CleaverBrooks

Accu-Trim

O2 Trim System

Installation, Operation, Maintenance, and Parts

750-267
02/09

TO: **Owners, Operators and/or Maintenance Personnel**

This operating manual presents information that will help to properly operate and care for the equipment. Study its contents carefully. The unit will provide good service and continued operation if proper operating and maintenance instructions are followed. No attempt should be made to operate the unit until the principles of operation and all of the components are thoroughly understood.

It is the responsibility of the owner to train and advise not only his or her personnel, but the contractors' personnel who are servicing, repairing, or operating the equipment, in all safety aspects.

Cleaver-Brooks equipment is designed and engineered to give long life and excellent service on the job. The electrical and mechanical devices supplied as part of the unit were chosen because of their known ability to perform; however, proper operating techniques and maintenance procedures must be followed at all times.

Any "automatic" features included in the design do not relieve the attendant of any responsibility. Such features merely free him of certain repetitive chores and give him more time to devote to the proper upkeep of equipment.

It is solely the operator's responsibility to properly operate and maintain the equipment. No amount of written instructions can replace intelligent thinking and reasoning and this manual is not intended to relieve the operating personnel of the responsibility for proper operation. On the other hand, a thorough understanding of this manual is required before attempting to operate, maintain, service, or repair this equipment.

Operating controls will normally function for long periods of time and we have found that some operators become lax in their daily or monthly testing, assuming that normal operation will continue indefinitely. Malfunctions of controls lead to uneconomical operation and damage and, in most cases, these conditions can be traced directly to carelessness and deficiencies in testing and maintenance.

The operation of this equipment by the owner and his operating personnel must comply with all requirements or regulations of his insurance company and/or other authority having jurisdiction. In the event of any conflict or inconsistency between such requirements and the warnings or instructions contained herein, please contact Cleaver-Brooks before proceeding.

Cleaver-Brooks
Accu-Trim
Standalone O2 Trim System

Installation, Operation, Maintenance, and Parts

Please direct purchase orders for replacement manuals to your local Cleaver-Brooks authorized representative.

Manual Part No. 750-267
02/09

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SECTION 1

GENERAL DESCRIPTION AND PRINCIPLE OF OPERATION

Milwaukee, Wisconsin
www.cleaver-brooks.com

1.1-Introduction

Congratulations, and thank you for choosing the Cleaver-Brooks Oxygen Trim System. This system has been designed with the user in mind, and should provide many years of dependable, safe, and efficient operation. To ensure continued trouble-free operation, please be sure to follow all instructions in this manual regarding proper installation, set-up, operation, and maintenance.

1.2-How to Use this Instruction Manual

This manual is arranged to provide a straight forward, step-by-step process from installation through operation and maintenance of your system.

Chapter 1 describes the system, components, and principles of operation, and explains how to identify what type of system and components you should have.

Chapter 2 details the installation procedures, including mounting, piping, wiring, and utility requirements, and the proper sequence to perform these procedures.

Chapter 3 explains how to setup the system with your boiler burner, and then place the system in operation.

Chapter 4 provides information on routine maintenance, troubleshooting, replacement parts, and warranty policy.

Chapter 5 contains a parts list for the system.

The appendix includes pertinent information such as wiring of the system.

1.3-System Description - General

The C-B Standalone O_2 Trim System is a PLC based control system. It is designed to maintain the proper fuel-to-air ratio of a boiler/burner. In its basic form, the system is intended for use on a Cleaver-Brooks boiler or burner with single point positioning, or jackshaft-type combustion controls. However, it may be customized for special applications such as parallel positioning, metering, or alternate fuel firing.

The complete system is comprised of oxygen and firing rate sensors, a control panel which houses the PLC, and an actuator or VSD system which trims either the fuel or air flow.

The system is used to maintain the proper fuel-air ratio of a properly tuned boiler/burner under varying operating conditions. It is not intended to improve the operation of a poorly tuned burner, and such use is a misapplication of this system. The system is intended to compensate for minor changes in conditions such as temperature, barometric pressure, fuel characteristics, and normal system hysteresis.

The system provides visual indication of flue gas percent oxygen. The PLC displays the oxygen process value, setpoint, and control output.

1.4-Principle of Operation

The system analyzes several key input parameters from the boiler and determines the proper corrective action which is applied to the output. These parameters are:

- Flue gas oxygen content
- Firing rate
- Type of fuel being fired

Firing rate and fuel selection inputs are used to determine the proper oxygen setpoint, which is then compared to the actual oxygen input value. The PLC uses a PID algorithm to determine the proper output required to correct and maintain the oxygen at the desired setpoint. The PLC produces 0-10 VDC analog control signals than can be used to control VSD speed, electric trim actuators or an E/P transducer which

provides a 3 to 15 psi air signal to pneumatic trim actuators. The system can accommodate up to two pneumatic actuators controlled by one E/P transducer. The actuator to be controlled is selected via a 3-way ball valve at the control panel. If electric actuators are used, the system can accommodate three actuators or a combined total of three electrical and pneumatic actuators.

1.5-System Components

1. Oxygen Sensor

The oxygen sensor is field installed in the boiler flue gas outlet to measure oxygen concentration in the flue gases exiting the boiler. The oxygen sensor consists of a direct sampling in-situ (or in-stack) probe. This probe is arranged so that one side of the cell is directly exposed to the flue gases in the stack. The other side is exposed to the ambient air in the boiler room. A heater in the probe assembly heats the cell to an elevated temperature which is controlled by the analyzer with the use of a thermocouple. At this elevated temperature, a reaction occurs within the cell which causes it to produce a small electrical signal which is directed to the analyzer. The signal varies relative to the difference in oxygen concentration in the flue gas and the surrounding ambient air. The oxygen concentration is then transmitted as an analog voltage or current signal to the PLC. The system can use any O_2 sensor/transmitter that can produce a voltage or current signal in linear proportion to the percentage of oxygen in the flue gases.

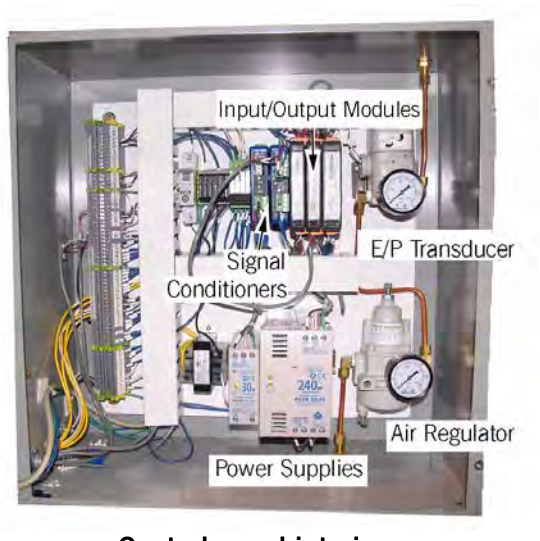
2. Firing Rate Position Sensor

The firing rate position sensor is an enclosed rotary potentiometer installed on the front of the boiler. Its shaft is connected via linkage to the modulating jackshaft. It provides a signal to the PLC that is relative to the burner firing rate.

3. PLC/HMI

The system is controlled by a Programmable Logic Controller (PLC). Operator interface is done via a 6" color touchscreen HMI. Three I/O modules allow the PLC to interface with all the field equipment (trim actuators, oxygen sensor, firing rate sensor, etc.). The PLC communicates with the I/O via Modbus RTU protocol.

HMI



Control panel interior

Since burner excess oxygen levels will vary based on the firing rate, the PLC monitors this rate via the firing rate position sensor. The PLC uses this to determine the proper oxygen setpoint. Since the excess oxygen levels vary with the type of fuel being fired, the PLC has a fuel type input. This input is either a contact input from the burner fuel selector switch or is selected by a push button at the HMI. The proper oxygen setpoints, based on firing rate and type of fuel, are entered into the PLC by the start-up technician. The PLC uses this information to calculate the proper setpoint for the current firing rate and compares it to the measured oxygen signal from the analyzer. A PID algorithm generates a control output which is used to actuate the trim device to bring the oxygen levels to setpoint.

When the boiler is off, purging, or just starting to light off, the measured oxygen will be the same as ambient air, at 20.9%. This value would be well above the desired oxygen setpoints under normal operating conditions. The normal control response would be for the output to try to reduce the oxygen level. For instances like these, the PLC maintains a null (midpoint) output value until the measured oxygen level drops to an acceptable level, at which point it will then begin controlling the fuel-air ratio. This "Trim Enable" level is factory set at 10% O_2 and may be changed by the operator at system startup. Due to the design of the various trim actuators, it is desirable for the PLC output to be at its midpoint whenever it is not controlling. From this point the PLC can either increase or decrease its output to vary the fuel-air ratio.

Due to the design of the gas trim actuator, it is desired to limit the minimum and maximum control output to maintain an acceptable range of control. The PLC incorporates provisions for limiting the output on gas trim.

The PLC also has provisions for re-transmitting the measured oxygen signal to a recorder or other remote device. The PLC also provides two dry contact alarm signals which can be wired to the boiler and/or an alarm annunciator (light, bell, etc.). Such conditions may include low oxygen level, low-low oxygen level, analyzer failure, high flue gas temperature (with an optional temperature transmitter), and several other conditions. See Appendix B for a complete list of alarms available. These contacts are user configurable through via the HMI Alarm Contact Setup screen. Setpoints and time delays for the low O2 and High Stack Temperature alarms are configurable through the Alarm Setup screen at the HMI.

4. Trim Actuators

Fuel trim actuators can be electric or pneumatic. Electric actuators are controlled directly from a 0-10 VDC analog signal from the PLC. Pneumatic actuators are controlled by a 3-15 psi pneumatic signal from an E/P (Voltage to Pneumatic) transducer inside the Oxygen Trim Control Panel. The transducer converts the 0-10 VDC signal from the PLC to the pneumatic signal required by the actuator.

A. Gas Trim (pneumatic) - The gas trim is accomplished by a pneumatic actuator mounted on top of the gas pressure regulator (or in some cases, the regulator pilot). The actuator acts against the spring in the regulator to effectively vary the setpoint of the regulator, which varies the gas flow.

B. Oil Trim (pneumatic) - Oil trim is accomplished by applying the 3-15 psi air signal to the top of the regulator diaphragm on the Cleaver-Brooks Fuel Oil Controller. This effectively varies the set position of the regulator, which varies the oil flow.

C. Gas Trim (electric) - The gas trim is accomplished by applying a 0-10 VDC analog signal directly to an electric actuator mounted on the gas pressure regulator. The actuator acts against the spring in the regulator to effectively vary the setpoint of the regulator, which varies the gas flow.

D. Air Trim (VSD) - Air trim is accomplished by adjusting the speed of the VSD driving the blower motor. The VSD is controlled via a 0-10VDC analog signal from the PLC. The VSD speed is adjusted according to the firing rate signal. Additionally, a trim factor is applied to correct for low or high oxygen conditions.

6. Temperature Transmitter

A thermocouple is field mounted in the boiler outlet, breeching or stack. The thermocouple measures the flue gas temperature. The voltage signal from the thermocouple is converted to a 4-20 milliamp signal

inside the control panel and sent to the PLC. The PLC displays this temperature at the HMI Overview screen. The PLC will also alarm when the high temperature setpoints are exceeded.

7. Oxygen Retransmission (Optional)

A 4-20mA retransmission of the O_2 level can be used to record oxygen levels in the flue gases at a chart recorder or data acquisition system.

1.6-Standard Warranty

The standard warranty on all Cleaver-Brooks products is as set forth in Form C9-188L4, Terms and Conditions of Sale.

SECTION 2

INSTALLATION

2.1-General

The following is the recommended sequence for installing a C-B O_2 Trim System. Do not attempt to proceed with installation and start-up until you have read this manual and understand its contents.

1. Check Boiler and Burner

The burner must be capable of firing within normal values for CO_2, O_2, CO, and smoke spot. The C-B O_2 Trim System will not compensate for abnormal combustion settings. High Turndown and Industrial Watertube burners must have gas spuds installed. The range of values for a properly adjusted burner at high fire are: Oxygen 2%-4.5%, carbon monoxide (gas) 0-400 ppm, smoke spot 0-2 (#2 oil) or 0-4 (#6 oil).

⚠ Caution

The boiler, breeching, and stack MUST be tightly sealed against air infiltration. It is recommended that infinitely adjustable cams be installed to facilitate more accurate adjustment of the oxygen level. Mechanically, all linkage should be in good operating condition. All worn components should be replaced as necessary. The damper should move freely and there should be no excessive "play" in the linkage.

DO NOT PROCEED UNLESS THESE CONDITIONS HAVE BEEN MET.

2. Component Mounting

Mount the control panel, probe, firing rate sensor and pneumatic components and tubing per instructions in this chapter.

3. Mount Trim Actuator(s)

Mount the Fuel Trim or Air Trim components as described in Chapter 3. At the time the actuator is installed, the burner must be able to achieve proper combustion characteristics.

⚠ Warning

Combustion adjustments should only be done by a fully qualified technician familiar with the boiler & burner and equipped with the proper instrumentation.

4. Final Adjustments

Make the final combustion adjustment per Chapter 3 and the Operating Manual for the burner.

2.2-System Requirements

Electrical	120 VAC, 60 Hz, or 110 VAC 50 Hz 6 Amp 3-wire grounded system.
Environmental	Temperature: Control Panel 32-122 °F Firing Rate Sensor 0-180 °F
Air Supply (For pneumatic actuators only)	25-125 PSIG, 2 SCFM CLEAN, DRY instrument quality air Oil content 1 ppm maximum Dew point 35 °F or less at line pressure.

2.3-Determining Locations

The following items are general instructions for determining locations. Figures 2-1 through 2-4 show typical system configurations.

- The interconnecting signal cables between the Control Panel, Probe, and Firing Rate Sensor should be located as far as possible from high voltage wiring and large electrical equipment. Items like the ignition cable and combustion air fan motor can introduce voltage spikes which could upset the operation of the PLC. The signal cables should be run at right angles to any power wiring and must not be routed with any boiler wiring.
- The pneumatic controls should be as close as possible to the trim actuator. A long air line (greater than 60 feet) will delay the response of the system and cause pressure drops. In such cases, 3/8" tubing and a minimum number of elbows should be used.
- The Probe should be located as close to the boiler flue outlet as possible. If there are additional flue mounted items (dampers, economizer, smoke detectors, etc.), the Probe should be the closest item to the boiler.
- The System is supplied with 50 feet of shielded cable for the probe and firing rate sensor wiring. All other cabling and wiring is customer-furnished.
- It is recommended to make electrical connections to the probe using flexible type conduit. The conduit's length should allow for easy removal of the probe.

Figure 2-1 Fuel Trim - Electric and Pneumatic Actuators

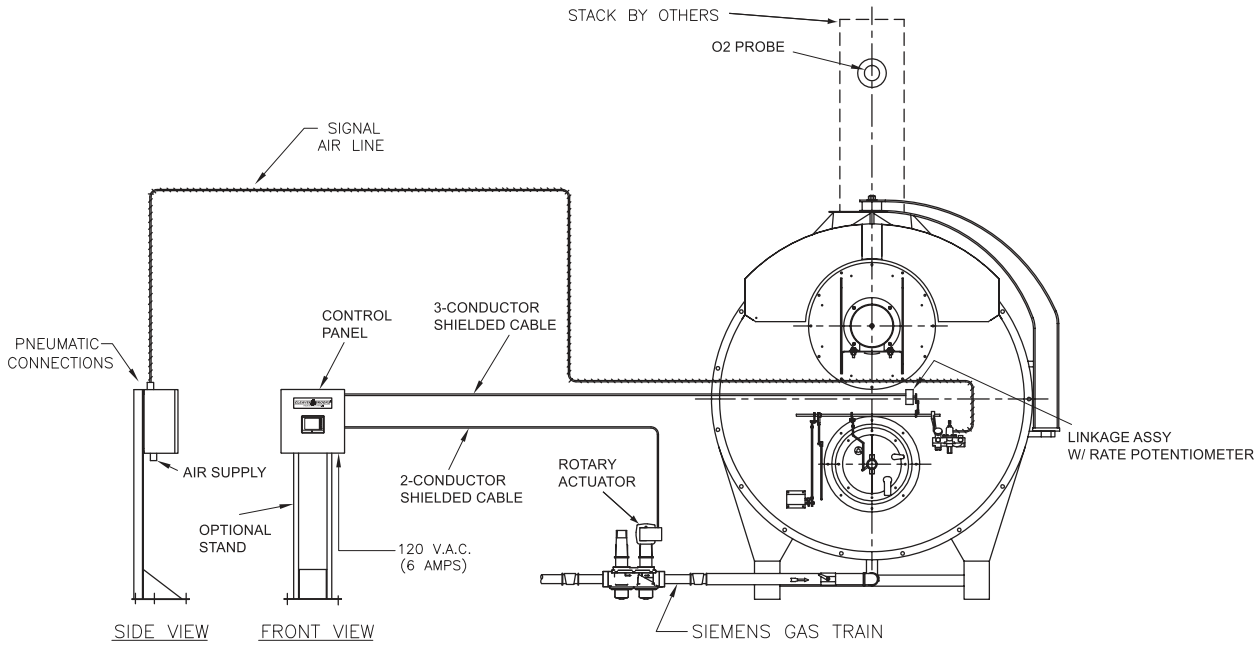


Figure 2-2 Fuel Trim - Electric Actuators Only

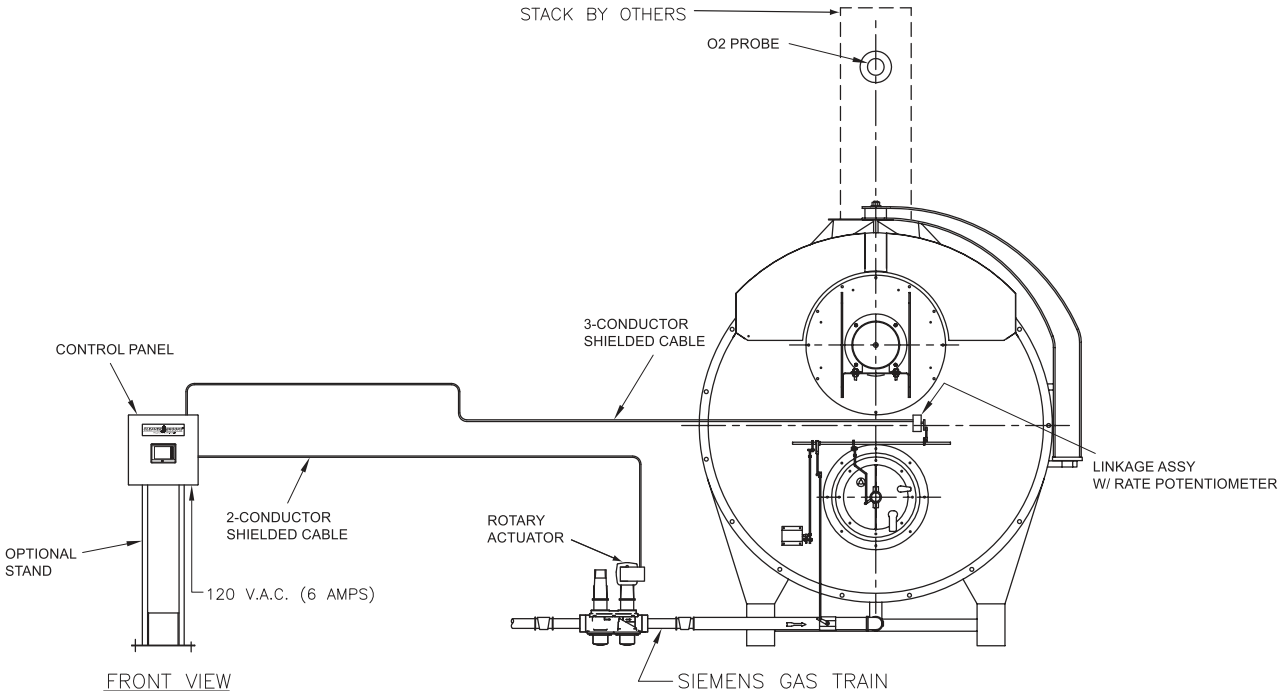


Figure 2-3 Fuel Trim - Pneumatic Actuators Only

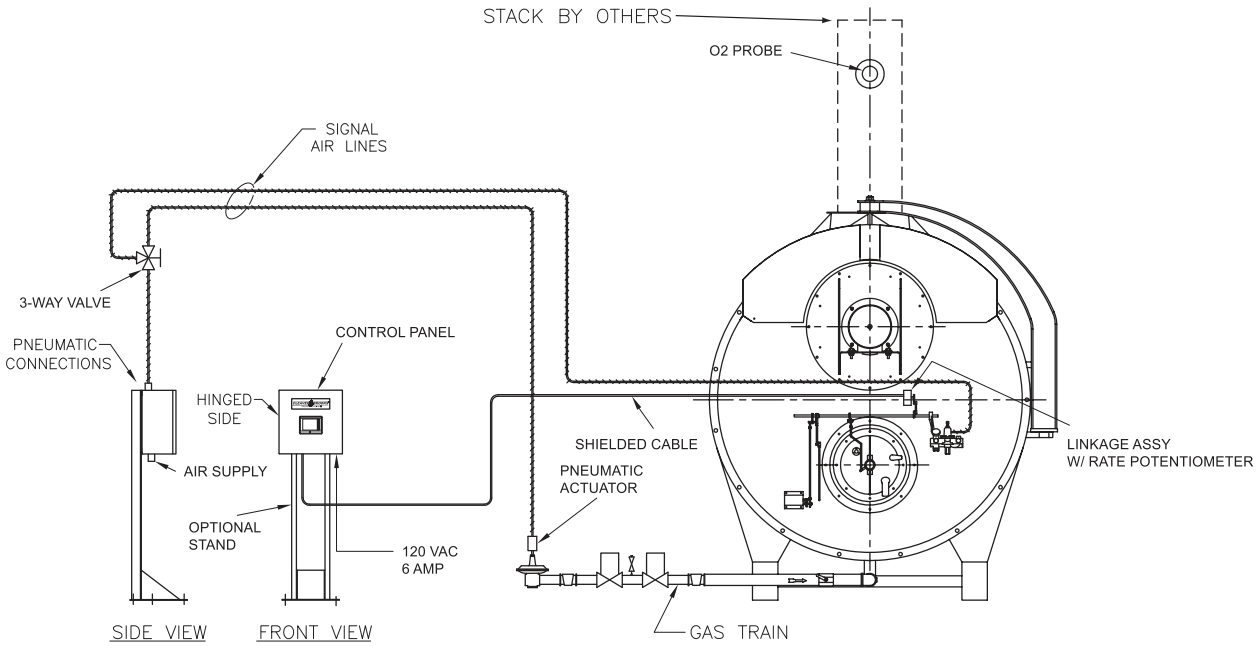
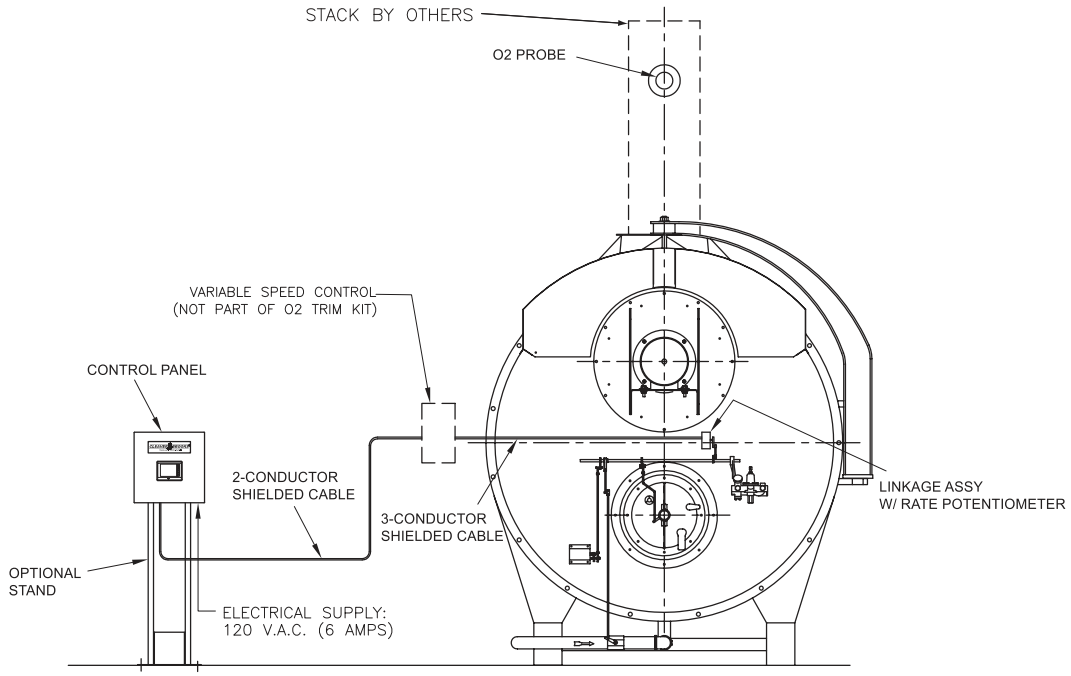


Figure 2-4 VSD Air Trim



2.4-Control Panel

The Control Panel may be mounted on its own (optional) pedestal, a wall, or a convenient post. To avoid excessive heat or vibration, it should not be mounted directly on the boiler. Also, it must be located away from large or high voltage equipment such as power distribution panels, motors, ignition transformers, etc. If pedestal mounted, the base must be securely anchored. A location in the vicinity of the front of the boiler is usually most convenient since it will allow the operator, when working on the controls, to directly see the effects of their actions. This is particularly useful when adjusting a fuel cam.

2.5-Oxygen Probe (C-B)

1. Cut a 2.5 to 3 inch hole in the stack.
2. Insert the sensor probe assembly into the stack and secure with sheet metal screws.
3. Remove the sensor housing back plate, which has the seal tight connector.
4. Connect the seal tight connector onto the sensor housing back plate.
5. Attach the other side of the conduit to the control panel where the O2 analyzer is mounted.
6. Insert the controller cable harness (part #817-04031) through the back plate, seal tight connector, and through the conduit.
7. Wire the harness to the control panel terminal according to the electrical drawings.
8. Connect the connector, which is attached to the controller harness to the mating connector that is exposed at the sensor housing.
9. Insert the connectors into the sensor housing.
10. Secure back plate to the sensor housing.

The probe can be located either in a vertical or horizontal run. For a horizontal location, the probe should be mounted on the side of the duct. The Probe should be located in a position away from bends and elbows.

The placement of the probe is critical in terms of flue gas sampling. Once the general location has been determined it may be necessary to probe the stack with a combustion analyzer. Some boiler and/or stack installations may have dead areas in terms of flue gas flow. With the boiler firing, check for an area within the stack which gives a reliable CO_2 or O_2 reading.

The air tightness of the entire stack and Probe is very important. If there is any air infiltration upstream of the Probe, the oxygen reading will not represent the correct flue gas condition. All leaks must be sealed. This may include any seams, flanges, and probe holes plugged with screws.

2.6-Firing Rate Sensor

The firing rate sensor enclosure contains a potentiometer which translates the jackshaft position into a voltage signal that can be read by the PLC. It is screw mounted to the front head of the boiler or windbox of the burner.

2.7-Pneumatic System

The customer's pneumatic supply is to be brought to the air supply connection on control panel. This supply must be clean, dry instrument quality air. The supply pressure should be a minimum of 25 psig and a maximum of 125 psig at 2.0 CF/h. If instrument quality air is not available, then an additional oil and/or water removing filter(s) is required. A suitable filter will have to be installed upstream of the Control Panel.

2.8-3-Way Ball Valve

On installations which include two fuels that are trimmed pneumatically, it is necessary to switch the control air signal from the E/P transducer to the appropriate fuel actuator. This valve should be installed in a convenient location to facilitate changing fuels. If the system is configured for “Remote” fuel selection, via the boiler fuel selection switch, the valve should be mounted at or near the boiler control panel. If the system is configured for “Local” fuel selection, then the valve should be located at or near the O_2 Trim Panel so that it can be switched at the same time as the fuel selection.

2.9-Wiring

The control panel requires 120 VAC, 6 amp. All wiring must conform to the National Electrical Code (NEC), and all applicable local codes.

Both the firing rate sensor and the probe are connected to the control panel with cables. It is recommended that these cables be kept away from large electrical equipment such as the combustion air fan motor and the ignition transformer. Do not route these signal lines along conduit runs.

Note: Alarm output contacts are rated at 2 amps. If used under more severe conditions, an interposing relay must be used.

SECTION 3

SYSTEM SET-UP AND CONFIGURATION

Milwaukee, Wisconsin
www.cleaver-brooks.com

3.1-PLC Overview

The PLC produces control output signals to the trim device(s). The signals are based on the flue gas oxygen level, type of fuel fired and firing rate. When a low O_2 condition is sensed, the control outputs change to create a leaner fuel/air mix. When a high O_2 condition is sensed, the control outputs change to create a richer fuel/air mix. The PLC also scales and supplies 0-10 VDC or 4-20 mA DC flue gas oxygen percentage signal to be used by a chart recorder or other data acquisition system (supplied by others).

The PLC can log data to a micro SD memory card. When Data Logging is enabled, data for the O_2 level is written once per second to a CSV file on the memory card. A new datalog file is created every hour with a time and date coded filename: MMDDHH.CSV. The data logging can be enabled or disabled via push button at the HMI. The used capacity of the memory card is also displayed at the HMI.

To install a Micro SD card: Align its 8-pin gold edge connector down, facing the front of the HMI. Carefully push it all the way into the Memory slot. Ensure that it clicks into place.

To remove the Micro SD card: Push down on the top of the card gently to release the spring. The card pops up for removal.

3.2-HMI Screens

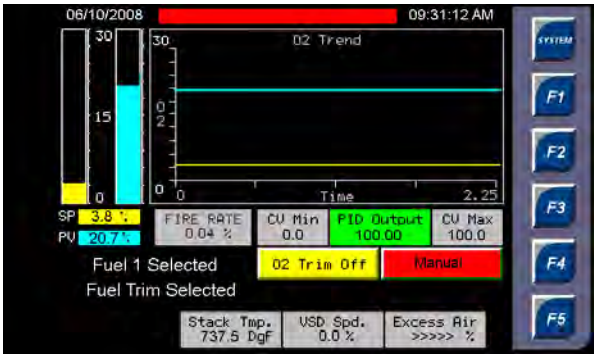
The HMI displays all the information required to set up and operate the *Accu-Trim* O_2 trim system. There are several screens that are used to view and/or change the system parameters.

1. Main Menu Screen

This screen allows access to all the other screens. Pressing the F1 key will display the Overview screen. The F2 key displays the fuel curve configuration menu screen. The F3 key displays the PID menu screen. The F4 key displays the system setup screen. The F5 key displays the alarm screen. Pressing the F1 key while on any other screen will display the main menu screen.

2. System Overview Screen

This screen displays all the pertinent data for the O_2 Trim System. Oxygen setpoint and value are displayed in both bar graph and trend format. The current output and status of the PID control loop are displayed. The current fuel selection and trim method are also displayed.

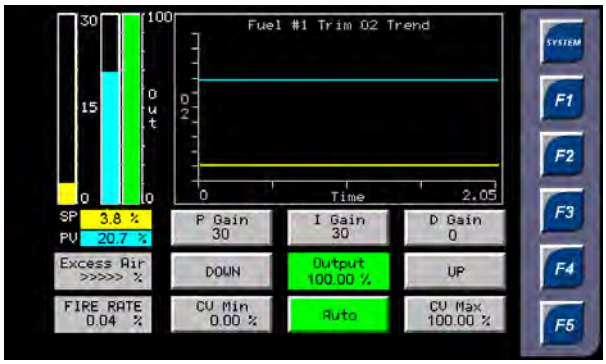


3. PID Menu Screen

This screen allows access to the PID loops that control the trim actuators that can be used by the system.

4. PID Screens (one screen for each trim device)

The PID screens allow the operator to tune the system by adjusting the PID parameters and the low and high limits for the CV. There is a separate PID screen for each trim device (Fuel actuators or VSD).



5. Trim Curve Menu Screen

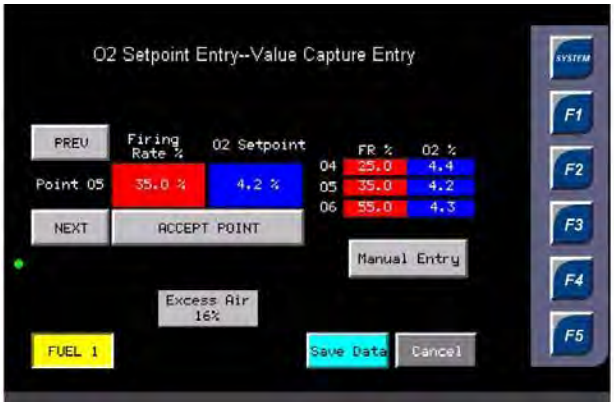
This screen allows access to the O_2 trim curve configuration screen and the firing rate-oxygen setpoint display for each trim device.

6. Trim Curve Display Screens (one screen for each trim device)

This screen displays the firing rate and O_2 setpoints for the selected trim device.

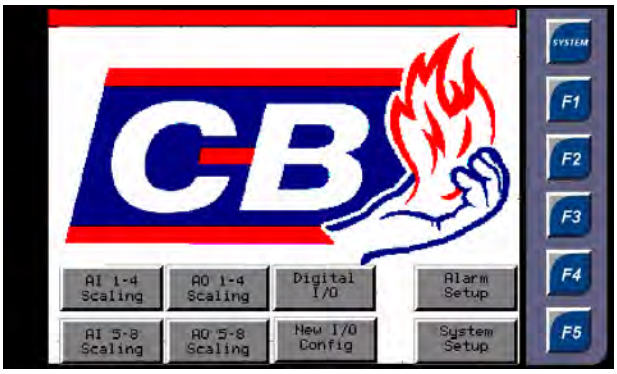
7. Trim Curve Configuration Screen

This screen allows the operator to enter the firing rate breakpoints and Oxygen setpoint for each breakpoint into the system. The breakpoints can be entered manually or by capturing the current values for firing rate and O_2. Up to three (3) curves can be entered (one for each fuel).



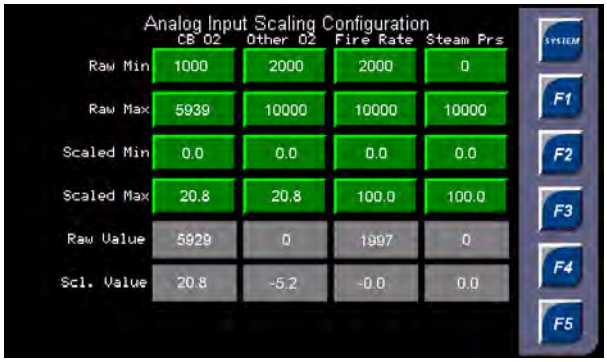
8. System Configuration Menu Screens

This screen allows the operator to access the Analog I/O scaling screens, the Digital I/O screen, the Alarm Setup screen, the System Setup screen, and the I/O Module Configuration Screen.



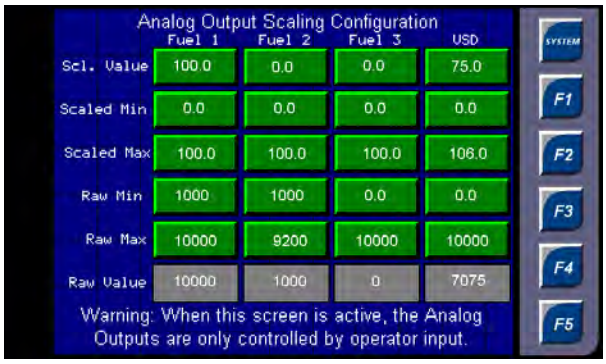
9. Analog Input Scaling Screens

There are two screens for analog input scaling with four (4) channels on each screen. The screen allows the operator to adjust the raw input and scaled values for each analog input point. Normal raw values are 1000 counts per volt of input signal. 4-20 mA signals are treated as 2-10 VDC voltage signals. The scaled values should correspond to the engineering unit range of the transmitter that is wired to the analog channel.



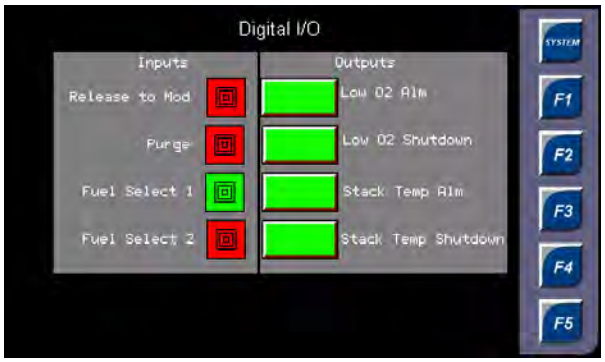
10. Analog Output Scaling Screens

There are two screens for analog output scaling with four (4) channels on each screen. The screen allows the operator to adjust the raw input and scaled values for each analog output point. Note: When this screen is displayed, the normal control values for the analog points are overridden by the values displayed on this screen. Analog output adjustments should not be done while the system is in operation. Normal raw values are 1000 counts per volt of output signal (typically 0-10 VDC). The scaled values should correspond to the engineering unit range of the device that is wired to the analog channel.



11. Digital I/O Screen

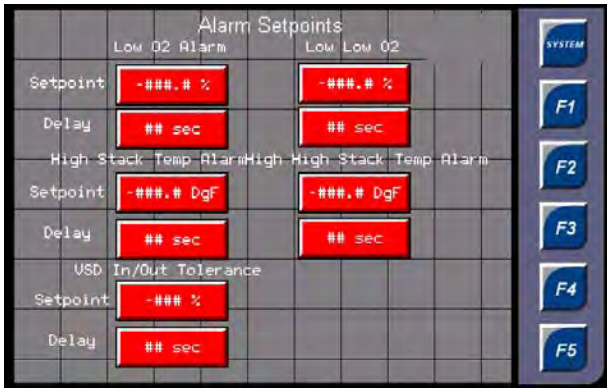
The screen allows the operator to view the status for each digital input point. When an input signal is on, the corresponding indicator for that point is displayed in green. When the input signal is off, the indicator is red. The operator can also view the current status of the output points. The operator is able to 'force' each output to an 'on' state by pressing the button corresponding to the digital output point.



Note: When this screen is displayed, the normal control values for the digital output points may be overridden by operator input. Changes should not be made while the system is in operation.

12. Alarm Setup Screen

The screen allows the operator to enter the setpoints and time delays for the low oxygen and high stack temperature alarm conditions.

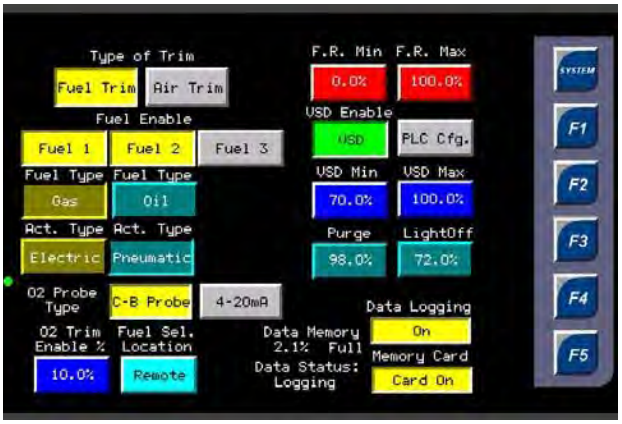


13. Alarm Contact Setup Screen

This screen allows the operator to choose which of the two alarm contact outputs is activated for each of the alarm conditions.

14. System Setup Screen

The screen is used to set the general operating configuration of the system. The parameters include the number of fuels that are to be controlled for trim and the type of trim to be done (Air or Fuel). Setpoints also include the operating range for firing rate and the VSD range. The VSD controls from the minimum setting to the maximum setting over the entire range of firing rate and VSD speeds for purge and light off are also set on this screen. The “Trim Enable” setpoint for oxygen is set from this screen.

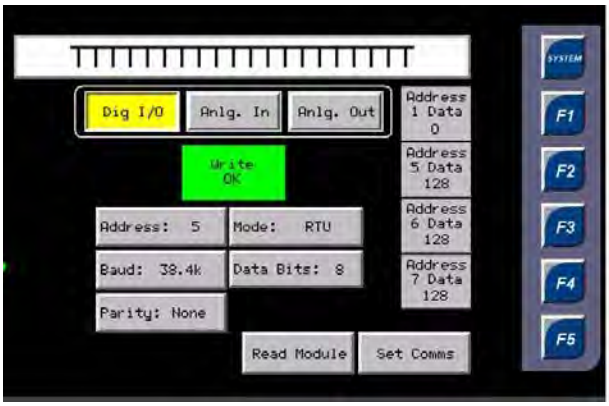


15. I/O Module Configuration Menu Screen

The screen allows the operator to select the screens for setting the communications parameters for new I/O modules or to configure the “safe” states for the output modules.

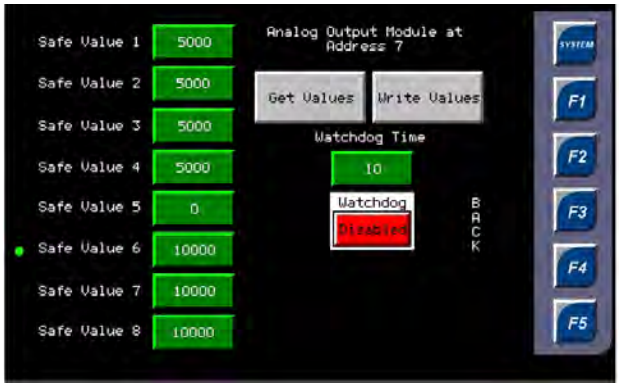
16. New I/O Module Configuration Screen

The screen allows the operator to configure the communications parameters for a new I/O module.



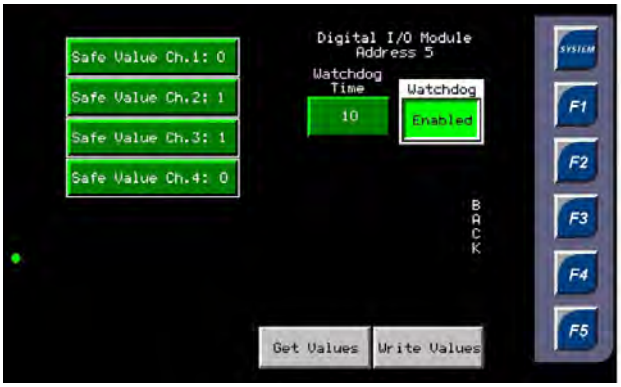
17. Analog Out Configuration Screen

The screen allows the operator to configure the “safe” output states for the analog output module in the event of a communications failure.



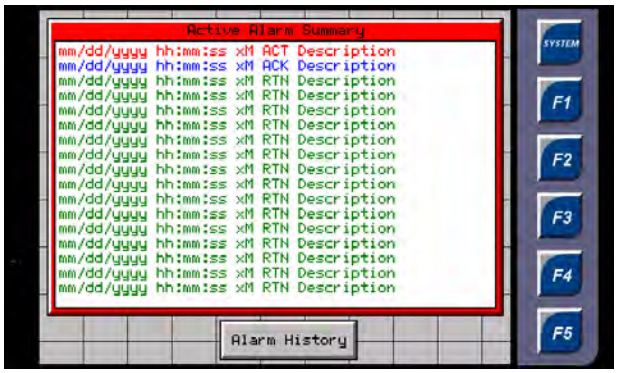
18. Digital I/O Configuration Screen

The screen allows the operator to configure the “safe” output states for the digital I/O module in the event of a communications failure.



19. Alarm Summary Screen

The screen displays the current alarm status of the system. Conditions in Alarm are displayed in red. Conditions that are in alarm and have been acknowledged are displayed in blue. Conditions that are out of alarm, but have not been acknowledged are displayed in green. The alarms are displayed with the date and time of their occurrence.



20. Alarm History Screen

The screen displays the alarm history of the system. The alarms are displayed with the date and time of their occurrence.

3.3-Control Terminology

PV (Process variable): Displays flue gas oxygen in % by volume.

SP (Setpoint): Displays flue gas oxygen setpoint in % by volume.

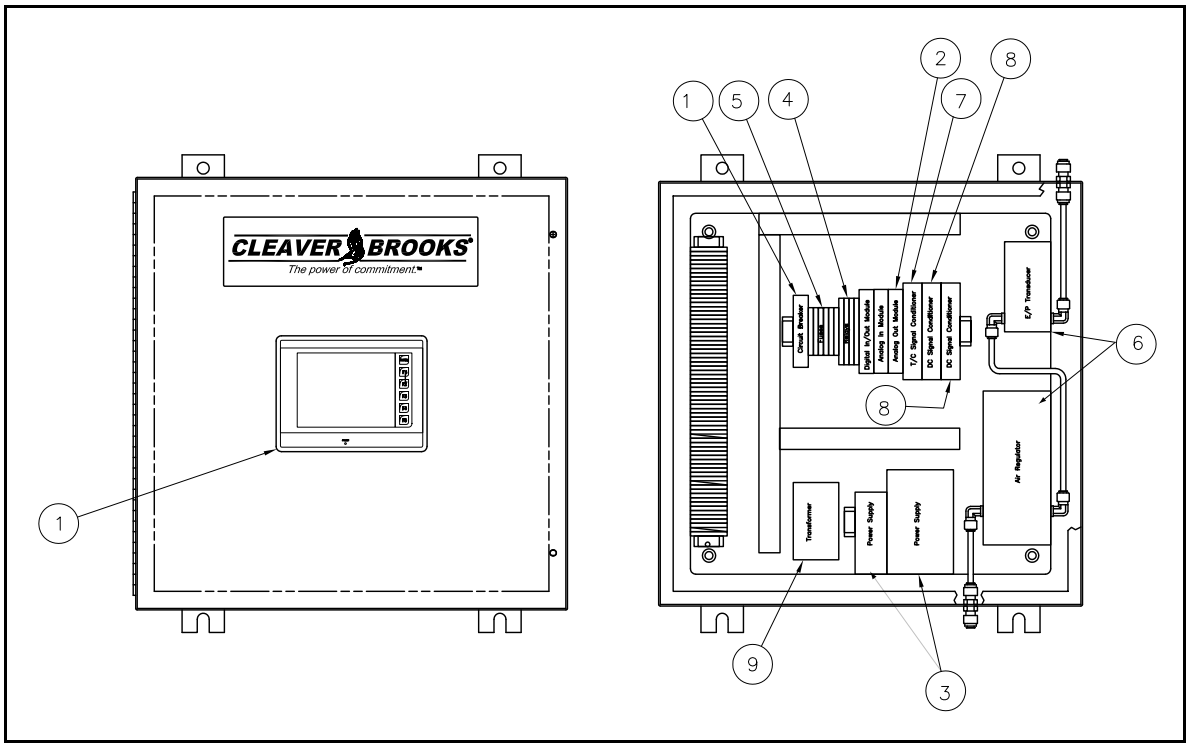
CV (Control variable): Displays control algorithm output.

The PLC has been programmed at the factory; however, there are several parameters that are specific to the job site. These parameters will be referred to in the set up section of this chapter. Please read this chapter before making any adjustments.

3.4-Control Panel

(1) HMI Display – The PLC has a built-in color touch screen display. It shows all the information pertaining to the O_2 Trim system and is the means for operator interface to the PLC. All operating parameters are entered and/or adjusted via this touchscreen interface.

(2) I/O Modules – The field mounted devices are controlled by the PLC via I/O modules. The I/O modules consist of three different types--Analog Input, Analog Output, and Digital I/O. The analog input module accepts analog signals from field devices such as the O_2 and temperature transmitters. The analog output module transmits analog control signals to the trim actuators or chart recorders. The digital I/O module accepts discrete signals such as fuel selection and outputs discrete signals such as alarm contact closures.



(3) Power Supplies – The 24 VDC power supply mounted on the back panel provides power to all the components in the control panel. The 12 VDC power supply provides power for the Firing Rate Potentiometer signal to the PLC.

(4) Relays – The relays provide signal isolation from the 120 VAC signals from the flame safeguard or boiler selection switch and the discrete I/O module.

(5) Circuit Breaker/Fuse Blocks – These provide protection from electrical shorts caused by improper wiring or damaged electrical equipment.

(6) Pneumatic Regulator and E/P Transducer – On installations with pneumatic actuators a regulator and E/P transducer are used. The regulator provides regulated air to the E/P transducer at the proper pressure. The E/P transducer provides a 3-15 psi control signal to the trim actuator. If more than one pneumatic trim actuator is used, a three way ball valve is used to route the control air signal to the correct actuator.

(7) Thermocouple to Analog Signal Converter – This device converts the millivolt signal from the stack thermocouple to a 4-20 mA analog signal that can be read by the PLC.

(8) DC Signal Converter – This device is used to isolate the 0-10 VDC analog signal from the PLC to be used by the E/P transducer. A second converter may be used to provide a 4-20 mA analog signal for the optional O_2 retransmission signal.

(9) Transformer – This device is used on installations that require 24 VAC power to operate the fuel trim actuator. The transformer steps down the 120 VAC panel power to 24 VAC for use by the actuator.

3.5-Placing System Into Operation

It is suggested the following sequence be used when the C-B O_2 Trim System is started for the first time.

If, at any time, the expected result is not obtained, see the troubleshooting chapter.

Before applying power to the unit inspect all wiring.

A. Control Air Pressure Adjustment

Loosen the lock nut on the air pressure regulator. Set the instrument air to 20 psig by rotating the adjustment screw on the top of air pressure regulator. Tighten the lock nut.

B. Supplying Power to the System

Check that the supplied voltage is 120 VAC (+/- 10%). Turn on the main power breaker. The PLC will power up, however the O_2 sensor will require a 10 minute warm up period in order to function properly.

C. System Configuration

The system needs to be configured to reflect the various options that have been selected for the installation.

1. Go to the Setup Screen Menu at the HMI.
2. Select the “System Setup” button to go to the setup screen (password protected).
3. Select the type of trim to be used by the system (Air or Fuel)
4. Enable the fuels to be used. Up to three fuels may be selected.
5. Select the type of fuel (Gas or Oil) for each of the fuels used. This is used to calculate the excess air percentage.
6. Select the type of actuator (Electric or Pneumatic) used for each of the fuels used for trim (fuel trim only).
7. Select the type of O_2 transmitter used by the system. The C-B O_2 transmitter should be wired to the first analog input channel. If a 4-20mA transmitter is used, it should be wired to the second analog input channel. Refer to the electrical drawings for the correct wiring configuration.
8. Select the low and high limits for the firing rate signal. This should correspond to the analog input scaled value at the low and high fire positions.
9. Enable or Disable the VSD as appropriate for the installation.
10. If the VSD is enabled, select the low and high speeds for the VSD. At low fire, the VSD will be run at the low speed setpoint. As the burner goes to high fire, the VSD speed will increase linearly with firing rate toward the high speed setpoint. At high fire, the VSD will be running at the high speed setpoint. This setting does not include any trim corrections that may be applied during system operation.

11. Select the O_2 trim enable percentage. This is the value of O_2 at which the trim system will start controlling. The control outputs are held at the null position until the O_2 readings fall below this value.
12. Select the location of the fuel selection signal. The “Remote” setting uses digital inputs from a fuel selector switch that is typically mounted at the boiler control panel. The “Local” setting uses information entered at the HMI overview screen to determine which fuel is currently being fired.

D. Oxygen Analyzer Calibration (C-B probe only)

The Oxygen sensor is automatically calibrated to read 20.8% O_2 at the end of the purge cycle. If the voltage signal from the sensor falls above or below a normal range, a calibration failure will be alarmed. Analyzer output range must correspond to the analyzer span. Adjustments are made on the Analog Input setup screen. A “Raw Minimum” value of 1000 corresponds to a 1 VDC minimum input signal. A “Raw Maximum” value of 6000 corresponds to a 6 VDC maximum input signal. The scaled minimum and maximum values correspond to the actual oxygen values at the zero and span points of the transmitter. The C-B O_2 transmitter input scaling is adjusted at AI 1. O_2 transmitters that provide a 4-20 mA signal are adjusted at AI 2.

E. Firing Rate Potentiometer Calibration

Turn the boiler off. Mount the firing rate potentiometer on the boiler front. Make sure that there is no binding. The potentiometer should be mounted so that the damper reaches the fully closed position before the potentiometer reaches the lower limit of travel. Ideally, the firing rate signal to the PLC should be around 2 volts (raw input value of 2000) at the low fire position. The firing rate potentiometer signal is displayed on the Overview screen. To get to this screen go to the Main menu and press the F1 key.

Modulate mod motor from low to high fire. The displayed firing rate value should increase. If it does not, reverse the connections of the red and black wires.

To calibrate the potentiometer, go to the setup screen for AI 1-4. AI 3 is the input for firing rate. At low fire, the scaled value should read zero. If it does not, adjust the value of the “Raw Min Value” to match the “Raw Value” display. At high fire, the scaled value should read 100. If it does not, adjust the value of the “Raw Max Value” to match the “Raw Value” display. The “Scaled Min” and “Scaled Max” values should be set for 0 and 100 respectively.

F. Voltage Output to Pneumatic Transducer Calibration

The purpose of an E/P transducer is to convert the electrical voltage (0-10 VDC) signal to the pneumatic 3-15 psig signal. It must be calibrated to insure proper actuation of the regulator. These steps only apply to systems that employ pneumatic actuators for fuel trim.

To check a calibration of the E/P transducer:

1. Turn the boiler off.
2. Go to the setup screen for AO 1-4.
3. Refer to the electrical drawings to determine which channel controls the pneumatic actuator.
4. Enter “0” for the scaled value for the correct AO channel for the E/P.
5. The pressure gauge on the E/P transducer must display 3 psig, if not adjust the pressure by turning E/P transducer "zero" adjustment screw.
6. Enter “100” for the scaled value for the correct AO channel for the E/P.
7. The pressure gage on the E/P transducer should display 15 psig. If not, adjust the pressure by turning the E/P transducer's "span" adjustment screw.

Repeat steps 4 - 7 until stable readings are achieved at both “0” and “100” points.

3.6-Fuel Trim — Mounting Actuators and Setting Combustion

The CB Oxygen Trim System allows for either Fuel Trim or Air Trim. Each case requires a different means of actuation.

When a single fuel is being trimmed pneumatically, tubing is run from the outlet of the voltage-to-pneumatic (E/P) converter to the fuel pressure reducing valve (PRV) in the fuel train. When two fuels are being controlled pneumatically, individual lines must be run to each fuel pressure regulator/actuator. In this situation, the pneumatic system is equipped with a three way ball valve fed with the control air signal from the E/P transducer. The position of this valve determines which actuator will receive the signal from the E/P transducer.

The tubing line from the E/P converter to the actuator must be copper tubing at least 1/4" OD for runs less than 50 feet. For runs over 50 feet use 3/8" tubing. The tubing lines should contain a minimum number of elbows.

A. Installation (Oil) - The air pressure signal from the E/P transducer is applied to the upper side of the PRV diaphragm in the Cleaver-Brooks Fuel Oil Controller. The full 3 to 15 psig span of the output is used to vary the fuel flow to the burner by exerting a variable force to the top of the side PRV diaphragm. A change of approximately 9% in fuel flow is expected from the force applied.

⚠ Caution

The following adjustments must ONLY be performed by a qualified boiler service technician fully familiar with burner operation.

1. Make sure that proper fuel is selected.

Note:Fuel selection is done either by pressing the key on the PLC or a fuel selector contact on the boiler panel. If more than one fuel is using a pneumatic actuator, the ball valve must also be moved to the correct position for the fuel being fired.

2. At the HMI screen, go to the PID loop for oil. Set PID loop for oil to manual. This will result in the output from the E/P to be at 50%, i.e. 9 psig.
3. Turn the boiler ON and slowly increase the firing rate to high fire.
4. Adjust the screw of the fuel oil control regulator until the oxygen readout is at the desired level.
5. Once the fuel pressure has been tuned at high fire, adjust each of the cam screws in order as the firing rate is reduced to low fire. This will obtain the correct oxygen level.

While making adjustments fill in Chart 1 below.

Chart 1 - Combustion settings, oil fuel trim

	Firing Rate %		Oxygen %	
Break Point	Factory Set	Actual Set	Factory Set	Actual Set
1	0		8.5	
2	5		8.5	
3	10		8.0	
4	15		7.5	
5	20		7.0	
6	25		6.5	
7	30		6.0	
8	40		5.5	
9	50		5.0	
10	60		4.5	
11	100		4.5	

6. Run the boiler between low and high fire several times to ensure the combustion settings are correct.
7. Enter the oxygen setpoint curve at the HMI. This may be done by two methods: Manual Entry or Value Capture.

To enter the curve data manually:

a. Go to the Configuration screen menu.
b. Select the 'Curve Config' button at the right side of the screen (password protected).
c. On the curve configuration screen, select the fuel that corresponds to oil. It should highlight yellow to indicate that the PLC is ready to edit the configuration.
d. Enter the firing rate percentage and Oxygen setpoint for each breakpoint. Press the "Accept Point" button after the entries are complete for each breakpoint. The system will then increment to the next breakpoint. The "Next" and "Previous" buttons may be used to view or reset other breakpoints.
e. When all setpoints have been entered, press the "Save Data" push button.

To enter the curve data with the Value Capture method:

a. Go to the Configuration screen menu.
b. Select the 'Curve Config' button at the right side of the screen (password protected).
c. On the curve configuration screen, press the "Value Capture" push button. The HMI will display the Value Capture curve entry screen. Note: The "Value Capture" push button will only appear when the boiler is running and O_2 trim is enabled.
d. On the HMI screen, select the fuel that corresponds to oil. It should highlight yellow to indicate that the PLC is ready to edit the configuration.
e. The current firing rate and O_2 value will be displayed for the current breakpoint. Use the "Next" and "Previous" buttons to change the current breakpoint. Increase or decrease the firing rate of the boiler to correspond to the breakpoint to be entered.
f. Press the "Accept Point" button to save the current firing rate and O_2 values as the setpoints for the breakpoint. The system will then increment to the next breakpoint. The "Next" and "Previous" buttons may be used to view or reset other breakpoints.
g. Repeat until all breakpoints have been set. When all setpoints have been entered, press the "Save Data" push button.

The oxygen setpoint depends on the firing rate signal. An oxygen setpoint curve is field adjustable. There are break points where a setpoint can be fixed at 11 different firing rates. It is recommended to have more break points at the lower firing rates, as shown in Chart 1.

B. Installation — Gas (pneumatic actuator)

A pneumatic actuator is attached to the gas pressure regulator to provide a means of increasing and decreasing the regulated gas pressure by small amounts. Before the actuator mounting, rough adjustments of the combustion must be made. When ready to install the actuator, shut the boiler down or operate it on oil if it is a combination fired burner. For safety's sake, eliminate the gas pressure on the regulator diaphragm by shutting off upstream gas cock. Remove the cap from the regulator. If an actuator extension is necessary, measure the distance from the top of the regulator neck to the spring retainer. Mark this distance on the actuator adapter (the distance from the top of the actuator spring retainer to the actuator adapter). Remove the regulator spring tension screw. Screw the actuator adapter into the regulator, neck up, to the mark which was just made. Attach the pneumatic signal line to the top of the actuator.

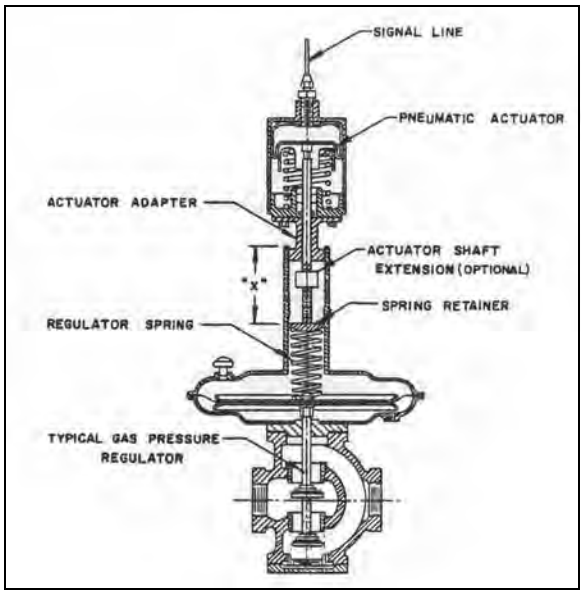


Figure 3-1 Gas Pressure Regulator

For some specific regulators, an actuator shaft extension is supplied to compensate for a long regulator neck. The shaft extension may have to be shortened with a hacksaw to an appropriate length. This length is determined by the previous method of locating the distance from the regulator neck down to the spring screw. Also allow additional shaft extension length so that when the actuator adapter is screwed into the regulator neck, there will be at least four threads exposed on the regulator neck. Once the shaft extension length is fixed, remove the regulator spring tension screw. Screw the actuator adapter into the regulator neck down to where approximately four threads are engaged. Attach the pneumatic signal to the top of the actuator.

When trimming gas, the output signal is applied to the trim device (air cylinder) mounted on of the gas pressure regulator (PRV). The signal causes the device to provide small changes in the regulated gas pressure. This pressure change is sufficient to cause a maximum change of 9% in gas flow.

⚠ Caution

The following adjustments must ONLY be performed by a qualified boiler technician familiar with burner operation.

1) Make sure that proper fuel is selected.

Note:Fuel selection is done either by pressing the key on the PLC or a fuel selector contact on the boiler panel. If more than one fuel is using a pneumatic actuator, the ball valve must also be moved to the correct position for the fuel being fired.

2) Set PID loop for gas to manual. This is done by going to the PID screen for the fuel to be trimmed. Decrease PID output to 0.

4) Turn the boiler on and modulate it to approximately screw # 4.

5) Slowly increase output of the PLC until gas pressure starts to change. Make a record of the control output at this position. This is the low gas output limit. Make a record of the excess air value displayed on the HMI.

6) Go to the PID screen and enter this value as the “CV Min” value.

7) Slowly increase output of the PLC until the excess air value displays value 0.18 lower than recorded at step 5. Record the control output at this position. This is the high gas output limit.

8) Go to the PID screen and enter this value as the “CV Max” value.

9) Manually adjust output of the PID loop until the CV displays 50%

10) Slowly modulate boiler to the high fire position. Adjust gas pressure by screwing actuator up or down to obtain desired oxygen level.

11) Once the fuel pressure has been adjusted at high fire, adjust each of the cam screws in order as the firing rate is reduced to low fire to obtain the correct oxygen level.

While making adjustments fill in Chart 2 below.

Chart 2 - Combustion settings, gas fuel trim

	Firing Rate %		Oxygen %	
Break Point	Factory Set	Actual Set	Factory Set	Actual Set
1	0		8.5	
2	5		8.5	
3	10		8.0	
4	15		7.5	
5	20		7.0	
6	25		6.5	
7	30		6.0	
8	40		5.5	
9	50		5.0	
10	60		4.5	
11	100		4.5	

12) Run the boiler between low and high fire several times to ensure the combustion settings are correct.

13) Enter the oxygen setpoint curve at the HMI. This may be done by two methods: Manual Entry or Value Capture.

To enter the curve data manually:

a. Go to the Configuration screen menu.
b. Select the 'Curve Config' button.
c. On the curve configuration screen, select the fuel that corresponds to gas. It should highlight yellow to indicate that the PLC is ready to edit the configuration.
d. Enter the firing rate percentage and Oxygen setpoint for each breakpoint. Press the "Accept Point" button after the entries are complete for each breakpoint. The system will then increment to the next breakpoint. The "Next" and "Previous" buttons may be used to view or reset other breakpoints.
e. When all setpoints have been entered, press the "Save Data" push button.

To enter the curve data with the Value Capture Method:

a. Go to the Configuration screen menu.
b. Select the 'Curve Config' button.
c. On the curve configuration screen, press the "Value Capture" push button. The HMI will display the Value Capture curve entry screen.
d. On the HMI screen, select the fuel that corresponds to gas. It should highlight yellow to indicate that the PLC is ready to edit the configuration.
e. The current firing rate and O_2 value will be displayed for the current breakpoint. Use the "Next" and "Previous" buttons to change the current breakpoint. Increase or decrease the firing rate of the boiler to correspond to the breakpoint to be entered.

- Press the "Accept Point" button to save the current firing rate and O_2 values as the setpoints for the breakpoint. The system will then increment to the next breakpoint. The "Next" and "Previous" buttons may be used to view or reset other breakpoints.
- Repeat until all breakpoints have been set. When all setpoints have been entered, press the "Save Data" push button.

The oxygen setpoint depends on the firing rate signal. An oxygen setpoint curve is field adjustable. There are break points where a setpoint can be fixed at 11 different firing rates. It is recommended to have more break points at the lower firing rates, as shown in Chart 2.

C. Installation — Gas (electric actuator)

An electric actuator is attached to the gas pressure regulator to provide a means of increasing and decreasing the regulated gas pressure by small amounts. Before mounting the actuator rough adjustments of the combudstion must be made at the regulator. The rough pressure adjustments are made with the large spring and a screw-in spring retainer. The fine pressure adjustments are made with a smaller spring and the electric actuator. Remove the cap from the regulator and unscrew the brass retainer.

Place the smaller spring on the pointed end of the of the spring holder. Place the larger spring over the smaller spring and reinsert the entire assembly into the regulator. Screw the brass retainer into the regulator until the measured gas pressure reaches the desired level. Place the electric actuator onto the regulator valve. Use a 1-1/4" open-end wrench to tighten the coupling piece. Remove the cover and complete the wiring as shown in the electrical drawings. Make fine adjustments to the gas pressure by inserting a long, flat blade screwdriver through the white actuator shaft. The screw should be adjusted so that pressure changes can be observed as the actuator is moved. Replace the cover on the actuator. The actuator can be forced to any position by going to the PID loop screen for the fuel to be trimmed by the actuator. Place the loop into "Manual" mode and press the "Open" or "Close" buttons as required to move the actuator.

⚠ Caution

The following adjustments must ONLY be performed by a qualified boiler technician familiar with burner operation

1) Make sure that proper fuel is selected.

Note:Fuel selection is done either by pressing the key on the PLC or a fuel selector contact on the boiler panel.

2) Set PID loop for gas to manual. This is done by going to the PID screen for the fuel to be trimmed. Set PID output to the null (50%) position.

3) Turn the boiler on and modulate it to approximately screw # 4.

4) Slowly decrease output of the PLC. The O_2 readings should increase as the actuator closes. If the O_2 readings are not affected by the change in output, make fine adjustments at the actuator as described above.

5) Slowly increase output of the PLC. The O_2 readings should increase as the actuator opens. If the O_2 readings are not affected by the change in output, make fine adjustments at the actuator as described above.

6) Manually adjust output of the PID loop until the CV displays 50%

7) Slowly modulate boiler to the high fire position. Adjust gas pressure by moving the PID loop output actuator up or down to obtain desired oxygen level.

8) Once the fuel pressure has been adjusted at high fire, adjust each of the cam screws in order as the firing rate is reduced to low fire to obtain the correct oxygen level.

While making adjustments fill in the following Chart 3.

Chart 3 - Combustion settings, gas fuel trim

	Firing Rate %		Oxygen %	
Break Point	Factory Set	Actual Set	Factory Set	Actual Set
1	0		8.5	
2	5		8.5	
3	10		8.0	
4	15		7.5	
5	20		7.0	
6	25		6.5	
7	30		6.0	
8	40		5.5	
9	50		5.0	
10	60		4.5	
11	100		4.5	

9) Run the boiler between low and high fire several times to ensure the combustion settings are correct.

10) Enter the oxygen setpoint curve at the HMI. This may be done by two methods: Manual Entry or Value Capture.

To enter the curve data manually:

a. Go to the Configuration screen menu.
b. Select the 'Curve Config' button.
c. On the curve configuration screen, select the fuel that corresponds to gas. It should highlight yellow to indicate that the PLC is ready to edit the configuration.
d. Enter the firing rate percentage and Oxygen setpoint for each breakpoint. Press the "Accept Point" button after the entries are complete for each breakpoint. The system will then increment to the next breakpoint. The "Next" and "Previous" buttons may be used to view or reset other breakpoints.
e. When all setpoints have been entered, press the "Save Data" push button.

To enter the curve data with the Value Capture Method:

a. Go to the Configuration screen menu.
b. Select the 'Curve Config' button.
c. On the curve configuration screen, press the "Value Capture" push button. The HMI will display the Value Capture curve entry screen.
d. On the HMI screen, select the fuel that corresponds to gas. It should highlight yellow to indicate that the PLC is ready to edit the configuration.
e. The current firing rate and O_2 value will be displayed for the current breakpoint. Use the "Next" and "Previous" buttons to change the current breakpoint. Increase or decrease the firing rate of the boiler to correspond to the breakpoint to be entered.
f. Press the "Accept Point" button to save the current firing rate and O_2 values as the setpoints for the breakpoint. The system will then increment to the next breakpoint. The "Next" and "Previous" buttons may be used to view or reset other breakpoints.
g. Repeat until all breakpoints have been set. When all setpoints have been entered, press the "Save Data" push button.

The oxygen setpoint depends on the firing rate signal. An oxygen setpoint curve is field adjustable. There are break points where a setpoint can be fixed at 11 different firing rates. It is recommended to have more break points at the lower firing rates, as shown in Chart 3.

3.7-Air Trim — Adjusting VSD Range and Setting Combustion

When Air Trim is used to control the oxygen level in the flue gas, a single VSD is used regardless of the number of fuels the burner is equipped to fire. The VSD controls the blower motor from a minimum to maximum speed as the burner goes from low to high fire. In addition, the VSD will also control according to a trim factor, which will adjust the VSD speed by up to 10% to bring the measured oxygen value to setpoint.

⚠ Caution

The following steps must ONLY be performed by a qualified boiler service technician fully familiar with burner operation.

1) Make sure that “Air Trim” is selected at the HMI.
2) On the Air Trim PID screen, set the “Min CV” to 0.9 and the “Max CV” to 1.1. These values should result in a +/- 10% trim range for the VSD.
3) Place Air Trim PID in manual and drive the control output to the null (1) position.
4) Turn the boiler on and modulate it to low fire.
5) Slowly modulate boiler to the high fire position. Adjust fuel pressure by screwing actuator up or down to obtain desired oxygen level.
6) Reduce the firing rate while adjusting each of the cam screws in order as the firing rate is reduced to low fire to obtain the correct oxygen level.

While making adjustments fill in Chart 4 below.

Chart 4 - Combustion settings, VSD air trim

	Firing Rate %		Oxygen %	
Break Point	Factory Set	Actual Set	Factory Set	Actual Set
1	0		8.5	
2	5		8.5	
3	10		8.0	
4	15		7.5	
5	20		7.0	
6	25		6.5	
7	30		6.0	
8	40		5.5	
9	50		5.0	
10	60		4.5	
11	100		4.5	

7) Run the boiler between low and high fire several times to ensure the combustion settings are correct.
8) Enter the oxygen setpoint curve at the HMI. This may be done by two methods: Manual Entry or Value Capture.

To enter the curve data manually:

a. Go to the Configuration screen menu.
b. Select the 'Curve Config' button.
c. On the curve configuration screen, select the fuel being fired. It should highlight yellow to indicate that the PLC is ready to edit the configuration.
d. Enter the firing rate percentage and Oxygen setpoint for each breakpoint. The system will then increment to the next breakpoint. The "Next" and "Previous" buttons may be used to view or reset other breakpoints.
e. When all setpoints have been entered, press the "Save Data" push button.

To enter the curve data with the Value Capture Method:

a. Go to the Configuration screen menu.
b. Select the 'Curve Config' button.
c. On the curve configuration screen, press the "Value Capture" push button. The HMI will display the Value Capture curve entry screen.
d. On the HMI screen, select the fuel being fired. It should highlight yellow to indicate that the PLC is ready to edit the configuration.
e. The current firing rate and O_2 value will be displayed for the current breakpoint. Use the "Next" and "Previous" buttons to change the current breakpoint. Increase or decrease the firing rate of the boiler to correspond to the breakpoint to be entered.
f. Press the "Accept Point" button to save the current firing rate and O_2 values as the setpoints for the breakpoint. The system will then increment to the next breakpoint. The "Next" and "Previous" buttons may be used to view or reset other breakpoints.
g. Repeat until all breakpoints have been set. When all setpoints have been entered, press the "Save Data" push button.

The oxygen setpoint depends on the firing rate signal. The oxygen setpoint curve is field adjustable. There are break points where a setpoint can be fixed at 11 different firing rates. It is recommended to have more break points at the lower firing rates, as shown in Chart 4. Repeat the chart entry and curve configuration for each fuel to be fired in the air trim configuration.

3.8-Adjusting the Response of the PLC

Response of the PLC can be changed by setting the PID parameters for the appropriate trim device. P is proportional band, I is integral time and D is derivative time. It is recommended to keep D = 0. Small values for P and I result in the slowest/smallest response.

With boiler firing at low fire manually increase the firing rate to the 3rd or 4th cam screw. Observe the value PV (oxygen reading) and SP (setpoint) on the HMI screen. Control Value output (CV) will move from the "null" value to bring the Oxygen PV to match the SP value. If the PV reading oscillates around SP (overshoot) slow the response, if it takes a long time for PV to match SP make the response faster by adjusting proportional band, integral time and derivative time.

⚠ Caution

The following adjustments must ONLY be performed by a qualified boiler service technician fully familiar with burner operation.

To adjust above parameters use the following method:

- When applying the controller to an unknown process, it is useful to examine the performance of the process in manual mode. This can be useful in estimating the proportional band, integral time and derivative time required for automatic mode.
- For example, if a small change in the PLC output causes a large fluctuation in the process variable value, the value of the Proportional variable must be decreased to assure stability. In the converse case, the Proportional variable must be increased.
- For a process which responds quickly to a change in the PLC output, the Integral setting shuold be relatively high. Conversely, for a process having a long recovery time, the Integral setting should be relatively low.

SECTION 4

MAINTENANCE AND TROUBLESHOOTING

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With normal care, very little maintenance should be required for the CB Accu-Trim system. The table below will assist with basic troubleshooting should problems occur.

4.1-Basic Troubleshooting

Problem	Possible Cause	Action
No display at HMI	Power Failure	Check supply voltage to the panel is 120 VAC +/- 10% Check supply voltage to the HMI is 24 VDC.
	Tripped circuit breaker or blown fuse	Check circuit breaker and fuses inside the control panel. 24 VDC power supply should have a green LED to indicate power
I/O Failure Alarms	Blown Fuse/Power Failure	I/O modules should have a green LED lit to indicate power. Check fuse F-5
	Communications Cable loose	Check communications cable connections
Oxygen continuously lower or higher than setpoint	PID loop in manual	Change PID loop to Auto
	Air supply pressure is low	Verify that supply pressure is at least 25 psi
	E/P pneumatic signal not responding to control signal	Manually change the analog output for the E/P. Verify that the 3-15 psi control signal changes with the analog output setting.
	E/P pneumatic signal not responding to control signal	Manually change the analog output for the E/P while measuring the voltage level of the signal. Verify that the electric control signal to the E/P changes with the analog output setting.
	PID loop too slow	Adjust values for P, I and D to provide a better response
	O_2 Transmitter Failure	Verify O_2 reading with a calibrated analyzer.
	Release for modulation signal not received at PLC	Verify that “O2 Trim On” message is displayed on the HMI Overview screen.
	Release for modulation signal not received at PLC	Verify that CR-2 is pulled in. An LED on the relay indicates the presence of a control signal at the relay coil.
Oxygen Setpoint doesn't change with firing rate	Firing rate sensor failure	Check that firing rate display changes from 0 to 100 as the burner goes from low to high fire.
	Firing rate sensor power failure	Check that the 12 VDC power supply is on. A green LED should be lit to indicate power. Check fuse F-3.

4.2-Adjustment of Analog Inputs

Adjustments may be made for each analog input channel to compensate for minor changes in transmitter outputs over time.

1) Apply the minimum process signal from a standard voltage or current generator to the analog input terminal. This signal should correspond with a 'zero' level signal from the transmitter that is normally wired to the analog input.

2) Using the I/O data panel of the tuning panel, check the value of the subject analog input raw value. Normal values are 1000 counts per volt of input. 4-20 mA current inputs are converted to a voltage of 2-10 VDC at the analog input module. The normal values for a 4 mA signal would be 2000 counts.

3) In the same manner apply 10.0 VDC or 20 mA as appropriate. The normal value should be 10,000.

4) Adjustments may be made by entering new "Raw Min" or "Raw Max" values at the Analog Input Setup screen. The "Raw Min" value should correspond to the actual value observed in step 2. The "Raw Max" value should correspond to the actual value observed in step 3.

4.3-Adjustment of Analog Output

Check the analog outputs by following the procedure below.

1) Connect the digital multimeter to the analog output terminals.

2) Go to the HMI I/O configuration screen for the subject analog output point.

3) Set the subject analog output signal to 0%. Verify that the voltage reading for the output is 0 VDC.

4) In the same manner, set the analog output signal to 50%. Verify that the voltage reading for the output is 5 VDC.

5) Finally, set the analog output signal to 100%. Verify that the voltage reading for the output is 10 VDC.

6) Adjustments may be made by entering new "Scaled Min" or "Scaled Max" values at the Analog Output Setup screen. The "Scaled Min" value should correspond to a value that will result in a 0 VDC output signal in step 3. The "Scaled Max" value should be changed to a value that will result in a 10 VDC output signal in step 5.

4.4-Digital I/O Verification

The digital I/O points can be verified by going to the Digital I/O screen from the I/O Configuration menu screen.

1) Press the buttons for each of the digital outputs. The digital outputs should change state as the button is pressed and return to the previous state when the button is released. A green button indicates that the point is 'on', red indicates that a point is 'off'.

2) Apply voltage to each of the digital inputs. The indicator on the screen should turn green when an input senses voltage.

4.5-I/O Module Replacement and Configuration

Should an I/O module need to be replaced, it will need to be configured with the correct Modbus address in order to function properly. The default Modbus address for a new I/O card is 1. Refer to Appendix A for information regarding I/O addressing.

1) Turn off power to the panel at the main circuit breaker.

2) Remove the terminals from the module to be replaced by pulling them out of their sockets.

3) Remove the module from the DIN rail by pulling the bottom tab down with a screwdriver. Pulling the tab should release the module from the DIN rail and allow it to be removed from the panel.

4) Install the new module on the DIN rail and connect the terminals. If multiple modules are being replaced, only one new (unconfigured) module should be connected at a time.

5) Go to the HMI Setup Menu screen and select “I/O Config”.

6) From the I/O Configuration menu, select “New I/O Config”.

7) Select the module type that is being replaced (Digital, Analog In or Analog Out).

8) Press the ‘Read Module’ button. After a short time, the communications parameters will be displayed on the screen for the new module.

9) Enter the new address for the module by pressing the ‘Address’ button. Enter a ‘5’ for a Digital module, ‘6’ for an Analog Input module or ‘7’ for an Analog Output module.

10) Press the ‘Set Comms’ button. A ‘Verify Write’ indicator will appear. If the configuration is successful, a ‘Write OK’ indicator will appear.

11) Verify the proper operation of the new I/O module by going to the I/O screen corresponding to the new module. Change the value of several inputs and/or outputs to/from the module and verify that it is responding correctly. Acknowledge any alarms indicating I/O module communication faults.

12) Repeat the procedure for any additional I/O modules being installed.

4.6-I/O Module ‘Safe Output’ state Configuration

The output modules are able to be configured to output specific states in the event of a communications loss. This is done by enabling a watchdog timer in the I/O module. The watchdog timer expires when a loss of communications continues for a specified period of time. The expiration of the watchdog timer is indicated by a blinking green LED on the front of the I/O module. When the watchdog timer expires, the outputs are set to their “safe” positions as programmed on the advanced configuration screens. The typical “safe” position for the Digital outputs is the “Off” state. The analog output “safe” position is typically the 50% position.

To set the watchdog timer, select Analog Out or Digital I/O from the I/O Configuration menu screen.

1) Press the ‘Get Values’ button. The data for the safe values and watchdog timer will update according to the configuration of the module.

2) Enter the safe values for each output channel. Analog values are ‘0’ for no output, ‘5000’ for a 5 volt (half range) output, and ‘10,000’ for a full range 10 volt output. Digital values are ‘0’ for ‘Off’ and ‘1’ for ‘On’.

3) Set the watchdog time (in seconds), and enable the timer. The watchdog button will be green when it is enabled.

4) Press the ‘Write Values’ button to send the new configuration data to the I/O module.

SECTION 5 — PARTS

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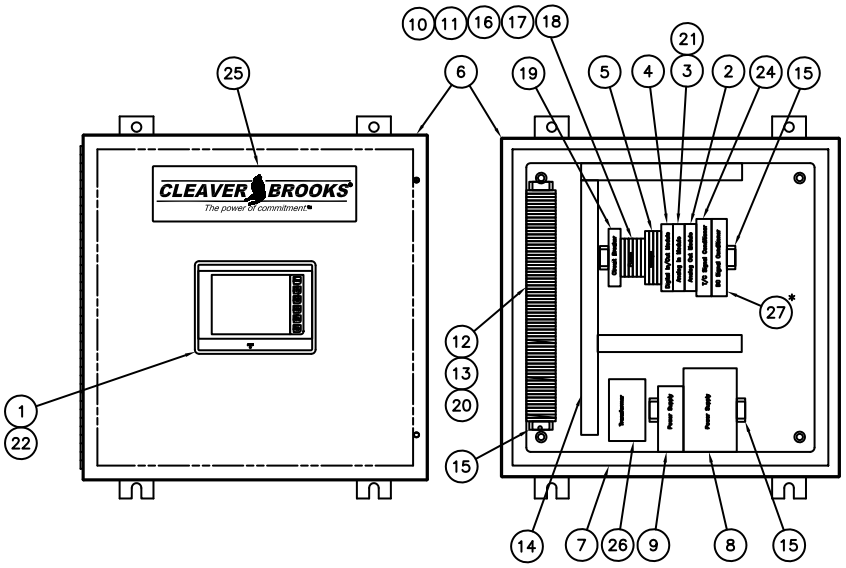
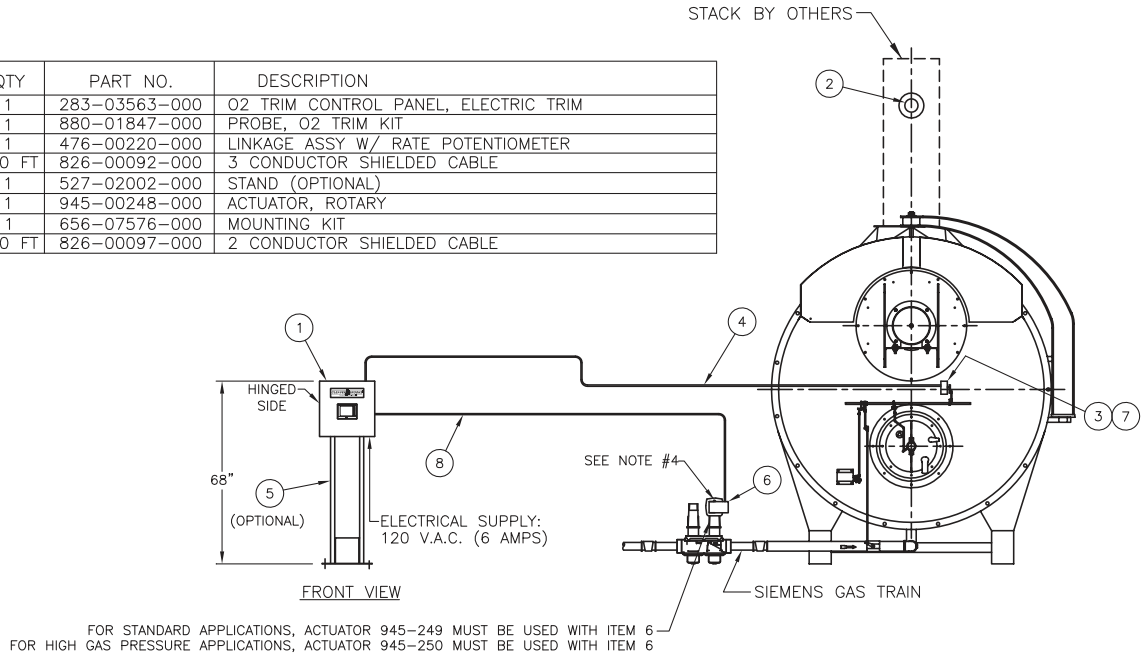
5.1-Parts List for Systems using Electric Only Fuel Trim Actuators

Item	Qty.	CB Part No.	Description
1	1	833-03752-000	PLC/HMI, 5.7" STN Color Display
2	1	833-03753-000	SmartMod Analog Output Module, 8 Channel, 0-10 VDC
3	1	833-03754-000	SmartMod Analog Input Module, 8 Channel, 0-10 VDC
4	1	833-03755-000	SmartMod Digital In/Out Module, 4 DC In, 4 Relay Out
5	4	832-02506-000	Relay, 110 VAC Coil, SPDT Contacts
6	1	848-01610-000	Panel, NEMA 12 20x20x8
7	1	848-01611-000	Sub Panel
8	1	832-02516-000	Power Supply, 24 VDC, 240 W
9	1	832-02517-000	Power Supply 12 VDC, 30 W
10	6	832-02507-000	Fuse Block Plug
11	6	832-02508-000	Terminal, Fuse Block
12	70	832-02509-000	Terminal, Block, Euro 2.5
13	10	832-02510-000	Terminal, Grounding
14	1	848-01612-000	Wire Duct, 1" x 4", with cover, 2 meter length
15	1	832-02518-000	DIN Rail, 35mm, 1 meter length
16	2	832-02511-000	Fuse 5x20mm, 1 A
17	2	832-02512-000	Fuse 5x20mm, 2 A
18	2	832-02513-000	Fuse 5x20mm, 5 A
19	1	832-02514-000	Circuit Breaker, DIN Mount, 6 A
20	1	832-02515-000	Terminal Markers, 1-100
21	4	832-02519-000	Resistor, Silicone Coated Wirewound, 500 Ohm, 1%, 1 watt
22	1	833-03756-000	Connector, RJ45 Plug
23	1		N/A
24	1	833-03758-000	Signal Converter, Thermocouple to Analog
25	1	118-03173-000	Nameplate, Cleaver Brooks "The Power of Commitment"
26	1	832-02504-000	Transformer, 120/24 VAC, 40 VA
*27**	*1*	*833-03759-000*	*DC Signal Conditioner *Optional*



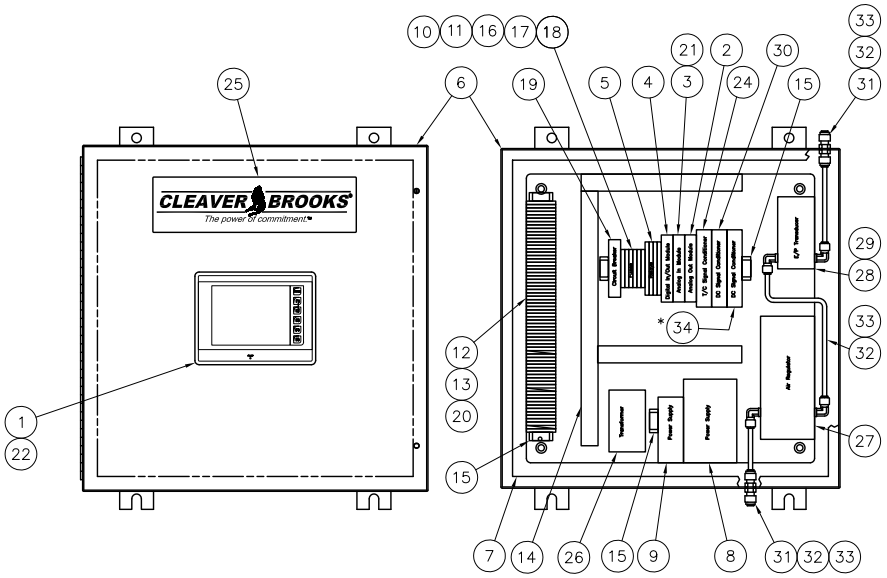
Electric Only Fuel Trim cont'd

ITEM	QTY	PART NO.	DESCRIPTION
1	1	283–03563–000	O2 TRIM CONTROL PANEL, ELECTRIC TRIM
2	1	880–01847–000	PROBE, O2 TRIM KIT
3	1	476–00220–000	LINKAGE ASSY W/ RATE POTENTIOMETER
4	50 FT	826–00092–000	3 CONDUCTOR SHIELDED CABLE
5	1	527–02002–000	STAND (OPTIONAL)
6	1	945–00248–000	ACTUATOR, ROTARY
7	1	656–07576–000	MOUNTING KIT
8	50 FT	826–00097–000	2 CONDUCTOR SHIELDED CABLE



5.2-Parts List for Systems using Pneumatic and Electric Fuel Trim Actuators

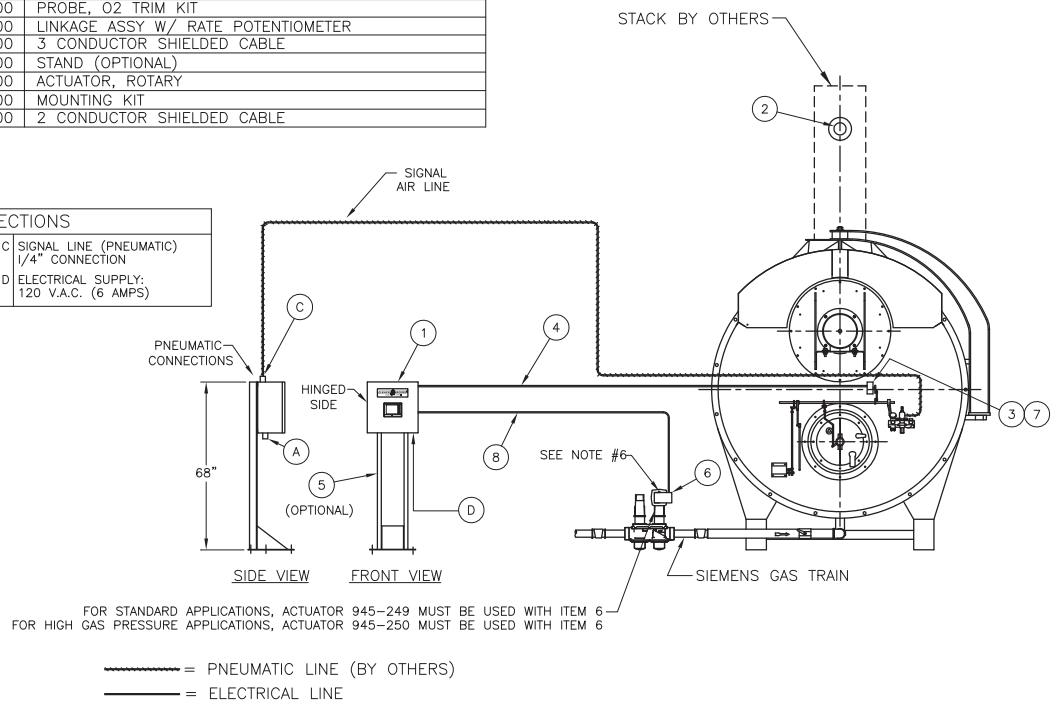
Item	Qty.	CB Part No.	Description
1	1	833-03752-000	PLC/HMI, 5.7" STN Color Display
2	1	833-03753-000	SmartMod Analog Output Module, 8 Channel, 0-10 VDC
3	1	833-03754-000	SmartMod Analog Input Module, 8 Channel, 0-10 VDC
4	1	833-03755-000	SmartMod Digital In/Out Module, 4 DC In, 4 Relay Out
5	4	832-02506-000	Relay, 110 VAC Coil, SPDT Contacts
6	1	848-01610-000	Panel, NEMA 12 20x20x8
7	1	848-01611-000	Sub Panel
8	1	832-02516-000	Power Supply, 24 VDC, 240 W
9	1	832-02517-000	Power Supply 12 VDC, 30 W
10	6	832-02507-000	Fuse Block Plug
11	6	832-02508-000	Terminal, Fuse Block
12	70	832-02509-000	Terminal, Block, Euro 2.5
13	10	832-02510-000	Terminal, Grounding
14	1	848-01612-000	Wire Duct, 1" x 4", with cover, 2 meter length
15	1	832-02518-000	DIN Rail, 35mm, 1 meter length
16	2	832-02511-000	Fuse 5x20mm, 1 A
17	2	832-02512-000	Fuse 5x20mm, 2 A
18	2	832-02513-000	Fuse 5x20mm, 5 A
19	1	832-02514-000	Circuit Breaker, DIN Mount, 6 A
20	1	832-02515-000	Terminal Markers, 1-100
21	4	832-02519-000	Resistor, Silicone Coated Wirewound, 500 Ohm, 1%, 1 watt
22	1	833-03756-000	Connector, RJ45 Plug
23			N/A
24	1	833-03758-000	Signal Converter, Thermocouple to Analog
25	1	118-03173-000	Nameplate, Cleaver Brooks "The Power of Commitment"
26	1	832-02504-000	Transformer, 120/24 VAC, 40 VA
27	1	797-03102-000	Pressure Regulator/Filter
28	1	833-03760-000	DIN Rail Mounting Kit for E/P Transducer
29	1	833-03761-000	E-P Transducer, 1-9 VDC In, 3-15 psi Out
30	1	833-03759-000	DC Signal Conditioner
31	2	845-01128-000	Bulkhead Fitting
32	4	845-01129-000	Elbow, Push To Connect, 1/4" OD x 1/4" NPT.
33	2 ft	939-01142-000	Tubing, 1/4" OD
*34**	*1*	*833-03759-000*	*DC Signal Conditioner *Optional*



Pneumatic & Electric Fuel Trim cont'd

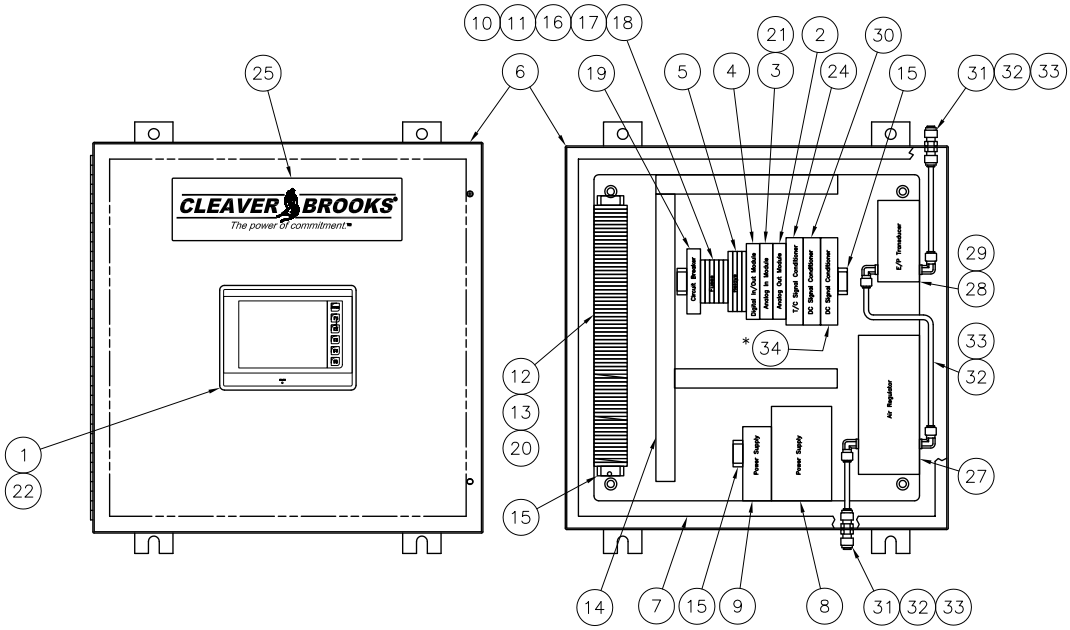
ITEM	QTY	PART NO.	DESCRIPTION
1	1	283–03565–000	O2 TRIM CONTROL PANEL, ELECTRIC & PNEUMATIC TRIM
2	1	880–01847–000	PROBE, O2 TRIM KIT
3	1	476–00220–000	LINKAGE ASSY W/ RATE POTENTIOMETER
4	50 FT	826–00092–000	3 CONDUCTOR SHIELDED CABLE
5	1	527–02002–000	STAND (OPTIONAL)
6	1	945–00248–000	ACTUATOR, ROTARY
7	1	656–07576–000	MOUNTING KIT
8	50 FT	826–00097–000	2 CONDUCTOR SHIELDED CABLE

CONNECTIONS			
A	AIR SUPPLY: 1/4" CONN., 125 PSIG MAX./25 PSIG MIN. 2.0 CFM, (SEE NOTE #4)	C	SIGNAL LINE (PNEUMATIC) 1/4" CONNECTION
		D	ELECTRICAL SUPPLY: 120 V.A.C. (6 AMPS)

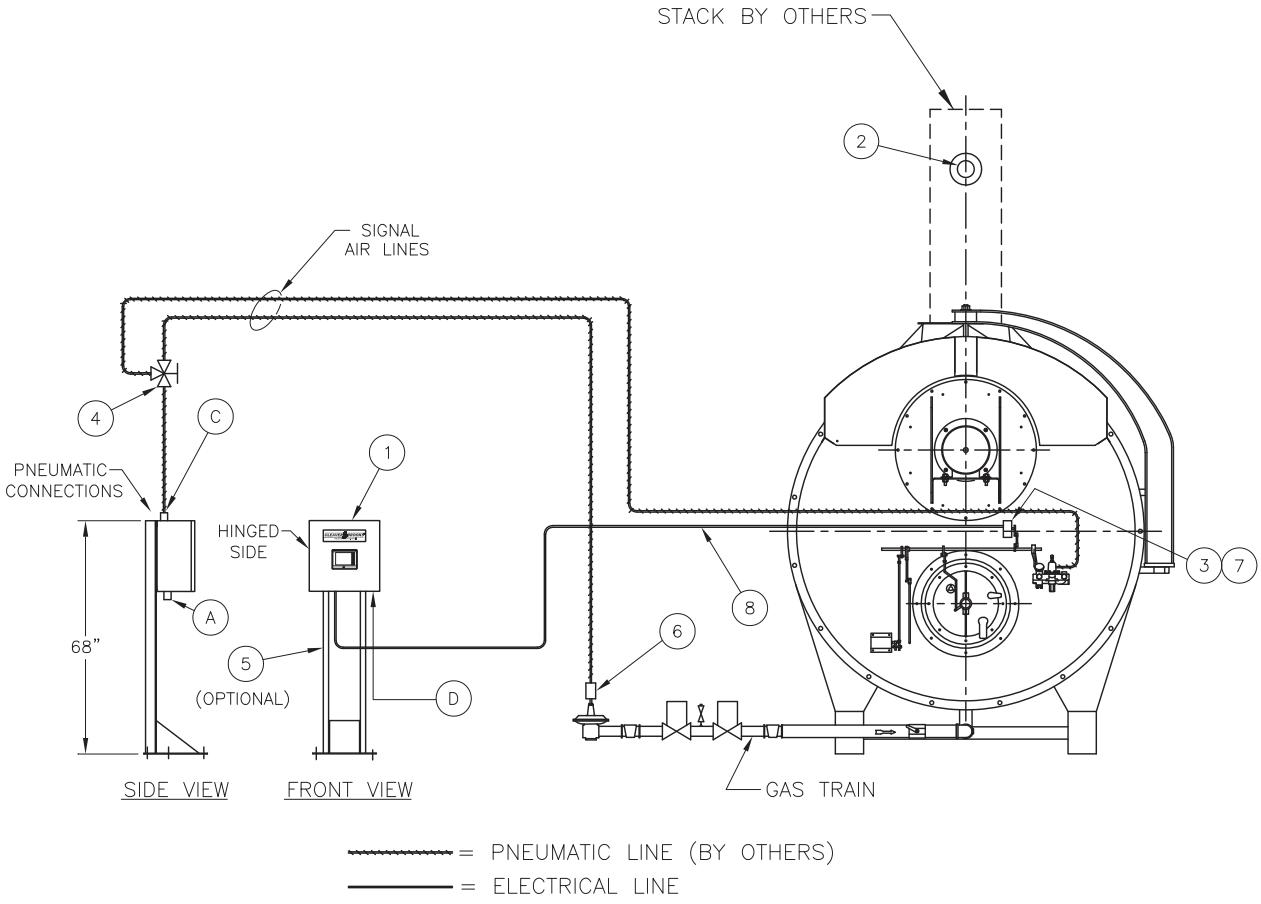


5.3-Parts List for Systems using Pneumatic Only Fuel Trim Actuators

Item	Qty.	CB Part No.	Description
1	1	833-03752-000	PLC/HMI, 5.7" STN Color Display
2	1	833-03753-000	SmartMod Analog Output Module, 8 Channel, 0-10 VDC
3	1	833-03754-000	SmartMod Analog Input Module, 8 Channel, 0-10 VDC
4	1	833-03755-000	SmartMod Digital In/Out Module, 4 DC In, 4 Relay Out
5	4	832-02506-000	Relay, 110 VAC Coil, SPDT Contacts
6	1	848-01610-000	Panel, NEMA 12 20x20x8
7	1	848-01611-000	Sub Panel
8	1	832-02516-000	Power Supply, 24 VDC, 240 W
9	1	832-02517-000	Power Supply 12 VDC, 30 W
10	6	832-02507-000	Fuse Block Plug
11	6	832-02508-000	Terminal, Fuse Block
12	70	832-02509-000	Terminal, Block, Euro 2.5
13	10	832-02510-000	Terminal, Grounding
14	1	848-01612-000	Wire Duct, 1" x 4", with cover, 2 meter length
15	1	832-02518-000	DIN Rail, 35mm, 1 meter length
16	2	832-02511-000	Fuse 5x20mm, 1 A
17	2	832-02512-000	Fuse 5x20mm, 2 A
18	2	832-02513-000	Fuse 5x20mm, 5 A
19	1	832-02514-000	Circuit Breaker, DIN Mount, 6 A
20	1	832-02515-000	Terminal Markers, 1-100
21	4	832-02519-000	Resistor, Silicone Coated Wirewound, 500 Ohm, 1%, 1 watt
22	1	833-03756-000	Connector, RJ45 Plug
23			N/A
24	1	833-03758-000	Signal Converter, Thermocouple to Analog
25	1	118-03173-000	Nameplate, Cleaver Brooks "The Power of Commitment"
26			N/A
27	1	797-03102-000	Pressure Regulator/Filter
28	1	833-03760-000	DIN Rail Mounting Kit for E/P Transducer
29	1	833-03761-000	E-P Transducer, 1-9 VDC In, 3-15 psi Out
30	1	833-03759-000	DC Signal Conditioner
31	2	845-01128-000	Bulkhead Fitting
32	4	845-01129-000	Elbow, Push To Connect, 1/4" OD x 1/4" NPT.
33	2 ft	939-01142-000	Tubing, 1/4" OD
*34**	*1*	*833-03759-000*	*DC Signal Conditioner *Optional*



Pneumatic Only Fuel Trim cont'd

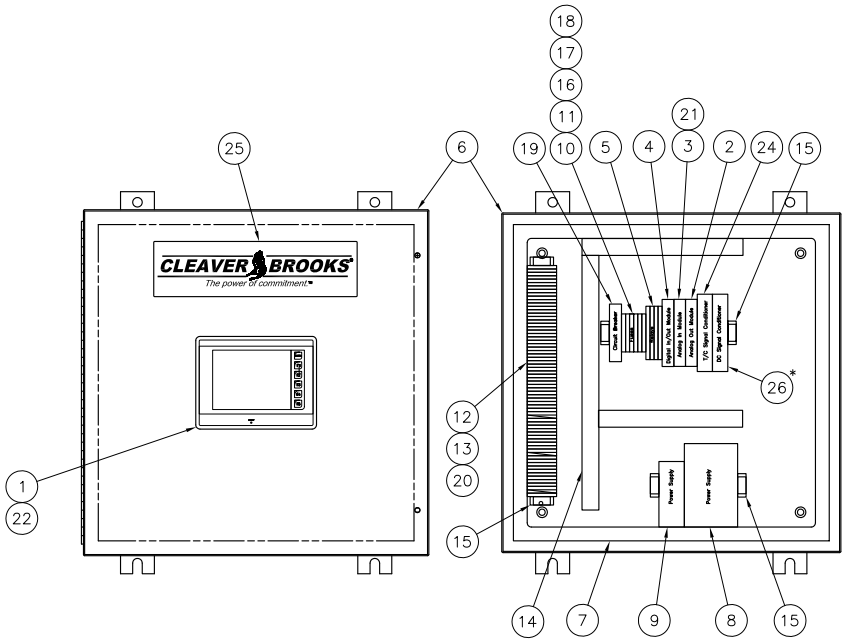


CONNECTIONS			
A	AIR SUPPLY: 1/4" CONN., 125 PSIG MAX./25 PSIG MIN. 2.0 CFM, (SEE NOTE #4)	C	SIGNAL LINE (PNEUMATIC) 1/4" CONNECTION
		D	ELECTRICAL SUPPLY: 120 V.A.C. (6 AMPS)

ITEM	QTY	PART NO.	DESCRIPTION
1	1	283-03564-000	O2 TRIM CONTROL PANEL, PNEUMATIC TRIM
2	1	880-01847-000	PROBE, O2 TRIM KIT
3	1	476-00220-000	LINKAGE ASSY W/ RATE POTENTIOMETER
4	1	941-01810-000	3-WAY VALVE
5	1	527-02002-000	STAND (OPTIONAL)
6	1	269-00010-000	ACTUATOR, GAS REGULATOR, PNEUMATIC
7	1	656-07576-000	MOUNTING KIT
8	50 FT	826-00092-000	3 CONDUCTOR SHIELDED CABLE

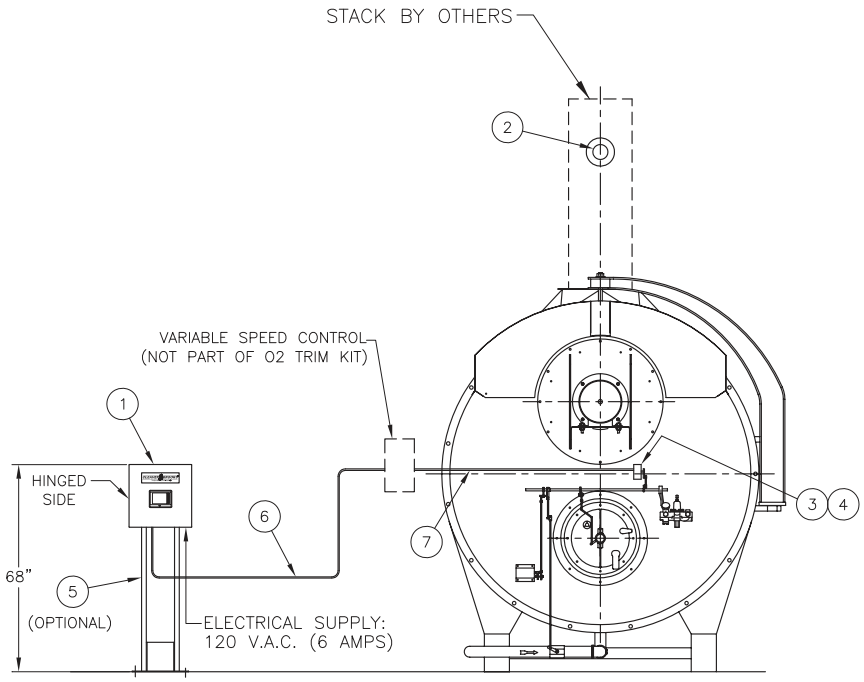
5.4-Parts List for Systems using VSD Air Trim

Item	Qty.	CB Part No.	Description
1	1	833-03752-000	PLC/HMI, 5.7" STN Color Display
2	1	833-03753-000	SmartMod Analog Output Module, 8 Channel, 0-10 VDC
3	1	833-03754-000	SmartMod Analog Input Module, 8 Channel, 0-10 VDC
4	1	833-03755-000	SmartMod Digital In/Out Module, 4 DC In, 4 Relay Out
5	4	832-02506-000	Relay, 110 VAC Coil, SPDT Contacts
6	1	848-01610-000	Panel, NEMA 12 20x20x8
7	1	848-01611-000	Sub Panel
8	1	832-02516-000	Power Supply, 24 VDC, 240 W
9	1	832-02517-000	Power Supply 12 VDC, 30 W
10	6	832-02507-000	Fuse Block Plug
11	6	832-02508-000	Terminal, Fuse Block
12	70	832-02509-000	Terminal, Block, Euro 2.5
13	10	832-02510-000	Terminal, Grounding
14	1	848-01612-000	Wire Duct, 1" x 4", with cover, 2 meter length
15	1	832-02518-000	DIN Rail, 35mm, 1 meter length
16	2	832-02511-000	Fuse 5x20mm, 1 A
17	2	832-02512-000	Fuse 5x20mm, 2 A
18	2	832-02513-000	Fuse 5x20mm, 5 A
19	1	832-02514-000	Circuit Breaker, DIN Mount, 6 A
20	1	832-02515-000	Terminal Markers, 1-100
21	4	832-02519-000	Resistor, Silicone Coated Wirewound, 500 Ohm, 1%, 1 watt
22	1	833-03756-000	Connector, RJ45 Plug
23			N/A
24	1	833-03758-000	Signal Converter, Thermocouple to Analog
25	1	118-03173-000	Nameplate, Cleaver Brooks "The Power of Commitment"
*26**	*1*	*833-03759-000*	*DC Signal Conditioner *Optional*



VSD Air Trim cont'd

ITEM	QTY	PART NO.	DESCRIPTION
1	1	283–03562–000	O2 TRIM CONTROL PANEL, VSD AIR TRIM
2	1	880–01847–000	PROBE, O2 TRIM KIT
3	1	476–00220–000	LINKAGE ASSY W/ RATE POTENTIOMETER
4	1	656–07576–000	MOUNTING KIT
5	1	527–02002–000	STAND (OPTIONAL)
6	25 FT	826–00097–000	2 CONDUCTOR SHIELDED CABLE
7	25 FT	826–00092–000	3 CONDUCTOR SHIELDED CABLE



APPENDIX A — Input/Output List

HE359DIQ512	
Modbus Address = 5	
DI 24 VDC	
%I0001	Release to Modulate
%I0002	Purge
%I0003	Fuel Select 1 (Gas)
%I0004	Fuel Select 2 (Oil)
DO Relay Out	
%Q0001	Alarm Contact #1
%Q0002	Alarm Contact #2
%Q0003	
%Q0004	VSD Signal Source

Modbus RTU Comms
38400, N,8,1

HE359ADC207	
Modbus Address = 6	
Analog Input Module (Scaled)	
%R0002	O2 Value (voltage)
%R0004	O2 Value (current)
%R0006	Firing Rate Signal
%R0008	Steam Pressure
%R0010	Stack Temp
%R0012	VSD Feedback
%R0014	
%R0016	

HE359DAC201	
Modbus Address = 7	
Analog Out Module (Scaled)	
%R0022	Fuel 1 Trim Out
%R0024	Fuel 2 Trim Out
%R0026	Fuel 3 Trim Out
%R0028	VSD Out
%R0030	
%R0032	O2 Retransmit
%R0034	
%R0036	

Analog Input Module (Raw)	
%AI0001	O2 Value (voltage)
%AI0002	O2 Value (current)
%AI0003	Firing Rate Signal
%AI0004	Steam Pressure
%AI0005	Stack Temp
%AI0006	VSD Feedback
%AI0007	
%AI0008	

Analog Out Module (Raw)	
%AQ0001	Fuel 1 Trim Out
%AQ0005	Fuel 2 Trim Out
%AQ0002	Fuel 3 Trim Out
%AQ0006	VSD Out
%AQ0003	
%AQ0007	O2 Retransmit
%AQ0004	
%AQ0008	

APPENDIX B — Alarm List

Low O2 and Low Low O_2 Alarms
These alarms are triggered when the O_2 level sensed by the transmitter is below setpoint for a user adjustable period of time. These alarms are intended to be used for a warning alarm and a shutdown alarm.

High Stack Temperature and High High Stack Temperature Alarms
These alarms are triggered when the stack temperture sensed by the thermocouple is above setpoint for a user adjustable period of time. These alarms are intended to be used for a warning alarm and a shutdown alarm.

O2 Probe Failure
This alarm is triggered when the signal from the O_2 probe is below the normal signal range for the transmitter.

O2 Calibration Failure
This alarm is triggered when the signal from the O_2 probe is outside of the normal signal range during the calibration operation that occurs during purge.

VSD Feedback Alarm
This alarm is triggered when the feedback from the VSD differs from the speed command sent to the VSD by a user adjustable percentage. This alarm has a user adjustable time delay.

Power Up/Reset Alert
This alarm is triggered when the PLC is restarted for any reason.

Analog Input Module Comms
This alarm is triggered when the PLC senses a communications loss to/from the Analog Input module.

Analog Output Module Comms
This alarm is triggered when the PLC senses a communications loss to/from the Analog Output module.

Digital I/O Module Comms
This alarm is triggered when the PLC senses a communications loss to/from the Digital I/O module.

APPENDIX C — Removable Media

Using Removable Media to Load and Save Applications

A special file type, with a .PGM extension, is used to store application programs on Micro SD. To load an application from Micro SD to the controller, open the Removable Media Manager in the System Menu. Find and highlight the desired .PGM file, and then press the Enter key.

To prevent data loss or corruption, be sure to turn off the memory card via the HMI setup screen before installing or removing a Micro SD card.

To install a Micro SD card: Align its 8-pin gold edge connector down, facing the front of the HMI. Carefully push it all the way into the Memory slot. Ensure that it clicks into place.

To remove the Micro SD card: Push down on the top of the card gently to release the spring. The card pops up for removal.

APPENDIX D — Electric Actuator Information

Spring Selection:

High Pressure Gas Trains

Main Spring	
Color	**Pressure (psi)**
Steel/Gray	0.45
Green	1.33
Blue	2.8
Yellow	11.6
Red	22

Trim Actuator Spring	
Color	**Pressure (psi)**
White	0.9
Steel/Gray	1.85
Red	4.2
Green	8.1

Low Pressure Gas Trains

Main Spring	
Color	**Pressure (psi)**
Steel/Gray	0.06
Green	0.2
Blue	0.4
Yellow	1.65
Red	3.2

Trim Actuator Spring	
Color	**Pressure (psi)**
White	0.13
Steel/Gray	0.26
Red	0.6
Green	1.16

The trim actuator spring should be selected based on +/-10% of the operating pressure.

Wiring guide for Electric Actuator:

Terminal	Voltage	Description
U		
M	0-10 VDC +	Control Signal
R		
Y	0-10 VDC -	Control Signal
G	24 VAC	Operating Voltage
G0	24 VAC	Operating Voltage Neutral

APPENDIX E — Pneumatic Regulator Information

The following gas pressure regulators may be used with the O2 Trim system for pneumatic gas fuel trim:

Fisher 66	Maxitrol RV-81	Equimeter 121-6
Fisher 133L	Maxitrol RV-91	Equimeter 121-8
Fisher 166-2	Maxitrol RV-110	Equimeter 121-12
Fisher 166-5	Maxitrol RV-131	Equimeter 122-6 & 122-8
Fisher 1098EGR	Maxitrol 210 D,E,G,J	Equimeter 122-12