REGAL

OIL TEMPERATURE CONTROLLER

TM

"RK" Series

with REGAL 2000 'HE' INSTRUMENT

I.O.M. #058 1/00

INSTRUCTION MANUAL

- INSTALLATION
- OPERATION
- MAINTENANCE

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MAKING WATER WORK™

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REGAL

OIL TEMPERATURE CONTROLLER

TM "RK" Series

INSTRUCTION MANUAL

REGAL 'RK'
HOT OIL TEMPERATURE CONTROLLER
HEATING AND COOLING MODELS
REGAL 2000 HE INSTRUMENT

COVERING

INSTALLATION
OPERATION
MAINTENANCE

ADVANTAGE®

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1.0 GENERAL

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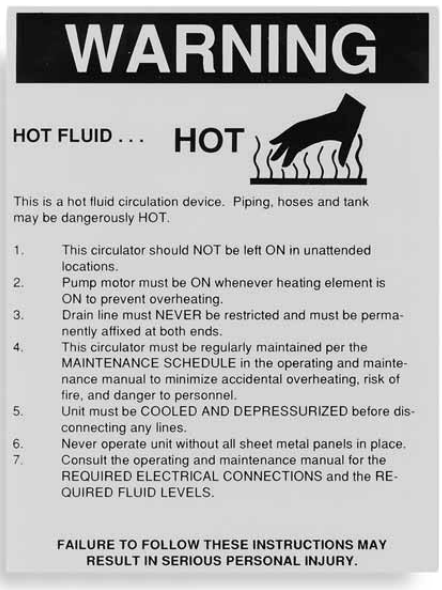
1.1 SAFETY

A. It is important to become thoroughly familiar with this manual and the operating characteristic of the equipment.

B. Several important references are made to safety considerations in this manual. It is the owner's responsibility to assure proper operator training, installation, operation, and maintenance of the **REGAL 'RK'** temperature controller.

1.2 EFFICIENCY

A. Long term efficiency of operation is largely determined by proper maintenance of the mechanical parts of the unit and the oil quality. **ADVANTAGE** accepts no responsibility for inefficient operation or damage caused by improper installation or foreign materials in the process fluid.



This warning label is attached to the lift off panel.

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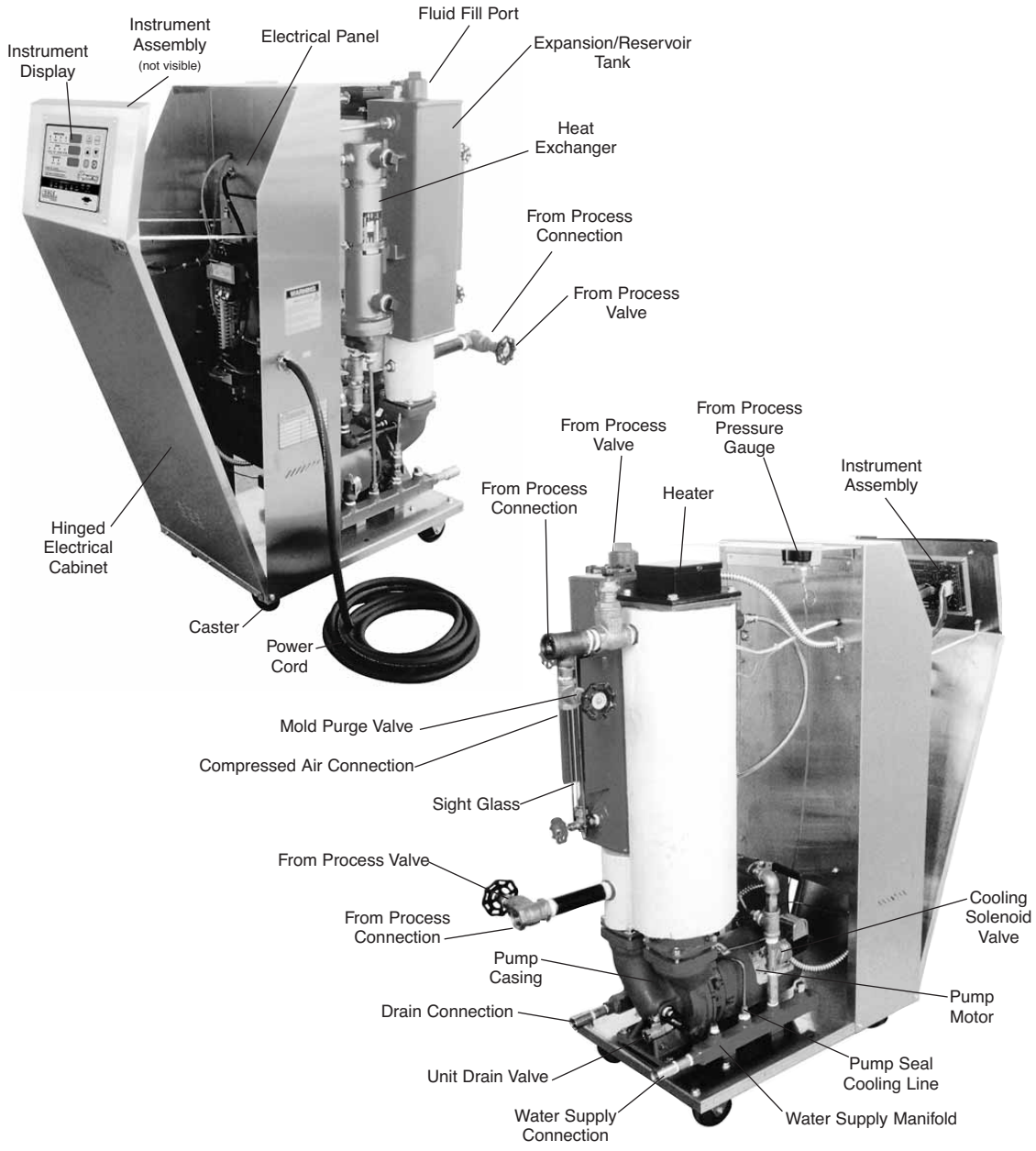
1.3 COMPONENT PLACEMENT

A. The **ADVANTAGE Regal 'RK'** temperature controller is designed to circulate temperature stabilized fluid through the process resulting in process temperature control.

B. The ability of the equipment to do this is significantly affected by the method of installation.

C. If any questions arise, please contact your **ADVANTAGE** Sales Representative or the **ADVANTAGE** Service Department at 317-887-0729.



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2.0 INSTALLATION

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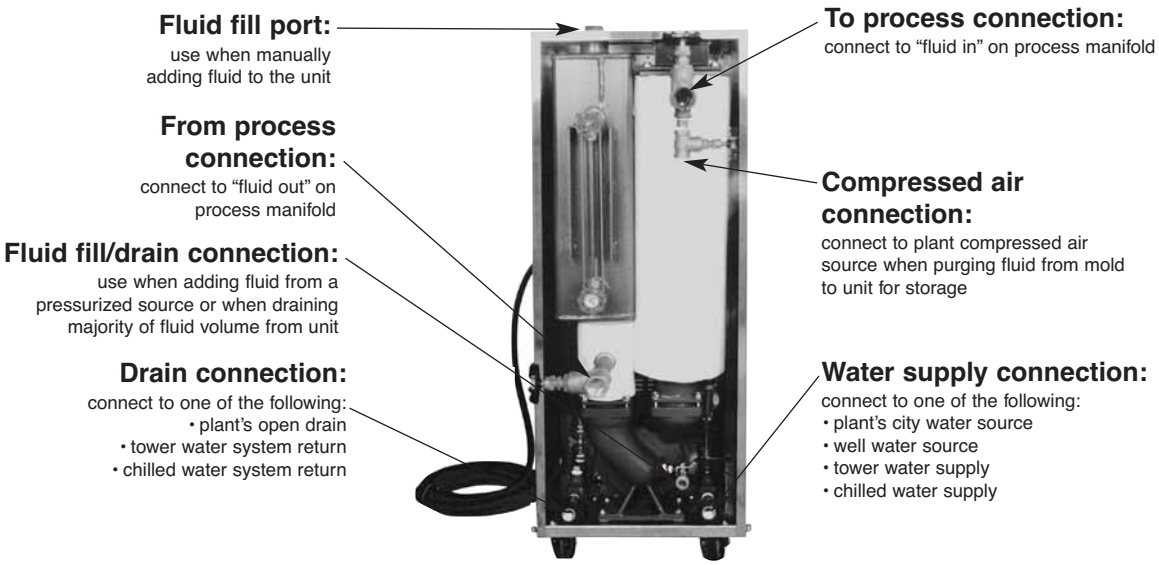
2.1 GENERAL

A. All process piping materials (such as hose, rigid piping, valves or filters) used in process water piping circuitry must be rated for 600°F minimum temperature and 75 PSI minimum pressure.

B. All such materials must have the equivalent or larger diameter of the particular process connection that length of process water piping is connected to.



2.2 TO AND FROM PROCESS CONNECTIONS

A. Connect the unit's **'TO PROCESS'** port to the 'fluid in' port on the process manifold.

B. Connect the unit's **'FROM PROCESS'** port to the 'fluid out' port on the process manifold.

C. Process circuitry should be designed to avoid an excessive use of elbows and/or lengths of pipe or hose. If hose is the material of choice, teflon lined steel braided hose is recommended for use. If hose is used, avoid tight twists or curls in the process circuitry.

2.3 WATER SUPPLY CONNECTION

A. Connect the unit's **'WATER SUPPLY'** port to the plant's city water supply, well water supply, tower water system supply or chilled water system supply as required.

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B. Water supply must be a minimum of 1/2 GPM at a maximum temperature of 100°F for efficient component cooling.

C. The factory recommend minimum operating water supply pressure requirement is identified on the unit's data pate**.** To protect the unit from operating without adequate supply water, a water pressure switch (figure 2.3A - panel mount switch shown) is plumbed into the supply manifold. If the supply pressure is not sufficient, the pressure switch will stop or prevent unit operations.

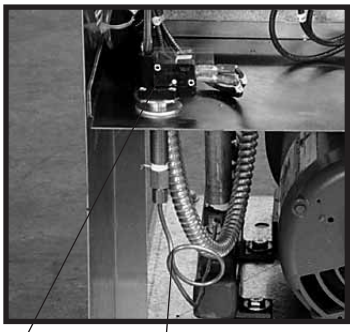

Figure 2.3A

D. On ***all*** **Regal 'RK'** units, cooling water circulates to the supply manifold (figure 2.3B), through the pump adapter cooling jacket, and is then rejected to the drain manifold. This action maintains proper pump seal cavity temperatures.

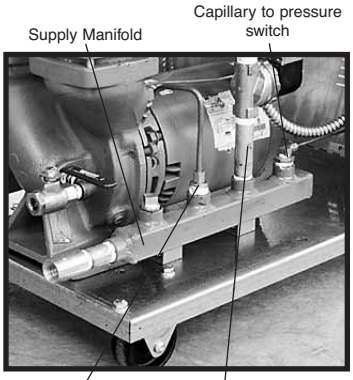

Figure 2.3B

E. On **Regal 'RK'** units with the installed cooling option, a tube and shell heat exchanger (figure 2.3C) for process fluid cooling is supplied and mounted to the expansion tank.

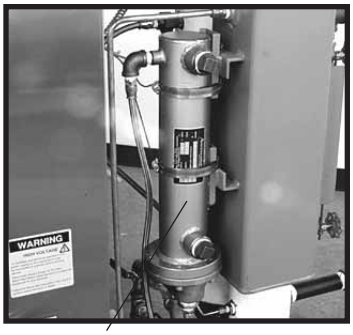

Figure 2.3C

1. The purpose of the heat exchanger is to cool the process fluid. Cooling water from plant water supply circulates through the "tube" side of the heat exchanger. The process fluid circulates through the "shell" side. Cooling water flow is controlled by the solenoid valve.

2. A 1/2" ball valve is placed in the heat exchanger water supply line after the solenoid valve (figure 2.3D). The ball valve should be open during

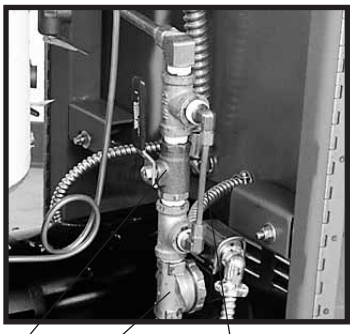

Figure 2.3D

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operations from 100°F to 200°F. During operations with temperatures over 200°F, this valve should be closed. In such cases, the necessary cooling water is proportioned to the heat exchanger through the small capillary line, which some water "steams off" to cool the process fluid. The steam and water mixture is then rejected to drain.

2.4 DRAIN CONNECTION:

A. Connect the unit's **'DRAIN'** port to one of the following as determined by the water supply source:

1. Plant's open drain for well or city water supply

2. Tower water system return for tower system water supply

3. Chilled water system return for chilled water system supply

B. The 'drain' manifold (figure 2.4A) serves as a collection point for the heat exchanger drain line (if installed) and the pump seal cooling drain line. In most cases, a pressure relief valve is plumbed into the drain manifold.

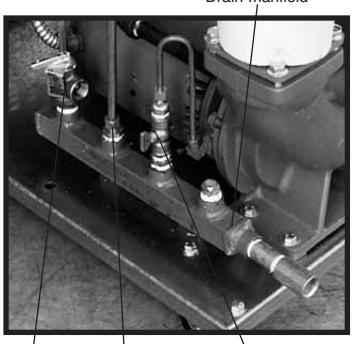

Figure 2.4A

C. The 'drain' connection should be made of galvanized iron pipe or teflon lined steel braided flexible hose, since steam may be present in the drain line during operations. Rubber hose is not recommended.

D. The factory recommends that the water supply and drain line pressure differential should be a minimum of 10 psi to ensure proper cooling.

E. For most applications, the drain line should not be valved. However, for installations with a pressurized drain system, it may be necessary to install a valve in the drain line. In such cases, the installed valve must be fully opened after installation and the valve handle removed. This prevents operating the unit with a closed drain valve. The valve handle can be reattached to the valve body when it is necessary to close the valve.

F. **CAUTION:** the unit must never be operated with a closed drain line valve. A closed drain line valve prevents adequate system cooling and will lead to the unit overheating. Overheating of the mold temperature controller may lead to unit damage or serious personal injury.

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2.5 ELECTRICAL CONNECTION

A. NEMA 1 MODELS

1. Electrical power supply requirements for Nema 1 units (figure 2.5A) are identified on the equipment data plate. **VERIFY THAT THE AVAILABLE VOLTAGE SUPPLY IS THE SAME AS THE UNIT'S VOLTAGE REQUIREMENTS.**
WARNING: Do not connect the unit to a voltage supply source not equal to the unit's voltage requirements as specified on the unit's data plate. Use of incorrect voltage will void the unit's warranty and cause a significant hazard that may result in serious personal injury and unit damage.

Figure 2.5A

2. A four conductor cable, 10 foot in length, has been provided for connection to a fused disconnecting means. The owner supplied fused disconnecting means shall be sized and installed according to the unit's power supply requirements and local electrical codes.

B. NEMA 12 MODELS

1. NEMA 12 units are constructed (figure 2.5B) with a dust tight electrical enclosure and branch circuit fusing. Electrical power supply requirements are identified on the equipment data plate. **VERIFY THAT THE AVAILABLE VOLTAGE SUPPLY IS THE SAME AS THE UNIT'S VOLTAGE REQUIREMENTS.**
WARNING: Do not connect the unit to a voltage supply source not equal to the unit's voltage requirements as specified on the unit's data plate. Use of incorrect voltage will void the unit's warranty and cause a significant hazard that may result in serious personal injury and unit damage.

Figure 2.5B

2. Appropriate conduit and fittings should be selected which will maintain the integrity of the cabinet.

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3. Supply a power conductor sized according to the unit's power supply requirements. Connect the power conductor to the unit's power supply entry terminal block on the fused disconnect switch.

C. CONTROL CIRCUIT WIRING

1. The unit's supplied control circuit is 110 volt, 1 phase, 60 cycle. The control circuit is supplied by the factory installed transformer. A control circuit fuse is located on the transformer chassis.

2. All unit safety and operational control circuits are interlocked and will not operate unless the pump is on.

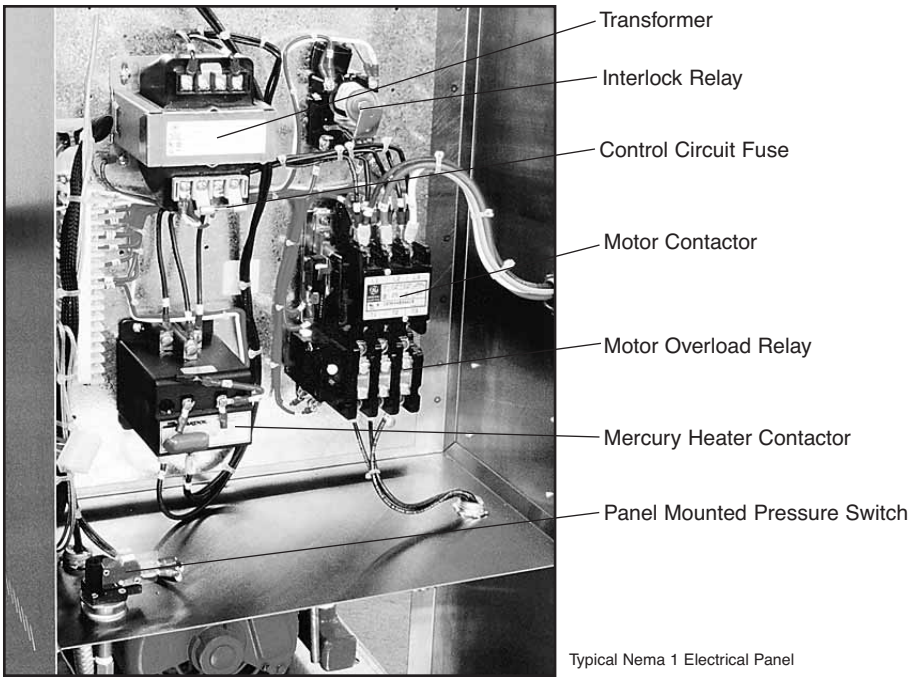
D. GENERAL

1. Make certain all ground connections to the unit are properly affixed.

2. Make certain power conductor, disconnecting means, and fusing are properly sized according to the unit's power supply requirements.

3. Make certain all electrical connections are tightly affixed. Any loose wiring connections must be tighten before engaging the power supply.

4. Make certain no moisture or standing water is present inside the electrical cabinet.



Typical Nema 1 Electrical Panel

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3.0 OPERATIONS

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3.1 GENERAL

A. Failure to follow the factory required operation procedures may adversely affect the unit's ability to adequately control process temperature and may create a hazardous operating condition which may result in unit damage and serious operator injury.

B. The operator must verify that all plumbing and electrical connections are in accordance to section 2 of this manual and local codes.

C. The Operations segment of this manual is outlined below:

3.2 **Start-up/operations procedure** - follow this segment to start the unit after the initial installation or to restart the unit after reinstallation to the same or different process system. This section includes information on system fill, electric motor phasing (pump rotation) and process flow adjustments.

3.3 **HE instrument** - follow this segment to start up and operate the **HE** instrument. This section includes information on setpoint selection and adjustment, and feature explanations.

3.4 **Shut down procedure** - follow this segment to shut down the unit. This segment includes information on system cool down, shut down, electrical power supply precautions, and disconnection from system.

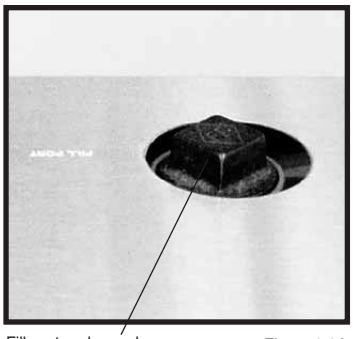
3.5 **Mold purge operation** - follow this segment to purge the process fluid into the unit when changing molds.

3.2 START UP/OPERATIONS PROCEDURE

A. SYSTEM FILL

1. The primary method of **Regal 'RK'** system fill is through the fill port located on the top of the unit (figure 3.2A). Simply remove the cap plug and add fluid. Replace the cap plug and tighten when the fill is complete.

2. The alternate method of **Regal 'RK'** system fill is through the fill/drain valve. If a pressurized source is available, simply connect to the fill/drain valve, open the valve and engage the supply source. Close the valve when the fill is complete.



Fill port and cap plug

Figure 3.2A

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3. Proper unit fill is essential for efficient and safe operation. An oil level sight glass is provided to determine unit fill (figure 3.2B). For initial fill: units up to 12 KW - fill until the sight glass is 1/2 full; for units up from 27 to 48 KW fill until the sight glass is completely full. When the pump is first started, the oil level will drop as the heater tank and process are filled. After which, the operator may need to top off as necessary to maintain oil level near the bottom of the sight glass. Check the system for any leaks and repair if necessary.

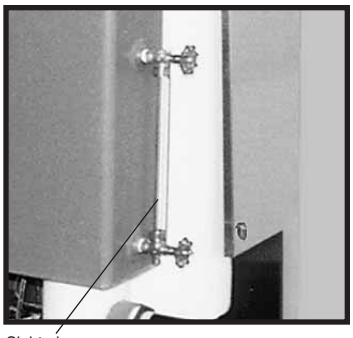

Figure 3.2B

B. ELECTRIC MOTOR PHASING (PUMP ROTATION)

1. The operator must determine the electric motor is phased correctly. This is done by visually inspecting the rotation of the motor shaft and is outlined below. Incorrect phasing of the unit will result in poor operation and eventual damage to the unit.

a. Supply electrical power to the unit by engaging the unit's disconnect switch. Once the correct voltage is supplied to the unit, the POWER light on the display will illuminate.

b. Access the pump motor by removing or opening the necessary panels. **Note that the electrical power is engaged at this point and caution must be observed while the electrical supply is engaged and cabinet panels are open.**

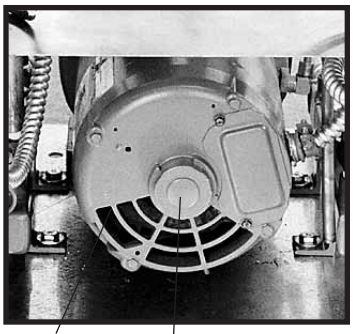

Figure 3.2C

c. Locate the electric motor (figure 3.2C). The operator must identify the motor shaft inside the electric motor housing. The motor shaft can be seen through the vent slots in the motor housing or by removing the shaft cover.

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d. To start the pump motor, press the ON push button. To stop the pump motor, press the OFF push button (figure 3.2D).

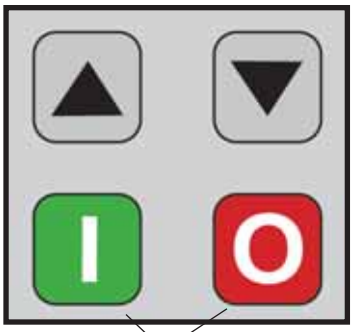

Figure 3.2D

e. When the pump is started, observe the motor shaft. When the pump is turned "off", the motor shaft will slowly "coast" to a stop. As the motor shaft slows to a stop, the operator can identify the rotation of the motor shaft. Correct rotation (correct phase) is "clockwise", when viewed from the rear of the motor. Incorrect rotation is "counter-clockwise" (incorrect phase) when viewed from the rear of the motor.

f. If the motor is phased correctly (turns in a clockwise direction), continue with the start up procedure at **step 3**. If the motor is phased incorrectly (turns in a counter-clockwise direction), continue with start-up procedure at **step 2**.

2. If the motor is phased **incorrectly** (motor turns in a counter clockwise direction), the operator must:

a. Disengage the electrical power supply to the unit at the disconnect switch. Follow proper lockout procedures before proceeding.

b. Once the electrical power supply is disengaged, reverse any two power leads of the power cord at the disconnect terminals.

c. **Note:** reversing any two power leads of the power cord will correctly phase an incorrectly phased power supply. **The operator must reverse the power leads at the disconnect switch only and not at the power entry terminals on the unit's electrical panel**. The unit's on-board internal electrical system wiring is phased correctly at the factory and must not be altered in the field.

d. Visually inspect motor rotation to determine the unit is phased correctly.

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C. PROCESS FLOW ADJUSTMENT

1. The operator must determine and set proper fluid flow rate for the most efficient and trouble free operation.

a. Fluid flow rate through the process is determined by the pressure losses in the unit-to-process flow system. Generally, higher flow rates result in maximum temperature control and lower maintenance.

b. If the pressure loss is too low, the flow rate will be too high and the electric motor will draw excessive amps. This will eventually result in tripping the thermal motor overload relay (overload relays open) and the unit will shut down and illuminate the PUMP OL light on the instrument display.

2. If a motor overload situation has occurred, the operator must manually reset the overload relay before operations can continue. This is done by opening the electrical panel cover, identifying the reset lever on the overload relay, and pushing the reset lever "in" until the overloads are reset (evidenced by a "clicking" sound as the overloads reset).

3. If a motor overload situation persists, the operator must reduce the flow rate to match the system pressure loss to prevent continual tripping of the overall relay. The procedure to reduce process flow rate is outlined below:

a. Open electrical cabinet panel door. **Note that the electrical power is engaged at this point and caution must be observed while the cabinet panel is open.**

b. Identify the motor starter block (figure 3.2E). This block consists of the motor starter contactor and the overload relay.

c. Place an amp meter on a single power lead emanating from the overload relay.

d. Identify the electric pump motor. Locate the motor name plate on the motor housing.

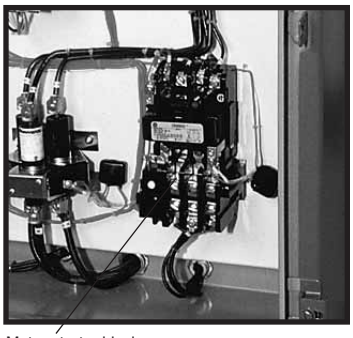

Figure 3.2E

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The full load amp rating for that motor is listed on the name plate.

e. Engage the electrical power supply and start the electrical motor pump by pressing the ON push button.

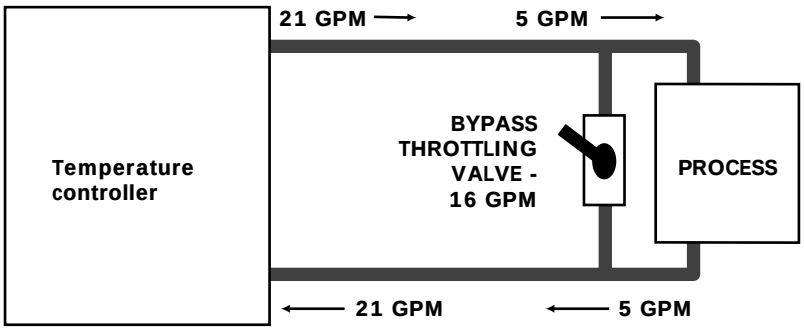
Motor data tag

Figure 3.2E

f. The amp meter will display the motor amps. Compare the actual motor amps as displayed on the amp meter to the full load amp rating as listed on the motor name plate.

g. If the amp draw is excessive (higher than the listed name plate amp rating), reduce flow by fully closing the from process valve. With the pump engaged, slowly open the valve and monitor the motor amperage as displayed on the amp meter. Continue to open the value until the motor amperage equals the listed full load amp rating of the motor. The process flow is now correctly adjusted. The valve should remain in this position during operations.

4. A low flow condition can cause the process fluid to degrade prematurely. If the process connections are not full line size the solids created by this premature degradation can plug mold passages, pump impellers, and build up on the heater elements causing heater failure. To prevent this condition, install a bypass (see diagram below) line between the process lines. The by-pass line should be as close to the mold as possible for best operation. The by-pass line should be 1/2 of the process line size with a shut-off valve to balance the flow.



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3.3 INSTRUMENT OPERATION

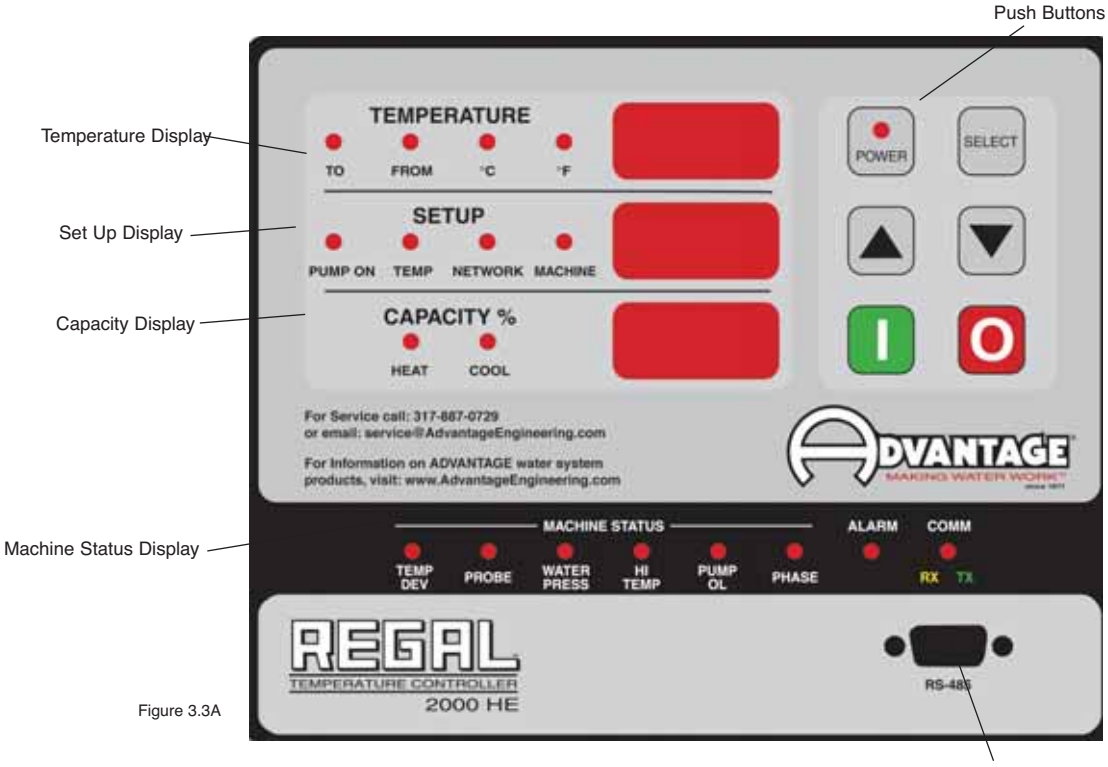

Figure 3.3A

A. INSTRUMENT START-UP

1. With the correct electrical power and adequate water supply pressure are supplied to the unit, it is possible to start the unit for temperature control duty.

2. When the electrical power supply is engaged to the unit, the **Regal HE** instrument (figure 3.3A) will momentarily illuminate all indicating lights and digits on the display. After a short delay, the instrument will display the controller's software version number. At this time, the operator can verify that all lights and digits are functioning properly. If the operator determines an indicating light or digit does not illuminate, the instrument must be removed and sent to the factory for repair.

3. With electrical power supplied to the unit, the POWER light will illuminate. The display will remain dark with exception of the PROBE and PHASE lights (which will be 'solid green' if those conditions are 'ok'). This is the normal "stop" state of the **Regal HE** instrument. If the operator determines the PROBE and PHASE lights are 'flashing red', the operator must determine the reason and correct:

a. **Probe error:** a possible cause of a probe error is the probe service connection is wet. Locate the 2 pin (white plug) service connection, open and dry

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with compressed air. If this action does not remove the error indication, inspect the probe wiring, which could be incorrect or damaged. Probe connections are at the instrument panel. Correct wiring is (from top to bottom) 'white' - 'black' - 'white' - 'black' - 'red' - 'red'. If probe connections are correct, the probe may be faulty and should be replaced.

b. **Phase error:** follow the procedure outlined in section 3.2. paragraph B 'Electric Motor Phasing' to clear a phase error. If a phase error can not be cleared even though the pump motor is rotating correctly, the three phase monitor is defective and should be replaced. Disconnect the unit until a replacement is obtained.

4. After a 'flashing red' fault indication is diagnosed and repaired, the 'flashing red' indication will turn 'solid red'. The operator can clear a 'solid red' fault indication by pressing the START key.

5. When the START key is pressed, The instrument will immediately check the status of the water supply pressure switch (WATER PRESS light), the motor overload switch (PUMP OL light) and the high temperature safety switch (HI TEMP light) for acceptable operating conditions. If these systems are found to be 'ok', the lights will be 'solid green' and the unit will begin process temperature control operation. If a system is not found to be 'ok', the light will 'flash red' and the instrument will prevent process temperature control operation.

6. Conditions that will prevent the unit from starting are:

a. **Water supply pressure inadequate** (pressure switch is open). The WATER PRESS indicator light is 'flashing red'. The unit is prevented from operating without adequate water supply pressure by the electrical panel mounted pressure switch. Sufficient water supply pressure must be present to close the switch and consent the safety circuit.

b. **Motor overload switch opened.** The PUMP O/L indicator light is 'flashing red'. The electric motor is protected from overload conditions (excessive flow) by a set of thermal overload relays which open (trip) with excessive amperage and prevent electric power from reaching the electric motor. If the overload relay is open, the overload relay must be reset before operations can continue. An excessive flow condition must be corrected immediately.

c. **High temperature limit switch open.** The HI

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TEMP indicator light is 'flashing red'. The unit is prevented from operating with temperatures exceeding 510°F by the high temperature limit switch. This switch is installed in the "to process" temperature sensor. If this switch is open (due to a high temperature condition), the control circuit is not consented and the unit cannot be started. If a high temperature condition exists, the unit must first cool down (reduce process water temperature) before the high temperature limit switch will automatically reset to allow operation.

B. INSTRUMENT OPERATION

1. The operator must verify the PROBE, VALVE, AND PHASE lights are 'solid green'. If these lights are 'flashing red', the operator must determine why and correct.

2. Operation is started by pressing the START push button.

a. When the START push button is pressed, the instrument will immediately display the previously selected setpoint temperature in the SETUP display window, as indicated by the TEMP light. The selected setpoint temperature is displayed continuously unless the operator selects the NETWORK or MACHINE setup displays. After 10 seconds of inactivity in the NETWORK or MACHINE setup parameters, the setup display will automatically revert to the TEMP display.

b. When the START push button is pressed, the instrument will immediately display the TO PROCESS temperature as read by the TO PROCESS temperature sensor. The TO PROCESS temperature sensor is mounted at the top of the heater/discharge tank. All controlling functions are based on this temperature. The operator can select between the TO or FROM process temperature for display in the TEMPERATURE window. The display reverts to the TO process temperature after 10 seconds of inactivity if the FROM process parameter is selected. Process temperatures can be programmed to display in Fahrenheit or Celsius as indicated by the °F or the °C lights.

3. The operating SETPOINT temperature is selected by using the SELECT push button to index to the TEMP indicating light. Depress the UP arrow push button or DOWN arrow push button until the preferred setpoint temperature is indicated in the SETUP display window. Setpoint temperatures can be adjusted anytime during the process

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temperature control cycle. Once adjusted, the instrument controller will bring the system in line with the adjusted setpoint. **Note:** the operator may adjust the setpoint without using the SELECT key when the TO process light is on.

6. The TEMP DEV (temperature deviation) light will remain off unit the setpoint temperature is achieved and maintained.

7. Press the STOP key to halt unit operations.

C. INSTRUMENT CONTROLS (FIGURE 3.3B)

1. **START PUSH BUTTON**: this switch starts unit operations by engaging electrical supply to the pump, heater and cooling valve. Depress and hold the START push button to initiate a forced vent of the unit by opening the cooling valve to quickly cool the unit on demand.

Figure 3.3B

2. **STOP PUSH BUTTON**: this switch stops unit operations by disengaging electrical supply to the pump, heater and cooling valve

3. **SELECT PUSH BUTTON:** use this push button to select the programmable parameters. Parameters will appear in the TEMPERATURE window and the value will appear in the SETUP window.

4. **UP ARROW**: depress and hold this push button to increase the selected parameter. If this push button is pressed momentarily the value is incremented by one unit. If the push button is held down for more than one second, the value will increase slowly at first and then faster after about two seconds.

5. **DOWN ARROW**: depress and hold this push button to decrease the selected parameter. If this push button is pressed momentarily the value is incremented by one unit. If the push button is held down for more than one second, the value will increase slowly at first and then faster after about two seconds.

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D. TEMPERATURE DISPLAY (figure 3.3C)

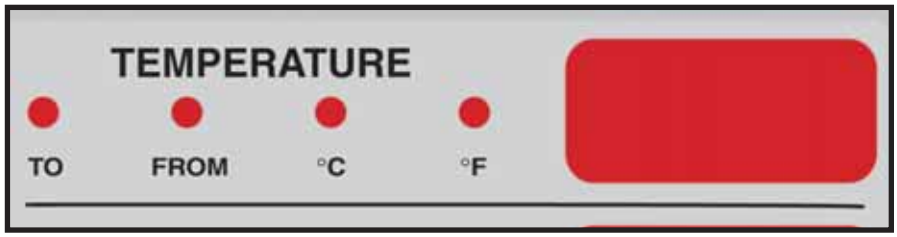

Figure 3.3C

1. **TO**: illuminates when the "to process" water temperature is displayed. TO is the default setting of the TEMPERATURE display window.

2. **FROM**: illuminates when the "from process" water temperature is selected. **Note:** The controller will revert back to the TO temperature display after 10 seconds if the FROM process temperature was selected and displayed and the controller was left in that state.

   a. Use the SELECT key to index to the FROM indication light. The "from process" temperature will be displayed in the TEMPERATURE window.

3. **°C**: illuminates when the °C (Celsius) temperature display parameter is selected.

4. **°F**: illuminates when the °F (Fahrenheit) temperature display parameter is selected. °F is the default setting of the controller.

E. SETUP DISPLAY (figure 3.3D)

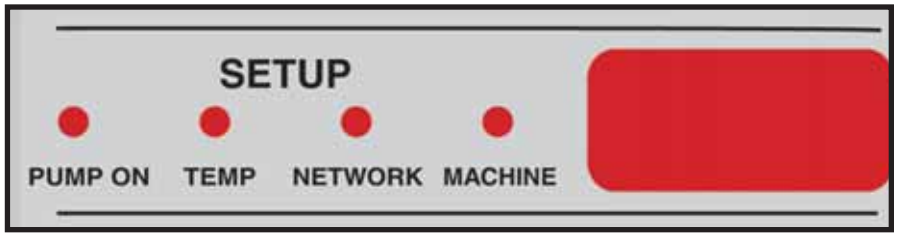

Figure 3.3D

1. **TEMP**: illuminates when SETPOINT temperature is displayed. TEMP is the default display setting of the SETUP display window.

2. The setpoint temperature can be adjusted by:

   a. Use the SELECT key to index to the "SP" display in the TEMPERATURE window (the TEMP light is illuminated). The setpoint temperature value is displayed in the SETUP window. Use the UP arrow

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or DOWN arrow keys to select the setpoint temperature value.

b. When the instrument is in the default state (TO process temperature display), the operator may adjust the setpoint temperature with the UP or DOWN arrow keys without using the select key. If the instrument is in any other state (i.e. the NETWORK parameter state) the operator must use the SELECT key to index to the TEMP indication to adjust the setpoint.

3. The HI and LOW temperature alarm values are programmed by:

a. Use the SELECT key to index to the "HI" display in the TEMPERATURE window (the TEMP light is illuminated). The high temperature alarm value is displayed in the SETUP window. Use the UP arrow and DOWN arrow keys to select the value (1-30 units selectable).

b. Use the SELECT key to index to the "LO" display in the TEMPERATURE window (the TEMP light is illuminated). The low temperature alarm value is displayed in the SETUP window. Use the UP arrow or DOWN arrow keys to select the value (1-30 units selectable).

4. **PUMP ON**: illuminates when the pump is on.

5. **NETWORK**: illuminates when the communications parameters are selected. Communications parameters available are "communications address", "baud rate" and "protocol". The communications parameters are programmed by:

a. **Communication address:** the communications address is the number assigned to the unit in a network. Use the SELECT key to index to the "Adr" display in the TEMPERATURE window (the NETWORK light is illuminated). The communication address value is displayed in the SETUP window. Use the UP arrow or DOWN arrow keys to select the value (1-99 units selectable).

b. **Baud rate:** the baud rate is the data transfer rate of between the unit and the host computer. Use the SELECT key to index to the "rAt" display in the TEMPERATURE window (the NETWORK light is illuminated). The baud rate value is displayed in the SETUP window. Use the UP arrow or DOWN arrow

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keys to select the value (1200-2400-4800-9600 units selectable).

c. **Protocol:** the protocol is the data format for communication between the unit and the host computer. Use the SELECT key to index to the "Pro" display in the TEMPERATURE window (the NETWORK light is illuminated). The protocol value is displayed in the SETUP window. Use the UP arrow or DOWN arrow keys to select the value (SPI or CAC selectable). "SPI" is the standard Society of Plastics Industry, Inc. protocol. "CAC" is the CAMAC protocol used on older CMI machines.

6. **MACHINE**: illuminates when the machine parameters are selected. Machine parameters available are: "Fahrenheit temperature display", or "Celsius temperature display".

a. Use the SELECT key to index to the "Unt" display in the TEMPERATURE window (the MACHINE light is illuminated). The machine value is displayed in the SETUP window. Use the UP arrow and DOWN arrow keys to select the value ("F" or "C" are selectable). "F" indicates Fahrenheit temperature display. "C" indicates Celsius temperature display.

G. **CAPACITY % DISPLAY** (figure 3.3F)

1. The CAPACITY % display shows information concerning the "in use" heating and cooling capacity of the unit. HEAT and COOL indicating lights determine which capacity percent is

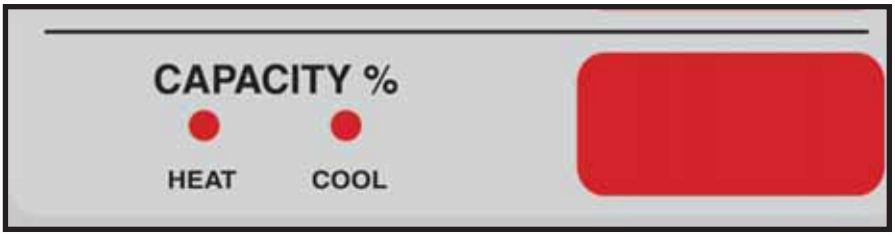

Figure 3.3F

displayed.

a. **HEAT:** when this light is illuminated, the unit is in the heating mode (heater on). The number displayed in the CAPACITY % window is percent of "on-time" use of the heater.

b. **COOL:** when this light is illuminated, the unit is in the cooling mode (heater off) and the AVT valve is opening. The number displayed in the CAPACITY % window is "how much" the cooling valve is open.

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c. **DEAD BAND:** when this light is illuminated, the unit is not in the HEAT or COOL mode.

H. MACHINE STATUS (figure 3.3H)

1. Machine status lights indicate the operating status of several machine components. For each component: a 'solid

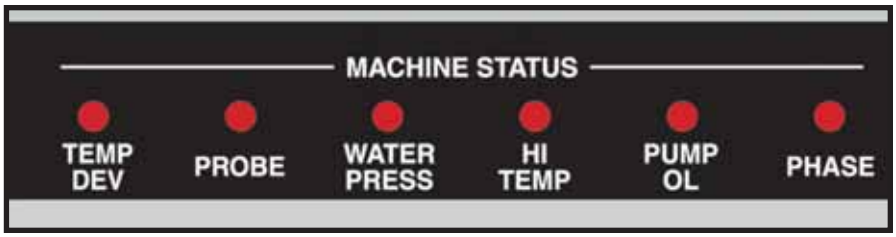

Figure 3.3H

green' light indicates an acceptable run condition; a 'flashing red' light indicates that the component is currently in an unacceptable run condition; a 'solid red' light indicates the component had once been in an unacceptable run condition but is now in an acceptable run condition. A 'solid red' light can be cleared to a 'solid green' light by pressing the START key.

a. **TEMP DEV:** this light will be 'solid green' when the process temperature is within the programmed setting. The light will be 'solid yellow' if the process temperature deviates outside the programmed setting. If the temperature remains out of band for 90 seconds or more, the light will 'flash red' and activate the alarm.

b. **PROBE:** indicates the status of the "to process" and "from process" sensor probes.

c. **WATER PRESS:** indicates the status of the water supply pressure switch.

d. **HI TEMP:** indicates the status of the high temperature limit switch.

e. **PUMP OL:** indicates the status of the pump motor overload relay. See section 3.2 paragraph C.2 for more information on the motor overload relay.

f. **PHASE:** indicates the status of the electrical phasing of the unit. See section 3.2 paragraph B for more information.

I. ALARM DISPLAY (figure 3.3I)

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1. **ALARM:** when this light illuminates 'solid red', an unacceptable condition has developed. A 115 volt alarm output is provided for external (factory or customer installed) alarm beacon or buzzer. An alarm signal can be silenced by pressing the START key.

Figure 3.3I

J. **COMMUNICATION DISPLAY** (figure 3.3J)

1. The communications display indicates the kind of exchange between the host computer and the unit. A single light is used:

Figure 3.3J

a. **GREEN FLASH:** indicates the unit is sending information to the host computer.

b. **YELLOW FLASH:** indicates the host computer is sending information to the unit.

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3.4 SHUT DOWN/DISCONNECT PROCEDURE

A. PRECAUTIONS/WARNINGS

1. The operator must precisely follow all shut down procedures outlined in this manual. If the operator fails to follow precisely all procedures outlined in this manual, an unsafe condition can develop resulting in damage to the unit or serious personal injury to operating personnel.

2. **WARNING:** when stopping unit operations and/or disconnecting the unit from the process system, the operator must determine the unit's process fluid temperature is below 100°F, all water system pressure is relieved and the unit's pressure gauge reads "0". Serious Injury to operating personnel and damage to the unit could result if a hot and pressurized unit is disconnected from the system.

B. UNIT SHUT DOWN (without system disconnect)

1. Adjust the setpoint temperature to 100°F or below. Setpoint temperature is indicated in the 'setpoint' window. The instrument will disengage the heater contactor (if engaged) and open the solenoid cooling valve (if installed). Allow the unit to operate in this condition until process temperature as indicated on the "temperature" display is at the ambient temperature or below 200°F. Failure to cool the process fluid below 200°F may damage the pump shaft seal when the unit is shut down.

2. Stop unit operations by toggling the ON/OFF rocker switch to 'off'. This action disengages the unit's electric pump motor.

3. Disengage the water supply to the unit by closing the unit's water supply valve (if installed) or by turning off the water supply source at the central control point. Relieve all water supply pressure via the pressure relief valve.

4. Disengage the electrical supply to the unit by switching 'off' the fused disconnect. Determine the POWER light on the display is **OFF**.

C. UNIT SHUT DOWN (with system disconnect)

1. Adjust the setpoint temperature to 100°F or below. Setpoint temperature is indicated in the 'setpoint' window. The instrument will disengage the heater contactor (if engaged) and open the solenoid cooling valve (if installed). Allow the unit to operate in this condition until process temperature as indicated on the "temperature" display is at the ambient

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temperature or below 200°F. Failure to cool the process fluid below 200°F may damage the pump shaft seal when the unit is shut down.

2. Stop unit operations by toggling the "on/off" rocker switch to "off". This action disengages the unit's electric pump motor.

3. Disengage the water supply to the unit by closing the unit's water supply valve (if installed) or by turning off the water supply source at the central control point. Relieve all water supply pressure via the pressure relief valve.

4. Disengage the electrical supply to the unit by switching "off" the fused disconnect. Determine the POWER light on the display is **OFF**.

5. Before disconnecting and removing the process circuity, be certain all system pressure is vented and the pressure gauge reads "0". When the process circuitry is disconnected and removed from the unit, follow the **mold purge procedure** (section 3.5) to contain most of the process fluid in the unit if required. If draining process fluid from the system, discharge fluid into a suitable container and dispose according to the fluid's manufacturer's instructions. When the process circuitry is removed, a small amount of fluid will be discharged from the unit. Please note that this fluid should not be warm or pressurized if all shut down and disconnecting procedures were followed. Remaining process fluid can be discharged by removing the pump casing drain plug.

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3.5 MOLD PURGE PROCEDURE

A. The **REGAL 'RK'** temperature controller is equipped with a mold purge feature (figure 3.5A). This enables the operator to change molds without losing a substantial amount of process fluid.

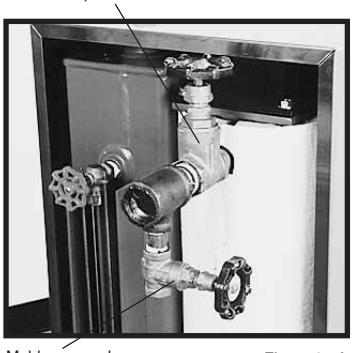

Figure 3.5A

B. **Caution:** the expansion reservoir is sized to allow the purging of most process systems. Oversized, extra long process lines or oversized process fluid channels could cause an overflow of the expansion reservoir during the mold purge procedure.

C. **Warning:** never attempt to purge hot fluid back to the unit. Damage to the unit and personal injury could result. Always cool the process fluid to below 100°F before beginning the mold purge procedure.

D. To use the mold purge system:

1. Cool the process fluid to 100°F or below for safety.

2. Turn off the unit and disconnect the power supply as outlined in this manual.

3. Fully close the "to process" shut-off valve. Please note, the "from process" valve remains open at this time.

4. Connect a compressed air line to the mold purge valve. The compressed air source must be regulated to a maximum of 10 psi. **Note: the air supply for mold purging must be completely dry!** Introduction of moisture to the oil supply may cause the unit to discharge oil and steam through the vent tube when reheated above 220°F.

5. Slowly open the "mold purge" valve. The compressed air will push the process fluid back to the expansion tank in the unit.

6. When the purge is complete as revealed by a completely filled sight glass, close the "mold purge" valve.

7. Close the "from process" line shut-off valve.

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4.0 TROUBLESHOOTING

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4.1 UNIT WILL NOT START ("POWER" LIGHT IS NOT ILLUMINATED)

A. Power supply to the **Regal** unit is **OFF**. The operator should determine the POWER light on the display is "off". The operator should check for the follow conditions:

1. One or more fuses at the main disconnect device are open (blown). Determine continuity at each fuse. If continuity is not determined, replace the fuse.

2. Control circuit transformer fuse open (blown). Determine continuity at the control circuit transformer fuse. If continuity is not determine, replace the fuse.

4.2 UNIT WILL NOT START ("POWER" LIGHT IS ILLUMINATED)

A. **Power supply to the Regal unit is ON.** The operator should determine that electrical power supply to the unit is "on" by an illuminated POWER light on the display. Even with the main power supply on, the unit is prevented from operations by one of the following conditions:

1. **Water supply pressure inadequate**. The unit is prevented from operation without adequate water supply pressure by a pressure switch. Sufficient water supply pressure must be present to close the switch and consent the circuit to the electric motor starter.

2. **Motor overload switch opened.** The electric motor is protected from overload conditions (excessive flow) by a set of thermal overload relays. These relays will open (trip) and prevent electric power from reaching the electric motor. If the overload relay is open, overload relay must be reset before operation can continue. An excessive flow condition must be isolated and corrected immediately.

3. **High temperature limit switch open.** The unit is prevented from operations with temperatures exceeding 510°F by a 'high temperature limit switch'. This switch is installed in the heating cylinder. If this switch is open (due to a high temperature condition), the control circuit is not consented and the unit cannot be started. If a high temperature condition exists, the unit must first 'cool down' (reduce fluid temperature) before the 'high temperature limit switch' will reset.

4.3 UNIT STOPS

A. The operator should determine the main power supply to the **Regal** unit is **ON** by an illuminated POWER light on the display head. With the main power supply 'on', the unit will be prevented from operations by the following conditions:

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1. **Water supply pressure inadequate**. The unit is prevented from operation without adequate water supply pressure by a pressure switch. Sufficient water supply pressure must be present to close the switch and consent the circuit to the electric motor starter.

2. **Motor overload switch opened.** The electric motor is protected from overload conditions (excessive flow) by a set of thermal overload relays. These relays will open (trip) and prevent electric power from reaching the electric motor. If the overload relay is open, overload relay must be reset before operation can continue. An excessive flow condition must be isolated and corrected immediately.

3. **High temperature limit switch open.** The unit is prevented from operations with temperatures exceeding 510°F by a 'high temperature limit switch'. This switch is installed in the heating cylinder. If this switch is open (due to a high temperature condition), the control circuit is not consented and the unit cannot be started. If a high temperature condition exists, the unit must first 'cool down' (reduce fluid temperature) before the 'high temperature limit switch' will reset.

B. The operator should check the POWER light on the display. If the light is off, main electrical power to the unit is not supplied. The operator should check the following conditions:

1. One or more fuses at the main disconnect device are open (blown). Determine continuity at each fuse. If continuity is not determined, replace the fuse.

2. Control circuit transformer fuse open (blown). Determine continuity at the control circuit transformer fuse. If continuity is not determine, replace the fuse.

4.4 UNIT OVERHEATS

A. The **Regal** unit will overheat when one of the following conditions are present. Overheating is evidenced by operations with 'to process' temperatures consistently above the selected setpoint temperature. Overheating is also evidenced by a 'to process' temperature that continues to escalate above the 'setpoint' temperature with no apparent cooling action, even though the COOL light is on. Extreme overheating is evidenced by 'to process' temperatures over 510°F. The operator should check for the following conditions:

1. **Solenoid cooling valve defective (optional):** The instrument opens (and closes) the cooling valve as prescribed by the current process load. If the solenoid valve becomes clogged with debris or scaled with mineral

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deposits, its operation is hindered (or fully prevented) and adequate cooling is prevented. The operator must service the cooling valve and remove any loose debris. Massive debris or scale deposits necessitate replacement of the cooling valve.

2. **Drain line obstruction:** The operator must determine if the drain line is obstructed by the following conditions. Section 2.4 outlines the parameters of correct drain line installation.

   a. **Closed drain line valve.** An installed but partially or fully closed valve in the drain line prevents full discharge to drain and contributes to an overheating condition. The operator should determine the drain line is open.

   b. **High drain back pressure.** Pressurized plant drain lines will prevent flow to drain if the differential between the water supply pressure and the drain line pressure is inadequate. The factory recommend minimum differential is 10 psi. If the differential is less than the factory recommendation, plant service personnel should take measures to reduce drain line pressure.

3. **Low process flow rate:** The **Regal** unit works most efficiently when the flow rate is high. When conditions of low process flow rate develop due to obstructions in the process system, the heat input into the system is unable to "dissipate" normally and "collects" in the system. The operator should check that all valves are open and hoses (if used) are void of kinks. Obstructions could occur in the process tooling and the operator should take steps to fully open water channels in the tooling.

4. **Control sensor probe defective:** A defective control sensor probe "fools" the instrument that "to process" temperature is lower than the actual temperature. In such cases, the instrument will engage the heater to elevate process temperature resulting in an overheat condition. The operator must replace the defective probe with a probe in working order.

5. **Instrument defective:** The instrument is designed and manufactured exclusively by **ADVANTAGE.** The instrument is life-tested and found to be field reliable. However, in the case where the instrument is determined to be defective, the operator must remove the assembly and return the assembly to the factory. The instrument is not a field serviceable component.

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4.5 UNIT UNDERHEATS

A. The **Regal** unit will underheat when one of the following conditions is present. Underheating is evidenced by operations with 'to process' temperatures consistently below the selected setpoint temperature.

1. **Process water leakage.** When the instrument engages the heater to elevate process temperature, the input of heat into the process can be offset by the following:

a. **Defective cooling valve.** If the solenoid valve is defective, it may pass a larger than required stream to drain, thus providing unwanted cooling. A defective valve should be repaired immediately.

2. **Heater element failure.** A failed heater element will not input adequate heat into the process to elevate temperature. The operator must check the amps at the heater contactor with the contactor energized. Zero amps indicates a failed heater. The operator should remove the failed heater and replace it with a new heater.

3. The process may experience heat loss by:

a. **Radiation.** Radiation may be experienced when process lines are long and excessive.

b. **Unit capacity too low.** This occurs when the process requires more heat than the **Regal** unit's heater is capable of producing. In such cases the heat input is not sufficient to maintain setpoint temperature. The only option in such cases is to install a **Regal** unit with an adequate heater KW rating for the load.

4. **Control sensor probe defective.** A defective control sensor probe "fools" the instrument that 'to process' temperature is higher than the actual temperature. In such cases, the instrument will disengage the heater and open the cooling valve to cool the process resulting in an underheat condition. To correct this condition, the operator must replace the defective probe with a probe in working order.

5. **Regal 400° instrument defective:** The instrument is designed and manufactured exclusively by **ADVANTAGE.** The instrument is life-tested and found to be field reliable. However, in the case where the instrument is determined to be defective, the operator must remove the assembly and return the assembly to the factory. The instrument is not a field serviceable component.

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5.0 MAINTENANCE

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5.1 PREVENTIVE MAINTENANCE

A. The following is a guide to preventive maintenance. The frequency of maintenance will vary with each application, installation conditions, flow rates, hours of use and operating temperatures.

B. Preventive maintenance:

1. Tighten all wiring connections.

2. Check plumbing. Repair any leaks. The factory recommends using a high temperature graphite paste and teflon tape on all plumbing connections.

3. Descale water cooling channels in the pump seal cooling adapter.

4. Descale water cooling channels in the heat exchanger (if installed).

5. Check process fluid for degradation. The operating conditions affects the useable life of the process fluid. Most heat transfer fluid manufacturers have an analysis program where a sample of process fluid can be sent to the manufacturer to determine when the fluid should be replaced. Some manufacturers even have reclamation programs of the spent fluid.

6. Check sight glass for proper operation. Due to oil degradation, the sight glass feeder tubes may become clogged. In such cases, the sight glass may show an inaccurate level. Follow proper shut down procedures before removing sight glass to check feeder tubes.

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5.2 PUMP SEAL REPLACEMENT

A. The **Regal** unit pump seal is a carbon/niresist shaft seal assembly including a stationary member, rotating member and tension spring (figure 5.2A).

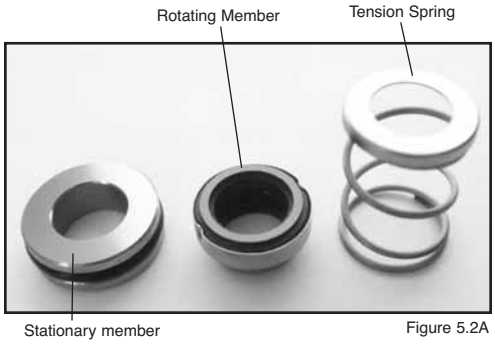

Figure 5.2A

B. The operator can determine the pump seal is leaking when fluid is identified leaking from the pump case adapter.

C. Generally, a pump seal will leak due to inadequate unit pressure, excessive flow and poor fluid quality.

D. The operator should follow this procedure to replace the pump seal:

1. Disengage process operations according to the procedure outlined in **section 3.4**. The operator must be certain process fluid temperature is under 100°F and pressure is relieved (pressure gauge reads "0") and water system flow is shut off and all pressure relieved.

2. Disengage main power supply. The operator must verify the POWER light on the display is off.

3. Disengage the component cooling water supply to the unit by closing the unit's water supply valve (if installed) or by turning off the water supply source at the central control point. Relieve all water supply pressure by opening the pressure relief valve.

4. Access the pump motor by opening or removing any cover panels as necessary (figure 5.2B).

5. Drain machine. The machine can be drained by using the drain valve located on the pump case. Drain fluid into a suitable container for reuse or disposal according to manufacturer's instructions.

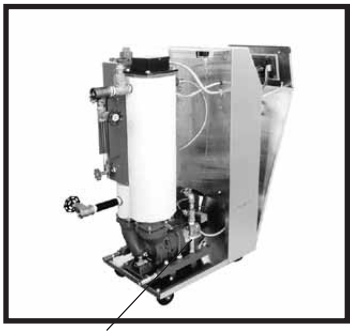
Lift-off panel removed. RK-1230 shown

Figure 5.2B

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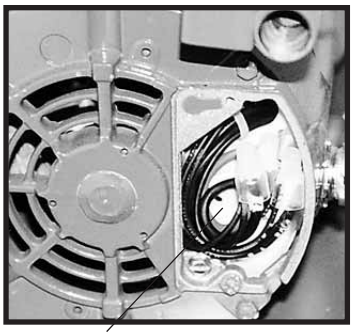
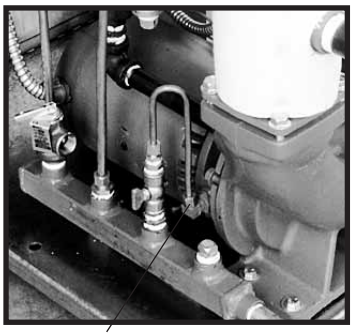
6. Locate and remove the three motor wire leads from the motor wiring terminals. The operator should "map" the wire terminal locations to ensure correct rewiring. The power cord should be removed from the motor housing (figure 5.2C).



Motor wires exposed

Figure 5.2C

7. Locate and disconnect the water lines from the pump adapter. These copper tubes supply cooling water to the pump seal cooling jacket (figure 5.2D).

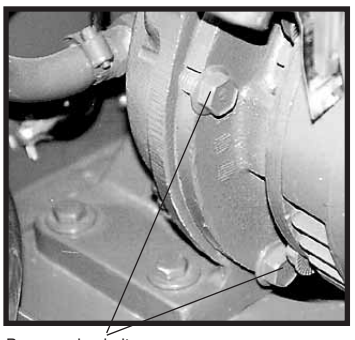


Pump seal cooling line

Figure 5.2D

8. Locate and remove the pump casing bolts. These bolts secure the motor and motor adapter to the pump casing (figure 5.2E).

9. Separate the motor and motor adapter from the pump casing to expose the pump impeller (figure 5.2F). Remove the motor and motor adapter from the **Regal** unit and place on a workbench to continue the procedure.

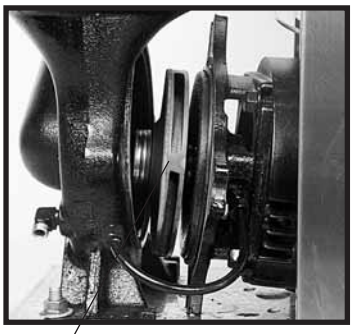


Pump casing bolts

Figure 5.2E

10. Locate and remove the dust cap from motor end to expose slotted motor shaft. The motor shaft is free to rotate, but must be secured to remove the impeller. To secure the motor shaft, insert a flat bladed screw driver in slot to hold the shaft stationary (Figure 5.2G).

11. Locate and remove impeller locking screw (Figure 5.2H). Using a socket and ratchet, the impeller retaining screw can be removed. Once the



Typical motor and casing separation

Figure 5.2F

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retaining screw is removed, the impeller can be "unthreaded" from the motor shaft to expose the pump seal assembly.

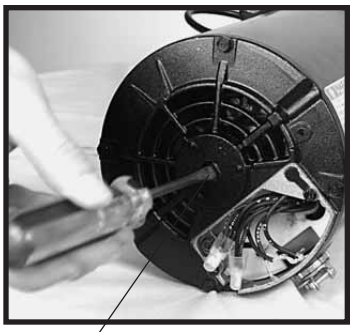

Figure 5.2G

12. Remove all seal parts (Figure 5.2I). Note seal component arrangement to facilitate reassembly.

13. Clean motor shaft and lubricate with a mild soap solution.

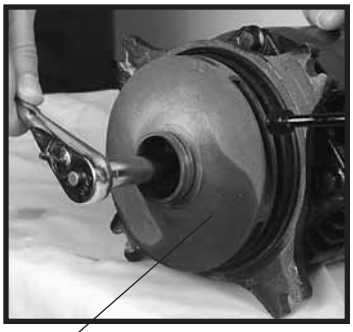

Figure 5.2H

14. Install new stationary seal member in pump casing cavity (figure 5.2J). The operator must be certain the stationary seal member is fully squared and seated in cavity.

15. Slide the rotating member onto the lubricated pump shaft (figure 5.2K). The operator must be certain not to damage or tear the rubber bellows assembly.

16. Place the spring onto the rotating member.

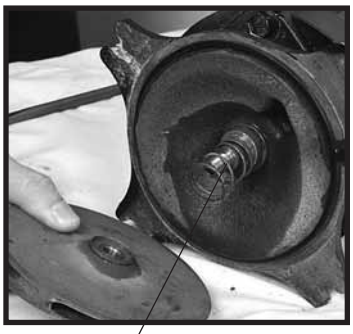

Figure 5.2I

17. Align the impeller, spring and rotating member before reinstalling the impeller (figure 5.2L). The operator must be certain the spring and rotating member are aligned before the impeller is fully tighten and the impeller retaining screw is reinstalled.

18. Clean pump casing, cavities, impeller and O-ring before reassembly.

Figure 5.2J

19. Mate the motor and motor adapter to the pump casing. Reinstall the pump casing bolts.

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20. Reconnect the water cooling lines to the pump adapter.

21. Reconnect the motor power cord and leads.

20. Restore all cover panels as were removed.

E. When the pump seal replacement procedure is complete, the operator may restart the **Regal** unit according the **section 3**. In some cases, a new pump seal will experience a small amount of leakage for a short time. This is normal. After operating a few moments, the new seal will take action and the leak will stop.

Figure 5.2K

Figure 5.2L

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5.3 HEATING CYLINDER REPLACEMENT

A. The **Regal** unit's heater is a flange mounted assembly (figure 5.3A). The heater assembly is inserted into a cast tank and secured by mounting bolts.

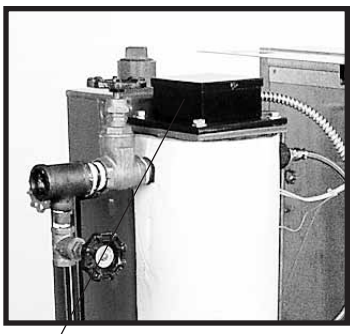

Figure 5.3A

B. The operator can determine the heater requires replacement when the heater draws "0" amps or when a continuity check of each heater element is negative.

C. Generally, heaters fail due to low fluid flow or contamination of the fluid.

D. The operator should follow this procedure to replace the heater:

1. Disengage process operations according to the procedure outlined in **section 3.4**. The operator must be certain process fluid temperature is under 100°F and pressure is relieved (pressure gauge reads "0").

2. Disengage main power supply. The operator must verify the POWER light on the display is "off".

3. Remove the lift-off access panel and set aside

4. Drain process fluid into a suitable container. The machine can be drained by opening the drain/fill valve.

5. Remove heater's junction box cover to located wiring connections. The operator should "map" the wiring connections to ensure correct reinstallation (figure 5.3B).

Figure 5.3B

6. Disconnect the three power leads from heater terminals. Remove the power cord from junction box.

7. Remove the heater mounting bolts (figure 5.3C).

Figure 5.3C

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8. Remove heater (figure 5.3D).

9. Before the new heater is installed, the mating surface of the cast tank should be cleaned. Once cleaned, place the new heater gasket onto the mating surface. Coat the mating surfaces with a high temperature gasket sealant.

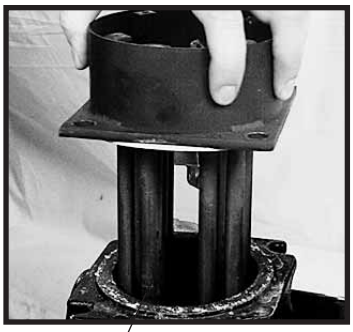

Figure 5.3D

10. Set new heater into tank. Aligning the bolt pattern of the heater and tank flanges.

11. Replace the heater mounting bolts. Alternate to the opposite bolt while tightening.

12. Reconnect the power cable to the heater terminals. Be certain to tighten the power cord junction box connector. Replace the junction box cover.

D. When the heater replacement procedure is complete, the operator may restart the **Regal** unit according to the procedure outlined in **section 3** of this manual.

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5.4 SOLENOID VALVE SERVICE

A. **Regal** units with the optional cooling system use a solenoid valve (figure 5.4A) to regulate flow through the heat exchanger. The solenoid valve is controlled by the instrument.

Typical cooling solenoid valve on RK units

Figure 5.4A

B. The operator can determine the solenoid valve requires service when the process fluid is not cooled (unit overheats) as required.

C. Generally, cooling solenoid valves fail due to poor water quality, low water flow, or defective valve elements.

D. The operator should follow this procedure to service the cooling solenoid valve:

1. Disengage process operations according to the procedure outlined in **section 3.4**. The operator must be certain process fluid temperature is under 100°F and pressure is relieved (pressure gauge reads "0") and water system flow is shut off and all pressure relieved.

2. Disengage main power supply. The operator must verify the POWER light on the display is "off".

3. Remove or open any access cover panel and set aside to gain access to the cooling solenoid valve.

4. The operator must be certain all water system pressure is relieved. Use the pressure relief valve mounted in the drain manifold to relieve all pressure.

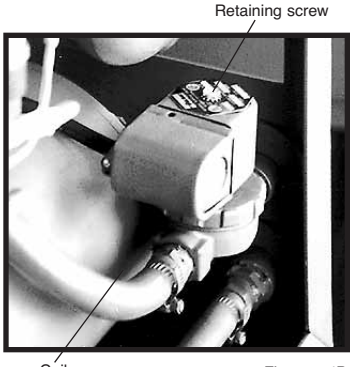

Figure 5.4B

5. Identify the retaining screw (figure 5.4B) on the solenoid valve coil. Remove the screw. Keeping all electrical connections intact, lift the coil off of the enclosure tube and set aside.

6. Use a pair of channel lock pliers or a pipe wrench to separate the bonnet assembly from the valve body. The plunger is "loose" inside the enclosing tube. Be certain it is retained in the enclosure tube as the bonnet is removed (figure 5.4C).

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7. Identify the diaphragm assembly. Gently remove the assembly from the valve body (figure 5.4D).

8. Identify the mesh screen. Gently removed the mesh screen and clean or replace as necessary. Clean the valve body.

9. Reset the mesh screen into the valve body.

10. If a new diaphragm assembly was obtained, continue with step 11. If not, disassemble the diaphragm assembly and note component order (figure 5.4E). Clean the valve port, plate, collar and O-ring. Once cleaned, reassemble the diaphragm.

11. Set the reassembled diaphragm assembly into the valve body. The stem should be facing out of the valve body.

12. Inset the plunger with spring first into the enclosing tube of the top bonnet (figure 5.4F). Holding the plunger in the enclosure tube, set the top bonnet onto the valve body and tighten.

13. Place the coil onto the top bonnet and replace the retaining screw.

14. Open the water supply and drain valves (if installed) to circulate water through the supply and drain manifolds. check the solenoid valve for leakage. Restart the unit**.**

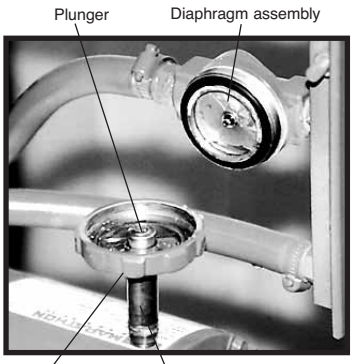

Figure 5.4C

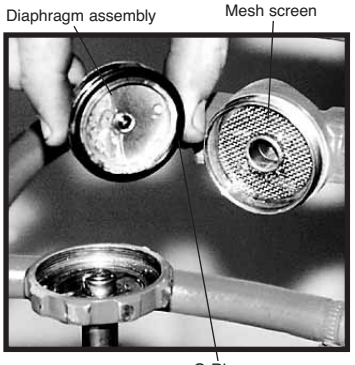

Figure 5.4D

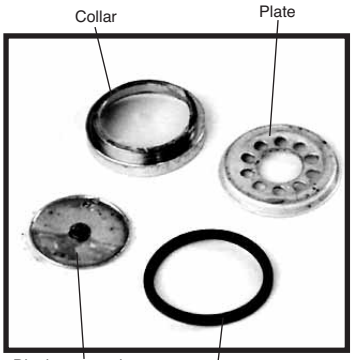

Figure 5.4E

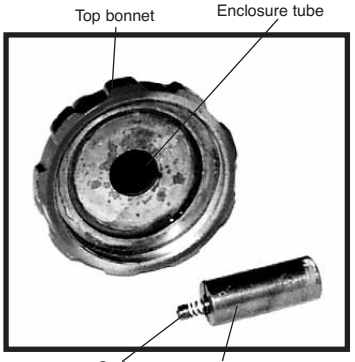

Figure 5.4F

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6.0 REGAL COMPONENTS

6.1 MECHANICAL SYSTEM
6.2 ELECTRICAL SYSTEM

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6.1 MECHANICAL SYSTEM

A. PUMP/MOTOR ASSEMBLY: The **Regal** unit pump is a multi-component assembly serving to circulate fluid through the process system. The pump will increase system pressure from 15 - 40 PSI over the at-rest pressure. The pump is driven by an electrical motor.

1. Pump casing: The pump casing is an exclusive **Regal** design. The casing is cast of iron and flanged to accept the heater/discharge and expansion tanks. The casing is the support element in the pump/motor assembly and is secured to the unit base (figure 6.1A).

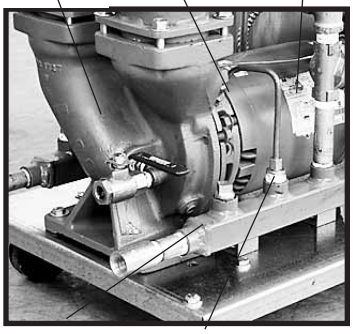

Figure 6.1A

2. Pump adapter: the pump adapter is the mating element between the pump casing and the electric motor. Molded into the adapter is the pump seal cooling channel. The stationary pump seal member is set in the seal cavity of the pump adapter and is cooled by circulating water through the cooling channel from the supply manifold. (figure 6.1A).

3. Electric motor: the electric motor is a 3 phase, ODP motor. The motor serves to turn the pump impeller creating process flow (figure 6.1A).

4. Impeller: the impeller is custom to the **Regal** unit and creates the process fluid flow (gpm) (figure 6.1B).

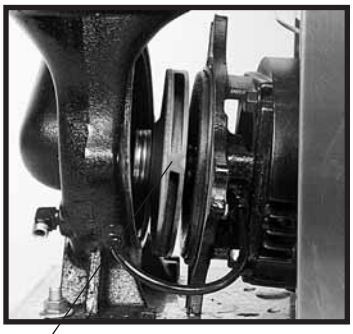

Figure 6.1B

5. Pump Seal: the pump seal prevents fluid leakage from the pump adapter. The seal is made up of three items: the stationary member (seated in the seal cavity), the rotating member (placed on the motor shaft) and the tension spring (figure 6.1C shows the stationary member only).

Figure 6.1C

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B. **HEATER:** the heater is a flanged mounted immersion heater set in the pump discharge cylinder. The heater elements have a steel sheath. Electrical supply to the heater is provided via a mercury contactor (figure 6.1D).

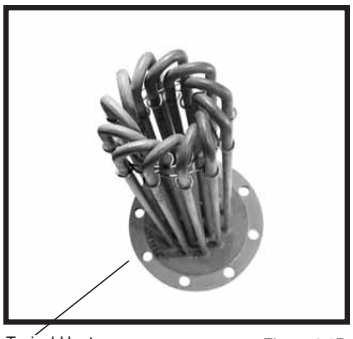

Figure 6.1D

C. **HEATER/PUMP DISCHARGE CYLINDER:** the heater/pump discharge cylinder is a custom cast tank. The tank is heavily wrapped with layered fiberglass insulation, flanged mounted to the pump casing and the flanged mounted heater is placed inside the tank. The 'to process' connection and valve and mold purge valve assembly are mounted at the top of the tank. Thermocouple sensors, high temperature limit and oil feeder line to the heat exchanger (optional) are located at the top of the tank (figure 6.1E).

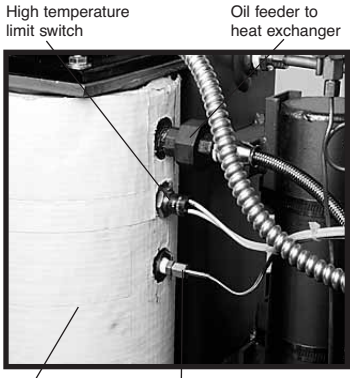

Figure 6.1E

D. **EXPANSION TANK/SUCTION CYLINDER:** the expansion tank is a custom welded tank designed to contain the expanding volume of heated process fluid. The tank is also designed to accept a majority of fluid volume for storage during mold purge. The suction cylinder is flanged mounted to the pump casing and accepts the "from process" valve and line (figure 6.1F).

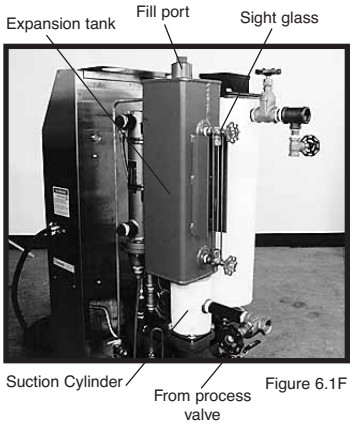

Figure 6.1F

E. **SIGHT GLASS:** the fluid level sight glass gives an indication of the fluid level in the expansion tank (figure 6.1F).

F. **FILL PORT:** the fill port accepts fluid for initial unit fill or "topping off" fluid level as required.

G. **HEAT EXCHANGER:** the optional heat exchanger is of tube and shell design for high temperature use. The process fluid circulates through the "shell" side and cooling water from plant supplies circulates

Figure 6.1G

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through the "tube" side. Process fluid flow originates from the top of the heater/discharge tank, flows through the heat exchanger and returns to pump casing. Cooling water flow is controlled via the solenoid valve.

H. **WATER SUPPLY MANIFOLD:** the cooling water supply manifold serves to provide cooling water flow for pump seal cooling, optional heat exchanger cooling, and pressure switch (figure 6.1H).

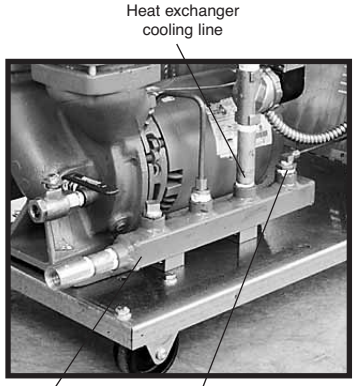

Figure 6.1H

I. **DRAIN MANIFOLD:** the return manifold serves as a collection point for the optional heat exchanger and the pump seal cooling. The **PRESSURE RELIEF VALVE** is mounted in the return manifold on most models. The pressure relief valve is a 150 psi relief valve serving to discharge excessive unit pressure to the atmosphere. The valve can be manually activated by lifting the actuating lever (Figure 6.1I).

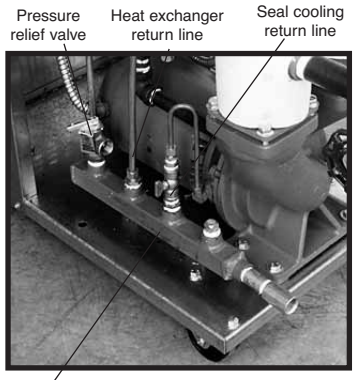

Figure 6.1I

J. **PRESSURE GAUGE:** "to" process pressure gauge displays the system pressure, as generated by the process pump (figure 6.1J).

K. **CASTERS:** the **Regal** unit is mounted on 4 (2 swivel and 2 rigid) ball bearing casters. The casters allow the unit to be pushed to location (figure 6.1J).

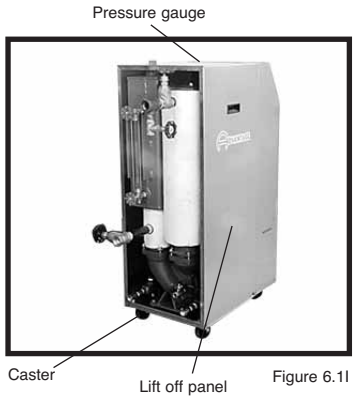

Figure 6.1I

L. **STAINLESS STEEL CABINETRY.** The stainless steel cabinetry prevents unsightly rust and metal decay. The electrical cabinet cover is hinged and held open by support straps. The unit base is made of pressed steel with galvanized zinc coating. The lift off access panel is secured to the unit base by 4 thumb screws (figure 6.1J). The factory recommends using a dedicated "stainless steel" cleaning

Figure 6.1J

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agent to clean the **Regal** cabinetry. Common household cleaners such as "Windex" will not maintain the mirror finish of the stainless steel (figure 6.1J).

6.2 ELECTRICAL SYSTEM

A. **REGAL INSTRUMENT:** the **Regal** instrument is a custom designed and assembled microprocessor controller. The instrument is mounted to the electrical panel cover in most cases. The instrument controls the cycling of the heater, motor pump, cooling valve. System temperature is displayed continually. System parameters are programmable (figure 6.2A).

Figure 6.2A

B. **TRANSFORMER.** The transformer supplies 110 volts to the controlling instrument (Figure 6.2B).

C. **MOTOR STARTER/OVERLOAD RELAY:** the electrical motor is engaged when the motor starter contacts close, on command by the **Regal** instrument. The electric motor is protected from excessive amperage by a set of thermal overload relays, which open when excessive amperage "heats" up the overloads and the relay opens (figure 6.2B).

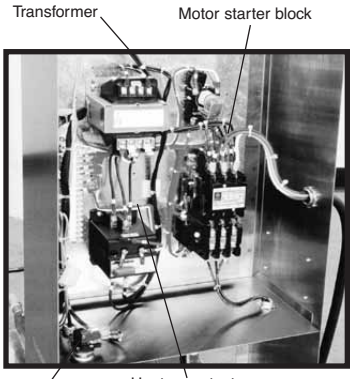

Figure 6.2B

D. **HEATER CONTACTOR.** The heater contactor is a mercury contactor. On command from the **Regal** instrument, the mercury contactor will close and voltage will be supplied to the heater (figure 6.2B).

E. **PRESSURE SWITCH.** The electric panel mounted pressure switch will close when sufficient pressure is supplied to the **Regal** unit (20 psi). A closed pressure switch will consent the control circuit to the **Regal** instrument to allow process operations (figure 6.2B).

F. **THERMOCOUPLE PROBE.** The **Regal** uses type-J thermocouple sensors. The "to process" sensor is mounted in the top of the heater/discharge tank. The "from process" sensor is mounted in the suction cylinder.

G. **POWER CORD.** The supplied power cord (Nema 1 units only) is factory installed to the **Regal** unit. The power cord is a 3 conductor with 1 ground wire sized for the **Regal** unit and 10' in length.

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7.0 RELATED DRAWINGS

7.1 REGAL 'RK' PHYSICAL - 6-12 KW HEATERS & 1-3 HP PUMPS
7.2 REGAL 'RK' PHYSICAL - 36-48 KW HEATERS & 5-7.5 HP PUMPS
7.3 REGAL 'RK' MECHANICAL SCHEMATIC
7.4 REGAL 'RK' ELECTRICAL - REGAL 400° INSTRUMENT

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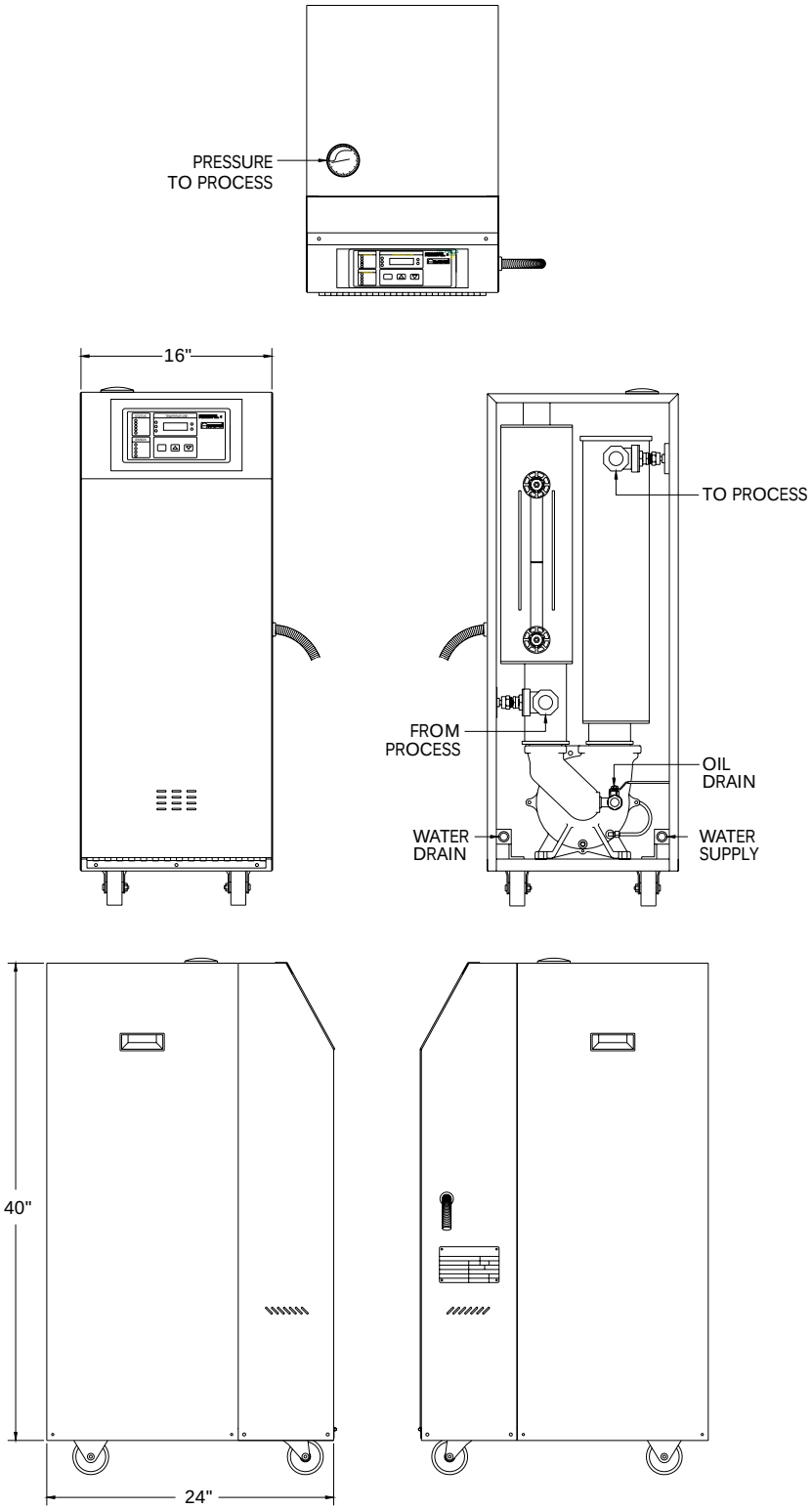
7.1 REGAL 'RK' PHYSICAL - 6 -12 KW HEATERS & 1-3 HP PUMPS



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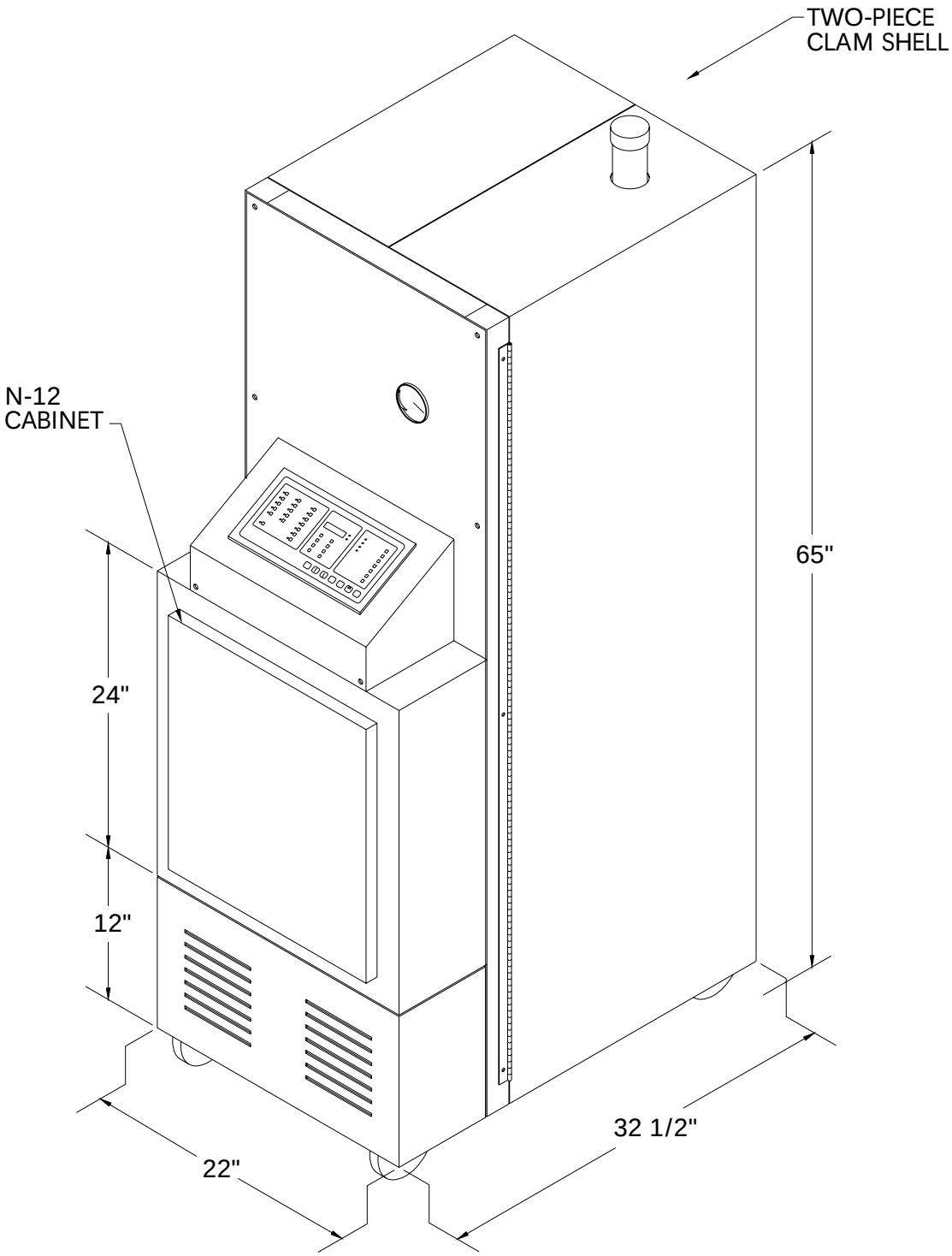
7.2 REGAL 'RK' PHYSICAL - 36-48 KW HEATERS & 5-7.5 HP PUMPS



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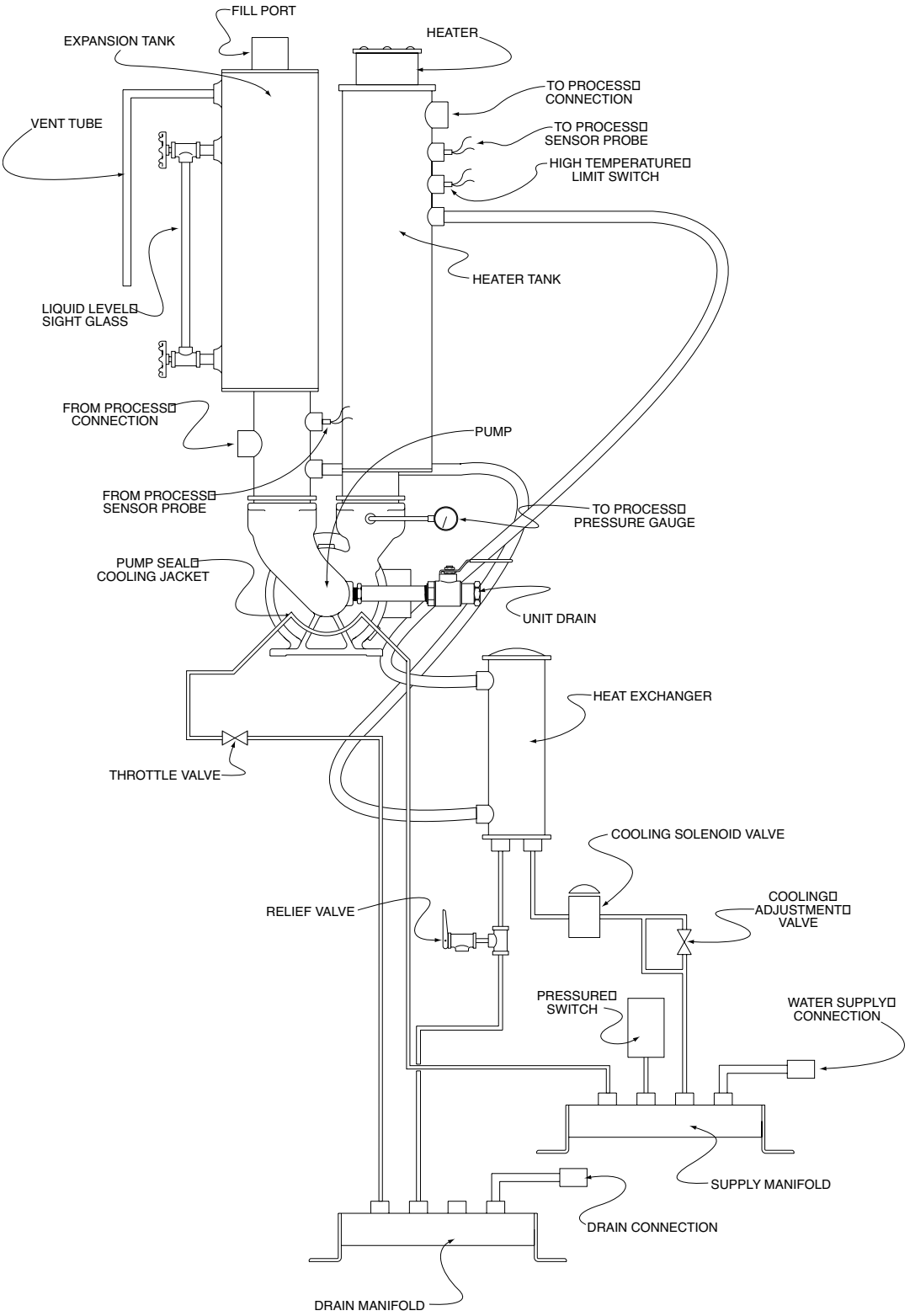
7.3 REGAL 'RK' MECHANICAL SCHEMATIC



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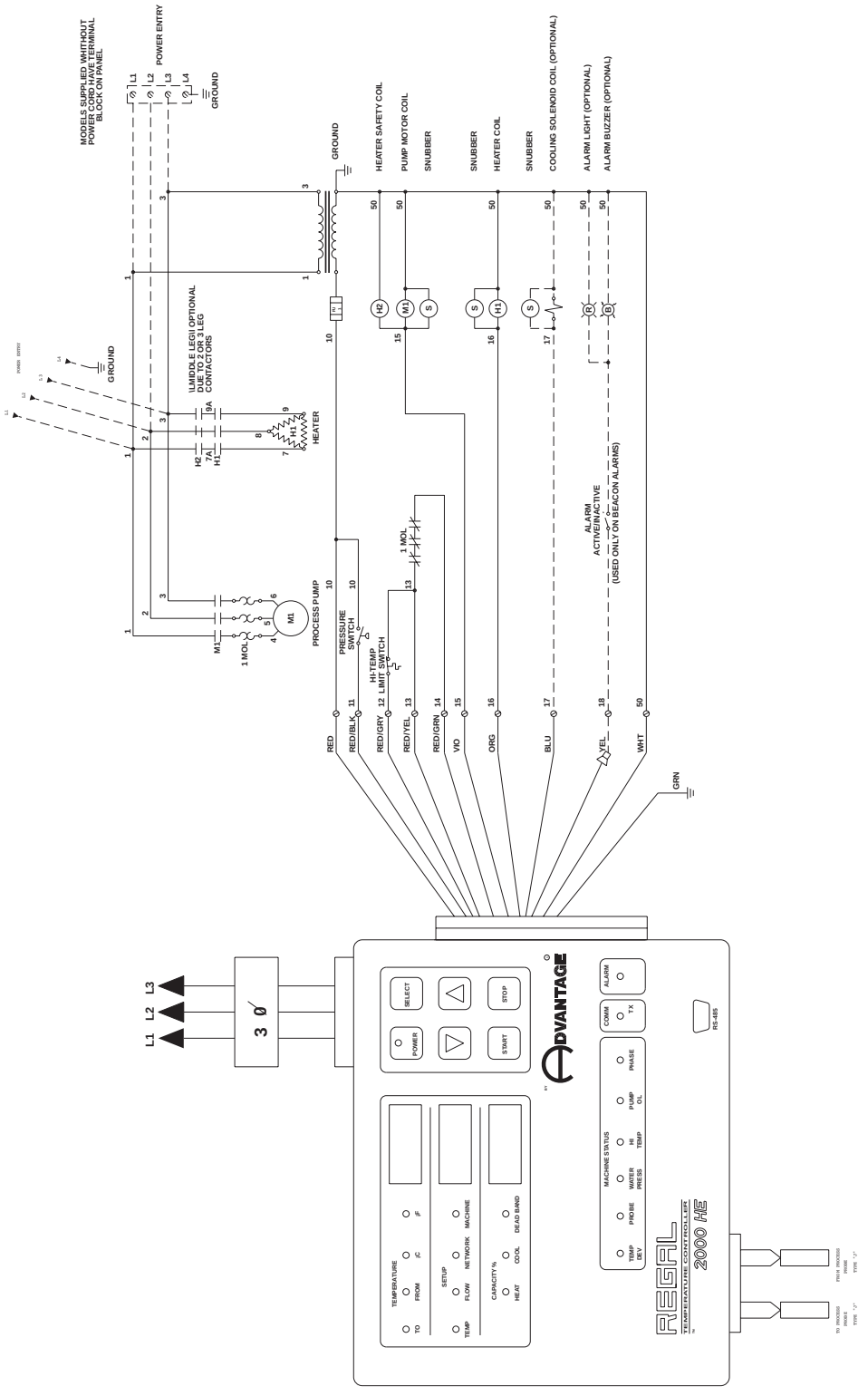
7.4 REGAL 'RK' ELECTRICAL



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8.0 APPENDIX

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8.1 REGAL 'RK' SPECIFICATIONS

MODEL	HTR KW	PUMP HP	PUMP GPM	PUMP PSI	AMPERAGE[1] 230	AMPERAGE[1] 460	DIMENSIONS[2] H	DIMENSIONS[2] W	DIMENSIONS[2] D	PIPE SIZE A[3]	PIPE SIZE B[4]	WGT[5]
RK-1230H	12	1	30	24	34.8	17.9	44	16	24	1	1/2	275
RK-1230HC	12	1	30	24	34.8	17.9	44	16	24	1	1/2	280
RK-1245H	12	1.5	45	26	36.4	18.7	44	16	24	1	1/2	285
RK-1245HC	12	1.5	45	26	36.4	18.7	44	16	24	1	1/2	290
RK-1250H	12	2	50	28	38.0	19.5	44	16	24	1	1/2	300
RK-1250HC	12	2	50	28	38.0	19.5	44	16	24	1	1/2	305
RK-1845H	18	1.5	45	26	40.8	26.2	55	20	28	1 1/2	1/2	580
RK-1845HC	18	1.5	45	26	40.8	26.2	55	20	28	1 1/2	1/2	585
RK-1850H	18	2	50	28	51.6	27.0	55	20	28	1 1/2	1/2	595
RK-1850HC	18	2	50	28	51.6	27.0	55	20	28	1 1/2	1/2	600
RK-1860H	18	3	60	26	56.0	28.4	55	20	28	1 1/2	1/2	610
RK-1860HC	18	3	60	26	56.0	28.4	55	20	28	1 1/2	1/2	615
RK-2760H	27	3	60	26	78.4	39.6	55	20	28	1 1/2	1/2	625
RK-2760HC	27	3	60	26	78.4	39.6	55	20	28	1 1/2	1/2	630
RK-2770H	27	5	70	28	84.0	42.4	65	22	33	2	1/2	715
RK-2770HC	27	5	70	28	84.0	42.4	65	22	33	2	1/2	720
RK-27100H	27	7.5	100	44	90.8	45.8	65	22	33	2	1/2	730
RK-27100HC	27	7.5	100	44	90.8	45.8	65	22	33	2	1/2	735
RK-3660H	36	3	60	26	101.1	50.9	65	22	33	2	1/2	640
RK-3660HC	36	3	60	26	101.1	50.9	65	22	33	2	1/2	695
RK-3670H	36	5	70	28	106.7	53.7	65	22	33	2	1/2	725
RK-3670HC	36	5	70	28	106.7	53.7	65	22	33	2	1/2	730
RK-36100H	36	7.5	100	44	113.5	57.1	65	22	33	2	1/2	740
RK-36100HC	36	7.5	100	44	113.5	57.1	65	22	33	2	1/2	745
RK-4870H	48	5	70	28	136.8	68.9	65	22	33	2	1/2	750
RK-4870HC	48	5	70	28	136.8	68.9	65	22	33	2	1/2	755
RK-48100H	48	7.5	100	44	143.6	72.3	65	22	33	2	1/2	770
RK-48100HC	48	7.5	100	44	143.6	72.3	65	22	33	2	1/2	775

1. Full load amps shown.
   For 575 FLA: amps @ 460 x .81
   For 208 FLA: amps = 230 x 1.11
2. Dimensions shown in "inches"
3. Process pipe size shown in "inches"
4. Water supply and drain pipe size shown in "inches"
5. Shipping weight shown in "pounds"

REGAL OIL TEMPERATURE CONTROLLER ™ "RK" Series ONLY FROM ADVANTAGE®

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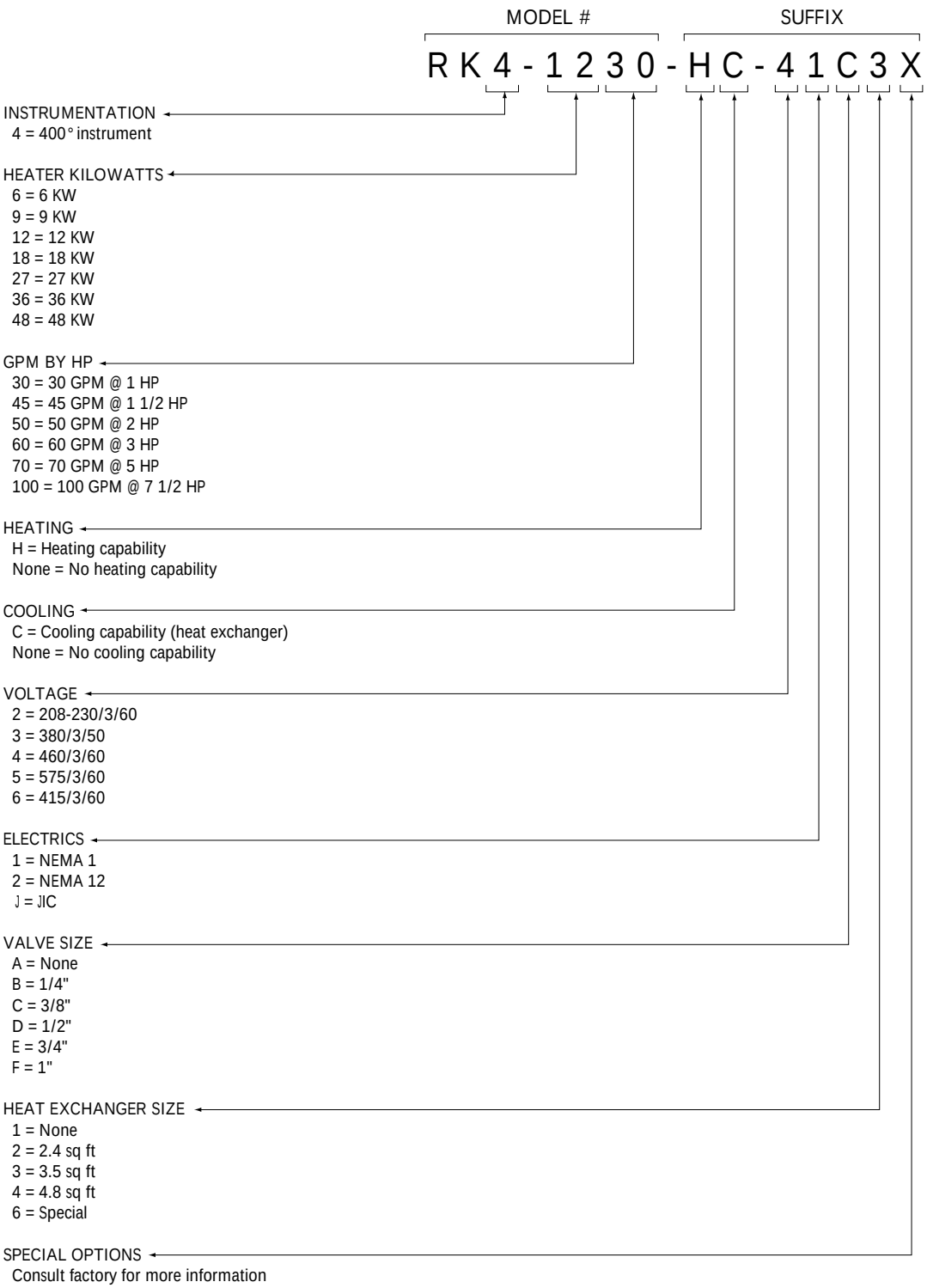
8.2 REGAL 'RK' MODEL # AND SUFFIX CODING



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8.3 REGAL WATER COOLED PROCESS PUMPS

A. The centrifugal pumps used on **ADVANTAGE** Regal RK series temperature controllers employ a water circuit to cool the mechanical seal.

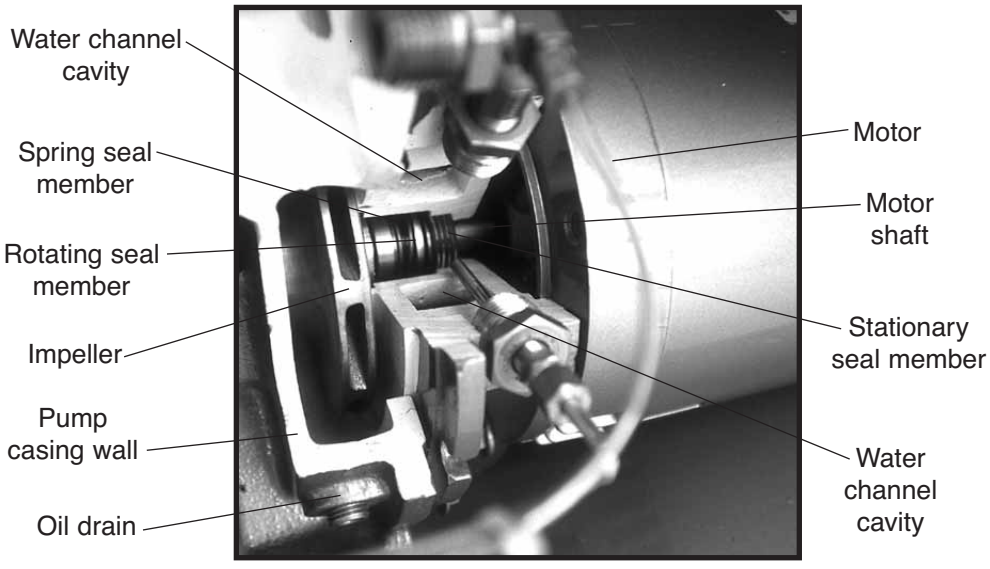
B. The exclusive **ADVANTAGE** hot oil pump has a "hidden" channel cavity molded into the casing. This channel circumscribes the seal area. The channel is fed cooling water from the plant's supply source. As the unit pumps hot oil (up to 500°F) to process, the cooling circuit serves to "protect" the seal by "spot" cooling the area immediately around the seal (see photograph below).

C. As a safety precaution, a pressure switch is installed in the supply line to monitor the water source. If the pressure falls below 10 psi, the switch cuts the control circuit and the unit stops. Thus, the **ADVANTAGE** hot oil temperature controller can only operate when there is adequate cooling supply water.

D. On Regal I microprocessor control instruments, a temperature sensor is installed into the channel to monitor the water temperature. If this temperature rises above 200°F, the microprocessor will signal a fault and shut down the unit as a safety precaution. Normally, this temperature is well below 150°F, even when the unit is heating oil to 500°F.

E. The advantages to the **ADVANTAGE** water cooled hot oil pump are:

1. Lower shaft seal temperatures for longer seal life (less maintenance!)
2. Motor bearings run cooler for longer motor life (less maintenance!)



Pump casing has been "cut away" for this photograph

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8.4 DIP SWITCH SET UP

A. DESCRIPTION

1. The 5 position DIP switch is located in the center of the CPU board and is used to set options for machine operation. **The switches should only be changed when the instrument is turned OFF**. Definitions of the 5 DIP switches are listed below.

B. DEFINITIONS

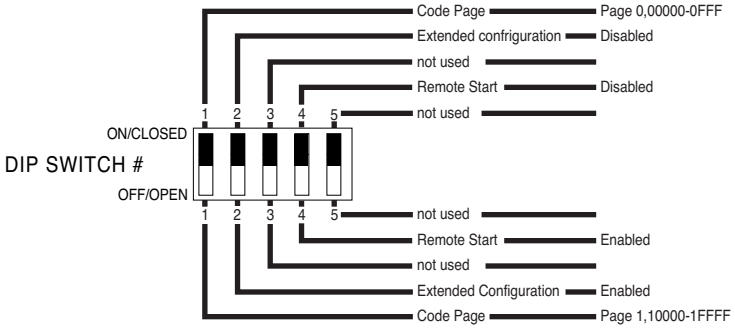
1. SW1 - code page for EPROM.
ON - (default) code page 0 is active.
OFF - code page 1 is active.

2. SW2 - extended configuration
ON - (default) extended configuration is DISABLED
The display will NOT show additional information
OFF - extended configuration is ENABLED
The display will show:
"SP2" - 'no'/'yes' Disable/Enable 2nd Setpoint
"rSP" - 'no'/'yes' Disable/Enable Remote Setpoint

3. SW3 - not used
ON - (default)
OFF -

4. SW4 - remote start/stop
ON - (default) remote start DISABLED
OFF - remote start ENABLED

5. SW5 - not used
ON - (default)
OFF -



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8.5 ADVANCED SETUP

A. When the instrument powers up, the display will go through a "WOW" mode where all LEDs are turned on for approximately 4 seconds. The version will scroll from right to left in the first (top) and second display windows. The display will then go into a STOP mode where all displays are OFF except the Probe, Phase and Power LEDs. When the START key is pressed, the instrument will enter the RUN mode display as described below:

RUN mode display:

1. "TTT" - TO process temperature
2. "SSS" - SETPOINT
3. "CCC" - CAPACITY

B. When the SELECT key is pressed, the 1 and 2 display will cycle through the following combinations. Display 3 will remain CAPACITY as above. Where indicated, with + - , the value of display 2 can be modified by pressing the UP and DOWN ARROW keys. If no keys are pressed within 5 seconds, the display will return back to the NORMAL TO process display.

C. NORMAL Display Mode:

	1	"TTT"	TO process temperature
+ -	2	"SSS"	SETPOINT local or remote + (SP2, if enabled)
	1	"FFF"	FROM process temperature
+ -	2	"SSS"	SETPOINT local or remote + (SP2, if enabled)
	1	"SP "	Setpoint - only when "rSP" equals "NO"
+ -	2	"SSS"	SETPOINT local - 0 to 250
	1	"rSP"	Remote Setpoint Select - *Only when extended configuration is enabled
+ -	2	"Loc"	Local Setpoint Enabled - "rSP" equals 'yes'
+ -	2	"REn"	Remote Setpoint Enabled
	1	"SPL"	Local Setpoint - *Only when "rSP" equals 'yes'
+ -	2	"SSS"	Local Setpoint Value
	1	"SPr"	Remote Setpoint - *Only when "rSP" equals 'yes'
+ -	2	"SSS"	Remote Setpoint Value
	1	"SP2"	2nd Setpoint - **Only when "SP2" equals 'yes'
+ -	2	"SSS"	2nd Setpoint offset - +- 99, bounded by Setpoint
	1	"HI "	High temp deviation limit
+ -	2	"HHH"	limit - 0 to 30

note: * and ** require additional hardware

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	1	"Hi "	High temperature deviation limit
+ -	2	"HHH"	Limit - 0 to 30
	1	"Lo "	Low temperature deviation limit
+ -	2	"LLL"	Limit - 0 to 30
	1	"Pro"	Protocol
+ -	2	"SPi"	for SPI
+ -	2	"CAC"	for CAMAC
	1	"Adr"	Protocol Address
+ -	2	" 1"	thru " 99" for SPI
+ -	2	" 0"	thru " 9" for CAMAC
	1	"Rat"	Protocol Baudrate
+ -	2	" 96"	where 96=9600, 48=4800, 24=2400, 12=2400
	1	"Unt"	Temperature Units
+ -	2	" F"	Fahrenheit
+ -	2	" C"	Centigrade

D. Extended Configuration Enabled by SW #2

*	1	"SP2"	2nd setpoint enable/disable
+ -	2	"no "	Disable 2nd setpoint
+ -	3	"YES"	Enable 2nd setpoint
**	1	"rSP"	Remote Setpoint enable/disable
+ -	2	"no "	Disable remote setpoint
+ -	2	"YES"	Enable remote setpoint

note: * and ** required additional hardware

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8.6 SPI COMMANDS

A. **INTRODUCTION:** In 1987 a group of member companies of the Society of the Plastics Industries began development of a communication protocol for use by their processing and auxiliary equipment. Their goal was to allow the exchange of information between various pieces of equipment from different manufacturers to be simple and reliable. The result of their work was released in 1990 and has made the interconnection of equipment much easier and straightforward. There are now over 40 companies that offer the SPI Protocol in their products. This document details the implementation of the SPI Protocol available in the SENTRA 'SK' temperature controllers and MAXIMUM 'MK' portable chillers with HE instruments.

B. **PROTOCOL BASICS:** The SPI Protocol is described by a 2 part specification. The largest portion of the SPI Protocol specification deals with how basic information is exchanged between equipment. The second part of the specification details the actual pieces of information exchanged using the protocol. Items such as Process Temperature, Process Setpoint and Process Status are detailed in this part. This FYI will list the commands that are supported by ADVANTAGE equipment.

C. **EQUIPMENT SETUP:** The setup of equipment to be connected in an SPI Protocol network is simple. Each device must have a unique address for its device type and it must use the same data transfer rate as the other pieces of equipment in the network. There are many acceptable ways used to 'set' the device address and data rate. ADVANTAGE equipment provides access to the information via the front panel operators and displays. Other manufacturers may use internal DIP switches or jumpers.

A typical cell may be configured as follows:

Data Transfer Rate: 9600 bits per second (bps)
Mold Temperature Controller (Qty 2): Addresses 1 and 2
Chiller (Qty 1): Address 1

Note in the above example that different device types may have the same address. This is because the SPI Protocol uses the device type as part of its internal address.

D. **NETWORK TROUBLESHOOTING:** Troubleshooting a network is best done by verifying the setup of each piece of equipment and insuring that the network is installed with the correct electrical interconnection. Here are some basic things to do if equipment isn't 'talking' as expected.

1. Verify that each piece of equipment is properly grounded to its power source.

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2. Inspect cables inside and outside the electrical cabinet. Repair or replace as necessary.The cable scheme used by most manufacturers allows the communication signals to 'pass through' each piece of equipment. Therefore, when a piece of equipment is disconnected from the middle of the network, all the equipment 'after' that one will be disconnected, too. If a piece of equipment is being permanently removed, the device cables should be rearranged at the molding machine to reconnect the other equipment.

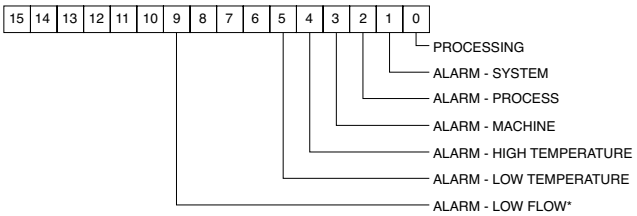
3. Check the Data Transfer Rate and Address of each piece of equipment. For example, if both Temperature Controllers have the same address, they will both try to 'talk' at the same time and garble each other's data.

4. Verify the network is properly terminated and that it is configured as a 'multi-drop'. This is best achieved by following the molding machine manufacturer's installation instructions and use extension cables provided by them or us.

5. Attach each device, singly, to the molding machine and see if it 'talks'. Add additional devices until a problem is seen.

REGAL 'RK TEMPERATURE CONTROLLER SPI COMMANDS

POLL C1	POLL C2	SELECT C1	SELECT C2	COMMAND	DESCRIPTION
20	20	20	21	Echo	Controller integrity command
20	20			Version	Controller version command
20	30	20	31	Setpoint	Desired process temperature
20	32	20	33	High temp	Hi temperature deviation alarm
20	34	20	35	Low temp	Low temperature deviation alarm
20	36	20	37	Flow Alarm	Low flow alarm setpoint*
20	40			Status Process	



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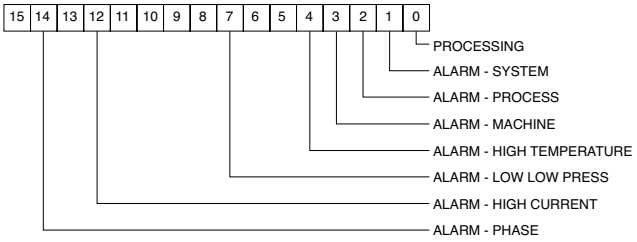
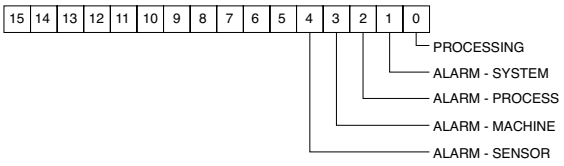
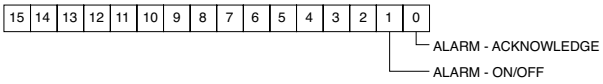
POLL C1 C2	SELECT C1 C2	COMMAND	DESCRIPTION
20 42			Status Machine 1



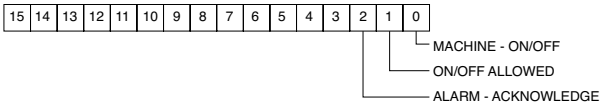
POLL C1 C2	SELECT C1 C2	COMMAND	DESCRIPTION
20 44			Status Machine 2



POLL C1 C2	SELECT C1 C2	COMMAND	DESCRIPTION
20 48	20 49		Machine



POLL C1 C2	SELECT C1 C2	COMMAND	DESCRIPTION
20 4A	20 4B		Protected mode - machine



POLL C1 C2	SELECT C1 C2	COMMAND	DESCRIPTION
20 70			Temperature to process
20 72			Temperature from process*
20 78			Flow rate from unit GPM*
20 E0			Blanket Poll
		Returns:	20 30 Setpoint
			20 32 High alarm deviation
			20 34 Low alarm deviation
			20 40 Status process
			20 70 To process temperature

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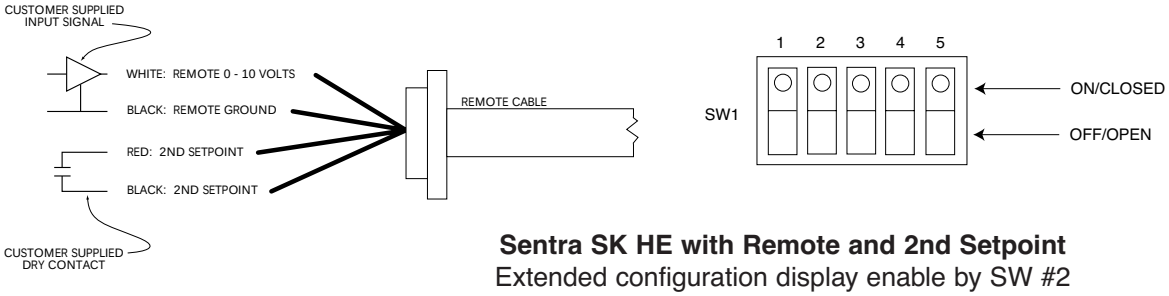
8.7 SECOND SETPOINT OPERATION

A. The SENTRA SK instrument is available with optional second setpoint capability. The second setpoint is activated by a contact closure between the red and black wires on the remote cable. The remote adjustable setpoint is activated by the input of 0-10 volts.

B. The instrument must be configured for second setpoint or remote setpoint before use. To access the extended configuration menu the second DIP switch (located on the top edge of the CPU board) must be toggled to the off position.

C. To activate the second setpoint function use the select key to access the "SP2" prompt in the extended menu. With the up arrow select 'yes' to enable the second setpoint option.

D. To activate the remote setpoint use the select key to access the "RSP' prompt in the extended menu. With the UP arrow select "yes" to enable the remote setpoint function.



Sentra SK HE with Remote and 2nd Setpoint
Extended configuration display enable by SW #2

	1	"AFL" Alternate Flow Sensor
+ -	2	"no" Internal - small flow sensor
+ -	3	"yes' Alternate - large flow sensor
	1	"Int" NO, Internal, small flow sensor selected
+ -	2	"SSS" Calibration factor for small flow sensor
	1	"ALT" YES, Alternate, large flow sensor selected
+ -	2	"LLL" Calibration factor for large flow sensor
	1	"SP2" 2nd Setpoint Enable/Disable
+ -	2	"no" Disable 2nd Setpoint
+ -	2	"YES" Enable 2nd Setpoint
	1	"rSP" Remote Setpoint Enable/Disable
+ -	2	"no" Disable Remote Setpoint
+ -	2	"YES" Enable Remote Setpoint

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8.8 REGAL 'RK' SPARE PARTS LIST - 460 VOLT

PART #	DESCRIPTION
800000	Caster 3" Swivel
810000	Caster 3" Rigid
1759992	Contactor CR353CA2AA1 30 AMP
1835050	Contactor 3030APS 30 AMP
2735418	Top/Back Cover RK EP-231
2746241	CABINET SK/RKD DWG #EP-109A
2761202	Electrical Sub Panel DWG #EP-109B
2851115	Gauge Bracket SK/RK DWG #EP-109B
2877543	Bottom Bracket SK.RK DWG #EP-109A
3570000	Pressure Gauge 0-60 PSI
3605000	Sight Glass Set 12"
3608600	Sight Glass Only 12"
5622290	O'Ring kit (two) for 1/2" sight glass
3708505	Plastic Handle P2-41
3725000	Heat Exchanger 3.6 sq/ft
3444106	Gasket for 0314Sx2000 Heat Exchanger
3804035	Heater 12KW oil 460 volt
3520007	Gasket 8" x 5" 8 hole
4251030	Braided hose 3/8" NPT x 22" length
4251035	Braided hose 3/8" NPT x 30" length
4460190	RK-HE Instrument kit #248100
6206499	Thermocouple ungrounded Type J #6430030
5723000	Petcock valve 38 1/4 FIP x 1/4 FIP
6211032	Motor/pump assembly A5WF 1HP Oil Pump
415	Adapter AE5W #C2-4460 5 Hole Flange
771601	Case AE5 #D2-1728
3444160	Heating cylinder gasket 3" #A2-8944
3444175	Case Gasket A5W #A2-8611
4310488	Impeller A5W 4-1/2" #A2-8609X
4757863	Motor AE5/AS5/A5W 1HP #S-2773R
5486521	Impeller Nut AE5 #124S07A1
6495550	Shaft Seal A5W #S-2143
7163511	Slinger AE5 #C-8854
7250000	Solenoid Valve GP-4 1/2"
1162300	Solenoid Coil GP
6658000	Repair Kit GP-4
7303000	Plunger Spring GP-4
7370000	Motor Starter CR354ABAA1B
1733456	Auxiliary Contact Kit
7541100	Panel Mount Pressure Switch #352XAAA
8156010	Thermostat High Temp Limit 520°F
8244000	Transformer 9T58B45
8770000	Valve Ball B600 1/2"
8890000	Valve Gate 79-016 1" bronze
9070000	Relief Valve #100 PSI

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8.9 REGAL 'RK' SPARE PARTS LIST - 230 VOLT

PART #	DESCRIPTION
800000	Caster 3" Swivel
810000	Caster 3" Rigid
1759993	Contactor CR353CA2AA1 30 AMP
1835100	Contactor 3030A 30 AMP
2735418	Top/Back Cover RK EP-231
2746241	CABINET SK/RKD DWG #EP-109A
2761202	Electrical Sub Panel DWG #EP-109B
2851115	Gauge Bracket SK/RK DWG #EP-109B
2877543	Bottom Bracket SK.RK DWG #EP-109A
3570000	Pressure Gauge 0-60 PSI
3605000	Sight Glass Set 12"
3608600	Sight Glass Only 12"
5622290	O'Ring kit (two) for 1/2" sight glass
3708505	Plastic handle PS-41
3725000	Heat Exchanger 3.6 sq/ft
3444106	Basket for 0314Sx2000 Heat Exchanger
3804030	Heater 12KW oil 230 volt
3520006	Heater flange gasket 6" sqaure 500'
4251030	Braided hose 3/8" NPT x 22" length
4251035	Braided hose 3/8" NPT x 30" length
4460190	RK-HE Instrument Kit #248100
6206474	Thermocouple 48" ungrounded #6433030
5723000	Petcock valve 38 1/4 FIP x 1/4 FIP
6211032	Motor/pump assembly A5WF 1HP Oil Pump
415	Adapter AE5W #C2-4460 5 Hole Flange
771601	Case AE5 #D2-1728
3444160	Heating cylinder gasket 3" #A2-8944
3444175	Case Gasket A5W #A2-8611
4310488	Impeller A5W 4-1/2" #A2-8609X
4757863	Motor AE5/AS5/A5W 1HP #S-2773R
5486521	Impeller Nut AE5 #124S07A1
6495550	Shaft Seal A5W #S-2143
7163511	Slinger AE5 #C-8854
7250000	Solenoid Valve GP-4 1/2"
1162300	Solenoid Coil GP
6658000	Repair Kit GP-4
7303000	Plunger Spring GP-4
7370000	Motor Starter CR354ABAA1B
1733456	Auxiliary Contact Kit
7541100	Panel Mount Pressure Switch #352XAAA
8156010	Thermostat High Temp Limit 520°F
8244000	Transformer 9T58B45
8770000	Valve Ball B600 1/2"
8890000	Valve Gate 79-016 1" bronze
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8.10 PARATHERM NF SPECIFICATIONS

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PARATHERM NF® SPECIFICATIONS

PHYSICAL PROPERTIES	
Feedstock	NF/USP hydrotreated hydrocarbon base
Appearance	Transparent, colorless, bright
Taste & odor	None
Optimum use range	120°F to 600°F (49°C to 316°C)
Maximum recommended film temperature	640°F (338°C)
Flash point (coc) ASTM-D-92	345°F (174°C)
Flash point (pmcc) ASTM-D-93	335°F (168°C)
Fire point (coc) ASTM-D-92	385°F (196°C)
Autoignition ASTM-D-2155	690°F (366°C)
Autoignition ASTM-E659-78	691°F (367°C)
Atmospheric boiling point	
10% fraction, ASTM D-1160	650°F (343°C)
Vapor Pressure	
@ 200°F	0.0005
@ 300°F	0.003
@ 400°F	0.147
@ 500°F	0.967
@ 600°F	4.720
Coefficient of thermal expansion	0.000304/°F
Average molecular weight	350
Density, lb/gal @ 75°F (24°C)	7.25
Pour point (crystal point) ASTM D-97	-45°F (-43°C)
Pumpability: centrifugal @ 2,000 centipoise	-13°F (-25°F)
H_2 solubility, @ 760 mm Hg/25°C	10 ppm by weight
Surface tension @ 760 mm Hg/25°C	28 dynes/cm
Heat of vaporization (calculated)	90.72 BTU/lb
ELECTRICAL PROPERTIES	
Dielectric strength @ 20°C	30-40KV/cm
DC volume resistivity	10^{12} ohm
Dielectric constant @ 1 MHz	2.17
Dissipation factor @ 1 MHz	0.0002
OPTICAL PROPERTIES	
Refractive index @ 20°C	1.4768

ADVANTAGE Engineering recommends the use of **PARATHERM NF®** heat transfer fluid in hot oil temperature controllers. **PARATHERM NF®** can be purchased directly from the Paratherm Corporation (1-800-222-3611), a local vendor or **ADVANTAGE**. This document covers handling and use of **PARATHERM NF®.**

FLUID FOULING

Unlike conventional heat transfer fluids, **PARATHERM NF®** will not cause hard carbon formation on heated surfaces. Conventional heat transfer fluids, when severely overheated, can produce sooty carbon at the film layer. This carbon adheres to the heated surface and bakes on forming a crust. As layer-upon-layer builds up, heat transfer-and in many cases, flows, are impaired. Nearly impossible to remove without scraping, sandblasting or using chlorinated solvents, carbon chunks can break off and circulate throughout the system impeding flows and fouling components. Where fouling is extreme, heater tubing and electrical elements can prematurely fail.

Under similar extreme overheat conditions, the **NF®** fluid evolves small carbon granules. These granules remain in suspension, and can be filtered out easily.

ADVANTAGE ENGINEERING, INC.
525 East Stop 18 Road Greenwood, Indiana 46142
317-887-0729 Fax: 317-881-1277
Service Department Fax: 317-885-8683

ENVIRONMENTAL SAFETY

The **NF®** fluid has passed the Bioassay test. Rainbow trout, Daphnia pulex and Mysidopsis bahia were subjected to a water-continued soluble fraction of the **NF®** fluid. No organisms died, and there were no ill effects. In the event of a spill, the **NF®** fluid can be treated using the same clean-up procedures employed for light lubricating oils. Once gathered and placed in a container, the **NF®** fluid can be sent to the local oil recycler, where it can be recycled into other usable materials. The **NF®** fluid contains no aromatics, heavy metals, or compounds of sulfur or nitrogen.

FLUID TOXICITY
PARATHERM NF® is completely non-toxic. It is certified by the FDA and USDA for use with food and pharmaceuticals, and carries the USDA's H-1 incidental food contact rating. Where other fluids can produce skin dermatitis, the **NF®** fluid has been reported to actually soften the skin. If the fluid is ingested in any quantity, laxative properties may be observed.

VAPOR PRESSURE
PARATHERM NF® fluid has a vapor pressure well below atmosphere at its maximum operating temperature of 600°F. Combined with a low pressure drop, low vapor pressures permit the designer more latitude in the choice of lower-cost equipment (at 600°F vapor pressure of the **NF®** fluid is just 4.72 psia).

EFFICIENCY
The lower a heat transfer fluid's viscosity, the lower the energy required to pump it through the system. **PARATHERM NF®** has among the lowest viscosity of any high temperature heat transfer fluid available. This means that less horsepower is needed for a given duty and that a smaller pump and motor can be specified.

CORROSION IN THE SYSTEM
The **NF®** fluid is manufactured from natural oil feedstocks, and offers similar metal-coating and lubricating properties as natural oils. However, any water allowed to stand in thermal oil systems can cause severe corrosion. Because the **NF®** fluid is slightly less dense than, and will not mix with water, water in the system can be easily drained from the system's low points. Open a low point and allow fluid to drain into a beaker. If you see a phase separation, continue to drain until no separation is observed.

STORING
Drums of heat transfer fluid should be kept in non-hazardous dry areas. Until ready for use, the seals should not be broken. Liquids should not be allowed to pool on the tops of the drums. In the afternoon and evening when temperatures cool, the heat transfer fluid will contact this "pooling" liquid. A partial vacuum is created in the drum, and if the bung seal is not perfect, any liquid on the top can be drawn through contaminating the fluid.

FLUID DISPOSAL
Because **PARATHERM®** heat transfer fluids are produced from natural feedstocks, they are exceptionally safe to use and easy to dispose. The fluids can be safely combined with used lubricating oils and recycled or burned for BTU value. **PARATHERM®** strongly encourages recycling of used heat transfer fluid to conserve our precious natural resources and to minimize the problem of liquid waste in landfills. We suggest you check local, state and federal regulations first. **Note**: liquids contaminated with chlorininated solvents or other regulated materials may require special handling, and may not be accepted by recyclers.

FLUID ANALYSIS
Overheating, oxidation and contamination of your heat transfer fluid will cause a reduction in its ability to perform. In severe cases, damage to the thermal oil system can result. Periodic analysis of your fluid can allow you to detect problems in the early stages, and can result in substantial savings. Once your system is charged with **PARATHERM®** heat transfer fluid, **PARATHERM®** offers the first analysis at no charge to encourage a regular program of testing.

QUALITY CONTROL
PARATHERM® tests each batch of heat transfer fluid to ensure that product specifications are being met. Each shipment is traceable to the master batch, with test results held at **PARATHERM®**.

TECHNICAL ASSISTANCE
PARATHERM®'s technical expertise is available to you during the planning and design stages, and through system construction, start-up and operation. **PARATHERM®** will be pleased to work closely with you in the recommendation of proven systems, components and procedures. We can also advise you on system cleaning and repair. should these become necessary.

FOR MORE INFORMATION CONTACT:

Paratherm Corporation
1050 Colwell Road • Conshohocken PA 19428
(610) 941-4900 • Fax (610) 941-9191 • **(800) 222-3611**

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