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

HARSCO INDUSTRIAL
Patterson-Kelley

ENVI® Boiler Controller

Advanced User's Guide

Installation Date: _____

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ENVI® Operation Manual

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1.0 ENVI® BOILER CONTROL

The ENVI® boiler control consists of 3 components and is an intelligent control system with advanced features such as text-based display, MODBUS® communication capabilities, and boiler sequencing. Firing rate and setpoint can be controlled via an external 0-10VDC analog control signal. Errors are date and time stamped, and the control records burner run time at various operating points. A single integral control for temperature control, flame safeguard, firing rate control, blocked flue protection, outdoor air reset, freeze protection, built-in cascade sequencing and more. Throughout this manual and in the ENVI® controller the term "Hysteresis" is used with the meaning of "Differential".

The ENVI® control is capable of accepting building management control via 0-10VDC and MODBUS®. Other languages require the use of a Protocol converter which is also available separately from your Patterson-Kelley representative.

ENVI® APPLICATION

Note: The ENVI® control is capable of running the boiler on its own without any external control hardware or accessories. However, certain applications warrant the purchase and installation of separate sensors such as:

26-0000-0507	Outdoor air sensor
BP-0000-0279	Well and sensor for header and DHW applications ENVI® Control
23-0000-0539	Surface mount strap on sensor kit for header or DHW applications ENVI® Control
BP-0000-0480	Kit, 12" brass thermowell, tank temperature sensor, DHW applications ENVI® Control
Consult Factory	Dual element immersion sensor

Optional flow switch: (necessary in some DHW applications)

86-8350-0800	Switch, flow switch

Optional aquastat: (necessary in some DHW applications)

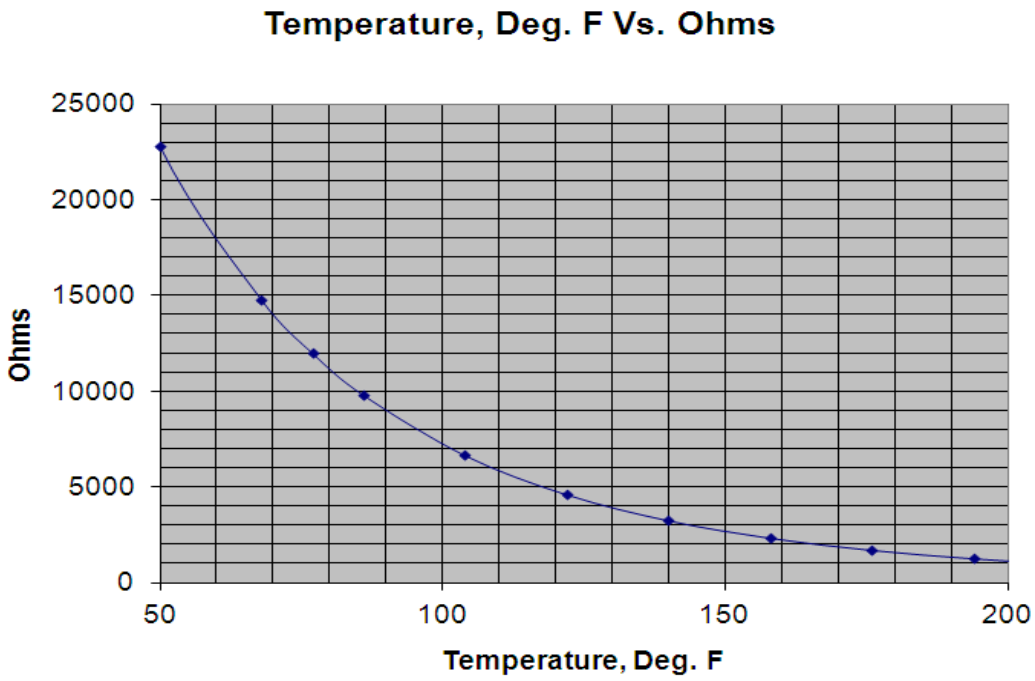
10-0000-1209	SW,THERMO,100-200F,HONEYWELL_L6008A1242
23-0000-0233	THERMOWELL, ½" NPT

These optional sensors will enhance the performance of the ENVI® control and may be necessary to sense the locations needed for some applications to perform properly.

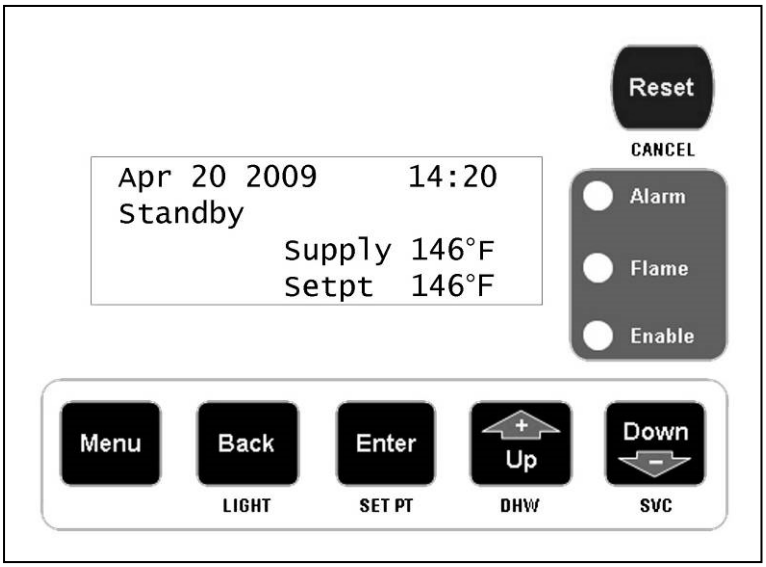
This chart represents the temperature/resistance relationship of the 12K ohm thermistor mentioned above.

Temp, C	Temp, F	Ohms
0	32	36129
10	50	22804
20	68	14773
25	77	12000
30	86	9804
40	104	6652
50	122	4607
60	140	3252
70	158	2337
80	176	1707
90	194	1266
100	212	952
110	230	726
120	248	560
130	266	438
140	284	345
150	302	275

Temperature Resistance for 12K NTC Thermistors on all ENVI controls



⚠ CAUTION The user should become thoroughly familiar with the operation of the boiler and controls before attempting to make any adjustments.



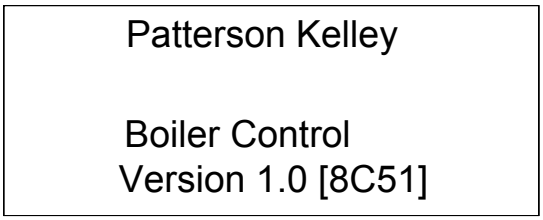
The display panel is used to setup and monitor boiler operation by means of six push buttons; MENU, BACK, ENTER, UP, DOWN, and RESET as shown.

There are shortcut functions also associated with these buttons; LIGHT, SET PT, DHW, SVC and CANCEL. The shortcut functions are available only when the default (home) screen is displayed.

The four line screen shows boiler operating information on various screens. The display screen is backlit for ease of viewing. The display panel will turn off its backlight after a period of inactivity. Press the BACK button to illuminate the screen.

In a cascade system it will be necessary to make control adjustments to every boiler display panel.

1.0 OPERATION OF THE ENVI CONTROL



The control displays the initial boot screen (above) when first powered.

The second line of text indicates one of three possible operating configurations:

- Boiler Control indicates the boiler is set up as a standalone (SA) operation (Factory default)
- Master Control indicates the boiler is set up as the master in a cascade system.
- Member 1 (or 2, 3, 4…) indicates the boiler is set up as a member 1 thru 24 within a cascade system.

The value shown on the fourth line of text inside the brackets [8C51] is the software version or code installed on the ENVI® boiler controls.

There are several versions of the ENVI® control. These include 112E, BD71, 49A7, 79F2, 8C51,1043 and 9820. Not all features are available with all versions. Parameters which are only applicable to certain release versions will be designated accordingly. If there is no mention of versions with the parameter, then it is valid for all versions.

The control displays the default (home) screen shown above once boot up is complete.
This screen displays; the date, time, boiler status, supply temperature, setpoint temperature, error codes, present operating mode (CH or DHW), CM=cascade master, or CS 01-24=cascade member (also referred to as subordinate or slave). Also, firing rate, FP (freeze protection), CL (cycle limit) and firing rate (Power) may be displayed. Cycle limit & freeze protection settings are explained later in the manual.

The control has multiple menu levels to provide set-up and operating information. Navigation through the various menus may be performed using the buttons beneath the display. The function of the buttons may be two-fold as shown below. The shortcut functions are available only when the default (home) screen is displayed.

Buttons	Function	Shortcut
Menu	Accesses the menu	None
Back / Light	Returns to the previous screen	Turns on backlight
Enter / Set Pt	Accepts the value	Accesses CH Settings
Up / DHW	Increases the value/moves cursor	Accesses DHW Settings
Down / SVC	Decreases the value/moves cursor	Accesses Service Mode
Reset / Cancel	Resets the control	Cancels Service Mode

1.1 ENVI® CONTROL FLOW CHART

Note: Parameter ranges in flow chart reference a typical MACH boiler. Parameter ranges will typically be different for a condensing vs. non-condensing boiler such as the Modufire Forced Draft boiler.

MENU → STANDBY → INFORMATION → ERRORS → PROGRAM PARAMETERS → FOLLOW TO CONFIGURATION

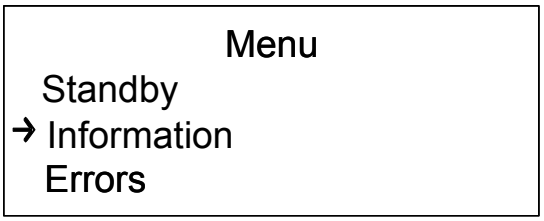
SUPPLY TEMP	RECORDS	CH SETTINGS →								SET POINT	42-185^0
RETURN TEMP	LAST	DHW SETTINGS →						DHW MODE	0-3	BLR OP	0-3
DHW TEMP	ERROR	BOILER SETTINGS →		BOILER TYPE	0-26			DHW TYPE	0-2	CH MODE	0-8
FLUE GAS		OEM SETTINGS →	ABS MAX FAN	0-7500	**MAX FAN SPD**	0-7500		DHW SETPOINT	86-185^0	HI ODA TEMP	40-86^0
HX			ABS MIN FAN	0-2010	**CH MAX FAN**	3510-6000		TANK SET	104-162^0	MIN ODA SETP	42-200^0
OUTSIDE TEMP			IGN FAN SPD	0-2010	**DHW MAX FAN**	3510-6000		ON DIFF	0-36^0	LOW ODA TEMP	-18 - 59^0
CH SET			**PREPURGE SPEED**	0-100%	MIN FAN SPD	0-7500		OFF DIFF	0-36^0	MAX ODA SETP	170-200^0
DHW SET			MAX FLUE TEMP	68-266^0	MAX SETPOINT	42-194^0		TANK OFF DIFF	0-36^0	ODA SHUTDOWN	45-140^0
HEADER TEMP			FLUE DIFF	0-180^0	MIN SETPOINT	40-185^0		TANK ON DIFF	0-36^0	NIGHT SETBCK	0-58^0
FLAME SIGNAL			ABS MIN SETPT	40-194^0	MAX TEMP	185-194^0		POST PMP TIME	0-255S	HYSTERES ON	0-22^0
FAN SPEED			ABS MAX SETPT	40-240^0	MOD BACK DIFF	0-64^0		PROP BAND	0-230	HYSTERES OFF	0-22^0
ANALOG IN			FLM DETCT TYP	UV/REC	MBD OFFSET	0-64^0		INTEGRAL RATE	0-255	POST PMP TME	0-2550S
ANALOG OUT			FLM SETPOINT	NA	LO FIRE HOLD	0-255S		DER TIME	0-255	ANTI CYC TME	0-2550S
IGNITIONS			FLM DELTA	NA	POST PURGE	0-255S		**PWR LMT STEP**	0-255	PROP BAND	0-230
BURNER HI HR			ABS TEMP DIFF	0-180^0	ACCEL BRN ON	0-15		**PMP ON DEMAND**	Y/N	INTEGRAL RTE	0-255
BURNER MD HR			HALL SWITCHES	0-5	ACCEL BRN OFF	0-15		**PRIORITY TIME**	0-255M	DER TIME	0-255
BURNER LO HR			PWM FREQ	NA	**FP ENABLE**	Y/N				**PWR LMT STEP**	0-255
WATER PRESS			NUM RETRY	0-4	**PWR LMT STEP**	0-255				**PMP ON DEMAND**	Y/N
WATER LEVEL			EXT IGNITION	Y/N							
LOW GAS PRESS			AIR SWITCH MOD	0-3							
AIR PRESSURE			HX RAPID RISE	0-24^0							
BLOCKED FLUE			OUT RAPID RISE	0-24^0							
CH PUMP			IN RAPID RISE	0-24^0							
DHW PUMP			HX TEMP SENSOR	Y/N							
AIR DAMPER			LEVEL CODE 1	XXXX							
HI GAS PRESSURE			LEVEL CODE 2	XXXX							
			OEM CODE	XXXX							
			PARM ASSIGNMENT	ASSN LEVEL CODE							
			RECYCLE FLM	Y/N							
			RECYCLE ASW	Y/N							

CONFIGURATION → CASCADE → SERVICE

LANGUAGE	CONTROL MODE →							**SINGLE BLR CONTROL**		BURNER ON TEST	HIGH
DATE TIME	MASTER SETTINGS →			HDR SETPOINT	42-194			**CASCADE MASTER**			LOW
CODE	CASCADE SETTINGS →	MAX SUPPLY T	185-194	POWER MODE	0-1			**CASCADE SLAVE**			**20%**
F OR C	INFORMATION ERRORS →	**MASTER**	LOLOAD HYS SLV	0-36^0	HEADER MODE	0-4					**40%**
MODBUS ADRESS		**SLAVE 1**	LOLOAD MOD DLT	0-54^0	HYST START BLR	0-36^0					**60%**
			LOLOAD WAIT SLV	0-255S	HYST STOP BLR	0-36^0					**80%**
			LOAD DETCT DLT	0-99^0	**WAIT BLR SW ON**	0-60M				BURNER OFF FAN	HIGH
		SLAVE 24	CSC MIN RET T	40-194^0	**WAIT BLR SW PWR**	0-100%					LOW
			HYST MIN RET T	0-36^0	**WAIT BLR SW OFF**	0-60M					**20%**
			RET T MAX PWR	104-194^0	**WAIT RESET TIME**	ON/OFF					**40%**
			RET T MIN PWR	104-194^0	PROP BAND	0-230					**60%**
			PRE PMP PERIOD	15-255S	INTEGRAL RTE	0-255					**80%**
					DER TIME	0-255					
					CYC LMT INCRMNT	0-50M					
					CYCL LIMIT MAX	1-255M					
					HYS QUIC START	0-51^0					
					QUIC START TME	0-255S					
					HYS QUICK STOP	0-51^0					
					QUIC STOP TIME	0-255S					
					LOLOAD WAITING	0-255S					
					START ROTATION	Y/N					
					NO BLR ON WAIT	0-255M					
					ANTI WIND UP	ON/OFF					

NOTE; BOLDFACE PARAMETERS ARE NOT VALID IN ALL SOFTWARE VERSIONS.
SEE EACH PARAMETER IN MANUAL FOR APPLICABLE SOFTWARE VERSIONS.

1.2 MENU SCREEN



From the main screen, pressing the Menu button provides access to the following sub-menus, shown below:

- Standby
- Information
- Errors
- Program Parameters
- Configuration
- Cascade Menu
- Service

Use the Up and Down buttons to scroll to the desired sub menu and the Enter button to select that sub menu.

1.3 BOILER STATUS SCREEN

Pressing Back while in the menu screen returns the boiler status (default) screen described in Section 1.0.

The default screen displays the current operating status. A list of possible operating statuses is shown below:

- Standby – boiler waiting for a call for heat or for temperature conditions to require heat
- Checking Air Switch – boiler is in its pre-ignition sequence, verifying the air switch is open prior to proceeding
- Pre Purge - boiler is beginning the ignition sequence, purging the combustion chamber
- Ignition - the igniter and gas valve are energized while flame is detected
- Run – flame is established, igniter is de-energized, gas valve is controlled to satisfy heat load
- Post Purge - boiler has completed the burn sequence and is purging the combustion chamber
- Post Pumping – circulator pump is energized for a specified period to remove residual heat from the boiler
- Reset – the ENVI® control has detected an error and locked out the boiler. (**DO NOT reset the control without determining and correcting the cause**)
- Blocking (Alarm)-*Auto reset-* automatic reset lockouts that will self reset when the error condition clears.
- Locking (Alarm)-*Manual reset-* manual reset lockouts requiring an operator to press the reset button.

If the ignition sequence is started it will be finished. Even if the demand is taken away, the sequence up to the burn state is completed.

1.4 INFORMATION MENU

Pressing 

at the INFORMATION menu displays the following information.

```
      Information
→ Supply   Temp  122°F
  Return   Temp  119°F
  DHW      Temp   14°F
```

Use the 

and 

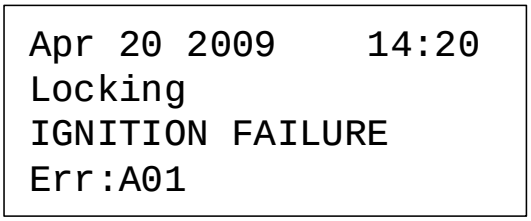
buttons to scroll through the INFORMATION menu.

Below is a list of values within the Information screen. This screen is very useful for obtaining values as it displays real time changes.

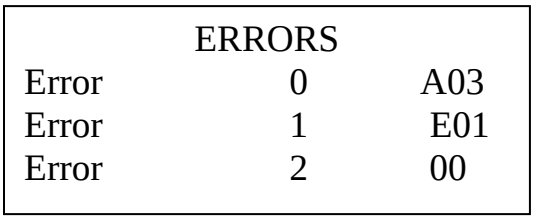
NOTE: Observe the 14°F value in the information screen above. This is the value displayed when the control recognizes an open circuit. This is common when a particular sensor such as the DHW sensor in the example above is not used, but may also occur in the event of an electrically open sensor or sensor circuit. The value displayed in the event of a shorted sensor or sensor circuit is 244°F. The values will be defined further in the following table.

Display	Description	Units	Open/Shorted Sensor Indication
Supply Temp	Outlet / Supply Temperature	°F	14°F (Open) / 244°F(Shorted)
Return Temp	Inlet / Return Temperature	°F	14°F (Open) / 244°F(Shorted)
DHW Temp	Domestic Hot Water Temperature at the location of the sensor(field installed)	°F	14°F (Open) / 244°F(Shorted)
Flue gas Temp	Flue Gas Temperature FD boiler - thermal disc switch breaks the display will indicate 50F	°F	50°F (Open) / 280°F(Shorted)
HX Temp	Heat Exchanger Temperature available on the MACH line C1500 thru to the C4000	°F	14°F (Open) / 244°F(Shorted)
Outside Temp	Outside Air Temperature at the location of the sensor (field installed)	°F	-40°F / 176°F
CH set Temp	Comfort Heat Setpoint Temperature	°F	N/A
DHW set Temp	Domestic Hot Water Setpoint Temperature	°F	N/A
Header Temp	Header Temperature at the location of the sensor(field installed)	°F	244°F / 244°F
Flame signal	Flame Signal (versions 49A7 and earlier were “YES/NO”)	µA	< 1.7 µA = Flame Not Detected > 1.7 µA = Flame Detected 0-10
Fan speed	Fan Speed	RPM	0-9999
Analog in	Analog Input	N/A	Not Currently Used
Analog out	Analog Output	N/A	Not Currently Used
Ignitions	Number of Ignitions	#	0-99999
Burn Hi HR	Hours at High Fire (75% to 100%)	HRS	0-99999
Burn MD HR	Hours at Medium Fire (45% to 75%)	HRS	0-99999
Burn LO HR	Hours at Low Fire (20% to 45%)	HRS	0-99999
Water press	Water Pressure	N/A	Not Currently Used
Water level	Water Level Sensor Status Aux LWCO status on FD boilers (if installed)	Off/On	0 = Low Water Cutoff 1 = Low Water Cutoff Detects Water
Low gas press	Low Gas Pressure Sensor Status	Off/On	0 = Low Gas Pressure Switch Open 1 = Low Gas Pressure Switch Closed
Air pressure	Air Pressure Switch Status	Off/On	0 = Air Pressure Switch Open 1 = Air Pressure Switch Closed
Blocked flue	Blocked Flue Switch Status	Off/On	0 = High Exhaust Back Pressure Switch Open 1 = High Exhaust Back Pressure Switch Closed
CH pump	Comfort Heat Pump Relay Status	Off/On	0 = CH Pump relay Off 1 = CH Pump relay On
DHW pump	Domestic Hot Water Pump Relay Status	Off/On	0 = DHW Pump relay Off 1 = DHW Pump relay On
Air damper	Air Damper Relay Status	Off/On	0 = Air Damper relay Off 1 = Air Damper relay On
Hi gas pressure	Hi Gas Pressure Switch Status	Off/On	0 = Hi Gas Pressure Switch Open 1 = Hi Gas Pressure Switch Closed

1.5 ERRORS MENU



Version [8C51] and earlier



Versions [1043] and [9820]

The ENVI® control stores the most recent error. Version 1043 and after store the last 6 errors. These errors may be locking or blocking errors.

Pressing Enter while in the menu screen with the cursor on Errors, the ERROR menu displays a list of the last 6 errors as shown.). Pressing Up and Down scrolls through the list of errors. Pressing Enter while the cursor is on an error displays several lines of information about the status of the boiler during the error.

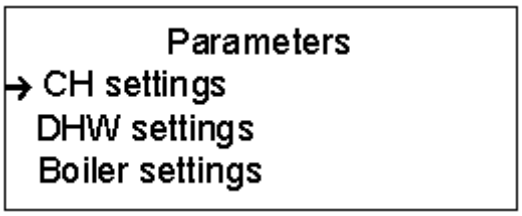
The error information recorded at the time of the error is shown in the table below.

Display	Description	Units
Varies	Error Description	N/A
Error code	Error Code	
Date	Date Error Occurred	DD-MM-YY
Time	Time Error Occurred	24:00
Supply Temp	Outlet Temperature	°F
Return Temp	Inlet Temperature	°F
DHW Temp	Domestic Hot Water Temperature	°F
Flue gas Temp	Flue Gas Temperature	°F
HX Temp	Heat Exchanger Temperature	°F
Outside Temp	Outside Air Temperature	°F
Operation Mode	Boiler Operation Mode (CH/DHW)	°F
Days run	Accumulated Days Runtime	#
State	State at time of error	

1.6 PROGRAM PARAMETERS MENU

1.6.1 Initial Setup of the Control

Press the Menu button, scroll down with the Down button and select PROGRAM PARAMETERS from the menu by pushing. Enter A screen opens that allows access to the adjustable sub menus.



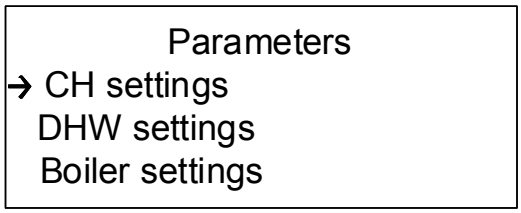
Sub Menu	Description
• CH settings	Comfort Heat Settings: Contains settings for specific operation of the comfort heat operation. Contains the different modes of operations available. Holds the outdoor air curve and night setback settings.
• DHW settings	Domestic Hot Water Settings: Contains settings for specific operation of the domestic hot water capabilities.
• Boiler Settings	Boiler Operating Settings: Boiler settings contain the primary settings for the boilers operation.
• OEM Settings	Original Equipment Manufacturer Settings: These setting are non configurable and are for information only.

Selecting and editing a sub menu

Note: There are three access levels including Service Level 1, Service Level 2, and OEM settings which can be viewed, but cannot be changed in the field. Service Level 1 and Service Level 2 require access codes. Access codes are provided to those individuals who have been properly trained by Harsco Industrial, Patterson-Kelley.

CAUTION: Do not change any parameter unless the function of that parameter is thoroughly understood. Improper modification of the parameters may cause the boiler to operate erratically or not at all.

1.6.2 CH Settings



While in the PROGRAM PARAMETERS menu, press Enter at the CH SETTINGS menu to access the comfort heat parameters listed in the table below. Alternatively, pressing Enter at the boiler status screen also accesses the CH SETTINGS menu. You can now select any parameter by using the Up or Down then pressing Enter. Each parameter can be edited by using the same buttons. Once editing of each parameter is complete save it by pressing Enter.

1.6.1.1 Comfort Heat Parameters and Descriptions

ENVI® Text Display	Function	Range	Units	Passcode Level
CH Setpoint	Comfort Heat Setpoint	See Appendix I	°F	User
BLR OP (Boiler Operation) Off = 0, On = 1, Off/Pump On = 2, and On/Pump On = 3	Boiler / Pump Run settings 0 = Boiler Off, Pump Off 1 = Boiler Auto, Pump Auto 2 = Boiler Off, Pump Continuous 3 = Boiler Auto, Pump Continuous	0-3		User
CH Mode	Comfort Heat Operation Mode	0-8		SVC1
CH Mode 0 (Setpoint & Stat)	See 1.6.3.1 below	0		
CH Mode 1 (Outdoor &Stat)	See 1.6.3.2 below	1		
CH Mode 2 (Outdoor Control)	See 1.6.3.3 below	2		
CH Mode 3 (Setpoint Control)	See 1.6.3.4 below	3		
CH Mode 4 (Header & Stat)	See 1.6.3.5 below	4		
CH Mode 5 (Header & Outdoor & Stat)	See 1.6.3.6 below	5		
CH Mode 6 (Header & Outdoor)	See 1.6.3.7 below	6		
CH Mode 7 (Analog Setpoint)	See 1.6.3.8 below	7		
CH Mode 8 (Analog Firing Rate)	See 1.6.3.9 below	8		
Hi ODA Temp	Maximum Outdoor Air Temperature	40 – 86	°F	SVC1
Min ODA SetP	Desired setpoint @ Hi ODA Temp	See Appendix I	°F	SVC1
Lo ODA Temp	Minimum Outdoor Air Temperature	-18 – 59	°F	SVC1
Max ODA SetP	Desired setpoint @ Lo ODA Temp	See Appendix I	°F	SVC1
ODA Shutdown	Outdoor Air Shutdown Temperature	45 – 140	°F	SVC1
Night Setback	Reduces CH Set point when enabled by this value	0 – 58	°F	SVC1
Hysteresis On	On Differential (subtract this temperature from the setpoint for start)	0 – 22	°F	SVC1
Hysteresis Off	Off Differential (add this temperature to setpoint for off)	0 – 22	°F	SVC1
CH Post Pump time	Post Pump Time After Burner Shuts Off	0 – 2550	Sec	SVC1
Anti-Cyc Time	Restart Time Delay to Prevent Short Cycling	0 – 2550	Sec	SVC2
Prop Band	Proportional Band	0 – 230	°F	SVC2
Integral Rate	Integral Rate	0 – 255	Sec	SVC2
Der Time	Derivative Time	0 – 255	Sec	SVC2
Pwr lmt step (ver. 8C51, 1043, 9820)	Power limit step limits the intervals of rate while driving towards high fire (the lower the value, the slower the step; the higher the value, the faster the step)	0 – 255	units	SVC2
PMP on demand (ver. 79F2, 8C51, 1043, 9820)	With the NO selection the boiler pump only runs when there is a need to fire the boiler. With the YES selection the boiler pump runs when an enable signal is present. This is overridden by the BLR OP setting	Yes/no		SVC2

1.6.2 CH Modes

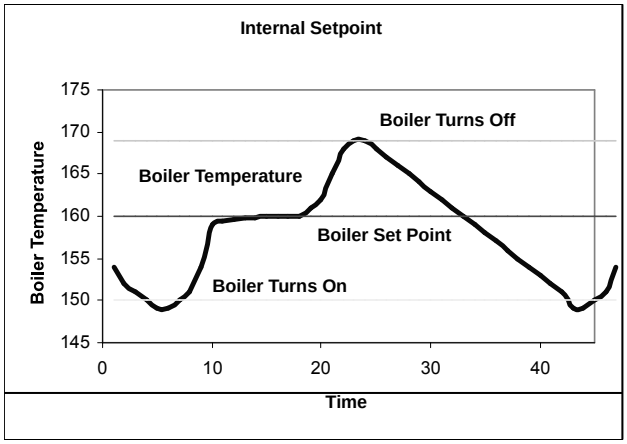
There are nine CH Modes (0-8). A more detailed description of each mode is included below.

1.6.2.1 CH Mode = 0 (Setpoint & Stat)

Description
Setpoint is the desired outlet water supply temperature. Upon heat demand (or enable/disable), the ENVI® control fires and modulates the boiler to maintain supply water temperature at the desired CH setpoint. The upper (HYSTERESIS OFF) and lower (HYSTERESIS ON) temperature differentials within CH settings control the temperature at which the burner turns on or off.

Example: A boiler with the following parameters (SETPOINT = 160 °F, HYSTERESIS OFF = 9 °F, HYSTERESIS ON = 10 °F) modulates to try to maintain 160° F. If the temperature increases above 169° F (160 °F SETPOINT + 9°F HYSTERESIS OFF), the boiler will shut off. Once it shuts off, it will not restart until the temperature drops below 150° F (160 °F SETPOINT – 10°F HYSTERESIS ON). This is illustrated graphically below.

The MIN SETPOINT and MAX SETPOINT parameters within the boiler settings menu limit the setpoint range. See Appendix 3.1 and 3.2 for the default values.



CH Mode 0 is recommended for all member boilers in a cascade system with the factory installed enable jumper left in place across LVTB -1 terminals 1 & 2.

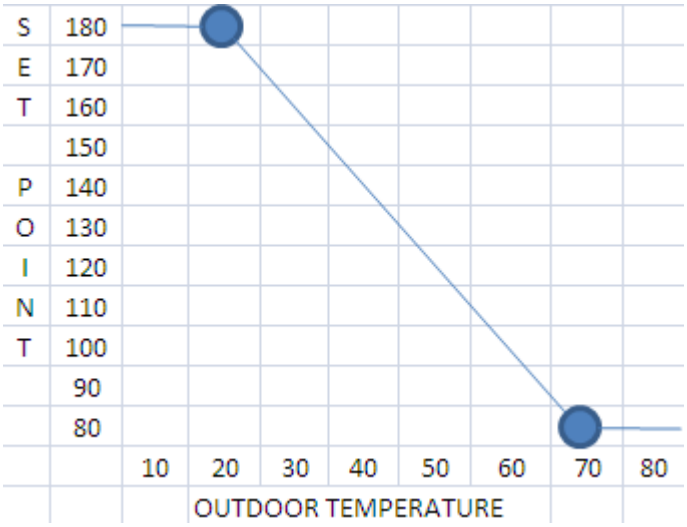
In the event of failure of the master boiler the members will operate as standalone and control to their CH set points.

NOTE: The boiler is enabled by the TB1/LV terminals 1 and 2 (enable/disable) becoming closed or shorted. This circuit is energized internally. **DO NOT APPLY EXTERNAL POWER TO THESE TERMINALS.**

1.6.2.2 CH Mode 1 (ODA & Stat)

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

Description
In this mode, upon enabling the boiler, setpoint is varied by the outdoor air temperature (ODA). The ENVI® control fires and modulates the boiler to maintain outlet water temperature at the setpoint which is determined by the outdoor air temperature and its settings. The upper (HYSTERESIS OFF) and lower (HYSTERESIS ON) temperature differentials control the temperature at which the burner turns on or off.



Within CH Settings		
Hi ODA Temp (Outdoor TMax)	70	°F
Min ODA SetP (Setpoint TMin)	80	°F
Low ODA Temp (Outdoor TMin)	20	°F
Max ODA Setp (Setpoint TMax)	180	°F
ODA shutdown	68	°F

(FACTORY SETTINGS SHOWN ABOVE)

The Outdoor air sensor reads outdoor air temperature and sends it back to the control. The setpoint is established based on the outdoor air temperature. If the outdoor air temperature is below the (HIGH ODA TEMP), the boiler control begins to maintain a setpoint set by the (MIN ODA SETP). As the outdoor air temperature drops, the setpoint temperature increases until (LO ODA TEMP) is reached by the outdoor air temperature. When the outside air temperature has dropped to meet the (LO ODA TEMP) setting, the setpoint of the boiler will be operating at (MAX ODA SETP).

Example: Using the values in the table shown below, the boiler setpoint is 80° F (MIN ODA SETPT) when the outdoor air temperature is 70° F (HI ODA TEMP). As the outdoor air temperature drops, the boiler setpoint increases until the outdoor air temperature is 20° F (LO ODA TEMP). When this occurs, the boiler reaches its maximum setpoint of 180°F (MAX ODA SETPT). If the outdoor air temperature drops further, the boiler setpoint remains at 180° F.

NOTE: The boiler is enabled by the TB1/LV terminals 1 and 2 (enable/disable) becoming closed or shorted. This circuit is energized internally. **DO NOT APPLY EXTERNAL POWER TO THESE TERMINALS.**
NOTE: while using CH MODE 1 (ODA&STAT) the ODA shutdown temperature is ignored and does not stop the boiler from running.

1.6.2.3 CH Mode 2 (Outdoor Control)

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

Description
In this mode, setpoint is varied by the outdoor air temperature (ODA). Upon enabling the boiler, the ENVI® control fires and modulates the boiler to maintain outlet water temperature at the setpoint determined by the outdoor air temperature and its settings. The upper (HYSTERESIS OFF) and lower (HYSTERESIS ON) temperature differentials control the temperature at which the burner turns on or off.

Notes: Reference table and graph in section 1.6.2.2 for example of ODA to Boiler Temp relationship.

NOTE: 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.
The TB-1/LV terminals 1 and 2 (enable/disable) operate the switching on/off of the night setback function. The night setback setpoint is set within CH settings and reduces the CH set point by its value while enabled. (TB-1/LV terminals 1 and 2 circuit closed)

1.6.2.4 CH Mode 3 (Setpoint Control)

Description
In this mode, the boiler functions as described in 1.6.2.1, **CH Mode** 0, except that the external thermostat does not create the call for heat. The closure of TB1/LV terminals 1 and 2 will reduce the CH setpoint by the value of the night setback setting.

Example: Using the values, CH SP=180° F and Night Setback=10° F, when TB1/LV terminals 1 and 2 are open the CH setpoint will be 180° F. When TB1/LV terminals 1 and 2 are closed the CH setpoint will be 170° F (180° F -10° F).

NOTE: In this mode the boiler will always run to setpoint, since there is no enable circuit closure required. The TB-1/LV terminals 1 and 2 (enable/disable) operate the switching on/off of the night setback function. The night setback setpoint is set within CH settings and reduces the CH set point by its value while enabled. (TB-1/LV terminals 1 and 2 circuit closed)

1.6.2.5 CH Mode 4 (Header & Stat) This mode is preferred for the master boiler in a cascade system.

A sensor will be needed to sense header temperature. A list of accessory choices for different applications is shown in section 1.0 on page 3.

Description
In this mode, the boiler functions as described in 1.6.3.1, **CH Mode 0**, except that the boiler maintains the setpoint temperature where the header sensor is located.

NOTE: The boiler is enabled by the TB1/LV terminals 1 and 2 (enable/disable) becoming closed or shorted. This circuit is energized internally. **DO NOT APPLY EXTERNAL POWER TO THESE TERMINALS.**

Note: Placing the master boiler in CH mode 4 on any cascade application will show the header temperature (HDR Supply) on the display in the place of the supply temperature on the third line of text on the master boiler.

1.6.2.6 CH Mode 5 (Header & ODA & Stat)

Two sensors are required to sense header temperature and outdoor temperature. A list of accessory choices for different applications is shown in section 1.0 on page 3.

Description
This mode is a combination of CH Mode 1 (ODA & Stat) and CH Mode 4 (Header & Stat). When the boiler is enabled through TB1/LV terminals 1 and 2, the setpoint temperature is maintained at the location of the header sensor based on the ODA reset schedule that is determined from the optional outdoor air sensor.

Note: While using CH MODE= 5 (HEADER&ODA&STAT) the ODA shutdown temperature is ignored and does not stop the boiler from running.

Note: Reference table and graph in section 1.6.2.2 for example of ODA to Header Temp relationship.

NOTE: The boiler is enabled by the TB1/LV terminals 1 and 2 (enable/disable) becoming closed or shorted. This circuit is energized internally. **DO NOT APPLY EXTERNAL POWER TO THESE TERMINALS.**

Note: Placing boiler in CH mode 5 will show the header temperature (HDR Supply) on the display in the place of the supply temperature on the third line of text on the boiler.

1.6.2.7 CH Mode 6 (Header & Outdoor)

Two sensors are required to sense header temperature and outdoor temperature. A list of accessory choices for different applications is shown in section 1.0 on page 3.

Description
This mode is a combination of CH Mode 2 (Outdoor Control) and CH Mode 4 (Header & Stat). The temperature is maintained at the location of the header sensor and the setpoint is based on the ODA reset schedule that is determined from an outdoor air sensor and the night setback feature. The closure of TB1/LV terminals 1 and 2 will reduce the CH setpoint by the value of the night setback setting.

Note: In this mode the boiler will always run to setpoint, as there is no enabling needed using this CH mode.

Note: Reference table and graph in section 1.6.2.2 for example of ODA to Header Temp relationship.

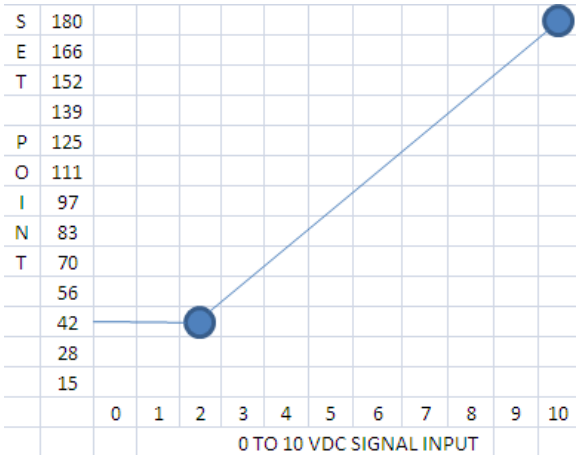
Example: Using the values, CH SP=180° F and Night Setback=10° F, when TB1/LV terminals 1 and 2 are open the CH setpoint will be 180° F. When TB1/LV terminals 1 and 2 are closed the CH setpoint will be 170° F (180° F -10° F).

NOTE: The boiler is enabled when the temperature of the outdoor sensor drops below the ODA SHUTDOWN temperature which 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 set within CH settings.

1.6.2.8 CH Mode 7 (Analog Control of Setpoint)

Description

In this mode, an external 0-10 VDC signal controls the setpoint of the boiler. From the factory, the Min Setpoint is set for 42° F for condensing boilers (130° F for non-condensing) and the Max Setpoint is set for 185° F for condensing boilers (220° F for non-condensing). Applying a voltage of at least .5 to 1.5 VDC creates the heat request. Applying 2 VDC sets the boiler setpoint to BOILER MIN SETPOINT. Applying 10 VDC sets the boiler setpoint to BOILER MAX SETPOINT. Applying less than .5 VDC removes the heat request. The Min and Max set points can be adjusted within the boiler settings menu.



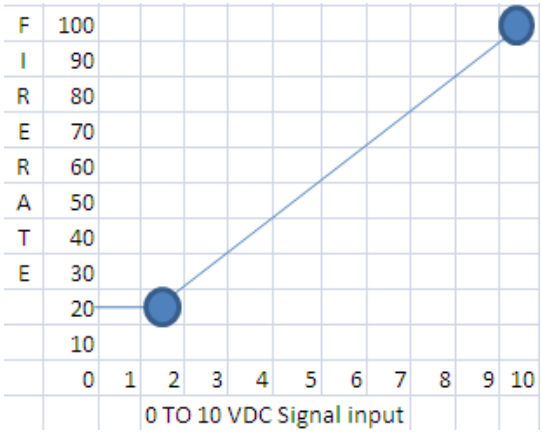
NOTE: When in analog control mode, enable/disable terminals are non-functional as the boiler is enabled/disabled by applying .5 to 1.5 VDC. Dropping below .5VDC will disable the boiler.

Many times the building automation sequence of operation requires an enable/disable circuit; this can be achieved by installing a relay in series with the control signal and opening the contacts to drop voltage to 0VDC thereby disabling the boiler. A normally closed contact will provide fail safe operation.

1.6.2.9 CH Mode 8 (Analog Control of Firing Rate)

Description

In this mode, an external 0-10 VDC signal from the building automation system or some external control determines the firing rate of the boiler. A signal of .5 to 1.5VDC generates a heat request and is required to start the boiler. At 2 VDC the firing rate is 20% and at 10 VDC the firing rate is 100%.



Boiler temperature limits and safety features are still active. Although the boiler may be receiving a 10 VDC signal, high fire will not be achieved if certain parameters, such as the boiler maximum temperature, are exceeded.

NOTE: When in analog control mode, enable/disable terminals are non-functional as the boiler is enabled/disabled by applying .5 to 1.5 VDC. Dropping below .5VDC will disable the boiler.

Many times the building automation sequence of operation requires an enable/disable circuit; this can be achieved by installing a relay in series with the control signal and opening the contacts to drop voltage to 0VDC thereby disabling the boiler. A normally closed contact will provide fail safe operation.

1.6.3 DHW Settings

```
        Parameters
  CH settings
→DHW settings
  Boiler settings
```

From the PARAMETERS menu use 

and 

to move the cursor to DHW settings then press 

to access the domestic hot water parameters listed in the table below. Alternatively, pressing 

at the default (home) screen also accesses the DHW SETTINGS menu.

1.6.3.1 Domestic Hot Water (DHW) Parameters and descriptions

ENVI® Text Display	Function	Range	Units	Passcode Level
DHW mode None = 0 Storage & Sensor = 1 Storage & Stat = 2 Plate HX = 3	Type of System 0 = No Domestic Hot Water 1 = Storage Tank with Temperature Sensor 2 = Storage Tank with Thermostat 3 = Plate Heat Exchanger w/Flow Switch	0 – 3		SVC1
DHW Type CH/DHW = 0 DHW Priority = 1 3 Way Valve NC = 2	Domestic Hot Water Operation Type 0 = Simultaneous CH and DHW Pumps 1 = DHW pump has priority over CH pump 2 = 1 Boiler Pump: when 3 way valve Normally Closed = DHW when 3 way valve Powered Open = CH	0 – 2		SVC1
DHW setpoint	Setpoint for Domestic Hot Water Output	86 – 185	°F	User
Tank set	Setpoint of Storage Tank (DHW mode 1)	104 –162	°F	User
ON different	Boiler On Differential	0 – 36	°F	SVC1
OFF different	Boiler Off Differential	0 – 36	°F	SVC1
Tank off dif	Tank Off Differential (DHW mode 1)	0 – 36	°F	SVC1
Tank on diff	Tank On Differential (DHW mode 1)	0 – 36	°F	SVC1
Post pmp Time	DHW Post Pump Time	0 – 255	Sec	SVC1
Prop band	Proportional Band	0 – 230	°F	SVC2
Integral RTE	Integral Rate	0 – 255	Sec	SVC2
DER time	Derivative Time	0 – 255	Sec	SVC2
Pwr lmt step (ver. 8C51, 1043)	Power limit step limits the intervals of rate while driving towards high fire (the lower the value, the slower the step; the higher the value, the faster the step)	0 – 255	units	SVC2
PMP on demand (ver. 79F2, 8C51, 1043)	With the NO selection the boiler pump only runs when there is a need to fire the boiler. With the YES selection the boiler pump runs when an enable signal is present. This is overridden by the BLR OP setting	No / Yes		SVC2
Priority Time (ver. 79F2, 8C51, 1043)	The maximum amount of time the domestic hot water operation has priority over the comfort heat operation. Timer is reset and starts when the domestic hot water call is enabled.	0 – 255	Min	SVC1

1.6.4 DHW Modes

The DHW system designs that can be accommodated by this control include:

DHW mode 1- a storage tank with temperature sensor

DHW mode 2- a storage tank with thermostat

DHW mode 3- a plate heat exchanger

Mach boilers, N Series Modufire boilers, and P-K Sonic Boilers can NOT be used for direct fire DHW applications. These boilers require an isolating heat exchanger between the potable water and the non-potable boiler loop.

D series Modufire boilers and Mach 'n Roll™ boiler packages can be used for direct potable water contact in the DHW mode.

1.6.4.1 DHW Mode 1 (Storage & Sensor) Storage Tank with Temperature Sensor

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

Description
A storage tank equipped with a temperature sensor is connected to the boiler. The 12K ohm NTC sensor must be wired into the boiler at the DHW sensor terminals (Typically terminals 7 & 8 on TB-1). When the temperature sensor reads that the tank temperature is below the TANK SET parameter by the TANK ON DIFF, the DWH pump circuit is energized and the boiler starts and supplies heat to the tank. The boiler modulates the firing rate to maintain the DHW SETPOINT at the boiler outlet. When the temperature in the tank exceeds the TANK SET parameter by the TANK OFF DIFF, the boiler shuts off the burner and the DHW pump continues to run for a pre-set time (POST PMP TIME).

Note: Proper sizing of the storage tank is important to prevent short cycling of the boiler equipment. Check with your authorized Patterson-Kelley Representative for assistance on tank sizing.

1.6.4.2 DHW Mode 2(Storage & Stat) Storage Tank with Thermostat

Installer needs to supply a closure device (aquastat, thermostat, flow switch, etc.) to close the DHW Enable circuit (Typically terminals 7 & 8 on TB-1). A list of accessory choices for different applications is shown in section 1.0 on page 3

Description
A storage tank equipped with a thermostat is connected to the boiler. When the closure device creates a closed state, the DWH pump circuit is energized and the boiler starts and supplies heat to the tank. The boiler modulates the firing rate to maintain the DHW SETPOINT at the boiler outlet. When the closure device opens, the boiler shuts off the burner and the DHW pump continues to run for a pre-set time (POST PMP TIME).

1.6.4.3 DHW Mode 3 (Plate Heat Exchanger) Heat Exchanger without Storage

Installer needs to provide a flow-proving device (flow switch) and a temperature sensor. A list of accessory choices for different applications is shown in section 1.0 on page 3.

Description
A plate heat exchanger equipped with a DHW flow proving device and a temperature sensor is connected to the boiler. When the flow-proving device closes, it creates a call for heat and the boiler's DHW Pump Contactor terminals close which starts the boiler DHW pump. If the DHW water temperature is below the DHW SETPOINT by the ON DIFFERENTIAL, the boiler fires and supplies heat to the exchanger. The boiler modulates the firing rate to maintain the DHW SETPOINT at the boiler outlet. When the temperature of the boiler water rises above the DHW SETPOINT by the OFF DIFFERENTIAL, the boiler shuts off the burner and the boiler DHW pump continues to run for a pre-set time (POST PMP TIME). When the demand is satisfied, the flow-proving device breaks the call for heat.

1.6.5 Boiler Settings

Boiler Settings Parameters and descriptions

Note: xxxx is dependent upon model of the boiler.

ENVI® Text Display	Function	Range	Units	Passcode Level
Boiler type	Selects the type of boiler.	xxxx	xxxx	OEM
Max Fan Speed (ver. 112E, BD71, 49A7, 79F2,8C51)	Selects the absolute maximum fan speed	xxxx	RPM	SVC2
CH Max fan (ver. 1043,9820)	Selects the maximum allowable boiler CH fan speed.	xxxx	RPM	SVC2
DHW Max fan (ver. 1043,9820)	Selects the maximum allowable Domestic Hot Water fan speed.	xxxx	RPM	SVC2
Min fan spd	Selects the minimum fan speed.	xxxx	RPM	SVC2
Max setpoint	Selects the maximum allowable setpoint	xxxx	°F	SVC2
Min setpoint	Selects the minimum allowable setpoint	xxxx	°F	SVC2
Max Temp	Selects the maximum allowable water temperature	xxxx	°F	SVC2
Mod back dif	Modulation back differential is the differential temperature (Supply temperature – Return temperature) allowable before MBD offset begins to modulate the boiler.	0 – 64	°F	SVC2
MBD offset	Modulation Back Differential Offset is a temperature buffer before the boiler drops completely to low fire. Example: 45°F (MBD) + 5°F (MBD Offset) = 50°F at which time the boiler will drop to low fire. Inside of this 5°F range it will step modulate to buffer out an application where the boiler flow may dip just beyond minimum flow for a short period of time. This stabilizes the modulation.	0 – 64	°F	SVC2
Lo fire hold	Upon ignition, the boiler drives to low fire and holds for this amount of time.	0 – 255	Sec	SVC2
Post purge	This is the amount of time the fan runs after the burner has shut off.	0 – 255	Sec	SVC2
Accel BNR ON	Selects the fire rate ramp up speed upon power increase rate (lower=slower)	1-15	units	SVC2
Accel BNR OFF	Selects the fire rate ramp down speed upon power decrease rate (lower=slower)	1-15	units	SVC2
FP Always enabled (ver. 112E, BD71) FP on/off (High settings) (ver. 49A7, 79F2) FP enable (ver. 8C51, 1043)	Frost Protection forces the CH pump and burner to run. The Burner will run until the lowest of both supply and return temperature measures above 59°F. HIGH: pump runs at 50° F Burner runs at 42° F LOW: pump runs at 30° F (GLYCOL APPLICATION) Burner runs at 22° F	High Low Off	°F	SVC2
Pwr Lmt Step (ver. 79F2)	Power limit step limits the intervals of rate while driving towards high fire (the lower the value, the slower the step; the higher the value, the faster the step)	0 – 255	units	SVC2

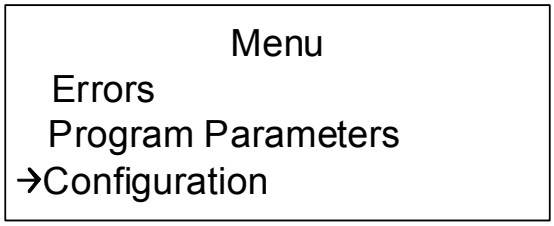
1.6.6 OEM SETTINGS

The **OEM Settings** are password protected by a numerical code and should only be changed by Harsco Industrial, Patterson-Kelley personnel.

The only adjustable parameter within OEM settings will be IGN fan speed. To change this parameter use the service level code 2.

1.7 CONFIGURATION MENU:

The CONFIGURATION menu is a general menu that allows selection of the display language, date/time, code, °F/°C temperature selection and MODBUS® address.



Use 

and 

to move the cursor to the desired setting then press 

to access for adjustment.

LANGUAGE options include English, French or Spanish. English is the default language. ENVI translation to French or Spanish text has not been developed in any version to date.

DATE TIME is factory set at the current date & time in the Eastern time zone at the time of production. The ENVI Display has a long life battery that will store this information. Date & time should be changed to reflect actual time zone, daylight savings time, etc.

CODE configuration indicates the display panel software version.

° **F or ° C** configuration allows the user to select Fahrenheit or Celsius.

MODBUS® ADDRESS configuration allows the user to set the Modbus® device identification. Each ENVI control defaults to Modbus® address 1. In applications with multiple boilers, it is necessary to assign distinct addresses to each boiler when Modbus® communication is used.

Section 1.8 will address the cascade menu: There are two separate polarity sensitive communication paths each referred to as a “bus”.

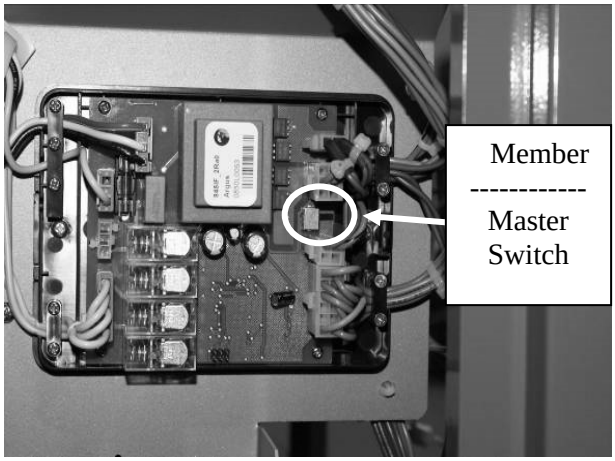
For clarification purposes it is important to understand that the member boilers transfer data to & from the master boiler via the **Cascade bus** which could be described as an **internal bus** of the cascade boiler system.

The **Modbus circuit**, which could best be described as an **external bus**, is a total separate communication path and transfers data to and from all connected boilers, not with each other, but with an external communication system such as a building management system utilizing the Modbus protocol. Communication with other protocols can be established using a protocol converter. Your local Patterson-Kelley Representative can provide information on the Protonode protocol converter that is designed for use with the ENVI control.

1.8 CASCADE MENU:

1.8.1 Cascade setup

With the power off, you can connect up to 24 boilers into the ENVI® Cascade system. Wires are connected from the Cascade terminals (A & B) on the master boiler to the Cascade terminals (A & B) on the member (subordinate or slave) boilers. Connect A to A and B to B. The boilers are connected in series (daisy chain topology) using 18/2 shielded wiring. The wire shield should be grounded on one end only (typically at the master) and the shield connected together and insulated from ground for the rest of the wiring. The result will be a continuous shield grounded on one end only.



After making the boiler to boiler connections, select one boiler as the master boiler. Remove the interface cover (if present) and confirm the master/member selector switch is set to the MASTER position (factory set to member position). Ensure that the remaining member boiler switches are set to the MEMBER position. A picture of the master/member selector switch is shown to the left. Note: the MASTER position is away from the blue transformer, while the MEMBER position is towards the blue transformer. The orientation of the board may vary from the picture shown.

CAUTION! Setting more than one master/member selector switch to the MASTER position may damage the control and cause incorrect operation.

Turn the power on. Press Menu button and scroll down to **Cascade menu,** then press Enter**.** Then you will see

Cascade Menu	
Control Mode	SA
Master Settings	
Cascade Settings	

These settings include:
CONTROL MODE,
MASTER SETTINGS,
CASCADE SETTINGS,
INFORMATION ERRORS.

1.8.2 Control Mode

In this menu, the operational mode is selected.

Single boiler control – SA (stand-alone) as shown in example above
Cascade Master - CM
Cascade member (subordinate or slave) – CS01, CS02, etc.

When the boiler is set as master, the cascade address shall be automatically set to 0. When the mode is set as member (slave), the user enters a unique address (1-23) for each boiler. For Example: Boiler 1 (Master) = Cascade address 0, Boiler 2 (Slave) = Cascade address 1, and Boiler 3 (Slave)= Cascade address 2.

Note: A boiler selected as a cascade member and not connected to a master or with the master powered down, will result in a NO COMM error.

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.**

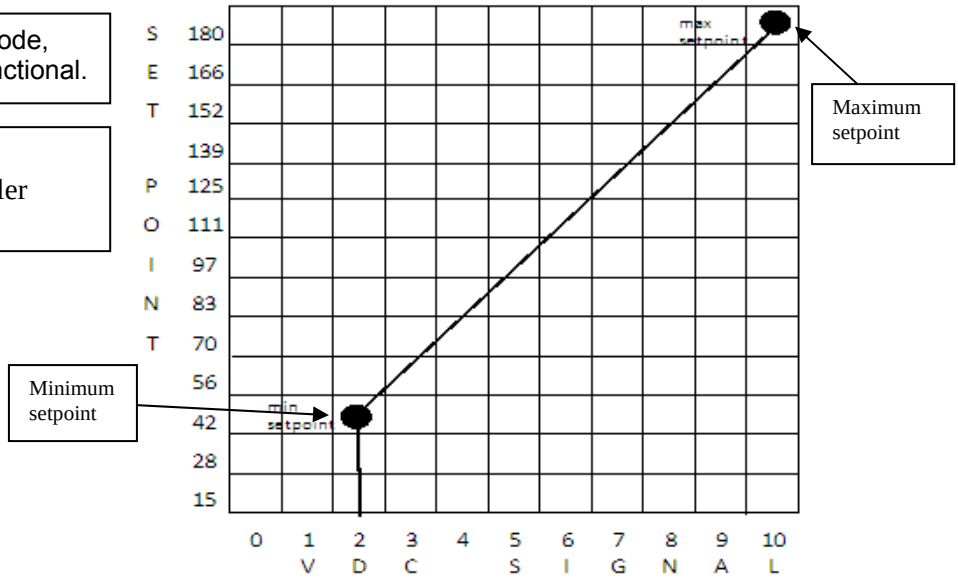
1.8.4.6 Header Mode = 4, (HDR Analog Setpoint)

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 42ºF max 180ºF 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 to130° (**10° below SP**)
The proportional action of the control will be **50%**.

If the header temperature drops to120° (**20° below SP**)
The proportional action of the control will be **100%**.

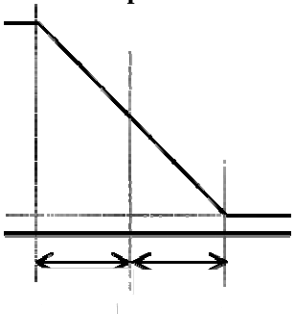
OR: With the proportional band left at the default setting of 20° and a header setpoint of 140°:
With the Derivative time set at 0 (and up to 127), the proportional band is symmetrical around the setpoint (figure 1)

If the header temperature drops to130° (**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%**.

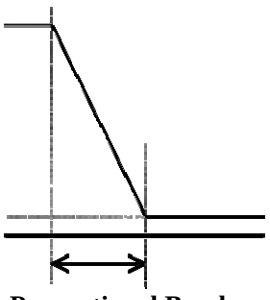
As the header temperature rises above 140° (**10° above SP**)
The proportional action of the control will decrease output to **0%** until reaching 10° above setpoint. (**50% of proportional band**)

Figure 1 **setpoint**



Proportional Band

Figure 2(default) **setpoint**



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(degrees below setpoint) ÷ **50**(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 Cyc 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 Enter 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
  Loload hys slv  15°F
  Loload 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 ***(see note 1 & 4)***	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 ***(see note 4)***	0-36	°F	SVC2
Loload mod dlt	Slave modulation starts when supply temperature is higher than max supply temperature less this value ***(see note 1 & 2)***	0-54	°F	SVC2
Loload wait slv	Delay time before the low load condition can be set inactive ***(see note 3 &4)***	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.

- **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

The master boiler has the following default parameters:

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	

Each condensing boiler has these default cascade parameters:

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

Each non-condensing boiler has these default cascade parameters:

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

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 forth 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 it's 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.

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.

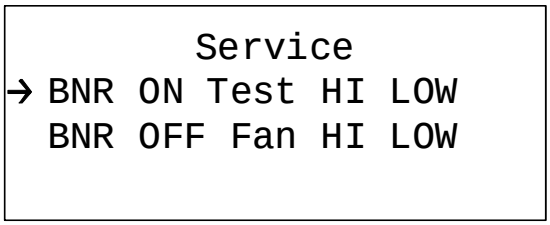
If a condensing boiler cannot be found, the Master ENVI® control goes into NO BLR ON WAIT. When the NO BLR ON WAIT time period expires, the first available boiler will start and burn at high fire until the boiler inlet temperature is greater than RET T MAX PWR. If the return water temperature remains 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 Enter button and using the Up and Down buttons until the cursor is next to *SERVICE. Press* Enter. 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.

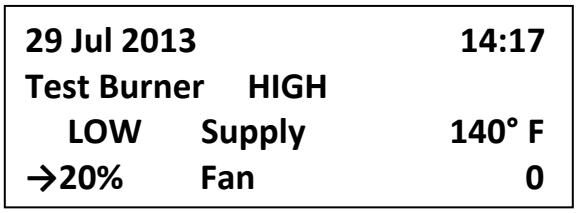


Two test modes are available:

1) BNR ON TEST HI LOW

2) BNR OFF FAN HI LOW

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



Then press Up or Down to select HI or LOW (for ver. 1043; 20%, 40%, 60% and 80% selections are included). Then press Enter 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 than300 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.

CH Parameters	CH SETPOINT		MASTER SETTINGS	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	
DHW Parameters	DHW MODE			LOLOAD WAITING	
	DHW TYPE			START ROTATION	
	DHW SETPOINT			NO BLR ON WAIT	
	TANK SET			ANTI WINDUP	
	ON DIFFERENT			LEAD BOILER	
	OFF DIFFERENT		CASCADE SETTINGS	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	
BOILER SETTINGS	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				