

# Power Flame Incorporated



## **SUGGESTED SPECIFICATION FOR MODEL C<sub>MAX</sub> COMBINATION GAS/LIGHT OIL BURNERS**

### ***THE POWER TO MANAGE ENERGY***

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**Suggested Specifications for Model CMAX  
Combination Gas/Light Oil Burners**

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**Suggested Specifications for Model C<sub>MAX</sub>  
Combination Gas/Light Oil Burners**

**General Requirements**

1. Furnish and install \_\_\_\_\_ Underwriters Labeled combination gas/light oil burners. The burner design, construction, components and installation shall meet all applicable code requirements.
2. (Spec writer - omit the following boiler conversion installation descriptions if new boilers are being installed and are described in another section of the specification. If the following descriptions are used - select the most appropriate).
  - a. The new burner system shall be installed in (Scotch Marine), (Water Tube), (Other) \_\_\_\_\_ type boiler(s). The boiler model number is \_\_\_\_\_ manufactured by \_\_\_\_\_.
  - b. The burner shall be mounted to fire on the centerline of the boiler furnace. (The existing steel front plate will be adapted to fit the new burner). (A new \_\_\_\_\_ inch steel boiler/burner mounting plate will be supplied). A new refractory front plate shaped and installed in accordance with the burner manufacturer's instructions will be provided.

**General Burner Description**

1. The burner shall be Power Flame forced draft flame retention model \_\_\_\_\_. Each burner shall be capable of burning \_\_\_\_\_ CFH of \_\_\_\_\_ BTU/Cu. Ft. (natural) (propane) (other)\_\_\_\_\_ gas, with a specific gravity of \_\_\_\_\_. Gas pressure applied to the burner gas train supply connection shall be a minimum of \_\_\_\_\_ (in. w.c.) (PSIG) at full high rate and a maximum of \_\_\_\_\_ (in. w.c.) (PSIG) at static conditions. Each burner shall be capable of burning \_\_\_\_\_ GPH of (No. 1, 2 fuel oil) (kerosene) (diesel) or \_\_\_\_\_ fuels with a rating of \_\_\_\_\_ BTU/GAL.

**Approval Codes**

1. Each burner shall be listed by Underwriters Laboratories and shall bear the appropriate U.L. label (in addition to the U.L. requirements, all equipment and installation procedures will meet the requirements of (IRI) (FM) (ASME CSD-1) (other)\_\_\_\_\_ codes). Each burner shall be designed and constructed as an integrated combustion system package and shall be factory fire tested. Supply a three dimensional AutoCAD drawing of the burner to assure proper fit up to the boiler or heat exchanger

**Combustion Head Design**

1. Each burner shall be of welded steel construction and have a baked on powder coat finish. The combustion head shall incorporate a multi blade, stainless steel, flame retention diffuser. The gas firing head shall include a series of gas injection spuds that distribute the fuel evenly around the periphery of the diffuser assembly. A gas annulus shall provide a secondary layer of fuel to create a staging effect to achieve maximum fuel/air mixing and minimal emissions. Burners with cast alloy blower housings will not

be accepted. The burner combustion head will carry full five (5) year replacement warranty.

2. The design shall also include an adjustable sleeve for setting the secondary gas and varying the primary air/gas mix within the combustion zone. The burner combustion head components will be easily accessible through an access door located on the side of the burner blast tube. The burner combustion head components shall be easily adjusted or replaced, and the oil gun assembly maintained without having to disconnect fuel supply piping or electrical connections to the burner assembly.
3. All air required for combustion shall be supplied by a blower mounted integral to the burner. The blower wheel shall be of the backward inclined centrifugal design and shall be directly driven by a \_\_\_\_\_ HP 3450 RPM \_\_\_\_\_ volt, 60 Hertz \_\_\_\_\_ phase motor. A multiple blade damper assembly located on the inlet side of the blower wheel shall meter the combustion air flow.

### **Ignition System**

1. The burner ignition system, which will light either the main gas or oil flame, shall utilize (natural) (propane) gas as the fuel source. The gas pilot system components shall include spark ignited pilot assembly, 6000 Volt ignition transformer, pilot solenoid valve, pilot gas pressure regulator and manual gas shutoff cock. The flame proving system shall incorporate an Ultra-Violet flame detector, which will monitor both the pilot and main flames. The pilot assembly shall fit within the confines of the blast tube - avoiding special burner front plate pilot cut outs.

### **Fuel/Air Control System**

1. Modulation

The main On-Off gas supply shall be controlled by a motorized gas valve. The main On-Off oil supply shall be controlled by a solenoid oil valve. A modulating motor shall control the modulated positioning of the air inlet dampers, butterfly type gas proportioning valve and a metering type oil valve, to best meet varying system load conditions.

Provide a Cam actuated Characterized Fuel Metering device, which will be an integral part of the burner fuel metering system. The system shall be U.L. listed and capable of providing an adjustable and accurately repeatable fuel/air ratio throughout the burner's full firing range. The system shall be capable of providing a constant fuel/air ratio, or a linearly adjusted fuel/air ratio, in order to satisfy individual burner application requirements. Each system shall be complete with fourteen (14) separately adjustable cam development set-points. Each set-point shall be complete with locking set screw. The cam follower shall be equipped with a double spring set, in order to insure maximum reliability. All bearing points shall be provided with oil impregnated bronze bushings, requiring no field lubrication.

The positioning of the modulating motor shall be controlled by a 135 Ohm, or 4-20 milliamp, or 0-10 VDC, modulating type (temperature) (pressure) controller. When the operating control is satisfied the burner shall shutoff and return to the low fire start position. The modulating motor shall provide an electrical interlock to insure a guaranteed low fire start position prior to the pilot trial for ignition sequence.

## Gas Control Train

### 1. U.L. Requirements

The gas valve train shall contain the following:

- a. Manual Shutoff cock
- b. Main gas pressure regulator (Spec writer - Specify "tight shutoff type" if gas supply pressure exceeds 1 PSIG).
- c. Automatically operated main gas valve.
- d. Automatically operated main motorized gas valve with proof of closure interlock switch.
- e. Automatically operated auxiliary gas valve.
- f. Manual reset Low and High Gas Pressure.
- g. Manual leak test cock.
- h. Burner manifold gas pressure gauge and gauge cock.
- i. Automatically operated Normally Open Vent Valve (specify as standard above 12,500 MBH for fuel gases with a specific gravity of less than 1.0 - optional at 12,500 and below and/or specific gravities of 1.0 or above).

### 2. FM Requirements

- a. U.L. listed leak test cock.
- b. Automatically operated main motorized gas valve with proof of closure shall carry an FM label.
- c. Automatically operated auxiliary gas valve shall be motorized type, incorporate proof of closure feature and carry a FM label.
- d. Both automatically operated motorized gas valves shall be equipped with 13 second timing motorized operators.

(Spec writer - add for FM burners with input exceeding 12,500 MBH)

- e. Both automatically operated motorized gas valves shall incorporate the proof of closure feature.

### 3. IRI Requirements

(Spec writer - In addition to U.L. gas train requirements, add the following:)

- a. U.L. listed leak test cock.

- b. Both automatically operated gas valves (main and auxiliary) shall have motorized operators.
- c. Automatically operated main gas valve shall have proof of closure feature.
- d. One (1) normally open vent valve sized according to IRI requirements.
- e. Manual reset low and high gas pressure switches.

### **Oil Control Train**

#### 1. General Requirements

The oil train shall incorporate U.L. approved components as supplied by the burner manufacturer to provide specified Fuel/Air Control System operation capable of an 8:1 turndown.

- 2. Fuel flow to the air or steam atomizing nozzle shall be delivered by a single or two stage gear type pump capable of producing 100 PSIG discharge pressure and 15 in. hg. vacuum. It shall be a separate unit mounted on its own support base with direct drive motor. The unit shall be complete with suction line manual gate valve, removable mesh type oil strainer, 0-30" HG. 0-30 PSIG vacuum/pressure gauge with gauge dampening orifice, 0-100 PSIG oil nozzle pressure gauge with gauge dampening orifice and nozzle line solenoid safety shutoff oil valve.
- 3. Additional oil components shall be provided as follows:
  - a. Oil nozzle line auxiliary solenoid safety shutoff oil valve.
  - b. Low oil pressure switch, when remote burner pump is furnished
- 4. Burner mounted air or steam atomizing piping train shall consist of solenoid shutoff valve, low atomizing air or steam pressure switch and pressure gauge.
- 5. A separate \_\_\_\_\_H.P. piston type air compressor set with pressure indicating gauge shall be provided. Rotary vane air compressors will not be accepted.
- 6. Furnish and install (simplex) (duplex) oil circulating pump set(s) which will supply No. \_\_\_\_\_ fuel oil at \_\_\_\_\_ PSIG to inlet of the burner high pressure oil pump(s). The circulating pump shall have a minimum capacity of \_\_\_\_\_ GPH at a nominal discharge pressure of \_\_\_\_\_ PSIG. The pump set shall be completely factory pre-piped, wired and assembled. The oil pump shall be rotary gear type.

(Spec writer - add the following for FM:)

- 7. For burners up to and including 12,500 MBH use two (2) FM labeled valves, or one (1) valve with proof of closure and FM label.
- 8. For burners above 12,500 MBH, both valves shall have proof of closure and FM label.

### **Burner Operating Controls**

1. The On-Off operation of the burner shall be controlled by a (pressure) (temperature) control. System (pressure) (temperature) shall be \_\_\_\_\_ (PSIG) (Degrees F).
2. A safety manual reset type limit control shall be provided to shut the burner down in the event of excessive (pressure) (temperature).
3. Modulation. The position of the modulating motor and other fuel/air components shall be controlled by a 135 Ohm, or 4-20 milliamp, or 0-10 VDC, (pressure) (temperature) control in addition to the On-Off operating control.

### **Interlocks**

(Spec writer - select below as required)

1. For U.L. Modulation. The modulating motor shall be sequenced to allow for four (4) complete air changes of the combustion chamber and breaching, and through an integral end switch be electrically interlocked with the control burner circuit to insure the fuel/air linkage is in the low fire start position before burner ignition sequence can begin.
2. (If automatic outside fresh air intake louvers are specified). A fresh air louver end switch electrical interlock shall be provided in the burner operating circuit which will insure that the fresh air louvers are open before the burner can operate. Boiler room freeze protection circuit shall be provided to close the fresh air intake in the event of a flame failure.
3. (If induced draft fan has been specified). The induced draft fan operation will be electrically interlocked with the burner operating circuit to insure that the burner will not operate if the draft fan is not operating or if the draft is below a preset level.
4. (If automatic overfire draft equipment has been specified). The overfire draft system circuitry shall be interlocked with the burner circuitry to insure correct sequencing of all combustion system components.

### **Flame Safeguard Control**

1. U.L. Requirement  
(Spec writer - select below system as required)
  - a. The flame safeguard control system shall include Ultraviolet sensor for flame detection and provide fully automatic sequencing of pre-purge and post-purge, blower motor, interrupted ignition system, and fuel/air flow components. Burner shall purge with full open-air louver at not less than 60% of high fire airflow rate for a minimum of four (4) air changes and not less than 60 seconds. Flame safeguard shall provide safety shutdown with manual reset on air flow failure. The flame safeguard control shall be Honeywell model RM7840L or equal as manufactured by Fireye.
2. FM Requirements
  - a. FM flame safeguard requirements are the same as those imposed by U.L.

### 3. IRI Requirements

- a. (Spec writer - specify the following for modulating burners).

The flame safeguard control system shall include Ultraviolet sensor for flame detection and provide fully automatic sequencing of pre-purge and post-purge, blower motor, interrupted ignition system, and fuel/air flow components. The flame safeguard control shall be the Honeywell model RM7840L or equal as manufactured by Fireye.

#### **Control Panel – With Honeywell controls.**

1. (Spec writer - select 1. a, b or c as appropriate)

- a. Each burner shall be complete with an integral burner mounted control panel, which shall house all required operating electrical components. All flame safeguard wiring within the combustion control system shall be factory pre-wired utilizing a UL listed preprinted main circuit board. All optional controls will be wired to a din rail mounted terminal strip within the control panel. The main Honeywell flame safeguard control will plug into the main circuit board and provide minimal wiring within the control panel. The main circuit board will connect to the light and switch circuit board on the top of the control panel with a plug in connector. The light and switch circuit board will have a laminated indication label for each function on the light and switch circuit board.

The light and switch circuit board will included On-off power switch, ultra bright LED indication lights for “Power On”, load “Demand”, “Main Fuel”, Flame Safeguard “FSG Alarm” and “Low Water”, Fuel selector switch for Gas or Oil with ultra bright LED indication lights for fuel selected. Manual-Auto selector switch and manual potentiometer with ultra bright LED indication when in the manual mode.

- b. Each burner shall be complete with a remote control panel (wall mounted) (mounted on the side of the heat exchanger) which shall house all required operating electrical components. All flame safeguard wiring within the combustion control system shall be factory pre-wired utilizing a UL listed preprinted main circuit board. All optional controls will be wired to a din rail mounted terminal strip within the control panel. The main Honeywell flame safeguard control will plug into the main circuit board and provide minimal wiring within the control panel. The main circuit board will connect to the light and switch circuit board on the top or front of the control panel with plug in connector. The light and switch circuit board will have a laminated indication label for each function on the light and switch circuit board. A junction box pre-wired to the burner components shall be mounted on the burner. It shall have a din rail mounted terminal strip, which will match a terminal strip in the remote panel. Field wiring will be required between the burner mounted junction box and the remote control panel.
- c. Each burner shall be complete with a remote control panel to be free standing and floor mounted, which shall house all, required operating electrical components All flame safeguard wiring within the combustion control system shall be factory pre-wired utilizing a UL listed preprinted main circuit board. All optional controls will be wired to a din rail mounted terminal strip within the control panel. The main Honeywell flame safeguard control will plug into the main



circuit board and provide minimal wiring within the control panel. The main circuit board will connect to the light and switch circuit board on the top or front of the control panel with plug in connector. The light and switch circuit board will have a laminated indication label for each function on the light and switch circuit board. A junction box pre-wired to the burner components shall be mounted on the burner. It shall have a terminal strip, which will match a terminal strip in the remote panel. Field wiring will be required between the burner mounted junction box and the remote control panel. The design and construction of the panel will incorporate fabrication that will insure the necessary rigidity and support of a free standing unit. The control panel will mount on a single 48" high x 3" deep x 7 gauge steel single vertical support column. The support column shall be mounted on a 12" x 12" steel base. All joints shall be welded. Construction of the back side of the control panel will mechanically match the vertical support column to allow raising and lowering the panel height in 6" increments to best suit job height requirements.

2. Appropriate electrical knockouts shall be provided on both sides and bottom of the panel to allow for necessary power and limit control wiring. The control panel shall be constructed of 16 gauge steel and shall be complete with a top mounted switch and control section which shall be hinged to allow for full access to all panel mounted components. The control panel shall be painted in a color and finish identical to the burner being supplied.
3. The control panel shall include (if 208, 230 or 460 volts) a din rail mounted control circuit transformer with integral fuses on both the primary and secondary windings. Flame safeguard control as specified above. Din rail mounted motor starters, relays, terminal blocks and other electrical devices as required.

**(Spec writer: Select packaged light and alarm systems as needed)**

4. Optional lights and alarms indications: Additional ultra bright LED auxiliary light circuit boards nested in groups of 4, 6 or 8 lights on printed circuit boards will be mounted in the top indication section of the panel and include an engraved label indicating the function of each light. The following indication lights will be supplied along with necessary isolation circuits as required.
  - a. Auxiliary Light Circuit Board with **4** additional ultra bright LED's. "High Temperature" (R), "Low Gas Pressure" (R), "High Gas Pressure" (R), "Pilot Failure" (R) with alarm buzzer and alarm silencing switch.
  - b. Auxiliary Light Circuit Board with **6** additional ultra bright LED's. "High Temperature" (R), "Low Gas Pressure" (R), "High Gas Pressure" (R), "Pilot Failure" (R), "Ignition On"(A) "Air Flow Failure" (B), with alarm buzzer and alarm silencing switch.
  - c. Auxiliary Light Circuit Board with **8** additional ultra bright LED's. "High Temperature" (R), "Low Gas Pressure" (R), "High Gas Pressure" (R), "Pilot Failure" (R), "Ignition On"(A), "Air Flow Failure" (B), "Low Oil Pressure" (R), "High Limit" (R) with alarm buzzer and alarm silencing switch.

Additional auxiliary light circuit boards with ultra bright LED indications are available in-groups of 4, 6 or 8 lights specify desired light functions and isolation circuits as required.

## **Control Panels – With Fireye controls.**

1. (Spec writer - select 1. a, b or c as appropriate)
  - a. Each burner shall be complete with an integral burner mounted control panel, which shall house all required operating electrical components. All wiring within the combustion system shall be factory pre-wired to a din rail mounted terminal strip within the control panel. The flame safeguard control will connect to a light and switch circuit board on the top of the control panel with a plug in connector. The light and switch circuit board will have a laminated indication label for each function on the light and switch circuit board.

The light and switch circuit board will included On-off power switch, ultra bright LED indication lights for "Power On", load "Demand", "Main Fuel", Flame Safeguard "FSG Alarm" and "Low Water", Fuel selector switch for Gas or Oil with ultra bright LED indication lights for fuel selected. Manual-Auto selector switch and manual potentiometer with ultra bright LED indication when in the manual mode.
  - b. Each burner shall be complete with a remote control panel (wall mounted) (mounted on the side of the heat exchanger) which shall house all required operating electrical components. All wiring for remote panel electrical components will be factory pre-wired to a din rail mounted terminal strip within the control panel. The flame safeguard control will connect to a light and switch circuit board on the top or front of the control panel with plug in connector. The light and switch circuit board will have a laminated indication label for each function on the light and switch circuit board. A junction box pre-wired to the burner components shall be mounted on the burner. It shall have a terminal strip, which will match a terminal strip in the remote panel. Field wiring will be required between the burner-mounted junction box and the remote control panel.
  - c. Each burner shall be complete with a remote control panel to be free standing and floor mounted, which shall house all, required operating electrical components. All wiring for remote panel electrical components will be factory pre-wired to a din rail mounted terminal strip within the control panel. The flame safeguard control will connect to a light and switch circuit board on the top or front of the control panel with plug in connector. The light and switch circuit board will have a laminated indication label for each function on the light and switch circuit board. A junction box pre-wired to the burner components shall be mounted on the burner. It shall have a terminal strip, which will match a terminal strip in the remote panel. Field wiring will be required between the burner-mounted junction box and the remote control panel. The design and construction of the panel will incorporate fabrication that will insure the necessary rigidity and support of a freestanding unit. The control panel will mount on a single 48" high x 3" deep x 7 gauge steel single vertical support column. The support column shall be mounted on a 12" x 12" steel base. All joints shall be welded. Construction of the back side of the control panel will mechanically match the vertical support column to allow raising and lowering the panel height in 6" increments to best suit job height requirements.
2. Appropriate electrical knockouts shall be provided on both sides and bottom of the panel to allow for necessary power and limit control wiring. The control panel shall be constructed of 16 gauge steel and shall be complete with a top switch and control section which shall be hinged to allow for full access to all panel mounted components.

The control panel shall be painted in a color and finish identical to the burner being supplied.

3. The control panel shall include (if 208, 230 or 460 volts) a din rail mounted control circuit transformer with integral fuses on both the primary and secondary windings. Flame safeguard control as specified above, On-Off switch, Gas/Oil selector switch and din rail mounted motor starters, relays, terminal blocks and other electrical devices as required.

### **Burner Graphic Management System with integral annunciator status lights.**

1. The control panel shall be furnished with an eight- (8) color Burner Graphic Management System with integral annunciator status lights. The system shall allow the operator a view of the operational status of the burner on a lighted graphic display. The Graphic shall be mounted on the control panel door with a quick disconnect device to enable the operator to disconnect the system or remove the access door while maintaining the annunciator in full operation. The following points shall be annunciated on the Graphic Display:
  - a. Modulation
    1. Power On - Green
    2. Limit Circuit Closed - Green
    3. Modulation Mode - Green
    4. Main Gas - Blue
    5. Main Oil - Amber
    7. Flame Failure - Red
    8. Low Water Cutoff - Red

The Burner Graphic Management System shall be the "Director<sup>®</sup>" as manufactured by Power Flame, Inc.

2. (Spec writer - the following are control panel options which can be added to the basic annunciation features listed in 1. a above):
  - a. The control panel shall also include an Alarm Buzzer (required for IRI) with automatic reset silencing switch. The buzzer shall activate on Flame Failure or Low Water condition.
  - b. For First-Out Annunciation include the following:

The Burner Graphic Management System shall include a pre-programmed controller, which shall annunciate all boiler failures on an first-out basis. The operation of the annunciator shall be as follows:

1. The first failure of any annunciated device in the burner/boiler system shall cause the associated indicating lamp to flash at a rate of 2.5 times per second, and the alarm buzzer shall sound until the alarm has been cleared and the annunciator reset.
2. Any subsequent failure(s) of annunciated devices in the burner/boiler system shall cause the associated indicating lamp to flash at a rate of 1 time per second, and the alarm buzzer shall sound until all alarm conditions are cleared and the annunciator is reset.

3. The programmed controller shall log all occurrences of any annunciated device, and shall keep a running total of all occurrences of each failed device. In addition the annunciator will store in an history table of last 50 individual failures the system has logged. The system will also store burner operation elapsed hours and lockout elapsed hours.
4. Depressing the reset button of the annunciator for 5 seconds will cause the programmed controller to energize all annunciation system lights and ring the alarm buzzer for 0.5 seconds.
5. An optional display panel can be attached to the front of the programmed controller for service and trouble shooting purposes to check failure history data.
6. In addition to the annunciation features detailed above for the Burner Graphic Management System, first out annunciation shall include the following annunciated points:
  - low water
  - low, low (or high) water
  - high limit
  - low gas and/or oil pressure
  - high gas pressure
  - low combustion air pressure
  - flame failure lamp will indicate the following:
    - flashing 2.5 times per second - pilot flame failure
    - flashing 1.0 times per second - main flame failure
    - flashing sporadically - main flame ignition failure

### **Lead/Lag Boiler Control System**

Introduction for Specification Writer: This guide specification is for a microprocessor based lead-lag-sequencing controller. This controller is generally employed for fire tube steam or hot water boiler applications where multiple boilers are in service, each with their own steam pressure or temperature controls and not under control of a *master* pressure or temperature controller. Plant energy demand is satisfied by the start up and operation of any single boiler to maintain required pressure set point or temperature, followed by the start up and operation of additional boiler(s) as additional energy is required. As the energy demand decreases, boilers are taken off-line in the reverse order sequence from which they were placed on-line.

### **Guide Specification**

#### **Part 1- Hardware and Control Capability Specifications**

The lead lag-sequencing controller shall be microprocessor based menu driven site tunable unit that is preprogrammed for the specific functions delineated. The unit shall have a two-line Vacuum Fluorescent display with 20 alphanumeric characters per line. This display shall show all input variables, set points, status, alarm messages and prompts for on/off and timers. Operator interface shall be through a front panel alphanumeric keypad with 20 tactile-feedback buttons for entering configuration parameters and for scrolling between display screens. The controller shall exhibit sequential logic as well as proportional and integral loop control capable of full modulating control as specified. CPU failure with auto boiler failure skip and manual transfer capability for modulating control shall be standard.

As a minimum the controller shall have 22K RAM or 52K EPROM with a 0.5 ms/K scan time and

CMOS RAM with battery back up. The unit shall have as a minimum 11 optically isolated inputs including transmitted or digital inputs, with expansion if the application should require it. Modulating outputs signals to the final elements shall be 135 ohm or 4-20 ma. On off and digital outputs shall be through isolation relays.

The process variable shall be continuously displayed by a 1/32<sup>nd</sup> din Digital Indicator mounted on the panel.

Two communications ports shall be available if required as RS-232 or RS-485 with the capability of remote initiation by a building management system.

The controller shall also have the optional capability of sequencing pumps, positioning combustion make-up air louvers, outside air temperature reset, firing rate indication, assured low fire shut down and warm up and night set back/weekend skip. For full modulating control, separate modulating M/A stations shall be available.

(Optional) The sequencer shall be supplied in a wall/surface mounting steel cabinet with the approximate dimensions of 16" H X 16" W X 6 1/2" D (24"X24"X10" for 5810 and depends on options selected). This cabinet shall contain all input and output interface devices, relays, alarm horn (5810, if specified), boiler on-off lights and Auto-Off-Manual switches for each (all) boiler(s).

An Open Mount (5830-\*O-OM) version comprising a panel-mounted faceplate connected via a flexible wiring harness (up to 5ft in length) to a remote mounted electronics sub assembly board shall be available.

## **Part 2- Specifications for Lead Lag and Sequencing Control**

Select <text 1> or <text 2> and add to final specification.

1. Provide panel mounted lead/lag sequencer with features per Paragraph \_\_\_\_ to operate \_\_\_\_ [insert quantity] <steam><hot water> boilers.
2. Boilers are to be taken from cold stand-by to low fire condition <manually><by the control system>. Boilers are to be taken from low to high fire by <the control system><each boilers existing control system>. Boilers are to be shut down <manually><by the control system>.
3. Auto-Off-Manual switches, boiler status (on) lights and boiler fail lights shall be provided for each boiler. Alarm horn optional (5810 only).
4. The Auto-Off-Manual feature shall provide boiler skip during sequence if switch is in the off position.
5. As the process <pressure><temperature> varies from set point, the controls shall enable additional boilers to be used to satisfy the load/demand, or remove boilers as the load decreases. The sequence for the boilers to come on or off line shall be selectable. An adjustable time delay (0 to 50 minutes) shall be utilized and compared to the process variable before bringing another boiler on or off line.
6. On/Off sequencing shall control the plant master <steam pressure><temperature> set point.

7. Specification Writer Select One (Optional); 7.a or 7.b.
  - 7.a. Supply a gauge pressure transmitter for the plant header steam line with 4-20ma input to the controller. Pressure transmitter shall be 4-wire type or be furnished with a 24 V loop power supply. It shall sense the steam pressure directly with a capsule that is inside the transmitter enclosure. The Pressure set point range shall be \_\_\_ to \_\_\_ psig.
  - 7.b. Supply a temperature transmitter to sense the supply water temperature with 4-20 ma input to the controller. The temperature sensor shall be 100 ohms Platinum RTD with 4.5-inch insertion length in a SS thermo well. Temperature set point range shall be \_\_\_ to \_\_\_ deg F.
8. The controller Vacuum Fluorescent panel shall display all inputs, set points and operating parameters.
9. Sequencer shall have retentive memory in case of power failure and shall recall the last operating sequence and number of boilers in service when power is restored.
10. Auto Lead Boiler Changeover shall be front panel programmable for either of the following, accumulated lead boiler run hours, day/hour changeover time.
11. Sequencer shall have the ability to accept universal types/ranges of process transmitters and be configurable from the front keypad.
12. Sequencer must have Master Set Point Tracking of all cut in/out points and modulation parameters.

**Part 3- Options For Specification (Select and Add to Final Specification)**

- a. Provide full modulating control of each boiler with signals to match the actuators supplied for each boiler (135ohm standard or 4/20ma optional).
- b. For full modulating control, provide auxiliary automatic/manual modulating control stations that provide both automatic and manual control of each boiler-firing rate that will operate in case of lead/lag sequencer control failure. Provide one per boiler on the front of the panel. The controller shall have a LED display of boiler firing rate actuator position and control capability of ratio, dead band and proportional action. Transfer from the sequencing controls to the auto/manual controls shall be automatic in the event of CPU failure or faults.
- c. Provide outside air temperature reset control action. Include a temperature transmitter with 4-20 ma signal to the controller. The controller will reset the set points based on the variations in the outside air temperature. The outside air temperature sensor shall be 100 ohms Platinum RTD, equipped with a stainless steel weather/sun shield. A dedicated 24 VDC loop power supply shall be furnished in the cabinet for the transmitter.
- d. Provide automatic sequencing upon boiler failure that shall enable another boiler to be brought into sequence in the event of flame failure of an on-line boiler.
- e. Provide set point scheduling of all, on and off set points at a selectable time of day/week/month to implement night set back and weekend skip.
- f. Provide output from the controller to enable hot water circulating pumps to be staged with the sequence of the boiler. Pumps are to remain on for a time adjustable period after the boiler is turned off.
- g. Provide assured low fire warm up and low fire shut shutdown from proof of position contacts that are required on the firing rate actuators.

- h. For boilers with non-modulating outlet draft dampers, provide outputs to fully open and fully close the outlet dampers in response to the sequence of bringing a boiler on or off.
- i. Provide the RS-485 output and programming of the controller to permit remote changes of control commands from the building management system.
- j. Provide combustion efficiency reading (available from the front panel display of the controller) for each boiler and based upon boiler flue gas temperature. For this, provide one flue gas temperature transmitter for each boiler with a stainless steel protected 18-inch insertion 100 ohm platinum RTD and a dedicated digital flue gas temp indicator mounted on the cabinet front for each transmitter (option available on 5810 only).
- k. Flue Gas Temperature Monitoring, same as above but with FGT readout and no combustion efficiency readout.

2. The Sequence of Operation shall be as follows:

- a. Upon start-up, burners shall always start in the low-fire position. Upon release of the combustion control system, they shall modulate via the programmable controller.
- b. As the pressure/temperature increases, the header mounted transducer will signal the programmable controller. In turn, the programmable controller shall sequence the proportional firing rate circuits of each modulating burner in an appropriate lead/lag sequence.
- c. Upon still further increase in pressure/temperature, the programmable controller will - in a time response - de-energize the lag boiler(s) in the appropriate lead/lag sequence. The burners will be in the low fire position before de-energizing. Upon reaching the final pressure/temperature set point, the controller will de-energize the lead burner.
- d. With a drop in pressure/temperature, the programmable controller will reverse the sequence and call the burners on line in a timed response.
- e. In the event that the lead burner fails to operate, the programmable controller shall automatically transfer control to the lag burner without any requirement for changing pressure/temperature/aquastat settings.

Item f. is optional.

- f. The lead/lag control shall have a summer and winter range of operation requiring only that the operator depress a selector button to change ranges. Upon range changes all values (selected pressures/ temperature) shall be revised to the new value without intervention by the operator.
3. The lead/lag controller shall be mounted in a separate wall mounted panel made of 16 gauge steel with a hinged door and latch assembly. (Note: optional pedestal mounting is available).
  4. The lead/lag control shall be complete with a pressure/temperature transducer to be installed in main steam/water header.
  5. The control panel shall be constructed in accordance with U.L. specifications and shall bear the U.L. listing label for Enclosed Industrial Control Panels.

## Draft Control

1. A double acting type of barometric draft damper shall be supplied and installed on (each) (the) boiler breeching. An electrical interlock will shut the gas supply off in the event that flue gases escape from the damper opening for a period of 60 seconds. The draft control shall be \_\_\_\_\_ inches in diameter.
2. Automatic Sequence Overfire Draft Control System.

The contractor shall furnish and install a UL approved Power Flame Model DC-3 Sequence Overfire Draft Control System. The controller shall be installed in the burner panel and must have a two line vacuum florescent display for all tuning and scaling operations and for display of variables such as draft pressure. The operator interface must have four pushbuttons on the front panel for all operator functions such as alarm acknowledgement, selection of displays and control functions. The display must include set points and tuning parameters and operational values such as flue gas temperature, draft pressure and alarms.

The controller must sense the draft pressure by direct connection to the furnace tap without the need for an external transmitter. The controller must have a piezoresistive silicon sensing element that is capable of measuring positive or negative pressures within the range of 0 to + or – 2” W.C.. This element must be temperature compensated and must produce a signal that is directly proportional to the differential pressure between atmospheric and the furnace pressure.

The controller must be field configurable for selecting the sequence mode from non-sequencing to sequencing with post and pre-purge capability and for positive or negative set point control applications. Post and pre-purge capability must have adjustable time delays of 20 to 120 seconds selectable from the front panel. The controller must retransmit the draft pressure as 4-20 mADC signal for recording or remote display and must have Modbus (selectable as 9600 or 19200 baud rate) communications as standard.

The controller must have an electronic draft indicator. The draft pressure must be indicated on the two line vacuum florescent display for the range.

The controller must include a closed/auto/open selector switch and all necessary relays for full programming and control actions. The closed position will bypass all automatic functions and closes the damper. The open position will open the damper and the boiler can be operated in the case of controller malfunction or boiler maintenance. In the automatic position the controller will maintain the desired setting to within one-hundredth (0.01) inch water column by varying the position of the draft damper. The controller will include proportioning band adjustment and will filter out the furnace pulsation without loss of sensitivity.

The controller circuit shall interconnect with the combustion safeguard and limit control circuits governing burner operation, to provide fixed damper opening for pre-purge and stable ignition, full modulation of damper during firing, and close damper after boiler shut down. However, burner shall shut down when switch is moved from automatic. The open damper switch shall provide means to fully open damper without interrupting firing.



The controller must have a UL approved draft cutoff switch, Model AFS-952, that will shut down the system in the event of an unsafe draft condition in the furnace extending over 8 seconds. The switch must be mounted inside the controller cabinet. After safe draft is reestablished, the combustion system must recycle from the original starting position. The cutoff point of the minimum draft switch shall be adjustable from zero to within two-hundredths (0.02) inch of the operating draft. The relay panel and solid-state control section shall each be of the modular type, permitting easy replacement. The controller shall also indicate alarm values on the display.

The controller output shall drive a 150 inch-pound torque rotary actuator. Unit must be equipped with an adjustable "start position" switch. A purge position signal switch must be an integral part of the operator. The operator must be equipped with a mechanism permitting selection of any partially open setting of the damper for the purge position (minimum 20 percent). This feature must allow the full range of the damper opening to be utilized during the firing cycle, and also permit adjustment of the purge position to provide maximum opening of the damper without adverse effect on pilot operation.

All necessary linkage, including adjustable clevises, pipe adapters, and damper lever arms must be designed for the particular use of the equipment to be installed, to provide free, smooth and rigid operation, but eliminate unnecessary play and lost motion.

(Options)

(Thermocouple Option):

The controller must have an internal flue gas temperature indicator and transmitter and meet ISA Sequence M alarm functions. A Type J Thermocouple shall be provided and remote mounted by the contractor.

The controller shall accept the input from the thermocouple directly and shall display the temperature on the front panel vacuum florescent display. The controller must have the capability of setting the alarm temperature, provide a flashing display of temperature alarms and have two alarm contact outputs. The controller must have local reset; remote reset or automatic alarm reset capability. The controller must have dual fail-safe SPDT contacts for remote alarming or indication. This temperature must re-transmitter as a 4-20 mADC signal for the range of 32 deg F to 1000 deg F. The controller must have the capability of temperature display in degree Celcius via front panel operation. Thermocouple failure must result in a fail-safe response by immediately going to the maximum output of 20 mADC.

(Heavy Duty Linkage Option):

Supply a 300 inch-pound torque rotary actuator with mounting bracket and heavy-duty linkage.

(Remote Mount Option):

The controller may be remote mounted in a separate enclosure.

## **Product Liability Insurance**

1. The burner manufacturer will provide an Insurance Certificate documenting his current coverage of Product Liability Insurance.

## **Burner Start Up Information and Test Data**

1. On completion of the burner system start up - the installing contractor will complete the "Burner Start Up Information and Test Data" form and "Control Settings" form (both attached) and deliver to the Specifying Engineer.

## **NOx Emissions Reduction - Low NOx Burner**

(Spec Writer - For a future low NOx burner, omit paragraphs 1. through 4. and use paragraphs for "Future Low NOx")

1. Burner(s) must be low NOx type, U.L. listed specifically for reduced emissions service. Burner NOx reduction strategy shall reduce the production of NOx by controlling low excess air operation and reducing flame temperature. Optimum stoichiometry shall be maintained by a Varicam operated fuel metering control with characterized cams for each fuel. Each cam shall have 14 points of adjustment through the modulating range assuring NOx reduction and high fuel efficiency.
2. Internal recirculation and staged air burners, where portions of the main flame are combusted within the burner head, behind a cone or diffuser assembly shall not be acceptable due to the potential for burner head failure caused by the resultant thermal stress of the referenced components.
3. Steam injection emissions reduction burners will not be acceptable because of the potential of mineral deposits on, and/or damage to heat transfer surface and refractory - and also due to the cost of steam.

(Spec Writer - Since NOx control is application specific, it is recommended that low NOx applications be reviewed by Power Flame's Engineering Department).

4. Low NOx Burner(s)
  - a. Type: Induced Flue Gas Recirculation (IFGR).
    - (1) Each burner shall be equipped with a burner mounted induced FGR purge assembly, complete with motor driven diverter damper to ensure that FGR is not introduced into the burner combustion air during the pre-purge, ignition, initial main flame establishment, or post purge cycles.
    - (2) Induced FGR piping shall be furnished and installed by others (not provided by the burner manufacturer) to connect the boiler stack to the burner FGR inlet connection. FGR piping shall be seamless carbon steel pipe or tubing, minimum Schedule 10, sized in accordance with the burner manufacturers recommendations and run to avoid interference with flue doors, boiler inspection parts, etc.. Piping and insulation (by others, if required) shall be in accordance with all applicable codes.

- (3) On natural gas firing, NOx emissions will not exceed 30 PPM, and CO emissions will not exceed 50 PPM. NOx emissions on oil firing shall achieve up to a 40% reduction of NOx emissions, from that experienced without NOx control, with CO not exceeding 100 PPM. All emissions measurements are to be corrected to 3% O<sub>2</sub>.
- (3) Burner Start-Up Information and Test Data Form must include NOx and CO emissions measurements. Form, completed with all test data values, shall be furnished to the owner prior to final payment.

### **Future Low NOx**

The burner(s) shall be U.L. listed, forced draft type. Each system shall be capable of being field retrofitted to low NOx operation without modification to, or replacement of any major component assemblies initially supplied. The original burner blower housing, blower, blast tube (head), and diffuser assembly shall be used. Future retrofit hardware shall be limited to a factory supplied, bolt on, low NOx kit that shall be U.L. approved for field retrofit as well as for factory installation. The completed retrofit shall be in accordance with the U.L. listed low NOx system normally supplied by the burner manufacturer for new applications.

Low NOx retrofit shall be accomplished without the need for derating the boiler-burner input or output - and without the need to increase gas supply pressure or electrical power supply.

1. Internal recirculation and staged air burners, where portions of the main flame are combusted within the burner head, behind a cone or diffuser assembly shall not be acceptable due to the potential for burner head failure caused by the resultant thermal stress of the referenced components.
2. Steam injection emissions reduction burners will not be acceptable because of the potential of deposits on, and/or damage to heat transfer surface and refractory - and also due to the cost of steam.
3. At the time of bid, burner manufacturer shall specify the NOx reduction method and guarantee that, on natural gas firing, NOx emissions will not exceed 30 PPM, and CO emissions will not exceed 50 PPM. Low NOx retrofit on oil shall achieve up to a 40% reduction in NOx emissions, with CO not exceeding 100 PPM. All emissions measurements corrected to 3% O<sub>2</sub>.

# BURNER START UP INFORMATION & TEST DATA

The following information shall be recorded for each burner start up:

Power Flame Model \_\_\_\_\_ Job No. \_\_\_\_\_ Serial No. \_\_\_\_\_  
 Installation Name \_\_\_\_\_ Start Up Date \_\_\_\_\_  
 Start Up Contractors Name \_\_\_\_\_ Phone \_\_\_\_\_  
 Name of Technician doing Start Up \_\_\_\_\_  
 Type of Gas: Nat.  LP  Other  Fuel Oil Grade No. \_\_\_\_\_

**Gas Firing**

**Gas Pressure at Train Inlet**  
 Burner in Off Position \_\_\_\_\_ "W.C."  
 Low Fire \_\_\_\_\_ "W.C."  
 High Fire \_\_\_\_\_ "W.C."

**Gas Pressure at Firing Head**  
 Low Fire \_\_\_\_\_ "W.C."  
 High Fire \_\_\_\_\_ "W.C."

**Gas Pressure at Pilot Test**  
 Tee \_\_\_\_\_ "W.C."

**Flame Signal Readings** D.C. Volts  Micro Amps   
 Pilot \_\_\_\_\_  
 Low Fire \_\_\_\_\_  
 High Fire \_\_\_\_\_

**CO<sub>2</sub> or O<sub>2</sub> (Specify)**  
 Low Fire \_\_\_\_\_ %  
 High Fire \_\_\_\_\_ %

**CO**  
 Low Fire \_\_\_\_\_ PPM  
 High Fire \_\_\_\_\_ PPM

**Input Rate**  
 Low Fire \_\_\_\_\_ BTU/HR  
 High Fire \_\_\_\_\_ BTU/HR

**Overfire Draft**  
 Low Fire \_\_\_\_\_ "W.C."  
 High Fire \_\_\_\_\_ "W.C."

**NOx (Corrected to 3% O<sub>2</sub>)**  
 Low Fire \_\_\_\_\_ PPM  
 High Fire \_\_\_\_\_ PPM

**Stack Outlet Test Point Draft**  
 Low Fire \_\_\_\_\_ "W.C."  
 High Fire \_\_\_\_\_ "W.C."

**Net Stack Temperature**  
 Low Fire \_\_\_\_\_ ° F  
 High Fire \_\_\_\_\_ ° F

**Combustion Efficiency**  
 Low Fire \_\_\_\_\_ %  
 High Fire \_\_\_\_\_ %

**Windbox O<sub>2</sub> (Low NOx Only)**  
 Low Fire \_\_\_\_\_ %  
 High Fire \_\_\_\_\_ %

**Oil Firing**

**High Fire Vacuum Reading on Oil**  
 Pump Inlet \_\_\_\_\_ "H.G."

**Gas pressure at Pilot Train**  
 Inlet (if applicable) \_\_\_\_\_ "W.C."

**Gas Pressure at Pilot Test**  
 Tee (if applicable) \_\_\_\_\_ "W.C."

**Oil Nozzle Supply Pressure**  
 Low Fire \_\_\_\_\_ PSIG  
 High Fire \_\_\_\_\_ PSIG

**Oil Nozzle Atomizing Medium Pressure**  
 Low Fire \_\_\_\_\_ PSIG  
 High Fire \_\_\_\_\_ PSIG

**Flame Signal Readings**  
 Pilot (if applicable) \_\_\_\_\_ D.C. Volts  
 Low Fire \_\_\_\_\_  
 High Fire \_\_\_\_\_

**GPH Firing Rate**  
 Low Fire \_\_\_\_\_ GPH  
 High Fire \_\_\_\_\_ GPH

**CO<sub>2</sub> or O<sub>2</sub> (Specify)**  
 Low Fire \_\_\_\_\_ %  
 High Fire \_\_\_\_\_ %

**Bachrach Scale Smoke Number**  
 Low Fire \_\_\_\_\_  
 High Fire \_\_\_\_\_

**NOx (Corrected to 3% O<sub>2</sub>)**  
 Low Fire \_\_\_\_\_ PPM  
 High Fire \_\_\_\_\_ PPM

**Over Fire Draft**  
 Low Fire \_\_\_\_\_ "W.C."  
 High Fire \_\_\_\_\_ "W.C."

**Stack Outlet Test Point Draft**  
 Low Fire \_\_\_\_\_ "W.C."

**Net Stack Temperature**  
 Low Fire \_\_\_\_\_  
 High Fire \_\_\_\_\_

**Combustion Efficiency**  
 Low Fire \_\_\_\_\_ %  
 High Fire \_\_\_\_\_ %

**Control Settings**

**Gas**

Operating control cut out setting \_\_\_\_\_  
 Operating control cut in setting \_\_\_\_\_

Low gas pressure switch \_\_\_\_\_ "W.C."  
 High gas pressure switch \_\_\_\_\_ "W.C."

Limit control cut out setting \_\_\_\_\_  
 Limit control cut in setting \_\_\_\_\_

Other \_\_\_\_\_

Power supply: Volts \_\_\_\_\_ Ph \_\_\_\_\_ Hz \_\_\_\_\_  
 Control circuit: Volts \_\_\_\_\_  
 Blower motor amps at high fire \_\_\_\_\_

**Oil**

Other \_\_\_\_\_

Low oil pressure switch \_\_\_\_\_ lbs.  
 High oil pressure switch \_\_\_\_\_ lbs.  
 Atomizing low pressure switch \_\_\_\_\_ lbs.

Oil pump motor amps at high fire \_\_\_\_\_  
 Other \_\_\_\_\_

**Operation Checklist**

Checked For Proper Operation Of:					
	Yes	No		Yes	No
Low water cut off	_____	_____	Barometric damper	_____	_____
High water cut off	_____	_____	Boiler room combustion air & ventilation provision correct	_____	_____
Flame safeguard control ignition failure	_____	_____	Oil tank vent system correct	_____	_____
Flame safeguard control main flame failure	_____	_____	All oil lines checked for leaks	_____	_____
Burner air flow switch	_____	_____	All gas lines checked for leaks	_____	_____
Induced draft fan controls	_____	_____	Gas lines & controls properly vented	_____	_____
Over fire draft controls	_____	_____	Other system components (specify)	_____	_____
Fresh air damper end switch	_____	_____			

Notified \_\_\_\_\_ of the following system deficiencies: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

## **Comments to the Specification Writer on FM and IRI Code Requirements**

### **Factory Mutual (FM) Insurance Requirements**

Local FM inspectors are empowered to examine risks and impose or modify requirements which could result in substantial equipment (and price) change depending on decisions of the local inspector.

Purchasers (owners), or their consulting engineers, should contact the local FM office to determine any items, not included above, which must be supplied.

All systems specified are subject to acceptance by the local FM inspector.

### **Industrial Risk Insurers (IRI) Insurance Requirements**

The equipment specified in the attached under IRI incorporates the basic components and systems necessary to comply with the published standards.

Local IRI inspectors are empowered to examine the risks and modify the standards which could result in equipment (and price) change depending on the decision of the local inspector.

Purchasers (owners), or their consulting engineers, should contact the local IRI office to determine any items, not included above, which must be supplied.

All systems specified are subject to acceptance by the local IRI inspector