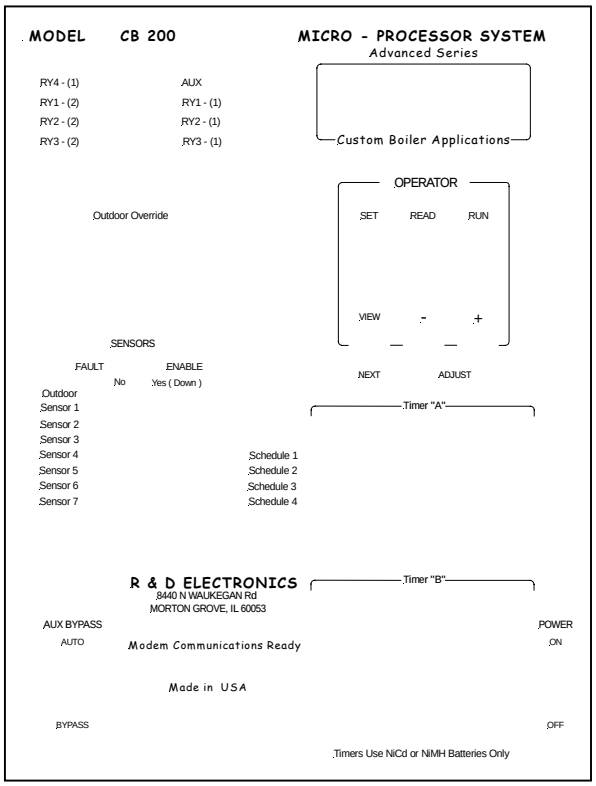
-- Brochure Supplements –

Model CB200 -D, -B, -F -- 4,6,8,12 Stage
- Hw4_ software - Hot Water Reset Control -
- On/Off - Lo/Hi/Lo and Full Modulating Burners -

Model CB200 -E2, -E3, -E4
- Sp1i software --- Steam Pressure Control -
-- Full Modulating Burners --

Model CB200 -G4 and -G8
-- SP2a software --- Steam Pressure Control --
-- On/Off - Lo/Hi/Lo Multiple Boilers --



The **CB200 D and B** series multi-stage boiler controls are used for small, medium and large cast iron and steel boilers requiring on/off, lo/hi fire, or full modulation of the burners. PID or proportional, integral, derivative control provides unmatched energy efficiency by measuring the rate of change in boiler water temperature resulting from actual boiler heat output. This information is fed back to the computer to (1) vary boiler start-up delays according to the derivative of the water temperature, thus minimizing the number of boilers in operation.

A unique "second integration " feature within the software maintains the programmed setpoint, even as the number of operating boilers increases. The error in the setpoint created by the interstage lag differential can be automatically nulled slowly over time.

The control can be setup for on/off, lo/hi/lo, or full modulation applications, but must be ordered with one of three field wiring circuit modules that provide (1) on/off or lo/hi/lo contact closure, (2) a Honeywell™ series 90 135 ohm resistance output, or (3) a 4-20 ma. current output

To achieve maximum efficiency while controlling multiple boilers (especially steel boilers with lots of stored water), the amount of time delay before starting an additional boiler should vary according to the rate of change in Water Temperature. The CB200 -B PID software varies the interstage time delays and prevent additional boilers from being
brought on line unnecesarily. The need to compute the interstage time delays arise when there are sudden changes in demand. The following causes are some examples of sudden changes in demand: (1) when outdoor temperature drops below the outdoor cut-off setting, (2) when additional building zone valves suddenly open, (3) any time the heating control is turned on after a temporary shutdown.

The CB200 -B, -D, software takes a first sample of the present water temperature, then takes a second sample ope PID sampling period later. The two readings are compared, and if the rate of rise is sufficient, a wait period is initialized and the next stage will <u>not</u> be activated. On the other hand, if the rate of rise is insufficient, the next boiler stage will be activated immediately and the process will start over.

The R&D Electronics Model CB200 consists of a main panel, a water temperature sensor, and an outdoor sensor. The main panel has 17 LED's which indicate all important ON/OFF operating conditions, including heat call, circulating pump, sensor faults, outdoor override, and the present time schedule. A simple 3 position slide switch labeled SET, READ, and RUN controls the 32 character LCD display menus. The SET menu is designed for operator adjustments. The READ menu displays outdoor and water temperatures. The RUN menu displays operating states, modulation levels, PID setpoint and water temperature data.

The computed water setpoint varies from the operator Initial Temperature setting at $+70^{o}$ F. to the Final Temperature at -10^{o} F. If the boiler water temperature falls below the computed setpoint by ½ the amount of the differential, boiler stage A or ry1 closes. If the boiler water temperature falls an additional lag differential, stage B or ry2 closes. If the water temperature continues to fall, additional stages are activated in a similar fashion. Modulation is considered as an additional stage similar to a lo fire call. The Outdoor Override setting (typically 55^{o} F.) programs the warm weather shutdown, turning off the "aux" pump. Fault indicating LED's turn ON if there is a sensor failure.

The amount of night water temperature setback will proportionally decrease as outdoor temperature decreases. At 70^{o} F. outdoors, the setback is equal to the value shown in the SET menu. At 30^{o} F. outdoors, the setback will have decreased to 1/2 the amount of the SET value. At -10^{o} F. outdoors, the setback equals zero. This patented method of varying night setback eliminates the possibility of tenant discomfort or building freeze-up during cold weather.

At the beginning of the DAY set period (when the setback timer first changes to ON), a morning BOOST period begins. For 60 minutes, the water temperature will be increased the amount of the night setback.

OPERATOR ADJUSTMENT

Place OPERATOR switch in SET. Press VIEW NEXT. Press + or - to change.

1 INITIAL TEMP. {90}

For most hot water heating systems, the INITIAL temperature will be set between 80 and 100^{o} F. Increasing the INITIAL temperature <u>will not</u> change the final temperature at -10^{o} F. outdoors. The INITIAL temperature and FINAL TEMPERATURE dials changes the slope of the reset curve. In order to increase room temperatures during warm weather, increase the INITIAL temp. 2^{o} F. for every 1^{o} F. you would like to increase the indoor room temperatures. Wait 24 hours after readjustments to allow the indoor temperature to stabilized at the new setpoint.

2 FINAL TEMP. {200}

In order to increase room temperatures during cold weather, increase the final temperature approximately 2^{o} F. for every 1^{o} F. you would like to increase the indoor room temperatures when it is cold outside.

The computed water temperature setpoint will continue increasing beyond the final temperature as the outdoor falls below -10^{o} F, but the hi limit safety control will prevent the water temperature from exceeding 220^{o} F. in most system. Most hot water systems have finned baseboards, requiring a final temperature of 200^{o} F. A low temperature hot water system with floor or wall mounted radiators may need a final temperature of only 170^{o} F., while systems with fan coils, cast iron radiators, or floor radiation may require a final temperature of only 140^{o} F. The optimum initial and final settings can best be determined by installing zone monitoring sensors and performing trials.

The higher the ***initial setback*** setting, the greater the fuel savings. Hot water systems take a long time to cool down, and boiler cycling can be reduced enormously during setback. <u>Because setback is proportioned to outdoor temperature and</u> recovery <u>problems are eliminated, very large initial water temperature setbacks are practical</u>. Chart 1 shows the computed amount of water temperature setback at various outdoor temperatures. Over a nominal setback period of 8 hours, and with outdoor temperatures in the range of 20 to 40^{o} F., and with an initial setback of 60^{o} F.; indoor temperatures may only decline 3 to 5^{o} F.

3 NIGHT WATER TEMPERATURE SETBACK {40}

The displayed value represents the setback only at 70^{o} F. outdoors, and can be thought of as the ***initial water temperature setback***. The computed water temperature setback decreases as outdoor temperature decreases. At

30° F. outdoors, the water temperature setback is 1/2 the initial value. At -10° F. outdoors, the water temperature setback is zero.

4 OUTDOOR CUTOFF (Warm Weather Shutdown) {56}
Set between 55 and 65° F.

5 HEATING CYCLE LENGTH (Differential) {16}
A setting of 15° F. is correct for most hydronic systems. If the heating cycle length is not in the 4 to 8 minute range, then readjust the differential. Copper tube boilers will require higher settings, while cast iron boilers will require lower. Too low a differential setting will cause short cycling and fuel waste, and too high a setting may cause room temperatures to rise and fall excessively. If the heating cycle length is too short with an differential setting of 30 (most common with copper tube boilers), then the circulating sensor will have to be moved to the return water side of the boiler.

6 INTER-STAGE LAG DIFFERENTIAL {4.0}
If the water temperature drops below the computed setpoint, minus ½ the heating cycle differential, minus the lag differential, the next boiler or stage will turn ON. This process continues until all the boilers or boiler stages are ON. The fewer the zone valves, the more stable the system, and the lower you may set the lag differential.

7 SELECT LEAD STAGE {1}
You may manually select the lead stage, or if auto rotation is ON, this number will automatically advance. The display shows 1 for stage A, and 8 for stage H. When the control is set to operate lo/hi or full modulation burners, software prevents the operator from selecting even numbered lead stages. In the lo/hi and full modulation modes, auto rotation of stages is: [1-2 3-4 5-6], [3-4 5-6 1-2], [5-6 1-2 3-4].

READ

Place the OPERATOR slide switch in READ. Press the VIEW NEXT. The READ menu will display the present circulating water temp., the outdoor temperature, and an optional second water temperature sensor.

RUN

The RUN menu will display (1) computed water setpoint determined by outdoor temp., schedule, and operator settings. (2) X pump operation [1 in display]; boiler stages in operation [ABCDEFGH in display]; and the time period. (3) valve modulation level as a percent; (4) water setpoint compensated for the setpoint error each time the number of "on" stages increases; (5) water temperature data logging for the last minute in 10 second increments, (6-10) water temperature data logging for the last 30 minutes in six 1 minute intervals. Data Logs reads oldest first (upper left) and most recent measurement last (lower right).

SYSTEM INITIAL SETUP

SYSTEM: (Press plus+ and minus- keys together).

1 ADVANCED SETUP MENU YES for visual identification only.

2 MORNING BOOST MINUTES {1:00}
The boost period begins at moment the time clock switches from night to day. Use a 60 minute boost for an 8 hour setback, or a 30 minute boost for a 4 hr. setback period. You can quickly reset from the boost state to day by setting the boost time value to zero.

3 WATER ABSOLUTE MINIMUM TEMP. {140}
Flue gases may condense and cause a boiler to sweat under certain conditions. The condensate may appear on fire tubes, cast iron sections, or the burner itself, etc. Consult the boiler mfg. to determine if a particular model boiler requires a minimum temperature setting to protect it from corrosion. A minimum temperature setting of 130° F will reduce boiler condensation, but may cause the building to overheat in warm weather. It may be necessary to install a piping system which includes a mixing valve to blend supply and return water.

4 BOILER AUTO ROTATION { -- }
YES will allow the LEAD STAGE to advance each morning at the beginning of the boost period. Once the application type is preset (on/off, lo/hi, full modulation) the software will correctly perform the auto or manual

rotation sequence. Boiler rotation occurs once a day at the beginning of the morning boost or startup period. If no night setback is desired, then the night setback amount should be set to zero, and the boost time to 5 minutes. **An on/off schedule must be in effect at least once during the week in order to perform the rotation.**

5 BOILER "ON" DELAY { :10 to 5:00 }

This value represents the minimum time delay between activation of sequential boilers; and once set does not vary. For atmospheric burners a setting of
{ :10 to 2:00 } or 10 seconds to 2 minutes is a reasonable minimum time delay. **Set this delay to at least {1:30} or 90 seconds for power burners, allowing for the ignition cycle.** In certain cases, if this delay is too short, a modulating burner may go into "lock out". The boiler "on" delay also serves the purpose of suspending the PID sampling of boiler water temperature prior to actual heat output from the boiler.

The software knows not to apply the "on" time delay if the next stage being activated (even stages 2, 4, 6, etc.) is either a hi fire, or a burner modulation call. In either case, the water temperature will start to rise immediately, and the PID sampling rate measurements described below will determine the variable portion of the total boiler sequential delay. *To achieve fast response during a boiler system test, set this delay to {0:10}.*

6 PID (interstage delay) SAMPLE RATE {1:00 to 5:00}

The PID sample shown in minutes and seconds, when multiplied by an integer number between 1 and 8, determines the variable portion of the total time between boiler stage activation's. The total delay between boiler stage activation's will be equal to the sum of the fixed boiler "on" delay (no. 5 above), and the variable portion described here. The maximum variable delay (8 sample periods) occurs when the boiler water temperature rises a sufficient amount after each sample period. Boilers will be shed or turned off after only a single PID sample rate delay.

Example Case 1: Suppose that the control setup is for a sample rate of 1 minute, a boiler "on" delay of 2 minutes, and <u>on/off sequencing</u> (*not* lo/hi fire or modulation). If the boiler water temperature were to suddenly fall a large amount, or the setpoint were to suddenly rise a large amount, the control will call for an additional boiler every 3 minutes; that is, the sum of the 2 minute fixed delay, and the 1 minute sampling rate delay. *Example case 2*: If we change the control setup to lo/hi fire, or modulation, the even numbered stages or "modulation" stages would be delayed 3 minutes (the fixed time delay + 1 sample period), while the odd numbered stages "boiler calls" would be delayed only 1 minute (one sample period).

Example case 3: *extending the variable portion of the time delay to maximize fuel efficiency.* At the end of the sampling period (1 minute in this case), <u>if the software determines that there has been a sufficient increase in water temperature</u>, the next sequential stage activation will be delayed for an additional delay period. So long as the water temperature shows sufficient temperature rise after each sample period, the delays will continue for up to 8 total sample periods. *This process keeps the number of boilers in use to a minimum*.

7 BURNER MODULATION RATE {slow/med/fast}

This setpoint has no effect unless the rotation sequence is set to {MODU}. In the {MODU} mode, Slow/Med /Fast select the amount of actuator movement during each sample period (see 6 above) , either 7%, 13%, or 20%. In other words, the actuator will move from full closed to full open in either 15 (Slow), 8 (Med), or 5 (Fast) sample periods. Start with a slow setting and increase if the water temperature does not "catch up" with the setpoint.

8 STAGE ROTATION SEQUENCE { on/off, lhl, modu-- }

Set this for the type of boiler application, on/off, lo/hi firing, or full burner modulation. *This setting is critical in order for auto rotation, PID control, and burner modulation to operate properly.*

9 # STAGES READY IN SYSTEM { 4 to 12 }

Set to the total number of operational boilers in the system.

A # STAGES IN USE NOW {0 to 2 stages less than item 9 above}

Set to some number less than the total number of operational boilers in the system if you would like one or more boilers to operate on standby. The standby boilers will automatically come on line only in the event of a boiler

failure. *Set this number equal to the* # STAGES READY IN SYSTEM *if you do not desire to maintain delayed standby boilers.*

B LAST BOILER HOLD FOR BACKUP {60:00}

This is the wait period before turning on a standby boiler. If the last boiler to turn on is unable to maintain the computed setpoint, and the number of stages presently in use are less than the number of stages ready in the system, then the next standby boiler or boiler stage will be activated.

C PID SETPOINT CORRECTION {off, slow, fast}

Activates the return to true setpoint feature of the CB200. The interstage lag differential lowers the actual boiler water temperature by lowering the temperature setpoint each time a new stage turns on. This creates the most stable control plan, but results in a setpoint that is lower than that the programmed value by [(n-1) x (lag differential)] where n is the number of stages in operation. In the slow mode, the setpoint will be increased by .5^{o} F. after 6 sample periods; or in the fast mode, the setpoint will be increased .5^{o} F. after only 2 sample periods the RUN menu screen no. 4 displays the running sum of the new "setpoint" after the integration. The PID effective setpoint will always remain less than computed setpoint plus [(n-1) x (lag differential)]. Begin with the slow integration rate, and if after 2 hours of monitoring the water temperature there is still more than a 4 degree difference between the average of the *actual water temperature* shown in the READ menu screen 1, and the *computed water setpoint* shown in the RUN menu screen 4, then increase the rate to fast.
A second method of compensating for setpoint error due to interstage lag is to try setting a low number for the interstage lag differential (1 or 2 degrees instead of the usual 4), and a longer PID interstage sampling rate. Unless you are operating 4 or more stages, there will be little need for the PID slow reset feature.

D CONTROL / UNIT PASS CODE {3 2 1}

Any number between 000 and 999 may be set. When dialing into the heat control over a modem, enter "P" followed by this number to gain access. DO NOT change this number through the modem or you will lose communication.

-- Model CB200 -E2, -E3, -E4
SP1i - software --- Steam Pressure Control
-- Full Modulating Burners --

The **CB200 E** series multi-stage boiler controls are used for small, medium and large cast iron and steel boilers requiring (1) on/off and lo/hi/lo contact closure, (2) a Honeywell™ series 90 135 ohm resistance output, or (3) a 4-20 ma. output. The CB200 can operate up to 4 full modulating or lo/hi/lo steam boilers, or 8 on/off boilers. PI or proportional integral, control provides unmatched energy efficiency.

GENERAL INFORMATION:
The R&D Electronics Model CB200 consists of a main panel, a steam pressure sensor, and an outdoor sensor. The main panel has 16 LED's which indicate all important ON/OFF operating conditions, including heat call, sensor faults, and outdoor override. A simple 3 position slide switch labeled SET, READ, and RUN controls the 32 character LCD display menus. The SET menu contains normally used operator adjustments. The READ menu displays outdoor temperature and steam pressure. The RUN menu displays P & I modulation levels, operating states, and 30 minutes of steam pressure history.

The operator sets the desired steam pressure setpoint, the boiler on/off differential range, boiler interstage lag, proportional start up percent, integral lead, integration rate, outdoor override, and the lead boiler. The Outdoor Override setting (typically 55^{o} F.) programs the warm weather shutdown, which will turn off the boilers and an "aux" relay which could be used to control a boiler room air damper. Sensor LED indicators turn ON if an outdoor sensor fault is detected, or when the 4-20 ma pressure sensor is reading zero pressure. Timer "A" schedules the auto boiler rotation. See Timer "A" programming in a later section of the manual.

Pressure and outdoor sensor fault LED's indicate when there is a sensor failure. ***It is normal for the pressure sensor LED to be ON until there is actual steam pressure.*** To test boiler operation during warm weather, set the outdoor sensor mini rocker switch to "disable" or increase the outdoor override setpoint.

PROPORTIONAL INTEGRAL "PI"CONTROL:
The lead boiler is called when steam pressure falls below the operator setpoint. The lead boiler will start at a modulation level determined by the *proportional startup* setting. The burner actuator moves towards full open as the boiler pressure decreases. If the *proportional startup* were set to 0%, the actuator will reach full open as pressure decreases by an amount equal to the on/off differential. The *proportional startup* is typically set between 0% and 50% of the on/off differential.

The actuator is also driven by an integral output. If the steam pressure is below the boiler "turn on point", the summed integral output is incremented at a rate determined by the *valve integral rate* (minimum time required to drive the actuator from closed to full open position). The higher the *valve integral rate*, the more the valve position will be effected by the integral settings. The *valve integral lead* determines the integral output equilibrium point. If the steam pressure is below this point, the actuator moves towards open, if the steam pressure is above this point, the actuator moves towards closed. The *valve integral lead* is typically set between 0% and 50% of the on/off differential. It is necessary to experiment to determine the best relationship between "P" and "I" values.

If steam pressure rises beyond the on/off differential, the lead boiler will turn off. On the other hand if steam pressure falls below the operator setpoint by an amount equal to the interstage lag differential, an additional boiler is called. Additional boilers are called each time the steam pressure decreases by the amount of the interstage lag differential. Proportional output resets to *proportional startup* value and the integral output resets to zero anytime boilers are added or removed. Boilers modulate in tandem, at the same modulation level.

OPERATOR ADJUST – SET MENU

Place OPERATOR switch in SET. Press VIEW NEXT key. Press + or - to change values.

			TYPICAL SETTINGS:
1	STEAM SETPOINT	(PSI)	{3.0 to 10.0}

Set to the desired steam pressure within the range of 1 to 12 lbs. The pressure transducer range maximum is 0 to15 lbs.

2	BOILER ON/OFF DIFF.	(PSI)	{1.2}

This parameter has two functions. First it represents the difference in steam pressure from boiler "turn on" to "turn off" pressure. Secondly, as steam pressure drops below the "turn on" point by the amount of the on/off differential, the proportional part of the modulation signal sent to the burner actuator increases from 0% to 100%. A lower differential than 1.2will increase actuator instability and decrease actuator movement resolution.

3	INTERSTAGE LAG DIFF.	(PSI)	{.6}

If steam pressure were to decrease below the operator setpoint by the amount of the lag differential, a second boiler is called. Additional boilers are called each time the steam pressure decreases the amount of the lag differential. The overall pressure setpoint decreases each time an additional boiler is activated. Increasing the lag differential will increase the accumulated setpoint error, but reduces the frequency of unnecessary boiler operations.

4	PROPORTIONAL START	(%)	{20%}

A higher *proportional startup* will accelerate the opening of the burner actuator as the steam pressure decreases. Setting this value to 50% results in a proportional output equat to 100% while the steam pressure has decreased only 1/2 the amount of the on/off differential.

5	VALVE INTEGRAL LEAD	(PSI)	{ 0 to (1/2) of (on/off diff.)}

When the steam pressure is above the operator setting + this value, integration results in a gradual closing of the valve. When steam pressure is below this reference, integration causes in a gradual opening of the valve.

6	VALVE INTEGRAL RATE	(minutes: seconds)	{0:00)

The valve position is determined by the sum of the proportional plus integral outputs. The higher the integration rate, the more the final position of the valve will be boosted by the integration output as opposed to perhaps a

slower proportional output only. This value is only an estimate of the time it will take for the motor to drive the actuator from full closed to full open and varies depending upon the actual motor speed.

7 OUTDOOR CUTOFF (Warm Weather Shutdown) {55}

8 SELECT LEAD BOILER {1, 3, 5, 7}

At the moment that Timer "A" switches from OFF to ON, the lead stage will be increment by 2. Run screen 2 displays an "A" for stage 1 and an "H" for stage 8. Only odd numbered entries are accepted by the software. Auto rotation looks like: [1-2, 3-4, 5-6]: [3-4, 5-6, 1-2]: [5-6, 1-2, 3-4].

OPERATOR MONITORING - RUN MENU

Menu 1 - burner modulation P+I output where 0 is lo fire and 100% is actuator full open; Menu 2 - valve integral or I output only; Menu 3 - output relays and auto rotation timer schedule, [character X] indicates combustion air damper open, [characters ABCDEFGH] represent boiler stages calling for heat, Timer ON signifies for pre-rotation period, Timer OFF represents rotation complete; Menu 4 - Steam pressure data logging.

CONTRACTOR SETUP:

(Press plus+ and minus- keys together)

1 BOILER AUTO ROTATION {YES}

YES enables the LEAD STAGE to advance each time Timer "A" changes from off to on state. Normally the timer is programmed to do this early in the morning. The On period can be any length, for example 5 minutes. **Set the timer ON schedule for 4:00AM and the OFF schedule for 4:05AM. Select either a daily or weekly program.** To observe how auto rotation works, you may press the long narrow manual override switch located on the Timer "A". The call LED's will turn on in the newly rotated order. Refer to Timer programming procedure located on the chassis door.

2 BOILER "ON" TIME DELAY { 00:01 to 00:30 }

Set to {0:10}or 10 seconds unless it is necessary to slow boiler reaction time. Increasing the delay will reduce unnecessary boiler operations, but slow the system response to load changes. *To test the boiler system and activate all boilers quickly, set the delay to one second.*

3. # STAGES READY IN SYSTEM { 2 to 8 }

Set to 2X the total number of operational boilers in the system. Data entry is restricted to even numbers. Each boiler is considered as 2 stages; (1) hi fire activation and (2) burner modulation from hi to lo fire as steam pressure increases.

4. # STAGES IN USE NOW {0 to 2 stages less than item 9 above}Set to less than the total number of operational boilers in the system if you would like one or more boilers to operate on standby only. The standby boilers will automatically come on line only in the event of a failure of the preceding boiler in the sequence. *Set this number equal to the* # STAGES READY IN SYSTEM *if you do not desire to maintain time delayed standby boilers.*

5. LAST BOILER HOLD FOR BACKUP Minutes {60:00}

Represents the wait period before turning on a standby boiler. If the number of boilers running is unable to maintain the computed setpoint, and the number of stages presently in use are less than the number of stages ready in the system, then the next standby boiler will be activated after this delay period.

6. CONTROL / UNIT PASS CODE {3 2 1}

Any number between 000 and 999 may be set. When dialing into the heat control over a modem, enter "P" followed by this number to gain access. DO NOT change this number through the modem or you will lose communication.

-- Model CB200 -G4 and -G8 --
-- SP2a - software --- Steam Pressure Control --
-- On/Off - Lo/Hi/Lo Multiple Boilers --

The **CB200 G** series multi-stage boiler controls are used for small, medium and large cast iron and steel boilers requiring on/off and lo/hi/lo contact closure, PI or proportional integral, control provides unmatched energy efficiency.

GENERAL INFORMATION:
The R&D Electronics Model CB200 consists of a main panel, a steam pressure sensor, and an outdoor sensor. The main panel has 16 LED's which indicate all important ON/OFF operating conditions, including heat call, sensor faults, and outdoor override. A simple 3 position slide switch labeled SET, READ, and RUN controls the 32 character LCD display menus. The SET menu contains normally used operator adjustments. The READ menu displays outdoor temperature and steam pressure. The RUN menu displays calculated pressure setpoint, operating states, and 30 minutes of steam pressure history.

The operator sets the desired steam pressure setpoint, the boiler on/off differential range, boiler interstage lag, lo fire lead differential (lo fire setpoint), outdoor override, and the lead boiler. The Outdoor Override setting (typically 55^{o} F.) programs the warm weather shutdown, which will turn off all the boilers and an "aux" relay which could be used to control a boiler room air damper. Sensor LED indicators are ON if an outdoor sensor fault is detected or when the pressure sensor reading is zero. Timer "A" schedules when boiler auto rotation takes place. See Timer "A" programming in a later section instructions.

Pressure and outdoor sensor fault LED's indicate when there is a sensor failure. ***It is normal for the pressure sensor fault LED to be ON until there is actual steam pressure.*** To test boiler operation during warm weather, set the outdoor sensor mini rocker switch to "disable" or increase the outdoor override setpoint.

BOILER SEQUENCING LOGIC

Resulting relay states as pressure decreases and then increases.

ON/OFF applications:

Boiler (1) call occurs when steam pressure *decrease*s to: [ry-1 closed ; ry-2 open]
(operator setpoint).
Boiler (2) call occurs when steam pressure *decreases* to: [ry-1 closed ; ry-2 closed]
(operator setpoint) – (lag differential).
Boiler (2) turn off occurs when steam pressure *increases* to: [ry-1 closed ; ry-2 open]
(operator setpoint) – (lag differential) + (on/off differential)
Boiler (1) turn off occurs steam pressure *increases* to: [ry-1 open ; ry-2 open]
(operator setpoint) + (on/off differential).

LO/HI/LO applications:

Boiler (1) hi fire call occurs when steam pressure falls below:
(operator setpoint).
[ry-1 closed; ry-2 open]
Boiler (1) lo fire call occurs when steam pressure *increases* to:
(operator setpoint) + (lead differential).
[ry-1 closed; ry-2 closed]
Boiler (1-2) hi fire occurs when steam pressure *decreases* to:
(operator setpoint) – (lag differential).
[ry-1 closed; ry-2 open] [ry-3 closed; ry-4 open]
Boiler (1-2) lo fire occurs when steam pressure *increases* to:
(operator setpoint) - (lag differential) + (lead differential).
[ry-1 closed; ry-2 closed] [ry-3 closed; ry-4 closed]
Boiler (1) hi fire occurs when steam pressure *increases* to:
(operator setpoint) - (lag differential) + (on/off differential).
[ry-1 closed; ry-2 open] [ry-3 open; ry-4 open]
Boiler (1) lo fire occurs when steam pressure *increases* to:
(operator setpoint) + (lead differential).

[ry-1 closed; ry-2 closed]
Boiler (1) turn off occurs when steam pressure *increases* to:
(operator setpoint) + (on/off differential).
[ry-1 open; ry-2 open]

OPERATOR ADJUST – SET MENU

Place OPERATOR switch in SET. Press VIEW NEXT key. Press + or - to change values.

TYPICAL SETTINGS:

1 STEAM SETPOINT (PSI) {3.0 to 10.0}

Set to the desired steam pressure within the range of 1 to 12 lbs. The pressure transducer range maximum is 0 to15 lbs.

2 BOILER ON/OFF DIFF. (PSI) {1.2}

Represents the difference in steam pressure from a boiler "turn on" to a boiler "turn off". As the steam pressure increases or decreases by more than the on/off differential, the number of boilers in operation will increase or decrease. A higher on/off differential setting will result in fewer changes in the number of boilers in operation (as the steam load changes). Setting the differential lower will maintain a tighter control over pressure. Therefore, choosing an on/off differential setting is *a tradeoff between attempting to maintain a constant number of boilers in operation or a more steady steam pressure*. In most cases a 1 or 2 lbs. variation in steam pressure has no significant effect upon heat distribution.

3 INTERSTAGE LAG DIFF. (PSI) {.6}

If steam pressure were to decrease below the boiler stage setpoint (which changes with the number of boilers in operation) by the amount of the lag differential, the next boiler will turn on, and all boilers in operation will revert to hi fire. Additional boilers are called each time the steam pressure decreases the amount of the lag differential, resulting in lower steam pressure setpoints as more boilers turn on. Therefore, choosing an interstage differential is again a tradeoff, but this time between attempting to maintain a constant number of boilers in operation or allowing the steam pressure setpoint to decrease each time an additional boiler is required.

4 LO FIRE LEAD DIFFERENTIAL (PSI) {.6}

Typically set to ½ the on/off differential. If steam pressure increases the amount of the lo fire lead differential, all even numbered lo fire output relays close, activating lo fire for all boilers currently in operation. As a result the net BTU firing rate decreased. The "lo fire ***lead*** differential" setting is a complement to the familiar term "interstage ***lag*** differential" which determined the steam pressure setpoint below which the net BTU firing rate increased.

5 OUTDOOR CUTOFF (Warm Weather Shutdown) {55}

6 SELECT LEAD BOILER {1, 2, 3, 4} lo/hi {1, 3, 5, 7} on/off

At the moment that Timer "A" switches from OFF to ON, the lead stage will increment.
Note: Run screen 2 displays an "A" for stage 1 and an "H" for stage-8. When control is set for lo/hi/lo applications, only odd numbered entries are accepted by the software.
Auto rotation looks like: [1-2, 3-4, 5-6]: [3-4, 5-6, 1-2]: [5-6, 1-2, 3-4] for lo/hi applications.

OPERATOR MONITORING – READ MENU

Place the OPERATOR slide switch in READ. Press the VIEW NEXT. The READ menu will display the present steam pressure and the outdoor air temperature

OPERATOR MONITORING - RUN MENU

Menu 1 – Pressure setpoint below which *starts* the next boiler; Menu 2 – Pressure setpoint above which either *starts* lo fire or *stops* "last stage on" stage; Menu 3 - output relays and auto rotation timer schedule, [character X] indicates combustion air damper open, [characters ABCDEFGH] represent boiler stages calling for heat, Timer ON signifies pre-rotation period, Timer OFF represents rotation complete; Menu 4 - Steam pressure data logging

CONTRACTOR SETUP:

(Press plus+ and minus- keys together)

1 BOILER AUTO ROTATION {YES}

YES enables the LEAD STAGE to advance each time Timer "A" changes from off to on state. Normally the timer is programmed to do this early in the morning. The On period can be any length, for example 5 minutes. **Set the timer ON schedule for 4:00AM and the OFF schedule for 4:05AM. Select either a daily or weekly program.** To observe how auto rotation works, you may press the long narrow manual override switch located on the Timer "A". The call LED's will turn on in the newly rotated order. Refer to Timer programming procedure located on the chassis door.

2 STAGE ROTATION SEQUENCE {ON/OFF or LO/HI/LO}

Application function setup for operating multiple on/off or multiple lo/hi/lo boilers.

3 BOILER "ON" TIME DELAY { 00:01 to 00:30 }

Set to {0:10}or 10 seconds unless it is necessary to slow boiler reaction time. Increasing the delay will reduce unnecessary boiler operations, but decrease system response time to load changes. *To test the boiler system and activate all boilers quickly, set the delay to one second.*

4. # STAGES READY IN SYSTEM { 2 to 8 }

Set to 2 times the total number of operational boilers in the system. Data entry is restricted to even numbers. Each boiler is considered as 2 stages; (1) hi fire activation and (2) burner modulation from hi to lo fire as steam pressure increases.

5. # STAGES IN USE NOW {0 to 2 stages less than item 9 above}Set to less than the total number of operational boilers in the system if you would like one or more boilers to operate on standby only. The standby boilers will automatically come on line only in the event of a failure of the preceding boiler in the sequence. *Set this number equal to the* # STAGES READY IN SYSTEM *if you do not desire to maintain time delayed standby boilers.*

6. LAST BOILER HOLD FOR BACKUP {60:00}

Represents the wait period before turning on a standby boiler. If the number of boilers running is unable to maintain the computed setpoint, and the number of stages presently in use are less than the number of stages ready in the system, then the next standby boiler will be activated after this delay period.

7. CONTROL / UNIT PASS CODE {321}

Any number between 000 and 999 may be set. When dialing into the heat control over a modem, enter "P" followed by this number to gain access. DO NOT change this number through the modem or you will lose communication.