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KEMCO SYSTEMS

Operations and Maintenance Manual

TE-100+ Direct Contact Water Heater – November 2019

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1 Introduction

1.1 System Overview

This manual describes the Kemco Water Heating system and covers the requirements for equipment installation, operation and routine maintenance. It is intended to be used as a quide for operator training and as a reference resource for maintaining the Kemco system in proper working order.

1.2 Purpose

The purpose of this Operations and Maintenance Manual is to provide sufficient information and direction to enable qualified personnel to install, operate and maintain the Kemco equipment safely.

This manual provides a comprehensive guide to the functions, parts, and instrumentation and controls associated with the provided equipment. Together with engineering drawings and other documentation supplied, sufficient information is provided to enable the reader to gain an overall understanding of the system.

This manual also outlines procedures used to operate and maintain the system properly. Diagnostic and troubleshooting information is provided to assist in identifying faults and corrective actions.

The information provided herein may not cover all operating details or variations for all conditions in connection with installation, operation and maintenance. Should questions arise which are not answered specifically in this manual, contact Kemco Systems Service Department. Training services are available or the equipment operatrors are included as part of the start-up, but follow-up training can also be arranged.

Kemco reserves the right to make engineering refinements that may not be reflected in these manuals. The material in these manuals is for informational purposes and is subject to change without notice.

1.3 References

The following documents are supplementary to this manual:

- List other equipment manuals provided with system
- Project-specific Schematic Flow Diagram(s)
- Project-specific Layout
- Project-specific Wiring Diagram(s)

1.4 Glossary

Approach – The approach is the difference between the primary fluid inlet temperature and the secondary fluid outlet temperature. In this case, it is the difference between the incoming water temperature and the exhaust.

Direct Contact Water Heater – Direct contact water heaters (DCWH) claim near 100% efficiency as they squeeze nearly every BTU from the combustion process. Flue gases are passed through the water being heated and the water vapor in the combustion air is condensed. Direct contact refers to the water coming into direct contact with the combustion gases.

Programmable Logic Controller (PLC) – An industrial -control component that utilizes a central processing unit (CPU) to monitor and control a system. One major difference between PLC's and computers are that PLCs continuously loop a single program of programming code which results in monitoring of parameters (via inputs) or manipulating components via electrical signals (outputs).

2 Safety

2.1 General

The importance of safety cannot be overstated. Safety for our customers, employees and our products, is of utmost importance to Kemco Systems. Reviewing this manual in its entirety is crucial to creating a safe environment for this system.

With all major items of equipment, know the equipment applications, limitations and potential hazards. Kemco recommends that both operators and installers read this manual prior to installation or operation of the equipment.

Incorrect installation, neglected preventative maintenance, abuse, and/or improper repairs or modifications to the equipment can cause unsafe operation, injury or death. The owner or owner's representative, herein referred to as "user", is responsible for understanding and ensuring proper operation and maintenance of the equipment. The user must familiarize himself/herself with the contents of all the equipment instruction manuals. The user should direct any questions regarding these manuals or equipment to the Kemco Systems Service Department.

2.2 Equipment Hazards

2.2.1 General Hazards

Careless user action during operation or maintenance can damage equipment or the facility, injure personnel and void warranty.

- Do not operate the equipment if it is damaged or operating incorrectly.
- Do not attempt any unauthorized modifications or repairs to the equipment.
- Never use the equipment for any purpose other than it's intended use.
- Never apply undue force to any fittings or valves and always open and close manual valves slowly.
- Use proper wiring and connection methods to satisfy local electrical codes.
- To avoid electrical shock hazard, do not remove covers or panels when power is supplied to the device. Do not operate equipment while covers or panels are removed.
- Connect this device to a properly grounded connection in accordance with the National Electric Code. Do not under any circumstances remove the ground wire or ground prong from any power plug. Do not use extension cords without proper consideration.

2.2.2 Gas Hazards

If you smell gas:

1. Open windows.
2. DO NOT touch electrical switches.
3. Extinguish any open flame
4. Immediately call your gas supplier.

Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other applicance. Improper Improper servicing of this equipment may create a potential hazard to equipment and operators.

Servicing must be done only by fully trained and qualified personnel.

Before disconnecting or opening up a fuel line and before cleaning or replacing parts:

1. Turn off the manual gas shutoff valve.
2. Turn off power to the burner.

3 System Description

3.1 Principles of Operation

The Kemco gas fired water heater is a non-pressurized direct contact unit constructed of high temperature stainless steel. The water being heated comes in direct contact with the combustion product gases. This design achieves the highest efficiency possible. Conventional heating units operate with efficiencies between 60 to 80 percent. The Kemco heater, however, can operate with a thermal efficiency of over 99 percent. In fact, since the unit can draw heat from the ambient air, it is not unusual to achieve operative efficiencies of over 100 percent.

3.2 Major System Mechanical Components

This section provides a brief description of major mechanical components and functionality with respect to the unit process. The operation of the heater is most easily understood by discussing in terms of working "zones".

Zone 1 is the spray distribution zone. Water enters the heater under pressure, usually 10-30 Psi. The water passes through a wide angle spray nozzle which distributes the water evenly over the heater cross section, and reduces the water pressure to atmospheric pressure. The water next falls into Zone 2.

Zone 2 is the heat transfer zone which is filled with stainless steel packing rings. As the water trickles down through this packing, it comes in contact with the combustion product gases that are being blown upward through the packing. This design reduces the temperature of the exhaust gases to nearly ambient temperature, thereby eliminating stack heat losses.

Zone 3 is the combustion zone. The preheated water passes through this zone and comes in direct contact with the hot combustion product gasses. The final heat transfer occurs here before the water settles into the storage zone.

Zone 4 Temporarily stores the hot water received from Zone 3 before it is discharged. Water is removed from the heater at the same rate that it enters the heater, consequently, the water level in Zone 4 is held constant. The storage zone, combustion zone, and part of the heat transfer zone are protected by the water wall. The water wall is another cylinder inside the heater. This cylinder is approximately 2 inches smaller in diameter than the heater outer shell. The gap between the water wall and the heater shell remains full of water at all times. Whenever the burner is firing "MAIN FLAME", water will be pumped into this gap causing the water stored there to overflow into the storage zone. This constant overflowing and wall of water makes a refractory unnecessary.

The burner mounting snout is protected in a similar fashion.

3.3 Heater Terminology and Construction

In order to better understand the operation of the Kemco direct contact gas fired water heater, it is first necessary to understand the terms used to describe the different items which make up the heater. The item numbers used below refer to Figure 1.

Item 1 – Heater Shell

The heater shell is the outside surface of the heater which extends from the floor to the top of the heater.

Item 2 – Water Wall

The water wall is an internal shell which extends from the base to a point near the middle of the heater. The water wall is concentric with the heater shell with a gap between the water wall and heater shell approximately one inch wide. The water wall is welded to the base of the heater. Water is circulated between the water wall and the heater shell during operation to keep the heater shell from overheating.

Item 3 – Media Screen

The media screen is an expanded metal sheet which is attached to the media support ring located inside the water wall and at an elevation that is approximately one foot above the center of the burner. The media screen supports the packing rings (media) used to transfer heat from the flame to the water.

Item 4 – Flame Shroud

The flame shroud is a sheet of alloy steel used to shield the burner flame from the water flowing down through the packing. The flame shroud is permanently attached to the bottom of the media screen.

Item 5 – Media

The media, or packing rings, are specially designed stainless steel rings which have expanded tabs to present as much surface area as possible to both the downward water flow and the upward combustion gas flow. This is the region of the heater in which most of the heat transfer occurs.

Item 6 – Spray Nozzle

The spray nozzle is used to direct a steady stream of water uniformly across the packing rings. Each nozzle is selected specifically for the heater application taking into account factors such as available water pressure, spray angle, height restrictions on the heater, and uniformity of the spray pattern. For special conditions, more than one nozzle may be used.

Item 7 – Water Inlet Pressure Switch

This pressure switch is used to detect and assure that water is flowing through the spray nozzle. If the pressure at this point falls below set level, which indicates insufficient flow, the heater will automatically shut itself off to prevent damage.

Item 8 – Flue Gas Outlet Stack

The flue gas outlet stack is the stubbed opening in the top of the heater through which the flue gas exits the heater. The outlet is sized to minimize the number of water droplets carried out of the heater as the result of the flue gas velocity. This stack also serves as a support for the spray nozzle piping and as an access point to the spray nozzle. A stack section is usually attached to the flange on the heater stack to direct the flue gas out of the building.

Item 9 – Stack High Temperature Switch

The stack high temperature switch is used to shut down the heater when the temperature of the flue gas exceeds a preset value.

Item 10 – Water Wall Level Switch

The water wall level switch is used to verify that there is water in the water wall. The control system will prevent the burner from lighting or will shut the heater down if there is no water in the water wall.

Item 11 – Gas Train

The gas train consists of the piping, fittings, and necessary control components to supply gas to the burner. The gas train typically includes a pressure regulator, blocking valve(s), high gas limit switch, and a low gas pressure switches.

Item 12 – Pilot Gas Train

The pilot gas train is a separate, smaller diameter train which extends from a point upstream of the main gas train regulator directly to the burner pilot connection.

Item 13 – Gas Burner

The burner is a commercial forced draft burner designed for use with either natural gas or LP gas.

Item 14 – Blower

The blower is a fan used to supply combustion air to the burner. Depending on the heater size and rating, the blower may be an integral part of the gas burner or may be floor mounted and connected to the burner inlet with a metal duck work or flexible hose.

Item 15 – Firing Rate Modulating Motor

The firing rate modulating motor is used to moderate (open and close) the gas and air dampers within the body of the gas burner. The modulating motor increases or decreases the firing rate based upon a signal received from the outlet water temperature control. Once the desired water temperature has been reached, the modulating motor will adjust the firing rate to that needed to maintain that temperature on a continuing basis. The modulating motor also works with the flame control system to purge any residual fuel gas from the heater before and after firing for safety purposes.

Item 16 – Air Pressure Limit Switch

The air pressure limit switch is used to assure that an adequate supply of combustion air is being supplied to the burner at all times. The heater will not initiate a firing sequence or, if running; will shut down immediately if proof of adequate air supply is not made.

Item 17 – Water Cooled Discharge Sleeve

The water cooled discharge sleeve is used to keep the burner mounting structure and the heater shell from overheating. Water is continuously pumped through the sleeve. A telltale tube drains from the sleeve into the water wall of float chamber to verify adequate flow.

Item 18 – Outlet Water Temperature Sensor

The outlet water temperature control sensor is a type "J" thermocouple which sends a signal to the controller in the panel. The temperature controller in turn displays the outlet water temperature and sends a control signal to the firing rate modulating motor.

Item 19 – Float Chamber

The float chamber is an external extension of the inside heater which will always have the same level of water in it as the heater. A sight glass on the float chamber indicates the depth of hot water in the bottom of the heater.

Item 21 - Heater Flood Level Switch

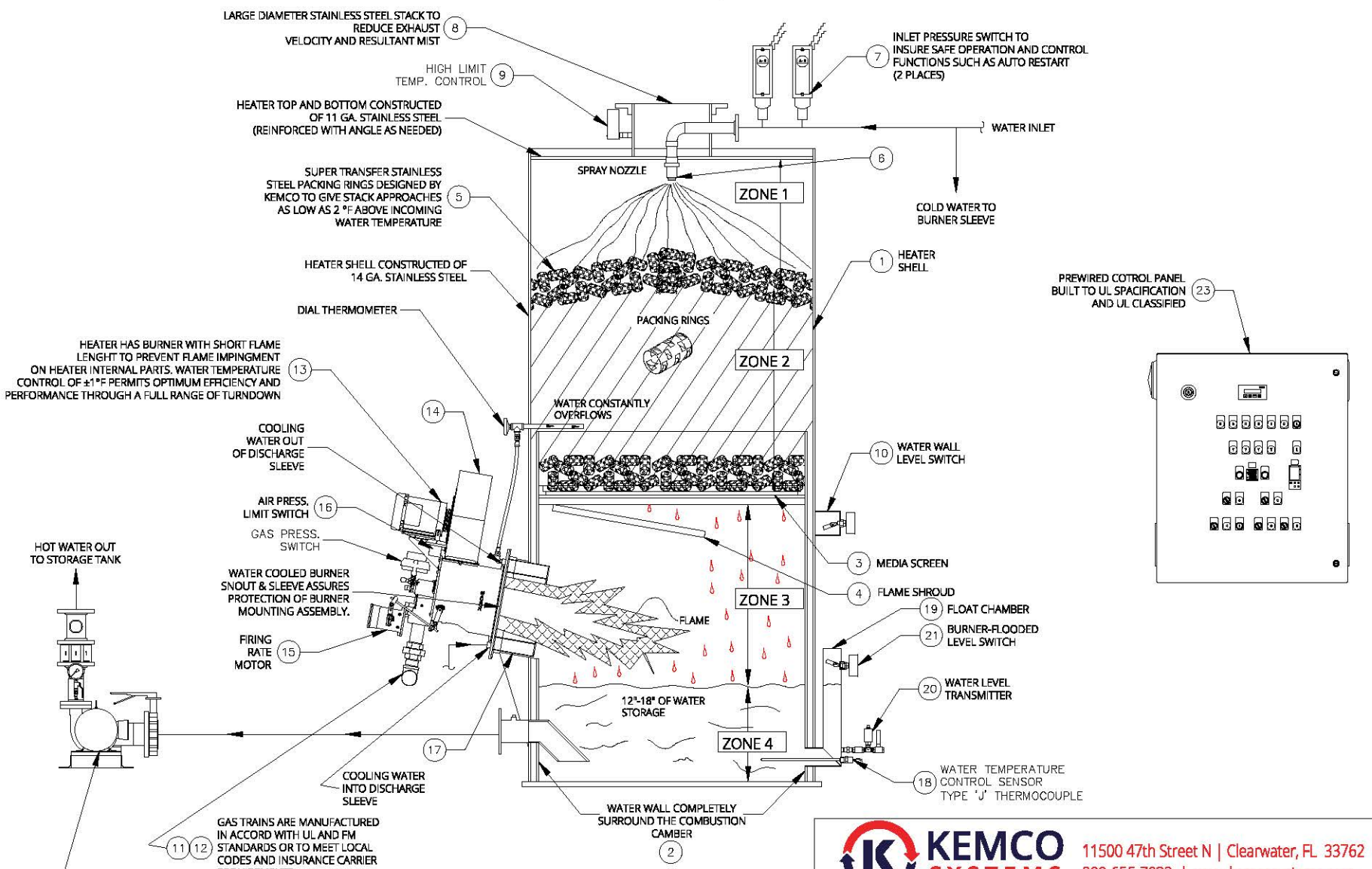
The heater flood level switch is a high level switch located in the float chamber which will cause the heater to shut down if the water should reach that level. This prevents the burners from flooding.

Item 22 – Heater Discharge Pump (only for non-Gravity Drain heaters)

The heater discharge pump is used to pump water from the base of the heater to an open hot water tank. The hot water tank acts as an accumulation device for the system to allow the heater to operate at a reasonably steady rate even though the system demands are sporadic.

Item 23 – Control Panel

The control panel may be mounted directly to the side of the heater or on a separate stand. The control panel houses the flame safety control and the rest of the devices used to control the heater automatically. The front of the panel contains display lights which indicate the current operating conditions or the reason for a heater shutdown. Also included on the panel front face are the control switches and a digital temperature display for inlet water, outlet water, and stack temperature. An alarm is mounted on the side of the panel to alert the operator to any condition which requires operator attention.



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HEATER SECTION VIEW

JOB #	THIS DRAWING IS THE PROPERTY OF KEMCO SYSTEMS INC. ALL RIGHTS OF DESIGN ARE RESERVED. DRAWING IS TO BE RETURNED UPON REQUEST.
DR.	
SCALE NONE	
DATE 10/31/19	
ENG. BILL HOWARD	DWG. NO. 10-534A
APP. WHH 11/12/19	

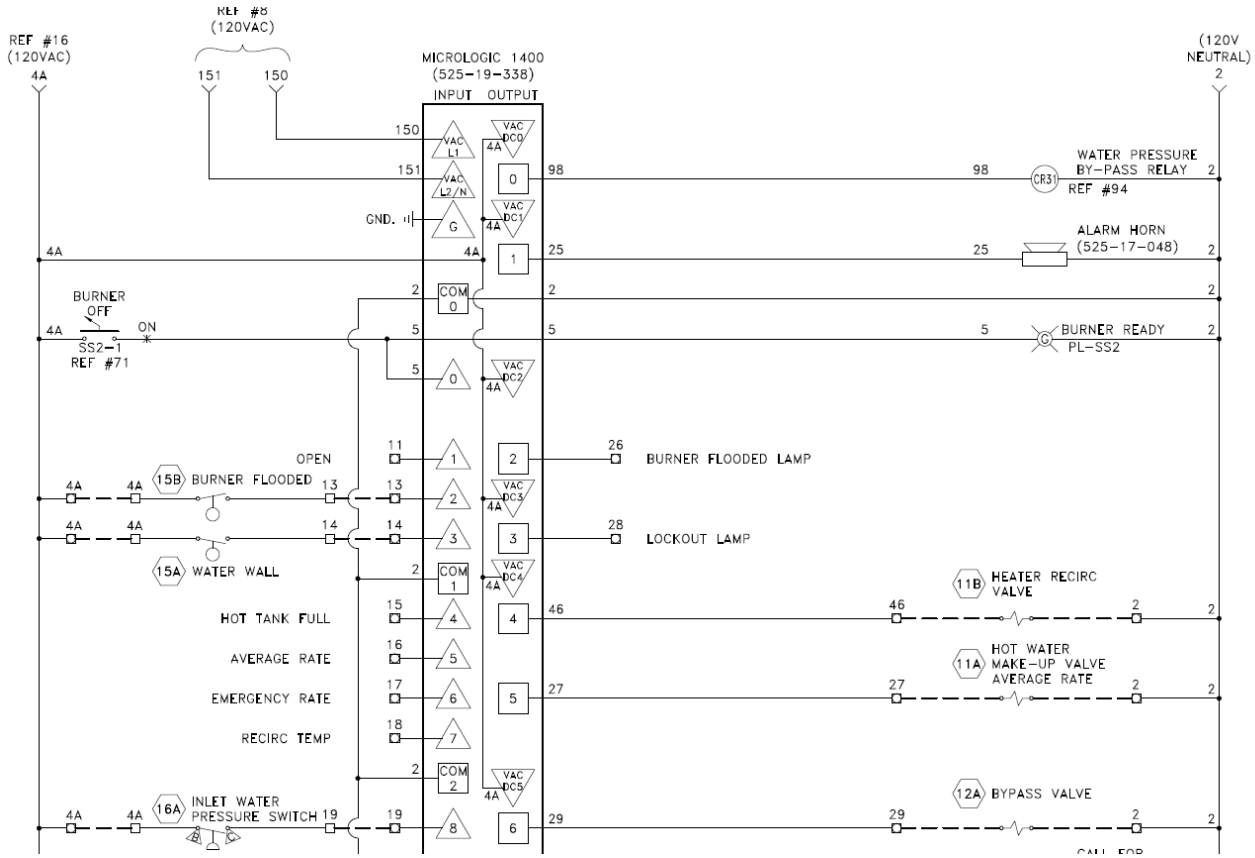
4 Control Philosophy

This section details the control steps performed by the heater as it automatically operates.

4.1 Sequence of Operation

This section details the specific control steps performed by the heater as it automatically cycles, several of which are carried out by the PLC. The flame safeguard controls the actual lighting and firing of the burner.

This section includes specific PLC inputs and outputs shown as either {IN:00} or {OUT:00}. This helps during troubleshooting while panel is open, the status of both the inputs and the outputs can be observed by looking at the indicators on the PLC face. See below image of an example of PLC inputs and outputs.



4.1.1 Normal Sequence

1. The Control Panel receives a signal indicating that water heating is needed from either the hot water tank, "Average Rate" level switch {IN:05} or the Hot Water Tank temperature switch or thermocouple {IN:07}.
2. The PLC response to the need for heating by first checking to make sure that the water storage level in the heater body is below the "Burner Flooded" switch {IN:02}. If the water is at normal levels, then the PLC energies {OUT:07} which connects power to the Call for Heat panel light, the flame safeguard control terminals and the proof of closure contacts on the main gas valves.

   If the Burner Flooded level switch is not closed (indicating a high water condition) then an alarm shutdown will occur (See Step 14E).
3. If the flame safeguard receives power through the proof of closure contacts on the main gas valves, then the blower will be started. If power is not received, then the unit will lock-out.
4. The flame safeguard control sends the firing rate modulating motor to the High Fire position to purge the heater.
5. The PLC checks to assure that the below have been met, then once met, the PLC will close a contact which connects power from the flame safeguard (Terminal #3) to the safety limit string {OUT:09}.
   a. The auto-restart counter is less than 3.
   b. The heater water wall is full {IN:03}.
   c. The water inlet pressure switch is not made {IN:08} (i.e. there is no pressure in the inlet line.) This is done to confirm the correct operation of the inlet pressure switch. Since the water inlet valve will not be opened until later in the sequence, there should be no pressure in the line. An indication of pressure at this point means that the switch is jumped out, is defective, or set too low. PLC will lock-out the heater if this condition exists. If the conditions are met, then the PLC will close a contact which connects power from the flame safeguard (Terminal 3) to the safety limit string {OUT:09}.
6. The safety string which is continually monitored by the flame safeguard includes the following four items. These four safety devices are wired in series. If all of the safety conditions are satisfied, an electrical circuit will be completed back to the flame safeguard (Terminal P). If this circuit is not completed, then the flame safeguard will lock out.
   a. High stack temperature switch
   b. High gas pressure switch
   c. Low gas pressure switch
   d. Blower air pressure switch

7. The high-fire interlock switch, located in the modulating motor, will close and high-fire purge timing begins. High-fire purge will continue for 30 seconds. NOTE: The purge cycle is designed to flow an amount of air through the heater that is over 4 times the volume of the combustion chamber.
8. After the 30 second high-fire purge, the firing rate modulating motor is sent to the low-fire position and the purge continues until a total of 60 seconds has elapsed. Note that TOTAL purge time is more than 60 seconds.
9. After the cycle has ended, the low-fire interlock switch, mounted in the modulating motor, will be closed.
10. After completing the 60 second purge, the flame safeguard will check to assure the low-fire interlock switch is closed and then begin "Pilot Trial for Ignition (PTFI)". The flame safeguard will energize the pilot gas valve and the ignition transformer. The flame detector must detect a flame within 10 seconds or the heater will lock-out.
11. Once the pilot frame is detected, the flame safeguard will begin the "Main Trial for Ignition" (MTFI). Power from the safeguard "main flame" terminal flows through a contact in control relay #CR31 to the main gas valves, causing them to open. At the same time, an inlet water valve is energized. If the heater has discharge pumps, the discharge pumps begin to pump. Flame safeguard turns off the pilot after 10 seconds. If the flame detector does not detect a flame, the heater will lock-out.
12. Once water starts flowing into the heater, the rising inlet water pressure closes the inlet water pressure switches. One of the switches is then used to electrically bypass the relay #CR31 closed in Step 11.
13. After a 30 second delay, the PLC will check the inlet water pressure switch with the higher setpoint {IN:08}. There are two possible conditions:
    a. If the inlet water pressure has closed the switch (indicating sufficient water flow for safe heater operation) then the PLC output {OUT:0}wired to the coil of relay #CR31 is deenergized and the gas valves remain powered through the pressure switch (as in Step 12). If pressure subsequently drops, the pressure switch will interrupt the circuit to the gas valves and the heater will shut itself off.
    b. If the inlet water switches are open (indicating insufficient water pressure), then the PLC will turn the heater off. After a post-purge and a 30 second delay time, the PLC will attempt to automatically restart the heater. The cycle will be at Step 1. The PLC will permit only 3 attempts to auto-restart. If heater does not start after third try, then the heater will be locked out, and the Auto-Restart Failure indicator light will be turned on. Please note that Auto-restart can ONLY be initiated by an open inlet water pressure switch.
14. If the heater continues to fire, then the flame safeguard will permit the temperature controller to adjust the firing rate modulating motor. This is the normal heater operating mode. The heater will remain firing in this manner as long as there is a demand for hot

water. There are several operating conditions which will, however, shut the heater down automatically. These are:

a. If a flame failure occurs, the flame safeguard will shut down and lock-out the heater.

b. If any of the safety switches open, then flame safeguard will lock-out the heater.

c. If the water level in water wall falls below the level switch, PLC will shut down the heater and lock it out.

d. If the inlet water pressure switch open (for any reason – typically due to low water pressure), then the heater will be turned off and 3 restarts will be attempted as detailed in Step 13b.

e. If the heater flood level switch opens, the heater will shut down and alarm horn sounded. Once the water level in the heater is returned to the normal level, the heater will be restarted beginning with Step 1.

15. Once demand for hot water has been satisfied, the PLC opens contact {OUT:07} connecting power to the flame safeguard (Terminal #13) and the Call for Heat panel light. The flame safeguard then closes the gas valves and sends the firing rate modulating motor to the low-fire position. The blower stays on for 15 seconds post-firing purge and then shuts off. The PLC continues to monitor the system for hot water needs.

4.1.2 Preliminary Safeties

As long as the Control Power switch is in the On position, then both the heater operating controls as well as the safety limits will be continually monitored. If, at anytime, one of the safety limits should trip, then the heater will immediately shut down and sound the alarm horn. These safety limits include the following:

a. Burner Flooded Level Switch. This switch will remain closed, electrically energizing control relay CR3, as long as the level of water inside the heater remains below the switch.
b. Water Wall Level Switch. This switch will remain closed, electrically energizing control relay CR2, as long as the level of water in the water wall remains above the switch.
c. Stack High Temperature Switch. This switch remains closed as long as the heater exhaust stack remains below the limit set point temperature (approximately 190°F.)
d. Low Gas Pressure and High Gas Pressure Switches. These switches will remain in the normal position so long as the pressure of fuel gas remains in the normal range. If an abnormal pressure condition causes one of these switches to trip, then the resulting safety lock out condition will continue until both the abnormal pressure condition is corrected, as well as the switch's manual reset is depressed.

Once a safe condition is proved through all of the above safety switches, then the heater will be allowed to continue in its operating sequence.

4.1.3 Firing Sequence

With all of the above safeties proved, and the Burner switch in the On position, then the heater will be in a stand-by mode until it receives a Call for Heat signal. This signal will come from one of the following two sources:

1. The hot water tank level drops below the Average Rate level. Control relay No. CR31 will be energized and initiate the Make-up Mode.
2. The temperature in the hot water tank drops below the setpoint on the hot water tank temperature switch or thermocouple. This initiates Recirculation mode..

NOTE: Make-up and Recirculation cannot occur simultaneously. Make-up will always take precedence.

3. The Call for Heat light will be illuminated, and if the heater is not in an alarm condition, then the burner blower will start the pre-fire purge.
4. The High Fire interlock switch (located in the firing rate modulating motor and wired between terminals No. 55 and No. 57) closes. This signals the beginning of a 60-second high fire purge. If this interlock does not close, then the sequence will be stalled at this point, and the heater will not light.
5. Once the high-fire purge timer has timed-out, the modulating motor will move to the low-fire position, and energize the main gas valve proof-of-closure contact.
6. The main gas valves must be proven to be completely closed by allowing continuity through the actuator proof-of-closure contacts. If the main gas valves are blocked open, or if any other reason prevents the proof of closure contacts from completing the circuit, then the sequence will be stalled, and the heater will not light.
7. Once the firing rate modulating motor reaches the Low-Fire position, the low fire position interlock switch will close, completing the circuit. Note that the lowfire position interlock is wired in series with the main gas valve proof of closure contact. Consequently both the main gas valve proof-of-closure contacts as well as the low-fire position interlock must be closed. .
8. Once 110VAC is applied, the Fireye® flame safeguard will indicate that the Operating Control Circuit has been energized. The LED labeled "OPR CTRL" on the face of the flame safeguard (inside the Kemco control panel) will be illuminated.
9. The flame safeguard next confirms that the air blower switch is closed, indicating sufficient airflow to the burner. Closure of this switch will allow illumination of the LED labeled Air Flow on the face of the flame safeguard. If the air pressure switch is not closed, then the red panel light labeled Blower will be lit, and the firing sequence will be stalled. Note that if the blower switch does not close, then the heater will not light.
10. Once airflow has been proven, the flame safeguard starts a 90-second low-fire preignition purge.

11. Following this purge period, the automatic inlet water valve is energized which starts water flowing into the heater, and the pilot gas and ignition transformer are energized.
12. A 10 second Pilot Trial For Ignition period is started. The flame safeguard LED labeled PTFI will be lit.
13. If a pilot flame is detected within the required 10 seconds, then the pilot flame is allowed to stabilize for 8 seconds after which the main gas valve circuit is energized. The LED on the Fireye® labeled Flame will also be lit whenever flame is seen by the Fireye® UV scanner. If no flame is detected within the required 10 seconds, then the pilot gas valve and spark igniter are de-energized, and a safety lock-out occurs which illuminates the Fireye® Alarm LED and a control relay. This will energize the alarm horn, and deenergize the blower motor. Manual reset of the Fireye® flame safeguard will be required after any flame related safety lockout.
14. If sufficient water is flowing into the heater, then the heater inlet water pressure switches will be closed. The main gas valveswill be powered from the Fireye® through this pressure switch. The following will also occucr:
    - Heater discharge pump (on pumped units)
    - Allow the temperature controller to adjust the firing rate modulating motor
    - By-passes the gas valve proof of closure and low fire position interlock switches
    - Re-initializes the high-fire purge timer

    If the pilot flame is proven, but the heater inlet water pressure switch fails to close, then the main gas valves will remain de-energized. After approximately 10 seconds, the pilot gas valve will de-energize, and the heater will automatically restart the sequence of operation in Step #9 above.

    Also, if the main gas valves are energized (during the normal operation of the heater) and the flow of water is interrupted (thru loss of water pressure at the heater inlet), then the heater inlet water pressure switch will open. This will de-energize the main gas valves, which will shut the heater down. If a “call for heat” condition still exists, then the heater will automatically restart the sequence of operation in Step #4 above.
15. Once the main fuel valves have been energized, the temperature controller is allowed to adjust the firing rate modulating motor.
16. The pilot gas valve, igniter and "PTFI" LED will be de-energized 10 seconds after Fireye® terminal #5 is energized.

NOTE: The heater is now in the normal operating mode. The heater will remain firing in this manner as long as there is a need for water heating.

17. The flame safeguard will be de-energized and the heater will be shut off. This will return the heater back to step 2 in the above Fireye firing sequence (on stand-by waiting for a “Call For Heat”).

5 Installation and Startup

5.1 System Prerequisites

Prior to installing and operating the system, the following must be available:

- Clean, dry instrument-quality air
- The Voltage AC power noted on the wiring schematics
- A floor that is strong and rigid enough to bear the equipment, with a reasonable factor of safety.
- Sufficient clearance for equipment access, so that proper preventative maintenance can occur.
- All service connections to installed machines meet local and national safety standards and codes.
- Long lengths of unsupported pipe work should be avoided. If the installation is subject to severe vibration, flexible hoses and connections should be used.

Check all local codes and regulations prior to proceeding. The information herein are general in nature and not intended to supercede any governing codes.

5.2 Drawing Review

It is extremely important to review the system design drawings prior to receiving the heater. These include the Schematic Flow Diagram, Panel Wiring Diagram(s), Layout Drawing, and Heater Assembly. Check each per suggested below:

5.2.1 Schematic Flow

- Compare Schematic Flow Diagram to existing piping and equipment. Confirm existing piping and equipment is shown properly on flow diagram. If flow diagram does not represent existing installation, record variations and inform Kemco Systems.
- Check for new water piping requirements necessary to integrate heater into existing system.

5.2.2 Panel Wiring

- Compare the primary voltage on the wiring diagram to the existing plant voltage. If the plant voltage is not as shown, contact Kemco Systems.

5.2.3 Layout and Heater Assembly

- Check the location of the heater shown in the Layout Drawing. The area selected should be level and away from normal traffic. The area must be well ventilated with adequate

space for the heater and its associated pumps, piping, and electric controls. The area must be protected from freezing temperatures and be dry and relatively clean. Although, the heater is a rugged piece of equipment, designed to operate in typical industrial environments, many of the electronic controls are not water-tight or dust-proof, and therefore must be kept dry and relatively clean. The heater's operating life will also be extended if it is protected from excess dust.

- Check the location where the new water and gas piping will be installed. Confirm any existing obstructions can be relocated. Confirm the available pressure in your gas piping is within the limits detailed on the Heater Assembly Drawing.

5.3 Equipment Receiving

5.3.1 Unloading and Positioning

The user is responsible for unloading and positioning the equipment. Always use care when handling the equipment. Leave any protective caps and covers on the product until installation.

It is recommended that the user arrange for a rigging company to receive the heater. Approximate weight of the main heater is shown in the Specifications section and on the Heater Assembly Drawing.

5.3.2 Inspection

The user will be notified by the freight carrier at least 24 hours prior to the delivery of the equipment. The following steps must be completed as soon as your shipment is received:

1. The shipping list should be checked immediately to ensure that all required parts have arrived.
2. Check pallet and loose piece count of Bill of Lading (BOL)/Delivery Receipt (DR) and match it to the actual number of pallets and loose pieces on the pallet.send
3. Inspect pallet for damaged or missing product and note specific details on the Delivery Receipt.
4. Identify and inventory all ship loose items. These smay be stack sections, spare parts, bolts, gaskets or other instrumentation that was removed for shipment. The items that are shipped loose are identified as such on the Kemco shipper.
5. Take pictures of any damaged product and packaging as they are required to file a claim.
6. Sign the paperwork for the driver.

If something appears to be missing: Make a note on all copies of the BOL/DR that lists the specific items missing.

If there appears to be damage to the product: Make a note on all copies of the BOL/DR that says "Damaged".

When this shipment arrives, you will be asked to sign the driver's delivery receipt. Take your time to carefully inspect this shipment. If the driver cannot allow you sufficient time for inspection, ask the driver to contact the freight terminal and speak to a manager.

DO NOT SIGN THE RECEIPT UNLESS YOU HAVE UNBOXED OR UNCRATED YOUR SHIPMENT AND CAREFULLY INSPECTED YOUR ENTIRE ORDER FOR DAMAGE. EVEN IF THE BOXES OR PALLETS ARE IN PERFECT CONDITION, YOU MUST ALWAYS CHECK FOR CONCEALED DAMAGE!

Plan in advance to have someone available to help if you are unable to inspect the shipment yourself. If anyone else will be accepting your order, make sure they are aware of these rules.

PROTECT YOURSELF – INSPECT SHIPMENT CAREFULLY.

5.4 Equipment Storage

If you are not immediately installing the product after delivery, store the product in a covered and dry location free from heat, dirt and vibrations.

Freezing Precautions: Protect all equipment from weather and water damage. All fluid piping and pumps must be protected from freezing conditions. If any fluid-handling equipment is installed outdoors or in other areas exposed to ambient temperatures that can fall below freezing, then the equipment (including, but not limited to, pumps and piping) must be both heat-traced and insulated. Idle pumps cannot be exposed to freezing conditions. Drain all liquid inside pump. Failure to do so can cause damage to the pump. Pump warranties will become void if freeze protection is not provided.

5.5 Pre-installation Checks

Check local codes and regulations before installing. The information in this manual is general in nature and is not intended to supersede any governing local, state or provincial regulations, nor guarantee compliance to local codes or regulations.

5.6 Installation

5.6.1 Location

See Layout Drawing for the heater location. Move the heater to this location using the shipping skid. Raise the heater into its normal vertical orientation using the lifting lugs supplied on the top of the heater. Cables and fork lifts should not be tied to the sides of the heater body or burner.

5.6.2 Heater Assembly

Prior to shipment, the heater package was completely assembled and tested. For shipping purposes, it is necessary to dissemble various items from this package. These items must be reassembled at the job site.

1. The gas train must be reconnected as shown on the Heater Assembly Drawing. NOTE: Make certain that the gas supply pressure is within the limits and is capable of

flowing within the required volume of fuel as specified on the Heater Assembly Drawing. Also, note that gas piping must always be checked for leaks prior to operation.

2. Make electrical connections from the gas train and control panel to the wiring junction box mounted beside the burner. These connections were removed for shipment. All wires are numbered. Numbered wires have junction connections with wire nuts or they terminate to the terminal strip in the panel.
3. Refer to the Heater Wiring Diagram for more details. The main power wiring for the control panel and motor starters should also be made. Installation of electric disconnects are required by the National Electric Code.

5.6.3 Water Connections

The water to be heated must have a chloride level of below 100 mg/L and a hardness of less than 90 mg/L as $CaCO_3$ or corrosion will occur.

Heater Water Supply Piping:

1. Connect water supply piping to the heater as shown in the Schematic Flow Diagram. Note: the Schematic Flow is not a piping diagram. It shows how pipes must be connected, but not where they are to be physically located. Good piping practice dictates that all automatic valves and pumps be mounted in locations where there is easy access for maintenance.
2. All automatic solenoid valves should be mounted in a horizontal position.
3. Mount pressure switches, thermometers and pressure gauges close to the heater. Gauges should be located for ease of reading.

Heater Recirculation Piping and Equipment

1. Pipe in recirculation piping as shown in the Schematic Flow Diagram.
2. Mount recirculation valve nest in an accessible location.
3. Install hot water tank recirculation temperature switch on tank as shown on Schematic Flow Diagram. If tank does not have a ½" NPT fitting for this switch, then one will need to be added, or you may install this switch into the suction piping on the hot water pump.

Heater Discharge Pump Piping and Equipment

(Not applicable for gravity drain heaters)

1. Heater Hot Water Discharge pump should be mounted within 5 feet of the heater.

5.6.4 Stack

Stack Connections and dimensions are shown on the Heater Assembly Drawing. Single wall stack constructed of minimum 16 gauge 304 stainless steel should be used.

PLEASE NOTE: Install stack and roof penetration in accordance with all local codes (this usually means that the stack must protrude through the roof a minimum of 5 feet). All joints and

flashings must be watertight and capable of withstanding 500° F. Seal all stack joints with a silicone based sealant.

5.6.5 Air Requirements

The heater must be able to draw a minimum of 200 cubic feet per minute (CFM) of fresh air for every million BTU/Hr. of combustion. Air can be supplied to the heater by either having an adequately sized air vent to allow outside air to enter the building, or an inlet air duct can be directly attached to the burner inlet. One added advantage to using an inlet air duct for drawing combustion air from outdoors is that inside building air will be completely sealed off from the heater. If the air inlet is not sealed, or if and adequately sized near-by outside air vent is not provided, then outside air can be drawn backwards down through the vent stack and out into the building during times when the heater is not running. This can lead to moisture build-up on the internal burner and blower components, which can result in their premature failure.

Adequate sizing of the outside air vent will depend on:

1. The total firing rate of all fuel burning equipment. (Factory Mutual Specifications call for a minimum free open area of ½ square foot for every 1 million BTU/Hr of combustion.) However, local codes may require larger amounts of open area.
2. The amount of air withdrawn by building exhaust fans, or dryers that draw in building air and exhaust it outdoors.

Do not store combustible or flammable materials near the combustion air intake.

Contact Kemco Systems for assistance in sizing and connecting air ducts to your burner.

5.7 Startup

5.7.1 Pre-Start Check

All power supplies must be verified prior to startup.

5.7.2 Startup Services

Before arranging for equipment start-up, the installation of water, and gas piping, electrical connections and stack connections should be fully complete and tested. A minimum of two weeks notice is required for equipment start-up personnel.

Kemco Systems is not responsible for equipment failure or contingent damages until the equipment is placed into service by our service technicians. The Kemco Equipment Warranty will be declared null and void if unsupervised start-up is attempted.

5.8 Operation

5.8.1 Daily Startup

The initial start-up and adjustment of the Kemco heater is always performed by a Kemco service technician. After the initial start-up, the procedure below may be used by qualified plant personnel who have received training from Kemco.

1. Check manual valve positions. Check to assure that the manual valves (piped in line with the following automatic valves) are all in their open position:
   a. Make-up water valves piped to heater inlet
   b. Hot water tank recirculation valve piped to heater inlet,
   c. Gas valves on the main and pilot gas trains.
2. Confirm burner air pathway is open. Confirm that there are no obstructions blocking the air intake on the burner blower. For heaters having floor-mounted blowers with manual blast-gates in the blower ducting, make sure that these blast gates are locked open to their normal-marked position.
3. Check Hot Water Storage Tank. Observe the level of water in relation to the level switches and pump suction pipe.
   a. Is the tank full or overflowing?
   b. s the water level below the "heater-start" or "Average-rate" level switch?
   c. Is the level near or below the pump suction pipe?
   d. Check theset point on the tank recirculation switch.

NOTE: If your unit has a recirculation temperature switch located on the hot water tank, it is normally set for a temperature that is approximately 10° F. cooler than the setpoint on the digital heater outlet-temperature controller. If the unit has a thermocouple, please look at setting via HMI.

4. Check the following heater safety conditions:
   a. Water wall level. Check water-wall sight glass to confirm that the water wall is full.
   b. Heater "flood" level. Check sight glass on the heater float chamber to confirm level of water in the heater storage zone is below the Burner Flooded level switch.
   c. Gas pressure switches. Check the manual-resets on the high-gas pressure and low-gas pressure switches.
5. Turn-on the "control power" switch and check:
   a. The control panel safety indicator lights. If any red safety indicator light besides "BLOWER" is on, then a safety "Lock-Out"condition exists that must be corrected.
   b. The digital outlet water-temperature controller. Check the controller hot-water-temperature "SET-VALUE".
6. Turn-on the water pumps (hot and cold). NOTE: Only start pumps that have their suction piping completely filled with water. If a tank water level is close to the pump suction, then wait until the level rises at least 6" above the suction pipe before starting the pump.
7. Check the hot water temperature. After the hot water pump has run for a few minutes, check the dial thermometer and note the hot water storage temperature.
8. Turn the switch on the panel labeled Burner to the On position. The Heater will be in one of the three modes listed below:
   a. If the level of water in the hot-water-tank is below the "HEATER START" or "AVERAGE-RATE" level switch, then the heater will start in the "fill" mode.
   b. If the hot-water-tank is nearly full, but the storage temperature is below the recirculation switch set point, then the heater will start in "recirculation" mode.

c. If the hot-water-tank is up to temperature and nearly full, then the heater will be in "stand-by" mode until either conditions "A" or "B" occur.

9. Once the blower starts, observe the burner lighting sequence
   a. Pre-fire purge cycle. Watch the burner firing-rate control crank and the modulating motor. The motor should stroke the burner through a "High-Fire" purge, a "Low-Fire" purge followed by the "Low-Fire" Pilot Trial For Ignition. NOTE: Refer to the SEQUENCE OF OPERATION section of these instructions for a detailed explanation of the firing sequence.
   b. Pilot trial for ignition (PTFI). Observe if the pilot lights. If the pilot fails to light on the first try, then wait for the flame safeguard to alarm and lockout the heater. Reset the flame safeguard and let heater purge and try to light pilot.
   NOTE: Air in the pilot gas line or moisture on the spark igniter or flame detector can prevent successful pilot ignition. Many times these problems can be rectified by simply letting the heater cycle through additional purge and PTFI stages. If the pilot fails to light after three attempts, then check to see if the pilot is getting fuel, and if the igniter is giving a good spark (refer to the Troubleshooting section in these instructions). If the pilot fails to light on the first trial, but does light on a subsequent attempt, then it is advisable to test the repeatability of the pilot by turning the Burner switch Off and then back On. This will re-start the purge and lighting sequence.
      c. Inlet water flow. Once the pilot is lit, an automatic inlet water valve will be energized. Watch for an amber-colored control panel indicator light labeled either Avg Rate Valve or Recirculation Valve. As soon as one of these indicators is illuminated, immediately check to confirm that water is flowing into the heater by observing the pressure gauge on the heater inlet water pipe. This pressure should build to over 10 psi.
      d. Main Flame. The amber indicator lights labeled either Main Flame or Main Gas should now be illuminated. This indicates that the main gas valves have been energized. Make a quick visual check of the main gas valve actuators to confirm they are open. The heater should now be in normal operating mode with the digital temperature controller adjusting the heater-firing rate (the burner will normally be adjusted to high-fire)

10. Check the discharge of water from the heater. Make sure that water is flowing smoothly out of the heater by observing the water level in the float chamber sight glass. The level should be well below the Burner Flooded level switch.
    Heaters having a discharge pump to control the transfer of water from the heater to the hot water tank require some additional checks. When the pump is working correctly, then the water depth should be maintained at about 18". This water depth will usually oscillate slowly only a few inches upand- down. If the water level is rapidly rising and falling, then there is most likely a problem with the discharge pump.
11. Check the flow of water through the burner discharge sleeve. There should be a small but stead stream of water flowing out of the burner discharge sleeve piping. If there are

periodic "puffs" of steam coming out of the sleeve, then the water flow must be increased.

12. Check the heater outlet water temperature. After approximately 3 to 5 minutes of firing, the outlet water temperature should be maintained within 1 to 2° F. of the "set value" on the digital temperature controller. Also check the dial thermometer on the heater discharge to confirm that the digital controller is reading true. The two temperatures should agree within 3 or 4° F.
13. Observe the heater firing. The last step in the daily start-up routine should be to just watch the heater run for at least 10 to 15 minutes. The heater should fire smoothly without locking-out, flooding or autorestarting.

5.8.2 Normal Operation

The conditions for normal heater operation are described below.

For a detailed step-by-step description of the heater automatic firing sequence, refer to the Sequence of Operation section of this manual.

When the switches on the heater control panel labeled "Control Power" and "Burner" are both in the "ON" position, then the heater will be in one of the four states listed below:

1. Making-up hot water to the hot water tank
2. Recirculation of water from the hot water tank through the heater so as to bring hot water tank temperature above the set point of the hot water tank temperature switch.
3. On stand-by waiting for a "Call For Heat" signal
4. On safety "Lock-out"

5.8.2.1 Make-up and Recirculation Modes

Make-up and "Recirculation" cannot occur simultaneously. Make-up always takes precedence over recirculation. Recirculation only occurs when the following three conditions occur:

- Water temperature in the tank is below the set point, and
- Water level in the hot water tank is above Heater start or Average-Rate level or level switch and
- Heater is not already in Make-up mode.

The heater will shut down during normal Make-up if:

- A lock-out condition exists, or
- The hot water "Tank-Full" level switch opens and the tank temperature is above the recirculation switch set point

The heater will shut down during Recirculation if:

- A lock-out condition exists, or
- The temperature in the hot water tank is re-established at (or above) the recirculation switch set point.

During recirculation, if the hot water tank level falls below the Heater Start or Average-Rate level switch, then the heater control circuitry will automatically change the water valving to the Make-up condition.

5.8.2.2 Lock-out Mode

A Lock-out condition can be identified by:

- Heater shutdown
- The alarm horn will sound

Any lock-out condition indicates a problem that requires immediate attention. Never bypass any safety to attain normal operation. Severe damage or injury may result.

If a Lock-out condition occurs, first consult the display on the flame safeguard and the safeguard operating manual. The message displayed by this control can provide an excellent troubleshooting guide. Do not press the reset button on the flame safeguard until the display has been read.

In order to reset any o Lock-out conditions, the problem must be resolved. The control power and burner panel switches must be On and the flame safeguard reset button must be pressed. There are three lock-out conditions which require an additional manual action prior to resetting the flame safeguard. These conditions are:

1. If the heater locks-out on high gas pressure, the high gas pressure switch must be manually reset (located on the switch itself).
2. If the heater locks-out on low gas pressure, the low gas pressure switch must be manually reset (located on the switch itself).

Once the condition causing the lock-out has been corrected, the burner may be restarted. Press reset button on flame safeguard and reinitiate the startup procedure.

5.8.3 Shutdown

Use the following procedure for the daily shutdown of the Kemco heater.

1. Turn the switch on the panel labeled Burner to the Off position. If the heater is firing, then this will cause the gas and inlet water valves to immediately close. Heaters with discharge pumps will also have them continue to pump out of the heater for approximately 30 seconds.
2. Confirm water has stopped flowing. Check the pressure gauge on the heater inlet water pipe. This gauge should show that there is no water pressure in the pipe. Also, check the water level in the sight glass on the float chamber. The level should be well below the Burner Flooded level switch, and should remain constant. A rising water level indicates that water is still flowing into the heater.
3. Turn the water supply pumps off, and then turn the panel Control Power switch Off. The heater and hot water system will now be completely shutdown. If the heater is going to be left unattended for a long period of time, then you may elect to close the manual

valves piped in line with automatic inlet water and main gas valves. This will prevent the possibility of leakage as the result of an automatic valve failure.

6 Maintenance

6.1 Inspection

Regular inspection of the heater and heater internals is recommended. If calcium deposits are present, the water hardness is likely higher than recommendations. Proper removal of build up and deposits is critical to the extended life and performance of the heater.

6.2 Preventative Maintenance

6.2.1 Monthly

All safeties can usually be checked in 30 -45 minutes. Checking safeties on a regular basis ensures safe operation of the Kemco heater. Factory Mutual recommends that these safeties be checked monthly. The basic procedure is to simulate the condition that the safety monitors are checking. If any of these safeties are proven defective, notify Kemco and shut down the heater immediately.

Begin the safety check procedure when the hot water tank is full and at temperature. With the heater Control Power and Burner switches both On, adjust the set point of the recirculation temperature switch to a point well above the current hot water temperature.

NOTE: This switch is typically mounted on the hot water storage tank.

This higher switch setting should trigger a Call for Heat in the recirculation mode. The heater should immediately start its firing sequence. Proceed with the following checks:

Burner Flooded Safety

Pumped Discharge Heaters

With the heater running, turn the Heater Discharge Pump switch to the Off position. After the burner fires main flame, water will enter the heater raising the level and sounding the alarm. The burner-flooded light will illuminate, the burner will shut itself off, and the valve supplying water will close. Turn the Heater Pump switch back to the Auto position. The pump should start pumping down the water level. The alarm will shut off and the heater will re-fire after completing the purge cycle.

Gravity Drain Heaters

While the heater is running, simulate a “flood” condition by manually lifting the float on the Burner Flooded Switch. The heater should shutdown and alarm as soon as the flood condition is detected. Releasing the float should automatically re-set this alarm.

High Stack Temperature Limit

In order to test this safety, the temperature of the heater's exhaust must be above the setpoint of this temperature switch. Turn the setpoint of the Honeywell® #L6006C1034 stack temperature switch down to 60°F. When the heater fires in the recirculation mode, then the high inlet water temperature will cause the High Stack Temperature light to illuminate, the heater to shut down and sound the alarm. Re-adjust the Honeywell stack switch back to where it was previously set. This should automatically reset the alarm condition. The heater should once again start.

Low Gas Pressure

With the heater firing and the "MAIN GAS" light illuminated, close the manual gas valve on the main gas line up-stream of the heater's gas regulators. The heater should remain firing for a few seconds while the gas inside the gas train's piping is consumed. The heater will soon stop, alarm and the "LOW GAS " light be illuminated. Re-open the manual gas valve and trip the manual reset on the LOW GAS PRESSURE SWITCH. The alarm will stop, and the heater should re-start.

High Gas Pressure

With the heater again firing Main Gas, first note the current setting on the High Gas Pressure Switch. Next, turn this setting as low as it will go. The heater should stop, alarm and illuminate the High Gas light . Once the setting is restored, the switch will need to be manually reset. The heater should re-start.

Blower Safety

While the burner is in the Low-Fire Purge position, turn off the circuit breaker or electric disconnect for the blower. Within four seconds the Fireye® will notice the lack of air and will shut down the heater. The alarm will sound, the LED located inside the panel on the Fireye® Flame Safeguard labeled Air Flow will turn off, and the red Blower light on the face of the panel should be illuminated. Re-connect power to the blower, wait 90 seconds and reset the Fireye®. The blower switch has no manual reset buttons, so the heater should re-start.

Flame Failure Detection

While the heater is completing its pre-fire purge cycle, close the manual gas cock on the pilot train. NOTE: this cock is normally installed very close to where the pilot gas train enters the burner.

Watch the Fireye Flame Safeguard as it attempts to light pilot. The PTFI LED will turn on, but the Flame LED should remain off. After 10 seconds, PTFI will no longer be lit, the heater will shutdown, and the Alarm LED and horn will be energized. Re-open the pilot gas cock and press the re-set button on the Fireye. The alarm will stop, and the heater should re-start.

Water Pressure Switch

With the heater burning Main Gas and water pressure entering the heater, slowly close down a hand valve on the water line to restrict the amount of water entering the heater. As the pressure feeding the heater drops below 4 to 6 Psi, the inlet pressure switch should break and de-energize the main fuel valve. The amber light marked Main Gas will also shut off at this time.

The heater will automatically re-purge and re-light. If the heater does not shut off when you reduce the water pressure, shut the heater off and notify Kemco immediately for procedures to correct this problem.

This completes the portion of the safety test procedure that requires the burner to be running. Turn Off the Burner switch and re-adjust the hot water tank recirculation switch setting to its normal position.

Water Wall Level Switch

Water must be drained from the water wall in order to test this safety. With the Burner switch Off, open the drain cock on the bottom of the water wall sight glass, or break a union on the line feeding the water wall. Continue to drain water till the level has dropped below the Water Wall Level Switch. The Water Wall light will illuminate indicating a safety lockout condition. Manually refill the water wall by running water into the top of the heater and/or by running the heater discharge pump (the water wall fill line piped from the pump discharge will have to be open). Once the water level rises above the switch, the safety should automatically reset

Main Gas Valve Leakage

Factory Mutual recommends that fuel valves be checked monthly for possible leaks. The main gas valves have test ports on the valve body that allow these test to be conducted. Follow the Valve Leak Test procedure listed in the manufacturer's instruction literature.

Clean Strainers And Solids Traps

Factory Mutual recommends that gas line strainers and drip legs be cleaned monthly. Consequently, the drip leg installed in the main gas pipe feeding the heater should be blowndown, and if your main gas piping has a strainer, then it should be cleaned now. The wye-strainer on the water inlet line to the heater should also be checked for debris.

6.2.2 Quarterly Maintenance

The following procedures must be completed every three months or 600 hours of heater run time, which ever comes first. An hour meter can be installed to monitor the actual run time.

Cleaning Of Flame Scanner

Remove and clean infrared scanner(s) located in the front center of the Maxon® burner(s). Unscrew the magnifying lens and make sure the photocell is tightly inserted in its socket. Replace the magnifying lens and reinstall the scanner(s) in the Maxon® burner. Repeat this procedure if you have more than one burner.

Cleaning Spark Igniter

Measure or mark how far the white porcelain igniter protrudes from the black compression bushing so it can be put back in the same position, and then remove the igniter from the burner. Check the porcelain on the igniter for cracks. If it is cracked, then a portion of the spark can escape causing pilot flame failure. Check the igniter tip for soot or solids build-up. Clean the tip if necessary, and then replace the igniter. If the igniter is not put back in its proper position, it

could create pilot flame failure problems. Refer to the Maxon® burner manual page number 3326 or 2120 for proper setting. Check the igniter cable. Replace any warn or loose parts. Automotive parts can be used if factory replacements are not available.

Lubrication Of The Maxon Burner

Lubrication of the internal, external linkages and pivot points are required to ensure long and trouble-free service from your Maxon® burner. With the heater burner switch off, loosen and remove the external linkage rod from the crankshaft attached to the Honeywell® module motor (s). Make sure the rod is marked on each side of the crankshaft clamp so the rod can be reassembled into the same position. This can be permanently marked using a hacksaw. When manually moving the linkage from low fire to high fire, it should move freely, as if there were nothing attached inside. If there is resistance, remove the two plastic windows on the face of the burner. This will expose several internal linkages. While manually moving the linkage from low to high fire, spray these linkages with WD-40® or similar penetrating lubricant. There are four additional pivot points visible externally that should also be lubricated. After the burner linkages move freely, lubricate all areas with a silicone lubricant or other lubricant that resists moisture. Reinstall the Plexiglas covers and the burner linkage making sure the linkage is clamped in the same position, a flame failure condition may occur during the transition between pilot and main flame if the linkage is not re-positioned correctly.

6.2.3 Annual Maintenance

The following procedure must be completed every 12 months or after 2400 hours of heater run time (which ever comes first). This procedure requires the heater to be taken off-line so that the burner must be removed for servicing. This process normally takes a 2-man crew at least 6 to 8 hours to complete. Consequently, this downtime and manpower must be included in your planning. Also be sure to have the necessary burner gasket and burner linkage kit (as mentioned in the Burner Maintenance procedure).

A replacement burner discharge sleeve may also be necessary. A preliminary estimate on the condition of your existing burner discharge sleeve may be made by observing the flow of water leaving the sleeve. If the leaving water can be adjusted to give a full, solid stream, then the sleeve probably does not have any internal water leaks, and is therefore “OK”. If you are only able to get a weak stream of water to flow out of the sleeve, then you should consider ordering a replacement.

Proceed as follows:

1. Follow the BURNER MAINTENANCE PROCEDURE included at the end of this section.
2. With the burner removed, check the condition of the burner discharge sleeve. The sleeve should be round and free of scale or water leaks. If the sleeve has a pin hole leak, then this can be welded closed. However, sizeable cracks or holes require replacement with a new sleeve.
3. With the burner removed, check the condition of the burner discharge sleeve. The sleeve should be round and free of scale or water leaks. If the sleeve has a pin hole

leak, then this can be welded closed. However, sizeable cracks or holes require replacement with a new sleeve.

a. Any "burn-thru" holes in the media support screen, especially holes large enough to allow packing rings to fall down into the combustion zone. Note that it is normal for the stainless steel in the combustion zone to have a dark-brown-colored tint.

b. Check the condition of the flame shroud, and make sure that it is solidly attached.

c. Check for leaks in the water wall.

d. Check for mineral build-up, especially any build-up that appears to be "blinding" the media screen. Chemical cleaning (as well as mechanical cleaning) may be required. If mineral build-up is a problem, then contact Kemco for cleaning procedures.

4. Check the water spray nozzle and level of packing in the top of the heater. Use the attached Spray Nozzle Check Sheet. Replace the nozzle and/ or add more packing if the performance does not match that shown on the CHECK SHEET and the Heater Assembly Drawing.

5. Reassemble the heater and check all of the piping, hoses, wiring and electric connections for leaks, corrosion or loose connections. Tighten, clean and replace as necessary.

6. Follow the start-up procedure found in the DAILY START-UP INSTRUCTIONS section of this manual.

7. Complete the BTU CONFIRMATION SHEET (see drawing 10-651 in this section). This will show you your current heater performance.

8. If a combustion analyzer is available, check the heater's combustion. If an analyzer is not available, then arrange for a local boiler company to come in and perform the check. With the heater operating on "HIGH FIRE" in the "WATER MAKE-UP MODE", the Oxygen concentration in the heater exhaust should be 4%, and the Carbon Monoxide level should be between 0 and 200 PPM, depending on the age and condition of the burner.

6.2.4 Summary

The below table is a summary of the regular suggested preventative maintenance required for the system.

Table 1: Heater System Preventative Maintenance

Schedule	Equipment	Task
Monthly	Heater Safeties	Test for Function
	Strainers and Solid Trap	Clean
	Gas Regulators	Check for Leakage
Quarterly	Flame Scanner	Clean
	Spark Ignitor	Clean
Annually	Burner	Inspection
	Spray Nozzle	Check for Leaks or Buildup

6.3 Burner Maintenance

Please read carefully before starting.

These instructions contain a recommended list of tools and materials that should be on hand before starting, followed by step-by-step procedures for the removal, disassembly, lubrication, necessary parts replacement, and reassembly of the Maxon Burner.

6.3.1 Recommended Tools and Material

The following should be on hand before starting:

- 18" Pipe Wrench
- 7/16" Wrench
- 1/8" Allen Wrench
- 1/8" Drift Punch
- Hammer
- Needle nose Pliers
- 3 Jaw Slide Hammer or Puller
- Penetrating Spray
- Anti-Seize Compound
- Burner Gasket
- Linkage Kit
- " Adjustable Wrench
- 1/2" Wrench
- 3/16" Allen Wrench
- 1/4" Drift Punch
- Screwdriver
- Wire Brush
- Teflon Spray Lubricant
- High Temp. Silicon Sealant
- Emory Cloth

6.3.2 Procedure

1. Disconnect and lockout main power supply to unit.
2. Shut off main gas supply to unit.
3 Disconnect both main and pilot gas supplies to burner at the unions.
4. Disconnect Modutrol linkage from operating shaft crank on the burner.
5. Remove Modutrol motor and linkage from the burner. It should be unnecessary to unwire the motor.
6. Unscrew the scanner and lay away from work area where it won't be damaged, then unscrew the adapter from the rear of the burner.
7. Remove the electrode from the burner after marking its position by wrapping a piece of electrical tape around the porcelain next to the mounting nut. After removal, inspect the porcelain for any cracks or damage, replace as necessary.
8. Floor or remote mounted blowers (EB-6 and EB-7 model burners), disconnect the blower hose. On all other models, it is necessary to unwire in some manner to speed reinstallation, otherwise blower rotation will have to be checked upon unit start-up.
9. Remove the four nuts mounting the burner to the discharge sleeve. Some help may be required to lift the burner to the floor.
10. With the burner lying on the floor & the cone facing upward, spray penetrating oil on the four screws supporting the burner cone, and also on the area where the nozzle and the cone meet.
11. Loosen the four lock nuts on the support screws. Back the nuts on the allen screws to the end of the screw without removing it, then remove all four support screws from the housing. It may be necessary to heat these screws to remove them.
12. Using a 3 jaw puller or slide hammer type, insert the jaw hooks on the puller outward. Then using the ridge on the cone near the nozzle, start to remove the cone. While continuing to spray penetrating lubricant on nozzle/cone contact area. DO NOT use excessive force or damage to the cone will result. It may be necessary to heat the area where the nozzle contacts the cone.
13. After the cone is removed, note the location of the positioning screw on the side of the nozzle, then remove the three allen cap screws holding the nozzle in if difficulty is encountered in removing the nozzle, it may be removed by inserting a long drift punch through the scanner opening and gently tapping it loose. Once removed, use a small wire brush to clean the groove on the nozzle, an the mating surface on the back of the burner, then using emery cloth, sand the area of the nozzle that inserts into the cone, and the corresponding area of the cone.
14. Next, inspect the internal linkage for wear, and operation. the linkage appears in good shape, spray teflon lubricant on all contact or wear areas and check for ease of operation, then proceed to Step 25. If linkage is tight, binding, or appears worn, proceed as follows:

a. Gas butterfly and linkage (refer drawing)

i. Remove gas inlet piping, and the observation glass at the rear of the burner.

ii. Through the window opening, remove the cotter pin from the gas butterfly connecting link, then push the link from the gas valve crank.

iii. Close the gas valve and note the position and arrangement of the gas valve crank, the remove the screw holding the gas butterfly and remove it. Using penetrating lubricant, loosen the shaft if tight, working back and forth until it moves freely.

iv. Using a 1/8" drift punch drive the roll pin from the gas crank through the shaft. On burners manufactured 1986 and later, it will be necessary to loosen the set collar. The gas shaft can now be removed. On 86 and newer, also remove the flanged bearing.

v. Install a new flanged bearing, then insert the shaft through the outer holes, about midway. Make sure at this point that the gas valve crank is on the right way. (Refer to sketch). Next lubricate the o-ring and slip it on the shaft, seating it into the groove. Carefully work the shaft through the inner hole without damaging the "o" ring. With the flat side of the shaft facing out, install the gas butterfly. When properly installed, the stop pin hole, and install the roll pin, making sure that the crank is positioned exactly like it was prior to disassembly. On newer models, the shaft collar is then located next to the flanged bearing and locked in place. Check for smooth and correct operation of the butterfly at this point. Install the new gas butterfly connecting link on the butterfly valve crank on the operating shaft, then insert the connecting correct operation before installing the cotter pin. With the operating shaft crank pointing to the low position, the gas butterfly should be closed, and in the high position, the butterfly should be fully open.

b. Air Damper and Linkage.

i. Remove cotter pin, then remove air butterfly connecting link.

ii. Next, with air butterfly closed, remove screws from the air butterfly studs. The studs can now be slid off of the butterfly and removed.

iii. Install new bearing, new studs, and new brass washers. Reassemble air butterfly.

iv. Replace air butterfly connecting link, then, by moving operating shaft crank, check for smooth and correct operation.

c. Operating Shaft.

i. Remove both gas and air butterfly connecting links from the butterfly crank on the operating shaft.

ii. Remove the shaft collar on the end of the operating shaft.

iii. Check positioning of the butterfly crank in relation to the operating crank on outside of the burner, then using 1/8" drift punch, remove the roll pin from the butterfly crank. The shaft can now be removed for bearing and shaft replacement.

iv. Reassembly is in the reverse order of above steps, with care in positioning of the butterfly crank to make sure it is exactly like it was prior to disassembly. Check for correct and smooth operation.

15. After completing linkage replacements, spray teflon lubricant on all moving points.

16. Using a small amount of anti-seize compound, lightly coat the ridge of the nozzle, then install it noting that the position of the alignment screw is as it was prior to removal.

17. Next, put a light coat of anti-seize compound on the nozzle area that inserts into the cone, and on the corresponding area of the cone. Then, with the burner facing upward, carefully set the cone over the nozzle, aligning the notch in the cone with the alignment screw on the nozzle.

18. Replace the old burner support screws with a socket head cap screws and lightly coat the cone support screws with anti-seize compound. Carefully install these to a point where they just come in contact with the cone - DO NOT TIGHTEN. This is important so cone will not be damaged. Check the gap between the cone and the housing. This should be approximately 1/8" and uniform around the cone. Next, install the locking nuts, snug only, except for the bottom nut, which should be locked at this time. Then check the cone. The cone should be slightly loose. If not, back the support screw up slightly (1/2 turn back) until the cone has a small amount of play. Holding the screws so that they do not turn, tighten the lock nuts, then recheck the cone for play. This is important, as over-tightening the support screws can damage or ruin the cone.

19. Install the electrode to its previously marked position before moving this burner.

20. The burner is now ready for reinstallation. Remove the "discharge sleeve" from the heater. Using a new burner gasket, fit the discharge sleeve to the burner.

Before tightening, check the fit of the discharge sleeve to insure that the gap between the housing and the cone is in no way obstructed. if the gap is covered, damage to the cone and/or the discharge sleeve will result. Next, using new gaskets (water cooled discharge sleeve gaskets need a light coating of silicon) install the burner/discharge sleeve as an assembly. Complete reassembly by following steps one through nine in reverse order. The unit is now ready to operate.

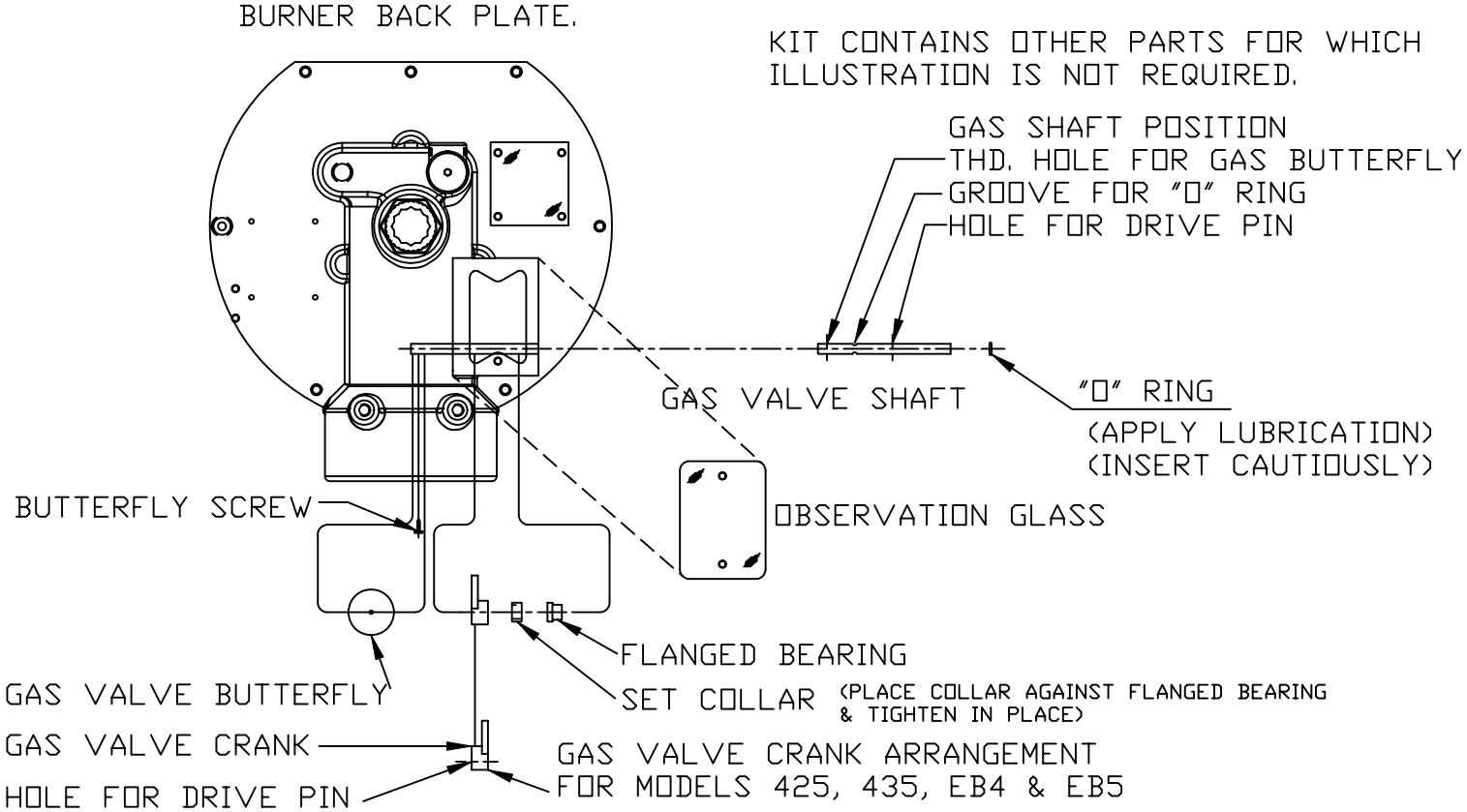
6.3.3 Repair Parts and Diagrams

The diagrams below provides visualization for the burner maintenance procedures outlined in the section above.

LINKAGE REPAIR KIT

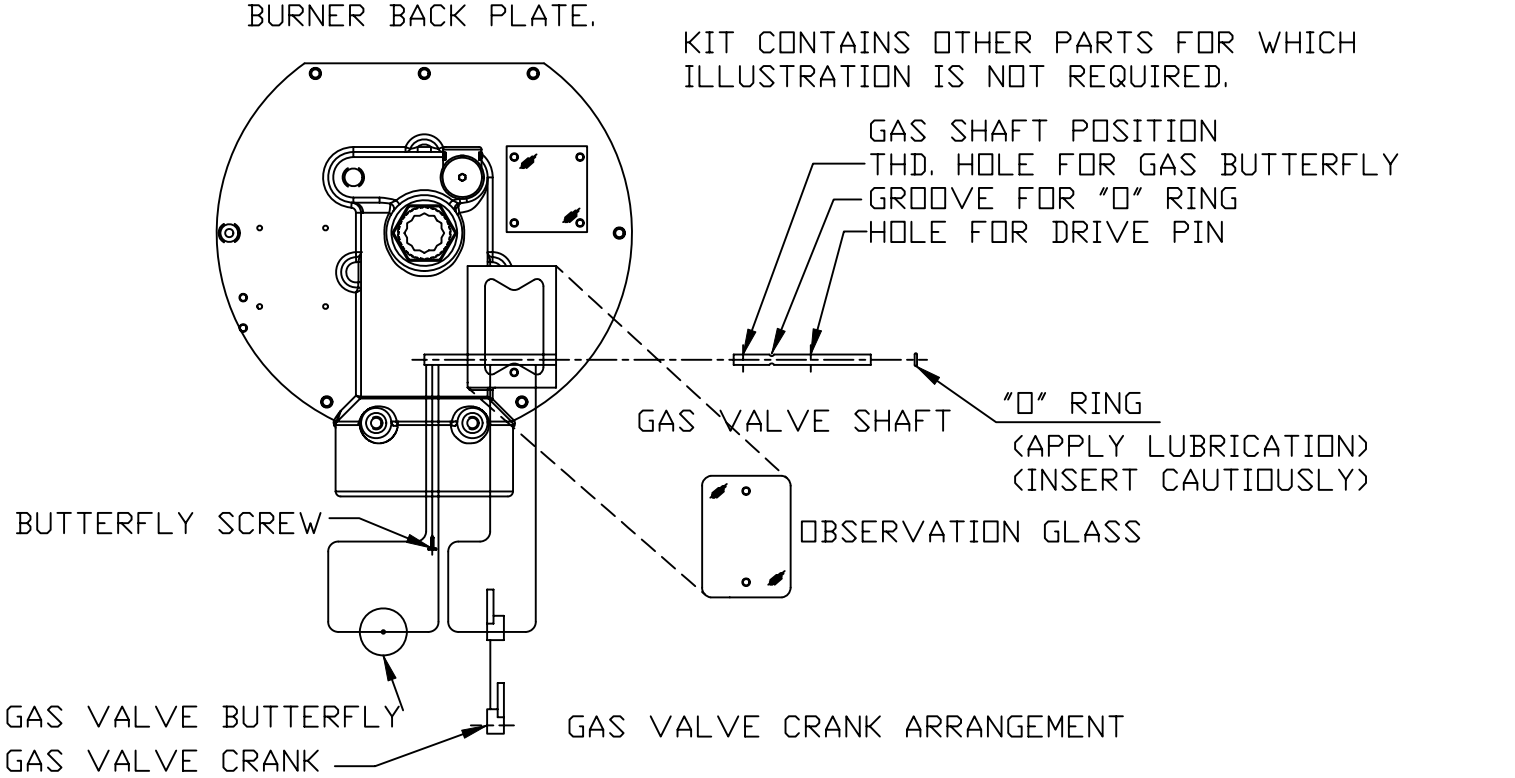
FOR BURNERS BUILT DURING AND AFTER 1986

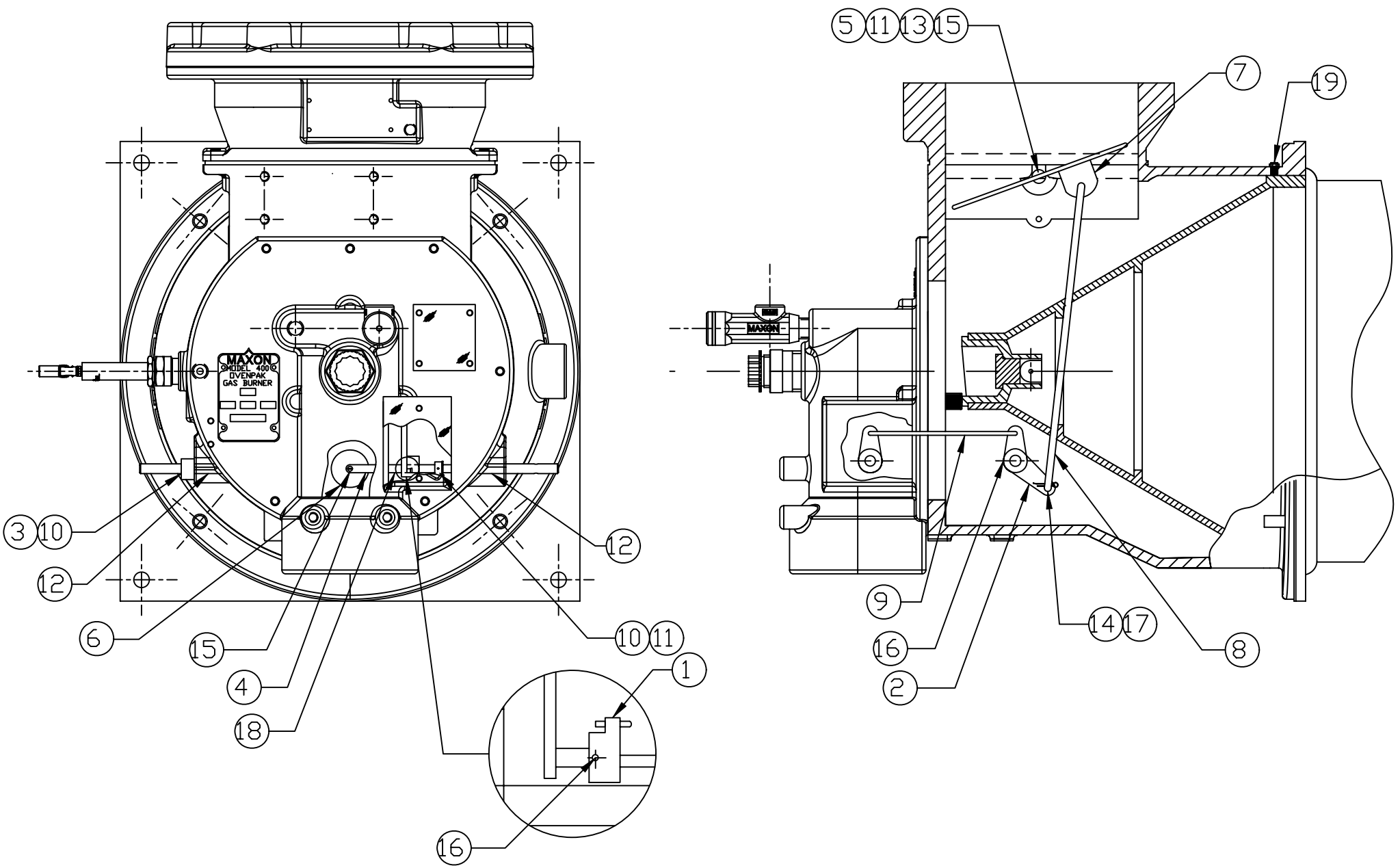
ONLY THE GAS VALVE PORTION OF THE LINKAGE REPAIR KIT IS ILLUSTRATED.



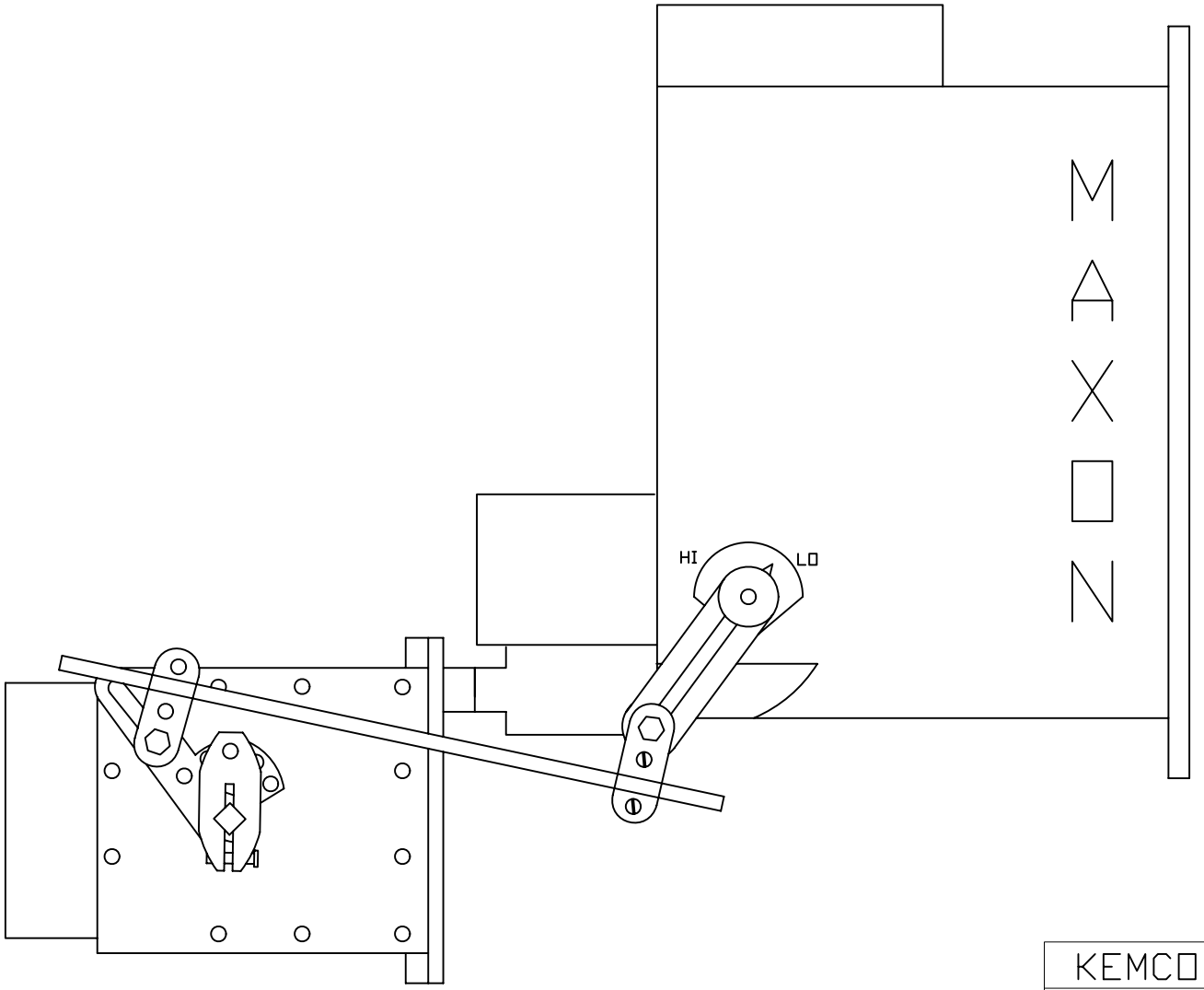
FOR BURNERS BUILT DURING AND BEFORE 1985

ONLY THE GAS VALVE PORTION OF THE LINKAGE REPAIR KIT IS ILLUSTRATED.





LINKAGE REPAIR KIT-2.DWG



FLOOR BURNER MOUNTED BLOWER

LET.	CHANGE	DATE	BY
A	TEXT ADDED	9/20/93	ALT

KEMCO SYSTEMS, INC.

MOD MOTOR LINKAGE

DR. S.McLEAN

SCALE 1/2"=1"

DATE 1-10-90

APP.

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DWG. NO. 20-1330

6.4 Spray Nozzle Check

The depictions below will help to determine if the spray nozzle is at the correct location and operating as designed. The spray pattern can be observed by removing the inspection plate at the top of the water heater. Confirm that the height between the nozzle and the media is per the Heater Assembly drawing. The media should be leveled.

It is recommended to test the spray pattern with an inlet water pressure of 15 psi. However, check the pattern at 10 and 30 psi as well. The spray angle should be similar.

Figure 5 shows a correct spray nozzle pattern. The spray should hit the intersection of the heater side and the packing ring providing full coverage. Figure 6 shows an incorrect pattern where the spray is providing too narrow coverage. Figure 7 shows one that is too broad.

Figure 5: Correct Spray Nozzle Pattern

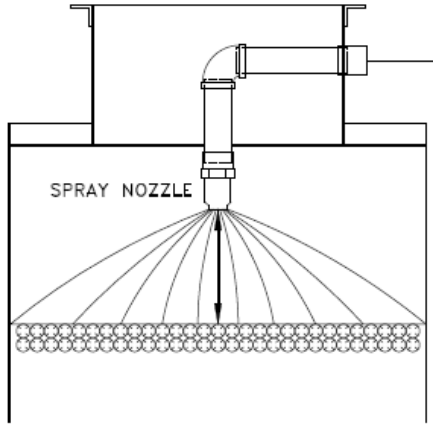


Figure 6: Incorrect Spray Nozzle Pattern (too narrow)

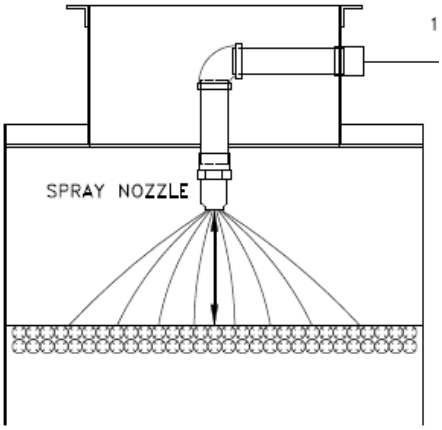
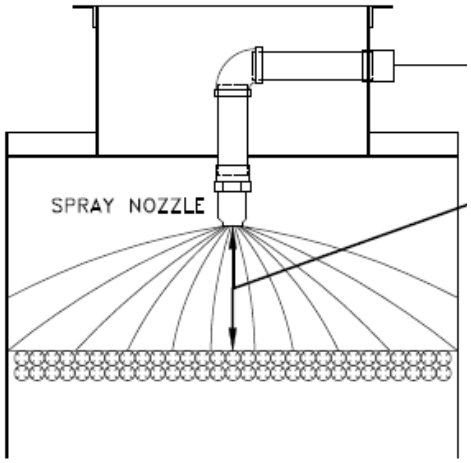


Figure 7: Incorrect Spray Nozzle Pattern (too wide)



6.5 Recommended Spare Parts

When ordering parts from Kemco Systems, please be prepared to provide the job customer and location at a minimum. For quicker service, please provide the job # and reference drawing numbers.

7 Troubleshooting

This section outlines some common problems that may occur during operation of the system and includes actions to take to find the cause of the issue.

7.1 General Tips

The most helpful tool in troubleshooting problems is the operator's knowledge of the normal operating conditions. Then, if the system develops an issue, the operator may note a change in conditions that may help in identification.

A well-kept log book of monitoring and operating data, tests, and changes in operation is an invaluable tool for troubleshooting.

Never overlook simple problems:

- Closed valve.
- Power off to a panel.
- Power off to a pump.
- Wires loose or disconnected.
- Low air pressure to valves or solenoids.
- Manual overrides.
- Incorrect setpoints.

7.2 Heater

There are three sources of information available to assist in troubleshooting:

1. The Fireye digital display
2. The Allen Bradley microprocessor lights
3. The red lights on the control panel

The red lights should only be used for troubleshooting when the Fireye reads "Lockout 3-P run interlock open". Lights should be ignored during any other message. The following pages show lockout conditions and corrective action. The Fireye flame safeguard must be reset after all safety lockouts except burner flooded. If problem cannot be resolved quickly do not hesitate to use our after hours service. Having a Kemco spare parts kit on hand is also helpful.

7.2.1 Blower Failure (Red Light on Panel)

Reason: Modutrol motor has not proven the low fire end switch.

During the purge cycle the modutrol motor moves to high fire, proving the high fire end switch, then to low fire proving the low fire end switch. If after 10 minutes, the low fire end switch does not confirm you will get this lockout condition.

1. Confirm the modutrol motor does move to high fire, then low fire. If motor does not move confirm you have 24-volt power to terminals T1 and T2 in the modutrol motor, replace the transformer.
2. If motor moves correctly, confirm the low fire cam makes the low fire end switch. Refer to the modutrol motor manual for cam location (picture below) and adjustment procedures.
3. Replace modutrol motor if this does not resolve the issue.

Reason: Flame Safeguard has lost sight of flame or loss of water pressure has shutdown main gas valves.

Additional Indicator: Flame Fail Auto on Fireye

1. Check flame scanner. A dirty or moist f flame scanner can cause this problem, especially if plant has a negative air condition. Clean scanner and correct negative air condition if necessary.
2. Check inlet water pressure switches – Both pressure switches should open at the same time. If the pressure switch in front of the main gas valves opens before the processor pressure switch, this lockout can happen. Contact Kemco for proper pressure switch setting.

Reason: Pilot did not light or scanner did not pick up on pilot.

Additional Indicator: Flame Fail PTFI on Fireye

1. Visually confirm pilot light is igniting- If pilot is igniting scanner or Fireye amplifier card is bad, replace. If pilot is not igniting proceed to Step 2.
2. Inspect igniter for rust or cracks in porcelain - Mark igniter, then remove and inspect for cracks in porcelain. If cracked, replace. Clean igniter tip with emory cloth.
3. Check ignition cable – Using conductivity meter, check ignition cable for resistance. Cable should read zero resistance. Replace cable if resistance is present.
4. Check ignition transformer – Holding the igniter with a fuse puller reset the Fireye controller when the digital display reads 60 seconds hold the igniter tip 3/16 inch away from a clean ground. A blue spark should arc this gap for 10 seconds. If spark is not present, is yellow or is not continuous replace ignition transformer providing steps 2 and 3 checked out okay.

5. Check pilot gas valve – Remove the solenoid from the pilot gas valve. Reset the Fireye controller when the digital display reads 60 seconds the gas valve will open. Replace gas valve or coil if valve does not open.
6. Igniter setting – Check igniter setting. Check the Maxon manual for the distance the porcelain should extend beyond the black compression fitting. If steps 2 through 5 check out okay and no pilot is achieved, insert the igniter 1/16 inch and retry for ignition.

Reason: Scanner lost flame signal after pilot was proven.

Additional Indicator: Flame Fail MTFI on Fireye

1. Check all manual gas valves – All manual gas valves should be open. If closed, return to open position.
2. Check main gas blocking valves – All blocking valves should open at the same time the main flame light on the panel comes on. If valve is not opening, confirm valve is getting powered, check for loose connections. If valve is powered and does not open replace gas valve actuator.
3. Check linkage for correct configuration – Refer to burner maintenance section of yearly maintenance procedure.
4. Check gas supply – Check main gas supply if lower than normal, usually 1 PSI, this lockout can occur. Call utility company to correct problem.
5. Check main gas regulator – If the main gas regulator has failed this lockout can occur. Gas pressures downstream of the main gas regulator must be confirmed. Consult Kemco for guidance for this problem.

NOTE: on dual burner heaters if the second burner does not light pilot the heater will lockout reading this message. refer to lockout flame fail – PTFI included in this section.

Reason: Safeguard is seeing flame prior to pilot or after call for heat has been shut off.

Additional Indicator: False Flame – Standby on Fireye

1. Check pilot gas valve for debris – The main reason for this lockout is debris under the pilot gas valve. Shut off main gas supply then clean pilot gas valve.
2. Check for any jumpers – The only other cause of this lockout is a jumper installed between power and the pilot gas valve or main gas valves. Remove any jumpers if found.

NOTE: This lockout requires the main gas supply to the heater be shut off immediately to prevent possible damage to heater.

Reason: Blower is not working or safety is defective.

Additional Indicator: 3P INTLK OPEN - PURGE

1. Check the blower starters overloads – If tripped, reset the blower starter and monitor amperage draw. Refer to manufacturers manual for preventative maintenance and lubrication instructions.
2. Check the blower circuit breaker – If tripped, check for shorts in wiring or possible bad motor. Replace motor is necessary.
3. Check position of blower blast gate – Blower blast gate must be in the same position as at start-up. Refer to start-up calibration sheet for proper air setting. Not applicable for burner mounted blowers.
4. Check blower safety for proper setting – Check setting of blower safety. Refer to start-up calibration sheet.
5. Clean blower sensing tube – If blower has lint accumulating on inlet fan blower pressure switch may be blocked by debris. Clean sensing tube and blower inlet.
6. Replace limit – If items 1 through 5 do not correct problem replace limit.

7.2.2 Water Wall Low (Red Light on Panel)

Reason: Water wall is below safety switch or safety is defective.

Additional Indicator: 3P INTLK OPEN - PURGE

Check water wall level indicated in the sight glass. If the level is above the water wall level switch and input 3 on the processor is not lighting, the water wall switch is bad, replace switch. If the water is below the water wall level switch, fill the water wall by running the heater discharge pump in hand. Make sure the manual valve between the pump and the water wall is open. Clean or replace the check valve and/or vacuum breaker in the water wall line replace if necessary.

7.2.3 Low Gas Pressure (Red Light on Panel)

Reason: Insufficient gas pressure is available or low gas limit is defective.

Additional Indicator: 3P INTLK OPEN - PURGE

1. Confirm gas supply – Make sure all manual gas valves are open. If gas supply was off and now is present, the low gas limit switch must be reset.
2. Check gas supply – Check main gas supply if lower than normal, usually 1 PSI, this lockout can occur. Call utility company to correct problem.
3. Check main gas regulator – If the main gas regulator has failed, this lockout can occur. Gas pressures downstream of the main gas regulator must be confirmed. Consult Kemco for guidance

7.2.4 High Gas Pressure (Red Light on Panel)

Reason: More gas pressure is reaching burner than designed or high gas limit is defective.

Additional Indicator: 3P INTLK OPEN - PURGE

1. Confirm gas supply – Using a water tube manometer, confirm gas pressure at the test connection with the burner on high fire.
   Consult Kemco for proper gas pressure. If pressure is incorrect a Kemco technician or local boiler technician will be required to reset the combustion.
2. Check gas supply – Check main gas supply if lower than normal, usually 1 PSI, this lockout can occur. Call utility company to correct problem.
3. Check main gas regulator – If the main gas regulator has failed, this lockout can occur. Gas pressures downstream of the main gas regulator must be confirmed. Consult Kemco for guidance

7.2.5 High Stack Temperature (Red Light on Panel)

Reason: Stack temperature has exceeded 200°F.

Additional Indicator: 3P INTLK OPEN - PURGE

1. Check high stack limit for correct set point/calibration.
2. Check spray pattern. A defective spray nozzle or blockage can cause a high stack temperature.
3. Check heater inlet switches for proper operation. See preventative maintenance section.

7.2.6 Burner Flooded (Red Light on Panel)

Reason: Water has reached burner flooded level switch or switch is defective.

1. Confirm level in float chamber. If level is below switch, replace switch
2. Check pump. If motor is running, proceed to Step 3. If not, check the following:
   a. Circuit Breaker
   b. Motor Starter
   c. Loose wires
   d. Proper selector switch position
3. Check for proper pump pressure.
   a. If 0 pressure, shut off pump, bleed air from plug and restart pump.
   b. If greater than 30 psi, check handvalves for proper position.
   c. If between 0 and 30 psi, pump is likely worn. Consult Kemco for proper deadhead pressure. Replacement of impeller may be required.

7.3 Solenoid Valve

All solenoid valves operate by the same basic principle. Water pressure is applied to the top and bottom of a diaphragm creating a balance. A spring is installed on the top of the diaphragm to upset the balance and keep the valve closed. When the electric solenoid is powered a small plunger lifts allowing the water on top of the diaphragm to bleed off downstream making the

pressure on top of the diaphragm lesser than on the bottom of the diaphragm thus opening the valve. When the solenoid is de-powered the plunger drops building up pressure on top of the diaphragm again closing the valve.

Table 2: Solenoid Valve Troubleshooting

Issue	Possible Cause(s)	Corrective Action
Valve sticking open	Electrical malfunction and power is not being provided to the valve	Check valve coil for power. If powered, check level switches.
	Debris in valve or defective component	Check valve coil for power. If not powered, check valve for debris. If no debris, check diaphragm, plunger or plunger seat. Replace defective component or clean as required.
Valve not opening	Low water pressure	Confirm water pressure is available using valve bypass.
	Defective coil.	Check coil to see if powered by partly removing coil. By using a screwdriver, check to see if magnetic field present. If no magnetic field present, check carefully 110V wiring. If 110V power is present and no magnetic field, replace coil.
	Debris in valve or defective component	Check valve coil for power. If powered but does not open, check valve for debris. If no debris, check diaphragm, plunger or plunger seat. Replace defective component or clean as required.

7.4 Control Panels

Add to or modify table below. Include solenoids or other related items located within the panel(s). There should be a table for with PLC and without.

Table 3: Control Panel Troubleshooting

Issue	Possible Cause(s)	Corrective Action
24 VDC Power Fails	Circuit breaker for 24 VDC power supply tripped	Check/reset circuit breaker
	Control Power is Off	Check to see if selector switch on control panel is On

	High load or fault	Check to see if power supply indicated high load or fault condition.
VFD alarm	VFD fault	Check VFD fault status. Reset if VFD has faulted. If alarm does not clear, cycle power to VFD.

7.5 Technical Support

As troubleshooting efforts persist and manufacturer's technical support or parts support is needed, the following connections can be made:Monday thru Friday (with the exception of holidays):

8:00 am to 5:00 pm Eastern Standard Time

Technical Assistance: 727-573-2323 Ext 317 / Email: Service@kemcosystems.com

Parts Support:727-573-2323 Ext 319 / Email: Quotes@kemcosystems.com.

Afterhours

Call 1-800-633-7055.