Rex TCS

Thermal Control Solution

Installation and Service Manual

Clamshell Heater Design

Heat with Cooling Option

RMG

Rex Materials Group

DOC #0100006 Revision 0

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DOC #0100006 First Edition - First Revision 0

Printed in the United States of America

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Introduction and Welcome

Thank you for choosing the **Rex T**hermal **C**ontrol **S**olution (**Rex TCS**) for the temperature control needs on your plastic injection molding, blow molding, or extrusion machines. Rex TCS engineers have designed the Rex TCS Barrel Heaters and Cooling Units to provide the latest and most efficient barrel temperature control technology for users seeking to meet the following performance criteria:

Energy Savings - The Rex TCS heaters release high radiant energy directly into the barrel from exposed elements to maximize the heat transfer rate. Exposure of nearly the entire barrel surface to direct heat increases efficiency. The elements are captured in and protected by a high temperature ceramic insulating jacket which assures that the heat is contained and directed to the barrel, rather than heating the work area. The result is dramatically reduced energy usage in the range of 30-70%.

Faster Thermal Response Time - Traditional barrel heaters must heat themselves before they begin to conduct heat into the barrel. They also retain considerable residual heat. This results in considerable lag time before the heating and cooling actually affects the barrel temperature. The exposed elements of the Rex TCS heaters transfer heat immediately into the barrel providing much faster heat up and quicker response times. The high velocity air from the Cooling Units is applied directly to the exposed barrel surface allowing for quick response on cooling.

Better Temperature Control - The Rex TCS system's direct radiant heating and direct cooling results in faster response to changing barrel conditions. This reduces set-point overshoot on heat and cooling, resulting in much tighter barrel temperature control (typically better than $\pm$ 1.0 degree F). This improvement can result in tighter dimensional control and, thereby, better product quality and less scrap.

Improved Safety and Ergonomics - The Rex TCS heater elements are encased in a high temperature ceramic insulation which stays relatively cool compared to all other types of heaters, virtually eliminating the chance of burns. The excellent insulation also greatly reduces the ambient heat around the barrel. Therefore, the Rex TCS System contributes to a safer, more comfortable work environment.

Long Life and No Maintenance– Rex TCS heaters are designed to provide exceptionally long service life. This greatly reduces the ongoing replacement cost normally associated with standard barrel heaters. The system is also designed to relieve maintenance tasks related to other barrel heating and cooling systems, including oil and water cooled extruders.

Quick and Easy Replacement - Rex TCS heaters are modular for fast and easy installation and replacement.

About This Guide

This manual will 1) help you plan and prepare for implementing your Rex TCS system, 2) guide you through the installation procedure, 3) introduce you to the principles of its operation, and 4) describe the maintenance, troubleshooting and repair practices used to achieve optimum performance from your Rex TCS system.

It is not intended to serve as a comprehensive training program. However, it does provide detailed, easy-to-understand instructions.

If you have any questions that are not addressed by this guide, please consult your Rex TCS Sales Representative, or Rex TCS Technical Support at the numbers listed below.

Rex TCS Technical Support:

Telephone:	**1-517-223-3787**
Fax:	**1-517-223-6822**
E-Mail:	**tcsinfo@rexmaterials.com**
Internet:	**www.rexmaterials.com**

Safety

Safety is a primary consideration in the design of Rex Thermal Control Solution systems. Safety must also be a priority in its use. This manual provides guidelines and procedures to properly operate and maintain your Rex TCS system. It contains warnings and cautions that must be followed to reduce the risk of personal injury or damage to the equipment. However, due to the unique nature of each facility, it is impossible to foresee all of the potential hazards associated with its use. Your company is solely responsible for determining the adequacy of these recommendations and providing suitable safety instructions for your facility.

Carefully read and understand this entire document. This important information will maximize safety, heater performance, efficiency and system life.

All heating elements inherently pose burn, fire and electrical shock hazards. These can result in injury to personnel or damage to equipment. Care should always be exercised during installation and use. Do not install heaters in areas where combustible gas, vapor or dust is present.

Only instructed or skilled persons shall be entrusted with the maintenance work of electroheat installations. No maintenance work shall be carried out with equipment live. Special arrangements

Personnel whose activities involve the operation of electro heat installations or work in the vicinity shall be notified of the safety requirements to be observed during the operation of the installation by means of orders or service instructions brought to their attentions by posting up notices or, if necessary, by handing them a book of instructions for which acknowledgement is obtained. The responsible persons shall ensure that the safety requirements are observed.

Personnel shall have at their disposal the safety equipment required for carrying out the operations they are called upon to undertake and for facilitating their intervention in the event of an incident or an accident. This equipment shall be adapted to the working voltage and maintained in perfect condition.

Operating the heater above the maximum temperature rating may cause damage to the machine or heater.

It is recommended that the user install a high temperature protection device where conditions for an over temperature fault are likely to occur and pose a risk to the machine or orerating personnel. This control should be both functionally and electrically independent.

Insulate all live electrical connections. Exposed electrical wiring is a violation of Electrical Safety Codes including O.S.H.A.

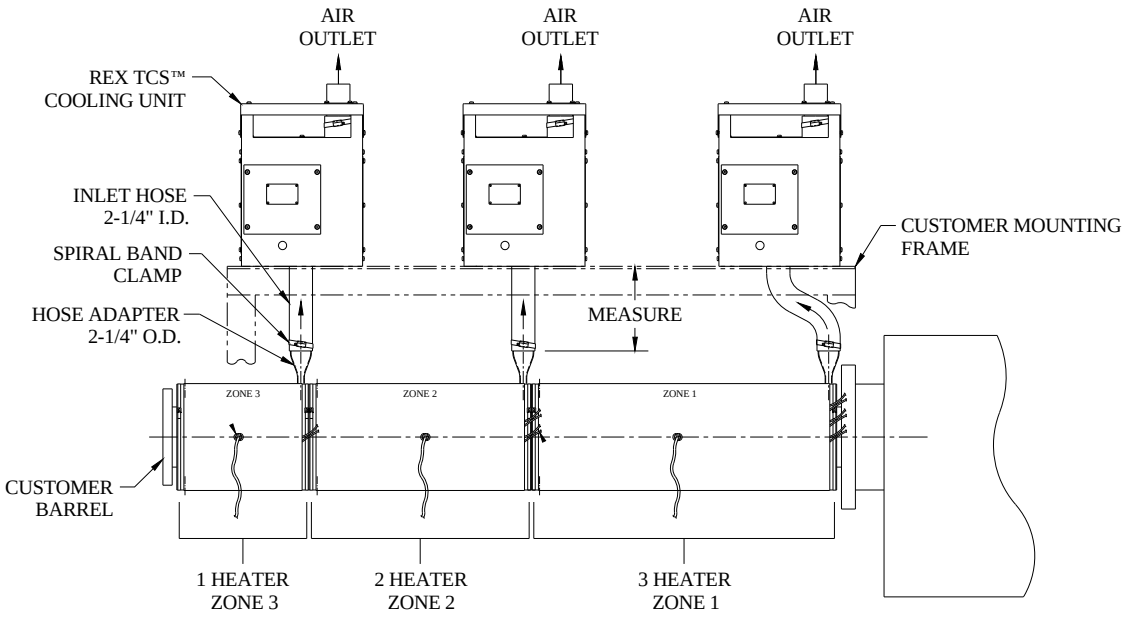
Surface temperature of the heaters is highly variable. The “Hot Surface” label supplied with the TCS System kit should be applied to the machine to alert all operators and maintenance employees of this danger.

Do not touch the heater surface or Teflon cover during or directly after operation. Allow heaters to cool before servicing.

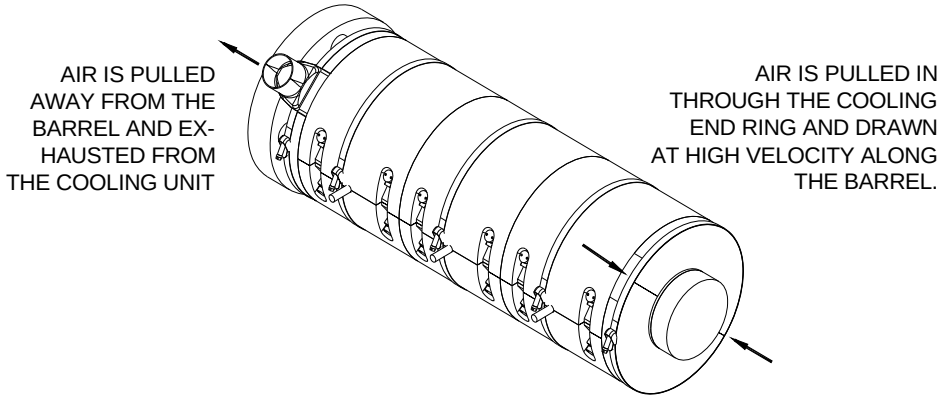
Equipment Overview

Rex TCS systems are designed using Rex TCS system integration software based on dimensions and specifications provided by the customer.

TCS barrel cooling incorporates a flexible design for continuous extrusion, blow molding and some injection molding applications. In extrusion and blow molding applications Cooling Units can be used to cool individual zones using an existing heat and cool temperature controller. In injection molding applications cooling can be applied to a section of the barrel or to the entire barrel to accelerate job changeovers from high to low temperatures.



INDIVIDUAL ZONE COOLING



BARREL COOL DOWN OPTION

FIGURE 1-1
Rex TCS System – General Assembly

Rex TCS™ Heater Assembly

Each Rex TCS™ Heater Assembly consists of two clamshell halves oriented around the barrel. Each clamshell has an exposed element secured in Pyrolite®, a high temperature ceramic insulation material**.** This material provides an excellent balance between superior insulating properties, high electrical resistivity, and durability for barrel set-point temperatures up to 750 degrees F. Higher temperatures may also be accommodated; contact your local Rex TCS representative or Rex TCS Technical Service as shown in Section One of this manual for more details on higher temperature applications.

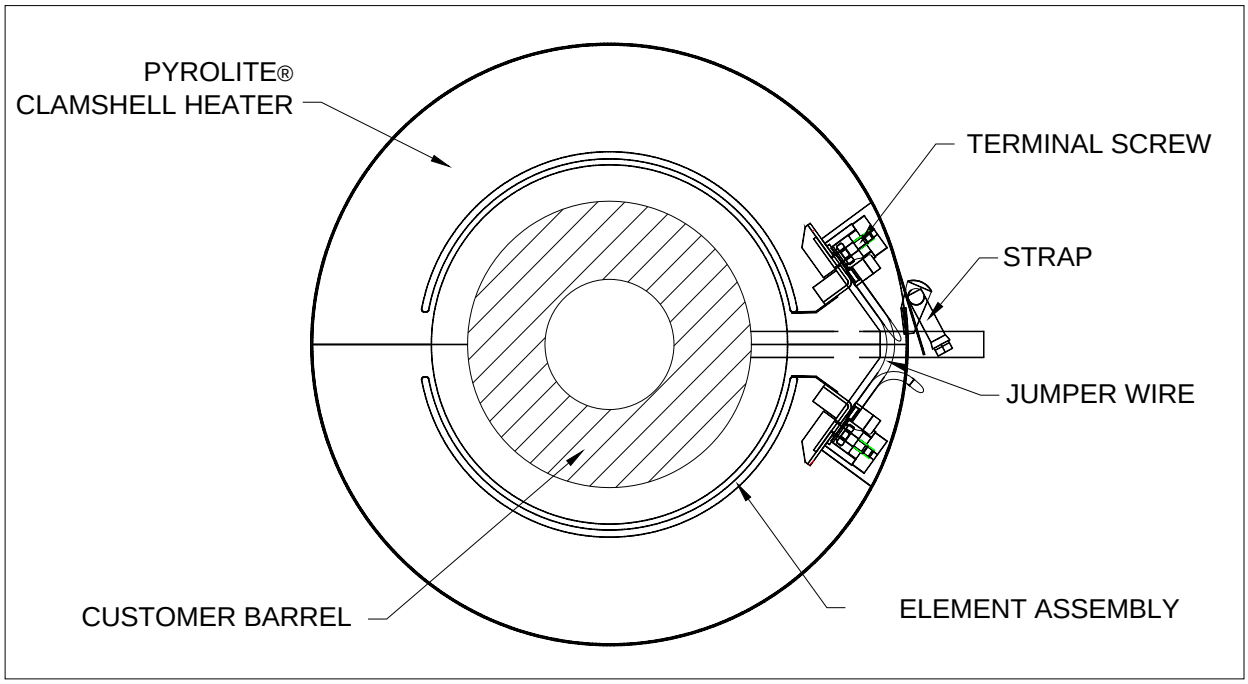


FIGURE 1-2
Rex TCS™ Heater Assembly

Rex TCS Cooling Unit

Rex TCS Cooling Units consist of a high speed, high output, vacuum blower designed for start/stop operation that is mounted in a durable steel enclosure. The interior of the enclosure is covered with sound absorbing foam in order to maximize operator safety and comfort. This system draws ambient air across the barrel and underneath each heater providing instant cooling on demand. The vacuum blower motor contains electronic circuitry which is kept cool by an auxiliary air circulating fan. The vacuum blower has a thermal protection fuse that trips if the electronics exceed safe operating temperatures and resets when temperature is within safe limits and the power is removed momentarily. See "Cooling Unit Problems" in section 3 for a more detailed explanation.

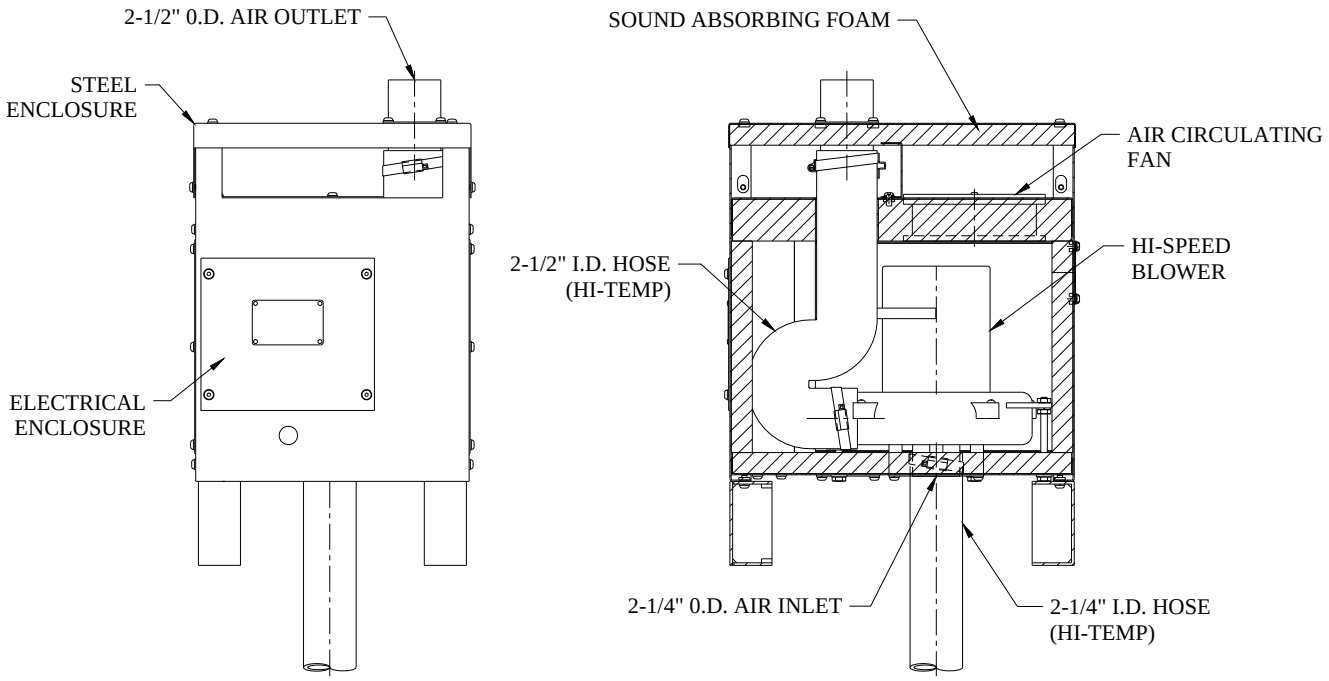


FIGURE 1-3
Rex TCS™ Cooling Unit

Site Preparation

Installation

Site Preparation

Overview

The installation and start-up of your Rex TCS system can be made much faster and easier through proper planning and preparation. The areas outlined below require attention well before the installation date. If you have any questions about these preparations, please contact your local Rex TCS representative or Rex TCS Technical Service, as shown in Section One of this manual.

Heater Clearance & Blow Back Prevention

Rex TCS heaters require a minimum of 3-1/4 inches of clearance around the full diameter of the barrel. Please verify that adequate clearance is available and make any machine adjustments necessary to provide the necessary clearance. Be sure to verify that there is a minimum of 3.25" clearance around the lead edge of the barrel to the stationary platen when the barrel is in the full forward position.

One area for special attention is around any barrel support bracket. Make sure that any angled brace on the foot or other obstruction does not interfere with the 3.25" clearance on the barrel diameter. Also, verify that the location of the support along the length of the barrel matches that shown on the drawing/datasheet. If not, adjust accordingly.

The Rex TCS heater design allows for a certain amount of cutting or trimming to clear small obstructions or 'tight spots'. Consult your Rex TCS Rep for details if necessary.

Like any heating system Rex TCS heaters are subject to damage due to exposure to high pressure molten plastic that may "blow back" from the molding machine. This is more common on injection molding machines, and it is recommended that a shield or "Purge-away" be installed behind the nozzle to divert any blow-back from reaching the heaters. Consult your local Rex TCS Representative or Rex Materials for recommendations.

Power Supply, Controls and Wiring

Rex TCS heaters can normally be served by the existing electrical power supply and control system. NOTE: Please verify that the actual power supply to each heater is as specified when ordering the heaters.

Rex TCS heaters are capable of controlling the barrel temperature within a very tight control band. While your TCS heaters will perform well with any standard controller, the use of self-tuning controllers is recommended to optimize performance. Also, your existing controller may be reprogrammed to a tighter control range for less variability in barrel temperature.

If the existing heater wires or their insulation have been damaged due to exposure to excessive heat from the old heaters, the wiring to the heaters should be replaced. See also Section Two of this manual under the heading - Rex TCS Heater Assembly Wiring.

Rex TCS Cooling Units can be wired to work with your existing machine control. Instructions on how to wire the Cooling Units are outlined in the section titled 'Rex TCS Cooling Unit Installation' of this manual. Additional details are provided on the drawing titled "TCS-1800 Cooling Unit & Electrical Specs".

Rex Materials can advise you about your wiring scheme and control strategy upon request. However, because every control system is unique and we cannot control plant conditions, we do not perform any wiring or take any responsibility for power supply or control circuitry.

Thermocouple Adaptors

Due to the 3" thick insulation on the Rex TCS heaters, it is recommended to install 3 ½" or longer thermocouple port extension adaptors.
NOTE: It is important to order these well in advance of installation to assure availability

Documenting Savings and Performance Gains

If you need to document the energy savings and performance gains you achieve with your Rex TCS barrel heaters, it is vital to gather data using your existing heaters before they are removed. We recommend recording the power consumption for a period of at least two hours of normal operation. Be sure to note the product / material being run, temperature set points, cycle times, shot size and any other significant process variables, so they can be duplicated for the "After" trials.

It is also important to record the range of barrel temperature variation around the set point to confirm the improvement in temperature control accuracy that you have achieved.

Also, accurately record the time required to heat the barrel to set point from a cold start.

Guarding

Rex TCS heaters have a much lower surface temperature than conventional heaters, so the need for guarding to protect against burns is normally eliminated.

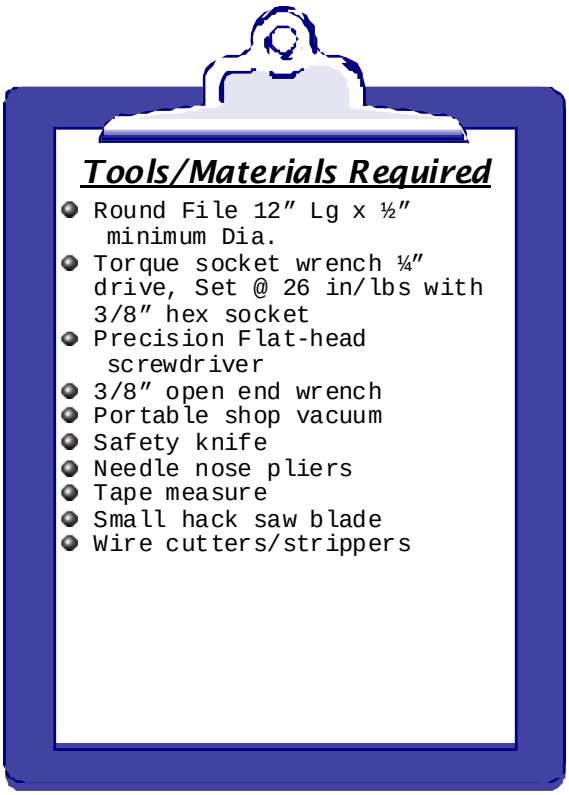
However, Rex Materials does recommend guarding to protect the heaters from possible damage due to work done on or around the heaters.

Installation Time and Labor Requirements

Your new Rex TCS heating and cooling system can normally be installed within 6-10 hours, given that the old heaters have been removed, the barrel prepared and a frame has been constructed and mounted for the Cooling Units. This excludes any time required for rewiring or control modifications. It is ideal to have at least two people involved during the complete installation, especially if the barrel is not easily accessible. This also assures that more than one person is trained on the installation procedures.

Final Machine Preparations

In-order to properly install your new Rex TCS system, the following machine preparation steps must be completed prior to installation.



1. Gather the tools and materials listed on the left, which will be required to install a typical Rex TCS system.
2. **Lock-out power** to existing barrel heaters.
3. Make sure the barrel has cooled to a safe working temperature per customer safety requirements (below 140 F preferred).
4. Disconnect electrical connections and completely remove all existing heaters, thermocouples, and cooling system.
5. Remove any barrel surface contamination to assure heating is applied directly to the barrel. Simply wiping the barrel with a cloth may be sufficient. If there is scale or plastic buildup, use steel wool, wire brush or tools as necessary to remove it. The ideal result is a clean, dry and smooth barrel with no remaining oil, dirt or moisture.
6. Grind off any metal burrs protruding from the barrel.
7. Verify barrel dimensions (diameter(s), lengths, thermocouple locations, etc.). Any variations from the original customer specifications can more easily be accommodated at this stage than after the installation has begun. If measured barrel dimensions do not match customer supplied design specifications, component modifications or replacements may be required.
8. **Caution** – It is very important that the barrel be electrically grounded to prevent possibility of electrical shock. Test with continuity tester to insure good conductivity between barrel and machine ground.
9. Fabricate and install mounting frame(s) to accommodate all Rex TCS Cooling Units ordered. Cooling Units can be mounted and wired ahead of time. Do not bolt the Cooling Units to the frame until after the heaters are installed and the cooling hoses are connected. Do not mount the Cooling Units more than 6' from the barrel without consulting RMG or your sales representative.

   Contact Rex Materials immediately if discrepancies are found.

Removing Packaging and Handling

Your Rex TCS system has been palletized to allow the use of a lift truck for unloading and transport to the work site.

CARE REQUIRED
HEATERS ARE FRAGILE: TAKE CARE NOT TO DAMAGE THE HEATERS WHEN REMOVING PACKAGING OR DURING HANDLING. **BE SURE THAT BOXES CONTAINING YOUR REX TCS HEATER ASSEMBLIES DO NOT HAVE ANYTHING STACKED ON TOP OF THEM.** **HEATERS MUST BE STORED IN A DRY LOCATION. HEATER REFRACTORY CAN ABSORB MOISTURE. IF MOISTURE IS ABSORBED THE HEATER MUST BE THOROUGHLY DRIED PRIOR TO INSTALLATION AND USE.**

Many items have individual labeling, but some components are identified only on the box label. Refer to the Installation Bill of Materials to help identify them during the installation process.

NOTE: Inspect TCS heaters to assure that they arrived complete and in good condition.

Installation

Overview

This section provides step-by-step instructions for installing your new Rex TCS barrel heating and cooling system. It is recommended that you carefully read the entire section before beginning the installation. Also, please assure that all preparations described in the previous section are complete.

NOTE

IF YOU PURCHASED THE BARREL COOL DOWN OPTION IN PLACE OF THE INDIVIDUAL ZONE COOLING OPTION, SEE THE SECTION TITLED "BARREL COOL DOWN OPTION" AT THE END OF THIS INSTALLATION SECTION.

A minimal amount of cutting and trimming of end rings and heaters is acceptable when proper clearance cannot be achieved at the time of installation. Do not trim the material to a thickness of less than 1" from the embedded elements; as you will begin to lose insulating properties. The portion to be trimmed should be measured and marked to clear the obstruction, and carefully 'sawed' off with a small hack saw type blade. The terminals and wires must not be modified. Be sure to use proper dust collection methods when performing modifications. Be very cautious when doing any modification to your system in order to reduce the risk of damage to the heaters and insulation.

CAUTION

HANDLING PYROLITE® MATERIALS MAY BE IRRITATING TO THE SKIN, EYES, AND RESPIRATORY TRACT. WEAR GLOVES AND WASH WITH SOAP AND WATER AFTER HANDLING. USE OF A DUST MASK AND / OR DUST COLLECTION IS RECOMMENDED WHEN SAWING, SANDING OR OTHER DUST GENERATING OPERATIONS ARE DONE.

Individual Zone Cooling Option

All zones normally begin and end with an end ring. Zones requiring cooling start with a single or dual port outlet end ring with hose adapter(s) and end with a dual port inlet end ring.

Each end ring is identified by the customer specified barrel diameter and zone configuration (single port, dual port, blank). The air inlet end rings are always dual port. Zones configured for cooling will have dual port inlet end rings for pulling air in, and single or dual port end rings for hose adaptors.

1. First, identify the end rings to be used for each zone. Then locate the two halves of the end ring for the first zone to be installed. Typically this will be a zone at one end of the barrel. Inlet and outlet end ring locations can be reversed if clearance for the hose adapter is an issue.

2. Locate the first Cooling End Ring starting point. Hold the two halves of the first ring around the barrel to check the fit under gentle compression. If the ring does not fit tightly to the outside barrel diameter, remove one gasket from one of the joints between the End Ring halves. Then check the fit again. If necessary remove one gasket from the other joint and re-check the fit. Continue removing gaskets until the inside diameter of the end ring fits very snuggly on the barrel's outside diameter without leaving a gap at the joints. When a good fit is achieved mount the ring on the barrel using the adjustable stainless steel straps provided and tighten the strap hand tight.

Rotation about the barrel is dependent upon thermocouple locations, sensor locations, etc. This can be adjusted at a later time. See Figures 2-1, 2-2 and 2-3.

3. Mount the hose adapter(s) using the worm-drive band clamp. Do Not tighten the clamp fully at this time. Orient the band clamp so that the worm-drive screw housing does not block any of the heater air-flow cavities. Slide the hose adapter(s) and clamp into the end ring hose adapter cavity. See Figure 2-1.

4. Place the leading edge of the end ring with the hose adaptor(s) flush with the end of the barrel or at a specified location. Rotate the end ring such that a high point is aligned with the thermocouple holes in the barrel. Securely tighten the strap. See Figure 2-1

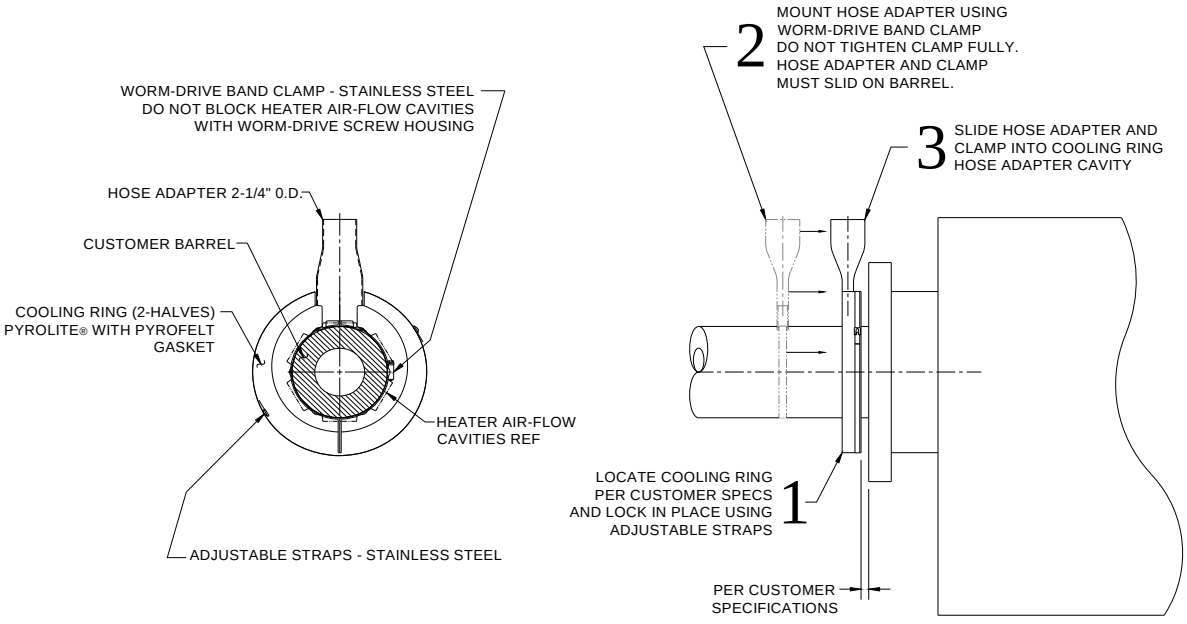
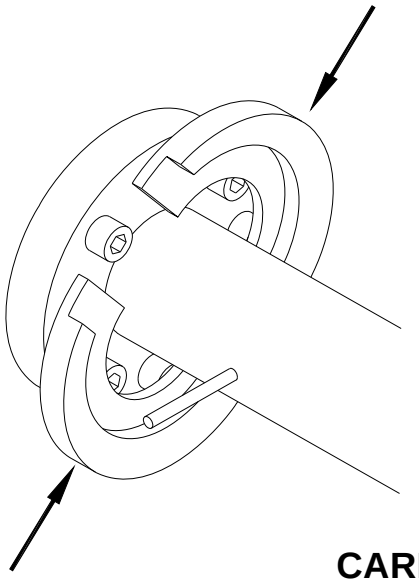


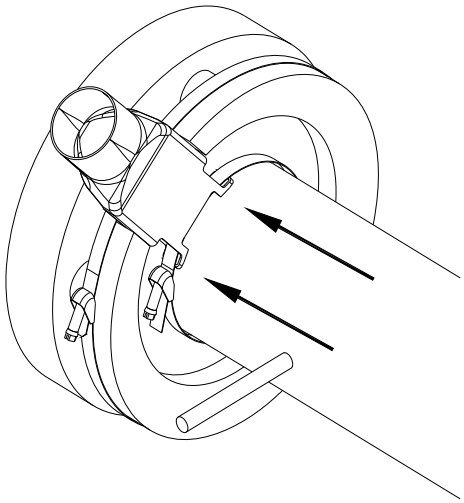
FIGURE 2-1
Rex TCS™ Outlet Cooling Ring/Hose Adapter Installation



CARE REQUIRED!

Carefully place, then secure the first end ring firm to the barrel using the strap supplied. Fasten the strap to a maximum of 10 in-lb. The ring should be placed on the barrel flush against the feed end bolt heads or platen.

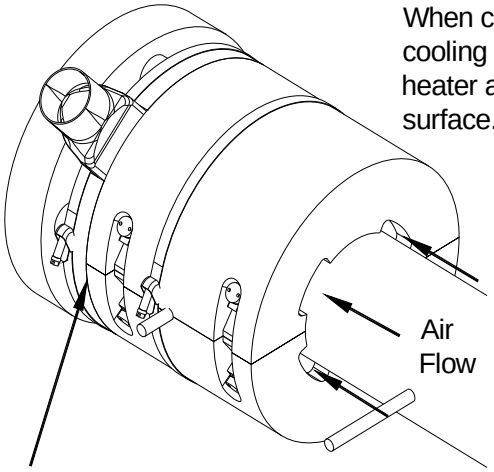
FIGURE 2-2



Install the hose adapter(s) specified. Push the adapter all the way back into the end ring cavity. If the BOM calls for two hose adapters in a single zone or barrel cooled section, both adapters are fastened with the same clamp and are to be installed 180° from each other.

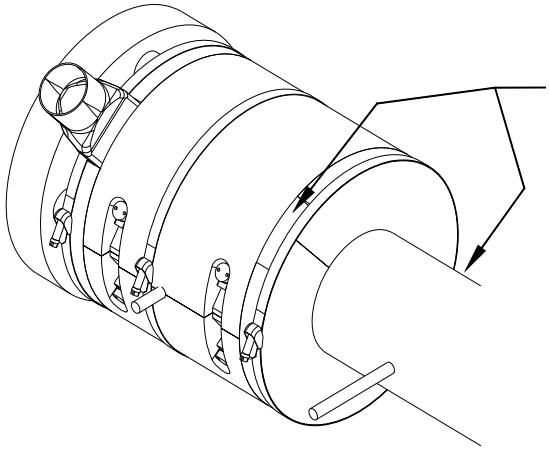
FIGURE 2-3

5. After the first end ring is installed the specified heaters can be mounted. Note that long zones may have more than one set of clamshell heaters depending on design. The heater installation instructions begin after this section. After all heaters in a given zone have been installed, mount the dual port inlet end ring halves snug to the last zone heater assembly with the internal air cavity toward the heater and lock it in place using adjustable straps. See Figure 2-4 and 2-5.



The heater should be pushed flush against the end ring with no gap. Gaps around the barrel hose adapter should be filled using the Pyrolite EZ-Fill tube in your cooling install kit. This material is applied to prevent air from "shorting"into this end of the zone resulting in lower air flow. Do not substitute for EZ-Fill material.

FIGURE 2-4



Install the air inlet end ring flush against the heater. The air inlet ring will allow for air to enter and flow under the heater.

FIGURE 2-5

6. For additional zones repeat steps 1 thru 5 starting at the last mounted end ring. If back to back End Rings include hose adaptors, then offset the hose adapter location to allow for the hose to be attached without interference. On occasion a two port intake end ring is not used due to limited space in the zone. Also, if spaces between zones are required it may be helpful to install a custom fit hi-temp insulating vest or ceramic blanket for insulation purposes.

Rex TCS Heater Assembly Installation

Once the first end ring has been installed, the installation of the Rex TCS heater assemblies can be completed following these steps.

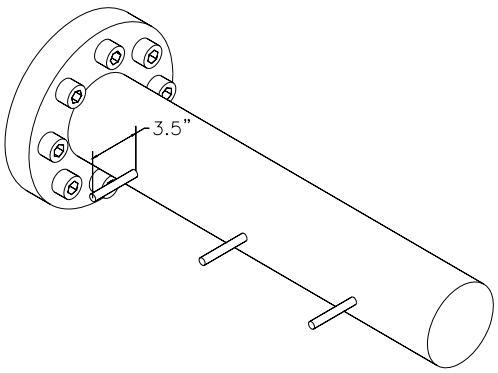
1. Identify the first heater to be installed. Each heater can be identified by the part number marked on the heater. The marking also shows the heater voltage and wattage. Refer to the Installation Bill of Materials for correct location of heaters.

CARE REQUIRED

HEATERS ARE FRAGILE: TAKE CARE NOT TO DAMAGE THE HEATERS WHEN REMOVING PACKAGING OR HANDLING.

WHENEVER POSSIBLE, THE HEATERS SHOULD BE HANDLED BY THE OUTSIDE. GRIPPING THEM BY THE INSIDE MAY DISPLACE THE HEATER ELEMENT.

2.



Replace thermocouple adaptors with a longer adaptor if the existing adaptor is shorter than 3.5”. 4” adaptor length is recommended. Thermocouple adaptors are not included in the TCS System kit.

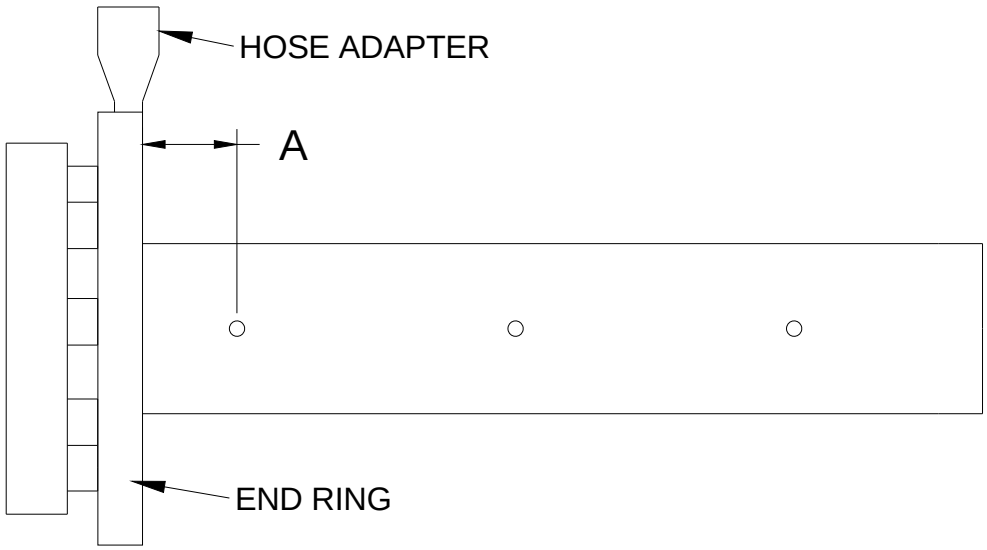
3.

TCS-0xxxxx TCS System kit

Zone	Qty per zone	Item Number	Description
1	2	TCS-120xxx	TCS HTR HALF x.xD I2.0L 480V xxxxW
1	2	TCS-070xxx	TCS HEATER STRAPS x.xD
1	2	TCS-060xxx	TCS ZONE COVER x.xD x.xW 32.0C
1	1	TCS-060xxx	TCS JUMPER WIRE x.xL
1	1	TCS-140xxx	TCS END RING 1 PORT x.xx D
1	1	TCS-150xxx	TCS END RING 2 PORT x.xx D
1	1	MFB-03153-002	BARREL HOSE ADAPTER
2	2	TCS-120xxx	TCS HTR HALF 5.5D x.xL 480V 5290W
2	2	TCS-070xxx	TCS HEATER STRAPS x.xD
2	2	TCS-060xxx	TCS ZONE COVER x.xD x.xW 32.0C
2	1	TCS-060xxx	TCS JUMPER WIRE x.xL
2	1	TCS-140xxx	TCS END RING 1 PORT x.xx D
2	1	TCS-150xxx	TCS END RING 2 PORT x.xx D
2	1	MFB-03153-002	BARREL HOSE ADAPTER

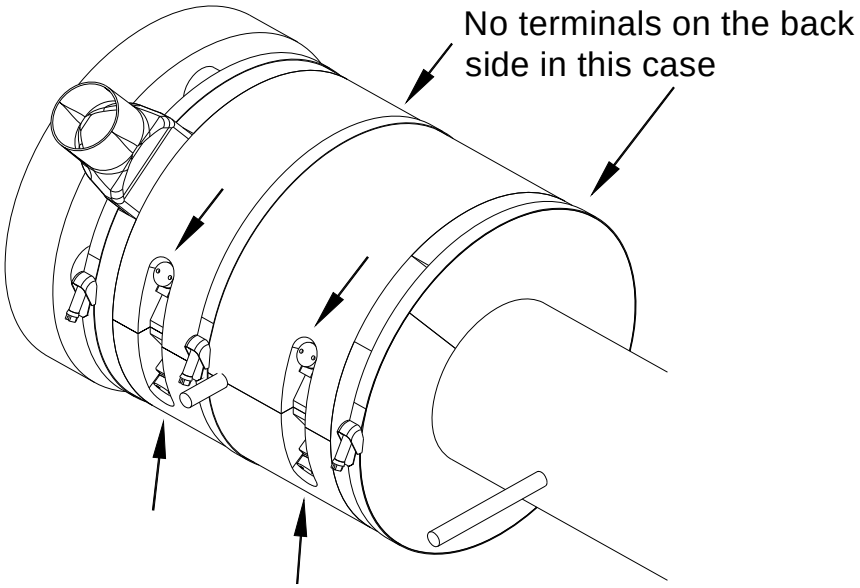
Review the installation BOM for your specific machine make, model and size to identify all parts needed for each zone.

4.



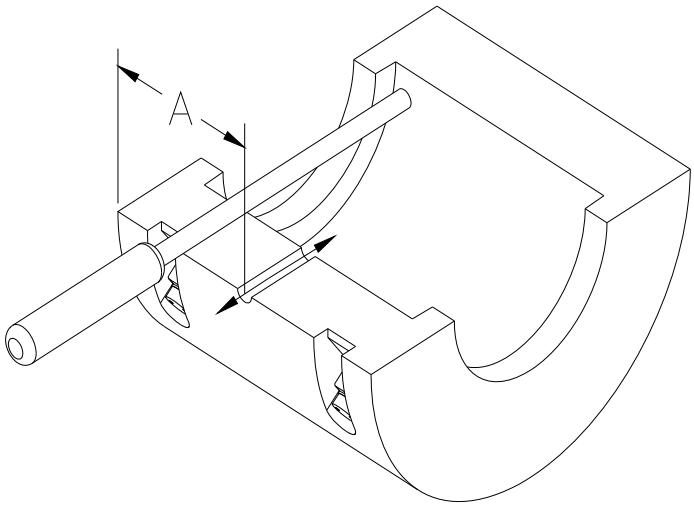
Measure distance A from face of end ring to the center of the first thermocouple.

5.



Check before installing! Heater halves are supplied with two terminal connections on each half. The two terminals on a half could be on the same or opposite sides depending upon the length of the heater. In the case where both terminal connections are on the same side of each half, the heaters should be installed such that all four terminals are on the same side of the barrel.

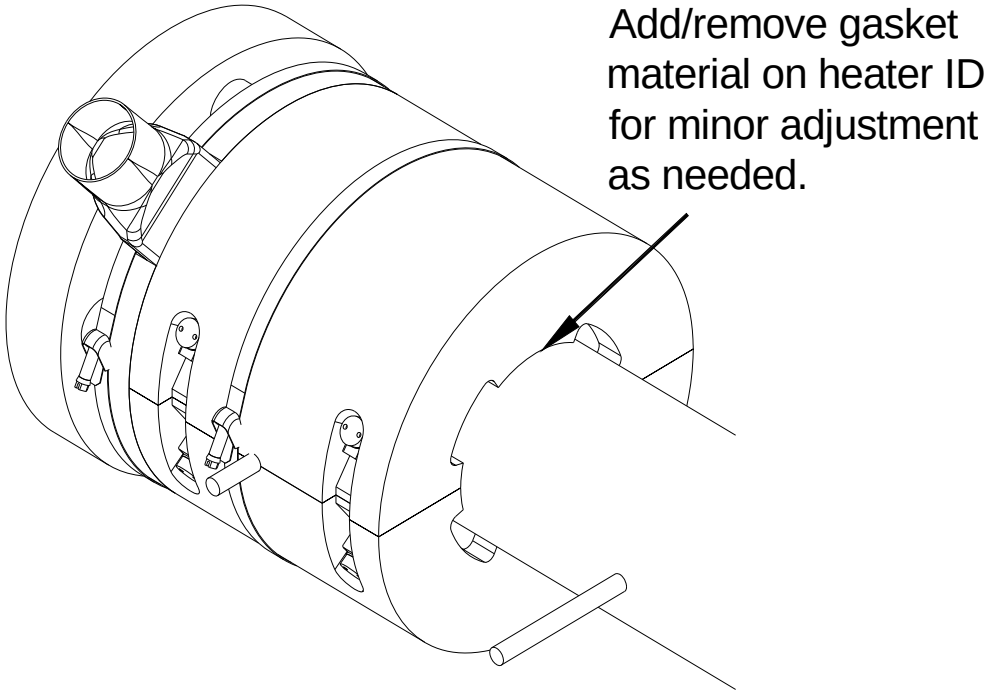
6.



Use measurement A from step 4 to locate where the thermocouple will lie within the first set of heater halves. If zone is long, thermocouple may lie within the second set of heater halves. Use a 5/8" diameter round file to cut **half** of the thermocouple hole on each heater half. **Do not exceed 3/8" depth of cut on either half!**

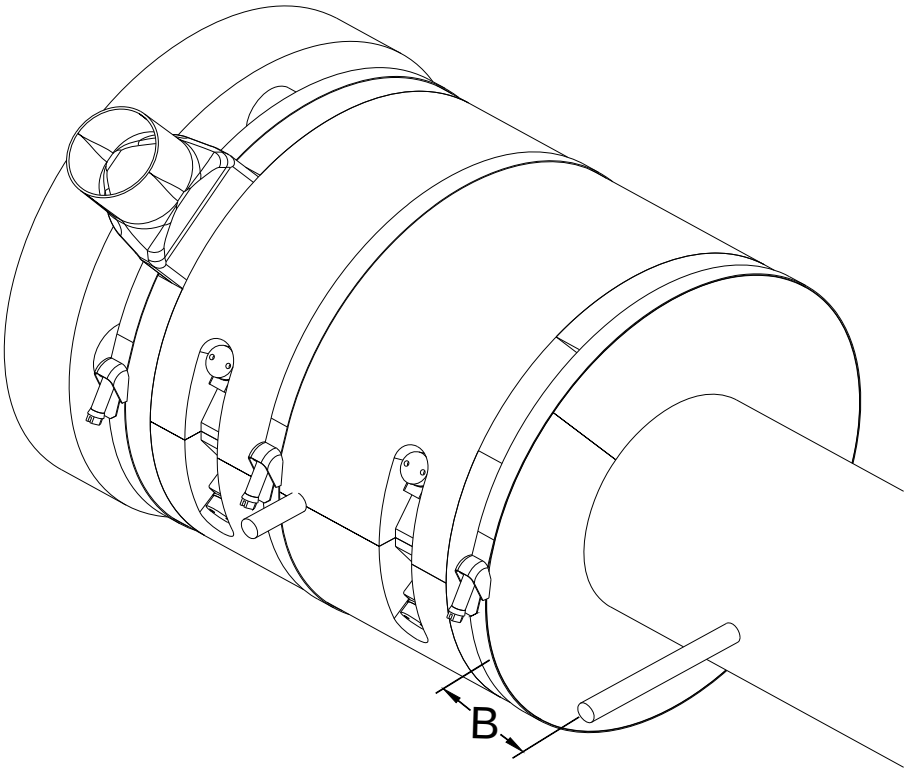
7.

Place the heater halves on the barrel, and place the strap(s) around the heater. Two straps are supplied for any heater 9.25” or longer.



Secure the heater firm to the barrel by fastening the strap(s) to a maximum of 10 in-lb. Heater should not be movable by hand when tight, but over tightening can cause damage to the heater.

8.



Measure dimension B from edge of the first installed zone to the center of the next zone thermocouple. Repeat installation steps for each zone. There should be little or no gap between zones, and the last heater will generally stop short of the end cap.

TCS™ Heater Assembly Wiring

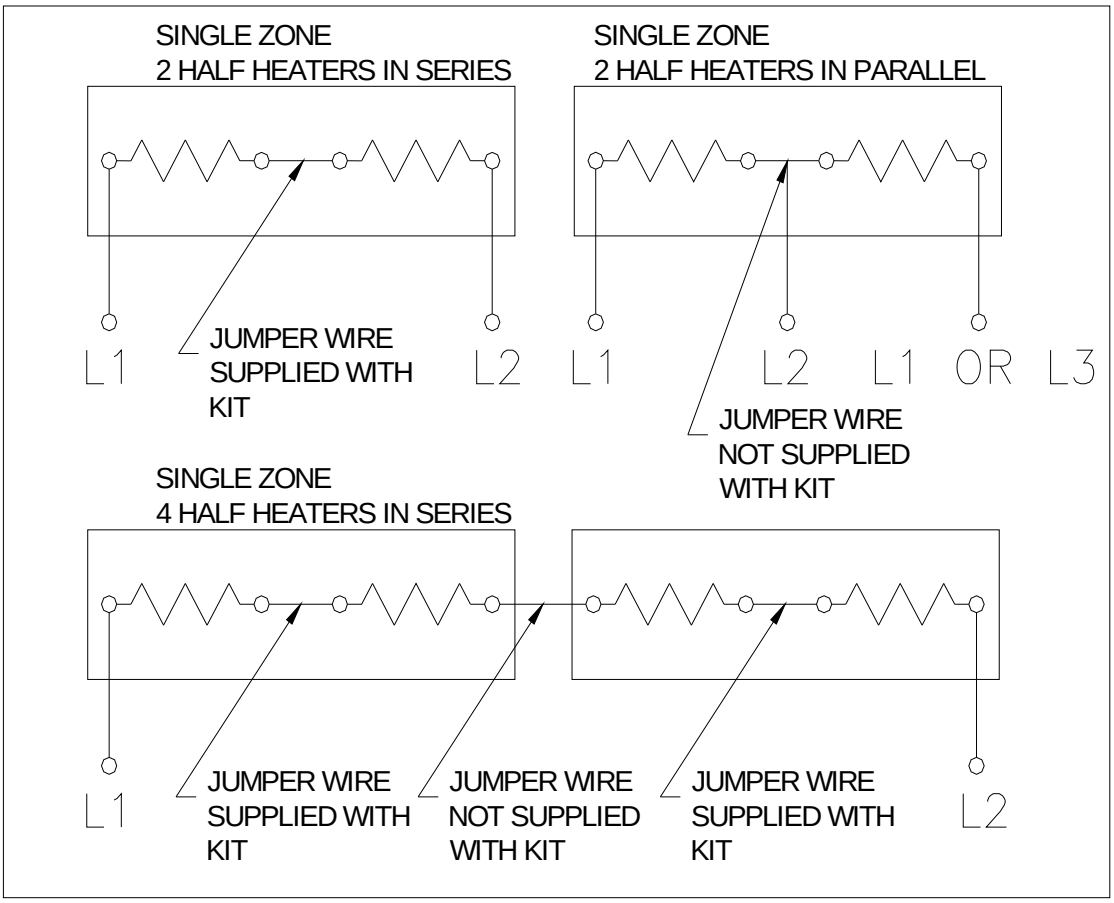
CAUTION
TO AVOID POSSIBLE INJURY,
DISCONNECT MAIN POWER SUPPLY
BEFORE WIRING REX TCS™ HEATER ASSEMBLIES.
Use of "LOCK-OUT, TAG-OUT" PROCEDURES IS HIGHLY RECOMMENDED

Each Rex TCS Heater Assembly must be wired to the minimum specifications below and in accordance with customer's standard wiring practices.

1. Customer supplied lead wire should be rated for exposure to a minimum of 250 degrees C. We use and recommend 14 GA, Type MGT, 450 Deg C.

   Cut customer supplied lead wire lengths to suit locations of all Rex TCS™ Heater Assemblies. Allow sufficient wire length to run the lead wires under the Zone Covers as shown in Figure 2-4.

<u>NOTE:</u> It is extremely important to apply the correct voltage to each heater half. Refer to the voltage marked on each heater half. In rare cases with four heater halves in a zone, it may be necessary to wire all four in series or a combination so that zone voltage is properly divided.



HEATER WIRING SCHEMATIC

Applying higher than the actual rated voltage to the heaters will increase the watt density which can lead to premature failure and/or damage to barrel.

Verify that an “over-current” device (ex: fuse) is installed to prevent the heater from being subject to higher amperage than the heater is rated for. See heater markings for rated amperage.

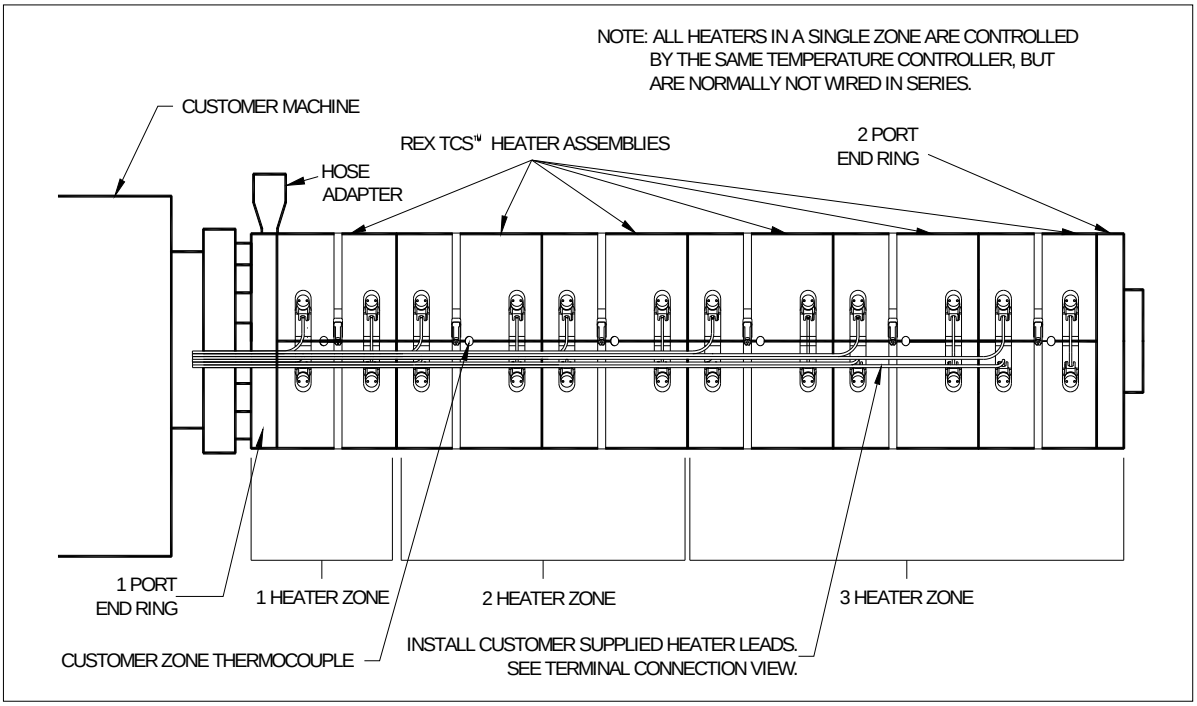


FIGURE 2-1
REX TCS™ HEATER LEAD WIRE VIEW

Note: Fig. 2-1 shows heater terminals on one side. Depending on heater length, terminals may be on alternating sides.

CAUTION
TO PREVENT PREMATURE HEATER FAILURE,
EACH ASSEMBLY MUST BE CONNECTED TO THE PROPER VOLTAGE
AS INDICATED ON THE HEATER ASSEMBLY.

2. Remove ceramic terminal caps, hex nuts, washers, and loose ring terminals from Heater lead wire terminals (no jumper wire). Remove 5/16" of jacket from customer supplied lead wires and crimp ring terminals onto wires. Make sure terminal bar is free of mold flashing. Reinstall the lead wire with ring terminal, flat washer, lock washer and the hex nut. Hold the heater terminal with 3/8" open end wrench when tightening the nut. Torque the hex nut to **26 in-lbs**, and replace the ceramic cap. See Figure 2-2.

   NOTE: Do not torque nuts without holding the heater terminal with wrench, as heater damage may result from twisting the elements.

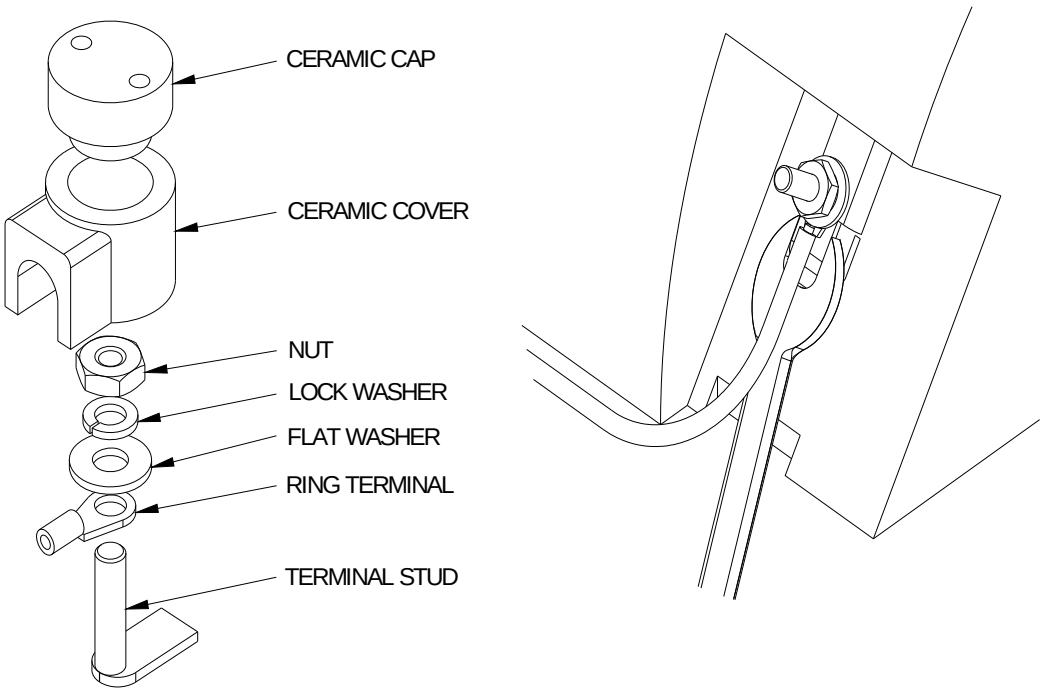


FIGURE 2-2
REX TCS™ HEATER TERMINAL CONNECTION VIEW

Check before wiring!
Note the voltage printed on each heater half and also specified on the BOM document. **Heaters are rated in halves and must be wired in series when line voltage is higher than the marked heater voltage. See figure 2-2 prior to making electrical connections.**

Care required! Electrical connections require 26in-lb tightness. Use 3/8" wrench to hold the terminal in place while tightening the nut to prevent potential damage due to twisting the terminal.

3. Heaters within the same zone are controlled by the same temperature controller. Verify that the voltage supplied to each heater is in accordance with the voltage marked on the heater. Refer to customer temperature controller literature for controller wiring.

Rex TCS Heater Sealing

The Rex TCS system is a closed insulated heating and cooling system which utilizes high velocity air applied directly to the barrel to remove heat from the barrel. To maximize its performance, it is very important to seal all openings around the hose adapter cavities and notches in the heater around thermocouple adapters.

1. Using a putty knife or finger, gently pack the cavities, gaps and openings around hose adapters (4 sides) with Pyrolite® E-Z Fill. See Figure 2-3.

2. Optional – To minimize heat loss gently pack ceramic blanket from the installation kit into the notches around all thermocouple adapters. See Figure 2-3.

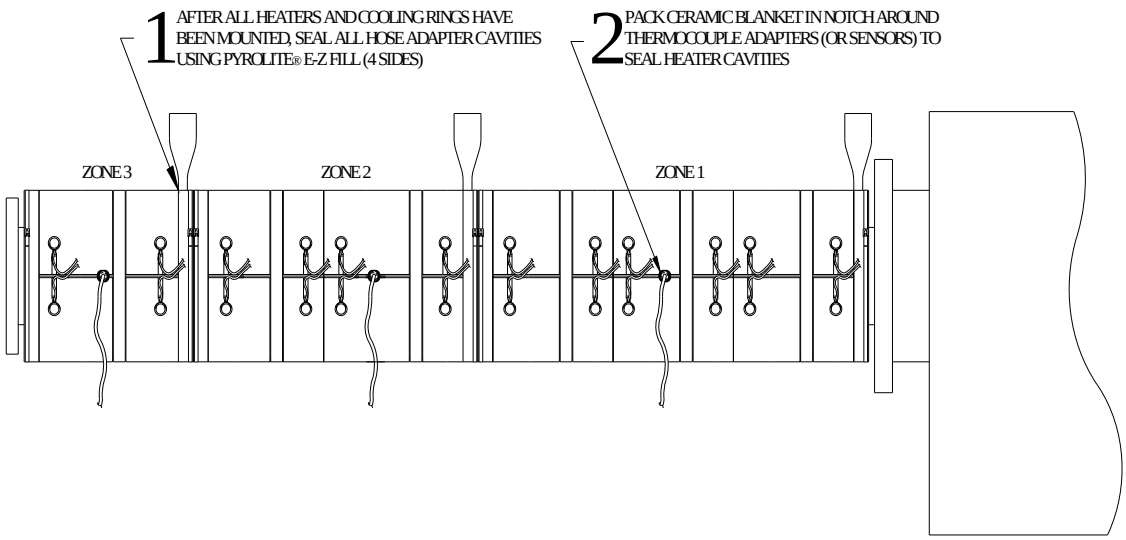


FIGURE 2-3
Rex TCS™ Heater Sealing

Teflon Zone Cover Installation

Teflon zone covers are used to cover small gaps between heaters and to protect the heater outside surfaces from contamination. Cover installation steps are as follows:

1. The Teflon zone covers are designed to cover all of the heater assemblies in the zone and only overlap the end ring on the hose exit side by ¾". The covers should end at the joint where the heater assembly meets the air intake end ring, there should be no overlap on the inlet end ring. The covers are to be arranged so that the intake cavities on the air inlet end rings are not covered at all. Covering even a small portion of the intake area can reduce cooling power. Wrap the Teflon zone covers around the heaters and output cooling as described above and tuck in excess tail under the lead edge of the cover. See Figure 2-4 .

2. Trim or cut holes in zone covers for thermocouple adapters (and sensors) and trim around hose adapters. See Figures 2-4, 2-5, 2-6 and 2-7.

3. Lead wires can be run under the covers if necessary. See Figure 2-4.

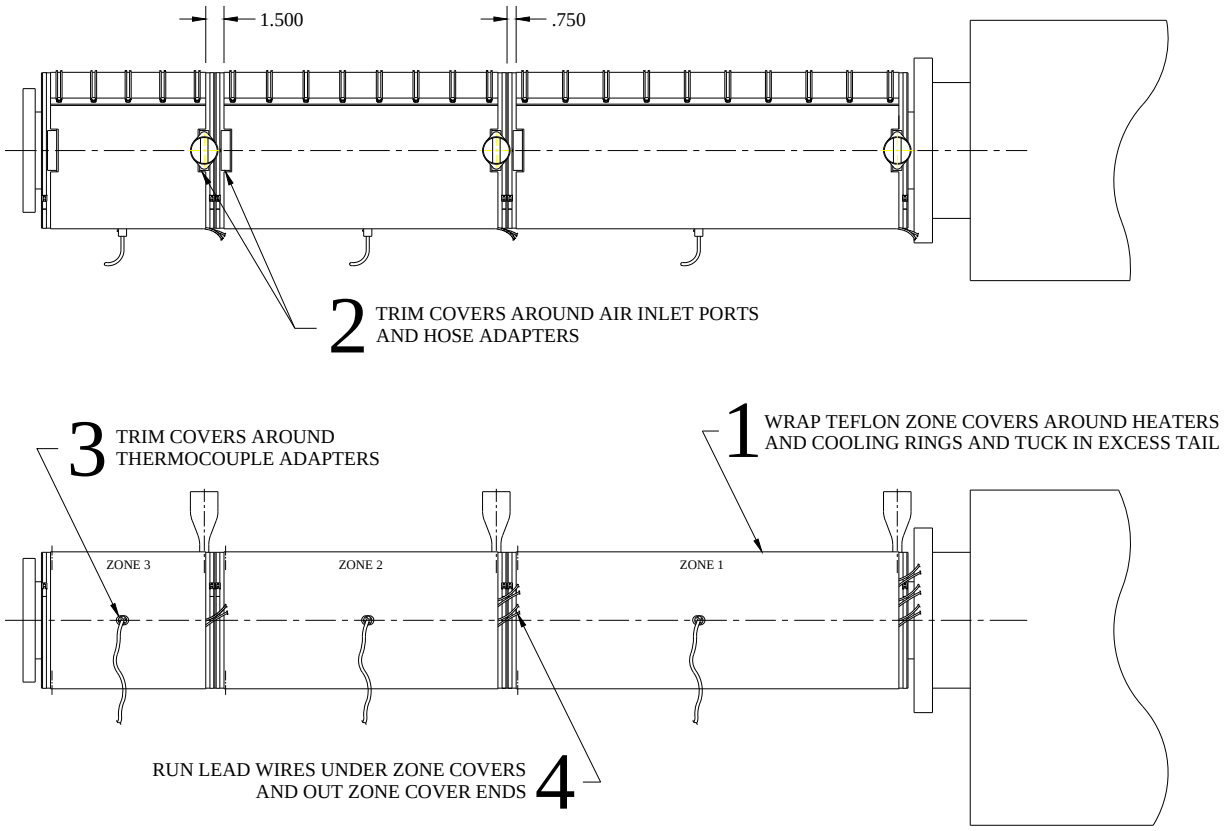


FIGURE 2-4
Teflon Zone Cover Installation View

4. Stretch O-rings over hooks to tighten zone covers around heaters and to hold zone covers in place. See Figure 2-5.

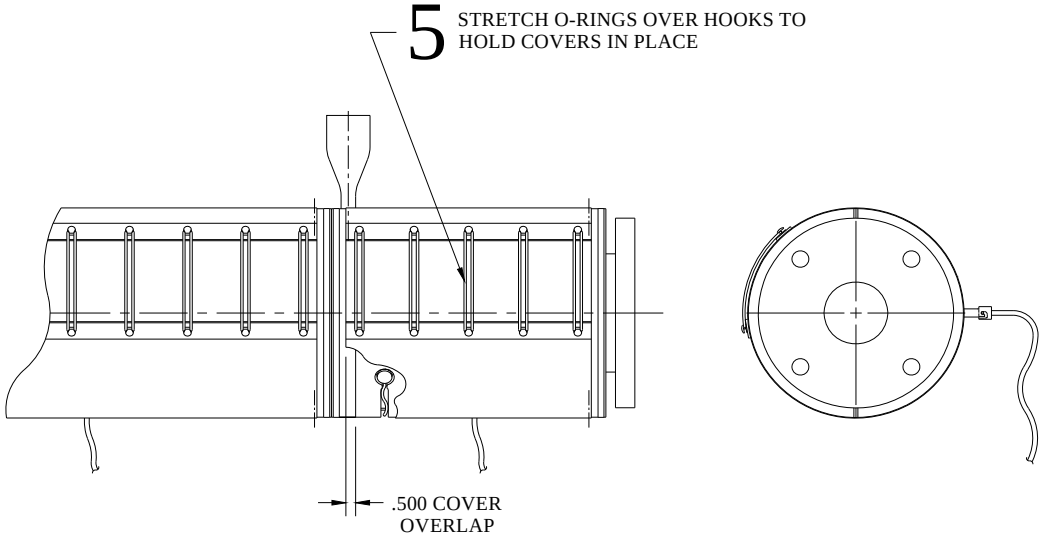


FIGURE 2-5
Teflon Zone Cover Attachment (Rear) View

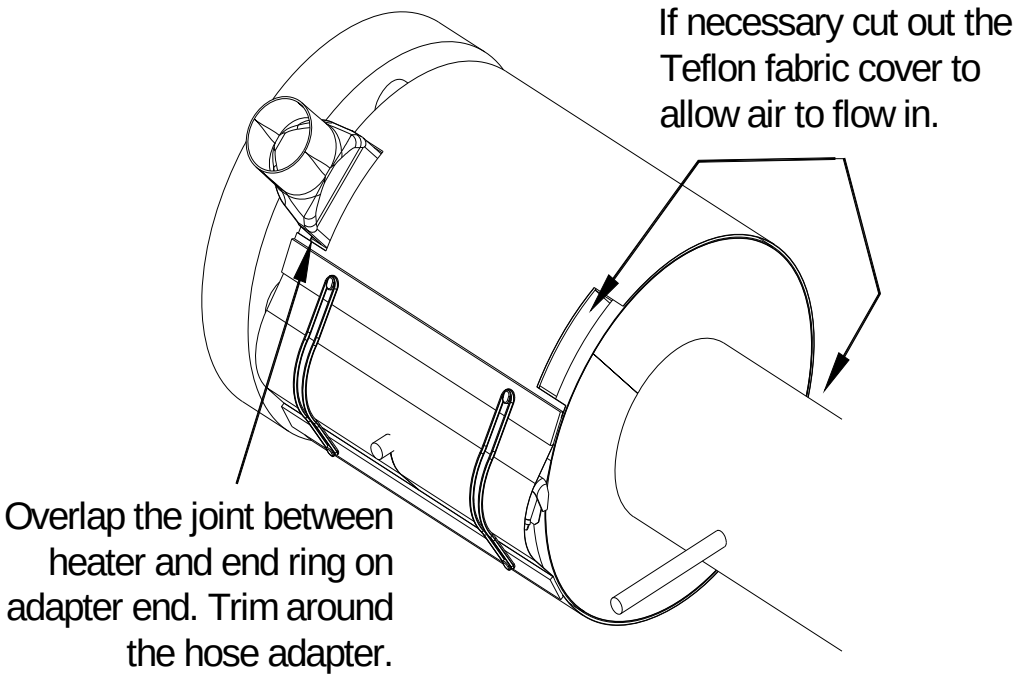


FIGURE 2-6

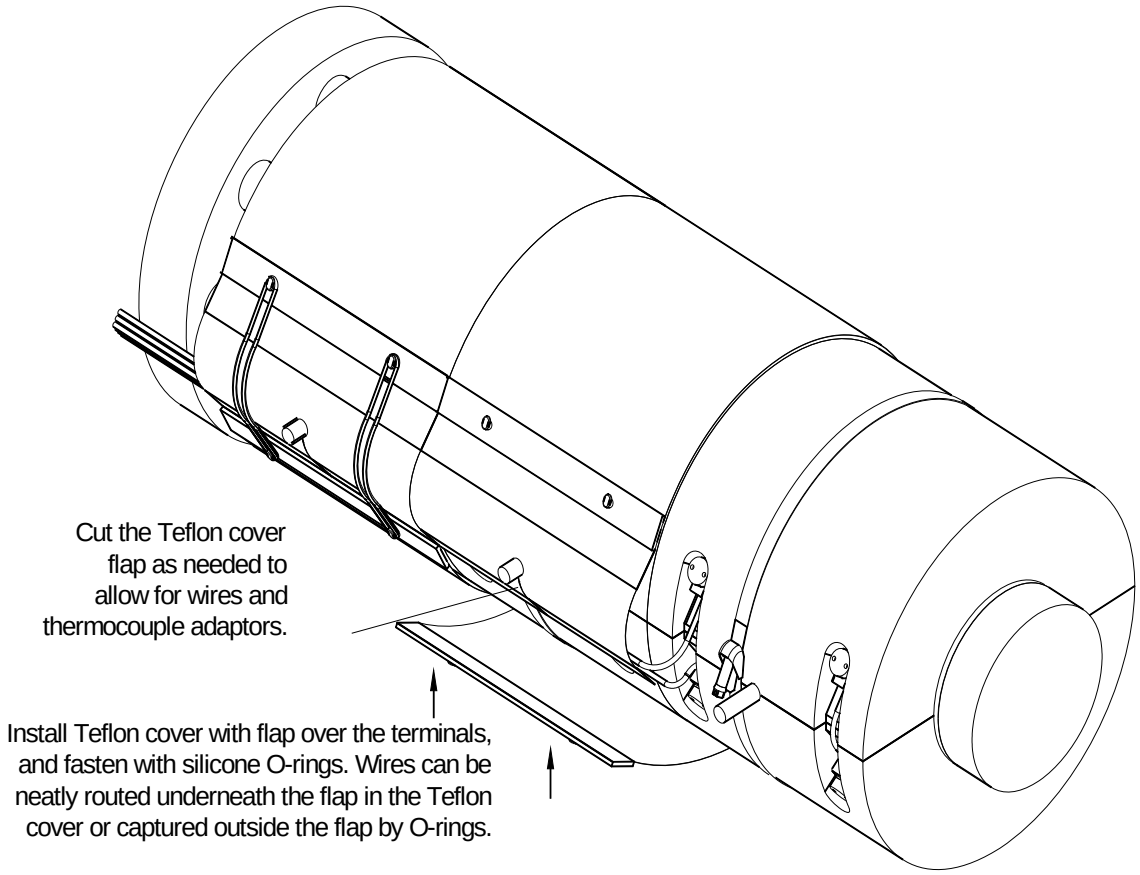


FIGURE 2-7

Rex TCS Cooling Unit Installation

Each barrel zone that requires cooling is identified per the customer specifications. Use the following instructions to install and mount each Rex TCS Cooling Unit purchased.

1. Verify that customer supplied mounting framework for Cooling Units can accommodate all Cooling Units ordered. Refer to the TCS Options drawing sent separately to see mounting options in more detail. Use these documents when setting up the Cooling Unit layout on your machine. Cooling Unit mounting frame(s) should be located near heaters in order to minimize inlet hose lengths. We recommend locating the cooling units above the barrel within 3 ft. to allow easy venting of the hot exhaust air. Before connecting the Cooling Unit wiring or hose make sure that the exhaust ports on the Cooling Units are positioned such that exhaust hose and ducting can be easily accommodated. The Cooling Units can operate in any position.

CAUTION
EXHAUST PORTS ON THE COOLING UNIT SHOULD BE POSITIONED SO THAT THE HOT EXHAUST AIR IS DIRECTED AWAY FROM OTHER COOLING UNITS TO MINIMIZE THE AMBIENT TEMPERATURE OF THE CONTROL CIRCUITRY INSIDE THE COOLING UNIT CABINET.

2. Mount Rex TCS Cooling Units on the frames using mounting dimensions and options found in TCS Options drawing.

3. Wire the Cooling Unit using the schematic included inside the Cooling Unit electrical compartment. The vacuum blower and auxiliary cooling fan in the Cooling Unit require 230V fused for 10 amps to be constantly available to terminals L1 and L2 when the machine is turned on.

   Also, refer to the schematic for the options available for wiring the control signal into the Cooling Unit used to turn the vacuum blower on and off. The current drawn by the Cooling Unit electronics for the on/off signal on your temperature controller is less than 0.5 amps.

4. Measure and cut inlet hose (2.4” I.D.) to the approximate length from the Cooling Unit inlet ports to their corresponding hose adapter(s) in each zone. See Figure 2-8.

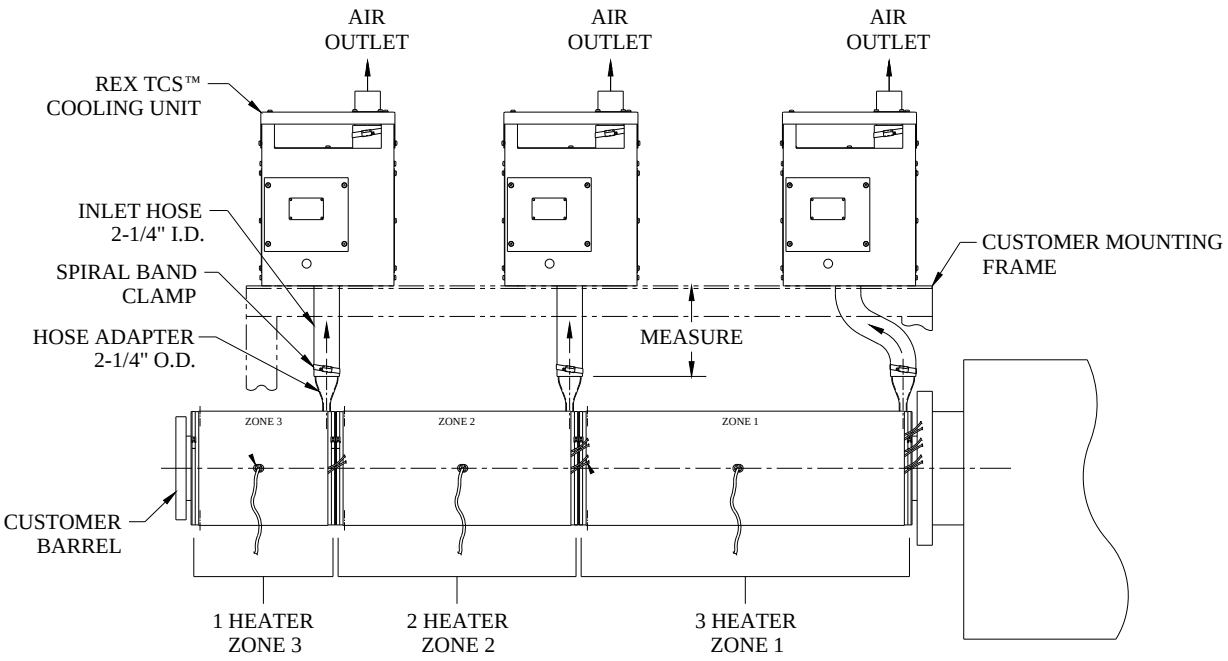


FIGURE 2-8
Cooling Unit Mounting

3. Attach the inlet hose lengths to the Cooling Unit inlet ports (2-1/4" O.D.) on each Cooling Unit purchased. Install a spiral band clamp on the end of the hose. Then slide the hose and clamp over the inlet port and tighten the spiral band clamp.

4. Install the spiral band clamps to the opposite end of each inlet hose (2.4" I.D.) and slide the hose ends with clamp over their corresponding hose adapters. If any inlet hose has excess length, trim to suit. Then tighten the spiral band clamps.

CAUTION
EXCESS HOSE LENGTHS WILL CAUSE REDUCED AIR FLOW, RESULTING IN DECREASED COOLING PERFORMANCE. IDEAL LENGTH IS 3 FT. OR LESS.

5. If the Cooling Unit air outlet ports need to be moved, remove the front and rear panels (six ¼-20 BHSC screws each) and remove the blank plate at the desire port location (four ¼-20 BHSC screws). Loosen the spiral band clamp on port adapter and remove the hose. Then remove the port adapter (six ¼-20 BHSC screws), and install at the desired location and cover the old port with the blank plate. Slide the hose back onto the port adapter and tighten the spiral band clamp. Reinstall the front and rear panels.

6. Outlet hose (2.6" I.D.) and spiral band clamps can be purchased to redirect outlet air to a desired location. The 2.6" outlet hose should be run immediately into a larger header pipe. The area of the header pipe should be at least as large as the sum of the areas of each 2.6"

diameter outlet hose coming into the header. This will keep the air being directed out of the plant from constricting any of the Cooling Units on the machine.

Barrel Cool Down Option

This cooling option allows for reducing the time it takes during job change-over to reduce the barrel temperature to a much lower set point temperature.

A single cooling unit may be utilized to cool the entire barrel as shown in Fig 2-9. Two cooling units may be required for more rapid cooling or for larger, longer barrels as shown in Fig 2-10.

Each cooling unit can be wired to be turned on from a manual switch, timed switch or auxiliary temperature control.

CAUTION: It is important that the cooling unit not be turned on when the heaters are operating as this may cause the heaters to over work, wasting energy and reducing the life of the heater.

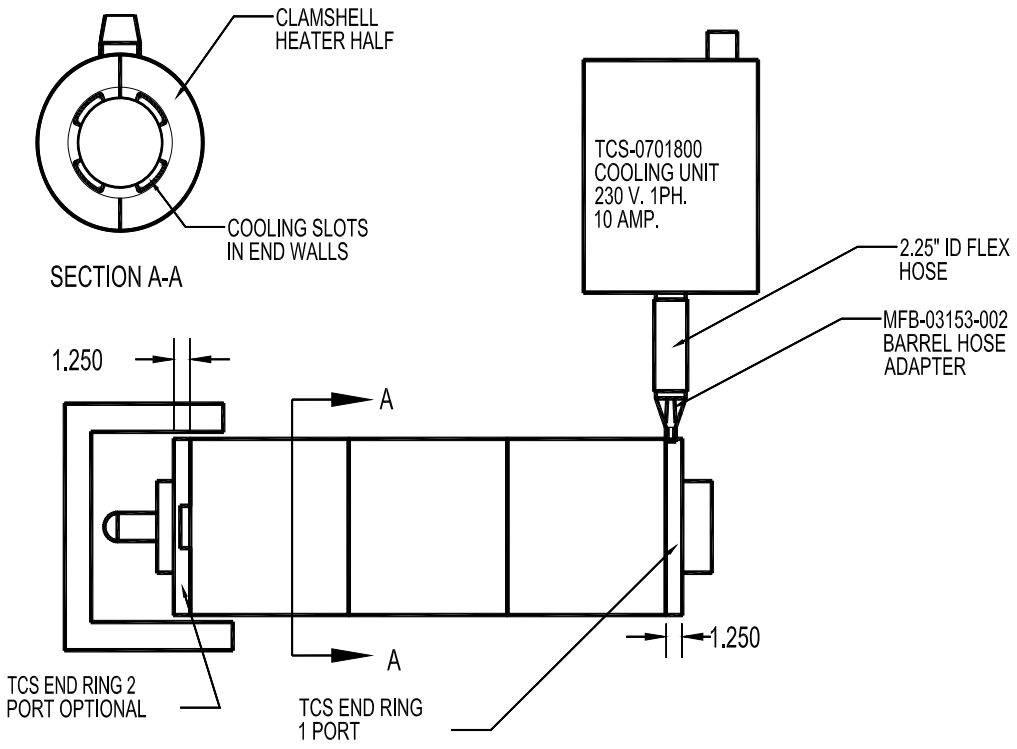


FIGURE 2-9

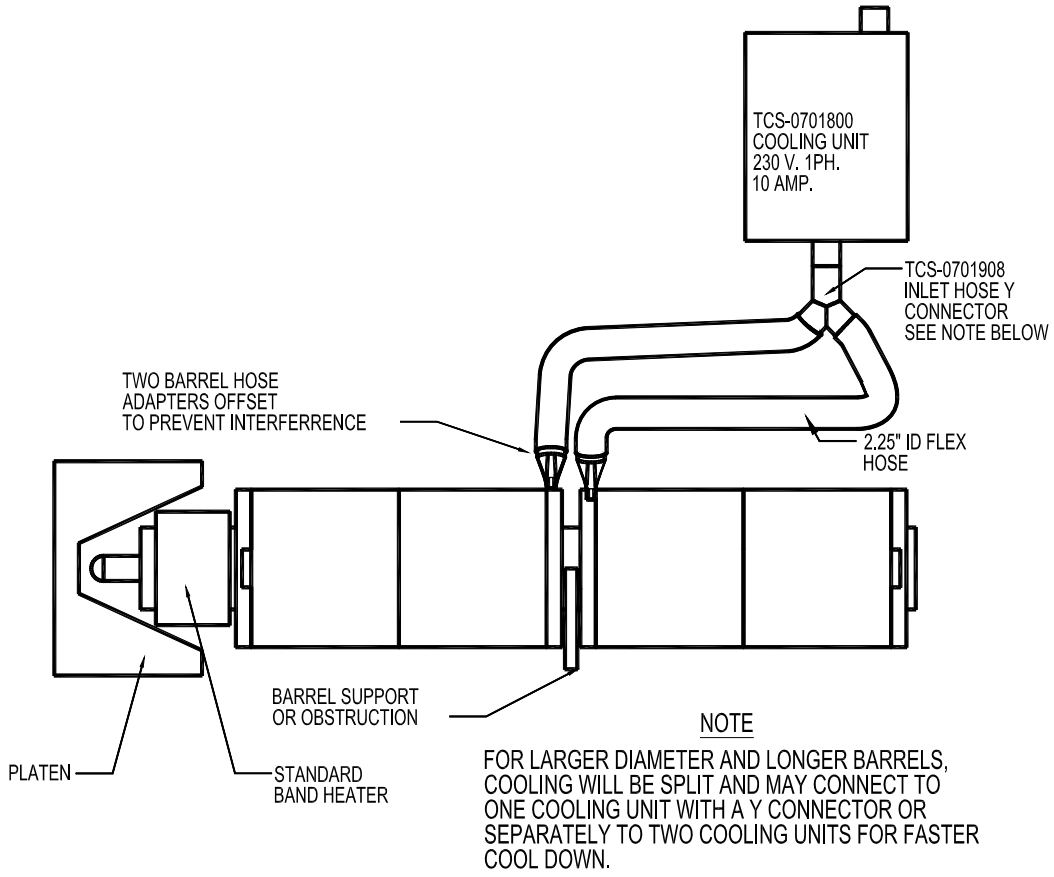


FIGURE 2-10

This completes the installation of your Rex TCS heating and cooling system.

Operation

Maintenance & Repair

Operation

Overview

Before applying power to your new Rex TCS system, it is important to verify that all assembly and wiring procedures have been properly performed. Then we will review the normal operation of the Rex TCS system and discuss how to monitor its performance.

Rex TCS Pre-Start Inspection and Checklist

Prior to switching on the power to your Rex TCS system please review the following checklist to assure that all components have been installed in accordance with Section Two of this manual. Please verify the following:

□ All Rex TCS heaters are tight on the barrel with no gaps between heaters.

□ There are no major gaps between the ends of the heater assemblies, end rings, and any gaps around hose adaptors have been sealed with Pyrolite® E-Z Fill.

□ All Rex TCS Cooling Units are wired, fastened and connected to the adaptors properly.

□ Double check that the power supply voltage to each heater is per its design.

□ Check that barrel is properly grounded. See page 13.

□ Lead wires are in good condition and securely fastened at all connections.

□ All heaters and Cooling Units in a given zone are controlled by the same temperature controller.

□ All temperature controllers are functioning correctly.

□ All thermocouples and sensors are mounted and adjusted to seat properly.

□ All thermocouple and sensor cavities are sealed with ceramic blanket – *optional*

□ All Teflon zone covers are installed and secured with o-rings.

□ All inlet ports on cooled zones are free of obstructions with Teflon covers trimmed for the openings.

□ All wires are neatly routed, secure, and protected.

Rex TCS System Start-up

Once the Rex TCS system has been installed and checked, it is time to switch on the power and start the initial heat up. It is recommended that the initial set point be 300 F and that once the barrel reaches this temperature, it be held there for 15-20 minutes to verify proper heater function and control system performance.

During this initial period, you may see or smell a small amount of 'burn-off' from the small amount of organic binders in the heaters. Any emissions are non-toxic, but some degree of ventilation may be useful to minimize any inconvenience.

This is the time to re-check that the barrel temperature thermocouples are properly seated and functioning properly.

It is also a good idea to inspect the heater connections. If any are seen to be glowing orange, it indicates that they are not sufficiently tightened to make a good connection. To correct the problem the glowing positions should be carefully noted and then the heating system shut down. Remove the Teflon zone covers and the ceramic insulator cap from the position and check the tightness of the nut using the torque wrench set at 26 in-lbs. Remember to hold the base of the terminal shown in Fig 2-2 to prevent the terminal from twisting when applying force to the terminal nut. If the nut is already tightened to the torque value, do not over-tighten. Instead, remove the nut, washers and connector. Check for and remove any debris or mold flashing on the stud or base. Then re-assemble the connection and re-tighten with the torque wrench, as above. Use of a high temperature lubricant or anti-seize may help to achieve a better connection.

After the initial check-out period at 300 F, Cooling Units should now be checked for proper function depending on which cooling option was chosen. After checking the cooling units, you can ramp up the barrel temperature to the desired set point. Once the barrel is stabilized at the target temperature, you can begin normal production using your standard practice.

The exact same set temperatures that were used before installation should be used with the Rex TCS system. There should be no need to change set temperatures from what was used with the replaced heating and cooling system.

Temperature Control and Monitoring

If you are controlling your Rex TCS heaters using an auto-tune type controller, the system will very quickly begin to control the barrel temperature to within a very tight control band. Typically this is within ± 1.0 F. It may tune to the point that the readout never varies from the set point (i.e., less than ± 0.5 F). If you do not have auto-tune controllers, you will need to manually tune the controllers to optimize the control band.

You may also wish to tighten the temperature variation alarms to provide the quickest possible response to any malfunction.

Increasingly, customers are using continuous data-logging systems to monitor the performance of their machines. This provides an excellent quality control and diagnostic tool to further optimize the process.

Documenting Savings and Performance Gains

If you wish to confirm the energy savings you achieve with your Rex TCS barrel heaters, it is necessary to gather performance data with your existing heaters before they are removed as described in Section Two of this manual. If you have done so, it is now time to again record the power consumption and heater on-time for a period of at least two hours of normal operation. Be sure that the product / material being run and any other significant process variables and conditions are the same as during the "Before" measurements.

Once you have tuned the controllers, again record the range of barrel temperature variation around the set point, so that you can confirm the improvement in temperature control accuracy that you have achieved. You may find that this improved process control translates into significant and measurably improved product quality control and higher yield.

Accurately record the time required to heat the barrel to set point from a cold start. This is normally reduced by more than half compared to band heaters. This should translate to higher machine utilization or at least reduce the need to bring people in early to start up the heaters.

Maintenance & Repair

Overview

One of the major benefits of the Rex TCS barrel heating and cooling system is that there is no routine or preventive maintenance required. In fact, barring any mechanical damage or electrical malfunction, the heaters can be expected to give years of trouble free service. However, to avoid any failures, it is recommended to occasionally inspect the heaters and their electrical connections, as described below.

Routine Inspection

Check for the following:

Mechanical Damage – Rex TCS heaters are made from Pyrolite vacuum-formed ceramic fiber material, which is relatively fragile. Therefore, the potential exists for mechanical damage due to physical abuse. The good news is that the units are quite robust and often damage can be repaired as long as the electrical elements and terminals are intact.
See Heater Repair section below for details.

Electrical Connections and Wiring – If the electrical connections are not properly tightened, significant overheating and possible arcing may occur at the terminal. This is normally indicated by glowing at the terminal. If this is observed, see Troubleshooting Section below.

Routine inspection of the wiring and terminals to assure that they are in good condition is advised.

Thermocouples – Improperly seated or malfunctioning thermocouples are a common problem. It is strongly advised to confirm that all thermocouples are fully inserted and properly seated prior to every start-up of the machine, but especially when the tube extensions are first installed. Worn thermocouples should be replaced on a preventive basis to avoid unplanned shut down of the machine and reduce the potential for heater and/or barrel damage.

Cooling Units – Under extreme conditions, filtering the inlet air to the auxiliary cooling fan may be necessary. The cooling units may be equipped with a filter to filter the ambient air used to cool the blower motor. The filter is located in the cabinet inlet slot that is above the auxiliary fan. The filter must be routinely cleaned or replaced. If the machine operates in an exceptionally high airborne dust or dirty environment, it helps to check for buildup on the inside of the casing of the Cooling Units quarterly. If there is any buildup the unit should be cleaned out by applying compressed air around the auxiliary cooling fan and the vacuum blower motor. We do not recommend filtering at the air intake end rings or filtering air through the vacuum blower.

Heater and Cooling Unit Troubleshooting

The procedures below are offered for diagnosing problems that may be experienced:

Barrel Zone Not Heating Up Properly or Temperature is Dropping from the Set-point

1. Verify that the controller is at the proper set point and is calling for power.
2. Check that the thermocouple controlling the zone is seated properly and functional.
3. Check that current is flowing through the wires to the heater assembly using a clamp on amp meter.
4. If not, verify that the relay serving the heater is functioning properly. If the relay is not stuck open, it indicates that one of the heater halves has failed. It will be necessary to shut down the machine and lock out the power supply to the heater and then proceed to the next section.

Diagnosing a Failed Heater Assembly

1. Disconnect one of the power supply leads. Use a meter to check the continuity of the entire heater assembly across the power supply terminals.
2. If there is not continuity through the heater assembly, check the continuity of each heater half individually to identify the one that has failed.

Barrel Overheating

If the zone temperature goes above the set point beyond the normal control range it could be caused by:

- Thermocouple is improperly located or switched with another zone thermocouple.
- Thermocouple not seated properly in the adapter.
- Thermocouple damaged.

If none of the above conditions exist, the overheating could be caused by excessive shear heat generated by the screw in combination with the excellent insulating properties of the TCS heater which prevents the heat from escaping, causing an over temp condition.

The excessive shear heat is wasted energy and should be minimized if possible by reducing the screw RPM or increasing the zone temperature of the previous zone to decrease the viscosity of the material entering the shear zone.

If you are unable to reduce the temperature to an acceptable level, contact your Rex TCS™ Sales Representative or Rex TCS™ Technical Support.

Connectors Glowing – Glowing at any terminal connection on the heater assembly indicates that the connection is not secure and may fail rapidly. If this is observed, mark or carefully note the terminal location, then shut down machine operation immediately. Lock out the power supply to the heater, remove the Teflon covers, and re-tighten the connection as described in Section Three of this manual.

Cooling Unit Problems – Before you troubleshoot the cooling unit it is important to first understand how it should work and how it should be wired. The vacuum blower motor inside the cooling unit is actually a DC variable speed motor with built-in circuitry inside the motor that converts an AC voltage between 200 and 250 volts that should be connected to terminals L1 and L2 on the cooling unit circuit board. The purpose of the cooling units circuit board is to significantly reduce start and stop speed when the vacuum blower is cycling. This significantly reduces the fan blade torque and stress that the fan blade sees during the constant start and stop cycles. This should significantly improve life. When the control board receives a signal from the machine's zone controller to turn "On" the vacuum blower instead of immediately going to 20,000 RPM, ramps up slowly because the circuit board converts the control signal to a zero to 24 variable DC voltage that has a fixed rate of rise which slowly increases the motor's speed. When the signal is removed to turn the blower "Off" instead of immediately slowing to a stop, the circuit board slowly reduces the DC voltage at a fixed rate controlling the rate of slow down. In rapid cycling conditions, instead of constantly turning on & off in short cycles the motor will vary its speed based on the amount of cooling required by the zone temperature controller.

If the Cooling Unit is not working properly, perform the following checks:

1. Check that 230 volts AC is present between L1 and L2 and fused for 10 amps.

2. Make sure it is wired correctly for one of three options available:
    - Option one requires a separate 120 volt control signal to turn the blower on and off. Also check to make sure jumpers are in correct position according to the Option one schematic.
    - Option two requires a separate 208 to 240 volt control signal to turn the blower on and off. Also check to make sure jumpers are in correct position according to Option two schematic.
    - Option three requires a normally open contact from the zone temperature controller that closes when cooling to the zone is required. If this option is chosen, make sure the jumper wire between terminals 5 & 6 is removed and that terminal 2 is jumpered to terminal 3.

3. Test to make sure the control signal from the zone temperature controller is "on" when cooling is required and "off" when cooling is not required.
    - For Option one, measure the control signal across terminals 1 & 4. A 120 volt signal from the machine's zone temperature controller should cycle "on" when cooling is required and "off" when cooling is not required.
    - For Option two, measure the control signal across terminals 1 & 4. A 208 to 240 volt signal from the machine's zone temperature controller should cycle "on" when cooling is required and cycle "off" when cooling is not required.
    - For Option three, make sure the zone temperature controller contact that is wired between terminals 5 & 6 is cycling on and off. Make sure jumper wire is removed between terminals 5 & 6. Also make sure there is no leakage voltage or current coming from the temperature controller.

4. If steps 1 & 2 above are working correctly then test the circuit boards output voltage across terminals marked (-) and (+). If the circuit board is functioning correctly a 3 to 24 VDC signal should be present when the blower is operating between slow and full speed and the zone controller is calling for cooling. It should then decrease from 24 to less than 3 VDC when motor is slowing down or has stopped or zone controller is no longer calling for cooling and control signal is off.

Note that the cooling unit vacuum blower motor has a thermal protection fuse that trips if the electronics inside the motor housing exceeds safe operating temperature of 135 F. The thermal protection fuse will reset only after the temperature has dropped to a safe limit AND the 230 volt power to terminals L1 and L2 is removed momentarily.

If the thermal protection fuse is tripping then check to make sure the auxiliary cooling fan is functioning and supplying ambient air to help keep the blower motor circuitry cool. If the ambient temperature of the cabinet gets above 115 F the auxiliary fan will turn on to cool the vacuum blower motor circuitry inside the motor housing. If the ambient temperature of the cooling unit is close to the 135 F maximum operating temperature it may be necessary to move the cooling unit to a cooler location or supply cooler air to prevent the thermal fuse from tripping.

If the vacuum blower motor has failed, proceed to the "Cooling Unit Replacement" section that follows.

System Repair and Replacement

Heater Repair and Replacement – If the insulating refractory of a heater has been damaged or broken, it may be possible to patch or repair it as long as the heater element and terminal are still sound.
NOTE: Check continuity before doing repairs to avoid needless work.

If a corner or small piece of the pad has broken off, it may be reattached using the high temperature cement supplied in your Rex TCS repair kit. Small punctures or broken areas can be filled or patched using Pyrolite E-Z Fill available from Rex Materials and provided in the repair kit.

CAUTION: If cement or E-Z Fill are used in contact with heater terminals or element wires, the products must be thoroughly dried before power is supplied to the unit to avoid potential electrical hazard. Allow 24 hours for air drying.

Cooling Unit Replacement – If the vacuum blower within the Cooling Unit happens to fail you will need to remove it from the unit. First, lock out power to the Cooling Unit and from the machine control and remove the panel over the electrical terminals on the Cooling Unit. Then remove the inlet hose from the bottom of the cooling unit. Remove only the wires on the terminal strip coming from the vacuum blower motor per the wiring diagram. Do not remove the wires from the auxiliary cooling fan or any of the other wires from the terminals. It is recommended that on each terminal location, after the vacuum blower wires are disconnected, the other wires present be secured in the terminal again to ensure that no connections are changed. Earlier units required protection against voltage spikes; in these early units two MOVs may be present inside each of the Cooling Unit electrical terminals. One is a 250 Volt MOV across L1 and L2, and the other is a 30 Volt MOV across terminals 6 and 7. If these MOVs are present in the terminal block when wires are removed, ensure that they are in place when the new vacuum blower is rewired.

After the appropriate wires are removed from the terminal strip, pull these wires into the vacuum blower cabinet. These wires are tied together with the two wires powering the auxiliary fan. Do not pull the auxiliary fan wires out of the terminals. When the vacuum blower wires are out, then remove both of the large side panels from the Cooling Unit. Loosen the outlet hose clamp and remove the hose from the vacuum blower inside the cabinet. Remove the nuts holding the vacuum blower onto the studs in three places. After these nuts are removed the vacuum blower can be lifted off of the studs and removed from the Cooling Unit. Continue by placing the new vacuum blower in its place and rewire based on the wiring diagram.

Note: When rewiring, confirm that all connections match the diagram and that both of the MOVs are present if they were present before the vacuum blower was replaced.

How to Order Spare Parts

The Rex TCS Heaters and End Rings if used are custom made to fit the specific machine requirements and are not normally stocked by Rex Materials.

It is strongly recommended that the Customer stock at least one heater half for each different heater assembly on the machine.

Spare parts should be ordered from the authorized TCS distributor where you purchased the original TCS system.

You can also contact Rex Materials Customer Service Department for assistance in identifying correct spare parts..

Telephone:	**1-517-223-3787**
Fax:	**1-517-223-6806**
E-Mail:	**customerservice@rexmaterials.com**

When ordering spare parts, include the *TCS-xxxxxxx* part number, the description as shown on the Heater or Installation Bill of Material.