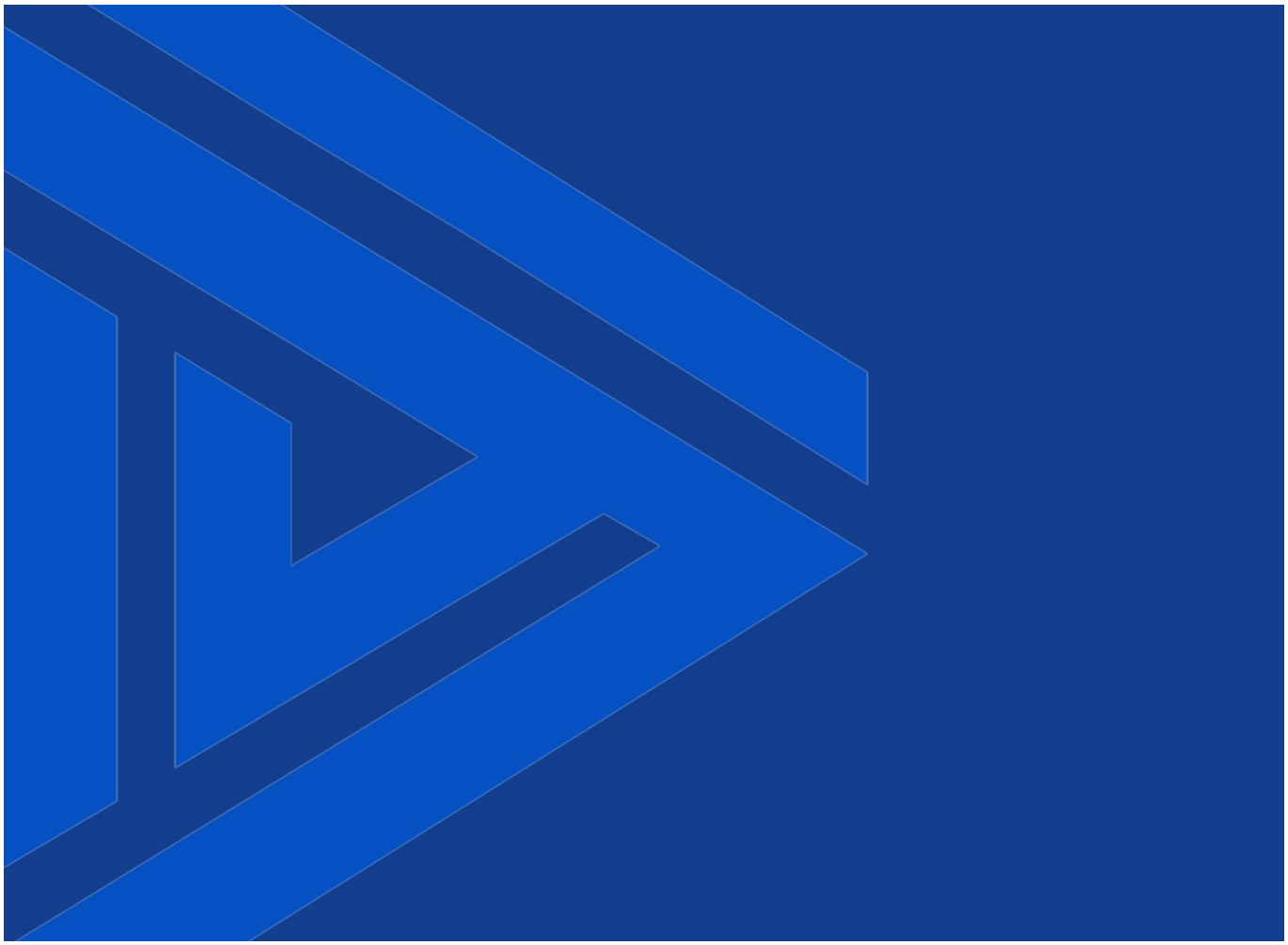
Model HTS

Installation, Operation and Maintenance Manual



Delta Controls
CORPORATION

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Contents

Installation Guide

Components of the HTS Claus Thermal Reactor Thermocouple System Referenced in this Manual			
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:			
Model		**Description**	**Notes**
HTS		Claus Thermal Reactor Thermocouple	Thermocouple assembly
HNP		Nozzle Insulation Kit	Woven disks for internal insulation of the nozzle
HFS		Flush Gas Control Station	Flow indicator, flow control valve, pressure regulator, filter, dripwell, and gauge on a stainless-steel panel with mounting hardware

Shipping Preparation, Storage and Handling

Transport

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.

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.

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.

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.

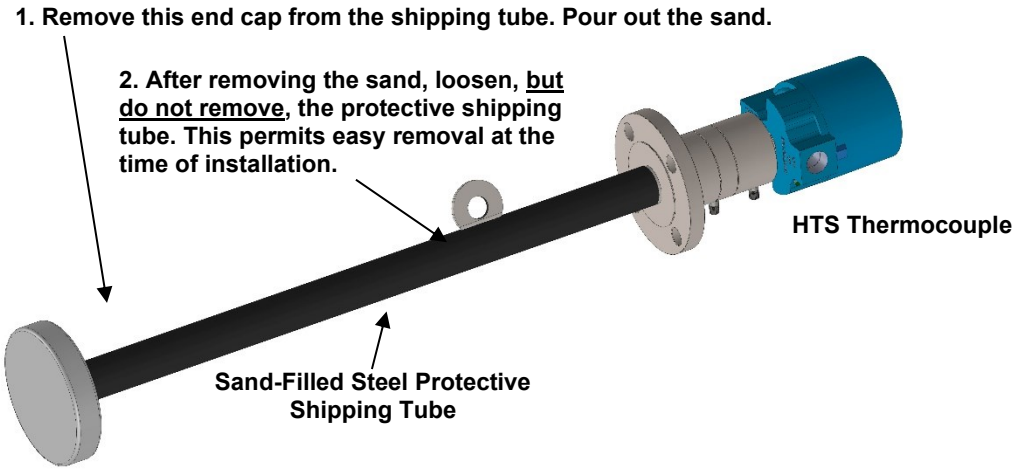
Pre-Installation Preparation

Survey the Installation

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.

Inspect the Thermocouple and Accessories

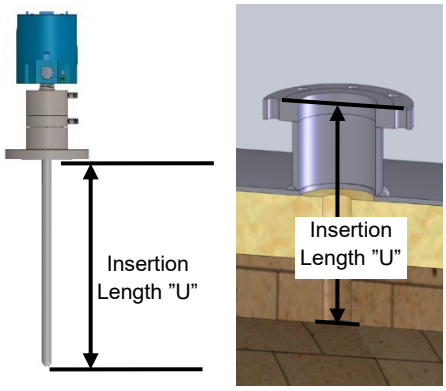
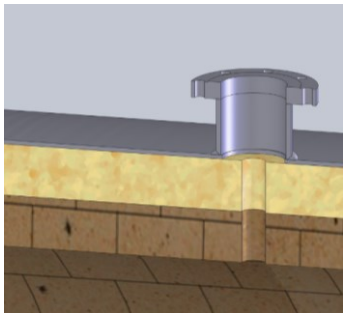
a. Open the carton and carefully remove the top layer of the packing materials.
b. Inspect the HTS Assembly for visible damage.
c. The protective steel tube attached to the flange surrounds the ceramic element well. This tube is filled with sand to support and protect the element well, during shipping. 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 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 to permit easy removal by hand at the installation site.
   Note: Occasionally, the use of a pipe wrench may be required to loosen the tube.
   ****Leave the pipe 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 element well 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.

Inspect the Nozzle

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

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 element well, as measured from the thermocouple flange to the tip of the well. *Note: If the thermocouple element well 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.*	
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. *Note: If the hole does not meet the above criteria, the thermocouple can become broken shortly after start up as refractory begins to shift.*	

Resolution of Dimensional Problems

Carefully measure the nozzle and refractory dimensions and compare them to the dimensions on the specific order. Dimensional discrepancies are commonly caused by the following conditions:

1. **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 it susceptible to damage from thermal shock.

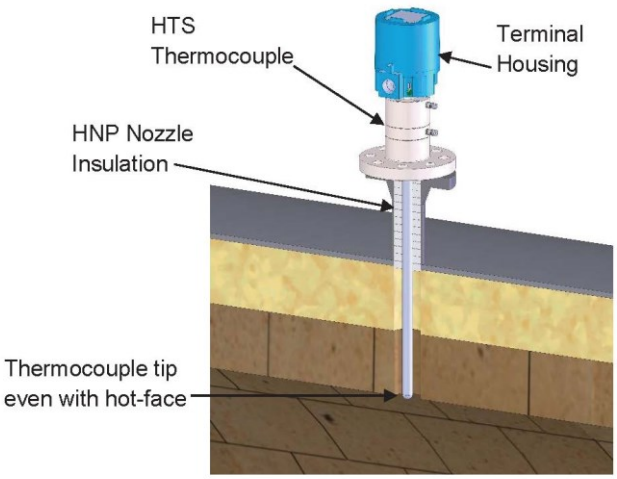
2. **Incorrectly specified thermocouple dimensions –** The design intent is for the thermocouple element tip to be positioned even with the refractory hot face. If these conditions are not met, it may cause be inaccurate measurements and/or breakage due to thermal shock
3. **Refractory is not installed 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.
4. **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.
5. **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.

Installing the Thermocouple

Mounting

1. Carefully remove the protective tube from the thermocouple and place it in a safe location.
2. Install nozzle insulation disks onto the ceramic thermowell, filling the nozzle completely.
3. Place gasket onto the flange.
4. Carefully insert the thermocouple into the nozzle.
5. Rotate the thermocouple to the desired position to attach conduit and tubing.
6. Install and tighten the flange studs.
7. Install conduit and purge tubing.



After installation and before reactor startup, perform the **Flush Gas / Element Well Integrity Test** on page 10. This will verify the element well 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 element well breakage. In general, replacement is not possible while the reactor is running. A thermocouple with a broken element well or which is improperly flushed will only operate for a short time before failing.

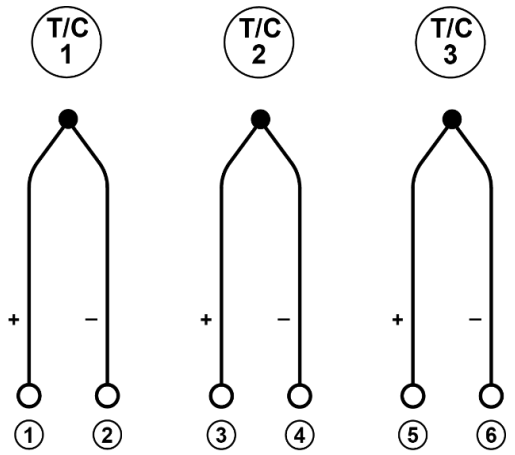
Wiring

- The conduit connection to the terminal enclosure should be equipped with a union and flexible conduit for ease of maintenance; and also, 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 comply with all governing codes.

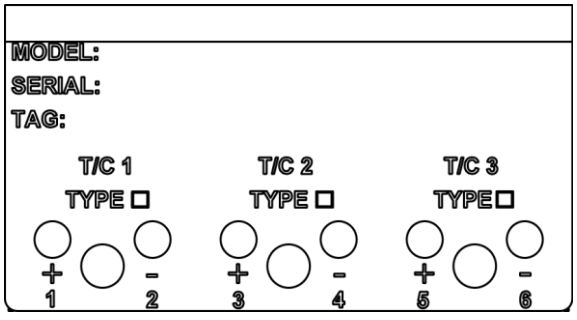
The thermocouple elements are terminated on the connecting blocks, which are mounted inside the thermocouple head. The block positions are marked “T/C 1”, “T/C 2”, and “T/C 3” to designate which thermocouple is connected at each set of two terminal points.

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; same type as the T/C 1 thermocouple.
T/C 3: The T/C 3 thermocouple; supplied as an option on some models.



Wiring Diagram

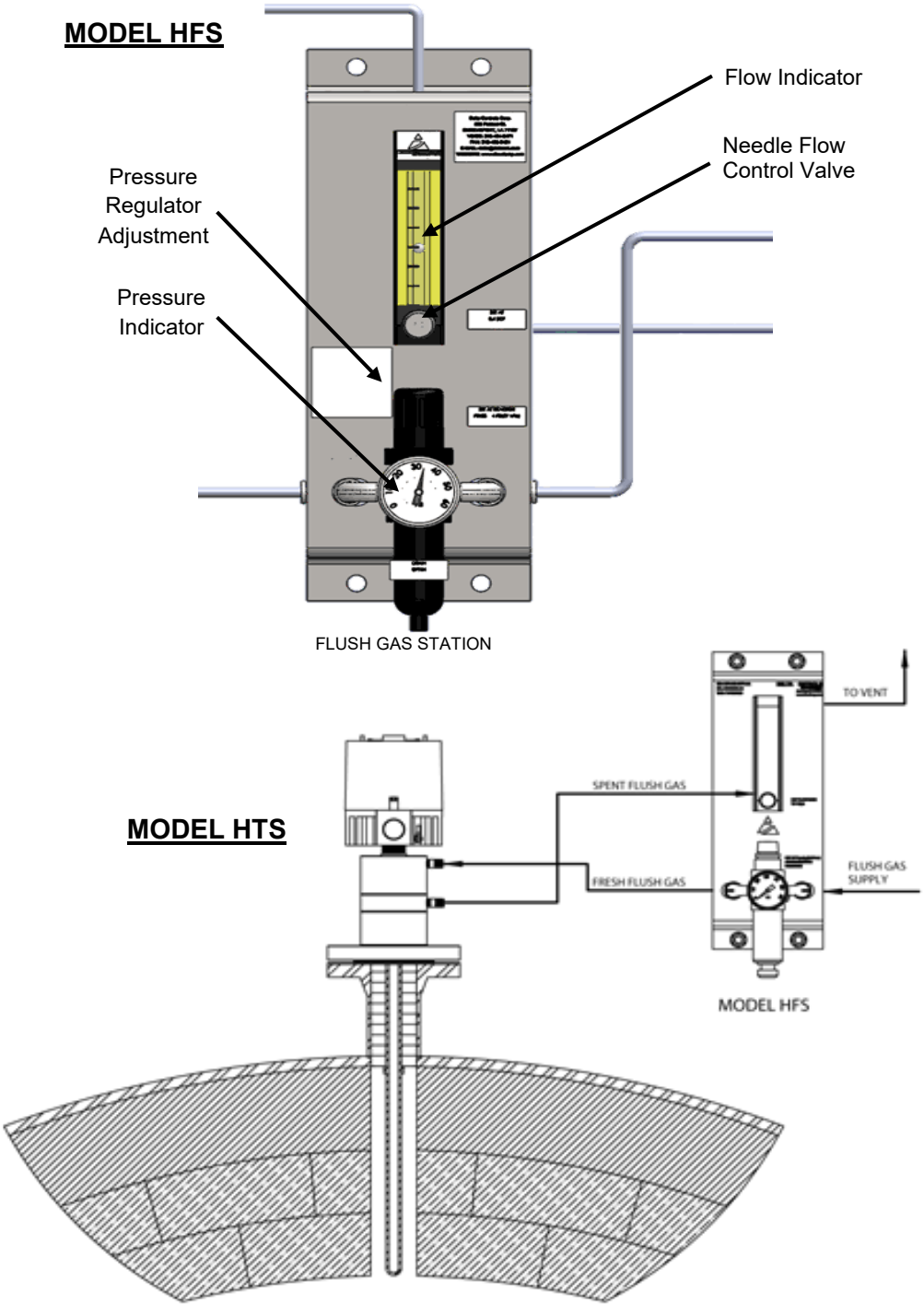


Terminal Block Diagram

Flush Gas Connection

The use of nitrogen as a purge gas is strongly recommended. The Delta Controls Model HFS Purge Control Station provides a convenient and effective means to properly control the purge gas pressure and flow rate. Consult document http://claustemp.com/00-hfs01.pdf for details.

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



Flush Gas/Element Well Integrity Test

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

1. **Pressure Setting** – Verify the pressure is at least 5 psi above the maximum operating pressure of the reactor (normally 15 to 20 PSIG is suitable.) Adjust if necessary.
2. **Flow Setting** – Verify the flow rate is correct: 11 LPH as indicated on the flow indicator. Adjust if necessary.
3. **Check for Integrity** - Elevate the pressure on the HFS regulator by approximately 10 - 15 PSIG. 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 pressure can indicate:

- Leaks – which will allow the gas to escape into the atmosphere and not return to the flow indicator.
- Breakage of the element well – 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 tubing – usually, is due to element well 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.

Technical Operation and Maintenance

Using Multiple Thermocouples within the HTS

The HTS can be equipped with up to 3 independent thermocouples in the same thermowell. On multiple thermocouple units, Thermocouple 1 is exposed to the interior of the thermowell. Thermocouple 2 is located adjacent to thermocouple 1, but is encased in ceramic. In the event of a loss of gas flow or other conditions which may cause corrosion to the thermocouple, Thermocouple 1 will begin to deteriorate due to exposure to corrosive gases. Thermocouple 2, being somewhat protected by ceramic, will deteriorate at a slower rate. This will cause a growing difference in reported temperatures between the two thermocouples; and also, as the deterioration progresses. Any discrepancy between the thermocouple measurements, is an indication of damage to one or more of the junctions.

Thermocouple 3 is typically one which offers a different range of temperatures than Thermocouples 1 and 2. For example, it is common to use type R or S for Thermocouples 1 and 2 and use a type B for Thermocouple 3. 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, but type B cannot be used below an approximation of 100 °C.

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 LPH as shown on the flow indicator.

Shutdown

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

Operation

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

Maintenance

No periodic maintenance is required on the thermocouple. It is recommended the Pressure/Element Well Integrity Test, on page 8, 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 thermal well 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.

Troubleshooting

For assistance with diagnostic procedures, go to the Delta Controls website, “HTP & HTX Troubleshooting” page at www.deltacnt.com/?s=an-htp39.

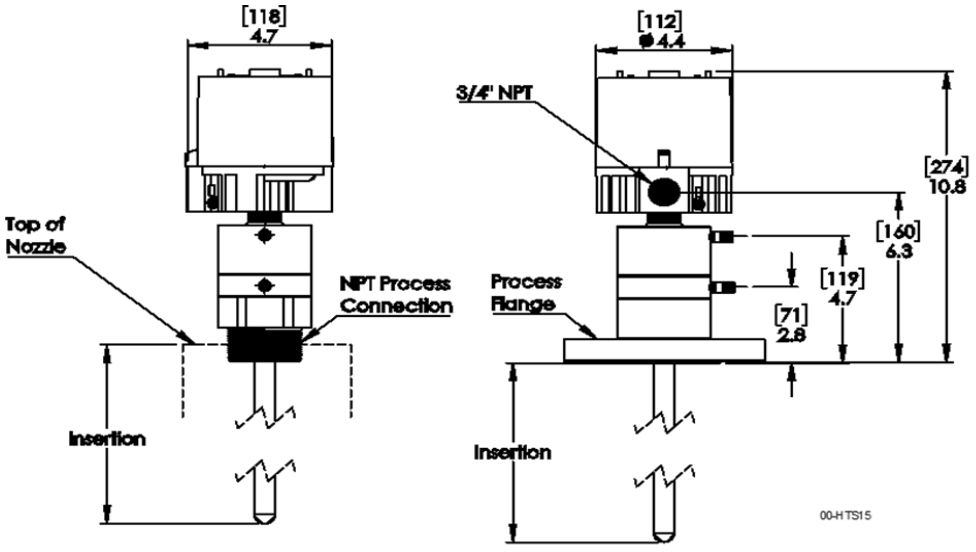
Specifications

Absolute Maximum Ratings:		
Maximum Process Pressure		150psig (10 bar)
Maximum Nitrogen Purge Pressure		30psig (2 bar)
Maximum Process Temperature		3272ºF (1800ºC)*
Maximum Process Temperature (measured at Process Flange)		650°F (343°C)
Maximum Rate of Temperature Change		200°C / HR
Minimum Operating Temperature		-4ºF (-20ºC)
Maximum Process Flange Temperature		446ºF (230ºC) see “X” below
Maximum Terminal Enclosure Temperature		383ºF (195ºC)
Ingress Protection		IP65
Terminal Housing Hazardous Location Rating		Class I, Zone 1, Ex AEx db IIB+H2; T2
Applied Hazardous Location Standard(s)	EAC:	TR CR 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
Protective well		Blended alumina, ceramic
Gas Requirements		Dry Nitrogen, 0.4 scfh (11 l/h)

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

Special Conditions of Use

“X” behind the approval number indicates special conditions for safe use: Flamepath joints are not intended to be repaired. Unit must only be disassembled or repaired by manufacturer. Flange temperature shall not exceed 230 ˚C (446 ˚F). Use fasteners with M6 x 1 mm 6g, 25 mm long 18-8 stainless steel with tolerance strength of ≥ 70 KPSI bolts. Fasteners incorporated in both lower and upper flange joints. Assembly shall be used with at least minimum 124.24 mm (4.89 in) high steel nozzle with maximum wall thickness 11.252 mm (0.443 in) and maximum nozzle diameter 174.625 mm (6.875 in). Minimum 131.940 mm (5.1945 in) refractory below the nozzle shall be provided by the end user. Thermowell shall not extend more than 25.1 mm (1 in) beyond the refractory hot face. Temperature insulating material provided by manufacturer shall be installed inside the nozzle. Refractory well provided by manufacturer shall be installed in the refractory borehole. This equipment shall be installed so that the flanged joints are not within 40 mm (1.7 in) of a solid object that is not part of the equipment. Terminal housing threaded conduit entries = ¾” NPT. Threaded adaptors size for Nitrogen connection = 1/8” NPT.



Dimensions

Model Numbering System

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MODEL	DESCRIPTION
HTS	Thermocouple, Sulfur Processing Service, Compact

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
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
3"MPTY	3 in male pipe thread, 316 Stainless Steel
4"150RY	4 in MPT, 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
	Other types and sizes (DIN, BS, etc.)

OPTIONS	DESCRIPTION
AA	None
XPB	304 Stainless Steel housing, NACE
T**.*	Temperature Extension (**.* *in*)

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

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