

**HARSCO**  
INDUSTRIAL  
Patterson-Kelley



ENVI® Boiler Controller

**Advanced User's Guide**

Installation Date: \_\_\_\_\_

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Printed: 5/6/2015

ENVI® Control  
Rev. 2.6 (01/27/2015)  
1004905953  
Software versions 112E, BD71,  
49A7, 79F2, 8C51, 1043, 9820

ENVI®  
Operation  
Manual

ENVI®  
Operation  
Manual

ENVI®  
Operation  
Manual





















































### 1.8.3 Master Settings

These settings can only be accessed on a designated master boiler.

The master settings are used in conjunction with the cascade settings to set the system response parameters.

These settings are described in more detail below.

ENVI® Text Display	Function	Range	Units	Pass code Level
HDR Setpoint	Sets the operating temperature at the header	104 – 194	°F	SVC2
Power Mode		0 – 1		SVC2
Power Mode Min Boilers On	See Below 1.8.4.1	0		
Power Mode Max Boilers On	See Below 1.8.4.2	1		
Header Mode		0 – 4		SVC2
Header Mode (Header & Stat)	See Below 1.8.4.3	0		
Header Mode (Header ODA & Stat)	See Below 1.8.4.4	1		
Header Mode (Header & ODA)	See Below 1.8.4.5	2		
Header Mode (HDR Setpt Control)	See Below 1.8.4.6	3		
Header Mode (HDR Analog Setpt)	See Below 1.8.4.7	4		
Hyst Start Blr	See Below 1.8.4.8.1	0 – 36	°F	SVC2
Hyst Stop Blr	See Below 1.8.4.8.2	0 – 36	°F	SVC2
Wait Blr Swtch (ver. 112E, BD71, 49A7)	See Below 1.8.4.8.3	1 – 255	Sec	SVC2
Wait Blr Sw on (ver. 79F2, 8C51, 1043, 9820)	See Below 1.8.4.8.4	1 – 60	Min	SVC2
Wait blr sw pwr (ver. 1043, 9820)	See Below 1.8.4.8.5	0-100%		SVC2
Wait Blr sw off (ver. 79F2, 8C51, 1043, 9820)	See Below 1.8.4.8.6	1 – 60	Min	SVC2
Wait reset time (ver. 8C51, 1043, 9820)	See Below 1.8.4.8.7	On/off		SVC2
Prop Band (Proportional Band)	Proportional Band	0 – 230	°F	SVC2
Integral Rate	Integral Rate	0 – 255	Sec	SVC2
Der Time (Derivative)	Derivative Time	0 – 255	Sec	SVC2
Cyc Lmt Incrmnt	See Below 1.8.4.8.11	0 – 50	Min	SVC2
Cycl Limit Max	See Below 1.8.4.8.12	1 – 255	Min	SVC2
Hys Quic Start	See Below 1.8.4.8.13	0 – 51	°F	SVC2

ENVI® Text Display	Function	Range	Units	Pass code Level
Quic Start Tme	See Below 1.8.4.8.13	1 – 255	Sec	SVC2
Hys Quick Stop	See Below 1.8.4.8.13	0 – 51	°F	SVC2
Quic Stop Time	See Below 1.8.4.8.13	1 – 255	Sec	SVC2
LoLoad Waiting	See Below 1.8.4.8.14	0 – 255	Sec	SVC2
Start Rotation (ver. 112E, BD71, 49A7, 79F2, 8C51) (ver. 1043, 9820)	See Below 1.8.4.8.15	Off On:1-255 On:1-255	Hours Days	SVC2
No Blr on Wait	See Below 1.8.4.8.16	1 – 255	Min	SVC2
Anti wind up	See Below 1.8.4.8.17	On/off		SVC2
Lead boiler (ver. 1043, 9820)	See Below 1.8.4.8.18	0 - 23		SVC2

**1.8.4 Master Modes (a more detailed description of Power Modes can be found in section 1.8.5.1.1)**

**1.8.4.1 Power mode = 0, Min Boilers on (typically not the most efficient of the two power mode options)**

In this mode, when more than two boilers are required to satisfy the load, the last two boilers on will run to 100% as needed. All other boilers will modulate in parallel. This satisfies the load with the minimum amount of boilers firing (Less efficient operation).

Example: BLR 1 on 100%, BLR 2 on 100%, as BLR 3 comes on BLR 1 will begin to modulate as BLR 3 runs to 100% when BLR 4 comes on and runs to 100%, BLR 2 will begin to modulate. This sequence will continue until the demand is satisfied. The staging procedure is first on, last off.

Power mode = 1, Max Boilers On (Parallel Modulation – Default Setting)

In this mode, the boilers modulate in parallel based on a signal from the master boiler. This satisfies the load with the necessary number of boilers firing at the lowest fire rate possible resulting in more efficient operation in most cases.

The staging procedure is first on, last off.

**1.8.4.2 Header Mode = 0, (Header & Stat)**

Sensor kit required to sense header temperature. A list of accessory choices for different applications is shown in section 1.0 on page 3.

In this mode, the master boiler controls the operation of all the boilers in the cascade system to maintain a supply temperature where the header sensor is located. Upon an enable signal, from the closure between terminals TB1-1 & TB1-2, the ENVI® control on the Master boiler fires and modulates the boilers to maintain header water temperature at the header setpoint. The upper (HYST STOP BLR) and lower (HYST START BLR) temperature differentials in conjunction with other cascade settings control the header temperature at which boilers are added or removed.

Example: The Master boiler operates the system to maintain the header setpoint of 160° F. If the temperature increases above 170° F (setpoint 160° F + 10°F HYST STOP BLR), a boiler will shut off. If the temperature decreases below 151° F (setpoint 160°F – 9°F HYST START BLR), another boiler will start.

**NOTE:** The cascade system is enabled by the TB1/LV terminals 1 and 2 (enable/disable) on the master boiler becoming closed or shorted.

This circuit is energized internally. **DO NOT APPLY EXTERNAL POWER TO THESE TERMINALS.**

#### **1.8.4.3 Header Mode = 1, (Header ODA & Stat)**

Sensor kits required to sense header & outdoor temperatures. A list of accessory choices for different applications is shown in section 1.0 on page 3.

In this mode, the temperature is maintained at the location of the header sensor based on a reset schedule that is determined from an outdoor air sensor. The parameters for changing the reset schedule are in PROGRAM PARAMETERS>CH SETTINGS. An external thermostat wired to the enable/disable circuit controls the heat demand. Upon an enable signal from the closure between terminals TB1-1 & TB1-2, the ENVI® control on the Master boiler fires and modulates the boilers to maintain header water temperature at the header setpoint which changes based on outdoor temperature. The upper (HYST STOP BLR) and lower (HYST START BLR) temperature differentials in conjunction with other cascade settings control the header temperature at which boilers are added or removed.

NOTE: The outdoor air shutdown does not prevent the boiler from running in this mode.

**NOTE:** The cascade system is enabled by the TB1/LV terminals 1 and 2 (enable/disable) on the master boiler becoming closed or shorted.

This circuit is energized internally. **DO NOT APPLY EXTERNAL POWER TO THESE TERMINALS.**

#### **1.8.4.4 Header Mode = 2, (Header & ODA)**

Sensor kits required to sense header & outdoor temperatures. A list of accessory choices for different applications is shown in section 1.0 on page 3.

In this mode, the temperature is maintained at the location of the header sensor based on a reset schedule that is determined from the outdoor air sensor. The parameters for changing the reset schedule are in PROGRAM PARAMETERS>CH SETTINGS.

The boiler is enabled when the temperature of the outdoor sensor drops below the ODA SHUTDOWN temperature that can be changed within the CH settings.

**NOTE:** The TB1/LV terminals 1 and 2 (enable/disable) operate the switching on/off of the night setback function. The night setback setpoint is found within CH settings and when enabled, reduces the present set point by its value on closure of the TB1 1&2 circuit.

This circuit is energized internally. **DO NOT APPLY EXTERNAL POWER TO THESE TERMINALS.**

#### **1.8.4.5 Header Mode = 3, (Header Setpoint Control)**

Sensor kit required to sense header temperature. A list of accessory choices for different applications is shown in section 1.0 on page 3.

This mode is similar to Header Mode = 0, Header & Stat, described in 1.8.3.3, except there is no external thermostat. The heat demand is continuously maintained and controlled by the header sensor and header setpoint relations.

**NOTE:** The TB1/LV terminals 1 and 2 (enable/disable) operate the switching on/off of the night setback function. The night setback setpoint is found within CH settings and when enabled, reduces the present set point by its value on closure of the TB1 1&2 circuit.

This circuit is energized internally. **DO NOT APPLY EXTERNAL POWER TO THESE TERMINALS.**

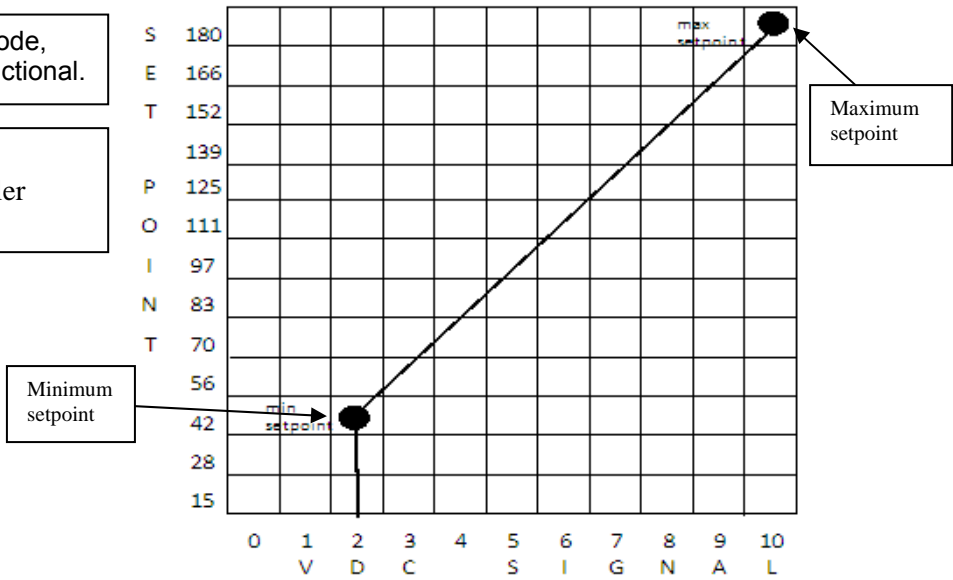
**1.8.4.6 Header Mode = 4, (HDR Analog Setpoint)**

Sensor kit required to sense header temperature. A list of accessory choices for different applications is shown in section 1.0 on page 3.

In this mode, an external 0-10 VDC signal controls the setpoint of the cascade system at the Master boiler. Applying a voltage of at least 0.5 to 1.5VDC creates the heat request. Applying 2 VDC sets the boiler setpoint to “Min Setpoint”. Applying 10 VDC sets the boiler setpoint to “Max Setpoint”. Applying less than 0.5 VDC removes the heat request. The BLR Min Setpoint and BLR Max setpoint parameters can be adjusted within boiler settings. The boiler is factory set for min 42°F max 180°F as displayed in the below graph.

NOTICE! When in analog control mode, enable/disable terminals are non-functional.

NOTICE! Minimum and maximum setpoints can be changed within Boiler Settings menu.



**1.8.4.7 Additional Master Settings**

**1.8.4.7.1 Hyst start blr {Hysteresis start boiler}**

This is the differential below header setpoint at which the master control will initiate the WAIT BOILER SWITCH ON timer to request the next member boiler to run. When the HEADER TEMPERATURE drops below the HEADER SETPOINT minus the HYSTERESIS START BOILER, the WAIT BOILER SWITCH ON timer begins counting down. When the timer expires, the member boiler is requested to fire and the WAIT BOILER SWITCH ON timer resets.

**1.8.4.7.2 Hyst stop blr {Hysteresis stop boiler}**

This is the differential above header setpoint at which the master control will stop a member boiler. When HEADER TEMPERATURE exceeds the HEADER SETPOINT plus the HYSTERESIS STOP BOILER, the WAIT BOILER SWITCH OFF timer begins counting down. When the timer expires, the member boiler is stopped and the WAIT BOILER SWITCH OFF timer resets.

**1.8.4.7.3 Wait blr swtch {Wait boiler switching}**

This parameter is the time the master boiler control waits to watch the effect of a change in the number of boilers operating, before making another change. Not available on all revisions.

**1.8.4.7.4 Wait blr sw on {Wait boiler switch on}**

This parameter is the time the master control waits to watch the effect of a change in the number of boilers operating, before making another change ON. See above 1.8.4.8.1 for descriptive example.

**1.8.4.7.5 Wait blr sw pwr {Wait boiler switch power}**

This is the power setting in 0-100% that the master boiler will wait for the last started boiler to achieve before switching on the next boiler in the cascade system. (Set to 100% to deactivate)

**1.8.4.7.6 Wait blr sw off {Wait boiler switch off}**

This parameter is the time the master boiler control waits to watch the effect of a change in the number of boilers operating, before making another change OFF. See above 1.8.4.8.2 for descriptive example.

**1.8.4.7.7 Wait reset time**

In versions 1043 & 9820 this feature allows the WAIT BOILER SWITCH ON timer and WAIT BOILER SWITCH OFF timer to reset back to zero, or pause at that current point whenever a heating cycle is complete.

This on/off setting allows the wait time to:

ON = resets time for sequence every time a reduction in heat load occurs back to zero

OFF = pauses time for sequence every time a reduction in heat load occurs.

The following sections 1.8.4.8.8 through 1.8.4.8.10 are intended to provide a basic overview of the PID control algorithm as it applies to the ENVI control. The default PID settings in the ENVI are based on tested application experience with P-K boilers in various hydronic systems. The default settings will be best suited to most P-K boiler applications.

Simply put, these values can be interpreted as a timeline: *P* depends on the *present* error, *I* on the accumulation of *past* errors, and *D* is a prediction of *future* errors, based on current rate of change

**1.8.4.7.8 Prop band {Proportional band}**

This parameter in the ENVI is the temperature range in degrees throughout which the logic of the boiler control proportionally modulates the reaction of the boiler to the deviation from setpoint.

**Proportional band in the ENVI is biased by the adjustment of Derivative time setting.**

Commonly referred to as the throttling range, ***proportional band is defined as the amount of change in the controlled variable required to drive the loop output from 0 to 100%.***

**For example:** With the proportional band left at the **default setting of 20°** and a header setpoint of 140°:

**With the Derivative time set at the default setting of 128 or higher (default setting) the proportional band is below the setpoint (figure 2)**

If the header temperature drops to 130° (10° below SP)  
The proportional action of the control will be 50%.

If the header temperature drops to 120° (20° below SP)  
The proportional action of the control will be 100%.

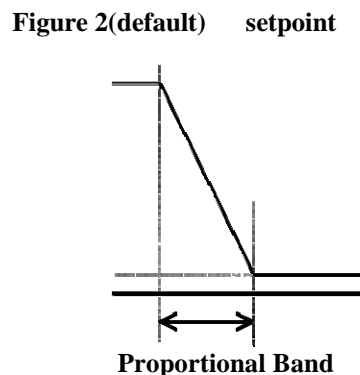
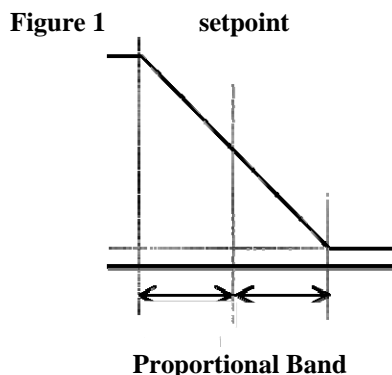
**OR:** With the proportional band left at the **default setting of 20°** and a header setpoint of 140°:

**With the Derivative time set at 0 (and up to 127), the proportional band is symmetrical around the setpoint (figure 1)**

If the header temperature drops to 130° (10° below SP)  
The proportional action of the control will be 100%.

If the header temperature reaches 140° (SP)  
The proportional action of the control will be 50%.

As the header temperature rises above 140° (10° above SP)  
The proportional action of the control will decrease output to 0% until reaching 10° above setpoint. (50% of proportional band)



#### 1.8.4.7.9 *Integral rate*

This parameter in the ENVI is the time in seconds that the boiler control calculates the deviation from setpoint and responds to drive the output towards setpoint.

The I-term is the integration factor as it applies to the ENVI. Every second the error between sensor input and setpoint is added to the sum of errors. This sum, divided by the I-term and added to the output power generated by the P-factor as described above. So if the sensor input stays below the setpoint this internally calculated sum increases and therefore the SUM divided by I-term increases so the PID output increases. If you increase this value the input of this sum of errors reduces and the system becomes slower.

**For example: With an Integral rate at the default setting of 50 and a header setpoint of 140°:**

If the header temperature is at 130° (10° below SP) the integral rate of adjustment will add 0.2° to the setpoint.

$$10(\text{degrees below setpoint}) \div 50(\text{Integral rate}) = 0.2$$

The ENVI control will add 0.2° to the setpoint making the effective setpoint **140.2°** (By changing the effective setpoint in the logic, this increases the action towards setpoint)

Integral rate continues to adjust the control output in accordance with both the size of the deviation from setpoint and the time it lasts to bring the process to setpoint regardless of load

#### 1.8.4.7.10 *Der time {Derivative time}*

Derivative time setting in the ENVI control serves as a bias setting for the Proportional band.

If the Derivative time setting is at the default setting of 128 or above, the proportional band is below the setpoint. See figure 2 on page 30.

If the Derivative time setting is at the alternate setting of 0 up to 127, the proportional band is symmetrical around the setpoint. See figure 1 on page 30.

#### 1.8.4.7.11 *Cycl lmt incrmnt {Cycle limit increment}*

Each time a starting or stopping of a boiler is detected, a cycle limit increment is added to the switch boiler counter. Every minute of cycle run time this counter is decreased by one (1). Only if the switch boiler counter value is below Cycle limit max can boilers be switched on or off. This feature prevents the boilers from short cycling, leading to increased boiler lifespan.

#### 1.8.4.7.12 *Cycl limit max {Cycle limit max}*

This parameter is the maximum amount of time allowed for the boiler to short cycle based on the cycle limit increment parameter and the switch boiler counter value. Once the switch boiler counter

exceeds this setting, CL will be displayed in the lower left of the ENVI display and the boiler will be unable to cycle until the switch boiler counter is below this parameter again. Every minute of cycle run time this counter is decreased by one (1).

**1.8.4.7.13 Hys quic start {Hysteresis quick start}, Quic start tme {Quick start time}, Hys quick stop {Hysteresis quick stop}, Quic stop time {Quick stop time}**

For those instances where the load changes rapidly quick start / quick stop parameters bypass the Wait blr sw on and Wait blr sw off parameters to allow the system to respond more quickly.

When the header temperature falls below the HDR SETPOINT by the HYS QUIC START temperature setting, the control uses the QUIC START TIME (time delay for quick start) to stage on member boilers. The master control shortens the interval between boiler starts, allowing the system to catch up more quickly.

When the header temperature rises above HDR SETPOINT by the HYS QUIC STOP temperature setting, the control uses the QUIC STOP TIME (time delay for quick stop) to stop the member boilers. The master control shortens the interval between boiler stops, allowing the system to prevent overshooting the HDR SETPOINT.

**1.8.4.7.14 Lo Load waiting {Low Load Waiting}**

The LOLOAD WAITING is set on the master boiler control and used in conjunction with the various other low load settings found in the cascade menu on the member boiler(s). This parameter allows the master to turn on a boiler that is below the HDR SETPOINT temperature if this time interval has passed. The master sends the header setpoint to the member boilers; each member boiler control monitors its own supply temperature to detect if a low load condition exists.

This and additional low load settings are described in the Cascade Settings section of this manual.

**1.8.4.7.15 Start rotation**

The START ROTATION is an On/Off selection. When this selection is ON; a sub-setting is required to be defined to determine the frequency of lead rotation from the current operating lead to the next boiler. The Master boiler will always remain the master and will be the lead boiler initially, after each rotation frequency period elapses, the next sequential boiler will rotate as the lead boiler. This rotation will continue until the master is once again the lead & then repeat.

Note: All settings and operating sensors will be maintained on the original master boiler

**1.8.4.7.16 No boiler on wait**

The NO BLR ON WAIT is the time the ENVI® Control waits to override a hold from a member boiler. For example, a low return temperature hold for a non-condensing boiler in a hybrid system will trigger the NO BLR ON WAIT function. After the NO BLR ON WAIT period expires, the ENVI® Control allows the non-condensing boiler to start.

**1.8.4.7.17 Anti windup**

This ON/OFF setting prevents “wind up” from occurring in the PID loop. The anti-windup setting is factory set to OFF; when set to ON, anti windup helps prevent the lead boiler from ramping to 100 percent fire rate before staging on the member (slave) boilers to satisfy the setpoint by restarting the PID logic at the beginning of every cycle.

**1.8.4.7.18 Lead Boiler**


This parameter will appear when the START ROTATION parameter is set to OFF. This allows the user to define a fixed boiler as the lead. There will be no rotation of lead boiler when this occurs. When START ROTATION is set to ON; this parameter is not available.



### 1.8.5 Cascade Settings

Cascade settings are used to make the member boilers operate as needed in a cascade system and are individually changeable parameters for each member.



Pressing  at the CASCADE SETTINGS in the CASCADE MENU allows the user to access the cascade settings. (Service code 2 is needed for access):

Cascade Settings	
→ Max supply t	191°F
Lo load hys slv	15°F
Lo load mod dlt	9°F

A list of the cascade settings is shown in the following table.

Cascade Settings	Function	Value	Units	Passcode Level
Max Supply T (ver. 112E, BD71, 49A7) (ver. 79F2, 8C51, 1043, 9820)	Temperature limit for boiler output <i>(see note 1 &amp; 4)</i>	190 – 194 185 – 194	°F	SVC 2
Lo load hys slv	When supply temperature is higher than header setpoint less this value, a start restriction on the member will be put in place <i>(see note 4)</i>	0-36	°F	SVC2
Loload mod dlt	Slave modulation starts when supply temperature is higher than max supply temperature less this value <i>(see note 1 &amp; 2)</i>	0-54	°F	SVC2
Loload wait slv	Delay time before the low load condition can be set inactive <i>(see note 3 &amp; 4)</i>	0-255	Sec	SVC2
Load detct dlt	When supply temperature is above the header setpoint plus this setting, the loload condition is set active	0-99	°F	SVC2
Csc Min Ret T	Minimum return temperature setting this setting plus the hysteresis will hold out the boiler from operation when the return temp is below the added set point. In a cascade system.	40 – 194	°F	SVC 2
Hyst Min Ret T	Differential above Csc Min Ret T	0 – 36	°F	SVC 2
Ret T Max Pwr	Below this temp, boiler fires at maximum power and should be set below Ret T min Pwr	104 – 194	°F	SVC 2
Ret T Min Pwr	Above this temp, boiler is allowed to modulate and in between min and max ret T power the boiler are modulated on a linear curve. And should be set above Ret T Max Pwr	104 – 194	°F	SVC 2
Prepump Period	Time for prepump before boiler starts to ensure correct return water temperature measurement	15 – 255	Sec	SVC 2

**NOTES:**

1: No member boiler is allowed to start when the header temperature is greater than the HDR SETPOINT or greater than the MAX SUPPLY T.

The member boilers are required to modulate back to a lower firing rate when the temperature of the boiler is above the MAX SUPPLY T minus LOLOAD MOD DLT setting.

2: The modulation will be at a minimum when the condition (Max Supply T – LoLoad Mod Dlt + 8°F) is reached.

*Example: (194 - 10 + 8 = 192)*

3. The members will also modulate back when the boiler water temp is within LoLoad Hys Slv of the HDR Setpoint.

4. Each member boiler can detect a low load condition when the member boiler supply temp is greater than MAX SUPPLY T – LOLOAD HYS SLV or when the member boiler supply temp is greater than HEADER SETPOINT – LOLOAD HYS SLV. Once a member detects a low load condition, this information is passed to the master boiler and the member goes to minimum fire and waits for the LOLOAD WAIT SLV time period to expire. The member boiler rechecks the low load condition at the end of this time and reports the status to the master. If the low load condition is still active, the master reduces the amount of active boilers and switches off the member boiler with the low load condition.

The Master boiler then waits for LOLOAD WAITING time period and re-evaluates the load situation. At the end of that time, if the low load condition is still detected by another member boiler, the master will shut down that member boiler. This process repeats in increments of one until no more boilers detect low load (or all the boilers are off).

**Boiler Start Restrictions**

When the master requests an additional boiler for cascade operation, two conditions must be satisfied.

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- **Startup Restriction #1 –Alarm Condition**

When a boiler is requested for cascade operation, it must be free from alarms. If the requested boiler is in an alarm state, the master will attempt to request another boiler. If no other boilers are available to start due to alarm conditions, the active boilers will continue to operate. Once the alarm conditions are corrected, the boilers will be able to rejoin cascade operation.

- **Startup Restriction #2 - Minimum Return Temperature**

When a boiler is requested for cascade operation, the return water temperature must exceed the “CSC MIN RET T” parameter. This parameter is designed to assign priority to condensing boilers and also protect non-condensing boilers from low return water temperatures.

When a boiler is successfully requested, the boiler shall energize its circulating pump until the “PRE PMP PERIOD” timer expires. If at any time during this timer “PRE PMP PERIOD” the return temperature drops below the “CSC MIN RET T”, the boiler will return to standby. Once this timer expires successfully, the boiler will operate as normal unless its return temperature drops below “CSC MIN RET T”, at which point the boiler will return to standby.

In periods of heavy load, it is possible that the active condensing boilers are unable to maintain the header temperature above “CSC MIN RET T”. The master boiler will continue to request additional boilers in order to satisfy the load, and eventually a non-condensing boiler will be allowed to start. This non-condensing boiler will come online at full power until its return temperature exceeds “RET T MAX PWR”. Above this temperature, the boiler will operate according to its PID settings until its return temperature equals “RET T MIN PWR”. Above this temperature, the boiler will operate at minimum power until its return temperature exceeds “CSC MIN RET T” plus “HYST MIN RET T”. Once the return temperature is satisfactory, the boiler will release to full modulation

**ENVI Cascade Factory Settings and Operational Summary**

<p>The master boiler has the following default parameters:</p> <table border="1"> <thead> <tr> <th>PARAMETER</th> <th>DEFAULT</th> <th>UNITS</th> </tr> </thead> <tbody> <tr><td>HDR SETPOINT</td><td>180</td><td>°F</td></tr> <tr><td>POWER MODE</td><td>1</td><td></td></tr> <tr><td>HDR MODE</td><td>0</td><td></td></tr> <tr><td>HYST START BLR</td><td>5</td><td>°F</td></tr> <tr><td>HYST STOP BLR</td><td>10</td><td>°F</td></tr> <tr><td>WAIT BLR SW ON</td><td>8</td><td>Min</td></tr> <tr><td>WAIT BLR SW OFF</td><td>2</td><td>Min</td></tr> <tr><td>HDR-P</td><td>20</td><td></td></tr> <tr><td>HDR-I</td><td>50</td><td>Sec</td></tr> <tr><td>HDR-D</td><td>128</td><td></td></tr> <tr><td>CYCLE INCRMNT</td><td>1</td><td></td></tr> <tr><td>CYCLE LIMIT MAX</td><td>10</td><td></td></tr> <tr><td>HYS QUIC START</td><td>25</td><td>°F</td></tr> <tr><td>QUIC START TME</td><td>60</td><td>Sec</td></tr> <tr><td>HYS QUIC STOP</td><td>18</td><td>°F</td></tr> <tr><td>QUIC STOP TIME</td><td>30</td><td>Sec</td></tr> <tr><td>LOLOAD WAITING</td><td>60</td><td></td></tr> <tr><td>START ROTATION</td><td>24</td><td>Hours</td></tr> <tr><td>NO BLR ON WAIT</td><td>10</td><td>Min</td></tr> <tr><td>ANTI WIND UP</td><td>OFF</td><td></td></tr> </tbody> </table>	PARAMETER	DEFAULT	UNITS	HDR SETPOINT	180	°F	POWER MODE	1		HDR MODE	0		HYST START BLR	5	°F	HYST STOP BLR	10	°F	WAIT BLR SW ON	8	Min	WAIT BLR SW OFF	2	Min	HDR-P	20		HDR-I	50	Sec	HDR-D	128		CYCLE INCRMNT	1		CYCLE LIMIT MAX	10		HYS QUIC START	25	°F	QUIC START TME	60	Sec	HYS QUIC STOP	18	°F	QUIC STOP TIME	30	Sec	LOLOAD WAITING	60		START ROTATION	24	Hours	NO BLR ON WAIT	10	Min	ANTI WIND UP	OFF		<p>Each condensing boiler has these default cascade parameters:</p> <table border="1"> <thead> <tr> <th>PARAMETER</th> <th>DEFAULT</th> <th>UNITS</th> </tr> </thead> <tbody> <tr><td>MAX SUPPLY T</td><td>194</td><td>°F</td></tr> <tr><td>LOLOAD HYS SLV</td><td>5</td><td>°F</td></tr> <tr><td>LOLOAD MOD DLT</td><td>5</td><td>°F</td></tr> <tr><td>LOLOAD WAITSLV</td><td>60</td><td>Sec</td></tr> <tr><td>LOAD DETCT DLT</td><td>90</td><td></td></tr> <tr><td>CSC MIN RET T</td><td>40</td><td>°F</td></tr> <tr><td>HYST MIN RET T</td><td>9</td><td>°F</td></tr> <tr><td>RET T MAX PWR</td><td>104</td><td>°F</td></tr> <tr><td>RET T MIN PWR</td><td>127</td><td>°F</td></tr> <tr><td>PREPUMP PERIOD</td><td>20</td><td>Sec</td></tr> </tbody> </table> <p>Each non-condensing boiler has these default cascade parameters:</p> <table border="1"> <thead> <tr> <th>PARAMETER</th> <th>DEFAULT</th> <th>UNITS</th> </tr> </thead> <tbody> <tr><td>MAX SUPPLY T</td><td>220</td><td>°F</td></tr> <tr><td>LOLOAD HYS SLV</td><td>5</td><td>°F</td></tr> <tr><td>LOLOAD MOD DLT</td><td>5</td><td>°F</td></tr> <tr><td>LOLOAD WAITSLV</td><td>60</td><td>Sec</td></tr> <tr><td>LOAD DETCT DLT</td><td>90</td><td></td></tr> <tr><td>CSC MIN RET T</td><td>122</td><td>°F</td></tr> <tr><td>HYST MIN RET T</td><td>9</td><td>°F</td></tr> <tr><td>RET T MAX PWR</td><td>113</td><td>°F</td></tr> <tr><td>RET T MIN PWR</td><td>127</td><td>°F</td></tr> <tr><td>PREPUMP PERIOD</td><td>30</td><td>Sec</td></tr> </tbody> </table>	PARAMETER	DEFAULT	UNITS	MAX SUPPLY T	194	°F	LOLOAD HYS SLV	5	°F	LOLOAD MOD DLT	5	°F	LOLOAD WAITSLV	60	Sec	LOAD DETCT DLT	90		CSC MIN RET T	40	°F	HYST MIN RET T	9	°F	RET T MAX PWR	104	°F	RET T MIN PWR	127	°F	PREPUMP PERIOD	20	Sec	PARAMETER	DEFAULT	UNITS	MAX SUPPLY T	220	°F	LOLOAD HYS SLV	5	°F	LOLOAD MOD DLT	5	°F	LOLOAD WAITSLV	60	Sec	LOAD DETCT DLT	90		CSC MIN RET T	122	°F	HYST MIN RET T	9	°F	RET T MAX PWR	113	°F	RET T MIN PWR	127	°F	PREPUMP PERIOD	30	Sec
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**1.8.5.1 Master Setup:**

The master boiler must be equipped with certain hardware to allow it to control the cascade system.

A list of accessory choices for different applications is shown in section 1.0 on page 3.

In order for the master boiler to function in a cascade system, the master boiler must be equipped with either of the following:

BP-0000-0279	Sensor and emersion well kit. can be used for header or DHW 12K(ENVI® Control)
23-0000-0539	Sensor, strap on, ENVI® control can be used for header or DHW, 12K

This temperature sensor shall be installed as a header sensor in the system supply piping, downstream of all the boilers, and can be purchased from Harsco Industrial Patterson-Kelley.

Additionally, the master boiler can be equipped with an outdoor air temperature sensor.

26-0000-0507	Sensor, outdoor air, Tasseron
--------------	-------------------------------

This allows the cascade to operate to an outdoor air reset schedule. It is also possible to provide the master boiler with a 0-10VDC analog control signal, which will establish a temperature setpoint schedule. Please refer to the ENVI Operation manual for setup of the master boiler using the "HDR MODE" parameter.

### 1.8.5.1.1 Power Mode

The cascade system can be configured for two distinct operation modes through the master boiler's "POWER MODE" parameter.

#### **POWER MODE 0 = Minimum Boilers On**

**This setting is sometime necessary but ideally less efficient as described below.**

When the header temperature drops below "HDR SETPOINT" minus "HYST START BLR" the lead boiler is requested for cascade operation. Once this boiler is online, it will be PID modulated toward the header setpoint. If the header temperature remains below "HDR SETPOINT" minus "HYST START BLR", the master boiler starts the "WAIT BLR SWITCH ON" timer. When the countdown timer reaches 0:00, an additional boiler is requested for cascade operation, the timer immediately resets and resumes counting down. This timer "WAIT BLR SWITCH ON" pauses when the header temperature is between the "HYST START BLR" and "HYST STOP BLR", also known as the dead band above and below the "HDR SETPOINT". If at any time the header temperature drops below "HDR SETPOINT" minus "HYST START BLR", the timer resumes its countdown from the last paused time and will not reset until it reaches 0:00.

Power Mode 0 will attempt to satisfy the load with as few boilers online as possible. When the load only requires two boilers, both boilers modulate in parallel according to the cascade PID settings. If the load requires three boilers, the first boiler operates at maximum power while the second and third are PID controlled; modulating in parallel. If the load requires four boilers, the first two boilers operate at maximum power while the third and fourth boilers are PID controlled; modulating in parallel. Only a maximum of two boilers can be PID controlled at any time.

If the header temperature exceeds the "HDR SETPOINT" plus "HYST STOP BLR", the master boiler starts the "WAIT BLR SWITCH OFF" timer. If at the end of the timer, the header temperature still exceeds the "HDR SETPOINT" plus "HYST STOP BLR", the last active boiler will be disabled. When the timer reaches 0:00 and a boiler is disabled, the timer immediately resets and resumes counting down. This timer pauses when the header temperature is between the "HYST START BLR" and "HYST STOP BLR". If at any time the header temperature exceeds the "HDR SETPOINT" plus "HYST STOP BLR", the timer resumes its countdown from the last paused time and will not reset until it eventually reaches 0:00.

As boilers are disabled, there can still only be a maximum of 2 PID controlled boilers. This process will continue until only the lead boiler remains online. If just the lead boiler is online and the header temperature still exceeds the "HDR SETPOINT" plus "HYST STOP BLR", the lead boiler will return to standby.

#### **POWER MODE 1 = Maximum Boilers On**

**This setting is more efficient as all needed boilers modulate in parallel at a lower fire rate see below.**

When the header temperature drops below "HDR SETPOINT" minus "HYST START BLR" the lead boiler is requested for cascade operation. Once this boiler is online, it will be PID modulated toward the header setpoint. If the header temperature remains below "HDR SETPOINT" minus "HYST START BLR", the master boiler starts the "WAIT BLR SWITCH ON" timer. When the countdown timer reaches 0:00, an additional boiler is requested for cascade operation, the timer immediately resets and resumes counting down. This timer pauses when the header temperature is between the "HYST START BLR" and "HYST STOP BLR", also known as the dead band above and below the "HDR SETPOINT". If at any time the header temperature drops below "HDR SETPOINT" minus "HYST START BLR", the timer resumes its countdown from the last paused time and will not reset until it reaches 0:00.

Each boiler that is brought online will operate to the cascade PID settings stored in the master boiler. Power Mode 1 will modulate all online boilers to the same power. If a particular boiler is not at the power level as commanded by the master boiler due to any of the boiler's internal settings, the power indication will flash repeatedly on its ENVI display screen. The master boiler will always attempt to equalize the power levels of the online boilers.

If the header temperature exceeds the “HDR SETPOINT” plus “HYST STOP BLR”, the master boiler starts the “WAIT BLR SWITCH OFF” timer. If at the end of the timer, the header temperature still exceeds the “HDR SETPOINT” plus “HYST STOP BLR”, the last active boiler will be disabled. When the timer reaches 0:00 and a boiler is disabled, the timer immediately resets and resumes counting down. This timer pauses when the header temperature is between the “HYST START BLR” and “HYST STOP BLR”. If at any time the header temperature exceeds the “HDR SETPOINT” plus “HYST STOP BLR”, the timer resumes its countdown from the last paused time and will not reset until it eventually reaches 0:00.

This process can continue until only the lead boiler remains online. If just the lead boiler is online and the header temperature still exceeds the “HDR SETPOINT” plus “HYST STOP BLR”, the lead boiler will return to standby.

If “WAIT RESET TIME” is ON then the timer resets to 0 every time a reduction in heat load occurs. If “WAIT RESET TIME” is OFF then the timer pauses time for sequence every time a reduction in heat load occurs. Once it reaches 0, then it resets.

#### **1.8.5.1.2 Lead Rotation**

The lead boiler will rotate position based on the “START ROTATION” parameter. After the lead boiler has operated for the defined number of accumulated time, the lead position will rotate to another boiler. The time setting value can be set from 1 to 255 hours with ver. 8C51 and prior; or 1 to 255 days using version 1043 or 9820. This function can be disabled by changing “START ROTATION” to off, in which the master boiler will always operate as the lead boiler.

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#### **1.8.5.1.3 Quick Start and Quick Stop**

If the system experiences rapid changes in temperature, it may be necessary to start or stop boilers at an accelerated pace. If the header temperature drops below the “HDR SETPOINT” minus the “HYS QUIC START”, the master boiler will begin the “QUIC START TIME” timer, which will bypass the “WAIT BLR SW ON” timer.

Once “QUIC START TIME” timer expires and the temperature condition is still true, a boiler will be requested for cascade operation. This quick start process can continue until all the boilers are online if the low temperature condition remains.

Similarly, if the header temperature exceeds the “HDR SETPOINT” plus the “HYS QUIC STOP”, the master boiler will begin the “QUIC STOP TIME” timer, which will bypass the “WAIT BLR SW OFF” timer. Once this timer expires, if the temperature condition is still true, a boiler will be removed from cascade operation. This quick stop process can continue until all the boilers are offline if the high temperature condition remains.

#### **1.8.5.1.4 Hybrid systems setup**





In a hybrid system that contains both condensing and non-condensing boilers, cascade settings help prevent the non-condensing boilers from operating in a condensing mode. The CSC MIN RET T is the minimum return temperature setting. The factory default CSC MIN RET T setting for P-K MODU-FIRE® FD boilers is 122°F. Each member boiler checks that the return water temperature is greater than the CSC MIN RET T plus the HYST MIN RET T. If the return temperature is too low, the non-condensing boiler signals the Master ENVI® control to skip this boiler.

If a condensing boiler cannot be found, the Master ENVI® control goes into NO BLR ON WAIT. When the NO BLR ON WAIT time period expires, the first available boiler will start and burn at high fire until the boiler inlet temperature is greater than RET T MAX PWR. If the return water temperature remains below CSC MIN RET T, the NO BLR ON WAIT sequence repeats. When the return temperature exceeds RET T MIN PWR, the boilers release to modulate according to the master controller. Other boilers in the member network may be enabled and modulated to meet the load.

**NOTICE! The Master ENVI® control will not override individual boiler protective parameters. For example, MOD BACK DIFF will still prevent the member boiler from exceeding the temperature differential setting.**

**1.9 SERVICE MENU:**

This service menu allows the operator to manually set the boiler to HI, or LOW blower operation (ver. 1043 and 9820 include 20%, 40%, 60% and 80% selections) or HI or LOW burner operation (ver. 1043 includes 20%, 40%, 60% and 80% selections) for setup and/or troubleshooting. This menu is protected by the service level 1 code (SVC1). Pressing the SVC shortcut key (DOWN button when the default screen is present, see Section 1.1) accesses the

SERVICE menu. Users can also access the SERVICE menu by pressing the  button and using the  and  buttons until the cursor is next to *SERVICE*. Press . This menu is protected by the service level 1 code (SVC1).




**NOTICE!** Combustion adjustments should only be performed by service personnel experienced and knowledgeable on the operation of the Harsco Industrial, Patterson-Kelley boiler.

Service




→ BNR ON Test HI LOW  
BNR OFF Fan HI LOW

Two test modes are available:

- 1) BNR ON TEST HI LOW
- 2) BNR OFF FAN HI LOW

Press the  or  buttons to select BURNER ON TEST HI LOW or BURNER OFF FAN HI LOW, then press .

<b>29 Jul 2013</b>		<b>14:17</b>
<b>Test Burner</b>	<b>HIGH</b>	
<b>LOW</b>	<b>Supply</b>	<b>140° F</b>
→ <b>20%</b>	<b>Fan</b>	<b>0</b>

Then press  or  to select HI or LOW (for ver. 1043; 20%, 40%, 60% and 80% selections are included). Then press  to select the desired operation.

For the first test mode, BNR ON TEST HI LOW allows the service technician to hold the boiler in high or low fire (for ver. 1043; 20%, 40%, 60% and 80% selections are included) during firing operation so that the combustion adjustment can be performed.

For the second test mode, BNR OFF FAN HI LOW checks the fan rate with the burner off at high fan speed or at low fan speed (for ver. 1043; 20%, 40%, 60% and 80% selections are included).

Note: BNR OFF test mode can be useful for drying the burner and heat exchanger after cleaning. Additionally, this can be used to dissipate heat from a boiler loop when necessary to enable other boilers to be operated for test purposes when the load is insufficient for boiler operation.

These test modes will automatically terminate after 15 minutes of inactivity or can be terminated from the control/display panel by pressing the cancel/reset button

Each boiler has a specific combustion adjustment procedure that is contained in each boiler's specific Installation & Owner's Manual. The correct combustion parameters are listed in the boiler specific manual as well. These specific procedures must be followed for the boiler being adjusted. There is a fire test from the factory on the back of the boiler.

## 2.0 TROUBLESHOOTING

**WARNING**

**If any boiler “Manual Reset” limit device trips,  
DO NOT  
Reset the control without determining and correcting the cause.**

### 2.0.1 Troubleshooting Table

Symptoms:	Possible Cause:	Solution:
No Display, No Operation	Loss of Power	Restore Power. The control retains any error/lockout code and may require a reset.
No Display, No Operation	Fuse on Main Board is Blown	Replace fuse
Boiler runs with some operation compromised, such as no remote input, alarm output, flame detected output, cascade, MODBUS®, etc.	1) Fuse on Interface Board is Blown 2) Boilers were wired A to B during cascade set-up AND more than one master switch was set to MASTER.	1) Replace fuse on interface board. 2) Replace the interface board.
No Display, Boiler is Operating	1) Display is not wired properly 2) Light source is not functioning 3) S4 switch is in the off position	1) Check the display wires. (twisted pair) 2) Use a flashlight to verify that text is present. Replace display board. 3) Turn S4 switch to the on position, which is on the main board
Display continuously shows CONNECT INIT	Incorrect communication between control boards	Check communication wiring. (twisted pair) Verify that all three control boards (Main, Interface, and Display) have the same software version.
Time & Date are incorrect	Battery in display is bad	Install replacement Battery CR2032

### 2.0.1 The Loss of Power

In the event of a power failure (or when the On/Off switch is in the Off position), the display panel is not illuminated and the entire system is de-energized, closing all automatic valves and halting all boiler operations. When power is restored the sequence of operation will resume. If any error/lockout is present when the power is lost, the control will retain that error/lockout and display the error/lockout when the power is restored. A manual reset may be required.

The ENVI® boiler control will display text based error descriptions to indicate any problems with the boiler. There are two types of lockouts the control may experience: manual reset lockouts requiring an operator to press the reset button, and automatic reset lockouts that will self-reset when the error condition clears. Below is a comprehensive list of the locking and blocking error codes

**2.0.1.1 Auto-reset Error Codes – E## (Blocking Errors)**

Code	ENVI® Control Display	Lockout	Description
E01	T FLOW OPEN	53	Flow sensor not connected
E02	T RETURN OPEN	54	Return sensor not connected
E03	T FLUE OPEN	59	Flue sensor not connected
E04	T DHW OPEN	57	DHW sensor not connected
E05	T HX OPEN	58	Heat exchanger sensor not connected
E06	HEADER SENSOR OPEN	70	Header sensor on IF board not connected
E11	T FLOW SHORTED	61	Flow sensor shorted
E12	T RETURN SHORTED	62	Return sensor shorted
E13	T FLUE SHORTED	67	Flue sensor shorted
E14	T DHW SHORTED	65	DHW sensor shorted
E15	T HX SHORTED	66	Heat exchanger sensor shorted
E16	HEADER SENSOR SHORTED	71	Header sensor on IF board shorted
E18	PHASE ERROR	46	Phase and neutral of supply voltage mains are reversed
E19	E2PROM READ ERROR	0	Problems from reading from or writing to E2prom
E20	FLAME ERROR 2	74	False flame detected
E21	LOW FLOW/ILK	73	Low flow or interlock error
E22	WD 50HZ ERROR	45	No earth ground connected or internal hardware error
E23	NET FREQ ERROR	47	Main supply voltage frequency differs more than 2% from 60HZ
E24	FAULTY EARTH ERROR	48	Faulty earth ground to boiler
E30	FLUE GAS ERROR	39	Flue gas sensor is above setpoint plus differential
E32	RETURN TEMP ERROR	42	Return temperature is above 90 degrees
E34	BLOCKED FLUE ERROR	41	Flue gas outlet is restricted or blocked
E41	REVERSE FLOW ERROR	43	Supply and return temp are reversed
E42	WD COMMUNICATION ERROR	49	Internal hardware error
E44	FLAME CKT FAULT	40	Ionization or flame rod wire is lost
E45	REFHI TOO LO ERROR	35	Internal hardware error
E46	REFHI TOO HI ERROR	36	Internal hardware error
E47	REFLO TOO LO ERROR	37	Internal hardware error
E48	REFLO TOO HI ERROR	38	Internal hardware error
E 49	RAPID RISE HX ERROR BLOCK	51	Heat exchanger temperature rise to rapidly (blocking)
E50	RAPID RISE ERROR BLOCK	72	Flow temperature rise too rapidly (blocking)
E51	RESET BUTTON ERROR	68	Reset button pressed more than 7 times within 1 minute
E52	APPLIANCE SELECTION ERROR	50	Appliance and resistor do not match at start up
E54	IF COMMUNICATION FAILURE	69	No communication with interface board



**2.0.1.2 Manual Reset Error Codes – A## (Locking Errors)**

A Code	Error	Int. nr	Description
A01	IGNIT ERROR	1	Three unsuccessful ignition attempts in a row
A02	TOO MANY FLAME FAILURES	24	Three times flame was lost during on demand
A03	T MAX LOCK ERROR	18	Overheat stat is open
A05	GV RELAY ERROR	5	Problems with gas valve relay= internal hardware error (pump not running)
A06	SAFTEY RELAY ERROR	6	Problems with gas valve relay = internal hardware error (pump not running)
A07	LOW FLOW / ILK	3	Water Flow is inadequate or Interlock Jumper is Open
A09	RAM ERROR	9	Internal software error
A09	FLAG BYTE INTEGRITY ERROR	27	Internal software error
A09	AD HI CPL ERROR	28	Internal software error
A09	AD LO CPL ERROR	29	Internal software error
A09	REGISTER ERROR	33	Internal software error
A10	E2PROM ERROR	12	No communication with E2prom
A12	WRONG EEPROM SIGNATURE	10	Contents of Eprom is not up-to-date
A13	STATE ERROR	13	Internal software error
A14	ROM ERROR	14	Internal software error
A15	15MS XRL ERROR	16	Internal software error
A16	20 MS XLR ERROR	22	Internal software error
A18	STACK ERROR	19	Internal software error
A19	FLAME OUT TOO LATE ERROR	20	Flame still present 10 sec. after closing the gas valve
A20	FLAME ERROR I	21	Flame detected just before gas valve opened
A30	HIGH GAS PRESSURE ERROR	32	Gas pressure is to high
A31	LOW GAS PRESSURE ERROR	31	Gas pressure is to low
A32	41MS ERROR	23	Internal software issue
A33	FAN ERROR	8	Fan deviation more than 300 rpm longer than 1 minute (when fan speed > 4200 rpm this error is ignored)
A34	AIR PRESS SW NOT OPEN ERROR	25	Air pressure switch doesn't open within 30 seconds
A35	AIR PRESS SW NOT CLOSED ERROR	26	Air pressure switch doesn't close within 30 seconds
A37	UV SENSOR BROKEN	11	UV scanner not functioning
A38	MOD BACK DIFF ERROR	4	Large difference between return and flow temperatures
A39	RAPID RISE ERROR LOCK RET	15	Return temperature rise too rapidly
A40	RAPID RISE ERROR LOCK FLOW	7	Flow temperature rise to rapidly
A41	RAPID RISE ERROR LOCK HX	17	Heat exchanger rise to rapidly
A43	LOW WATER CUTOFF ERROR	30	Water pressure is to low
A44	FLAME CKT ERROR	34	Ionization (flame rod) wire lost for more than 15 seconds

**NOTICE! When an Internal Error occurs, as identified above, the failure is internal to the ENVI® control and replacement of the ENVI® control is required. A qualified service technician must replace the ENVI® control.**

<b>CH Parameters</b>	CH SETPOINT		<b>MASTER SETTINGS</b>	HDR SETPOINT	
	BLR OP			POWER MODE	
	CH MODE			HEADER MODE	
	HI ODA TEMP			WAIT BLR SWITCH	
	MIN ODA SETPOINT			WAIT BLR SWITCH ON	
	LOW ODA TEMP			WAIT BLR SWITCH PWR	
	MAX ODA SETPOINT			WAIT BLR SWITCH OFF	
	ODA SHUTDOWN			WAIT RESET TIME	
	NIGHT SETBACK			HDR-P	
	HYSTERESIS ON			HDR-I	
	HYSTERESIS OFF			HDR-D	
	POST PUMP TIME			CYCLE LMT INCRMNT	
	ANTI CYCLE TIME			CYCL LIMIT MAX	
	CH-P			HYS QUIC START	
	CH-I			QUIC START TME	
CH-D		HYS QUIC STOP			
CH PNP ON DEMAND		QUIC STOP TIME			
<b>DHW Parameters</b>	DHW MODE		<b>CASCADE SETTINGS</b>	LOLOAD WAITING	
	DHW TYPE			START ROTATION	
	DHW SETPOINT			NO BLR ON WAIT	
	TANK SET			ANTI WINDUP	
	ON DIFFERENT			LEAD BOILER	
	OFF DIFFERENT			MAX SUPPLY T	
	TANK OFF DIFF			LOLOAD HYS SLV	
	TANK ON DIFF			LOLOAD MOD DLT	
	POST PUMP TIME			LOLOAD WAIT SLV	
	DHW-P			LOAD DETCT DLT	
	DHW-I			CSC MIN RET T	
	DHW-D			HYST MIN RET T	
	POWER LIMIT STEP			RET T MAX PWR	
	PMP ON DEMAND			RET T MIN PWR	
	PRIORITY TIME			PREPUMP PERIOD	
<b>BOILER SETTINGS</b>	BOILER TYPE				
	MAX FAN SPEED				
	CH MAX FAN SPEED				
	DHW MAX FAN SPEED				
	MIN FAN SPEED				
	MAX SETPOINT				
	MIN SETPOINT				
	BLR MAX TEMP				
	MOD BACK DIFF				
	MOD BACK DIFF OFFSET				
	LOW FIRE HOLD				
	POST PURGE				
	ACCEL BNR ON				
	ACCEL BNR OFF				
	FP ENABLE				
PWR LMT STEP					

