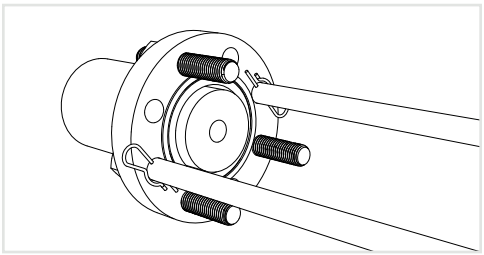
C. Place the threaded end of the mounting bar into a vessel nozzle flange bolt hole as shown. Secure the bar to the flange with the provided nut.



D. Repeat Steps B and C to install the second mounting bar on the opposite bolt hole.



E. Place studs in 3 locations as shown. Place the flange gasket in position. The studs will temporarily hold the flange gasket in position.

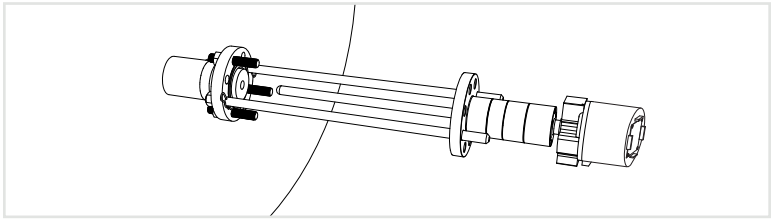


F. Carefully remove the protective shipping tube from the thermocouple and place it in a safe location.

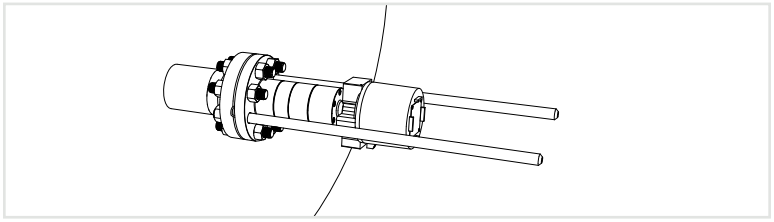
CAUTION

The ceramic primary thermowell can easily break. To prevent breakage, do not exert any sideways force on the ceramic thermowell. May require 2 or more people to install.

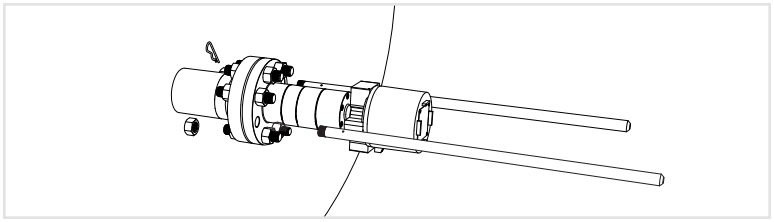
G. Confirm the thermocouple unit is correctly rotated so that the conduit and tubing are oriented in the desired direction. Place the thermocouple on the mounting bars and insert the thermowell tip into the borehole. Allow the mounting bars to support the weight of the thermocouple as it is carefully inserted flush to the flange gasket.



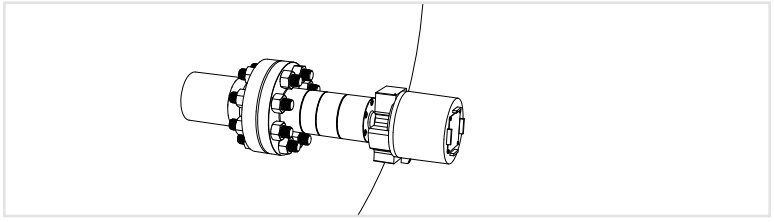
H. Install and hand tighten the stud nuts. Install remaining studs and stud nuts in all remaining holes to hold the thermocouple in place as the mounting bars are removed.



I. Remove the mounting bar nuts. Pull the r-clips and remove the mounting bars.



J. Install the last two studs and nuts. Confirm that the flange and gasket is centered. Fully tighten the nuts.



6. Wiring Multiple Thermocouples Within Model HTV

Model HTV can be equipped with up to 2 independent thermocouples in the same thermowell.

It is common to use type R or S for Thermocouple 1 and use a type B for Thermocouple 2. This allows the maximum possible range of measurement since types R and S can operate to ambient temperatures. Type B survives temperatures higher than types R or S; however, type B is not operable below approximately 212 °F (100 °C).

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

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

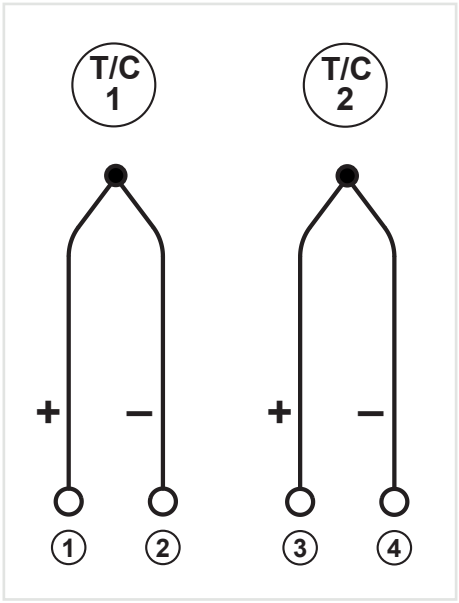
Installation shall be in accordance with EN60079-14 and/or other governing codes.

The thermocouple elements are terminated on connecting blocks that are mounted inside the thermocouple head. The block positions are marked “T/C 1” and “T/C 2” 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
- T/C 2: The T/C 2 thermocouple

Wiring Diagram



7. Using Multiple Thermocouples within the HTV

Model HTV can be equipped with up to 2 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 read 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.

8. Operation

Model HTV has no adjustments nor controls.

9. Maintenance

No periodic maintenance is required on the thermocouple.

Model HTV is not intended to be repaired in the field. Disassembling the HTV may compromise its reliability and safety.

10. Troubleshooting

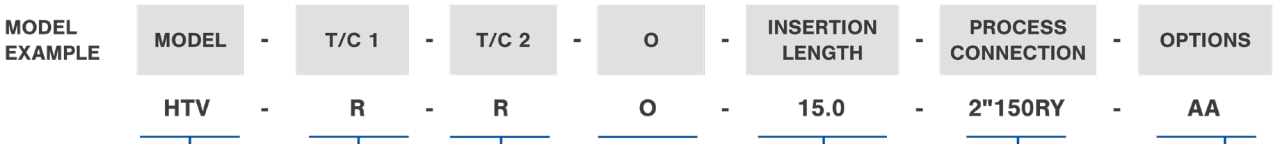
For diagnostic and troubleshooting procedures, please contact Delta Controls at 318 424 8471 or *support@deltacnt.com*

11. Specifications

Absolute Maximum Ratings:		
Maximum Process Pressure		150 psig (10.3 bar)
Maximum Process Temperature*		+3272 °F (+1800 °C)*
Maximum Rate of Temperature Change		+392 °F / hr (+200 °C / hour)
Minimum Operating Temperature		-4 °F (-20 °C)
Maximum Process Flange Temperature		+392 °F (+200 °C)
Maximum Terminal Enclosure Temperature		+383 °F (+195 °C)
Materials:		
Main Body		316 Stainless Steel
Primary Thermowell Material		Silicon carbide
Secondary Thermowell Material		Monocrystalline sapphire
Thermocouple Types:		B, S, R, K, T (“C” non-standard)
Ingress Protection:		IP65
Hazardous Location Rating:		II 2 G Ex db IIB+H2 T3 Gb
Applied Hazardous Location Ratings:	IECEx:	IEC 60079-0:2017 Ed. 7
		IEC 60079-1:2014 Ed. 7
	ATEX:	EN 60079-0:2018
		EN 60079-1:2014
	EAC	TRCU 012/2011

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

Model Numbering System



MODEL	DESCRIPTION
HTV	Thermocouple, Sulfur Processing Service, Unpurged, 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 only)	

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

PROCESS CONNECTION	DESCRIPTION
1.5"MPTY	1.5 in male pipe thread, 316 Stainless Steel
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
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

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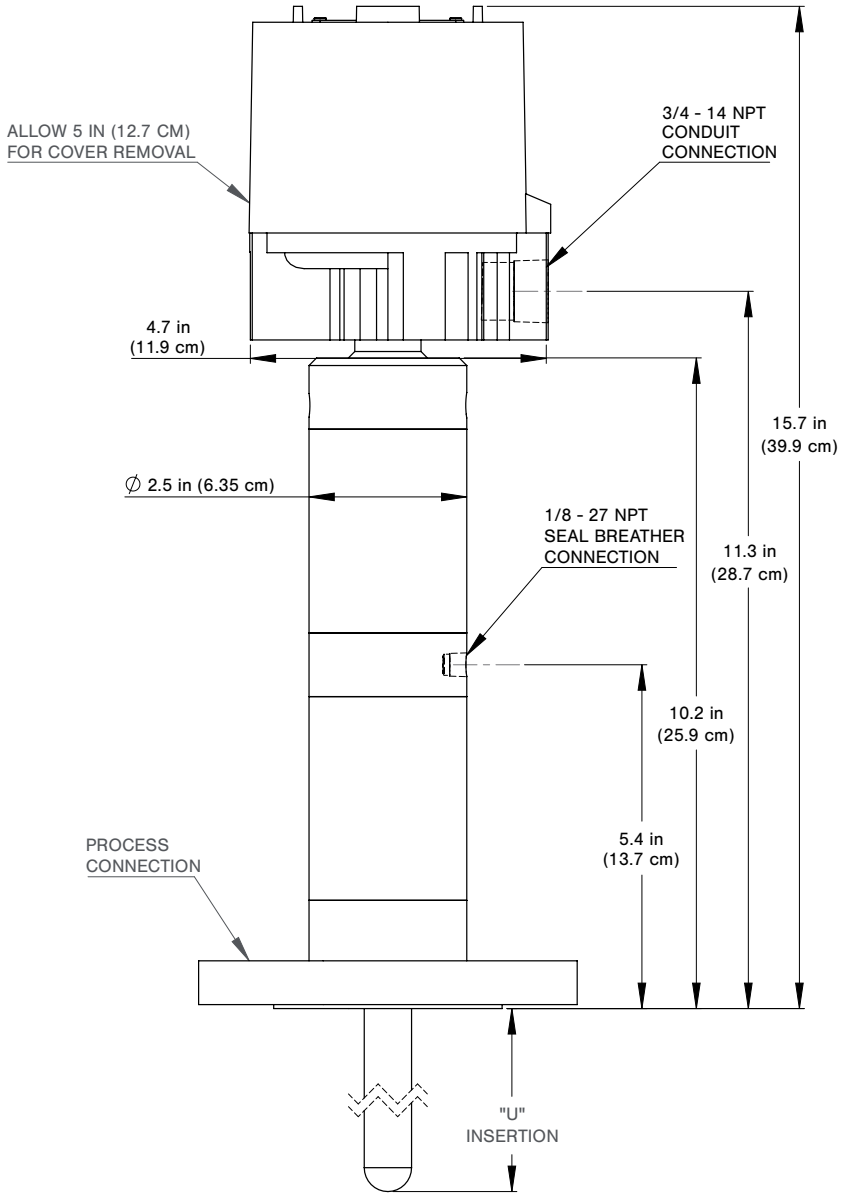
Model HTV Dimensional Drawing



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