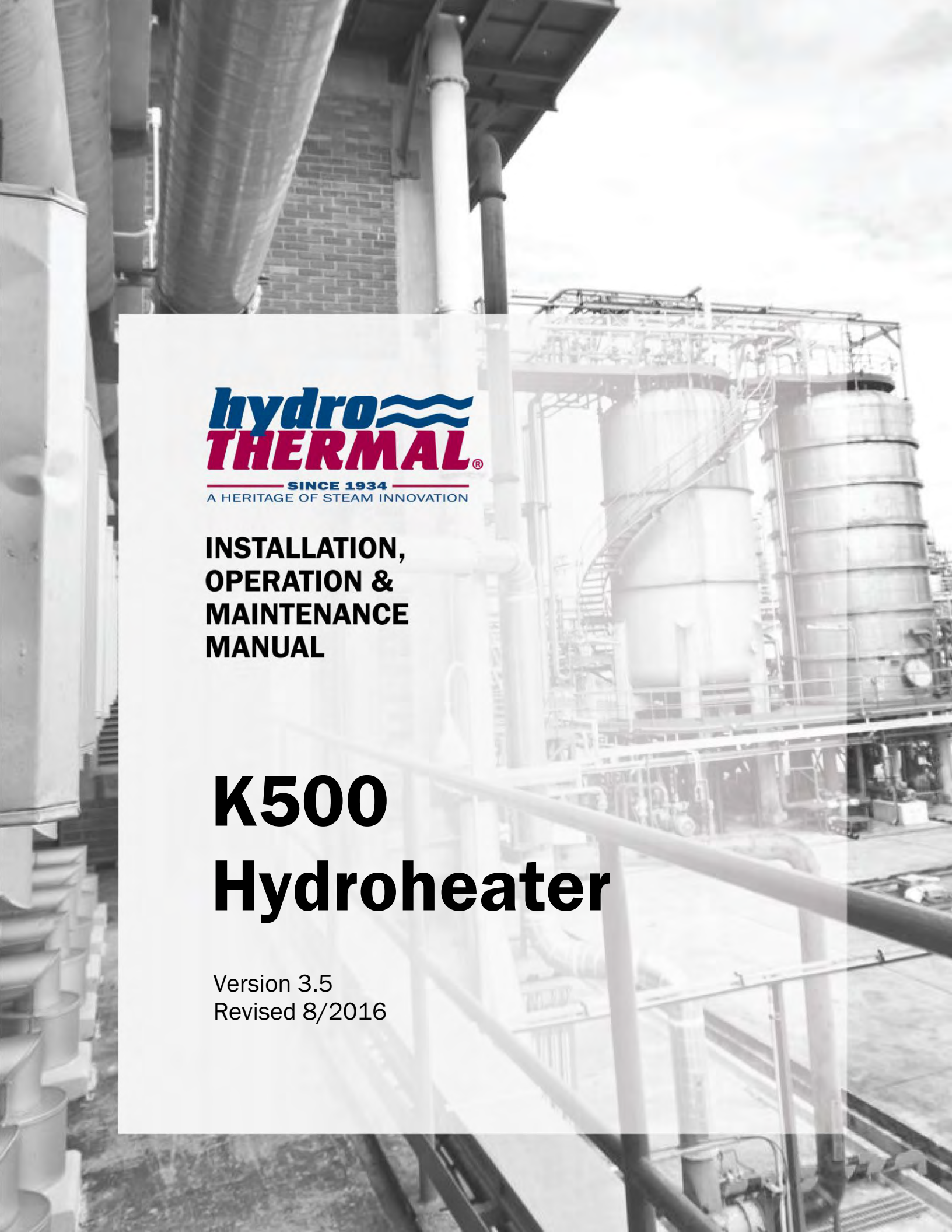

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SINCE 1934
A HERITAGE OF STEAM INNOVATION

INSTALLATION, OPERATION & MAINTENANCE MANUAL

K500 Hydroheater

Version 3.5
Revised 8/2016

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1.0 K500 Automatic Hydroheater – General Information

1.1 your smart ENERGY investment™

Your smart energy investment in the Hydro-Thermal® K500 Hydroheater® will bring you years of service for your heating needs. It is a highly engineered patented steam heating valve designed specifically for your process and operating conditions.

Hydro-Thermal direct steam injection heaters offer advantages no other heater can. We are confident you will be pleased with the performance of your heater and the increased efficiency it will bring to your operation. In fact, we guarantee the Hydroheater will work properly for your specific application and under the operating conditions you specified. Thank you for choosing a Hydro-Thermal heating solution.

1.2 Purpose of the Manual

Hydro-Thermal direct steam injection heaters are highly engineered products with patented complex and precisely manufactured internal components. Regular maintenance is essential to keep the heater in peak operating condition and continue the performance warranty. Please read the maintenance section of this manual carefully and follow the recommended schedule.

This manual contains information regarding installation, operation, troubleshooting, maintenance, assembly/disassembly, and spare parts for all models of the K500 Series Hydroheater. It is provided as a guide for proper and safe operation of the unit.

CAUTION – It is essential to understand the material in this manual for proper operation of the K500. Failure to follow these recommendations can result in equipment failure, bodily harm, or void the warranty.

NOTICE – material may be subject to change: Hydro-Thermal maintains a policy of continual product improvement. All information shown is correct when published, but subject to change without notice.

To assist you, Hydro-Thermal offers a variety of comprehensive support programs that include certification training, advance replacement, on-site maintenance, and total maintenance and repair/refurbishment packages. Please call toll-free 1-800-952-0121 or +1 (262) 548-8900. You may also visit www.hydro-thermal.com for more information.

1.3 Principles of Direct Steam Injection (DSI)

The K500 is a direct steam injection heater that heats fluids or slurries by mixing steam directly with the product. This method provides rapid steam condensation to transfer heat to the product safely, quickly and accurately.

Direct steam injection is capable of transferring 100% of the steam's heat energy, and may be more efficient and economical than indirect heating methods such as heat exchangers or tank spargers.

In a heat exchanger, the fluid and the steam conduct heat through a steel barrier layer that reduces heat transfer by as much as 15-30%. Additionally, scale and minerals build up over time producing an insulating effect that further decreases a heat exchanger's effectiveness. A heat exchanger also requires more maintenance and significantly more floor space.

Direct steam injection introduces steam directly into the product, resulting in a nearly instantaneous change in temperature. All of the sensible and latent heat energy of the steam is absorbed into the product, reducing actual steam usage. This efficient use of energy, along with precise temperature control, allows for maximum performance and reduced operating costs. Actual energy savings could be up to 30% over heater exchangers or sparging.

Direct steam injection does not require a complicated condensate return system, and since the K500 is internally modulated, there is no requirement for an external steam control valve. For these two reasons, and the simple system requirements detailed in Section 3.0, the K500 is easy to implement and provides an enhanced cost benefit.

1.4 How the K500 Works

Please reference figure 1 below. The K500 is an internally modulated steam injector with a 90 degree fluid flow design favorable for slurries that require high shear heating, applications with high changes in temperature, turbulent mixing, and self cleaning for products that cause burn-on. A liquid or slurry enters into the combining tube (CT) where steam is introduced into the fluid. Steam is modulated by a stem/plug, through a nozzle and discharged into the liquid or slurry. The nozzle discharges steam at very high, often sonic velocity. The turbulent nature of this high velocity discharge enables steam to instantaneously penetrate, disperse, efficiently mix and condense with the liquid or slurry to produce uniform heating. Temperature is measured downstream and feedback is sent to a controller. The controller modulates steam flow by sending a signal to an actuator directly linked to the stem/plug. The actuator opens and closes accordingly to achieve a target temperature.

The unit is designed such that steam pressure and steam velocity remain constant throughout the range of operation, regardless of the amount of steam being added. The high velocity of the steam discharge prevents burn on while creating a turbulent interface between the product and steam. This interface causes atomized steam to mix with the product and quickly condense, thereby transferring the heat rapidly and in a controlled manner.

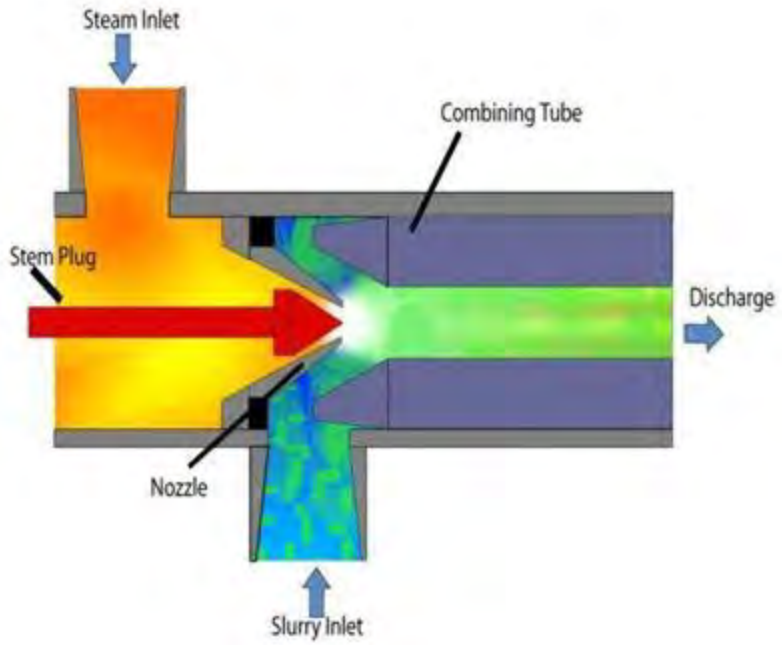


Figure 1: How the K500 Hydroheater Works

1.5 Model Number Designation, Dimensions and Capacities

1.5.1 Explanation of Model Numbers

The last two digits of the model number indicate the size of the Hydroheater.

Table 1: Explanation of Model Numbers

Model	Connection in inches [mm]	Discharge in inches [mm]
K510	2.5 inches [64 mm]	2.0 inches [51 mm]
K511	3.0 inches [76 mm]	2.0 inches [51 mm]
K512	3.0 inches [76 mm]	2.5 inches [64 mm]
K513	4.0 inches [102 mm]	4.0 inches [102 mm]
K514	6.0 inches [152 mm]	6.0 inches [152 mm]
K515	8.0 inches [203 mm]	8.0 inches [203 mm]
K516	10.0 inches [254 mm]	10.0 inches [254 mm]

1.5.2 Location of Markings on Body

Figure 2 shows the location on the body of the serial number and Figure 3 shows the model number. The serial number is stamped on the steam inlet. The serial number and model are also stamped on the nameplate.

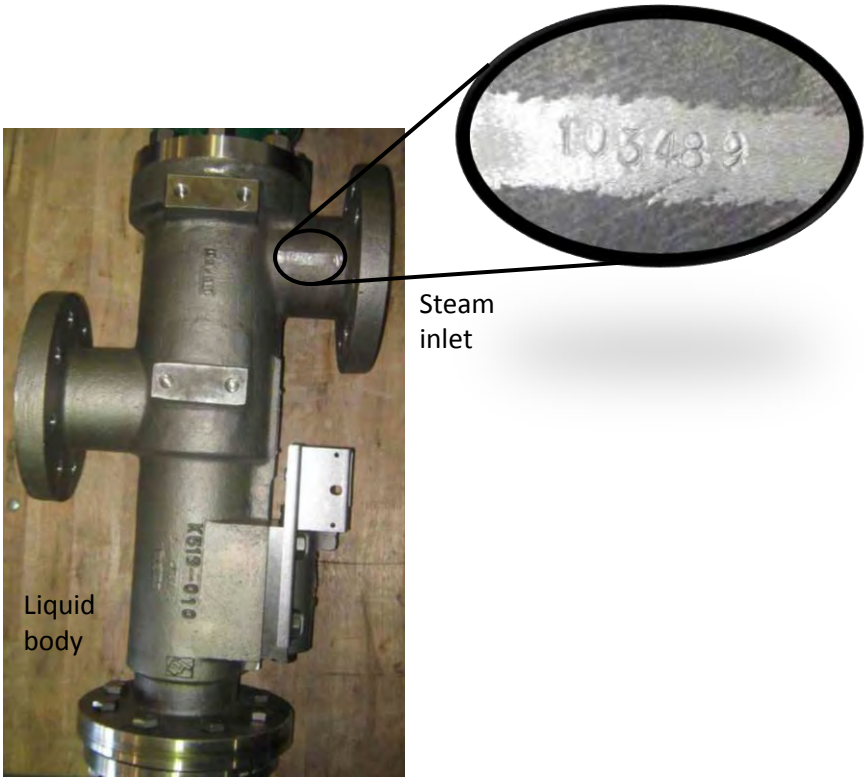
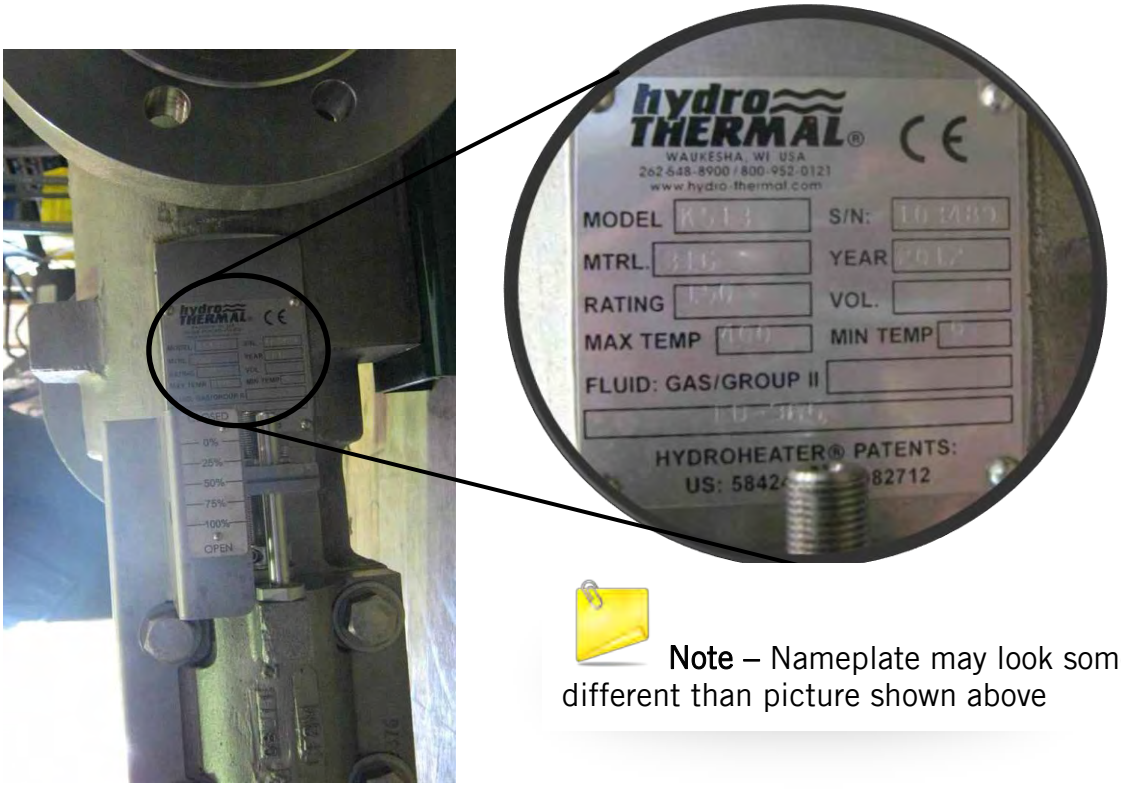


Figure 2 Body Serial Number



Note – Nameplate may look somewhat different than picture shown above

Figure 3: Model Number Location

The serial number (a 5 or 6 digit number) is unique to each Hydroheater unit manufactured. The code (i.e. 123456) is listed on the unit, the purchase order, as well as on supporting documentation from Hydro-Thermal Corporation. *This serial number is crucial for ordering additional units, spare parts, and accessories.* Please refer to this serial number whenever contacting Hydro-Thermal Corporation.

1.6 Application Criteria

1.6.1 Industries and Products

The K500 Hydroheater is a versatile direct steam heater that can be used to replace heat exchangers and/or spargers in many situations. These heaters fit into industrial sustainability initiatives by using less water, all of the steam's energy and they heat precisely using up to 30% less energy than other traditional fluid heating devices. Below is a partial list of applications for the K500 Hydroheater.

Table 2: Application Examples for the K500 Hydroheater

Industry	Product or Process
Ethanol	Process starch
Ethanol	Industrial mash
Ethanol	Slurry starch
Pulp & Paper	Size press starch dilution
Pulp & Paper	Size press (dry end) starch cooking
Pulp & Paper	Industrial coating starch cooking
Pulp & Paper	Industrial cationic (wet-end) starch cooking
Pulp & Paper	Process slurry PVOH
Pulp & Paper	Process pulp stock
Pulp & Paper	Brine dilution
Pulp & Paper	Black or other heavy liquor heating
Pulp & Paper	Green liquor heating
Pulp & Paper	Whitewater heating
Chemical/Pharmaceutical	Process chemical slurry
Chemical/Pharmaceutical	Jacketed kettle heating
Chemical/Pharmaceutical	Bio-kill
Food & Beverage	Fermentation, culture growing
Food & Beverage	MSG - mono-sodium glutamate
Food & Beverage	Cooking in-line soy products
Food & Beverage	Cooking in-line sauces, BBQ, tomato, ketchup, mayonnaise, etc
Food & Beverage	Cooking in-line dog food
Food & Beverage	Cooking in-line cheese
Food & Beverage	Cooking in-line baby food
Food & Beverage	Cooking in-line juice
Food & Beverage	Food related (thickening), Malt dextrin, Fructose, confectionary
Food & Beverage	Tapioca processing
Food & Beverage	Dairy
Multiple	Grain processing
Multiple	Water heating

1.6.2 Sizing Considerations

Note - For accurate sizing contact a Hydro-Thermal Representative

There are many factors to consider when choosing the specific size of a heater body and the internal components. Please note that a given body has a wide range of possible internals.

First, product flow rates, both now and in the future, should be considered to optimize performance. However, it is important to select internals for the current conditions. If higher flows are required in the future, they may be achievable by replacing the internals. Over sizing the components today, for possible increased future capacity, may result in poor temperature control. Please see section 5.0 – troubleshooting for more details.

Second, heating capacity needs should be clearly defined for the full range of expected process conditions—both process flow and temperature rise requirements.

The range of flow (steam or liquid) is called the system turndown, defined as the ratio of the maximum and minimum flow rates.

Sizing Example 1: A system with a maximum liquid flow of 600 GPM [136 m^3/h] and a minimum flow of 200 GPM [45 m^3/h] will have a liquid turndown of 600/200 = 3:1.

Steam turndown is a function of both liquid turndown and a variance in discharge temperature.

Sizing Example 2: The system in Example 1 uses a K500 Hydroheater® to raise the temperature of river water to 120° F [49°C]. In the winter, the river water is 40°F [4.4°C], so the K500 heats the water 80°F [27°C]. However, in the summer the river water is now 80°F [27°C], so the K500 only heats the water 40°F [4.4°C]. The resulting steam turndown at any given flow rate is 2:1. Further, because the system flow rate also has a turndown ratio of 3:1, the total steam turndown for the system is 6:1.

Continuous systems with steam and liquid turndown ratios less than 2:1 typically require only simple control schemes. As the turndown ratios increase, systems need more sophisticated instrumentation and control schemes.

The heater internals are typically sized to operate between 20-80% valve position. In general 20% minimum opening is necessary for accurate temperature control and for robust product reliability. Sizing to 80% capacity allows for variations in process conditions and some additional capacity.

1.7 Process and Steam Pressure Requirements

For stable operation, a correct relationship between steam and process pressure is needed.

Please note that the pressures stated are those immediately at the heater during operation. For example, steam pressure should be measured near the inlet flange of the heater, because extended lengths of piping, elbows or valves would result in lower steam pressure at the heater inlet. Process pressure should be measured near the heater discharge for the same reasons.

1.7.1 Maximum Process Pressure (Heater Discharge)

In order to maintain stable flow conditions, the absolute pressure ratio of water to steam should not exceed 0.6. Table 3 shows a number of common steam pressures and each respective maximum allowable water pressure.

Table 3: Maximum Water Pressure

Steam Pressure (psig)	Max Water Pressure (psig)
20	6
30	12
40	18
50	24
60	30
70	36
80	42
90	48
100	54
110	60
120	66
130	72
140	78
150	84

Steam Pressure Bar (g)	Max Water Pressure Bar (g)
1.5	0.5
2.0	0.8
2.5	1.1
3.0	1.4
4.0	2.0
5.0	2.6
6.0	3.2
7.0	3.8
8.0	4.4
9.0	5.0
10.0	5.6

Table 3 follows a linear relationship and may be interpolated or extrapolated to approximate your specific flow conditions. For more tailored, accurate and complete sizing, please contact your Hydro-Thermal representative at info@hydro-thermal.com or (262) 548-8900

1.7.2 Minimum Process Pressure

For a given discharge temperature, the water discharge pressure should be maintained at 5 psi [0.3 Bar] above the saturation pressure. Table 4 shows the minimum allowable discharge pressure for a range of temperatures. For a more complete table and curve, please see Appendixes A and B. As a general guideline, for high temperature applications, over 250°F [121°C] or high temperature differential, over 100°F [38°C], please contact Hydro-Thermal at (262) 548-8900 to discuss this with one of our Applications Engineers.

Table 4: Min Water Discharge Pressure

Water Temperature (°F)	Min Water Pressure (psig)
210	5
212	5
220	7
230	11
240	15
250	20
260	26
270	32
280	39
290	48
300	57
310	68
320	80
330	93

Water Temperature (°C)	Min Water Pressure Bar (g)
100	0.34
105	0.54
110	0.76
115	1.02
120	1.32
125	1.65
130	2.03
135	2.46
140	2.94

Example: Heating to 250˚F [121°C]
Steam Pressure: 110 psig [7.6 Barg]

Result: Maximum water discharge pressure: 60.1 psig [4.15 Barg]
Saturation pressure at 250˚F [121°C]:15.1 psig [1.0 Barg]
Minimum water discharge pressure: 20.1 psig [1.4 Barg]

1.7.3 Superheated Steam

Superheated steam should be a maximum of 50°F [28°C] above saturation temperature to assure smooth condensation. For superheat temperatures in excess of 50°F [28°C], please contact Hydro-Thermal for more detailed analysis.

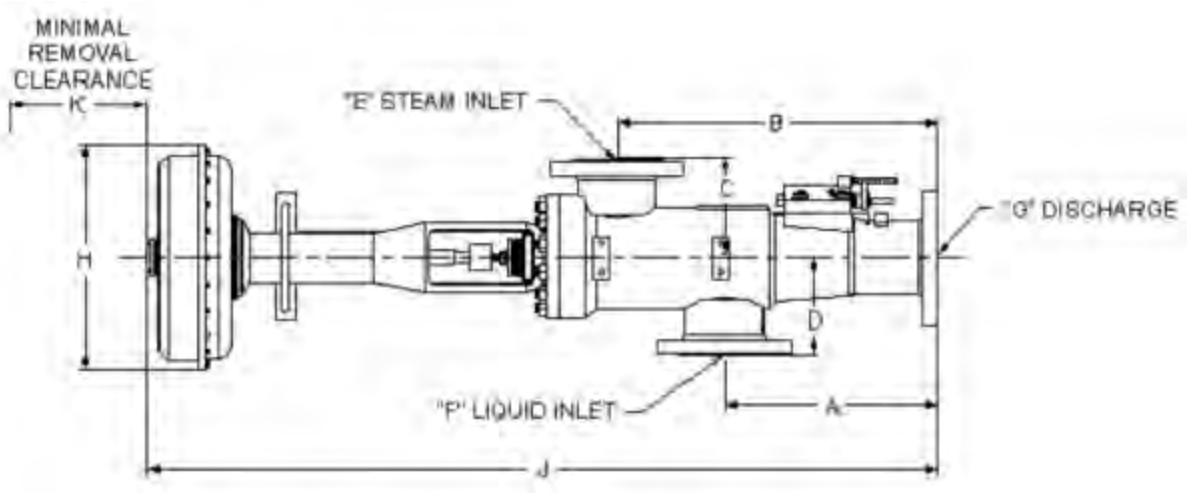


Figure 4: Dimensions of K500 Hydroheater

1.7.4 Model Capacities and Heater Sizes

Table 5: K500 Dimensions

Model	A	B	C	D	E,F	G	H	J	K
	in(cm)	in(cm)	in(cm)	in(cm)	in(cm)	in(cm)	in(cm)	in(cm)	in(cm)
K510	13.19 (33.50)	17.31 (43.97)	5.00 (12.70)	5.00 (12.70)	2.50 (6.35)	2.00 (5.08)	16.00 (40.64)	45.00 (114.30)	4.00 (10.16)
K511	16.00 (40.64)	21.13 (53.67)	6.00 (15.24)	6.00 (15.24)	3.00 (7.62)	2.00 (5.08)	16.00 (40.64)	55.75 (141.61)	4.00 (10.16)
K512	16.00 (40.64)	21.13 (53.67)	6.00 (15.24)	6.00 (15.24)	3.00 (7.62)	2.50 (6.35)	16.00 (40.64)	55.75 (141.61)	6.00 (15.24)
K513	15.38 (39.07	22.38 (56.85)	7.56 (19.20)	7.56 (19.20)	4.00 (10.16)	4.00 (10.16)	18.63 (47.32)	58.38 (148.29)	6.00 (15.24)
K514	19.50 (49.53)	29.50 (74.93)	8.88 (22.56)	8.88 (22.56)	6.00 (15.24)	6.00 (15.24)	21.13 (53.67)	73.13 (185.75)	8.00 (20.32)
K515	25.00 (63.50)	37.00 (93.98)	10.75 (27.31)	10.75 (27.31)	8.00 (20.32)	8.00 (20.32)	21.13 (53.67)	82.13 (208.61)	8.00 (20.32)
K516	38.13 (96.85)	52.13 (132.41)	12.56 (31.90)	10.69 (27.15)	10.00 25.40	10.00 25.40	21.13 (53.67)	102.00 (259.08)	9.00 (22.86)

Note – Dimensions shown are for K500 Hydroheaters with 150# ANSI flanges and should be used for reference only. For construction purposes, contact Hydro-Thermal directly.

Table 6: Approximate weight and general flow rate capacities

Model	Approx. Weight lbs(kg)	Flow Rate gpm(m3/h)
K510	160 (73)	28-174 (6.5-40)
K511	297 (135)	40-402 (9-91)
K512	305 (138)	40-402 (9-91)
K513	447 (203)	120-750 (27-170)
K514	704 (319)	300-1800 (68-409)
K515	934 (424)	400-2500 (91-568)
K516	1350 (612)	625-3900 (142-886)

Note - For accurate sizing contact a Hydro-Thermal Representative. Internals are specifically sized for the process conditions provided at the time of sale. Guidelines vary for different fluids & process conditions.

2.0 Safety Precautions

2.1 General Safety

It is the owners' and installers' responsibility that the installation conforms to all applicable local, state, regional and federal codes and standards. Accommodation should be made for compliance with further regulations relating to specific industries.

Complete systems incorporating a K500 should be designed to meet or exceed the temperature, pressure and flow ratings as specified under the DESIGN CONDITIONS on the EQUIPMENT SPECIFICATIONS sheet provided with the original quotation. Installation of single or double action Back Flow Preventer and/or Vacuum Breakers when connected to a potable water supply may be necessary.

The K500 is not designed to provide tight shutoff of steam flow. If the heater or its associated piping is to be disassembled in any way, the steam supply should be isolated from the K500 by closing a steam shutoff valve located on the steam line upstream of the K500.

If the process requirements exceed this limit, contact Hydro-Thermal technical service at 1-800-952-0121 or +1 (262) 548-8900.

The following symbols will be used throughout this manual. The basic definitions are listed below:

WARNING - This warning symbol means danger. You are in a situation that could cause bodily injury. Before you work on any equipment, be aware of the hazards involved with electrical circuitry and be familiar with standard practices for preventing accidents.

CAUTION - This caution symbol means reader be careful. You are capable of doing something that might result in equipment damage or bodily injury.

2.2 Specific Safety

WARNING - If the K500 or its associated piping is to be disassembled, the steam supply should be isolated from the unit by closing a steam shutoff valve located on the steam line upstream of the unit. Follow Lockout/Tagout procedures.

WARNING - The K500 is capable of heating water to very high temperatures. Access to extreme water temperatures and flash steam is a possibility. To avoid serious injury, use extreme care and wear protective gloves, garments and safety glasses at all times.

WARNING - Do not use the K500 with steam that exceeds the temperature and pressure rating of the unit.

WARNING - Use of copied or modified parts could result in deviation of the pressure vessel resulting in code violation and personal injury. Do not substitute any component parts of the assembly. Use only factory produced Hydro-Thermal genuine parts. Order through your Hydro-Thermal Representative or email: info@hydro-thermal.com. Factory leads time apply.

CAUTION - To ensure stable operation of the K500, steam will be injected at full pressure. For correct operation of the K500, refer to Section 1.7.

CAUTION - Read and understand all instructions before operating the K500. The K500 must only be operated by persons trained in its installation, operation, and maintenance. Hydro-Thermal offers maintenance and operations training for your plant personnel. Inquire to info@hydro-thermal.com

CAUTION - Always keep hands and fingers clear of moving parts and pinch points as the Actuator operates. Always wear protective clothing, gloves, and eyewear when working with steam.

CAUTION - Only use K500 for the intended purpose of heating appropriate liquids and slurries.

CAUTION - If you require assistance, or if your K500 cannot be installed in accordance with these recommendations, please contact Hydro-Thermal Technical Service, toll-free at 1-800-952-0121 or +1 (262) 548-8900 or info@hydro-thermal.com.

CAUTION - In high temperature applications (above 212°F [100°C]), the back pressure required to prevent flashing should be at least 5 psi [0.3 bar] higher than the saturation pressure given in the Steam Tables in Appendix A. Both the steam and the water supply pressures must be constant for the heating systems to operate with a uniform discharge temperature.

3.0 Installation

3.1 General Installation

Installation of the K500 requires American Society of Mechanical Engineers (ASME) or equivalent applicable codes for piping systems. The K500 can be mounted in any position. However for best operation, it is recommended that the heater be mounted with the steam line horizontal, or entering from above, leading directly into the heater as depicted in Figure 5. This preferred orientation will minimize backfilling ("dead-legs") in the steam line simplifying purging of condensate at start-up. If the K500 must be mounted vertically, the discharge should be orientated downward.

CAUTION - If the K500 is mounted with the actuator below the heater, leakage from the assembly may cause the steel actuator to corrode and fail unexpectedly.

To provide sturdiness, pipes should have a minimum wall thickness according to ASTM standard A53 grade B schedule 40, or equivalent, for at least 10 pipe diameters to the inlet and 40 pipe diameters at the discharge.

CAUTION - If your K500 cannot be installed in accordance with these recommendations, please contact Hydro-Thermal Technical service for assistance.

3.2 Hardware Requirements

3.2.1 Support and mounting

Piping surrounding the K500 should be adequately mounted, yet allow for thermal expansion. A possible rigid mounting configuration is shown in Figure 5 below.

CAUTION - The K500, like any fluid heating device, must be properly secured with rigid support for process instability conditions.

WARNING - The customer is responsible for adequately supporting the K500/ piping system in accordance with ASME B31.1 (Power Piping Code) and ASME B31.3 (Process Piping Code) while minimizing external loading to K500 flange connections.

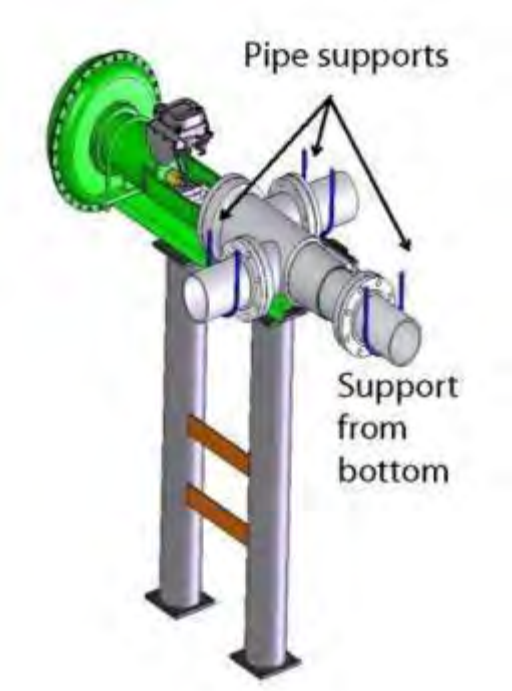


Figure 5: Support Diagram

3.3 Recommended Installation

See Figures 6 and 7
Installation Notes:

1. Recommended straight lengths of pipe without directional or size change:
   Inlet- 3 pipe diameters minimum
   Discharge- 10 pipe diameters minimum

2. Temperature sensor should be located 20-40 pipe diameters from the heater discharge (process parameters may influence exact locations).

3. For units 8" and above (K515 and larger) a steam warm-up valve (as shown on figure 7) may be recommended. Contact Hydro-Thermal Customer Service for further information.

4. Control system should verify process flow before permitting Auto On/Off Steam Valve to open, either through Flow Switch shown or another method.

5. Abrupt flow variations can cause temperature swings. The control system designer should allow for transient conditions and tune the temperature loop accordingly. If water flow is shut off quickly the heater should be closed and Auto On/Off steam valve should be disabled.

6. See sizing sheet for maximum discharge pressure. Pressure gauges should be installed for verification.

7. Steam check valve should be located 3-5 pipe diameters upstream from the heater.

8. Hydroheater can be oriented in any position, however, the preferred orientation is with steam entering horizontally or if not, then from above. Steam lines entering from below the unit could result in condensate slugging and possible damage. For larger units (typically 4" and above) the Hydroheater is best supported horizontally.

9. Steam line between the Auto On/Off steam valve and the heater should slope downward towards the heater.

10. Check valve at process inlet may not be required for all fluids or system configurations.

11. Isolation valves should be provided on each side of the Hydroheater for maintenance purposes.

12. Steam strainer to have maximum screen size noted in section 3.3.2.

13. All piping, including downstream components, should be rated for the full supply steam pressure or have an adequate safety relief.

14. For further details call Hydro-Thermal Customer Service at 800-952-0121 or email info@hydro-thermal.com.

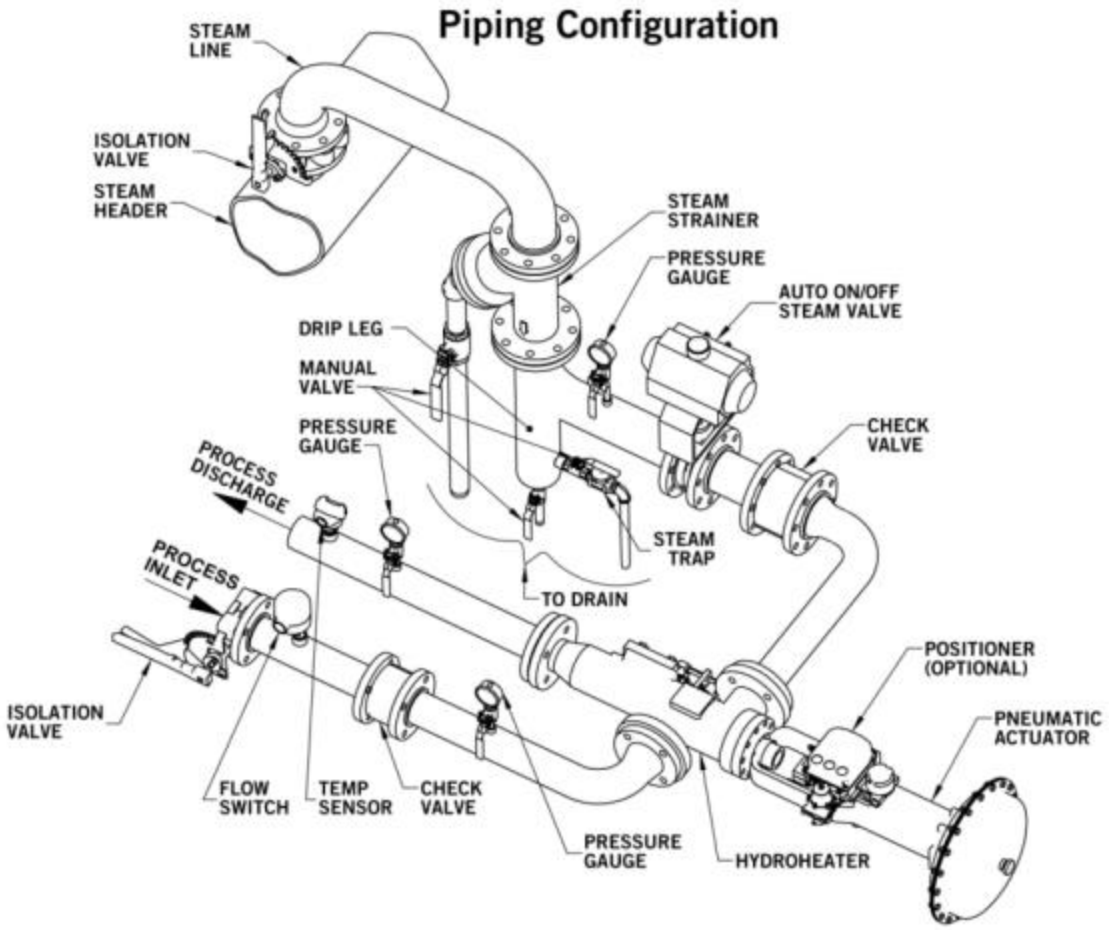


Figure 6: Piping Configuration

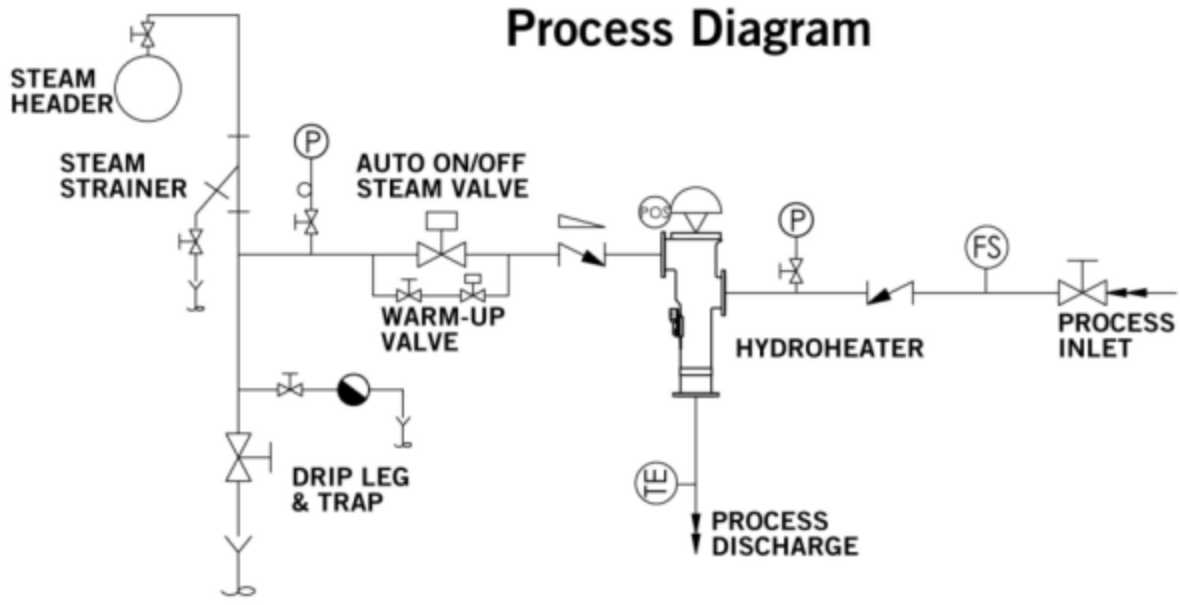


Figure 7: Process Diagram

3.3.1 Steam Line Requirements

Typically, the steam branch line is constructed of carbon steel, but can be substituted with stainless steel based on the application. The flange rating of the steam should be based on the pressure of the system and ASME, or other international code governing bodies, as well as local codes.

The steam branch line should be sized for allowable pressure drop and velocities. This is generally the same size, or a pipe size larger, than the heater steam inlet flange. The steam line should be sized to provide the pressure and capacity required at the heater during operation. The steam line should be engineered to minimize the number of bends and flow interruptions leading to the steam heater.

Steam branch connections should connect to the top of the steam main, rather than the side or bottom to avoid condensate and debris which will adversely affect equipment performance. (See Figure 8).

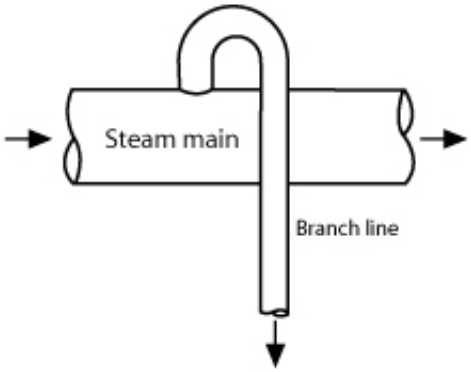


Figure 8: Line Connections

The shutoff valves or warm-up valve should be opened slowly to allow any existing condensate to flow through the drain traps before high velocity steam is introduced. This is especially important at a cold start-up.

The steam line must also include a check valve immediately upstream of the heater to prevent backflow. The shutoff valve should be automated to close when flow is not sensed.

CAUTION - It is necessary to install a properly rated shutoff valve on the steam inlet piping to the K500. The heater does not meet class IV shutoff guidelines.

A pressure gauge should be installed downstream of the check valve. It is necessary to read this pressure in order to properly adjust the heating system.

3.3.2 Strainer Sizing Table

In keeping with good piping practice, install a steam strainer in the supply line to prevent any rust or scale from entering the Hydroheater and downstream piping.

Table 7: Strainer Sizing

Model	Max Screen Size
K510, K511, K512	3/64" Perf or 20 mesh
K513, K514, K516	1/8" Perf

3.3.3 Condensate and Blow Down

The Hydroheater requires dry steam to operate, therefore adequate condensate removal through steam traps and drip legs is essential to eliminate rough operation.

A steam trap and drip leg with blow down valve should be installed on the steam inlet piping, upstream of the check valve. Steam piping should be blown down after any extended shutdown to insure all condensate has been purged from the steam line. Install a trap in the steam supply line close to the Hydroheater to remove any condensate before it can cause noise and vibration in the Hydroheater. Refer to Figure 9.

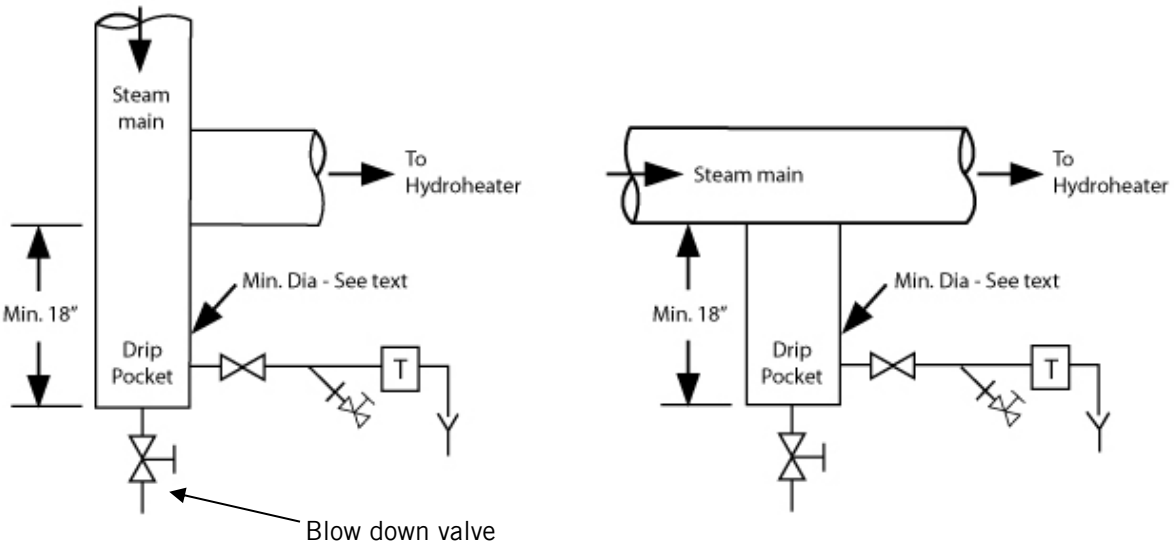


Figure 9: Drip Leg Installation

CAUTION - Steam and water exiting a trap or blow down valve is very hot and may cause severe burns. Adequate personal protection should be used by all personnel.

To help avoid water hammer, steam lines should be installed with a gradual fall in the direction of flow, and with drain points installed at low points and at regular intervals. Check valves should be installed after all steam traps. If they are not, condensate could run back into the steam line or plant during shutdown.

Drip leg diameter should be equal to the steam line diameter for 2-inch to 6-inch [50-150 mm] diameter steam lines. For 8-inch [203 mm] diameter steam lines or larger, the drip leg diameter should be one pipe size smaller than the steam line diameter.

Drip leg length should be 18 inches [457 mm] or greater for pocket length, with a blow-off valve at the end of the drip pocket. Allow 3 inches [75 mm] or more off the bottom of the connection for the drain line to the steam traps. (See Figure 9).

NOTICE - Proper steam trapping will ensure dry steam and smooth operation

3.3.4 Discharge Line Requirements

The piping diameter at the heater discharge should remain unchanged for at least ten pipe diameters from the heater flange to ensure good flow conditions.

Bends, elbows, and tees must not occur for at least ten pipe diameters downstream of the K500. Thereafter, piping bends should be minimized, large radius bends should be used, and gradual, concentric pipe size transitions should be used because these disturbances typically propagate steam flashing and process instability. When processing slurries that increase viscosity with heating, a 50% pipe size gradual increase should occur every ten pipe diameters, for three consecutive segments.

Discharge piping should be designed using Schedule 40 minimum for at least 40 pipe diameters to accommodate potential erosion.

An isolation valve, for maintenance needs, should be located a minimum of 40 pipe diameters downstream of the K500 to minimize the flow disturbances.

A temperature sensor should be located 20 to 40 pipe diameters downstream of the K500 to provide fast temperature response, yet protect the element from steam damage.

A liquid pressure gauge should be installed 20 to 40 pipe diameters downstream of the K500 to properly adjust and troubleshoot the system.

If the K500 discharges to atmospheric pressure (e.g. into a tank or open vessel), the piping should be arranged to assure the system piping is flooded at all times.

A flow control valve can be located in the discharge piping; however, it is important that the discharge pressure does not exceed the limits given in Section 1.7.

Consideration should be given to control temperature above 212°F [100°C] with a back pressure valve and proper safety precautions.

3.3.5 Insulation

It is essential to insulate system piping to minimize energy loss and workplace safety. Every surface over 120°F [49 °C] should be insulated including the steam leg and K500, and if applicable the product inlet leg and discharge leg.

CAUTION - The steam branch line will exceed 212°F [100°C], therefore safety precautions must be followed by properly insulating.

Insulation that has been damaged will also contribute to loss of efficiency, and should be promptly repaired or replaced. Wet insulation damage can be avoided by investigating and eliminating leaks from valves, flange connections, or adjacent equipment.

3.3.6 Utilities and Environmental Requirements

Use either 1/4-inch [6.35 mm] pipe or 3/8-inch [9.53 mm] tubing between the air supply, the positioner, and actuator. Keep the length of tubing as short as possible to avoid transmission lag in the control signal.

NOTICE - Air supply must be clean, dry, and of instrument air quality. Use filters and separators as necessary to remove condensation. At start-up, air lines should be purged of condensation prior to final connection.

When the actuator is completely installed and connected to the instrument, check for correct action, air-to-open, to match the controlling instrument.

Typical requirements:
Maximum Air Supply Pressure 75 psig [5.17 Barg]
Minimum Air Supply Pressure 40 psig [2.76 Barg]

Air pressure requirements and air volume requirements vary dependent upon actuator sizing and usage. Typical air consumption varies between 0.8 scfm (small units) to 7 scfm (large units). For further air requirements, refer to the associated actuator and positioner instruction manual.

The standard actuator temperature is rated at -40 to 180°F [-40 to 82°C].

3.4 Instrumentation and Control

CAUTION - Proper control mechanisms should be considered and incorporated.

The instrumentation and controls necessary to properly operate the K500 are application-specific; however, various components are utilized in most applications. The following sections describe typical instrumentation and controls.

3.4.1 General overview

K500 units are typically controlled by a single loop temperature control system, based on heater discharge temperature. A temperature sensor at the heater discharge is used as the input to a loop controller. The loop controller output manages the K500 position, metering flow into the process to maintain the set point temperature.

Discrete inputs to enable or disable operation can be based on various operating criterion; for example, flow rate within a given range, temperature not exceeding an alarm, remote or local control chosen and others.

Various systems components are utilized for measurement and control. These devices are best supplied as a system by Hydro-Thermal Corporation because the function, interaction, and benefits have been optimized over years of experience in thousands of applications.

For example, the standard control system includes a flow sensor, temperature sensors (for the heater inlet and discharge), a 4-20mA control, and automatic on/off steam valve control, and recirculation pump.

Steam flow is internally modulated in the Hydroheater using a diaphragm type, air-to-open, spring return actuator. It receives a control air signal (3-15 psig or 6-30 psig) [0.21 – 1.03 Barg or 0.41 – 2.07 Barg] typically to modulate its position. It is recommended that a positioner be used with the actuator. Positioner options include pneumatic, electro-pneumatic (4-20 mA) with various communications protocols and levels of diagnostics. Selection of the positioner depends on the response time, actuator size, and other factors. Refer to the Operations Manual of the positioner from the manufacturer or vendor for further details of product features and capabilities, as well as operations and maintenance information.

3.4.2 Components and Functions

CAUTION - The temperature sensor should be installed without a thermowell (unless necessary) on the discharge line at a distance of 10-20 pipe diameters from the K500 discharge flange. The location and type of temperature sensor should be selected to minimize the time required to sense and accurately transmit the process temperature. If using a thermowell, it is recommended

that a spring-loaded sensor be utilized, in conjunction with thermal conductive heat transfer paste to improve temperature reading response. The K500 control has virtually no lag time (i.e. discharge temperature is solely dependent on heater plug position). As a result, it is quite possible to overheat and flash the process fluid if the controller response significantly lags behind the actual process temperature.

1. Steam inlet isolation valve

   A manual or automatic valve which provides for steam isolation. As noted previously, the K500 is not rated as a tight shutoff valve. An automatic version consists of the valve body and air actuator.

2. Flow Sensor

   This sensor detects the flow/no flow condition of the process fluid to enable/disable steam supply for heating. Dependent on the flow sensor type, flow threshold and response time has to be adjusted during commissioning for the flow conditions of the respective installation.

3. Temperature Sensor

   This device measures water temperature and transmits the signal to the digital loop controller. This is typically a Thermocouple or RTD. The heater discharge sensor provides the process variable (PV) for the heating PID loop control.

4. Digital Loop Controller

   This controller receives the process temperature signal, compares it to the programmed temperature set-point, and uses a PID algorithm to respond with a control output signal (4-20mA) to the Hydroheater, modulating stem position (thus steam flow) to maintain the desired process temperature. The controller is generally 2-mode (Proportional/Integral). A 3-mode (Proportional/Integral/ Derivative) controller may be used, but generally the derivative function is set to zero because the heater responds so quickly. A single-mode (Proportional only) is only recommended for very stable systems with small flow rate or temperature variations or when temperature control is not important.

5. Positioner

   An electro-pneumatic device converts a 4-20mA control signal from the loop controller into the pneumatic signal (3-15 psig or 6-30 psig) [0.21 – 1.03 Barg or 0.41 – 2.07 Barg]. This pneumatic signal controls the position of the heater actuator and subsequently the steam flow. A positioner is essential to precisely control temperature, for rapid response time applications and when valve position feedback is needed.

6. Pressure Gauges

   Should be installed on all three connection lines to the K500. The gauges should be installed between any valves, reducers, etc. and the heater to assure the gauge pressure is equal to the pressure at the K500. It is important to

install gauge cocks on each pressure tap to isolate the gauge from the process when measurements are not required. If the process fluid is slurry or contains suspended solids, a diaphragm sealed gauge should be used to reduce the probability of plugging. Fluid filled gauges are recommended and should have a siphon installed when in a steam line.

3.4.3 Typical Control Logic

CAUTION - The control system should verify process flow before permitting the steam valve to open. This can be accomplished by a flow switch or some other method.

CAUTION - Inlet pressure must not exceed the figures in Section 1.7.

The K500 heater can be enabled when specific operating criterion is met. These criterion are application-specific, but can include the following:

- The operator enables heater operation, either in manual or automatic mode
- Process flow through the heater is verified
- Temperature does not exceed a high temperature set-point
- There is a call for heat

Once the operating criteria have been met, the heater will begin controlling to maintain temperature.

If the operating criterion is not met, the heater should be disabled.
Several examples follow:

- If loss of flow is detected, the system should rapidly close the steam shutoff valve and close the K500 heater.
- If a high temperature alarm is detected, the system should rapidly close the steam shutoff valve and close the K500 heater.
- The operator chooses to shut the unit off. In this case, the shutdown sequence described later in the section should be followed.

3.4.4 K500 Control Characteristics

The K500 is a precise and repeatable temperature control device. Successful operation of the K500 is dependent upon the design, installation, and tuning of its instrumentation loop.

The K500 has been designed for specific process conditions and needs to be operated within these circumstances in order to assure smooth operation. If the conditions vary from those listed in the specification sheet, contact Hydro-Thermal Customer Service for assistance.

See Figure 10 below for a typical K500 system temperature profile.

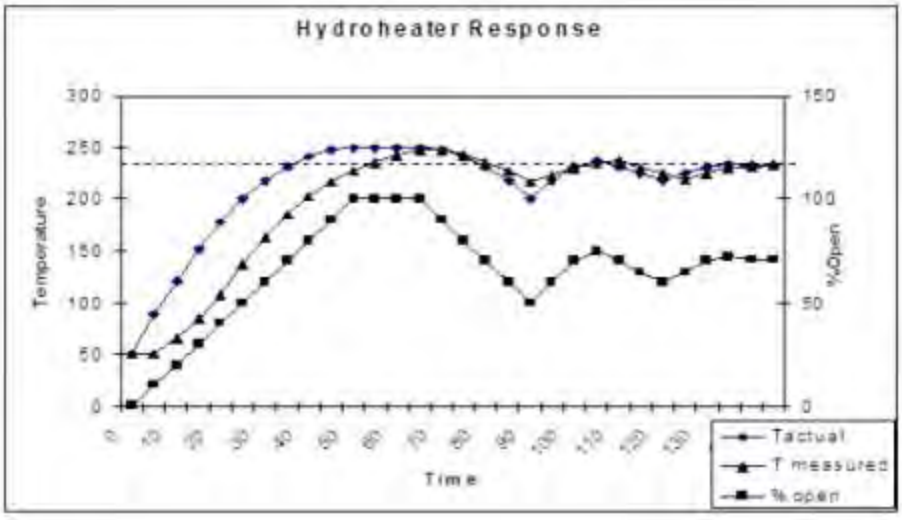


Figure 10: Typical K500 Response Time

3.4.5 Over Temperature Protection

To minimize the chance of overshoot or flashing in the discharge piping upon startup, an interlock should be provided to close both the K500 actuator and the upstream automatic steam block valve if there is no liquid flow through the heater. Depending upon system control complexity, this may take several forms:

Rapidly close the K500 when a loss of flow signal or high temperature alarm is reached. Generally, a K500 utilizing a positioner can close within 2-10 seconds.

The K500 could be closed independently of the control loop by utilizing a solenoid valve in the actuator air line. For this application a 3-way, normally open, bleed to atmosphere valve would be used. The “permit to run” (Enable) logic could be based on a flow switch (verifying flow through the Hydroheater), a high temperature alarm (verifying that temperature does not exceed the high alarm set point) or a combination.

The K500 steam valve could be closed using the same logic as described above. (See figure 11 below).

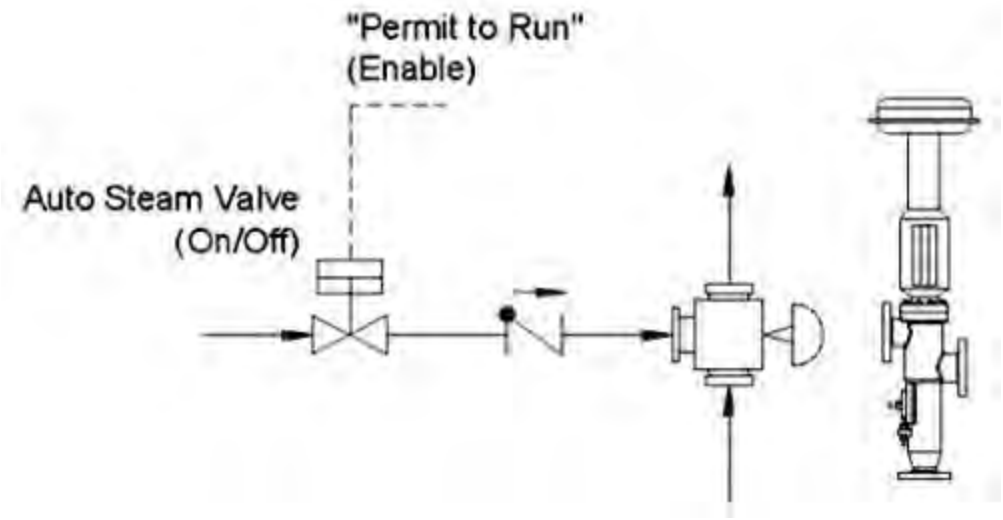


Figure 11: Logic for Closing the Steam Valve

Note -It is very important that the K500 control system be designed to ramp the heater to set point from a fully closed position upon startup.

4.0 Operation

CAUTION - Make sure K500 is properly installed and calibrated before use.

4.1 Pre-Start

CAUTION - For safety reasons the pre-start check-out should be performed without steam. This should be performed prior to initial operation or restart after extended shutdown.

1. Check for leaks prior to operation of the system.
2. Verify correct wiring to the system.
3. With the steam inlet isolation valve closed, apply power to the system.
4. Verify the target temperature set point in the controller.
5. Verify the operation of flow sensor.

Note - The flow switch trigger point may have to be adjusted according to the site specific flow conditions.

6. Verify correct operation of the steam shutoff valve.

7. Verify the operation of the Hydroheater, by manually setting to 25%, 50%, 100% position. Verify the % stroke on the Hydroheater actuator.

8. With the controller in manual mode at 0% outpout, start process flow. Verify that the flow sensor operates correctly and the steam valve opens. Stop the process flow and verify that the flow switch operates, closing the automatic steam inlet valve.

4.2 Initial Startup

1. Verify users are aware of the start-up situation and take appropriate safety precautions.

2. Open all manual utility isolation valves.

CAUTION - If your system is equipped with a steam trap, it will discharge condensate/steam automatically and unannounced.

3. Blow down steam line so that dirt, welding residue and other contaminants do not enter the steam line or K500. Begin with the steam strainer blow down valve. This will purge debris from the strainer. Then, open the blow down valve on the bottom of the drip leg to purge the drip leg.

CAUTION - Assure that blow down is done in a manner to prevent burns.

4. Verify the power switch to the system is in 'on' position and all devices are powered up. Set the controller in manual mode.

5. Establish product flow. Slowly increase the K500 steam output manually and verify that temperature rise. Once correct operation is established, manually close the heater.

6. Input and verify the temperature set point in the controller. It is recommended to begin with a lower temperature than normal to confirm loop parameters. Place the controller in automatic mode. Establish flow and begin heating.

7. Verify the controller's function of maintaining desired temperature. PID loop parameters may have to be adjusted to fit your system set-up. Refer to the controller manual for details. If the system response is erratic, place the temperature selector switch back to 'off / reset' before adjusting parameters.

CAUTION - An inadequately tuned loop can create hazardous conditions due to temperature overshooting.

CAUTION - Use extreme caution if attempting to "auto-tune." Generally the controller will cycle between 0 and 100% output in order to learn the system response. This can create hazardous conditions. Ensure adequate safety precautions prior to performing this function. **TIP**: Maximum output of the controller can generally be limited by a user setting to enhance safety.

8. Sequence a normal shutdown and start-up to confirm correct operation.

4.3 Shutdown sequence (clean processes or short term with dirty fluids)

1. Place the controller in manual mode and gradually lower the output to 0%. Alternatively, with the controller in automatic mode, lower the setpoint temperature to zero.

2. Stop process flow.

3. Disable the Auto On/Off steam valve and enable the bypass valve (If applicable).

4.4 Shut Down sequence (long term with dirty fluids)

1. Place the controller in manual mode and gradually lower the output to 0%.

2. Isolate the fluid flow and introduce flush water down the product line through the K500.

3. In control mode - gradually increase the output (in 5% increments) to a targeted temperature.

4. Allow the K500 to maintain temperature for the amount of time needed to clean the system.

5. In manual control, lower the output to 0%.

6. Stop the water flow through the system.

7. Close the steam Auto On/Off valve.

4.5 Applications with intermittent heat requirement

In some applications, the K500 is installed in piping where the process fluid is circulating, but there is no call for heat. The K500 heater is not rated as a tight shutoff, so the steam shut-off valve should be closed. This protects the seals and internal components which otherwise would wear rapidly. A time-out function could be used, for example, closing the steam valve if there is no call for heat for 15 minutes.

With the process fluid circulating (under pressure), the fluid will slowly leak into the steam line up to the check valve. Generally, fibrous materials will clear themselves once steam is reapplied. Some dirty fluids, however, could cause clogging or sticking that would require mechanical cleaning. If the heater will be installed in a line and will have no heating requirements for extended periods, please contact Hydro-Thermal for operating recommendations.

5.0 Troubleshooting

Please read the scenarios below. If these instructions do not resolve your concerns, please contact the Hydro-Thermal help line at +1 (262) 548-8900 and ask to speak with customer service.

5.1 Insufficient Heating Capacity

1. Verify that steam is reaching the system.

2. Check that the upstream steam supply line valve is fully open.

3. Ensure the steam supply line check valve is open. Observe steam pressure on the gauge nearest the unit.

4. Insure that the steam strainer is not clogged. Blow out the steam strainer if it appears to be obstructed.

CAUTION - Ensure liquid flow is established before actuating the K500.

5. Manually open the K500 heater, while observing the stem position. If there is no response, determine if the controller output is not reaching the heater or if the heater is not responding.

6. Verify that clean, dry instrument air is reaching the K500. Observe the positioner gauge pressures.

7. Note both process fluid and steam pressures and compare to design parameters. Verify it remains within the range while the heater rises to temperature.

5.2 Rough Operation

1. If condensate is not purged out of the steam supply line to K500, operation will be rough. The unit should have a drip leg and a condensate trap to supply dry steam to the K500.

2. The unit may be operating outside of design conditions. Review steam pressure at the heater inlet, water pressure, inlet and discharge temperatures and water flow rate. Compare with K500 sizing provided by Hydro-Thermal with unit.

3. The water flow rate, water temperature, and/or steam pressure may be varying too rapidly for the temperature controller to maintain smooth, stable operation. If this is the case, temperature overshoot and undershoot will occur. Minimize flow variations and adjust controller settings to optimize temperature control. If Hydro-Thermal provided the controller, refer to the system control manual.

4. The process pressure after the heater is not enough to prevent flashing in the discharge piping. This occurs at operating temperatures above 212°F [100°C]. Check the steam tables in Appendix A for the pressure required and reset back pressure valve if necessary.

5. Temperature sensor is too far from K500. Refer to Installation, Section 3 for guidelines on properly locating the temperature sensor.

6. Excessive condensate in the steam supply. This can be worse at startup, if a drip leg is not correctly installed or if the steam trap is undersized or unmaintained.

7. Heater components may be worn. If the unit has been in service for more than a year or has been subject to “wet steam,” a visual inspection of the internal components and seals is recommended. If necessary, reorder parts or schedule a service visit by contacting info@hydro-thermal.com.

8. Viscosity of the process fluid is varying.

9. Multi-phase fluid is present.

10. Combining Tube (CT) position is incorrect for the current parameters. Typically if rough operation is occurring an adjustment closed is necessary, depending on the fluid type.

11. Heater is operating outside the design parameters. Verify the steam and process pressures are within original design parameters

5.3 Excessive Temperature Variation

The temperature sensor should be verified for its position, function, and connection. The temperature sensor is maybe located too far downstream from the K500. Refer to section 3.3 for guidelines on properly installing temperature sensor.

PID control parameters should be reviewed relative to the response time of the heater, actuator position and the temperature changes and thereafter the parameters optimized.

Steam pressure trending should be observed. Rapid fluctuations in steam pressure will affect temperature control.

Flow rate data should be captured to observe sudden flow rate variations. Typically a high temperature reading will occur with a drop in flow if the response is too slow, and vice versa. It may become necessary to add a recirculation loop if the flow variation becomes too excessive, to stabilize temperature variation.

Heater components may be worn. If the unit has been in service for more than a year or has been subject to "wet steam," a visual inspection of the internal components and seals is recommended.

6.0 Maintenance

6.1 General Practices

Note – Hydro-Thermal has maintenance programs available, including on-site technician visits, to help you keep your K500 in top running condition.

The K500 is a very robust valve for process control but requires preventive maintenance of its wear components to maximize the life of the steam control components. Simply maintaining the disposable and less expensive components on a regular basis will reduce the total cost of the unit during the length of its operation.

If noise, vibration, or temperature variation occurs, maintenance may be necessary. Notify Hydro-Thermal if this happens at: info@hydro-thermal.com or call (262) 548-8900. If possible, please have the heater's serial number when calling. (See section 1.5.2).

To prevent unintended shutdowns or the potential for extended outages, Hydro-Thermal offers a range of preventive maintenance plans. These plans range from stocking a spare heater in your plant in case of emergency shutdown, stocking spare internal and soft parts for your heater, service technician visits and training your maintenance staff and operators, or complete refurbishment of your unit. Call us to learn about the various maintenance plans and options.

6.2 Recommended Maintenance

Weekly:

1. Examine the Hydroheater for any steam or water leaks

Monthly:

1. Ensure all external nuts and bolts are tight. Refer to Torque Table in Section 7.4
2. Examine stem for unusual scale buildup
3. Verify temperature control loop is working properly
4. Look for indirect signs of wear (such as failure to shutoff)

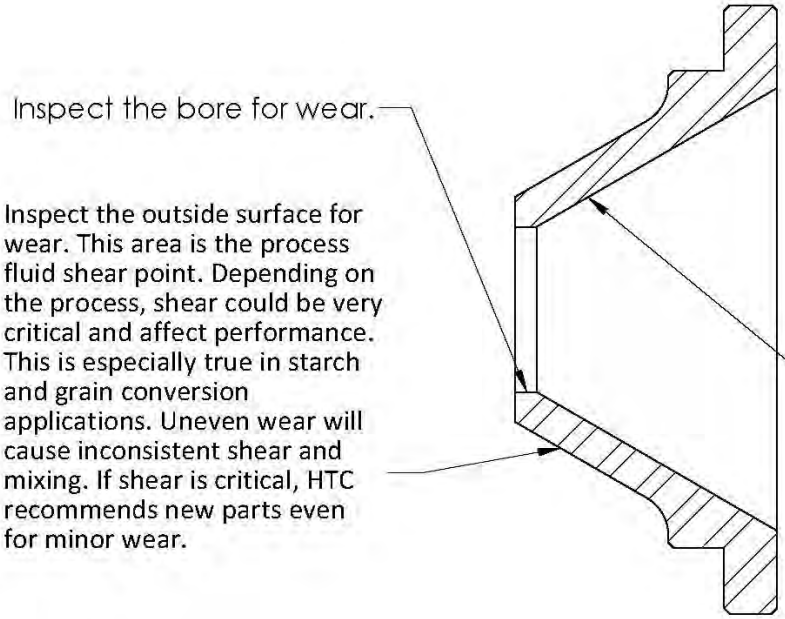
Annually:

1. Disassemble heater and check parts for wear
2. Replace all seals
3. Replace stem packing

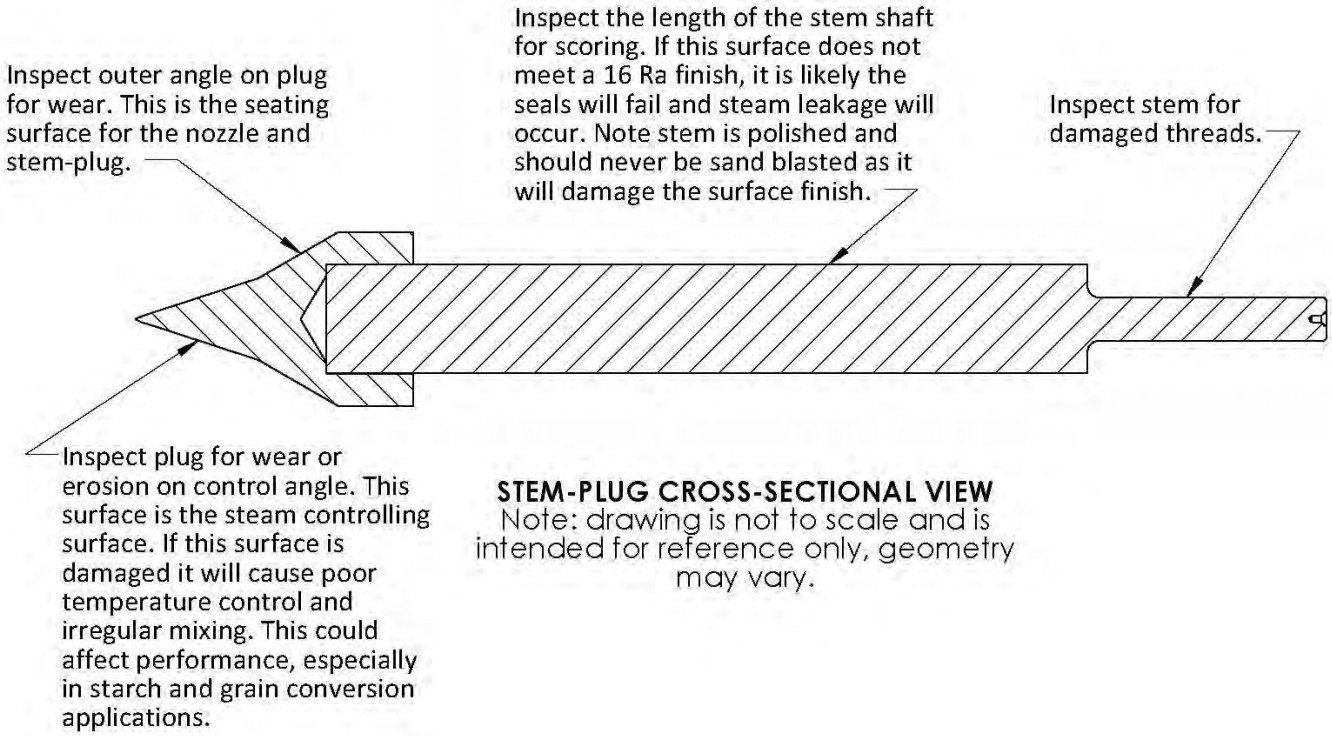
It is recommended having spare internals on hand prior to disassembling

6.2.1 Signs of Wear

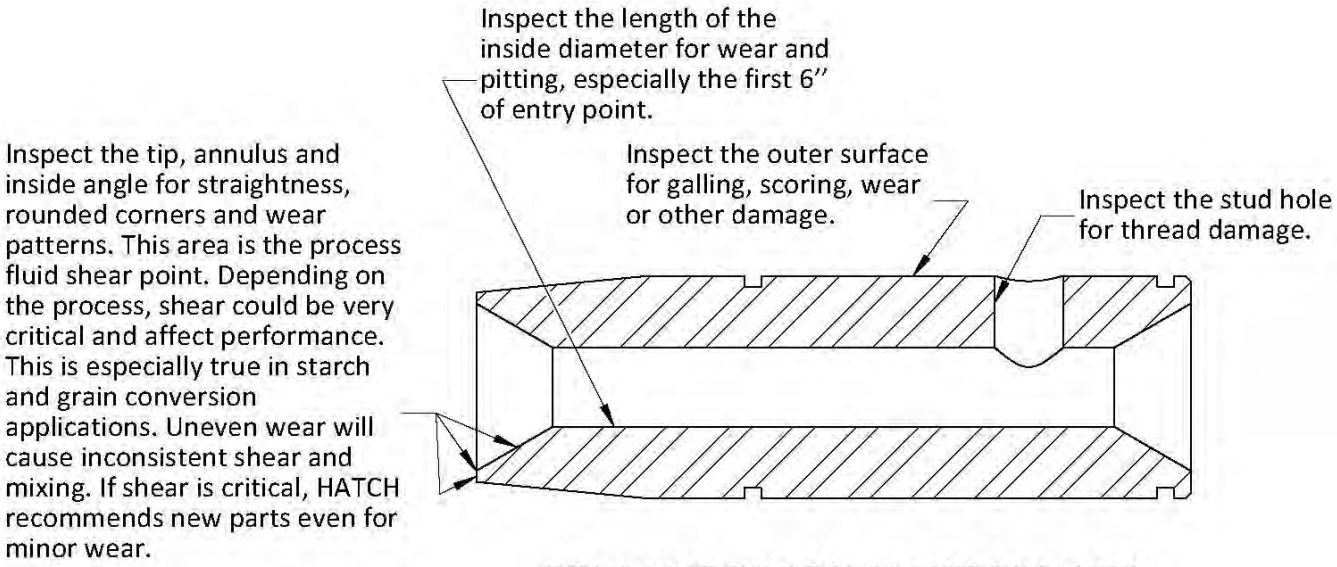
The K500 may exhibit wear on the stem plug, combining tube or seals. Wear on the stem plug may appear as scratches, gouges or pitting. A small amount of wear may not interfere with operation, but significant wear may prematurely wear the stem plug seals, and/or packing material which may cause the unit to leak externally. In general, if the stem plug is fully seated, the steam leakage internally through the unit should be very small. There should be no appreciable temperature rise at nominal flows, and if the process fluid flow is shut off, the temperature of the process fluid should rise very slowly. If it rises quickly, there may be wearing on the stem plug tip or nozzle, causing steam to leak past.



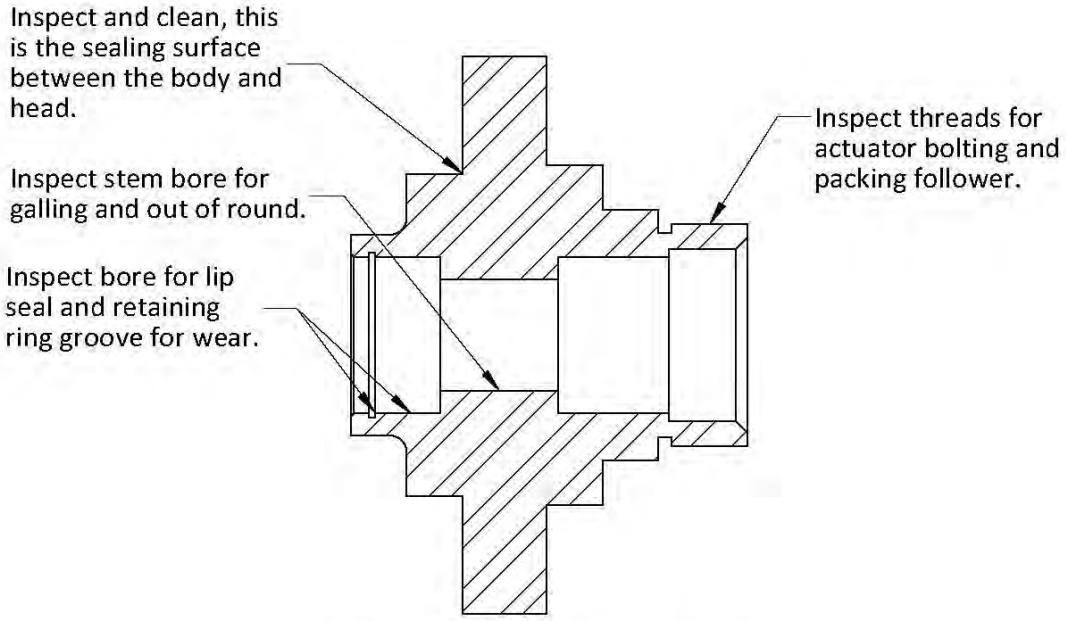
NOZZLE CROSS-SECTIONAL VIEW
Note: drawing is not to scale and is intended for reference only, geometry may vary.



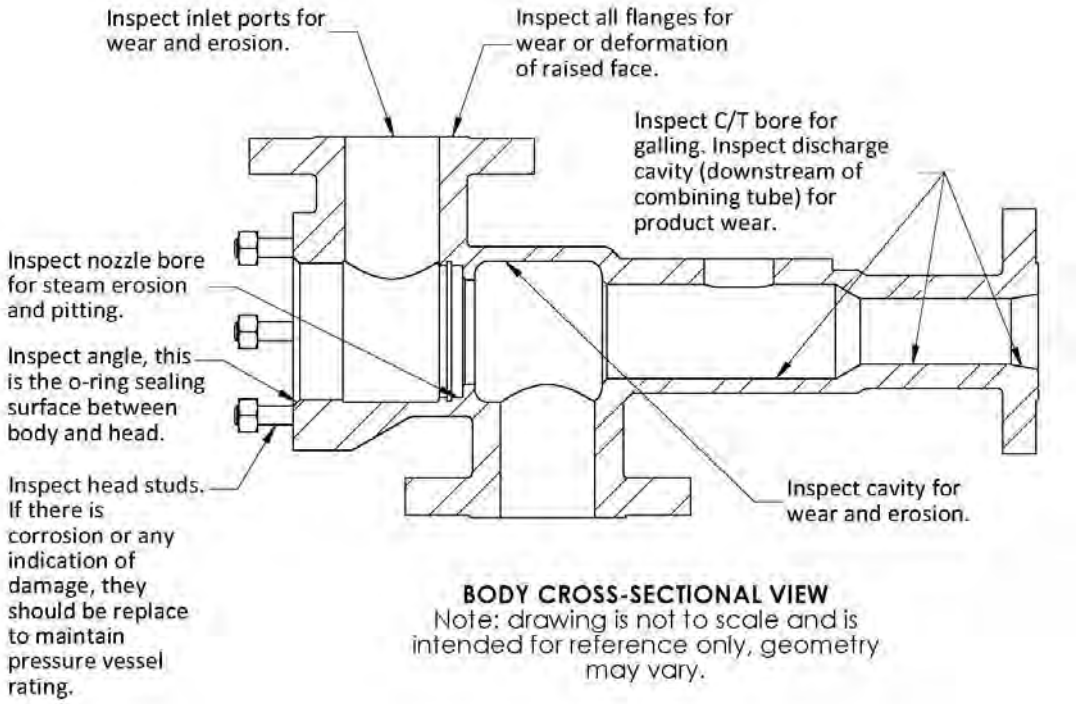
STEM-PLUG CROSS-SECTIONAL VIEW
Note: drawing is not to scale and is intended for reference only, geometry may vary.



COMBINING TUBE CROSS-SECTIONAL VIEW
Note: drawing is not to scale and is intended for reference only, geometry may vary.



HEAD CROSS-SECTIONAL VIEW
Note: drawing is not to scale and is intended for reference only, geometry may vary.



BODY CROSS-SECTIONAL VIEW
Note: drawing is not to scale and is intended for reference only, geometry may vary.

Note that these instructions are intended for a baseline inspection. Other portions of the heater that are not specifically identified should not be overlooked. A thorough inspection is required.

6.2.2 Anti-Seize Compounds

Anti-seize compounds should be liberally applied to all threaded components of K500 when they are reassembled after parts replacement. The recommended anti-seize compound is Loctite Nickel Anti Seize - #77124.

6.3 Inventory and Spare Parts Recommendations

Hydro-Thermal Corporation recommends either a spare Hydroheater or six spare parts be kept in your inventory at all times. While the Hydroheater is extremely reliable, it is also custom designed for your specific facility and application. Lead times apply so please contact your Hydro-Thermal representative for more details. It is an unnecessary risk to not retain proper inventory. If equipment breaks upstream of the Hydroheater (on the steam or process side), parts can get lodged in the Hydroheater causing damage as well. Proper inventory can minimize these unexpected downtimes.

Option #1 (Spare Hydroheater)

Over 50% of our customers have chosen to keep a spare Hydroheater for the following reasons:

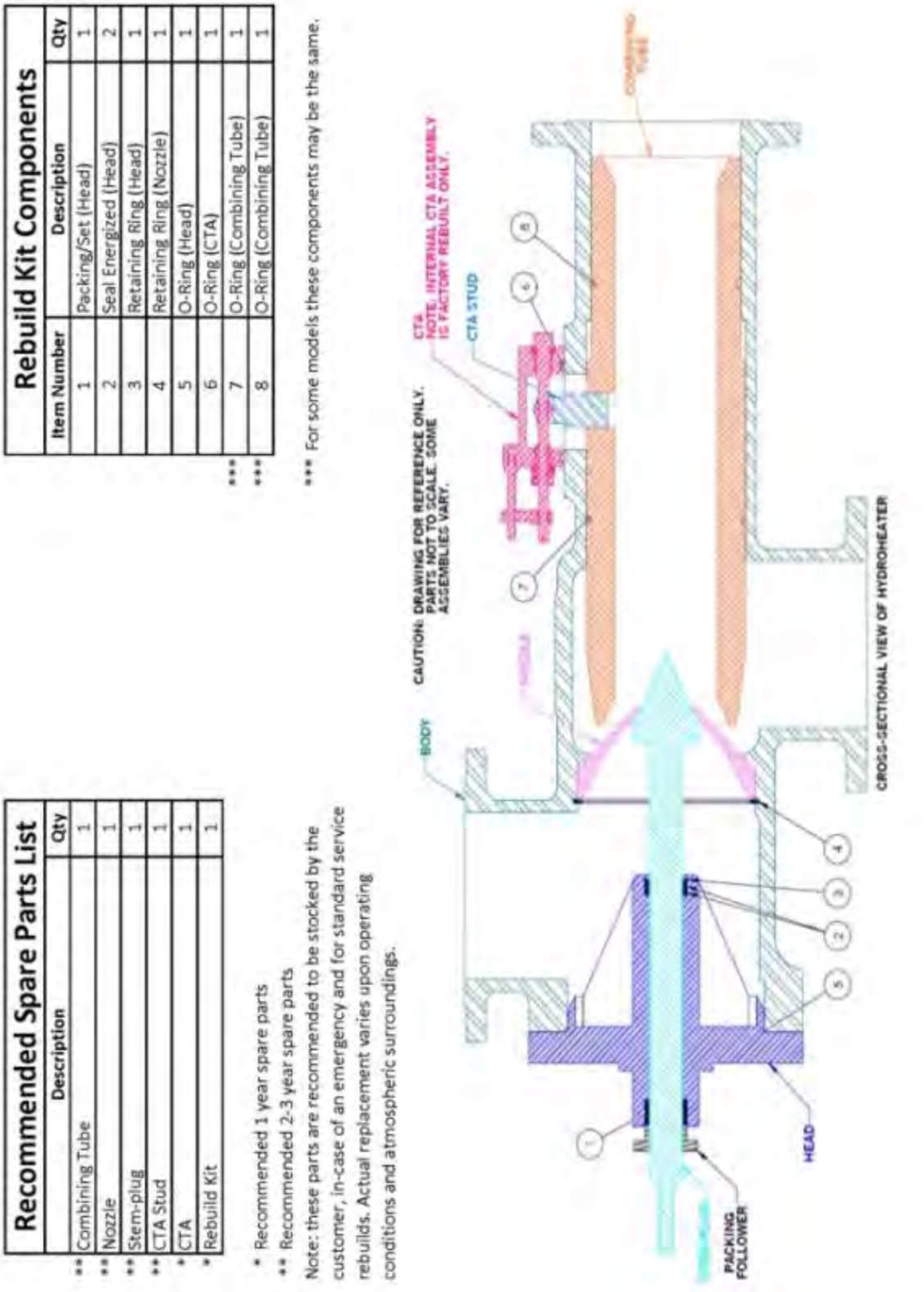
a. **One less vendor to manage during your shutdown**
   Your staff can swap out the units in about an hour. Then you can send the used Hydroheater to our facility for refurbishment.
b. **Refurbishment Program**
   Any refurbished Hydroheater receives a renewed warranty equal to a new Hydroheater.
c. **Longer lasting parts**
   We can offer advice from noticing wear patterns and can reuse parts at our facility (due to our manufacturing capabilities) that would have to be replaced in the field.

Option # 2 (Spare parts and Service)

If you don't have a spare Hydroheater we recommend you keep the following six parts in stock (at all times) in case they are needed. The first three items are **custom made parts for your specific plant.**

a. Combining Tube
b. Stem Plug
c. Nozzle
d. CTA Assembly
e. CT Stud
f. Rebuild Kit

Hydro-Thermal service technicians are available for start-ups, rebuilding your Hydroheater at your facility during a shut-down, or training/trouble-shooting. If you are interested in any of these options, please contact the service team at 1-800-952-0121 or email info@hydro-thermal.com.



Recommended Spare Parts List

	Description	Qty
**	Combining Tube	1
**	Nozzle	1
**	Stem-plug	1
**	CTA Stud	1
*	CTA	1
*	Rebuild Kit	1

* Recommended 1 year spare parts

** Recommended 2-3 year spare parts

Note: these parts are recommended to be stocked by the customer, in-case of an emergency and for standard service rebuilds. Actual replacement varies upon operating conditions and atmospheric surroundings.

Rebuild Kit Components

Item Number	Description	Qty
1	Packing/Set (Head)	1
2	Seal Energized (Head)	2
3	Retaining Ring (Head)	1
4	Retaining Ring (Nozzle)	1
5	O-Ring (Head)	1
6	O-Ring (CTA)	1
*** 7	O-Ring (Combining Tube)	1
*** 8	O-Ring (Combining Tube)	1

*** For some models these components may be the same.

Figure 12: Recommended Spare Parts

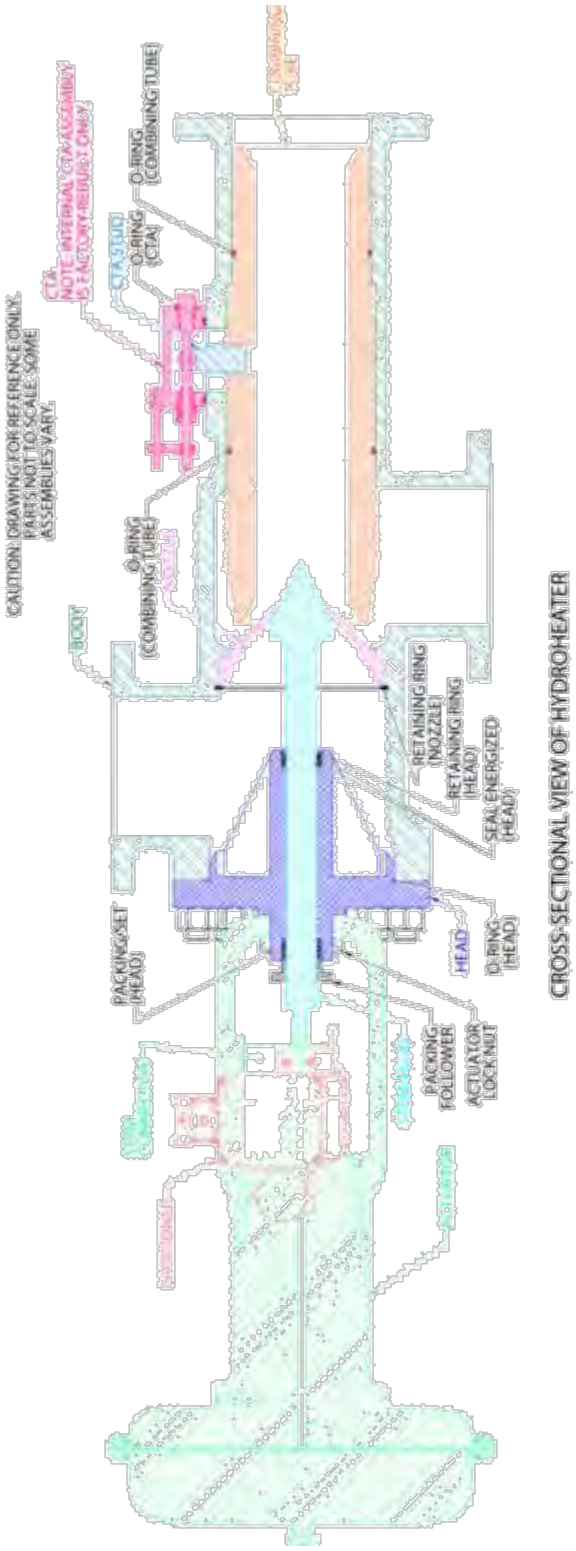


Figure 13: Cross Sectional View of Hydroheater

7.0 Disassembly and Assembly

7.1 Head-Actuator Removal

In some instances, it may be easier to remove the head, stem plug, and actuator as an assembly rather than completely disassembling the Hydroheater. This will save a significant amount of time and effort versus disassembling the stem plug and actuator. Examples of these circumstances are:

- Stem Plug not fully closing
- Stem Plug closing but still leaking steam
- Unstable Temperature Control, particularly at lower steam output

For inspection purposes, there is no need to disassemble the stem plug from the actuator. This allows for inspecting the inside of the nozzle for wear/debris and the tip of the stem plug.

Please follow the steps below or consult the Hydro-Thermal Service Department with any questions.

1. Personally verify that steam, process inlet, and heater outlet are "Locked Out and Tagged Out."

2. Mark current positions (Actuator to Head and Head to Body, etc) with a marker so you know where to orient each assembly for reassembly.

3. Remove the head nuts. On some models, the two nuts on each side of the actuator frames need to be removed after the head is partially removed for needed clearance.

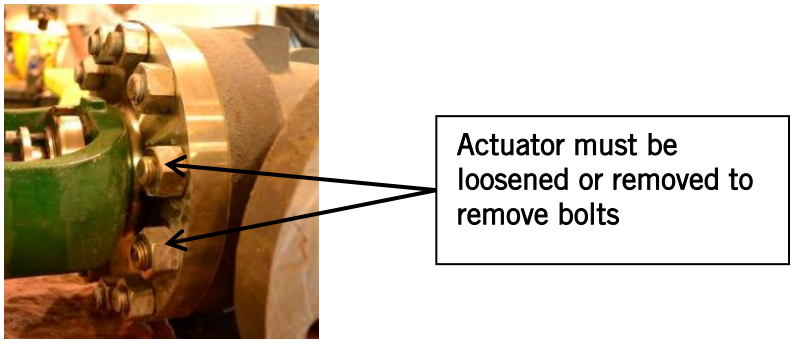


Figure 14: Actuator Mount to Head

4. Check adjustment left on the packing follower. If there is still plenty of travel and it is not leaking then move to the next step. If the opposite is true, then consider taking the heater completely apart. These steps are shown in section 7.2.

5. Remove the assembly from the Hydroheater. Be careful of the stem as the point may be sharp.

Note - If your Hydroheater head is equipped with two socket head cap screws (these are jack screws to assist in disassembly of the head during maintenance) near the hex nuts, these may be turned to loosen the head for ease of disassembly if the head is stuck to the body.

7.2 Complete Disassembly

Periodically, a Hydroheater will require a full disassembly and rebuild. The following section details step-by-step instructions to completely disassemble a K500 Series heater in preparation for rebuild. Hydro-Thermal strongly suggests having a seal kit available prior to disassembly. Please consult your Hydro-Thermal Sales Representative for part numbers, pricing, and delivery.

If there are any questions regarding this procedure or to schedule an on-site maintenance visit, please contact the Hydro-Thermal Service Department at (262) 548-8900 for further information.

1. Personally verify that steam, process inlet, and heater outlet are locked out and tagged out.

2. Mark current positions (actuator to head and head to body, etc) with a marker so you know where to orient each assembly for reassembly.

3. To avoid the need to bench set the actuator, take the two measurements as follows. Please refer to Figure 15 for more detail.

   Refer to items A and B of the photos for the dimensions needed.

   a. Measure the distance between the stem connector block and the top of the head (measurement A).

   b. Measure the distance between the actuator spring adjuster nut and the stem connector block (measurement B).

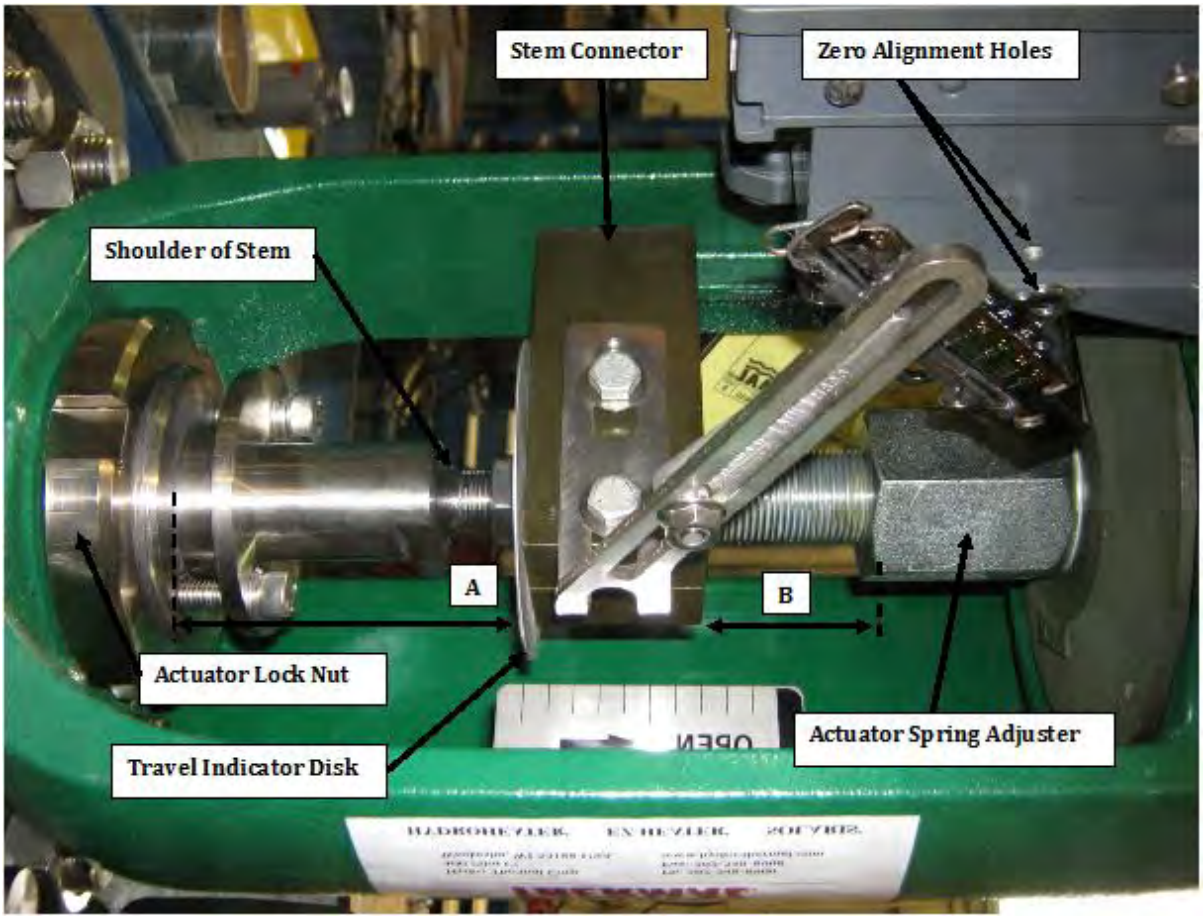


Figure 15: Refer to Step 3 above for values of "A" and "B"

4. Remove the positioner and disconnect the linkages.

5. Remove the stem connector block that joins the stem to the actuator (two – 9/16" bolts).

CAUTION - The actuator still has spring tension on the stem plug. Keep fingers away and a mallet to knock apart the block pieces after the bolts are removed.

6. Remove the actuator lock nut (the ring nut that binds the actuator to the Hydroheater).

7. Remove the actuator carefully. Avoid damaging the lock nut threads.

8. Remove the head from the Hydroheater. Be careful of the stem as the point may be sharp.

Note - If your Hydroheater head is equipped with two socket head cap screws (these are jack screws to assist in disassembly of the head during maintenance) near the hex nuts, these may be turned to loosen the head for ease of disassembly if the head is stuck to the body.

9. Take off the head nuts.

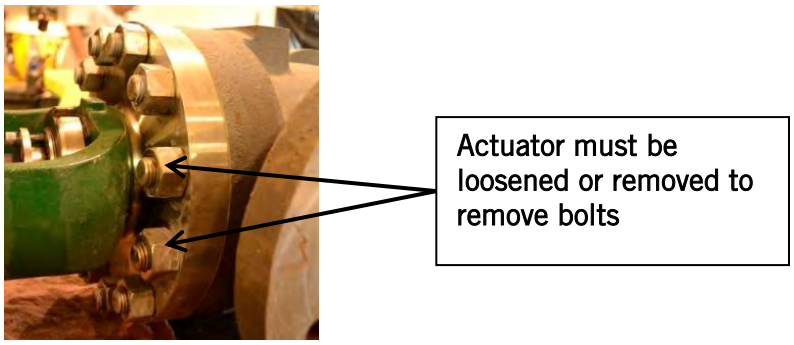


Figure 16: Actuator Mount to Head

10. Remove the stem out of the head by hand if possible, but a press may be needed.

11. Remove the snap ring and then both seals from the body side of the head and the packing material from the actuator end.

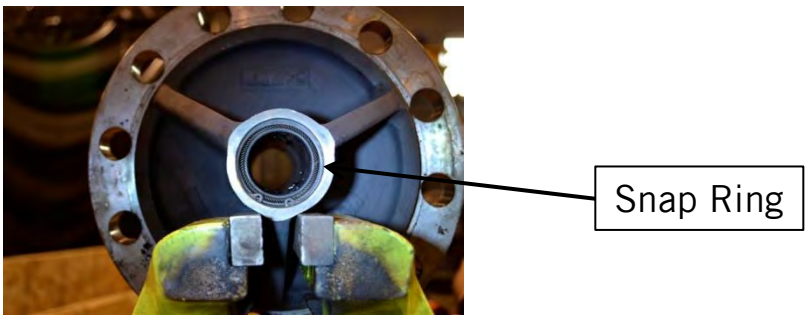


Figure 17: Body Side of Head

12. Inspect and clean out the stem plug bore in the head. Remove old O-Ring between head and body.

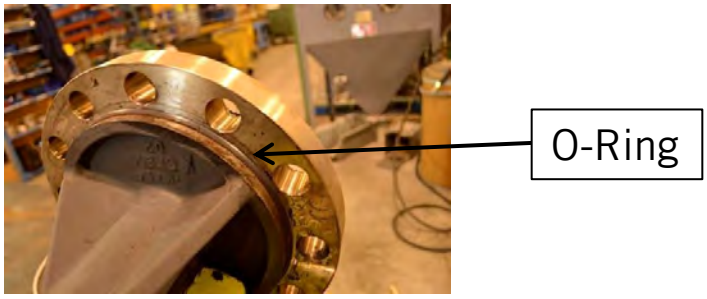


Figure 18: Different View of Body Side of Head

13. Remove the CTA (four bolts). Then remove the CT stud from the CT.

Figure 19: CTA

Figure 20: CTA Stud

14. Remove the spiral retaining ring holding in the nozzle. Some older models may have a snap ring instead.

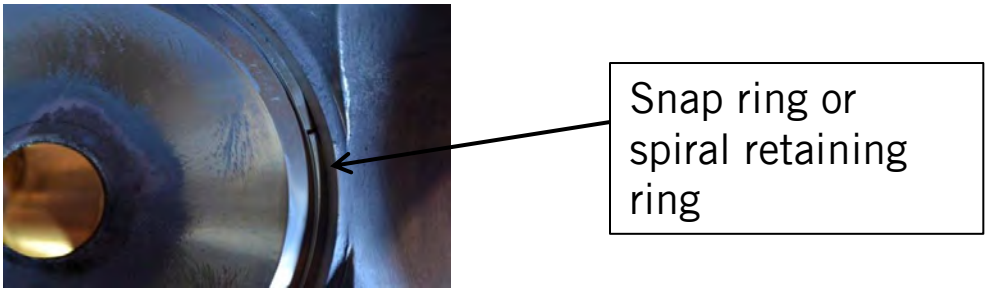


Figure 21: Body Internal at Steam Inlet

15. Pull out the nozzle. It may need to be gently tapped out from the discharge end with a long pipe. Do this carefully because if the nozzle becomes misaligned, it will be extremely difficult to remove.

16. Remove the CT (combining tube) through the head end. If need be, use a Porta Power and bridging assembly to push out the CT from the discharge end.

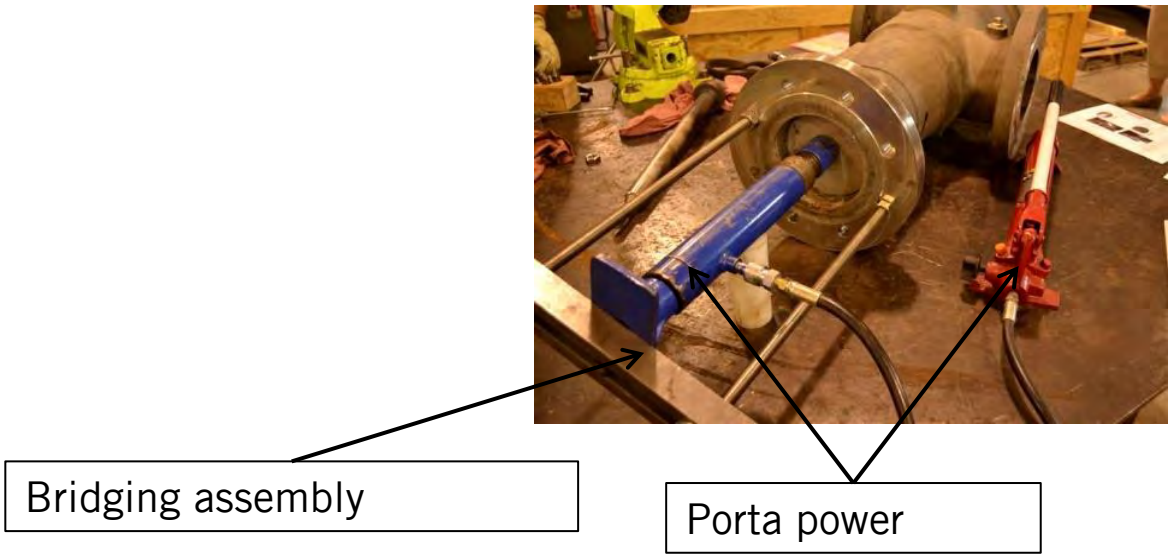


Figure 22: Extracting the Combining Tube

17. Inspect the CT and heater body for damage (scratches, dents, wear spots, etc) and clean completely. In particular, thoroughly clean all of the surfaces that the nozzle and CT will touch when reassembled. This step is critical for a successful reassembly.

7.3 Assembly

Upon completion of the disassembly procedure, the following procedure illustrates what is required to reassemble the heater. The same procedure applies whether or not new or used internals are used. Hydro-Thermal recommends keeping a spare set of internals (CT, stem plug, nozzle, CT adjustment, CT stud, and seal kit) in stock. This will prevent costly down time in the event of an internal part failure. Please consult your Hydro-Thermal Sales Representative for part numbers, pricing, and delivery.

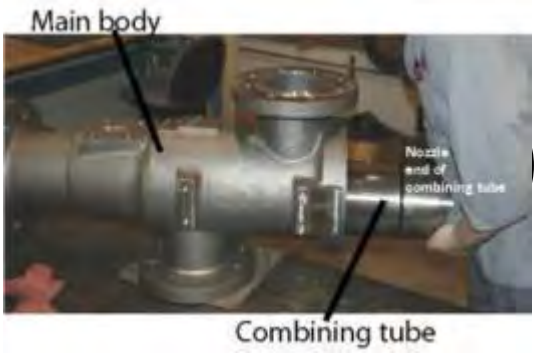
If there are any questions regarding this procedure please contact the Hydro-Thermal Service Department at (262) 548-8900 for further information.

CAUTION - Examine O-Rings for cuts, nicks, and elasticity before installing them. Replace if damaged or hardened.

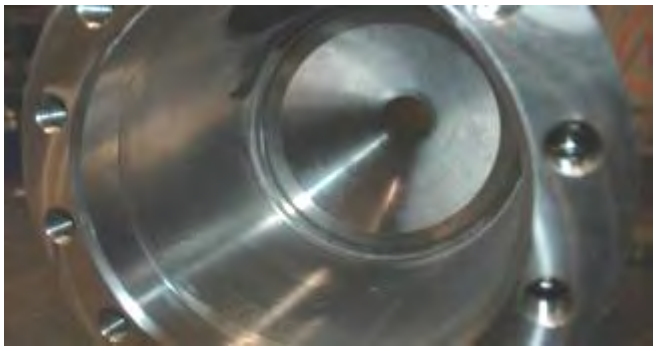
CAUTION - When replacing packing, the stem must be clean and free of nicks, burrs and scratches. A 16-20 Ra finish is required. If the stem is pitted, coat it lightly with Chesterton Nickel Anti-Seize or equivalent.

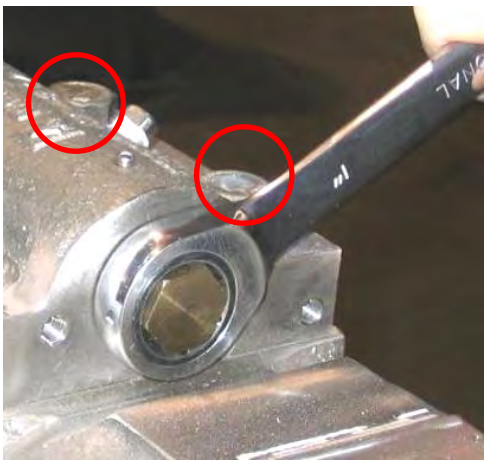
CAUTION - Do not mar or score the stem while handling.

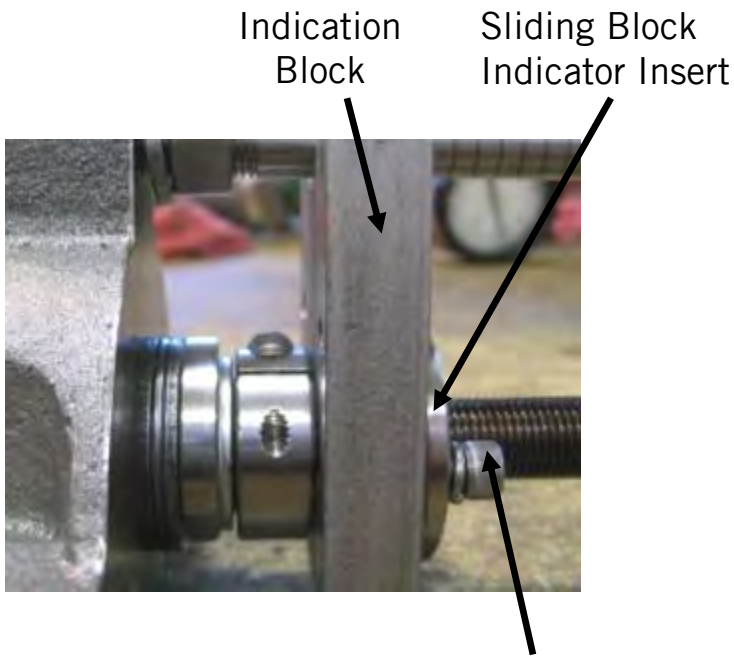
Table 8: Step by Step Assembly Instructions
Item numbers referenced are shown in figure 29 and table 10

Step 1: Gather tools and individual parts needed for assembly.	
Step 2: Slide two O-rings over combining tube into radial grooves.	
Step 3: Lubricate O-rings with glycerin.	
Step 4: Insert combining tube (item 3) into body (item 1) from the nozzle end. The circle shows the nozzle end of the CT. It is critical that the inside of the body and the outside of the CT to be completely clean of debris, scale, and/or product prior to starting this step.	

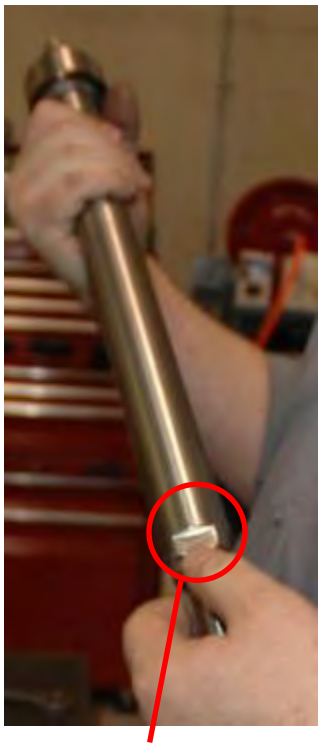
Step 5: Align combining tube stud hole with center of slot in main body. (might need a soft piece of stock to center hole without damaging the threads)	  
Step 6: Screw in CT Stud (item 8) until shoulder touches the body, then turn it counter-clockwise ½ to 1 full turn so that the slot in the CT stud aligns with the CTA barrel nut.	
Step 7: Insert nozzle (item 4) into body. Make sure the nozzle and nozzle seating area of the body are completely clean of debris, scale, and/or product. Failure to do so will make nozzle installation extremely difficult.	

Step 8: Slide nozzle until it travels just beyond retaining ring groove. The clearance between the nozzle and body is tight, so gently tap around the nozzle to complete insertion.	
Step 9: Install spiral retaining ring (item 15). Ensure ring is properly seated. (Some smaller units use a snap ring in place of a spiral retaining ring).	 
Step 10: Lubricate O-ring area and install O-ring (item 7) in CTA housing assembly (item 6).	
Step 11: Make sure the barrel nut is straight to ensure proper seating of the housing on the CTA stud. Grease shaft.	

Step 12: Install CTA Assembly on main body. Extreme care must be taken to assure the ears of the barrel nut inside the CTA are positioned to fit in the yoke of the CT Stud. **Note** – Orient CTA such that the indicator rod that shows the CTA percentage open, is facing away from the discharge end of the heater.	Discharge 
Step 13: Install 4 (5/8''-11) bolts (item 19) with one cupped washer (item 18) and one flat washer (item 17) for each bolt. Make sure cup is faced down. See Table 9 for torque specifications.	 5/8''-11 bolt Cupped Washer Flat Washer
Step 14: Turn the bolt end of the threaded drive shaft in one direction until the Indicator Sliding Block moves. Then reverse direction to verify that the CT opens and closes.	

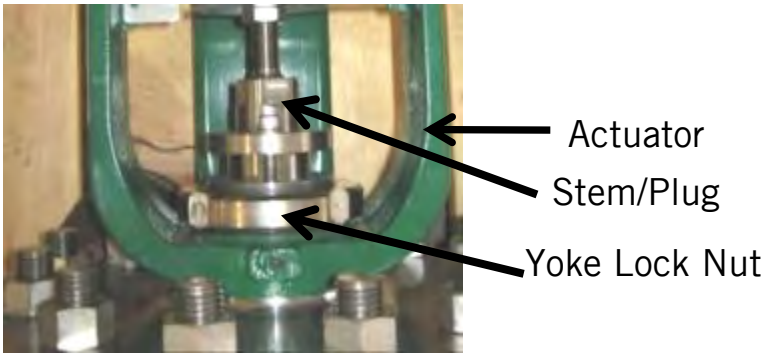
Step 15: Turn the CTA in the close direction until resistance is felt. The contact point of resistance will be noticeable. Do NOT force past this point. The sliding block indicator with the groove on top should line up with the "0%" mark on the scale. If not, remove the two 10-32 cap screws from the sliding block indicator insert. Screw the indicator insert in or out until the sliding block shows the zero position. Put the screws back in and verify that the zero point has not moved. Turn the CTA open and closed and verify that the CT moves and the zero location shows "0%" on the scale.	 

Set the CTA position to the plant's start-up position. Many plants use 25% as a starting point, but this is site specific.	
Step 16: Install head studs (item 25) if needed. Hand start and tighten with impact wrench or double nut configuration.	 
Step 17: On head, install 2 stem seals (item 30) with spring side facing up. Install the stem seals by gently tapping them into the bore. Lubricate seals with non-petroleum grease prior to installation. The seals are fully seated when the lock ring groove is visible.	 

Step 18: Install retaining lock ring (item 29) with lock ring pliers.	 
Step 19: Install O-ring (item 16) and lubricate with non-petroleum grease.	O-Ring 
Step 20: Check the flats on the stem to make sure there are no burs. Burs could rip stem seal. Install stem (item 5) into head (item 2).	 Remove Burs 

Step 21: Install head with stem plug into main body making sure the marks made during disassembly match up. Apply anti-seize to all studs after head is seated.	
Step 22: Tighten all (item 26) head nuts. Refer to Table 9 for torque specifications **Note -** If your Hydroheater head came with an additional two hex head cap screws, hand tighten them into the two tapped holes near the hex nuts. These are jack screws to assist in disassembly of the head during maintenance.	

Step 23: Install packing set: (two ropes (item 11) and three graphite rings (item 12)). First, one rope is installed, then 3 graphite rings, finally a single rope. Stagger ends of rope 70 degrees. The packing follower may be used to help depress packing set.	  Rope Graphite
Step 24: Install packing follower (item 13) with 2 (5/16'') Allen head capscrews (item 31) and 2 special lock washers (item 21) on each bolt. Hand tighten, then one turn with Allen wrench. **Note**—In model K510, the packing follower is threaded and does not require Allen capscrews and lock washers. An example of a K511 & 512 packing follower is shown to the right	 

Step 25: Apply Loctite Anti-Seize on stem plug lock nut threads.	
Step 26: Install actuator on steam head. Use caution to prevent damaging the exposed stem plug. Tighten Yoke Lock Nut.	
Step 27: Attach the stem connector between the stem plug and the actuator spring adjuster using dimensions A and B notes in section 7.2.	See Figure 15
Step 28: Proceed to bench setting instructions in Section 9.1.	See bench setting Section 9.1 **WIP ASSY 001**

7.4 Torque Requirement

Table 9 shows the required torque for K500 body bolts and diffuser screws.

Table 9: Torque Requirements

	HEAD BOLT						
	K510	K511	K512	K513	K514	K515	K516
Bolt Size	1/2-13	1/2-13	1/2-13	3/4-10	7/8-9	1-8	1 1/4-7
# of Bolts	6	10	10	8	12	12	12
Torque (in.lbs.)	255	255	255	905	1455	2180	4360
Torque (ft.lbs.)	20	20	20	75	120	180	365
Torque (Nm)	29	29	29	102	164	246	493
	CTA BOLT						
Bolt Size	1/2-13	5/8-11					
# of Bolts	4	4					
Torque (in.lbs.)	255	510					
Torque (ft.lbs.)	20	40					
Torque (Nm)	29	58					

WIP ASSY 011

7.5 Installing a Manual Combining Tube Adjustment (CTA)

In certain cases, replacement of the CTA Assembly only is required. The following procedure illustrates how to install a new Manual CTA. However, if this is being replaced due to broken parts, it is highly recommended that the cause of this failure is investigated and solved. If not, the same failure could happen again resulting in additional expense. If this problem persists it is likely that the Hydroheater needs to be completely rebuilt. Please contact the Hydro-Thermal Service Department at (262) 548-8900 for additional information.

1. Verify the CTA assembly is clean and well lubricated and that the barrel nut can rotate freely the complete length of the threads.

2. Complete step 6 of the assembly procedure on page 45.

3. Complete steps 10-14 of the assembly procedure on pages 46-47.

7.5.1 Zeroing Procedure

1. Turn the bolt end of the threaded drive shaft in one direction until the Indicator Sliding Block moves. Then reverse direction to verify that the CT opens and closes.

2. Turn the CTA in the close direction until resistance is felt. The contact point of resistance will be noticeable. Do NOT force past this point.

3. The sliding block indicator with the groove on top should line up with the "0%" mark on the scale. If not, remove the two 10-32 cap screws from the sliding block indicator insert. Screw the indicator insert in or out until the sliding block shows the zero position. Ensure that the flat on the indicator insert is on the bottom. Put the screws back in and verify that the zero point has not moved.

4. Turn the CTA open and closed and verify that the CT moves and the zero location shows "0%" on the scale.

5. Set the CTA position to the plant's start-up position. Many plants use 25% as a starting point and work their way to 10% open, but this is site specific.

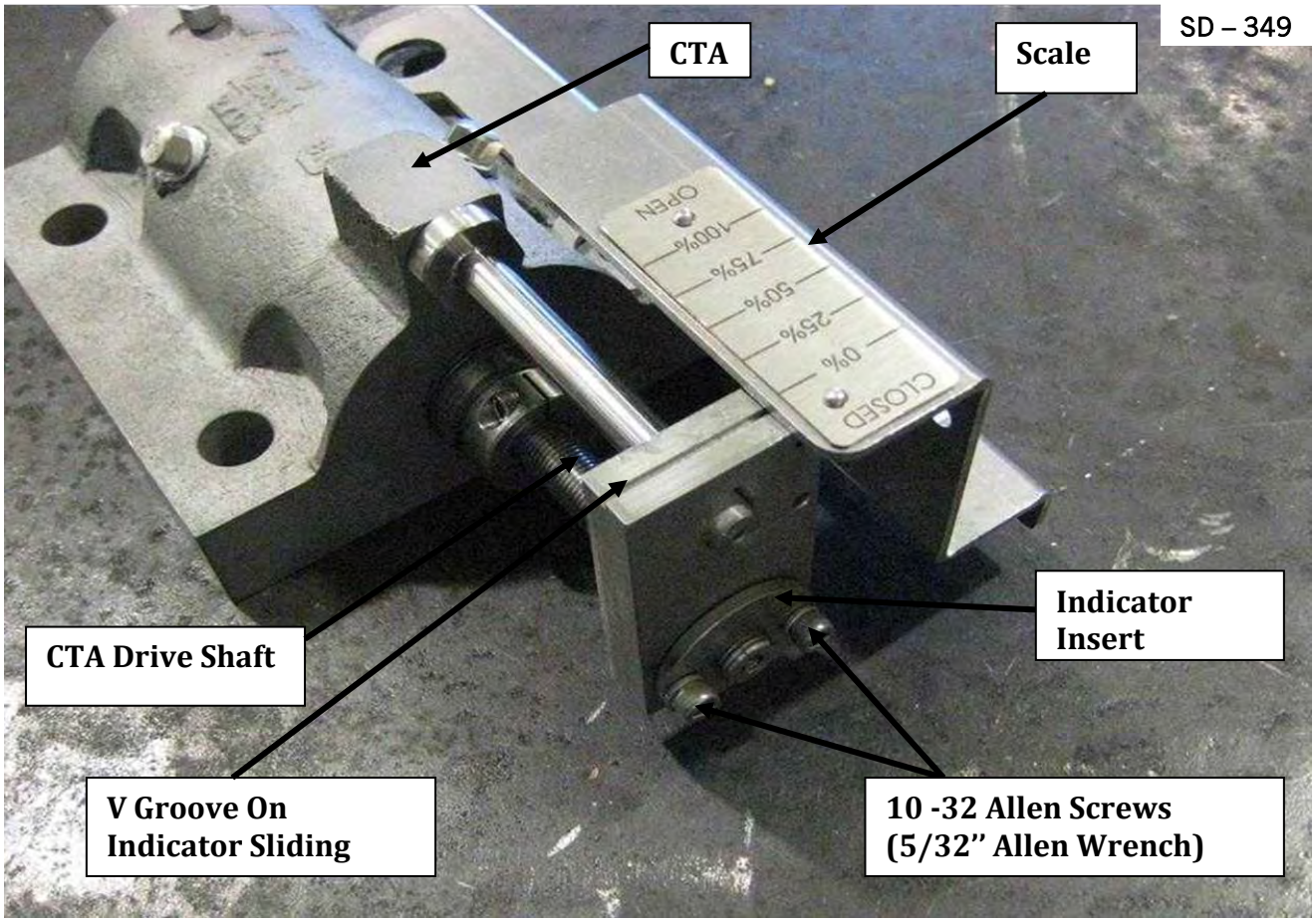


Figure 23: Manual CTA Assembly with Position Indicator

7.6 How to Reverse Mount a New Style CTA

Due to a design improvement in the casting, some older K514 & K515 bodies may not accept the new style CTA. The indicator block will contact the body casting and not allow the CTA to mount flush on the body. If this is the case, remount the CTA in the opposite direction. This will have the indicator block pointing toward the heater discharge (opposite normal). Then, remove and remount the scale indicator.

Figure 24: For some older bodies, CTA must be mounted in this direction

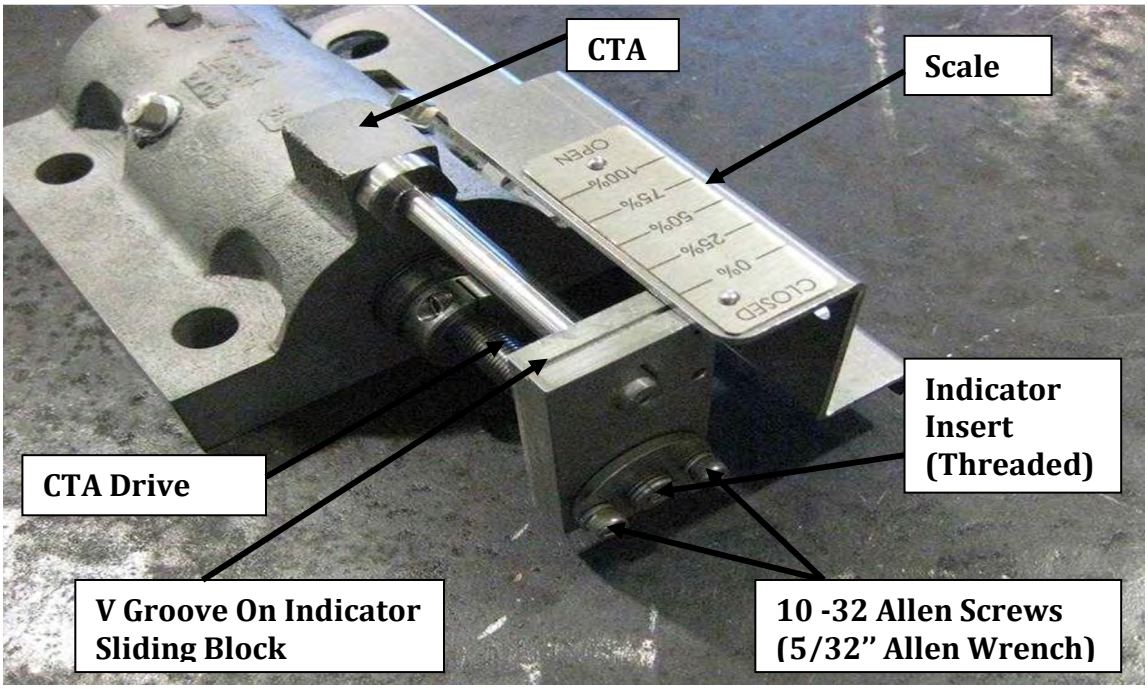


Figure 25: Scale needs to be removed and then reversed

7.7 Rotating the Actuator

For some installations, the orientation of the actuator/positioner as-shipped may be inconvenient. For example, the positioner may be located below the heater and difficult to see.

The following procedure outlines how to rotate the actuator/positioner for a more convenient orientation. In summary, the actuator will be raised slightly using air pressure to eliminate the closing force. Then it will be loosened from the Hydroheater, rotated and re-tightened. Please follow the steps below or consult the Hydro-Thermal Service Department with any questions.

1. Remove the air line between the positioner and actuator

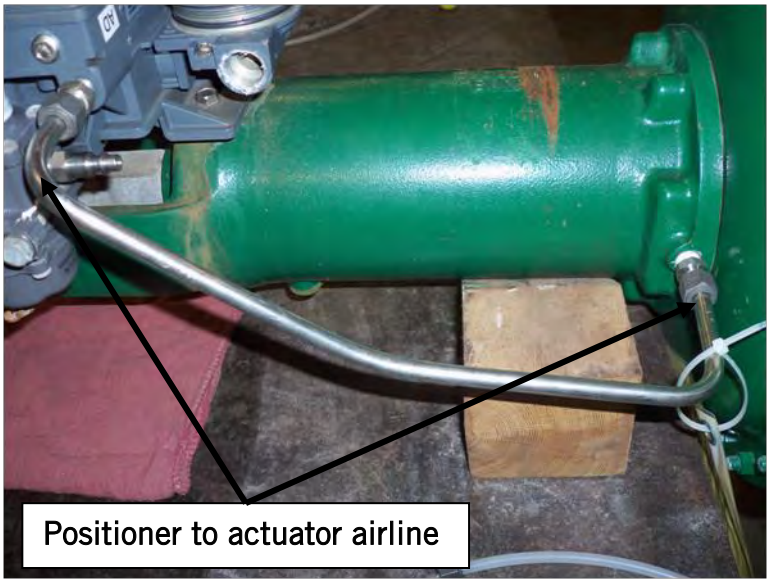


Figure 26: Positioner to actuator airline

2. Attach air supply with regulator to the actuator as shown below.

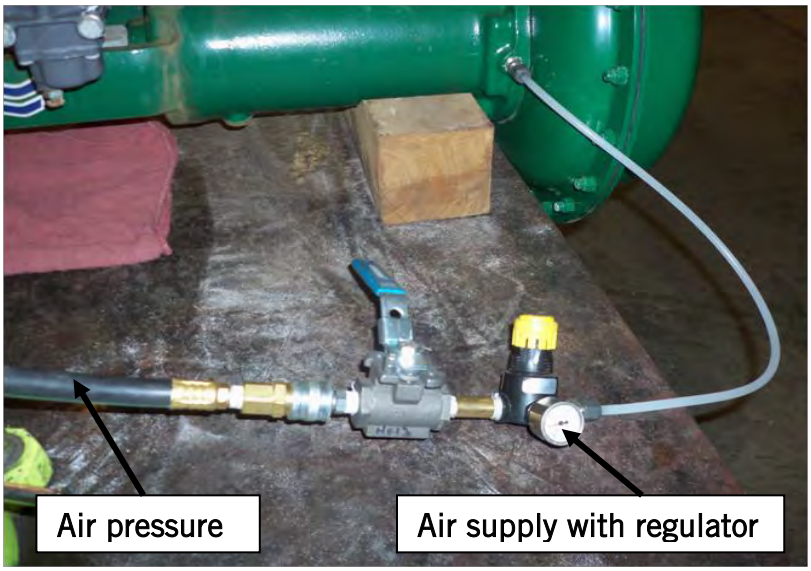


Figure 27: Air Supply to Actuator

CAUTION - To avoid applying excessive pressure, the max pressure of the regulator should be 0-30 psi.

3. Apply air pressure of 10-15 psi to the actuator. This will open the actuator slightly, removing the downward force on the stem plug.

CAUTION - In this condition, the actuator could close suddenly upon loss of air. Do not place anything (hands, fingers or tools) in the area of the actuator stroke.

4. Loosen the actuator lock nut slightly, just enough to allow movement. Do not remove the actuator.

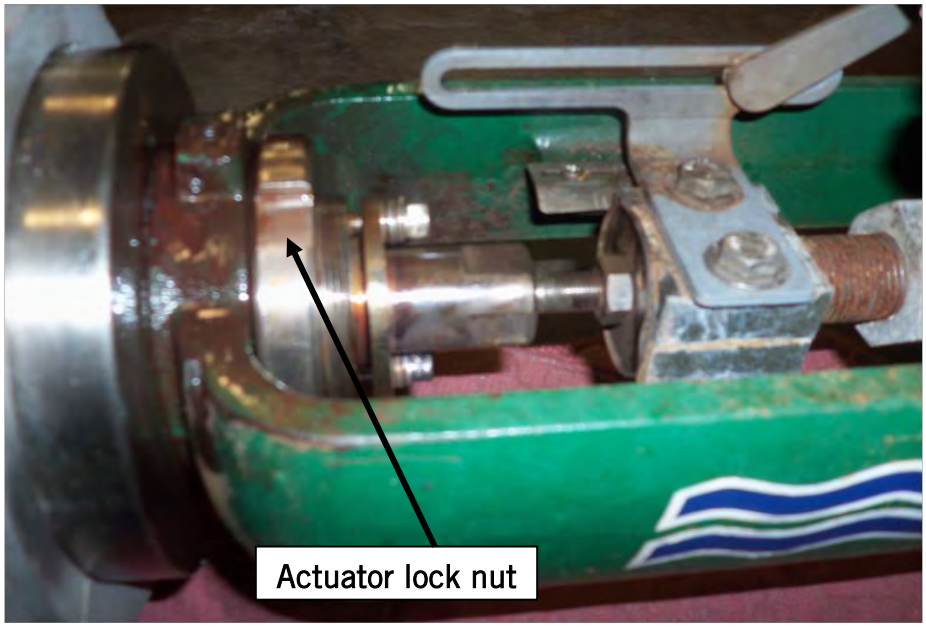


Figure 28: Actuator Lock Nut

5. Rotate the actuator to the desired orientation.
6. Tighten the actuator lock nut.
7. Reduce air pressure to zero psi. The actuator will close. Then, remove the air regulator.
8. Reinstall the airline between the positioner and actuator.

8.0 Illustrated Parts List

8.1 Exploded View – K500

Note - Mounting bracket shown (Item 27) is only used on K513 and larger heaters.

Figure 29: Exploded View of K500

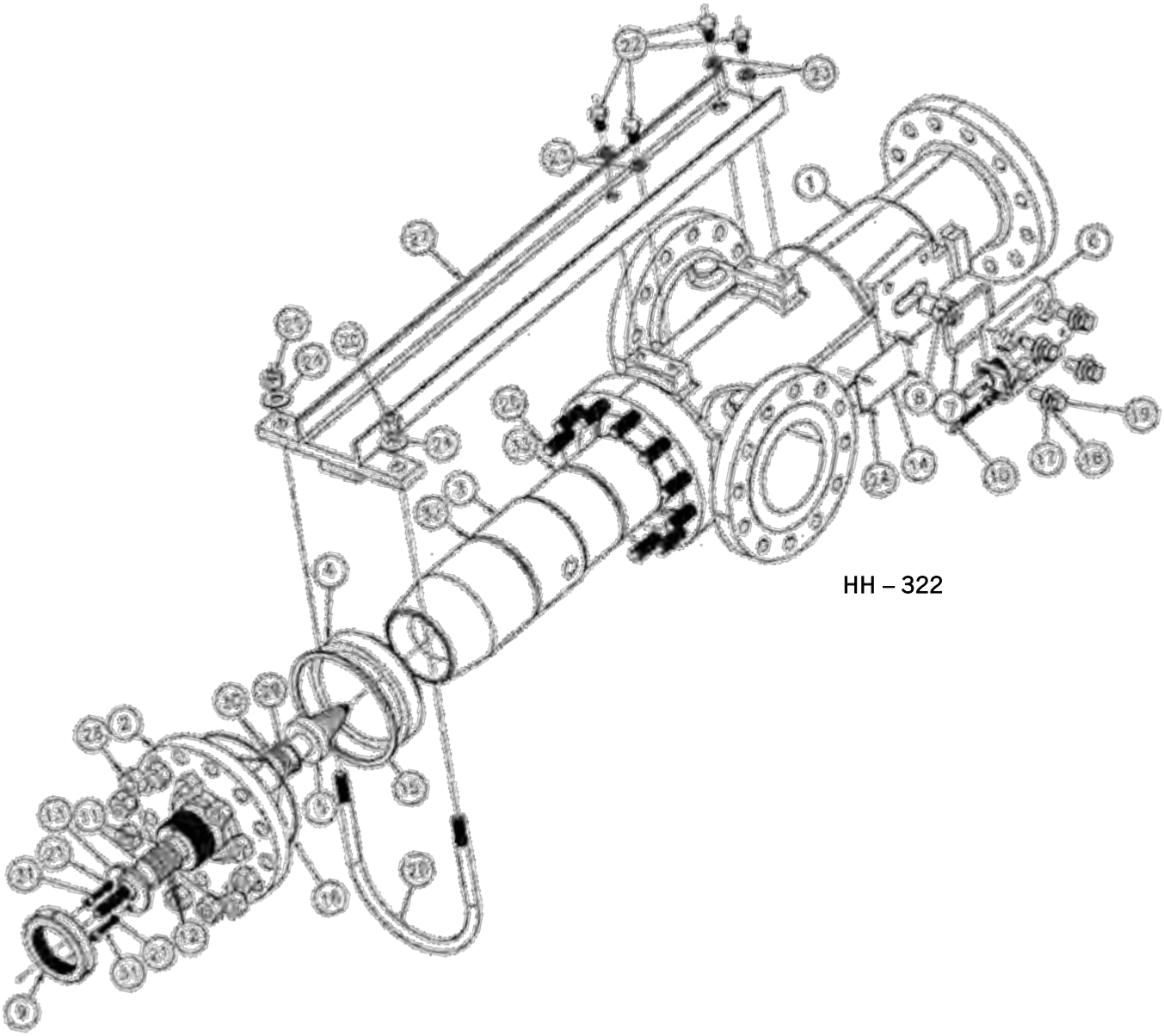


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Table 10: Bill of Materials - K500 Hydroheater

NO.	DESCRIPTION
1	BODY
2	HEAD
3	COMBINING TUBE
4	NOZZLE
5	STEM – PLUG ASSEMBLY
6	CTA ASSEMBLY
7	O-RING
8	STUD, CTA COMBINING TUBE
9	LOCKNUT
10	INDICATION ROD
11	PACKING ROPE
12	PACKING RING
13	PACKING FOLLOWER
14	NAMEPLATE
15	SPIRAL RETAINING RING
16	O-RING
17	WASHER
18	BELLEVILLE WASHER
19	BOLT
20	NUT HEX
21	LOCK WASHER 3/8"
22	CAPSCREW
23	LOCK WASHER 5/8"
24	RIVET
25	HEAD STUD
26	NUT HEX HEAVY
27	MOUNTING BRACKET ASSEMBLY
28	U BOLT
29	RETAINING RING
30	STEM SEAL
31	CAPSCREW SOCHD.
32	O-RING, CT
33	O-RING, CT

Note: Please reference torque tables

8.2 Exploded View – CTA Assembly

Figure 30: Exploded View - K500 CTA Assembly

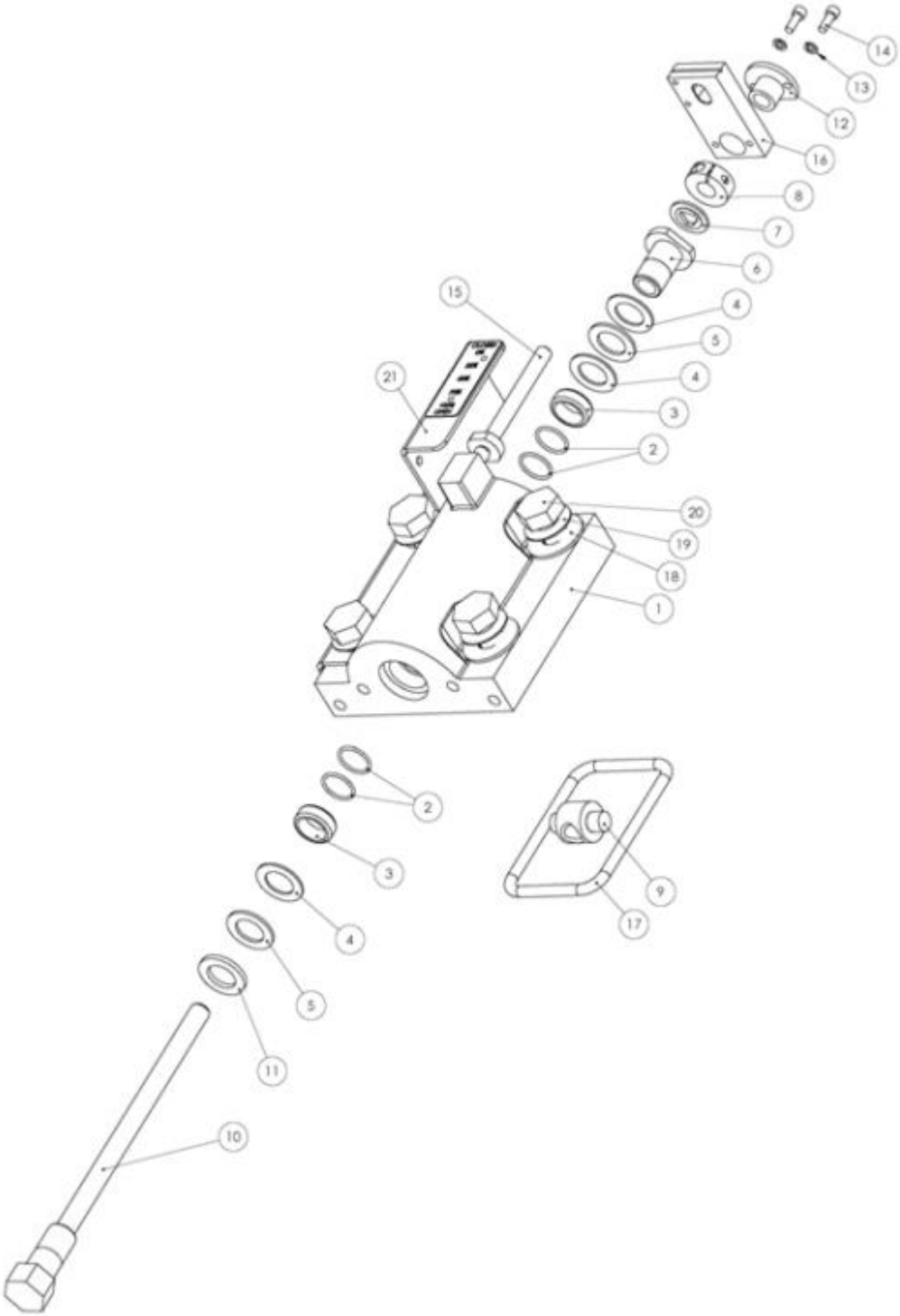

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Table 11: Bill of Materials - CTA Assembly

ITEM NO.	DESCRIPTION
1	CTA HOUSING FOR K511-K516
2	O-RING
3	BEARING, NEEDLE
4	WASHER, THRUST
5	BEARING, THRUST
6	END NUT (FOR CTA)
7	SEAL, THREAD, 1/2-20
8	SHAFT COLLAR, THREADED 1/2-20 UNF
9	ADJUSTING NUT FOLLOWER
10	THREADED DRIVE SHAFT K511-K516
11	WASHER, THRUST
12	INDICATOR INSERT
13	WASHER LOCK #10
14	SCREW, SHC, 10-32 X 0.5 LG
15	INDICATION ROD
16	SLIDING BLOCK
17	O-RING
18	WASHER
19	WASHER BELLEVILLE
20	SCREW HHCS 5/8-11 X 2.00L
21	BRACKET CTA SS ASSEMBLY

9.0 Bench Setting of K500 Hydroheater Actuator & Positioner

The purpose of this procedure is to ensure proper adjustment of the actuator and correct calibration of the positioner. This will ensure proper travel of the actuator, proper seat force of the plug into the nozzle, and the proper control characteristics of the hydroheater.

9.1 Actuator "Bench Set" Procedure (Pre-Installation of Positioner)

Note - The first few pictures are setting the travel of the actuator only. If this procedure is being done with the actuator still attached to the heater, loosen the two 9/16" bolts and the jamb nut holding the connecting block together and screw the stem plug towards the actuator several turns so it does not interfere with the travel during the setting process.

1. Note actuator ID plate pressure and travel range. Different actuators have different pressure and travel ranges. It is important to set the actuator based on its particular ID tag values.

2. Before connecting unregulated (plant) air to actuator install an air regulator inline before the actuator.

3. Set the air regulator to 0 psig.

4. Connect an air line from the regulator to the actuator.

5. Raise regulated air to 5 psi over actuator ID plate max operating pressure. Actuator should be at max open position.

CAUTION – Do not exceed maximum pressure of the actuator.

6. Note the position by measuring it or sliding the scale to its max open indicator mark. This point will be the max open of the actuator from now on. Drop the air slowly so actuator starts closing. When actuator reaches its specified travel limit, stop dropping the air. This point is important since there is still a small amount of movement left in the actuator. Move the connecting block (screw it in or out) to match 0% open on the metal scale.

7. If the stem plug is attached to the heater, unscrew it towards the heater until there is contact with the nozzle (it will be much more difficult to turn at that point). The remaining physical movement left in the actuator will be used to maintain mechanical pressure on the stem plug in the closed position (0 psig).

8. Snug up the two 9/16" bolts on the connecting block and tighten the jamb nut.

9. Note the position of the connecting block and then drop the air regulator to 0 psig. The stem plug should not move but the remaining travel of the actuator spring should continue pushing on the stem plug to keep some mechanical pressure to keep it closed.

10. Increase the air again to 5 psi over max operating pressure and measure travel distance. It should travel whatever the ID plate says and the connecting block should line up with the metal Scale 100% open mark. Release the air pressure completely and verify the connecting block does line up with the 0 mark on the scale. If not, do steps 5 – 10 until it does.

11. Dial air down to low limit (on a 3 psig to 15 psig actuator, set to 3 psig). Increase air slightly until actuator starts to rise. Should start about 3.5 psig or so. If it doesn't start to rise until 4 psig the actuator spring nut needs to be adjusted (unscrew loosens tension) just enough so it does not over power the air pressure being applied.

12. Dial air up to 14.5 psig and actuator should move to max open. If not the spring nut needs adjustment.

13. Adjust the metal scale to the travel limits of the actuator. Loosen the two Phillips head screws and slide the scale to match the travel. Next, retighten the screws if necessary.

14. Summary:
    a. The actuator should move its rated distance on the ID tag.
    b. It should start opening at or just above minimum rated pressure and be to max open position just below max rated pressure
    c. The actuator/stem plug movement should be smooth

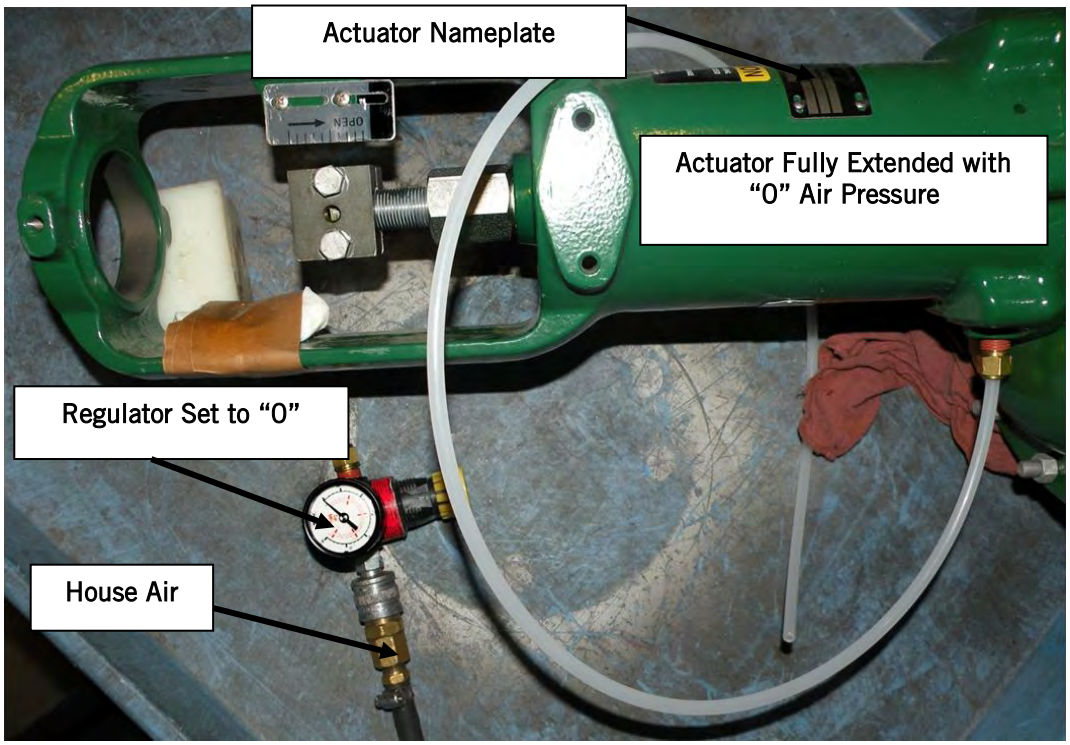


Figure 31: Actuator detached from stem plug and pressure released

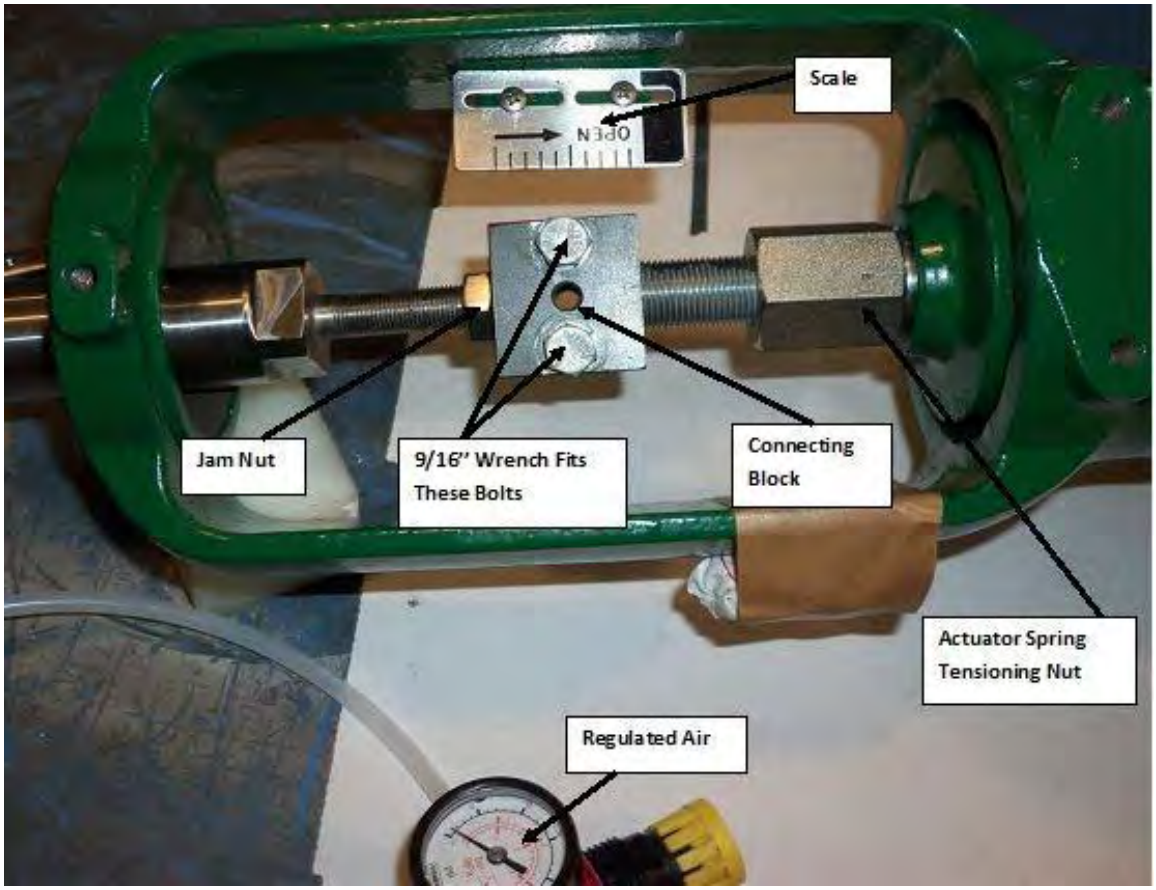


Figure 32: Actuator connected to stem plug

9.2 Positioners

A positioner can be mounted onto the K500 Hydroheater in order to better control steam flow and ultimately temperature. There are many types of positioners that are compatible with the K500 Hydroheater. Sections 9.3, 9.4, and 9.5 give instructions on how to install and calibrate the most common kinds. If you have a different positioner than those listed or are not sure what kind you have, please reference the positioner manufacturers' manual or contact Hydro-Thermal at (262) 548-8900.

9.3 Calibrating a Fisher DVC 6010 Positioner

Note – The following instructions are based on using a HART 475 communicator. If you have a different communicator or have additional questions about the DVC 6010, please reference the positioner manufacturers' manual or contact Hydro-Thermal.

Note -This procedure assumes the positioner has been bench set and linkage from stem plug and positioner has been installed properly. Double check adjustment arm pin is in feedback arm slot, and is on top of the spring as well as set to the max actuator travel number on the feedback arm. There is a stylus on the back side of the unit that can be used to select screen options.

1. Unscrew electrical cover and linkage cover. If there are wires already connected, disconnect them now remembering which terminal they came from to reconnect them after this calibration.

2. Hook up HART communicator and 4 – 20mA generator (+ (RED) to + and (BLACK) to loop terminals).

3. Set 4 – 20mA generator to 12 mA (this will be the cross over point).

4. Hook up house air to regulator and set it for 5 psi above the actuator tag max operating pressure. Then plug the air hose into the unit.

5. Turn on HART communicator.

6. Wait for HART application to display, then enter.

7. Wait for setup to display.

8. Select – setup (1). Push #1's most of the way.

9. Select - basic setup (1).

10. Select - auto setup (1).

11. Select – setup wizard (1).

12. Select – Follow prompts to select out of service, (1 – safe mode).

13. Select – travel control, enter.

14. Select – psi value on the tag, enter.

15. Enter value 5 psi over max value on actuator tag, enter.

16. Select – Fischer enter/OK.

17. Select - 667 Type/model, enter.

18. Select – size on actuator tag enter.

19. Select – Yes if the heater has a volume booster or No if there is not a volume booster, enter.

20. Select – send, 1/enter (configuration being sent).

21. Select – factory defaults yes, enter.

22. Run auto travel calibrate – OK, yes.

23. Cross over adjust, select – manual, enter.

24. Next (0 - 100% seeking high drive stop, then 100% - 0% seeking lo drive stop, then 0 – 50% while adjusting output bias is occurring.

Note - During the bias setting portion, the 475 HART Communicator can lockup in an endless loop. The only way out is to turn off the Milliamp generator and start over. However, if there is a volume booster, unscrew the screw another ½ turn or so when that screen comes up. If there is not a volume booster, tweak the air a couple psi when that screen comes up. These are the only two things that are proven to work to get past a lockup scenario.

25. Crossover adjustment source, select analog, 1/enter.

26. Adjust the current source until feedback arm is at crossover point (verify 12 mA on generator), enter. (12mA should put feedback arm at crossover point. Feedback arm should be perpendicular to the actuator stem at cross over point. Cross over point is when the pin in the feedback arm changes the direction it is moving, usually mid travel 50%).

27. Seeking hi and lo drive stops

28. Move valve now to set pressure range, hi – lo yes, enter/1.

29. Calibration Complete OK, OK.

30. Select – in service to put it back in service.

31. Shut off HART Communicator.

32. Increase and decrease mA generator signal and verify indicator follows generator values. Should start opening at 4.2 mA and should start closing at 19.9 mA.

33. If it doesn't start opening at 4.2 mA, redo the setup again. If that still doesn't work use the bench set procedure and recalibrate again.

34. Remount linkage cover.

    On DVC 6010HC Positioner – plug the output B hole and crank the little adjustment wheel in the proper direction. This will make it compatible with a single acting actuator. This type of positioner can be set up for double acting actuators.

Figure 33: 475 HART Communicator

9.4 Installing and Calibrating a DVC 2000 Positioner

9.4.1 Mounting Magnet Array for DVC 2000

Note - Do not use magnetized tools around the DVC 2000. Permanent damage to the magnet array could result. The actuator max travel must be the same as the distance between the white lines on the magnet array.

Make sure the magnet array is mounted such that the upper white line of the valid travel range on the magnet array is 1/8" above the white line (index mark) on the rear of the body. The key is that here is the single white line on the body should always be between the two white lines of the magnet array throughout its full travel. Please reference the positioner manufacturers' manual or contact Hydro-Thermal with further questions.

9.4.2 Calibrating a DVC 2000

1. Verify the disk below the connecting block lines up with 0% open on the scale and appears to be centered in the channel of the body.

2. If there is a signal, skip to step #6, if not continue to step #3.

3. Hook up 4 – 20 mA generator to the green power block as label indicates.

4. Hook up (0 preset pressure) air regulator and set pressure to the ID plate pressure on actuator.

5. Turn on the generator and set to 12 mA. Perform steps 6 – 11, and then positioner should follow generator settings.

6. Take the cover off using the two Phillips head screws. Next, there should be four grey buttons/arrows in a diamond arrangement visible. Whether the positioner is vertical or horizontal is not important. The up button/arrow pointing at the screen is the "up" button/arrow. The button/arrow pointing away from the screen is the "down" button/arrow. On the screen, the button/arrow on the right is the "right" button/arrow and the opposite button/arrow is the left.

7. Push the down button/arrow momentarily one time, quick setup should be displayed.

8. Other choices will be displayed if the down button/arrow is chosen more than once. Do not use c – f unless that is what specifically needs to be done. For now, use the quick setup to ensure that the positioner is working properly and want to verify its operation.
    a. Quick setup
    b. Travel calibration

c. Tuning
d. Detailed set up
e. Analog input calibration
f. Local control
g. You have to push the up button/arrow to go back up to quick set up.

9. Push right arrow once. Next, the screen will show valve will move - press right button/arrow for 3 sec warning. Push right arrow and hold for three seconds.

10. Calibration then starts. Next, the screen will show finding 0% then finding 100% then finding 0% again, than finding 50% (it takes about two minutes to complete quick setup).

11. Quick setup complete should show on the display after that with a successful setup.

12. If it did not complete, try it again and double check the magnet array in the rear of the unit. The single white line on the body should always be between the two white lines of the array and not binding with or touching the body anywhere through its travel. That is usually the problem (array came loose, is binding up somewhere or is moving past the body white line). If the array is moving freely within the lines, perform steps 6 – 11 again.

13. To abort procedure, press and hold both right and left arrows at the same time for three seconds.

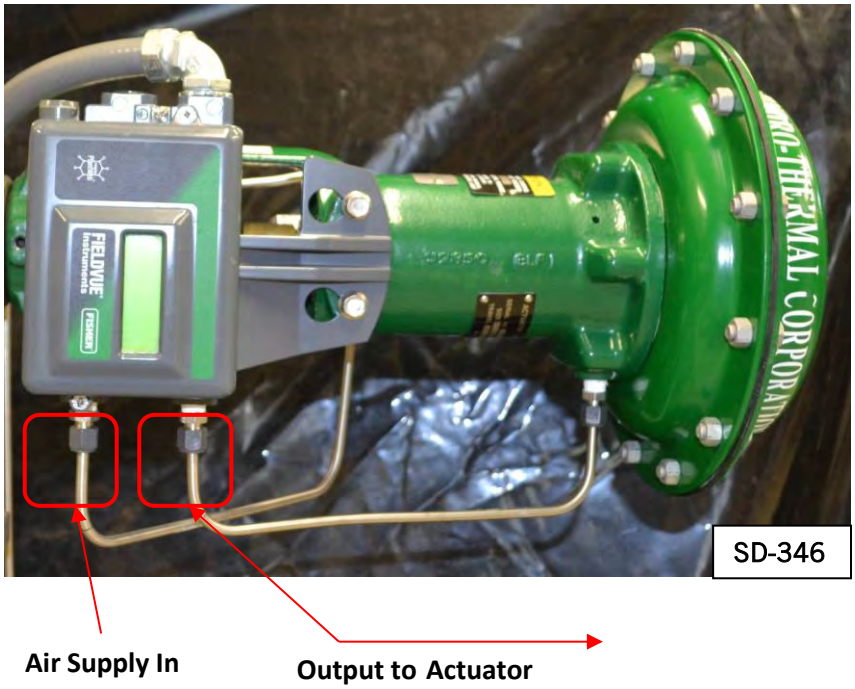


Figure 34: DVC 2000 Mounted on Actuator

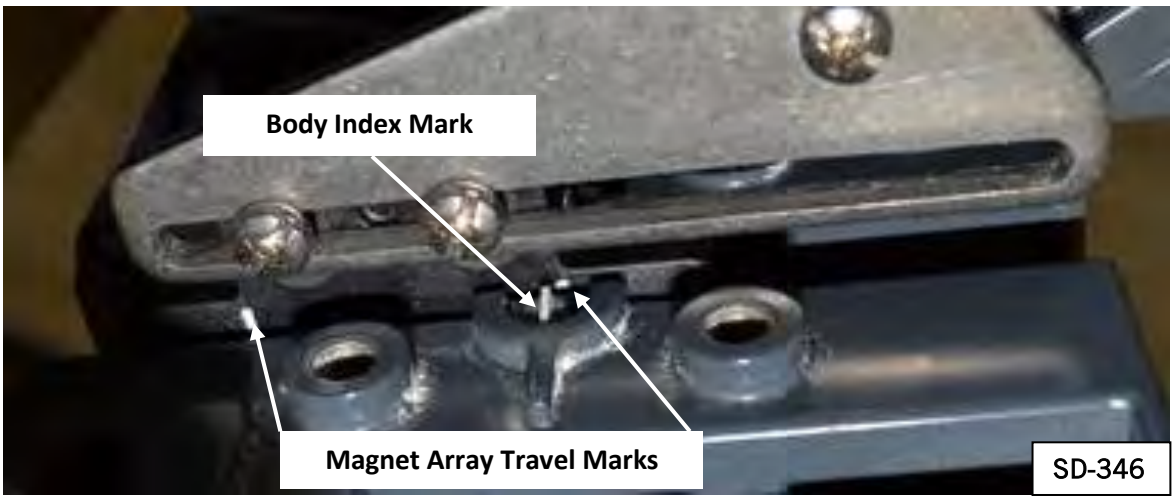


Figure 35: Array Mounting Location

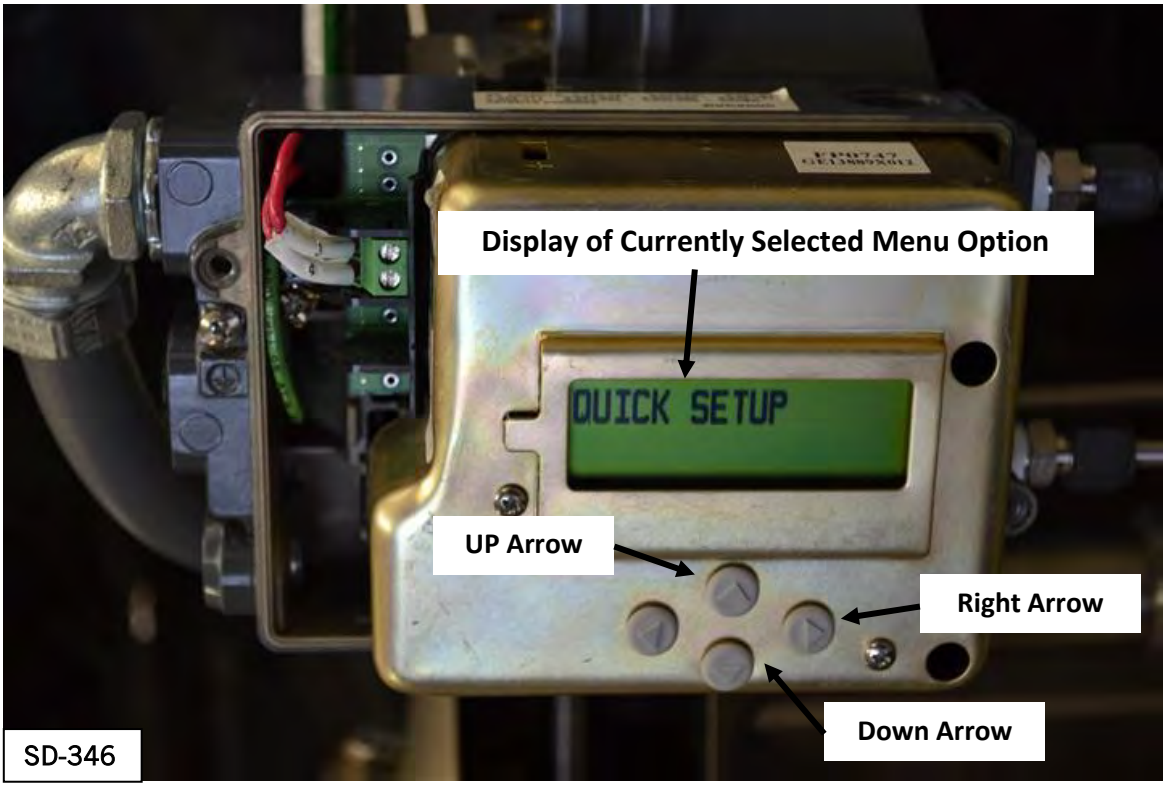


Figure 36: DVC 2000 Showing Screen Display and Arrow Placement

9.5 Installing and Calibrating a DVC 6200 Positioner

9.5.1 Mounting Magnet Array for DVC 6200

Note - Do not use magnetized tools or strap magnets on meters around the DVC 6200. Permanent damage to the magnet array could result. The actuator max travel must be the same as the distance between the white lines on the magnet array. Please reference the positioner manufacturers' manual or contact Hydro-Thermal with further questions.

Note – These instructions are written for air-to-open actuators only. Included in the mounting kit is a plastic template that should be used for initial setup. This template is also needed when converting from a DVC 6010 to a DVC 6200.

9.5.2 Calibrating a DVC 6200

1. Verify the actuator is fully closed and stem plug completely seated.

2. Attach the mounting bracket from the kit to the actuator.

3. Loosely attach the feedback pieces and magnet array to the valve stem connector. Before tightening any screws, verify that the magnet array matches the actuator travel. This is done by measuring the distance between the white lines of the magnet array and comparing that dimension to the max travel on the actuator metal ID plate. There are several different sizes and styles of magnet arrays so it is crucial to verify that it is the correct one. For instance, if the magnet array goes beyond the template/body index mark, then you will not have travel control. In this situation, please contact Hydro-Thermal at (262) 548-8900.If the magnet array does match, then proceed to the next step.

4. Using the black plastic alignment template, position the magnet array inside the retaining slot.

5. Vertically align the magnet array so that the center line/index mark of the plastic alignment template is slightly below the top white line of the magnet array (approximately 1/8"). The key is that the single white line on the body should always be between the two white lines of the magnet array throughout its full travel.

6. Loosen the bolts/screws and remove the alignment template.

7. Mount the DVC 6200 to the mounting bracket, using the supplied mounting bolts.

8. Check for clearance between the magnet array and the DVC 6200 feedback slot. Verify there is clearance throughout the full travel of the magnet array.

This can be done by slowly airing up the actuator. Once this is complete, tighten all of the bolts/screws.

9. Hook up the air supply to the DVC 6200 and from the DVC 6200 to the actuator.

10. The DVC 6200 will now need to be programmed with a HART Communicator. Please see section 9.3 for instructions on how to program a 475 HART communicator.

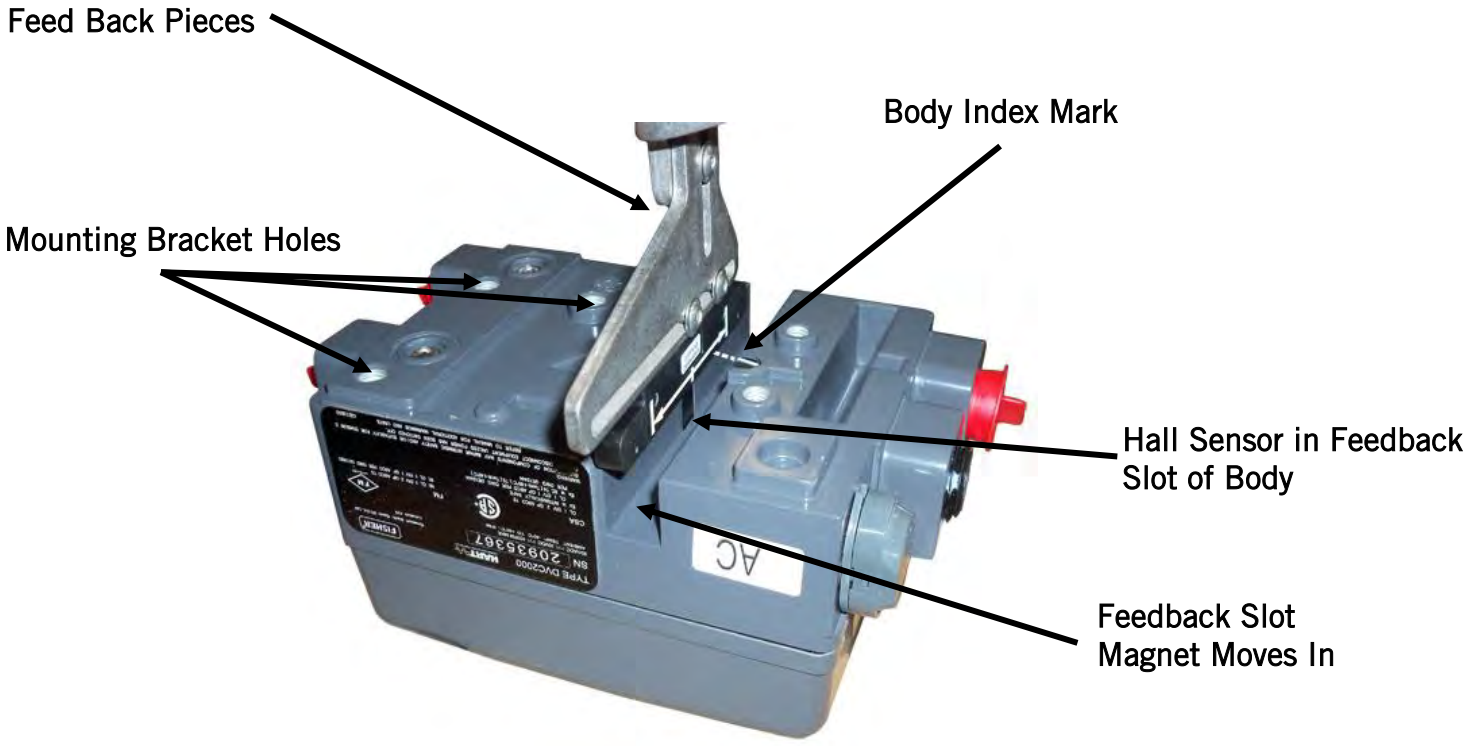


Figure 37: Bottom View of DVC

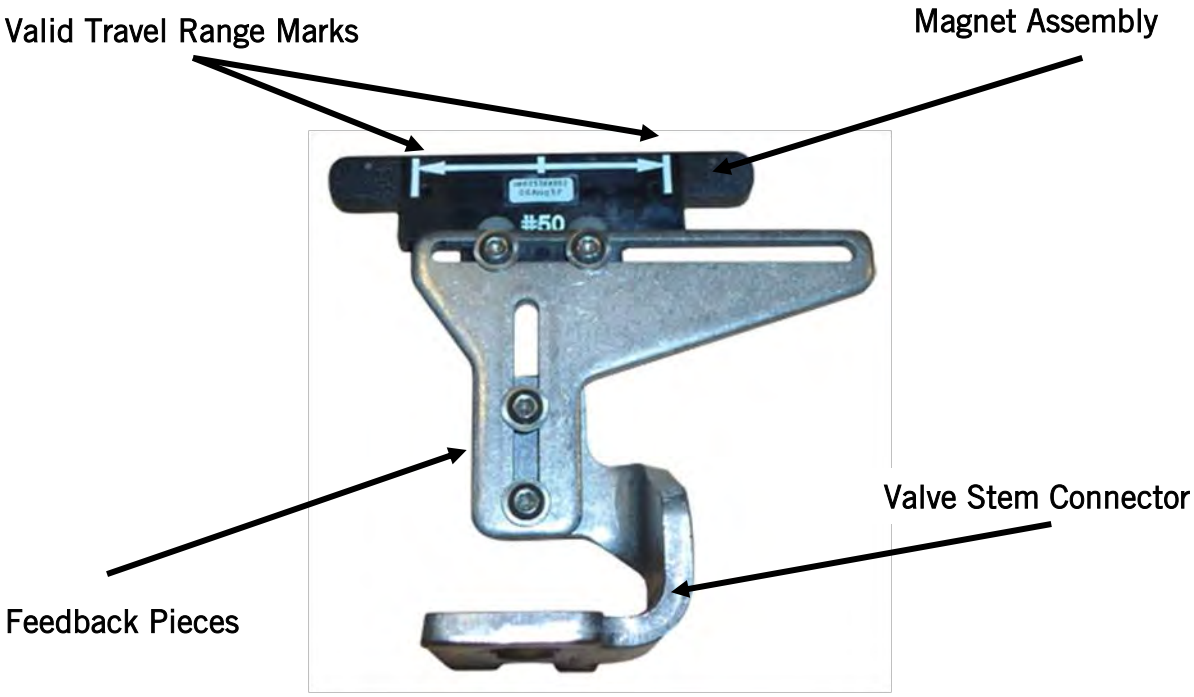


Figure 38: Magnet Assembly

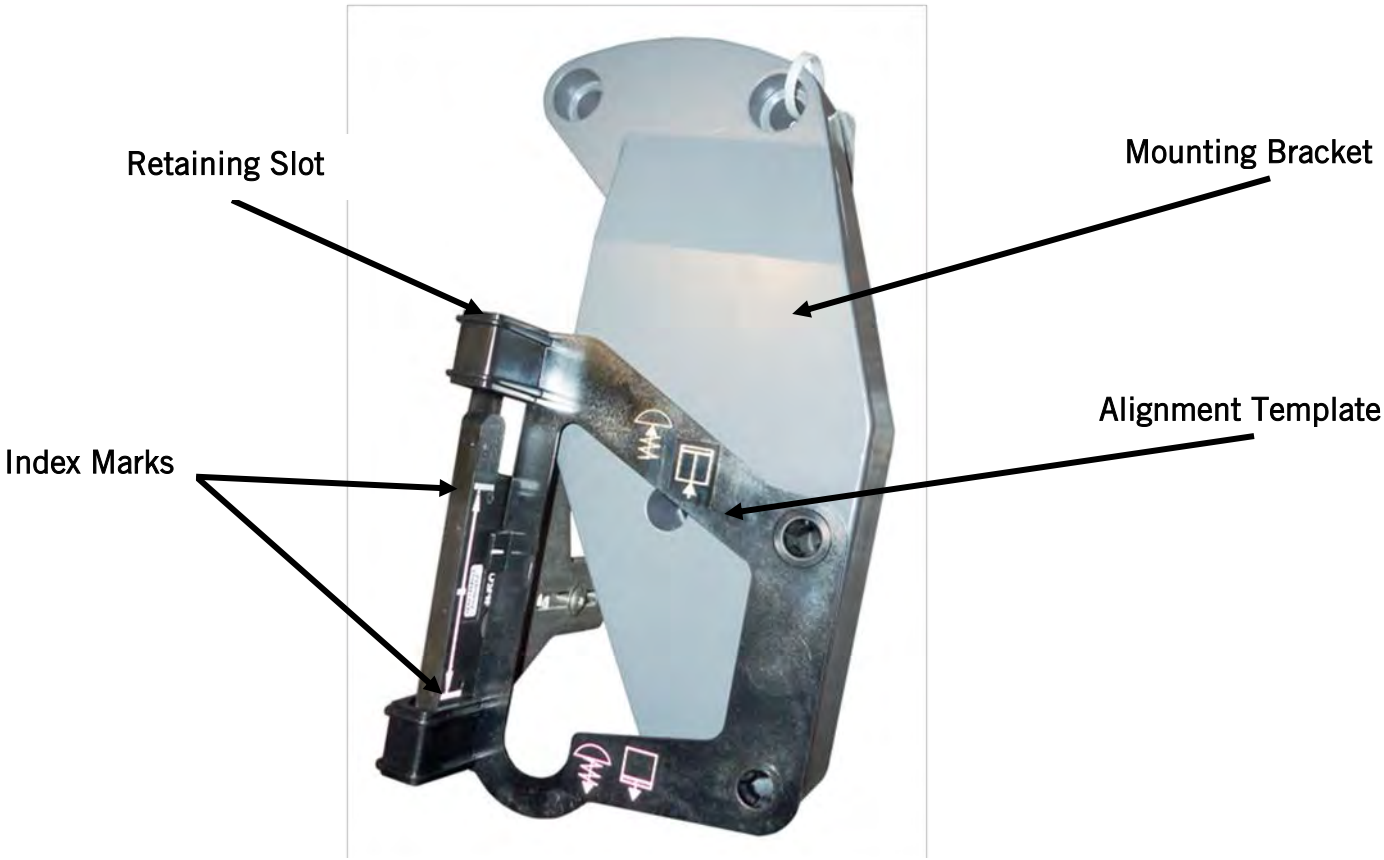


Figure 39: Alignment Template/Mounting Bracket

10.0 Limited Warranty

Hydro-Thermal Corporation warrants the original user of those products supplied by it and used in the service and in the manner for which they are intended, that such products shall be free from defects in material and workmanship for the period of twelve (12) months from the date of installation, or eighteen (18) months from the date of shipment, whichever period is shorter. This warranty does not extent to any product that has been subject to misuse, neglect or alterations after shipment from the factory.

Hydro-Thermal's sole and exclusive remedy with respect to the above limited warranty or to any other claim relating to the products or to defects or any condition or use of the products supplied by Hydro-Thermal Corporation, however caused, is limited to Hydro-Thermal Corporation's repair or replacement of the part or product, excluding any labor or any other costs to remove or install said part or product, or at Hydro-Thermal Corporation's option, a repayment of the purchase price. Notice of any warranty or any other claim must be given in writing to Hydro-Thermal Corporation (1) within 30 days of the last day or the applicable warranty period, or (2) within 30 days of the date of the manifestation of the condition or occurrence giving rise to the claim, whichever is easier.

Appendix

Appendix A: Steam Table

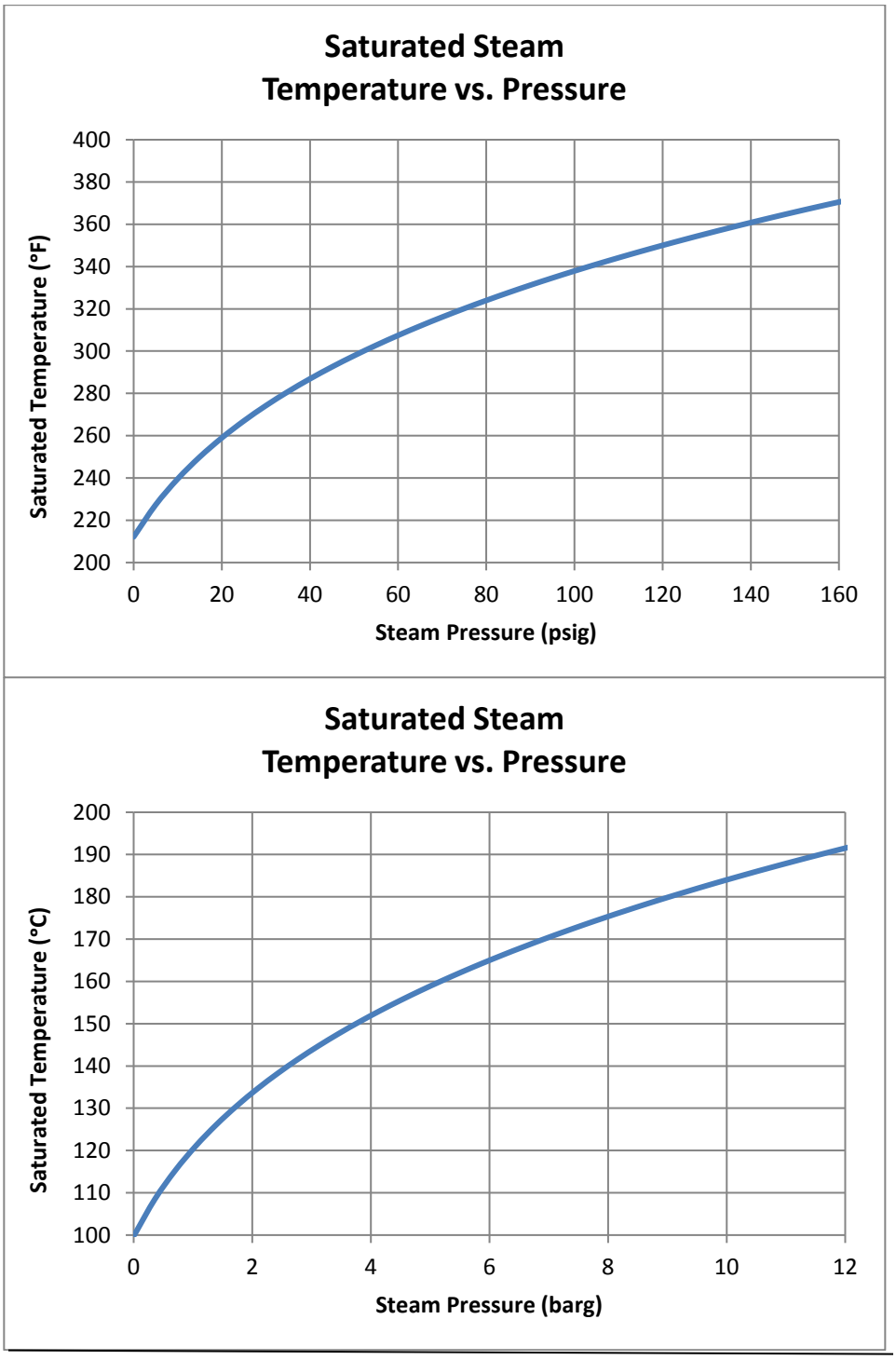
Table 12: Steam Table				
	Flash Pressure		Saturated Steam Table	
Temperature °F (°C)	psig	Barg	psig	Barg
212 [100]	0.0	0.0	5.0	0.34
214 [101]	0.6	0.04	5.6	0.39
216 [102]	1.2	0.08	6.2	0.43
218 [103]	1.8	0.12	6.8	0.47
220 [104]	2.5	0.17	7.5	0.52
222 [106]	3.1	0.21	8.1	0.56
224 [107]	3.9	0.27	8.9	0.61
226 [108]	4.6	0.32	9.6	0.66
228 [109]	5.3	0.36	10.3	0.71
230 [110]	6.1	0.42	11.1	0.76
232 [111]	6.9	0.48	11.9	0.82
234 [112]	7.6	0.52	12.6	0.87
236 [113]	8.5	0.59	13.5	0.93
238 [114]	9.4	0.65	14.4	0.99
240 [116]	10.3	0.71	15.3	1.05
242 [117]	11.2	0.77	16.2	1.12
244 [118]	12.1	0.83	17.1	1.18
246 [119]	13.3	0.92	18.3	1.26
248 [120]	14.1	0.97	19.1	1.32
250 [121]	15.1	1.04	20.1	1.38
252 [122]	16.2	1.12	21.2	1.46
254 [123]	17.3	1.19	22.3	1.54
256 [124]	18.4	1.27	23.4	1.61
258 [126]	19.5	1.34	24.5	1.69
260 [127]	20.7	1.43	25.7	1.77
262 [128]	21.9	1.51	26.9	1.85
264 [129]	23.2	1.60	28.2	1.94
266 [130]	24.5	1.69	29.5	2.03
268 [131]	25.8	1.78	30.8	2.12
270 [132]	27.2	1.88	32.2	2.22
272 [133]	28.5	1.96	33.5	2.31
274 [134]	30.0	2.07	35.0	2.41
276 [136]	31.4	2.16	36.4	2.51
278 [137]	32.9	2.27	37.9	2.61
280 [138]	34.5	2.38	39.5	2.72
282 [139]	36.1	2.49	41.1	2.83
284 [140]	37.7	2.60	42.7	2.94
286 [141]	39.4	2.72	44.4	3.06
288 [142]	41.1	2.83	46.1	3.18
290 [143]	42.8	2.95	47.8	3.30
292 [144]	44.6	3.08	49.6	3.42
294 [146]	46.5	3.21	51.5	3.55
296 [147]	48.4	3.34	53.4	3.68
298 [148]	50.3	3.47	55.3	3.81

Table 12: Steam Table Continued				
	Flash Pressure		Saturated Steam Table	
Temperature °F (°C)	psig	Barg	psig	Barg
300 [149]	52.3	3.60	57.3	3.95
302 [150]	54.3	3.74	59.3	4.09
304 [151]	56.4	3.89	61.4	4.23
306 [152]	58.5	4.03	63.5	4.38
308 [153]	60.7	4.18	65.7	4.53
310 [154]	62.9	4.34	67.9	4.68
312 [156]	65.3	4.50	70.3	4.85
314 [157]	67.6	4.66	72.6	5.00
316 [158]	69.9	4.82	74.9	5.16
318 [159]	72.4	4.99	77.4	5.34
320 [160]	74.9	5.16	79.9	5.51
322 [161]	77.5	5.34	82.5	5.69
324 [162]	80.1	5.52	85.1	5.87
326 [163]	82.8	5.71	87.8	6.05
328 [164]	85.5	5.90	90.5	6.24
330 [166]	88.3	6.09	99.3	6.43
332 [167]	91.2	6.29	96.2	6.63
336 [169]	97.1	6.69	102.1	7.04
338 [170]	100.1	6.90	105.1	7.25
340 [171]	103.2	7.12	108.2	7.46
342 [172]	106.4	7.34	111.4	7.68
344 [173]	109.7	7.56	114.7	7.91
346 [174]	113.0	7.79	118.0	8.14

CAUTION - To avoid undesirable steam characteristics, ensure that the steam discharge pressure is 5 psig [0.34 barg] greater than the Flash Pressure.

Appendix B: Saturation Table

Figure 40: Characteristics of Saturation Pressure vs Temperature



Appendix C: Table of Figures

Appendix D: Table of Tables

Contact information:

Contact Hydro-Thermal with any questions or concerns. We have a full staff of engineers, trained technicians and customer service personnel to help with all your needs.

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