



TRIAD Boiler Systems, Inc.

**Series 8900 SH
Space Heating Control Panel**

Operation and Installation Manual

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SECTION 1: INTRODUCTION

This manual explains the operation, installation and control of TRIAD Boilers using the Series 8900 Microprocessor Control Panel. This manual provides information needed to operate the panel and to fine-tune the boiler system depending on the requirements of the structure that requires heating.

We have taken care to make this manual as easy to understand as possible, and to anticipate common questions that might be asked. If we missed something along the way, please feel free to call us or your TRIAD Manufacturer's Representative with ideas and suggestions.

INSTALLATION PROCEDURES:

The Series 8900SH Control Panel requires 120V A.C., 5 AMP, 60 Hz single phase to operate. Service wiring should be run in an approved manner using black and white wire. Minimum wire size should be 14 gauge or as local code requires.

After running the service wire to the panel, connect to the fuse block and neutral terminal, which is marked. Be careful that the panel is not mounted in an area that could experience temperatures above 125°F.

Mounting the Outside Sensor:

The outdoor sensor is to be mounted on the North or Northwest outside wall of the building. The sensor should be mounted no less than twelve feet above the ground. In a high-rise installation, when the equipment room is on the top floor, install the sensor as close as possible to the panel with it still on a North wall. Caution – Do not mount the sensor near a heat source such as an air handler or lighting fixture.

Mounting the Return Line Sensor:

The immersion sensor is to be installed in the return side on the Primary Main of the boiler system, at least 12 inches away from the nearest boiler.

Use 18 gauge solid copper wire between the sensors and the control panel.

Use 18 gauge or heavier coded thermostat wire to connect the low voltage terminals between the boiler and the control panel.

TRIAD recommends that the boilers be numbered. The terminal strip in the panel is prenumbered at the factory. Direction of flow through the Primary Main should be noted. The #1 boiler is at the "Supply End" of the Primary Main. The last boiler in the series is on the "Return Side".

Connect each boiler to the control panel ensuring that each boiler number is connected to the corresponding number in the control panel. Maintain polarity! This means all first

terminals of each pair should be connected to the same terminal in each boiler control center. Follow the drawing and wiring information carefully!

KEYPAD WITH ENTRY PROCEDURES

All functions of the Control Panel are activated through the use of two-digit Entry Codes via a simple keypad, which operates as follows:

1	2	3
4	5	6
7	8	9
*	0	#

1. Press the appropriate two digit Entry Code.
2. Wait for the Entry Code in the display to begin flashing.
3. Enter the desired temperature, value code, etc.
4. Press the pound sign # to save the displayed entry.

Press the star sign * to abort an unwanted entry to prevent it from being saved and to revert back to the last display code viewed. To discontinue the entry procedure, press the star sign to start over.

STARTUP PROCEDURES:

To bring the Series 8900SH Control Panel online, the following three steps must be completed:

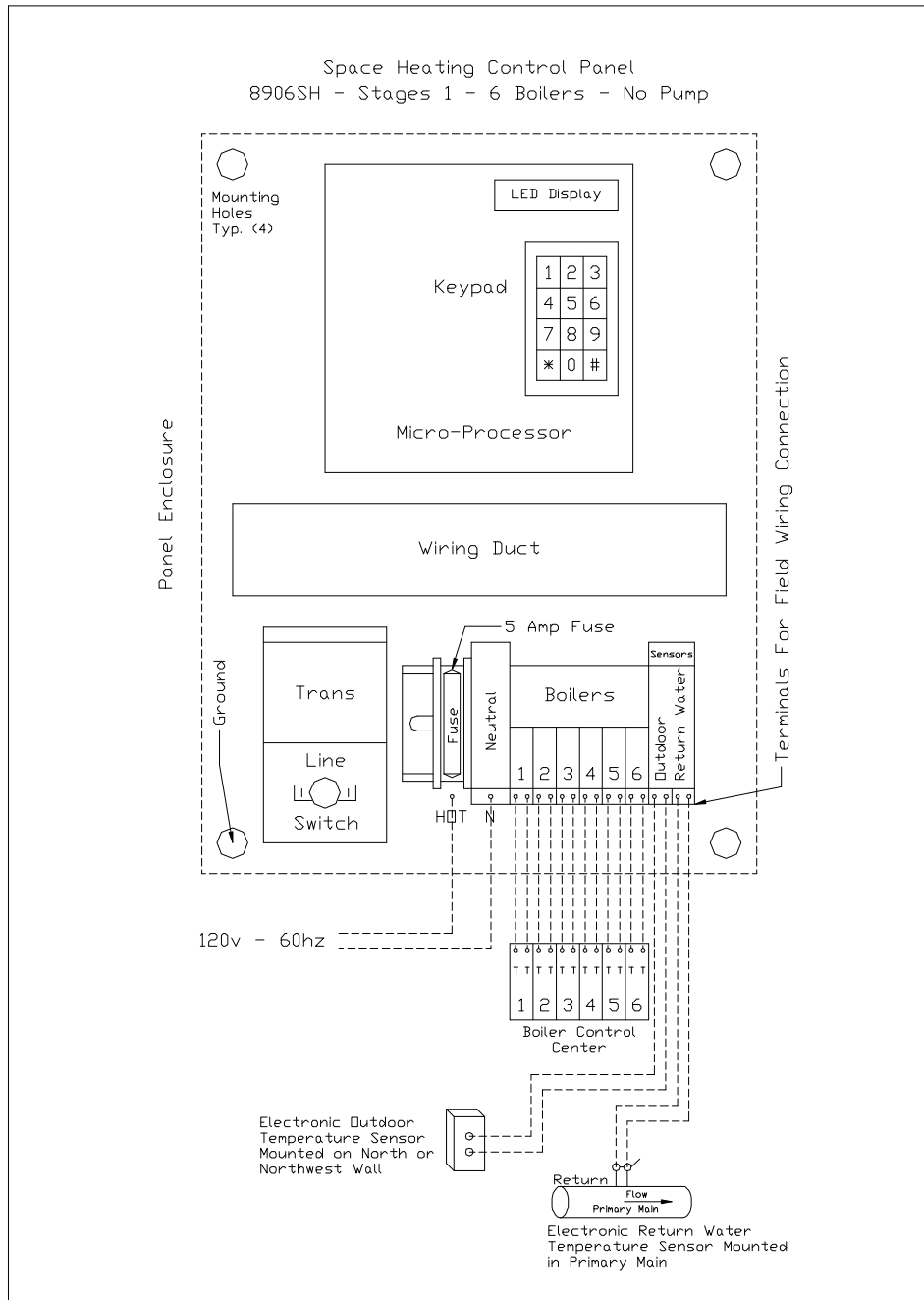
1. Unlock the keypad using code 61. (See Section 8)
2. Enter the code settings through the keypad. (See sections 3 and 8.)
3. Calibrate the sensors. (See Section 4).

System shut down and start-up should be done through the keypad only, (by using Code 62) and NOT by shutting off power to the control panel. If the power to the panel is off for more than 30 days, all control settings will be lost. In the event of temporary power loss the panel has two built-in rechargeable batteries that will maintain the settings for up to 30 days. THE FIRST TIME THE PANEL IS TURNED ON THE BATTERIES WILL REQUIRE 48 HOURS TO TRICKLE CHARGE.

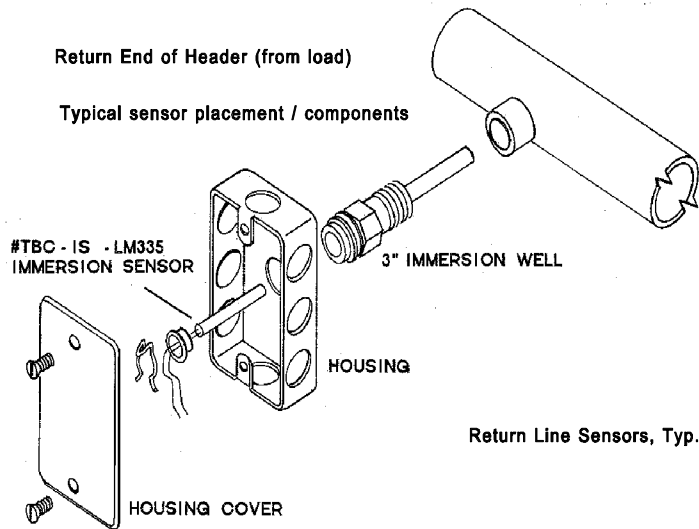
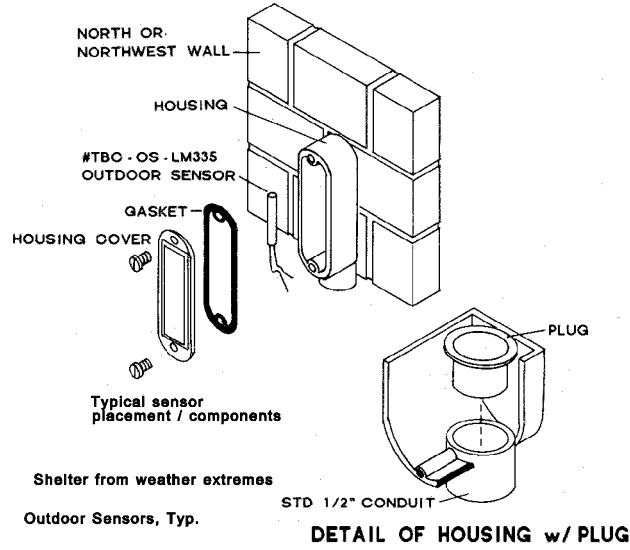
Code 61 is used to lock or unlock the system. Lock the system when you are completed with the initial settings, or any time you change the settings. The system display readings are always available, even with the keypad locked.

In the event of power loss or damage to the control panel the boilers will revert to self control. At that point each boiler will cycle on and off according to its high limit control. TRIAD recommends that in this situation the high limits be set at approximately 180°F.

WIRING DIAGRAM



OUTDOOR AND RETURN WATER LINE SENSORS:



SERIES 8900SH SPECIFICATIONS:

Input Voltage	9.8 vac, 50/60 Hz, max input 35 vac with transient/surge protection
Avg. Power Consumption	3VA
Battery Protected Memory	8K RAM
CPU	Industry standard Z80, 4MHz
Time Clock	Internal crystal based clock
Operating System Memory	8K EPROM
Serial Interface	1200 Baud standard TTL signal level. Can be interfaced with modem or direct connect to IBM compatible PC
Sensor Input Channels	Six
Sensor input Range	Voltage input of 1.9VDC is read at a value of -55 by the controller. Voltage input of 3.1VDC is read as a value of 200. If an input is shorted to common, the controller will read -40 at the input. If input is open, the controller will read 230.
Sensor Accuracy	Within + or - 1 degree Fahrenheit
Sensor Type	Solid-state linear sensing
Output Channels	Up to 24
Output Capacity	30VA, 24VAC
Relay Type	Coil 12VDC / "Dry Contact"
All Other Components	5VDC
Wiring	Multiconductor 18 AWG thermostat wire is recommended to wire sensor inputs and control outputs. Maximum length of wire from control panel to sensor is 300 feet.
Batteries	Two 1.2V sealed nickel-cadmium rated at 720 hrs. Standard charge 15 hrs at 18mA.
Display	Light Emitting Diodes

GLOSSARY:

Entry Codes: The set of two digit numbers that allow the operator to interact with the control panel.

Error Code: A code shown on the display that indicates a problem exists either in the sensors or in the computer itself.

Fine Tuning: Utilizing certain codes concerned with the boiler run time and the boiler staging to carefully "size" the output to the building to obtain the highest efficiency possible.

High Limit: A control mounted near the top of the boiler that shuts down the main flame of the burner if the boiler temperature exceeds the high limit setting.

Manual Override: When Code 63 is used to manually override the control panel.

Potentiometer: An electronic device used to adjust the sensor temperatures.

Program: A set of commands that tells the computer which calculations to carry out.

Ratio Control: The control that allows the operator to vary the Return Water Line temperature in relation to the drop in outside temperature.

Relay: An electromechanical device that opens or closes a current path on demand.

Sensor: A device used with the control panel to measure relative heat and cold.

Outside Temperature Shutdown: The pre-selected temperature that, when reached, shuts the boiler system off.

Stage: The position of a boiler in the firing sequence.

Supply Water Line: The supply water line is the line that provides heated water from the boilers to the building.

LIMITED FIVE -YEAR FULL TERM WARRANTY

The Manufacturer warrants the equipment described as the Series 8900 Control Panel to be free from defects in material or workmanship under normal use and service. The Manufacturer's obligation under this warranty shall be limited to repairing or replacing any part of said panel, which the Manufacturer's examination shall disclose to its satisfaction to be thus defective, for a period of One (1) Year after date of original installation provided proper evidence of such installation is recorded at the factory and installation is in accordance with TRIAD design.

The Manufacturer further agrees that if the Series 8900 Circuit Board(s) shall be disclosed to the manufacturer's satisfaction to be defective under normal use and service during a period of Five (5) Years after date of original installation, a replacement Circuit Board will be furnished the owner free of charge, exclusive of any applicable federal, state or local taxes.

All repairs and/or replacements furnished shall be F.O.B. TRIAD's factory. The Manufacturer shall not be liable for freight, drayages installation and/or other labor costs and any other costs or expenses involved with direct replacement of the defective parts. Defective part failures covered by this warranty should be promptly reported to the Manufacturer. This Warranty voided if Panel sustains an excessive surge in primary or secondary voltage.

This Warranty is in lieu of all other warranties expressed or implied and of all other obligations or liabilities on the part of the Manufacturer, and the Manufacturer neither assumes nor authorizes any other person(s) to assume for it any obligation or liability in connection with the sale of said equipment or any part thereof. This Warranty will not apply to said equipment or any part thereof which has been subject to any accident, negligence, misapplication, alteration, abuse or misuse. Nor does it apply outside the boundaries of the United States.

SECTION 2: SEQUENCE OF OPERATION

All functions of the Control Panel are activated through the use of two-digit Entry Codes that provide instruction to the panel. These codes are explained in more detail in Sections 3 and 8. The sequence of operation is best explained through the following example:

Assume a six boiler TRIAD system heating an office building that is empty at night and on weekends, an average outside temperature of 70°F, with an expected night temperature of 35°F.

The control panel is on and controlling the building heat. Through Entry Codes it has been instructed as follows:

Turn the heat on when the outdoor temperature drops below 60°F and off when it rises above 60° F.

Maintain a minimum Return Water Line temperature of 100°F, with a starting outdoor temperature of 60° F.

The manual Reset Ratio is set on Automatic.

The rate of system change factor is set at .10.

The boilers will fire in a sequence of 1, 2, 3, 4, 5, 6, and boiler number 1 is the lead boiler.

At 6:00 pm the temperature will automatically be set back by 5°F, with a return to normal temperature occurring 6:00 am.

As the outside temperature gradually drops from 70°F to 60°F, the control panel prepares to bring on heat. The decision has been made for the boilers to fire in a sequence of 1 through 6, so as the outdoor air temperature drops below 60°F, the control panel calls for the number 1, or lead boiler, to fire. As boiler 1 fires it begins to add heat to the return main. Because it is the designated lead boiler, number 1 will continue to fire intermittently while heat is called for. The lead boiler shuts off when the required Return Water Line temperature is reached (determined with code 14) and fires again when the Return Water Line temperature has dropped 2°F. This allows all the cycle time and the attendant wear and tear to be confined to the lead boiler. Any boiler can be designated the lead at any time.

As the temperature outside continues to drop, the control panel notes that the Return Water Line temperature has not reached the 100°F it must maintain, so it calls for the number 2 boiler to fire. However, before it can bring on the number 2 boiler it checks to make sure that the other instructions entered into the control panel are being satisfied. These are (i) the rate of system change factor, (ii) the required Return Water Line temperature, and (iii) the calculated Reset Ratio. With this information the panel can fire the other boilers in a way that will most efficiently satisfy the heating needs.

If the outside temperature continues to drop, then the calculated Reset Ratio (code 23) will be activated. More heat will be required to maintain the building temperature. To determine how much more, the control panel monitors (when in Automatic mode) the outdoor air temperature, the current Return Water Line temperature, the design return water temperature, and the design outdoor temperature. It then determines the Reset Ratio, which is simply a way of calculating how much heat to add to the system to make up for heat loss. If the Reset Ratio is set at 1:1.5 then for every 1°F the outdoor temperature drops, the Return Water Line temperature will be increased by 1.5°F. It is possible to override the automatic mode and enter your own Reset Ratio in code 23.

The next code that is monitored is the Rate of Change Factor (code 24) which sets the speed at which boilers are brought on line and off line. This rate of change factor has a range of .01 to 2.00. The rate of change factor is a timer that counts from 0.00 to 99.00. When 99.00 is reached, a boiler is brought on line or taken off line. The rate of change factor is important because it allows for a balancing of how much heat is increased against how much heat the building naturally loses. The rate of change factor also allows you to determine how long each boiler will run before firing the next boiler in line.

Assume it is now 7:00 pm, the building is empty and dark, and three of the boilers have been used to maintain the building heat. Because the control panel was set to lower the temperature in the Return Water Line at 7:00 pm, it directs one boiler to go off line, allowing the Return Water Line temperature to fall the required 5 degrees. At 6:00 am the panel will increase the Return Water Line temperature back to normal so the building will be warm when the employees arrive.

An important feature of the Series 8900SH control panel is its ability to handle setback recovery. The control panel starts monitoring the Return Water Line temperature and outdoor temperatures 2 hours prior to the 6:00 am set point so it can calculate the most efficient way to fire the boilers. Instead of all the boilers firing simultaneously, the panel may only fire one boiler, but allow it to run longer to save on fuel.

If heat was needed in the building after 7:00 pm a simple keypad entry (code 81) will override the setback. This set back override can be done in advance, or at the time the heat is needed.

Assume it is now early afternoon and the outdoor temperature continues to rise. Only two boilers are needed to maintain the building temperature. When the outdoor temperature rises above 60° F, the control panel shuts the system down until the next time it's needed.

SECTION 3: ENTRY CODES

The control panel is operated by Entry Codes, which are simple two digit numbers that provide the panel instructions. However, before entering any codes, you should become familiar with the features of the control panel.

The 8900SH has a keypad and a set of 6 display LED's. A code is entered by simply pressing any of the two digits on the keypad, which will then cause two LED's on the far left to light up in the order of the keys pressed. You must wait for the Entry Code in the display to begin flashing before entering the desired temperature, value, code, etc.

The (*) star key on the lower left of the keypad cancels any code you have entered. If the wrong code is entered, simply press the (*) key and start over.

IF THE PANEL DOES NOT POWER UP, OR THE RED DISPLAY LED'S ARE NOT ON, REFER TO THE WIRING DIAGRAM AND INSTALLATION INSTRUCTIONS. ALSO, REFER TO "SENSOR TROUBLESHOOTING" IN SECTION 5.

Below is a quick reference table showing the codes used to set up the control panel's basic operation. Do not be concerned that the codes are not listed in numerical order.

YOU MUST ENTER THE CODES IN THE ORDER SHOWN BELOW, THEN CALIBRATE ALL SENSORS CONNECTED TO THE CONTROL PANEL. MORE DETAIL ON EACH CODE IS AVAILABLE IN SECTION 8.

CODE	FUNCTION
60	This code starts the sequence for the "60" codes.
62	This code displays the System Mode, which tells us that the boiler system is either ready to heat or is shut off. Press 62 then press 0 (for System Off) or 1 (for System On).
63	This code manually overrides the control panel to control the boilers directly. Press Code 62 first, and enter 0, then press Code 63 <u>and</u> enter the number of the boiler you want to fire.
65	This code allows for the panel to control the system primary pump. After entering code 65, entering 0 shuts the pump off, entering 1 starts the pump, and entering 2 automatically cycles the pump. In the automatic cycle mode, the pump starts and stops along with the boilers according to the system shutdown outdoor temperature chosen in code 21. Please note that the pump starter must be an Automatic Reset type.
66	This code controls the temperature setback feature. When 66 is entered, the display will show 0 or 1. Press 0 to turn it off, or press 1 to turn it automatically on.
67	This code displays the 24 hour (military) clock. Press 67, enter the hour and minutes, and press # to save.
68	This code displays the day of the week and the day of the month. Press 68, enter the day of the week and press #, then enter the day of the month, 01 to 31, and press #.

69	This code displays the month and year. Press 69, then enter Month, 1 to 12, and the year, 01, 02, 03, etc. Then press #.
20	This code starts the sequence for the 20 codes.
21	This code stores the outside air temperature at which the heating system cycles off and on. While the system can be set anywhere between 0° F and 120° F, TRIAD recommends a setting of around 60° F. Press 21, enter the desired temperature, and the display will show the setting. The system will now shut down if the outside temperature rises above 60° F and turn back on when it drops below 60° F.
22	This code sets the Minimum Return Water Temperature. TRIAD recommends a setting of 100° F, even though the system can handle a range of between 50° F to 190° F.
23	This code allows you to override the computer to manually set the Outdoor Reset Ratio. The available range is from .10 to 2.50° F. Press 23, enter your desired Reset Ratio, and then press #. Control of the Outdoor Reset Ratio can be returned to the computer by entering "0" in code 23 and then pressing #.
24	This controls the Rate Of Change Factor, which determines how quickly the boilers are brought on line or dropped off line. The Rate Of Change Factor simply indicates the <u>speed</u> of the counter in code 17 (which counts to 100 and is described in Section 6). The range of code 24 is between .01 to 2.00 seconds. For example, a setting of 1.00 will be a 100 second delay, a setting of 2.00 will only be a 50 second delay, because the timer is counting up to 100 by two's (twice as fast). TRIAD recommends starting with setting at .10.
26	This code tells the panel how many boilers it will control, up to a maximum of 24.
27	This code sets the Design Return Water Line Temperature, which is determined by the Outdoor Design Temperature for your geographic region. The range of this code is 100° F to 225 ° F. To activate, press 27, input the desired Design Return Water Line Temperature, and then press #.
28	This code sets the Design Outdoor Temperature. The range can be from -20 to 50. To enter, press 28, input the correct Design Outdoor Temperature, and then press #. To enter a number below 0° F just press any two (2) keys side by side at the same time to obtain a negative number, then enter your temperature.
40-42	Stage/Relay/Boiler Activation (On). Please read section 8 for a complete explanation of this function before setting the control panel.
50-57	Not used at this time. Zero Out this code by pressing 50, then 9999, then #.
30-37	This code allows for temperature set-back when the building is empty. DO NOT ENTER SETTINGS IN THIS CODE NOW. ZERO IT OUT AT THIS TIME BY ENTERING 30, THEN 9999, THEN (#). Code 30 sets back the temperature for all 7 days of the week, and codes 31 through 37 will set back the temperature on a specific day or days.
90	Zero this out by entering 9999 in Code 91 and pressing the # sign.

Record your settings the following worksheet and keep for future reference.

Worksheet For Code Settings

Date of Entries _____

CODE	FUNCTION	SETTINGS
62	System Mode	
65	System Primary Pump (When Used)	
66	Setback – On/Off	
67	Hours and Minutes – 24 Hour Clock	
68	Day of the Week – Day of the Month	
69	Month and Year	
21	Outside Temperature Shutdown Setting	
22	Minimum Return Water Temperature Setting	
23	Reset Ratio Setting (Manual Setting When Used)	
24	Rate of Change Factor	
26	Total Number of Boilers	
27	Design Return Water Temperature Setting	
28	Design Outdoor Temperature Setting	

SECTION 4: SENSOR CALIBRATION

This section will deal with the calibration of the sensors that measure both outside air temperatures and water system temperatures. Correct calibration is very important so the control panel receives the accurate information necessary to properly control the building temperature.

The TRIAD system uses a minimum of two sensors, one which is placed outside, on the north or northwest side of a building, and the second which is placed in the Return Water Line coming back to the boilers.

The panel monitors temperature by passing a very weak electrical current through the sensor and back to the control panel. The resistance to this current changes when the temperature around the sensor changes, which is interpreted by the panel as an increase or decrease in temperature.

CALIBRATION:

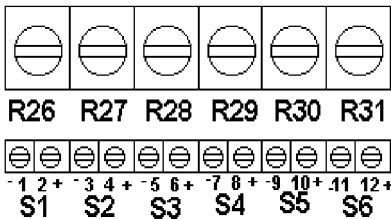
To calibrate the sensors you will need an accurate digital thermometer, a small non-magnetic flat screwdriver, a medium non-magnetic flat screwdriver, and a small crescent wrench.

PLEASE NOTE THAT THE SERIES 8900SH CONTROL PANEL MUST BE TURNED ON FOR AT LEAST 15 MINUTES BEFORE ATTEMPTING TO CALIBRATE THE SENSORS.

Press the function CODE for the sensor to display the current reading.

CODE xx = Potentiometer # = Sensor #
CODE 11 = R26 = Outdoor Sensor = S1
CODE 12 = R27 = Return Temp. Sensor = S3

Take off the cover of the main circuit board by loosening the two screws on either side of the cover and pulling it straight off.



The sensors should be wired up to the sensor terminal strip. If they are not, skip to "Troubleshooting The Sensors" in Section 5.

Then, locate the outside sensor and take a reading with your digital thermometer as close as possible to the sensor. Now, go directly back to the control panel and enter 11. The display light will indicate what the panel thinks is the temperature at the outside sensor; (S1). Carefully

rotate the screwdriver slot on the potentiometer R26 until the temperature shown on the display matches the outside temperature. The sensor is now calibrated.

Now locate the Return Water Line sensor and measure the temperature as close as possible. Then, at the control panel enter 12. The display will show what the panel believes is the Return Water Line temperature. Correct as before, turning the screwdrive slot on potentiometer R27.

There are three ways to determine accurate Return Water Line temperature.

1. Clean the copper surface of the return line next to the sensor well and tape the thermometer probe to the clean copper. Wait until the temperature shown on your digital thermometer stabilizes, and accept that as the correct temperature.

2. Remove the sensor from the well and let it hang in the air as far away from the hot return line as possible. Place your thermometer probe next to the sensor in the air. Wait for your digital thermometer to stabilize: Take that temperature and use it to calibrate your sensor. When you return the sensor to the well on the return line, the sensor will show an accurate temperature.

3. Insert the probe of your digital thermometer next to the sensor in the sensor well on the Return Water Line.

SECTION 5: SENSOR TROUBLESHOOTING

The wiring within the control panel from the Terminal Strip For Field Connections to the sensor input terminals on the circuit board are completed at the factory.

Inside the panel is a second set of wires from each sensor to the "Terminal Strip For Field Connections" that is generally completed by the electrical contractor.

Each pair of wires from a sensor is connected to the terminal strip inside the panel (for field wiring) and from there to the sensor input terminals on the circuit board. Below is a list of where the wires for each sensor are attached and the code that allows you to read the temperature.

SENSOR LOCATION	INPUT TERMINALS	ENTER CODE
Outside Sensor	S1	11
Return Sensor	S2	12

GENERAL TROUBLESHOOTING

If the display is showing **Error Code 230**, either the sensor is bad or a wire is broken. To check the wire between the input terminals on the circuit board and the sensor itself remove the circuit board cover and, using the chart above, identify the correct sensor. With a small screwdriver, loosen the two terminals and gently remove both wires. With an Ohm meter, check the resistance (continuity) between the two wires. No resistance (continuity) indicates a wire is broken. The second test is to attach a good sensor to the terminal strip in place of the one removed. If the display now reads a temperature then the old sensor is probably bad and should be replaced.

If the display is showing **Error Code -40**, the wires either have a short or the wires are reversed at the sensor input terminals. Each sensor has a positive wire and a negative wire that could have been reversed during installation. To test for this, remove the cover and reverse the wires. If the display now reads a temperature the problem is solved.

If the display still reads **Error Code -40** the wiring between the sensor terminal input and the sensor itself must be checked for shorts. Remove the wires from the terminal strip and, using an Ohm meter set at 1K, touch the Ohm motor leads together and adjust the needle to 1. Now touch the Ohm meter leads to the wires from the sensor. If the needle again goes to 1, or the end of the scale, the wires are shorted. If the needle only moves part way up the scale, the sensor is bad and must be replaced.

If you are adjusting a sensor potentiometer R26 through R31, and the display is not changing, make sure the correct monitor code for the sensor being adjusted has been entered. If the code is correct and the display still will not change, replace the sensor.

If the sensor has been replaced and the display continues to show the incorrect temperature, the control panel may be bad. Try a different sensor by switching them around on the terminal strip. If this still does not work, send the the board back to TRIAD for recalibration.

SECTION 6: MONITORING CODES

Monitoring codes display the information programmed into the control panel, such as what temperatures it was asked to maintain, what temperature setbacks it was instructed to use, and any other customized settings.

The difference between Monitoring Codes and Entry Codes is that Entry Codes allow us to enter items such as the time, dates, setback, etc. through the keypad, while Monitoring Codes allow us to display what was entered.

CODE	DISPLAY
10	This code begins the automatic monitoring of the first nine codes. When code 10 is entered, the control panel will sequence through codes 11 to 19, displaying each for 3 seconds before moving to the next one.
11	This code displays the Outside Air Temperature.
12	This code displays the current Return Water Line temperature.
13	This code displays the day of the week and the 24 hour military time clock, alternating between the two.
14	This code calculates the required Return Water Line Temperature using the Outside Temperature, the Ratio that was entered, and other information within the processor. Codes 12 and 14 are usually very close.
15	In this code, the panel checks the values of Codes 11, 12, 27, and 28, to calculate the Outdoor Reset Ratio. This automatic function can be overridden via code 23.
16	This displays the heating system status by using twelve horizontal display LED's that indicate which functions are operating. Each light correlates to a function, as shown below:

BOILER ON NA SYSTEM PUMP	SYSTEM MODE NA SYSTEM ON	AUTO SETBACK NA NA	NA NA SETBACK OVERRIDE
--	--	--	--
--	--	--	--

17	This code allows you to monitor the computer. The control panel is continually reviewing the Return Water Line temperature (Code 12) and comparing it to what the temperature should be in Code 14. When viewed, this code will be counting up to 99.00. When 99.00 is reached a boiler is either brought on line or dropped off line. The <u>speed</u> at which the computer counts up to 99. 00 is based on the Rate Of Change Factor entered in code 24.
18	This shows the last boiler that has come on, and for how many minutes it has been running.
19	This indicates which boiler(s) are currently running. It rotates as you watch, showing each boiler number.

90	This code, and the ones that follow, are all time clocks, providing elapsed running time since the boilers were originally installed. Press Code 90 to start the display.
91	This code allows you to pick which boiler to check the elapsed time on. To view boiler # 5 enter 91, and then 5. Then the panel will automatically go to code 92.
92	This code shows the total number of <u>hours and minutes</u> that a boiler has run since it was installed up to a maximum of 23 hours, 59 minutes. When 24 hours have accumulated one day is automatically added to code 93. Press # to view code 93.
93	This code shows the total number of <u>days</u> a boiler has run since it was installed up to a maximum of 9999.

You can clear the accumulated time for all boilers and start over at time zero by entering code 91, then entering 99, and pressing the # sign. This is useful when boiler maintenance is planned. By zeroing out the elapsed time after a maintenance procedure, you now have a timer that can count upwards to the point when maintenance must be done again.

NOTE: WHEN THE KEYBOARD LOCKED, ALL CODES CAN STILL BE VIEWED.

OTHER IMPORTANT ITEMS:

The panel has two rechargeable batteries that will retain all stored information for 30 days if the power goes out for any reason.

If the control panel fails for any reason, or is accidentally unplugged, the boilers automatically come on and are then controlled by their own high limit switches. Thus, the system will never be out of heat because of panel failure.

SECTION 7: ERROR CODES

Error codes are the way the control panel indicates if there are any system problems or faults.

DISPLAY	EXPLANATION
230	If this is displayed after entering any of codes 11, 12, 73, 74, 75, or 76, then you have an Open Sensor, which means the sensor is bad, or the wire connected to the sensor input terminal is broken. See Section No. 5, Sensor Troubelshooting to test.
-40	If this is displayed after entering any of codes 11, 12, 73, 74, 75, or 76 then you have either a bad sensor, or the polarity at the sensor input terminals is reversed. See Section No. 5. Sensor Troubelshooting to test.
CODE N.A.	This will display if you attempt to enter a code the panel does not recognize. Make sure you are using a valid code.
OUT OF RANGE	Some codes have limits. For example, code 26 tells the panel the number of boilers in the system. The maximum number it can operate is 24, so if 25 was entered the display would read "out of range".
PROG LOSE	This display, which means program lost, could be an indication of any of the following: <ol style="list-style-type: none"> 1. The first time the control panel is powered up PROG LOSE may flash. Press * (star) to reset the computer and then proceed with entering the codes. 2. If pressing * (star) does not clear the display, the E- PROM chip may be bad. Contact your TRIAD service representative or TRIAD Boiler Systems for a replacement. 3. If the replacement of the E-PROM chip does not solve the problem. the batteries may have gone bad. In this case the computer will have to be returned to the factory for service.

Replacement of E-PROM Chip:

The E-PROM Chip can be replaced if (i) it fails or (ii) to update the program and keep it tailored to the heating system.

THE E-PROM CHIP HAS A NOTCH ON ONE END. WHEN THE CHIP IS INSERTED INTO THE SOCKET IT IS CRITICAL THAT THIS NOTCH LINES UP WITH A MATCHING NOTCH ON THE RIGHT SIDE OF THE SOCKET. INSERTING THE CHIP WITH THE NOTCH TO THE LEFT WILL PERMANENTLY DISABLE THE E-PROM.

To insert the chip in the socket, gently rest the upper pins in the upper sockets without applying any downward pressure, and then insert the lower pins into the lower sockets. DO NOT FULLY INSERT THE PINS! With all pins properly alligned, place your fingers behind the circuit board to prevent it from bending, and your thumbs on the top of the EPROM. Apply slow and even downward pressure with your thumbs until the pins are snugly seated.

SECTION 8: ENTRY CODE DETAILS

This section provides more detail to better understand the control panel Entry Codes.

The Keypad is used to (i) provide instructions to the computer (ii) read, via the display LED's, what current settings are stored in memory, and (iii) aid in monitoring the system after the settings are complete.

KEYPAD WITH ENTRY PROCEDURES

1	2	3
4	5	6
7	8	9
*	0	#

1. Press the appropriate two digit Entry Code.
2. Wait for the Entry Code in the display to begin flashing.
3. Enter the desired temperature, value code, etc.
4. Press the pound sign # to save the displayed entry.

Press the star sign * to abort an unwanted entry to prevent it from being saved and to revert back to the last display code viewed. To discontinue the entry procedure, press the star sign to start over.

ENTRY CODE 21: OUTSIDE TEMPERATURE SHUTDOWN SETTING

PRESS + = ENTRY CODE

ENTER YOUR CHOICE

PRESS = SAVE KEY

FOR AN OUTSIDE TEMPERATURE SHUTDOWN SETTING OF 60°F.
THE AVAILABLE RANGE IS + 0°F to + 120°F

This code shuts down all boilers when the outside temperature reaches or goes above a specified point and turns on the boilers when the outside temperature drops below the specified point. A common setting is around 60°F degrees.

ENTRY CODE 22: MINIMUM RETURN WATER TEMPERATURE SETTING

PRESS + = ENTRY CODE

ENTER YOUR CHOICE

PRESS = SAVE KEY

FOR A MINIMUM RETURN WATER TEMPERATURE SETTING OF 100°F.
THE AVAILABLE RANGE IS + 50°F to + 190°F

This code allows the panel to set and monitor a minimum allowable boiler system Return Water Line temperature. When the outside temperature drops below the setting in code 21, the control panel will maintain a minimum of 100°F in the boiler system return line.

**ENTRY CODE 23: OUTDOOR RESET RATIO SETTING
(AUTOMATIC CALCULATION)**

PRESS + = ENTRY CODE

ENTER YOUR CHOICE

PRESS = SAVE KEY

The above setting of "0" is entered when you want the computer to automatically calculate the outdoor Reset Ratio setting. This calculation will be displayed in monitor code No. 15.

**ENTRY CODE 23: OUTDOOR RESET RATIO SETTING
(MANUAL CALCULATION)**

PRESS + = ENTRY CODE

ENTER YOUR CHOICE

PRESS = SAVE KEY, FOR A RESET RATIO OF 1.00.

THE AVAILABLE RESET RATIO DEGREE RANGE IS -.10 TO 2.50

This code allows for manual fine tuning of the boiler system to the requirements of the building's host system. As an example, assume it is 60°F degrees outside and that 100°F water is needed in the system Return Water Line. As night approaches and the temperature begins to drop, the 100°F Return Water will not keep the building warm. So, as the outside temperature drops one degree, the control panel senses this and increases the Return Water Line temperature by the ratio amount. If the ratio is set at 1.00, as in the example above, for

every 1°F the outside temperature drops, the Return Water Line temperature is increased 1°F. If the ratio is set at 1.50, the Return Water Line will increase 1.5°F for every 1°F drop in outside temperature.

THE FORMULA BELOW WILL HELP YOU DETERMINE THE INITIAL RATIO SETTING.

Outdoor Reset Ratio Formula:

$$\frac{\text{Design Return Water Temperature} - \text{Minimum Return Water Temperature}}{\text{Outside Shutdown Temperature} - \text{Outside Design Temperature}} = \text{Outdoor Reset Ratio}$$

Example:

$$\frac{180^{\circ}\text{F} - 100^{\circ}\text{F}}{60^{\circ}\text{F} - (-10^{\circ}\text{F})} = \frac{80^{\circ}\text{F}}{70^{\circ}\text{F}} = 1.14 \text{ Reset Ratio}$$

ENTRY CODE 24: RATE OF CHANGE FACTOR

PRESS + = ENTRY CODE

ENTER YOUR CHOICE

PRESS = SAVE KEY, FOR A RATE OF CHANGE FACTOR OF .10.

THE AVAILABLE RANGE IS FROM .01 TO 2.00

This code allows you to set the speed of the counter that was explained in code 17. The Rate of Change Factor directly influences how fast or slow boilers are brought on line when heat is called for. If boilers are brought on line too quickly, a waste of fuel can result due to too many boilers running and short-cycling. Too long a count between boilers may result in unsatisfactory heat to the building. TRIAD recommends an initial setting of .10. The lower the factor, the longer (slower) the response time of the boilers, and the higher the factor, the shorter (faster) the response time.

ENTRY CODE 26: NUMBER OF BOILERS TO BE CONTROLLED

PRESS + = ENTRY CODE

ENTER YOUR CHOICE

PRESS = SAVE KEY, TO CONTROL 24 BOILERS.

THE AVAILABLE RANGE IS FROM 1 TO 24

ENTRY CODE 27: DESIGN RETURN WATER TEMPERATURE SETTING

PRESS + = ENTRY CODE

ENTER YOUR CHOICE

PRESS = SAVE KEY, TO SET DESIGN RETURN WATER TEMPERATURE.

THE AVAILABLE TEMPERATURE RANGE IS +100°F TO +225°F

This sets the Design Return Water Temperature. It is important to set it correctly because many of the panel's calculations are based on this figure. Usually the system design engineer will have already calculated this. However, if you do not know the proper temperature simply use 180°F.

ENTRY CODE 28: OUTSIDE DESIGN TEMPERATURE SETTING

PRESS + = ENTRY CODE

ENTER YOUR CHOICE

PRESS = SAVE KEY, TO SET OUTSIDE DESIGN TEMPERATURE.

THE AVAILABLE TEMPERATURE RANGE IS - 20°F TO +50°F

This code sets the Design Outside Temperature, which is the average coldest temperature your geographic area is expected to experience. The correct figure can be found by calling a local heating contractor or your mechanical engineer.

To enter a number below 0°F degrees, press any two keys side by side at the same time to set the display to a negative number, then enter the temperature.

ENTRY CODE 30 – 37: WATER TEMPERATURE SETBACK SCHEDULES

PRESS + = ENTRY CODE FOR ALL 7 DAYS OF THE WEEK

ALL 7 DAYS THURSDAY

MONDAY FRIDAY

TUESDAY SATURDAY

WEDNESDAY SUNDAY

SETBACK TIME ON AND TEMPERATURE SETBACK = 6:00 AM, 5°F SETBACK

FIRST SETBACK OFF-TIME = 6:00 AM, 0°F SETBACK

PRESS = SAVE KEY

This code programs water temperature setback schedules for either the entire week or for each day of the week. This feature is primarily used for night, or whenever the building is empty.

The control panel uses 24 hour military time. Choose the hour (on the hour) for setback to begin, say 6 p.m., or 1800 hours in the example above. Then enter the amount to set back, which can be anywhere from 1°F to 99°F. The example above assumes 5°F. After entering the "on time", and the degrees to be setback, press the enter key (#). When # is pressed at the end of each entry, it not only enters the values into program memory, the display is advanced to the next slot.

Next, input the time to turn the setback off to return to normal running conditions, 6:00 am in this example. The panel now knows to lower the water temperature by 5 degrees at 6 p.m. and return to the original temperature at 6 a.m.

An important feature of the panel is that it begins the warming process two hours prior to the programmed time. Thus, the panel will begin monitoring both the outside and Return Line Temperatures at 4:00 a.m to determine the most fuel efficient way to reach the desired water temperature by 6:00 a.m..

Each of the codes 30 through 37 can handle four complete on and off setback schedules every 24 hours. Remember that code 30 sets the time for all seven days of the week, and 31 through 37 sets each individual day for its own setback. A simple way to customize certain

days is to input the times and temperatures that will be the same for the most of the days into the 30 code, and then enter the times and temperatures that will be different into the appropriate Entry Code(s) 31 through 37. The values entered into the 30 code are saved in program memory, but a specific entry into a specific day will override the 30 code entry for that day.

To eliminate the entries in codes 30 through 37 simply enter 9999, then press #.

Please note that codes 30 through 37 are used for scheduling purposes only. In order to activate the automatic operation of the setback times and temperatures, another entry must be made into Entry Code 66.

ENTRY CODE 40 – 42: STAGE /RELAY /BOILER ACTIVATION (ON)

These codes determine the boiler firing sequence.

The control panel has 24 stages, and thus can control up to 24 boilers. Inside the control panel enclosure is a terminal strip that is connected to the boiler wiring and sensor wiring. For each boiler there is one on/off relay (mounted under the panel cover or on the inside of the enclosure) which closes to fire a boiler and opens to shut down a boiler.

Your mechanical contractor should have numbered the boilers to correspond with the numbers on the terminal strip. If not, use Code 63 to manually activate boiler No. 1. If it won't fire, rewire the terminal strip so relay 1 fires boiler 1, relay 2 fires boiler 2, etc. The sequence in which the boilers fire is important for both efficiency and maintenance reasons.

Now, assume a system has 12 boilers. To sequence them, use Code 40 to enter a 1 to represent the first stage to fire when there is a call for heat. (See example No. 1).

Then enter a “blank” or zero (0) to separate the stage number from the boiler number.

Then enter a 1 so the first stage called on will fire boiler number one. If you make a mistake, enter 9999 and # to start over.

When # is pressed, the display will clear and show you 40 0000. This means that the information related to stage 1 was saved and you have been bumped to the second slot. There are eight slots in each code 40 through 42. If you forget where you were or get confused, simply press *, which will take you out of the 40 codes and back to the last code monitored. Enter Code 40 again, and then repeatedly press # until you find your place. Each pressing of # moves you to the next slot in whatever code you are in.

Example 1:

ENTER CODE "40"					
DISPLAY WILL SHOW	4	0	0	0	0
ENTER STAGE "1"	4	0	.		1
ENTER A BLANK "0"	4	0	.	0	1
ENTER BOILER NO. 1	4	0	1	0	1

PRESS = SAVE KEY, TO HAVE BOILER #1 OPERATE AS THE FIRST STAGE.

To set firing of the second boiler, enter 2 for the stage, then a 0, then a 2 for the second boiler. The display should read 40 2.02. Now press # to save that slot to memory. Again, the display will automatically bump you to the next slot with the display showing 40 0000, indicating you are in slot 3. The control panel will automatically go into the next slot.

Once the eighth boiler has been entered, all of the slots available in Code 40 have been used. Because there are still 4 more boilers remaining, simply press Code 41 and continue entering the last 4 stages.

Example 2:

4	1		9	0	9
4	1	1	0	1	0
4	1	1	1	1	1
4	1	1	2	1	2

PRESS = SAVE KEY, TO HAVE BOILERS 9 THROUGH 12 ENTERED.

Changing The Lead Boiler Firing Sequence:

After a boiler has been in the number 1 position for a year, it will have accumulated more firing time because it is always first to fire and last to go off, so it is recommended that the lead boiler be changed. Generally, the position of the lead boiler is moved to the next boiler down the line. So, in Code 40, simply change boiler 2 to be in stage 1, boiler 3 to be stage 2, boiler 4, stage 3, etc., until finally, in Code 41, boiler 1 will be in stage 12.

ENTRY CODE 61: KEYBOARD LOCK - UNLOCKPRESS + = ENTRY CODEPRESS + + + = LOCK OR UNLOCKDISPLAY SHOWS OR PRESS = SAVE KEY

Code 61 prevents tampering with the entries by locking the panel. When code 61 is entered, the display will show either "loc" or "unl". If loc is displayed, the keypad can only be used to view the settings. If the display shows unl, the settings can be changed. It is recommended that the keypad be locked after each entry session.

ENTRY CODE 62: SYSTEM MODEPRESS + = ENTRY CODEDISPLAY SHOWS = OFFOR = ONPRESS = SAVE KEY

The system mode turns the boiler system off and on, and is commonly used to shut it down at the end of the heating season and turn it on again in the Fall. When turning the system on, the panel takes over control of the boilers, and in some cases the primary system pump. To use this code, enter 62, and the display will show either 0 or 1, for off or on, respectively. Enter your choice and press # to save.

ENTRY CODE 63: MANUAL OVERRIDE OF BOILER STAGESPRESS + = ENTRY CODEDISPLAY SHOWS ENTER YOUR CHOICE PRESS = SAVE KEY, TO SET CONTROL STAGE 12.

The code allows for manual control of up to 24 stages. During normal operation, the panel controls all the boilers. Code 63 will override that to control any boiler you choose. To use this code, you must first enter 0 in code 62, then enter code 63, and then enter the boiler/stage you want to run. Remember to always press # after each entry.

This code turns off when a zero is entered and turns on when the number of boilers you want is entered. Thus, to give control of the boilers back to the panel, enter 0 to turn code 63 off, and enter a 1 to turn code 62 on. Code 63 is commonly used during maintenance or testing.

ENTRY CODE 65: MANUAL OVERRIDE OF THE SYSTEM PRIMARY PUMP

PRESS + = ENTRY CODE

DISPLAY SHOWS = OFF

OR = MANUAL ON

OR = AUTOMATIC

PRESS = SAVE KEY

This code allows the system primary pump to be turned on, off, or put on automatic. The system primary pump circulates water from the boilers through the building. To use this code, enter 65, and then enter 0 or 1 to turn it off or on, respectively, which takes control of the pump away from the panel. Enter 2 to have the panel control the system pump. Please note that the pump must have an auto-reset feature to work with setting number 2.

ENTRY CODE 66: SETBACK - ON / OFF

PRESS + = ENTRY CODE

DISPLAY SHOWS = OFF

OR = ON

PRESS = SAVE KEY

This code turns the system setback feature off and on. Once this is turned on, then refer to codes 30 through 37 to actually set when and how much you want the temperature to decrease.

ENTRY CODE 67: 24 HOUR CLOCK - HOUR AND MINUTE

PRESS + = ENTRY CODE

DISPLAY SHOWS = 6:30 PM

This code allows you to set or observe the 24 hour military time clock. To set the clock, enter 67, then the hour, then the minute, then press #.

ENTRY CODE 68: DAY OF THE WEEK AND DATE OF THE MONTH

PRESS + = ENTRY CODE

PRESS = SEVENTH DAY OF THE WEEK

PRESS = TWENTY-NINTH DAY OF THE MONTH

PRESS = SAVE KEY

This code allows you to set, or observe, the day of the week and month. To set the proper day of the week, enter a single digit of 1 through 7 to represent Monday through Sunday, then enter two digits to represent the calendar day of the month and then press # to save.

ENTRY CODE 69: MONTH AND YEAR

PRESS + = ENTRY CODE

PRESS = JUNE

PRESS = YEAR 2001

PRESS = SAVE KEY

This code allows you to set, or observe, the month and year.

ENTRY CODE 81: SETBACK OVERRIDE

PRESS + = ENTRY CODE

ENTER CHOICE = MINUTES OF SETBACK

RANGE IS FROM 1 TO 240 MINUTES

PRESS = SAVE KEY

This provides flexibility to the setback schedule. For example, a school might set back every night of the week, but occasionally have a special activity in the evenings. To warm the building, you could re-enter the code for that night and change the settings. However, it is much easier to enter Code 81, the number of minutes of override, and then press #.

SECTION 9: FINE TUNING THE HEATING SYSTEM

The key to fine tuning any boiler system is to understand the building use. A hospital, an office building, a school, and an apartment all have very different hosting needs.

The following codes are used to fine tune a system's heating output:

Codes 30 to 37 - Setback Temperature.

Code 21 - Outside Air Temperature Shut Down.

Code 22 - Minimum Return Water Line Temperature.

Code 23 - Outdoor Reset Ratio Setting.

Code 24 - Rate of Change Factor.

The goal of fine tuning a system is to find a balance between the comfort of the occupants and the cost of operation. Boiler staging is a function of building needs, not outside temperature or Return Water Line temperature. The following provides a step-by-step way to improve the settings.

Codes 30 to 37:

First, determine the times each day that the heat can be set back using Codes 30 – 37. Some buildings, such as hospitals, are always occupied, and thus do not allow for much, if any, setback. However, in a normal office building temperatures can be reduced by 20°F overnight and on weekends (the maximum recommended by TRIAD). Setback can be as much as 20°F because the control panel begins determining the most fuel efficient way to reheat the building two hours prior to the end of the setback period instead of just firing all the boilers simultaneously. While watching both the outside temperature and the system Return Line Temperature, the panel will fire the boiler(s) only enough to bring the heat back normal. So the energy savings realized during setback are not wasted by firing all the boilers at the last minute.

Remember that the panel is capable of 4 setbacks every 24 hours, so setback can also be scheduled, for example, in the afternoon when the sun and body heat from the occupants, can naturally contribute to warming the building.

Code 21:

The setback function in codes 30-37 are now operating and the building cools off when vacant and warms back up when occupied. The next step is to use Code 21 to slowly reduce the outside air shutoff temperature degree by degree. If the current setting is 60°F, once a week reduce the setting by 1°F. The goal is to reduce the heat to the lowest temperature the occupants will comfortably allow. If it becomes too cold increase the set point by 1°F.

Code 22:

Next, begin reducing the minimum system Return Line Temperature by 1°F each week using Code 22. If the starting temperature is 100°F, reduce it to 99°F for a week, and every week thereafter, until the building is comfortable. If it becomes too cold, then increase the set point by 1°F.

Code 23:

The next step is to use Code 23 to ensure the panel has automatic control of the Reset Ratio. Enter code 23 and input 0 to have it automatically calculated.

Code 24:

The next step is to use Code 24 to set the Rate of Change Factor. As explained in Section 8, the rate of change factor controls the speed at which the timer counts from 00 to 99. When 99 is reached, the panel either fires a boiler or shuts a boiler off. The Rate of Change Factor is important to the system's efficiency because if the count is too fast the boilers will short cycle, and if the count is too slow there is a lag between the need for heat and the firing of the boilers. TRIAD recommends an initial setting of .10.

By viewing Code 18 you can get a feel for how long the boilers have been running in each cycle. For maximum efficiency, the boilers should fire for a minimum of 30 minutes. If they aren't, reduce Code 24 by .01, for a setting of .09. Check daily and continue to reduce your entry by .01 until a run time of 30 minutes is achieved.

Once you feel the building is being heated as efficiently as possible, record the settings and keep in a safe place.

TRIAD has a system available that can remotely monitor the control panel that is designed to be used with an IBM-compatible PC and consists of a modem, an interface, and software. This allows the control panel settings to be monitored or changed from a remote station. It is possible to operate several buildings from one central location. More information is available from TRIAD.

SECTION 10: TROUBLESHOOTING

THE BUILDING EXPERIENCES A POWER OUTAGE

In the case of a power outage, the control panel has two built-in rechargeable batteries that will power the memory for 30 days, allowing the panel to continue where it left off when power is restored. However, the boilers will not run without electricity, and the building has lost the hosting system until power is restored. Please note that the batteries require 48 hours to trickle charge the first time the panel is turned on.

THE RED DISPLAY LED'S ARE OUT

First check the breaker that feeds the control panel.

Next, make sure the switch in the panel is "on", and there is a good fuse in the fusestat. If there is a spare fuse in the panel enclosure, replace the fuse.

Pull the cover off the panel circuit board, and with a volt meter, check that there is between 9.8 and 10.5 VAC to the two "WALL XFMR" terminals (transformer terminals) on the control relay output terminal strip. If there is insufficient voltage, the power from the transformer to the circuit board has been lost. If you do have proper voltage, the control panel may be bad. Turn the panel off so the boilers will automatically revert to self control via their high limit controls and continue to supply the building with heat. Contact your TRIAD Service contractor or your TRIAD representative.

THE CONTROL PANEL IS RUNNING, AND THE BOILERS ARE RUNNING, BUT THE BUILDING IS TOO COLD

Use Code 23 to reset the Ratio Control slightly upwards.

THE CONTROL PANEL IS RUNNING, AND THE BOILERS ARE RUNNING, BUT THE BUILDING IS TOO HOT

Use Code 23 to reset the Ratio Control slightly downwards.

THE BUILDING IS TOO COLD AND YOU CANNOT IDENTIFY THE PROBLEM

Turn off the control panel by flipping the power switch off, allowing control of the system to be returned to the boilers. Then, set the boilers high limit controls at 160°F and increase or decrease as necessary. Call your TRIAD representative.

THE BOILERS ARE NOT OPERATING

First decide if the problem is with the boilers or the control panel by flipping the power switch off. The boilers should fire and maintain temperature through their own high limit controls. If not, the problem is with the boiler equipment. First check the power supply to the boilers at the breaker box. Next check the boiler fuel supply. If the problem is still not resolved, contact your TRIAD representative.

THE CONTROL PANEL IS DAMAGED

Turn off the control panel and contact your TRIAD service contractor or TRIAD representative.

THE BURNER WILL NOT COME ON DURING TESTING OF THE SYSTEM (CODE 63)

Be sure that the control panel is calling for the boilers by:

1. Making sure that 0 has been entered in code 62
2. Making sure that 1 has been entered in code 63
3. Making sure the high limit set points on the boilers have not been exceeded

THE CONTROL PANEL WILL NOT ACCEPT ENTRIES

Make sure the Keypad is unlocked in code 61

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