DELTA CONTROLS CORPORATION

SHREVEPORT ENGINEERING DEPARTMENT

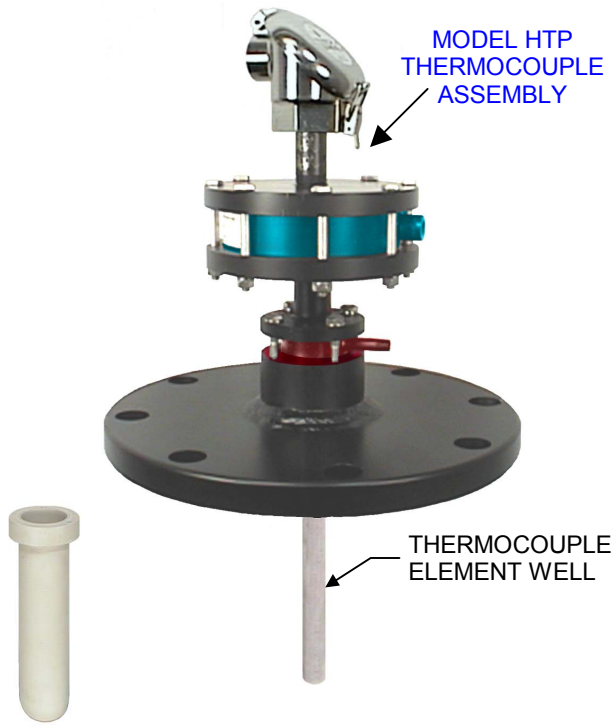
Preparation of The Claus Reactor Vessel
For Installation Of
The HTP Series Claus Thermal Reactor Thermocouple
Refractory Installer Instructions
For ANSI 4” S160 Up Thru 6” 300#
And 90mm up Thru 175mm Flanged Nozzles

The purpose of the Delta Controls **HTP Series Thermocouple** is to provide the operator with a reliable and accurate means of measuring the reactor temperature. A Claus Thermal Reactor probably represents the most severe and demanding temperature measurement application in all of heavy industry. Not only are the operating temperatures reaching nearly 3000°F (1650°C), but the corrosion and operating conditions are severe as well.

In spite of these conditions, failure of the **HTP** is rarely due to either the temperature or corrosion. Improper installation is the primary reason for operational problems. Improper installation usually results from failure to follow the installation guidelines.

This document is intended to inform the vessel designer and refractory contractor of the proper installation techniques.

Note: See document #00-HTP45 for smaller size nozzle installations.



HRW1&2 REFRACTORY WELL

Installation Position	
1	The **HTP** should be installed in the vertical position on the top centerline of the vessel.
Reason	The refractory lining in a Claus Thermal Reactor has different expansion/contraction coefficients from the reactor’s steel shell, which supports the Delta Controls **Model HTP Thermocouple**. As the reactor is brought up to operating temperature, the refractory shifts relative to the vessel shell, to which the **HTP** is rigidly connected. The potential damage to the HTP element caused by movement of the refractory relative to the vessel shell (primarily the “shear” axis movement) is minimized by mounting the nozzle/HTP on the top centerline area of the reactor. During the expansion, contraction, and aging of refractory materials, bits and pieces become dislodged. In a vertical installation, these “bits and pieces” tend to fall harmlessly down and into the vessel. However, in a horizontal installation, they fall on the **Refractory Well,** accumulating around the lower side of it. This creates pressure points, where subsequent expansion/contraction cycles could fracture the well.

Entrance Nozzle Size and Type	
2	A 6-inch (150mm) nozzle size flange is recommended, consult the factory regarding smaller sizes. Smaller size flanged mounting nozzles require special considerations.
Reason	Installation of the **HTP** in a Claus Thermal Reactor requires the use of the **HRW Refractory Well** that fits into and rests on the vessel refractory. This **Refractory Well** utilizes a 2.50" (63mm) OD collar to support it from the top cold face of the refractory and to hold it in the proper position. A six-inch (150mm) size nozzle ID affords adequate space around the collar to install the proper amount and kind of rope insulation to protect the nozzle and shell from excessive heating. A smaller 4" (100mm) nozzle installation affords some space for this rope insulation, but is not as satisfactory as a 6" (150mm) size. A three-inch (75mm) nozzle has inadequate space for insulation. Also, a three-inch installation positions the collar so close to the I.D. of the nozzle, that it is likely that the collar of the basic size **Refractory Well** will come in contact with the nozzle during movement of the refractory. Such an occurrence will fracture the **Refractory Well**. Therefore, if installation must be made in an existing 3" or smaller nozzle, contact Delta Controls for special installation instructions. 3.35" (85mm) and smaller ID sizes require a refractory protective well hole which has a recess that places the top of the well support collar below the vessel shell. See document NO. 00-HTP45 for details.

Height of the Nozzle	
3	Nozzles should not be overly tall. 4"(100mm) to 6" (150mm) height is recommended.
Reason	The nozzle should stay hot to prevent condensation of water and sulfur. Tall nozzles, sometimes installed to get the HTP above the rain shield, are counterproductive. The HTP lower body can withstand 600˚F (330˚C) and the top chamber can withstand 400˚F (200˚C) continuously. Tall nozzles, e.g. 12" to 18" (300 to 450mm) cause the sensing element to be overly long; the nozzle to be too cool; the HTP cost to be higher, and the HTP to be more difficult to install.

Refractory in the Nozzle	
4	No refractory should be allowed to get inside the nozzle during installation procedure. No refractory (or mortar) should protrude up into the nozzle above the top surface of the refractory liner.
Reason	Refractory in the nozzle defeats a major advantage of the Delta **HTP**. The combination of the **Refractory Well**, **Woven Mineral Rope**, **Woven Mineral Discs** and **Pressed Mineral Discs** are key to realization of the long life expectancy and good value of the **HTP**. If refractory material protrudes up into the nozzle above the bottom of the vessel shell, the **Refractory Well** cannot rest down in the proper face position and elevation to provide adequate clearance for the inner **Element Protective Well**. If, through movement of the refractory, the **Element Well** contacts the **Refractory Well**, it is probable that one or both wells will be broken. This will cause subsequent failure of the thermocouple element due to corrosion from the reaction gases. Lining the nozzle wall with castable creates a smaller I.D. in the nozzle and limits the effectiveness of the nozzle insulation packing intended to allow movement of the refractory without damaging the ceramic components of the **HTP**. If refractory should inadvertently be put in the nozzle, then it must be removed. Contact Delta Controls for a properly sized drill to do this job. The Delta **Model HNP** insulation components have proven to provide adequate insulating properties while minimizing space for sulfur to precipitate into a solid. Solid sulfur acts like castable and can also cause mechanical damage to the **HTP** components.

Use of the Casting Mandrel	
5	The HRM installation mandrel provides a correctly sized and located hole on the centerline of the HTP mounting nozzle.
Reason	Proper installation requires that a 2.18 inch (55mm) hole be created through the refractory. The hole must be centered on the nozzle centerline, and must be perpendicular to the nozzle flange face. The Delta Controls **Model HRM Casting Mandrel** provides an effective and accurate means to create the proper cavity and hole for installation of the **HTP**. The hole is cast in place during installation of the refractory. The HRM is inexpensive to acquire and easily installed. To insure the proper clearances between the **Element Well** and the **Refractory Well**, it is necessary that the components be installed on the nozzle centerline, at the design elevation, and perpendicular to the face of the mounting flange. The **Mandrel** is equipped with a "**Stop-Disc**" that prevents refractory material from entering the base of the nozzle and upsetting the clearance between the bottom of the **Element Well** and the inside bottom of the **Refractory Well**. The "**Stop-Disc**" also creates a smooth flat surface for the collar of the **Refractory Well** to rest against, it also prevents any pressure point loading on the collar.
Disad-vantage	The HRM mandrel must be installed before the refractory lining process is begun. The mandrel must protrude down inside the reactor. It must extend 1" (25mm) or more beyond the future position of the refractory hot face. This protruding mandrel is somewhat bothersome to the installation crew. They generally consider the HRM too much of a hindrance and prefer to drill the hole after the lining is complete. Drilling is equally effective, if properly done.

Preparing For Drilling of the Refractory Hole	
6	The cold face of the refractory liner must be flat and at 90˚ to the centerline of the mounting nozzle. See "Mandrel" above for a detailed explanation.
Reason	An HRS refractory stop must be installed in the mounting nozzle before the lining crew begin work. The HRS prevents refractory from entering the nozzle and also leaves a flat refractory face after the lining has been installed
Advantage	The HRS does not protrude into the reactor and is not considered to be a hindrance by the refractory installation crew .

Drilling the Bore Hole thru the Refractory	
7	It is well understood that drilling may be used to create the hole through the refractory. Some refractory installers believe that it is easier to drill the hole rather than install refractory around the mandrel, which protrudes into the vessel. An HRG drill guide must be used if the drilled hole is to be straight and located on the centerline of the mounting nozzle.
Reason	Drilling through a nozzle commonly results in an "off-center" bore and misalignment relative to the flange face. This occurs because installers try to drill "by hand" and "by eye". It is nearly impossible to manually establish accurate alignment when mounting the drill assembly and starting the core drill. Taller nozzles intensify the difficulty. The probability of obtaining a proper result by hand positioning is near zero. If the **HTP Thermocouple** is to be installed thru existing refractory, then drilling is the only means available to create the required bore hole. In this case, be deliberate and very careful; put the hole on the exact centerline of the nozzle and drill at 90° to the face of the mounting flange. This can be reliably done using the **HRG Drill Guide**. The HRG matches and bolts onto the mounting nozzle flange. It is equipped with a guide tube located on the nozzle centerline. This provides a reference that holds the refractory drill precisely on the centerline of the nozzle and at 90° to the flange face. The guide tube extends to the top face of the refractory. The diamond core bit is equipped with two sleeve bearings which ride on the tube ID. The resulting drilled hole is straight and on the centerline of the nozzle.

Checking the Work	
8	You should determine if the refractory work is suitable for the proper installation of the **HTP**. Check the dimensions to be sure that they are correct, that there will be no interference between components, and that spacing is correct. This will help ensure that no failures occur due to movement of the refractory, or from interference between components as the installation proceeds.
Reason	If the refractory work has resulted in improper dimensions or misalignment of the bore; it may be possible to put the **HTP** in place; however it is likely to fail as the vessel is brought on line and movement of the refractory begins. Just because the HTP and HRW well could be put in the hole does not indicate that the installation is proper. Steps to check that the installation was properly performed: 1. Check the hole size and other dimensions for accuracy. 2. Verify that the top surface of the refractory is smooth and flat in the base of the nozzle. If it is still uneven, the "bumps" must be removed. The top surface should be even with the bottom inside surface of the vessel shell. (This is why using the **HRM Mandrel** or the **HRS Refractory Stop** with the "**Stop-Disc**" is important during initial lining or relining of the reactor). 3. If drilling work was performed… A. Place a bright light in the vessel directly below the thru-bore and observe that the thru-bore is clean with no protrusions. Also, using the light, observe the alignment of the bore relative to the centerline of the vessel nozzle. All diameters should appear concentric to each other. B. Check that the thru-bore diameter is between 2.18 or 2.28 inches (55 or 58mm) ID.

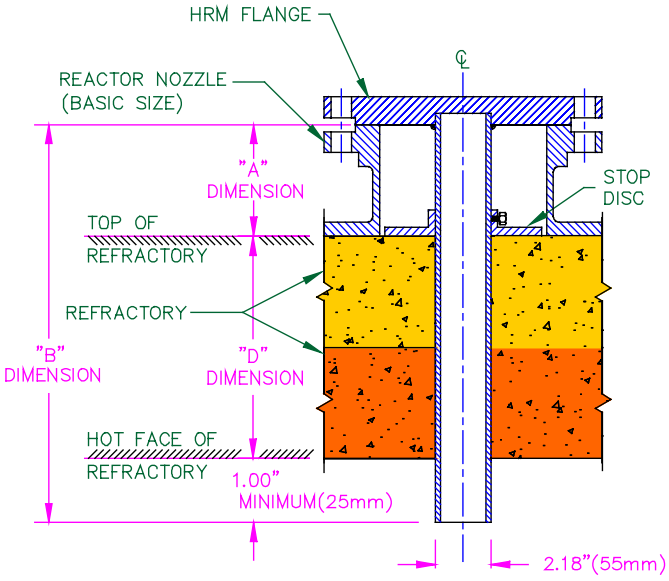
This document is intended only for the purpose of informing the refractory installation personnel of the key elements of the correct preparation of the vessel and refractory for installation of the **HTP**. Complete Instructions for installation of the **HTP** are contained in document 00-HRW03, which is available from Delta Controls. Installation of the **HTP** should not be attempted without studying and following the detailed installation instructions contained in Document 00-HTP03.DOC.

Please consult Delta Controls if any questions arise relative to the installation of the **HTP**. Proper installation and operation will provide maximum protection for the vessel/lining, and will result in a long and effective life for the **HTP**.

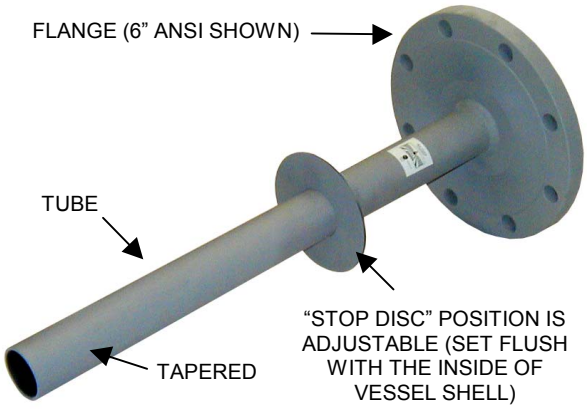
CREATING A CAST REFRACTORY HOLE WITH THE HRM MANDREL

The HRM is used to create a completely aligned and centered hole, of the correct diameter, through the refractory lining of a Claus Thermal Reactor. A tapered tube, which has been greased, prevents the refractory from sticking to the mandrel tube and makes the arm easy to extract.
Low cost, as well as good results for the owner is achieved when the Delta HRM is used during the refractory installation process. Perfectly aligned holes of the right size are easy to produce with the Delta HRM Refractory mandrel.

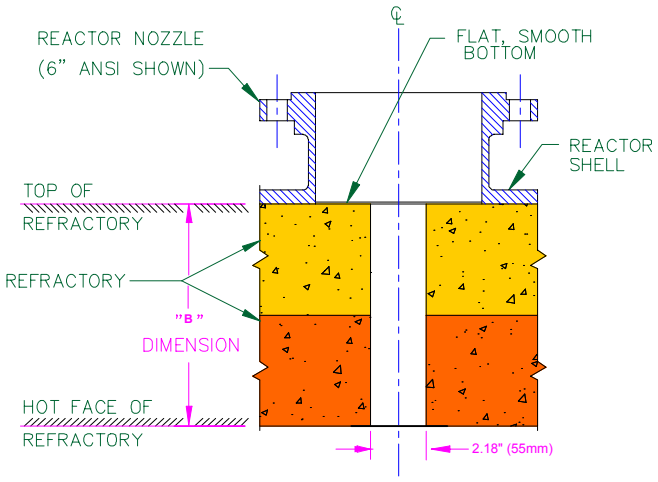
Note that the tube does stick down into the reactor shell. It does somewhat obstruct access during installation of the refractory. Some installers consider this to be objectionable and prefer to drill the hole after the lining is installed.



SHOWN BEFORE MANDREL IS REMOVED



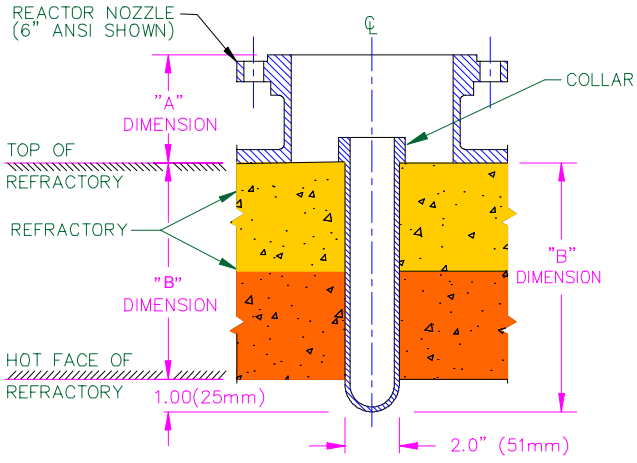
HRM MANDREL WITH 6"/150#RF FLANGE



SHOWN AFTER MANDREL REMOVED

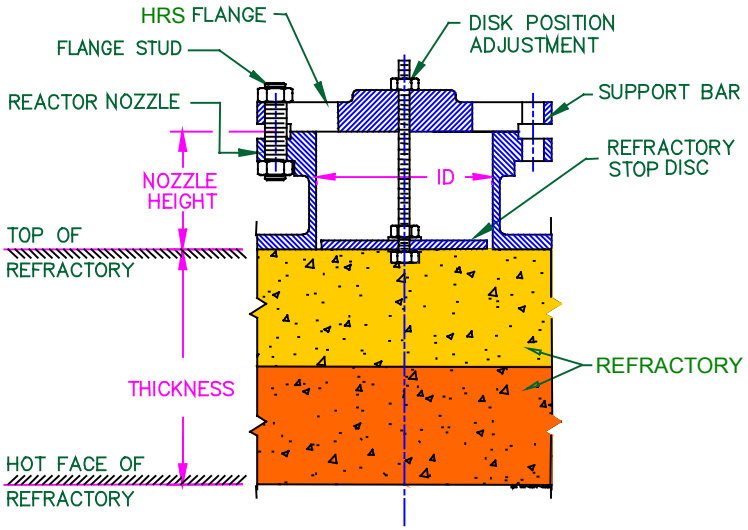
FINAL RESULT

Either casting or drilling can produce the same desired result. The requirement is a concentric hole on the centerline of the mounting nozzle.

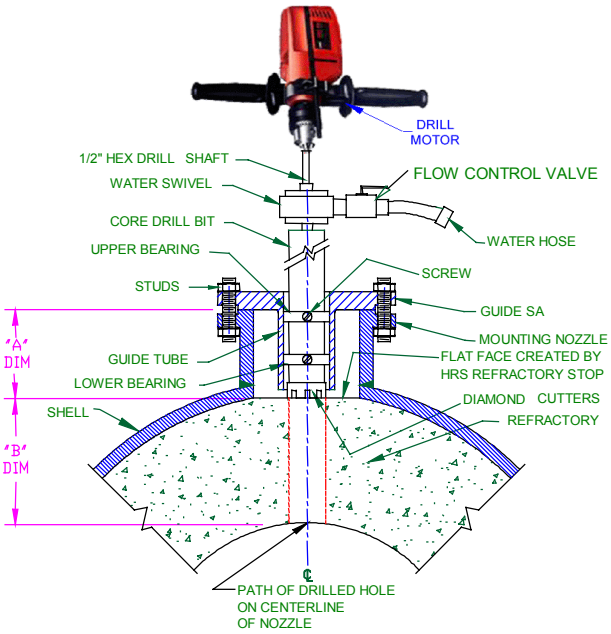


SHOWN AFTER HOLE DRILLED

CREATING A REFRACTORY HOLE BY DRILLING WITH THE HRG GUIDE



HRS REFRACTORY STOP IN PLACE



H6G GUIDE AND DRILL BIT

Generally, refractory installers prefer to drill the bore hole through the refractory instead of mounting the casting mandrel. The mandrel sticks into the reactor space and also requires that the refractory fire brick be cut and fitted around the mandrel tube.

But, it has been found that creating a “drilled hole” that is on-center, straight, uniform and of the proper bore size is difficult, in fact it is nearly impossible to achieve with hand held techniques. A correct hole is even more difficult to achieve when the nozzle length is long. Boring an incorrect hole through the refractory is very likely to cause the thermocouple assembly to become broken during installation or by shifting refractory, which will result in early thermocouple failure. Also, once an improper hole is drilled through the refractory, it is very difficult, expensive, and time consuming to correct it.

The first step is to install an HRS refractory stop on the mounting nozzle before the refractory lining is installed in the reactor. The HRS prevents refractory from getting up into the nozzle. It also produces a flat smooth face on the refractory surface at the bottom of the nozzle. This allows the core drill bit to easily start straight and provides a smooth surface for the HRW refractory well to rest on.

The second step is to remove the HRS after lining job is complete. Replace it with the HRG drill guide. The drill guide is rigidly fixed to the face of the mounting flange. A guide tube extends down into the nozzle and nearly to the refractory top face. The tube is concentric with and exactly on the centerline of the nozzle flange. The tube type bearing race is concentric with and exactly on the centerline of the nozzle flange. The drill bit is positioned by the tube and drills a straight hole on the centerline of the flanged mounting nozzle.

Two sleeve bearings are located on the core drill bit. These slide against the inside of the guide tube. The drill bit is kept aligned and produces a straight hole on the centerline of the mounting nozzle.

Attach a heavy duty variable speed drill motor to the shank of the drill bit. Start the flow of water. Turn the drill bit at speeds of 50 to 600 rpm, depending on the hardness of the refractory material. The resulting finished hole should be straight, smooth, and concentric with the centerline of the mounting nozzle.

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