

# BurnerMate Universal

## System Overview

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The **BurnerMate Universal (BMU)** is a total boiler control system designed for both firetube boilers and watertube boilers. Utilizing the latest technology in microprocessors to give you the highest quality in combustion control for your boiler room. The BurnerMate Universal is available for immediate delivery, requires no programming, and is U.L. Certified to UL 60730-2-5 and ISO 23552-1.

Many of the most common boiler control functions are incorporated in the BMU.

- Flame Safeguard Control with detailed first out Annunciation, last 10 Lockout History each with 162 data points
- Gas Valve Proving (Leak Test)
- Oil Gun Post Purge
- High Flue Temp Lockout (extra Low Water and overfiring protection)
- Combustion control ( parallel positioning, with optional oxygen trim) using up to ten servos and up to four Variable Speed Drives (VSDs)
- Draft control
- Feedwater control: single, two-element, or three-element.
- Large 10" color touch screen (optional)
- Burner firing rate control (local PID control, remote firing rate input, or remote set point input)
- Outdoor air temperature reset for hot water boilers.
- Warm standby and domestic hot water override
- Low fire Fuel Transfer without burner shutdown
- Five auxiliary relays can be configured to control common boiler room auxiliaries
- Supervised or automatic water column blowdown and low water level test logic
- Boiler cold start function allows for adjustable boiler thermal shock protection

### Fully Field Configurable

Integral keypad and display allow full configuration and burner commissioning without a laptop.

### Advanced Flame Safeguard Control

Separate processors are used for flame safeguard and combustion control for NFPA 85 compliance. The BMU accepts over forty boiler limits into separate digital inputs and supports first out annunciation as well as advanced diagnostics.

### Fuel Air Ratio Control

The BMU can be configured for parallel positioning or Fully Metered combustion control for up to 3 fuels. Each digital servo includes a microprocessor and all servos are networked to the BMU chassis.

### Fan VSD

Optimal control over FD fan allowing the BMU to optimally control the speed of the FD fan saving electrical cost and noise in the boiler room. BMU includes 6 sets of curves (3 fuels each with 2 FD Fan modes: VSD or Full Speed FD fan. Operators can change all curves from VSD mode to VSD full speed bypass with the flip of a switch.



*BMU Controller*



*Standard BMU Cabinet Front*



*Standard BMU Cabinet Inside*

*Specs found here*



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### Feedwater Control

The BMU is capable of single, two-element, or three-element feedwater control. Controlled outputs include a feedwater control valve or feedwater pump VSD.

### O<sub>2</sub> Trim

Flue gas Oxygen is used to continuously trim the air/fuel ratio to create optimal burner operation and increase overall efficiency. O<sub>2</sub> trim adds additional safety by alerting the operator with a Warning Alarm and also includes a Burner Lockout for Low-Low Oxygen.

### Low Fire Fuel Transfer

The BurnerMate Universal allows the user to change fuels without shutting down the boiler, in accordance with NFPA 85 **Procedures for Single Burner Simultaneous Firing of Two Fuels for Fuel Transfer Only**. The loss of production is much less than shutting down the boiler, purging, and re-lighting.

### Tandem Oil/Gas Valve Servo Option

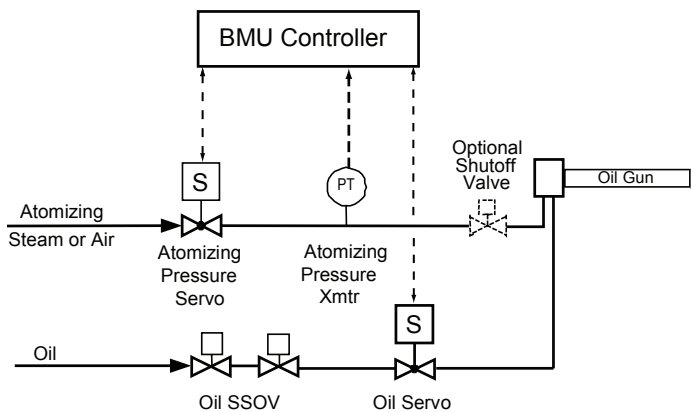
A single BMU servo can replace jackshaft control on a gas and oil fired burner. This feature reduces the number of servos required for a gas/ oil burner retrofit, and speeds installation. Separate curves are provided for standby, purge, and ignition positions for oil and gas.

### Digital Communication

The BurnerMate Universal communicates via a secure, safety rated digital protocol. The optional touchscreen OIT acts as protocol converters and can speak Modbus, Modbus over Ethernet, BACnet, or a number of other open digital protocols to a Building Automation System (BAS) or Energy Management System (EMS).

### Analog Inputs

The BurnerMate Universal accepts industry standard 4-20 mA, 0-5 VDC, 1-5 VDC, thermocouple, and thermistor inputs. Analog inputs are self-powered by the BMU. Analog outputs are 4-20 mA.



Atomizing steam pressure is monitored and held "on curve" at all boiler firing rates.

### Windbox Oxygen FGR Control

Automatic control of windbox oxygen content is included for those Ultra Low NO<sub>x</sub> burners that require advanced control techniques.

### Atomizing Steam Pressure Control

The BMU controller monitors atomizing steam pressure, and modulates a flow control valve to deliver virtually any steam pressure required at any firing rate. Alternately, an atomizing steam/ oil differential pressure transmitter can be used and the BMU will hold the steam/ oil differential pressure "on curve" at all firing rates.

### Fuel Flow Meter Display and Totalizing

To monitor and track fuel usage (and savings) the BMU displays and totalized fuel flows for up to three fuels.

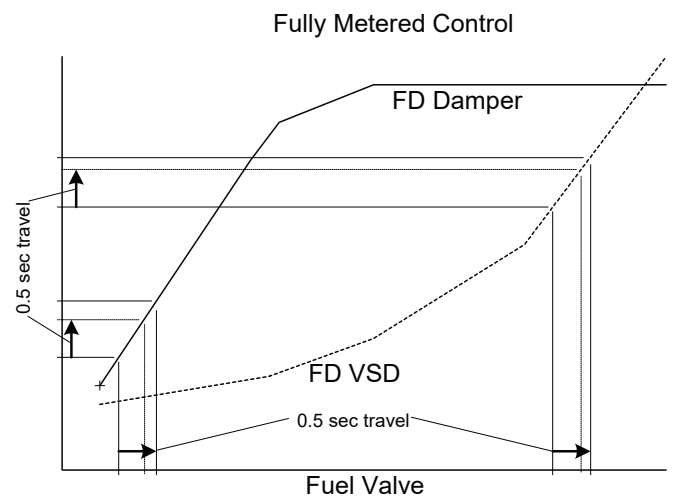
### "Position Pacing" Fuel-Air-FGR Cross Limited Control

"Position Pacing" assures the positions of all Fuel, Air, and FGR Servos and related VSD speeds remain "on curve."

During load swings, position pacing avoids:

- Periods of lean combustion that can cause rumbling, vibration, or flame-outs during firing rate increases
- Fuel rich conditions that can cause smoking, burn-back, and excessive CO or unburned hydrocarbons during firing rate decreases

BMU "position pacing" is fully automatic, does not require any tuning, and drastically improved firing rate response.



Two Servo Example of Fully Metered

# BurnerMate Universal Boiler Controller

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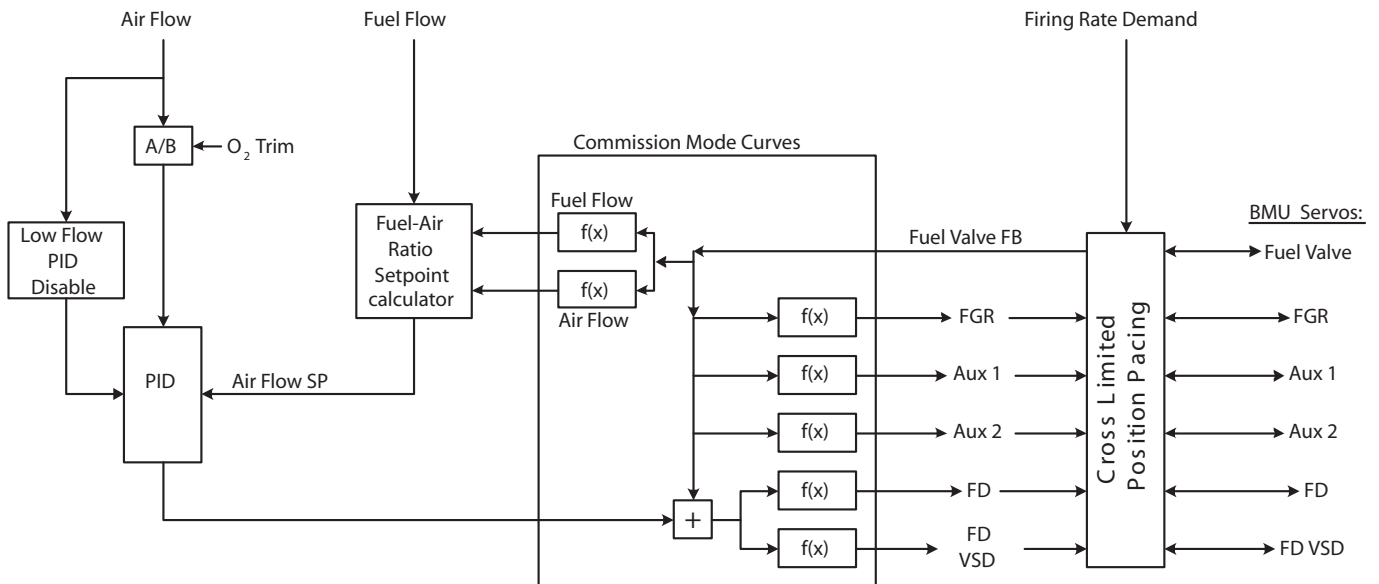
## Control Strategies

### Predictive Full Metering Combustion Control

The BurnerMate Universal's patented "Predictive Metering" combustion control strategy combines the best attributes of Positioning control and Full Metered control. Fuel, air, VSD, and FGR 'as-commissioned' position curves predict Servo/VSD changes during a load change for rapid response. Separate 'as-commissioned' fuel and air flow rate curves provide precise PID fuel-air ratio control. Cross-Limited Position Pacing provides Safe firing rate changes without the wasteful excess air that traditional Cross limiting casues.

These strategies are of particular importance when applied to sensitive low NOx burners with narrow limits of flammability.

Most importantly, if a flow meter malfunctions, with a single parameter selection the BMU controller can be directed to operate as a parallel positioning combustion control system with oxygen trim until the flow meter is repaired or replaced.



BurnerMate Universal Industrial Predictive Metering Control Schematic

# BurnerMate Universal Boiler Controller

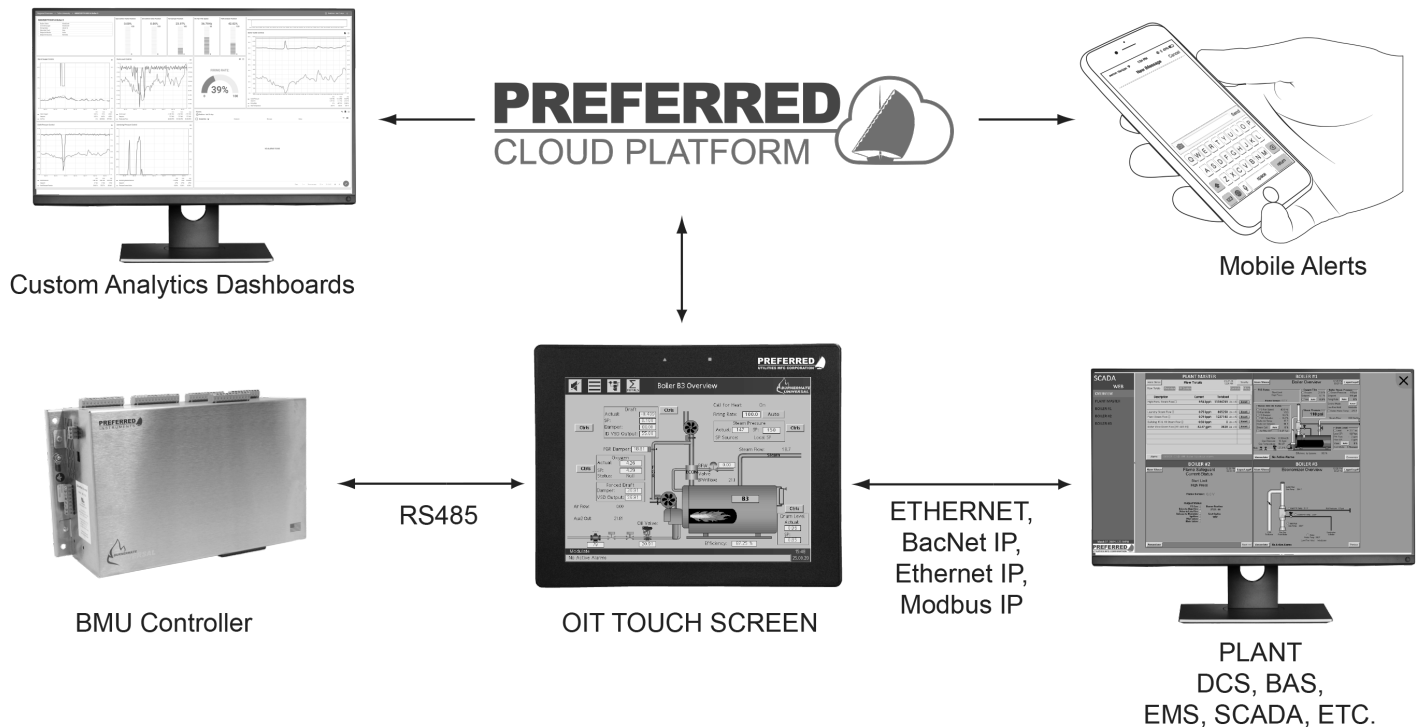
Ordering Information

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## Digital Communication Options

The BMU has Modbus addresses assigned for the status of many digital and analog inputs and outputs. This data is accessible by Modbus using the RS485 connection on the BMU controller. The RS485 connection can be converted to Ethernet or many other protocols using the OIT touch screen.

Description	Communication
BMU Controller Only	RS485 Only
BMU Controller with OIT touch screen	Ethernet BacNet IP Ethernet IP Modbus IP RS485



*This is the most common digital communication scenario used with the BMU. There are many terms for the control system the BMU typically interfaces with, including: Distributed Control System (DCS), Building Automation System, (BAS) Energy Management System (EMS) or Preferred Supervisory Control and Data Acquisition System (SCADA).*

# BurnerMate Universal Boiler Controller

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## BurnerMate Universal OIT Touch Screen

The BMU-OIT-10 color touch screen display is available for enhanced graphics and communications. Supported communication protocols include:

- 10/100 Base Ethernet, Modbus TCP/IP, Modbus RTU, SCADA/ BAS connection, BacNet IP, and BMU connection
- One RS-485 port
- Integrated with Preferred Cloud

Over 75 pre-programmed graphics pages are included. Boiler overview screens are field-selectable to fit the application.

## Touch Screen Specifications

### Electrical

Input Voltage: 24 VDC, 1.4 A

### Monitor Performance

Size: 10.4"

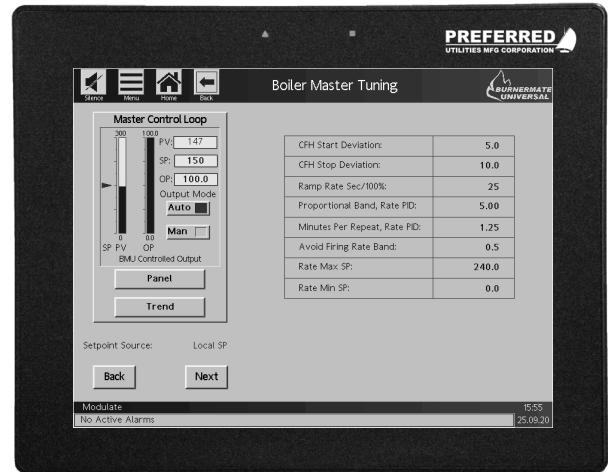
Colors: 256 VGA

Resolution: 640 x 480 pixels

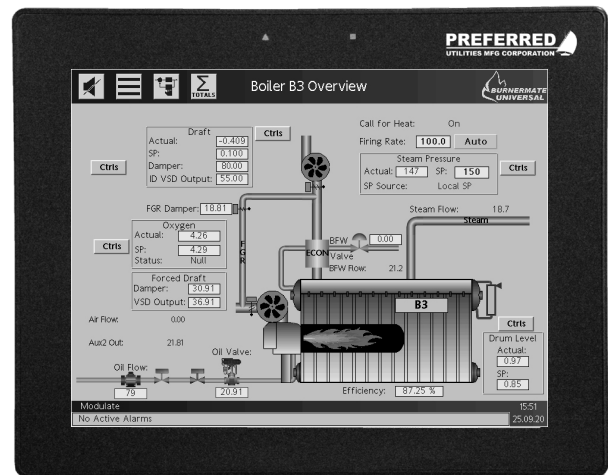
### Environmental

NEMA Rating: NEMA 4X (flush-mount)

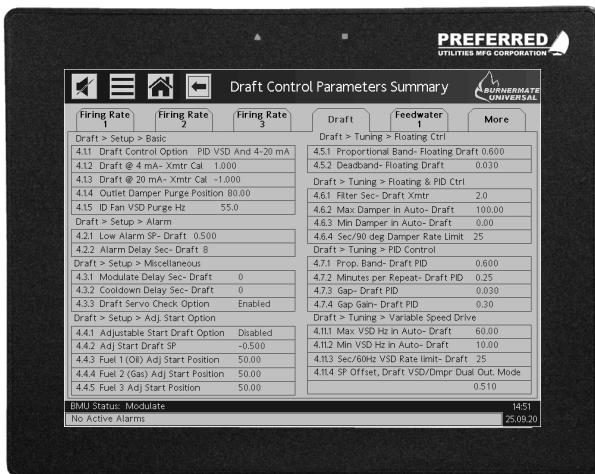
Description	Catalog Number
10.4" Operator Interface Terminal Color Touch Screen Display with BMU operation and commissioning displays.	BMU-OIT10
OIT Terminal Wiring Adapter	190777
120 VAC/24 VDC/2.5 A DIN rail power supply	92443



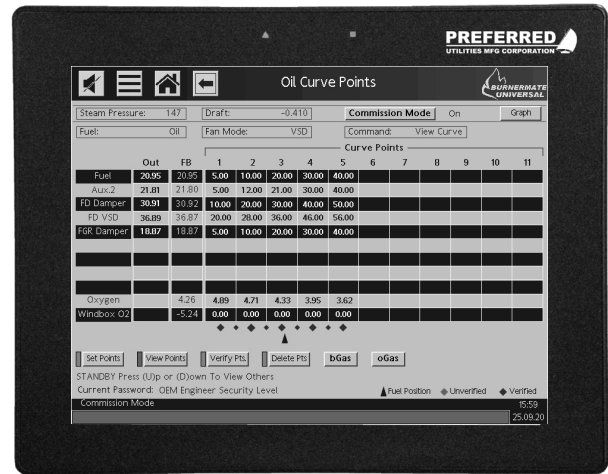
BMU Tuning Screen



Typical Watertube Boiler Overview Screen



Controller I/O screens help troubleshoot problems



Fuel Combustion Curve Setup Screen

# BurnerMate Universal Boiler Controller

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## Ordering Information

### BMU Chassis Selection

There are several BMU chassis to choose from depending on the functionality required in the control system. The key pad is required whether or not the optional 10" OIT color touch screen is provided.

### BMU Chassis Specifications

#### Electrical

Input Voltage: 120 VAC (+/- 15%)

Frequency: 60 Hz

Consumption: 42 VA

#### Environmental

Operating Temperature: 32 to 140 deg. F

Storage Temperature: -20 to 150 deg. F

Humidity: 15 to 95%

\*See page 42 for Control Devices such as Servos and O2 Analyzers

Optional Pre-Configured Touch Screens	Catalog Number
10" OIT touch Screen	-OIT10
15" OIT touch Screen	-OIT15

Optional Control Panel	Catalog Number
24"H x 30"W x 10"D	PANEL243010
30"H x 24"W x 10"D	PANEL302410
Custom Designed Enclosure	Consult Factory

**BMU - \_ Z N 0 - \_ - \_**

Chassis Description	Catalog Number
<p><b>Basic BMU-0ZN0</b>                      Advanced Flame Safeguard, up to 3 fuels, First Out Annunciation, 160 data pts for each of last 10 Lockouts                      Parallel Fuel-Air-VSD-FGR ratio control, 6 sets of curves                      Oxygen Trim with Oxygen Analyzer continuous self checking logic.                      Cross-Limited "Position Pacing"                      Firing Rate Control with Cold Start protection and Boiler Lead-Lag interface                      Supports up to seven (7) independent servos--3 for fuel, 1 for air, 1 for FGR and 2 Auxiliaries.                      Up to (2) 4 to 20 mA outputs for FD fan VSD or an Auxiliary device</p>	0
<p><b>Expanded BMU-1ZN0</b>                      All of the features in the Basic model plus:                      Feedwater Control; 1, 2, or 3 Element                      Draft Control with firing rate feedforward curves                      Atomizing Pressure control with (3) Setpoint Curve                      Windbox O2 FGR Trim with (3) Setpoint curves                      (3) Fuel Flow and (1) Steam Flow Totalizers                      Supports up to ten (10) independent servo actuators--3 fuel, 1 air, 1 FGR, 1 feedwater flow control valve, 1 draft damper and atomizing steam flow control valve.                      Up to (6) 4- 20 mA outputs: firing rate, FD VSD, ID VSD, Aux device, Draft damper, feedwater valve/VSD.</p>	1
<p><b>Full Metered BMU-2ZN0</b>                      Fully Metered Combustion Control is now available in an economical, pre-engineered, parameter-driven control package. Includes the following features:                      Patented "Predictive Full Metering" Fuel-Air Ratio Control                      Cross-Limited Actuator "Position Pacing"                      Single PID Fuel-Air Ratio Tuning                      Air Flow Temperature Compensation                      Gas Flow Pressure Compensation                      Windbox O2 FGR Trim + Flue O2 Air Flow Trim                      All features of <b>Basic</b> and <b>Expanded</b> BMU versions.</p>	2



# BurnerMate Universal Boiler Controller

Suggested Specifications

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## 1. Quality Assurance

The boiler control system shall be manufactured and supported in the United States. The burner fuel-air-FGR ratio control system and the burner flame safeguard system shall be manufactured and labelled in accordance with U.L. 372, U.L. 60730-2-5, CSA C22.2 No. 60730-2-5 and ISO 23552-1. The assembled control cabinet as a whole must be inspected for proper wiring methods, fusing, etc., and must be labeled as conforming to UL508A and CSA C22.1 #14. Inspection and labeling shall be supervised an OSHA approved Nationally Recognized Test Lab (NRTL). The system shall comply with NFPA 85 "Requirement for Independence," the flame safeguard system shall be provided with independent hardware shall be physically separated from the combustion control logic.

## 2. Parallel Positioning Combustion Control

A parallel positioning combustion control system with oxygen trim and VSD FD fan control shall be provided for each boiler. Each system shall be designed to provide continuous boiler operation within boiler design limits with a high level of safety and energy efficiency. As required the system shall provide continuous monitoring and control of steam pressure (or water temperature), water level, combustion air and fuel ratio & flue gas recirculation. The system shall be fully integrated to the burner management system to provide fully automatic, safe and reliable startup and shutdown. Position pacing shall be used to ensure up to eight servos will be continually monitored and held "on curve" during boiler load changes.

## 3. Oxygen Trim System

Provide a boiler breeching mounted in-situ, zirconium oxide oxygen analyzer for each boiler. Extractive type oxygen analyzers are not acceptable for combustion control. The probe shall be of a suitable length to sense the oxygen level in the middle third of the breeching. All wetted parts shall be stainless steel. The oxygen analyzer shall:

- Include continuous self-diagnostics with diagnostic codes for at least 10 common faults.
- Automatically send the trim control to the 'null' position and trigger the alarm dry contacts in the event of an oxygen analyzer fault.
- The detector shall be field replaceable without removing the probe from the stack and shall not require special tools.
- The analyzer shall automatically perform periodic detector cell impedance tests to be used by the operator as an indication of calibration shift.
- Analyzer calibration shall be pushbutton semi-automatic (no trim pots) with English language prompts and diagnostic messages. Analyzer output shall be field selectable as 0-10% or 0-21% without field re-calibration.

## 4. Flame Safeguard System (FSG)

Integral to the control system furnished shall be a Burner Management System (BMS) /Flame Safeguard System (FSG) controller. The system shall be designed to ensure the safe start-up, on-line operation, and shutdown of fuel firing equipment.

Burner management system components shall be located in the combustion control cabinet and shall be fully integrated for automatic sequencing of light off and shutdown. For safety the BMS microprocessor and BMS I/O shall be on a physically separate circuit board.

Microprocessor-based FSG shall provide: safety interlocks, flame monitoring protection, and timed sequences. Sequences shall include forced draft fan start and stop, furnace purge, burner light off and shutdown and post-purge. The FSG shall be capable of firing up to three fuels (two gas fuels, one oil fuel), one fuel at a time. Fuel changeover shall from oil to gas, or gas to oil firing shall be accomplished "on the fly" at low fire without boiler shutdown per NFPA.

A panel front-mounted English language, four line, twenty character LCD message display shall be provided to display flame signal strength, startup and shutdown sequence status, alarm, system diagnostic, first-out messages and burner historical information. Historical information shall include the status of all limits and servos for the last ten lockouts.

To ensure boiler low water cutouts are working correctly, the controller shall be capable of performing a daily automatic water column blow-down test. The user shall select the time of day of the water column blow-down test. The controller shall ensure the low water cutoff switches are functioning correctly, and alarm the operator or lockout the boiler if it detects a switch malfunction.

To prevent nuisance trips, the flame safeguard system shall accommodate two flame scanners with one required to prove flame. The controller shall provide 120 VAC or 24 VDC scanner power, and accept two analog inputs indicating flame strength. Flame safeguard system shall include oil gun post purge for oil firing. Assured low fire cutoff shall be provided.

For additional nuisance trip protection, field adjustable time delays shall be provided for F.D. fan start, fresh air damper, minimum air flow, low draft cut out, and fuel pressure limits. Five field selectable auxiliary relays shall be included for common alarm, auxiliary fan start, blow-down, flame on, fuel valve open, hot water pump or valve.

To protect against dry firing, an option shall be available for high flue gas temperature lockout.

To ensure air switches are functioning, a minimum air flow pressure switch and purge air flow pressure switch safe start check shall be included.

## 5. Feedwater Control

Provide a boiler water level controller capable of single-, two-, or three-element feedwater control with the ability to automatically switch between control strategies dependent on system demands.

# BurnerMate Universal Boiler Controller

Suggested Specifications

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## 6. Draft Control

The controller shall provide two-element draft control utilizing a Preferred Instruments JC-22XMTR draft transmitter. Burner firing rate shall be used as a feed forward for improved response to load changes. The control shall provide both automatic and manual damper control. All adjustments shall be made from the front panel display in engineering units.

## 7. Flue Gas Recirculation Damper Control

The controller shall have a characterizable curve output signal to vary FGR fan speed or position an FGR damper. All the logic required to automatically signal pre-purge, postpurge, light-off, and burner modulate cycles shall be provided within the controller.

## 8. Windbox Oxygen FGR Control

The controller shall accept an analog input for burner windbox oxygen to be used as a measure of flue gas recirculation rate. During commissioning, a windbox oxygen vs. firing rate curve shall be established. The controller shall trim the flue gas recirculation damper (or FGR blower motor VSD) curve positions to maintain windbox oxygen on the pre-established curve despite changes in ambient conditions. Provide this feature when specified for specific Ultra-Low NOx burners that are sensitive to off-normal FGR levels.

## 9. Atomizing Media Pressure Control

The controller shall accept an input for atomizing steam pressure or atomizing steam/oil differential pressure. During commissioning, an atomizing steam pressure (or atomizing steam/oil differential pressure) curve shall be established. The controller will modulate an atomizing steam flow control valve to keep the atomizing steam pressure on curve at all firing rates.

## 10. Additional Control Requirements:

- Minimum number of f(x) Curves to be provided per servo: 6 (3 fuels x 2 FD fan modes)
- Minimum number of points per f(x) Curve to be provided: 11
- Cold FGR low fire cutback shall be provided when FGR is utilized for NOx reduction.
- Separate curves shall be provided for FD fan VSD control and for full speed bypass of the VSD.
- Controller shall include the capability of receiving a remote firing rate input and remote set point input.
- Controller shall include warm standby start / stop cycle.
- Controller shall include low fire hold, and cold start warm up ramping.
- All power supplies necessary for electronic transmitters (or final control element) shall be included.
- Boiler control software shall be Certified by an NRTL to U.L. 1998, or UL/CSA 60730-2-5 and be inaccessible to prevent tampering. Unit commissioning shall be by parameter selection, not requiring ladder logic or blockware programming.
- The controller shall accept standard 4-20 mA, 1-5 VDC, or thermistor inputs for analog inputs. No special sensors shall be required.

- Controller shall receive and display inputs for fuel flow, air flow, and steam flow. Controller shall be capable of future upgrades to fully metered combustion control.

## 11. OIT Color Touch Screen

Provide as an option a ten (10) inch Operator Interface Terminal (OIT) designed to provide local operation, graphic display of information, alarm message display, historical and real time trending, remote control tuning, x/ y plots of fuel-air curve data for intuitive commissioning, Ethernet connectivity and standard internet browser remote communication. The OIT shall contain a minimum of 75 graphic pages and be networked to the boiler control and burner management systems. The OIT shall provide graphic pages allowing step-by-step commissioning of the controller parameters using English language prompts and selections.

The system shall be an industrial hardened operator interface terminal. The terminal shall be enabled by the web and allow remote monitoring via a standard internet browser and support Modbus TCP/IP Master, TCP/IP Slave, RS-485 Modbus Master, and Ethernet communications.

## 12. High Torque Servo Features:

- Easy pushbutton set-up, not requiring the adjustment of internal or external potentiometers.
- Servo zero, span, and direction of travel shall be accomplished by push-button configuration.
- Totally enclosed, dust tight, and splash-proof covers.
- Provide a separate direct acting digital servo actuators for the fuel gas and fuel oil.
- Electrically isolated shaft position feedback potentiometer, integral brake, 90° rotation in 25 seconds.
- The actuator shall be capable of being stopped, started, or instantly reversed without loss of torque or overloading.
- Servo actuator positioning accuracy: +/- 0.1 degrees. Servo full stroke safe start check shall be provided.
- For high torque applications such as watertube boiler air dampers, servo torque shall be rated minimum 70 ft-lbs with 0.4 degree accuracy.
- No servo feedback adjustments shall be required with pushbutton zero setup. Adjustable travel limit switches shall be integral, with re-adjustment not requiring new fuel air ratio curve re-entry.
- Servos shall be cycled during each light-off cycle, and the feedback from each servo monitored to ensure safe actuator operation.
- Servos shall be Preferred Instruments, model BMU-SM or BMU-UM (high torque).