CleaverBrooks®

Model M5M

Watertube Boiler

with Premix Burner

2,000 - 6,000 MBTU

Operation and Maintenance Manual

750-372
09/2015

c UL us

⚠WARNING

If the information in this manual is not followed exactly, a fire or explosion may result causing property damage, personal injury or loss of life.

— Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.

— WHAT TO DO IF YOU SMELL GAS
- Do not try to light any appliance.
- Do not touch any electrical switch; do not use any phone in your building.
- Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions.
- If you cannot reach your gas supplier, call the fire department.

— Installation and service must be performed by a qualified Cleaver-Brooks, service agency or the gas supplier.

⚠WARNING

To minimize the possibility of serious personal injury, fire or damage to the equipment, never violate the following safety rules.

— Always keep the area around the boiler free of combustible materials, gasoline, and other flammable liquids and vapors

— Never cover the boiler, lean anything against it, stand on it, or in any way block the flow of fresh air to the boiler.

Notice

Where required by the authority having jurisdiction, the installation must conform to the Standard for Controls and Safety Devices for Automatically Fired Boilers, ANSI/ASME CSD-1.

⚠WARNING

The boiler and its individual shutoff valve must be disconnected from the gas supply piping system during any pressure testing of that system at test pressures in excess of 1/2 psi (3.5 kPa).

⚠WARNING

Improper installation, adjustment, service, or maintenance can cause equipment damage, personal injury, or death. Refer to the Operation and Maintenance manual provided with the boiler. Installation and service must be performed by a qualified Cleaver-Brooks service provid-

⚠WARNING

Be sure the fuel supply which the boiler was designed to operate on is the same type as specified on the boiler name plate.

⚠WARNING

Should overheating occur or the gas supply valve fail to shut off, **do not** turn off or disconnect the electrical supply to the boiler. Instead turn off the gas supply at a location external to the boiler.

⚠WARNING

Do not use this boiler if any part has been under water. Immediately call your Cleaver-Brooks service representative to inspect the boiler and to replace any part of the control system and any gas control which has been under water.

Notice

This manual must be maintained in legible condition and kept adjacent to the boiler or in a safe place for future reference. Contact your local Cleaver-Brooks representative if additional manuals are required.

⚠WARNING

The installation must conform to the requirements of the authority having jurisdiction or, in the absence of such requirements, to UL 795 Commercial-Industrial Gas Heating Equipment and/or the National Fuel Gas Code, ANSI Z223.1

CLEAVER-BROOKS

Model M5M

Model 5 *with Premix Burner*

Packaged Boiler
Operation and Maintenance Manual

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

Manual Part No. 750-372
09/2015

Printed in U.S.A.

⚠ WARNING

DO NOT OPERATE, SERVICE, OR REPAIR THIS EQUIPMENT UNLESS YOU FULLY UNDERSTAND ALL APPLICABLE SECTIONS OF THIS MANUAL.

DO NOT ALLOW OTHERS TO OPERATE, SERVICE, OR REPAIR THIS EQUIPMENT UNLESS THEY FULLY UNDERSTAND ALL APPLICABLE SECTIONS OF THIS MANUAL.

FAILURE TO FOLLOW ALL APPLICABLE WARNINGS AND INSTRUCTIONS MAY RESULT IN SEVERE PERSONAL INJURY OR DEATH.

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. Failure to follow all applicable instructions and warnings may result in severe personal injury or death.

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. Although these components afford a high degree of protection and safety, operation of equipment is not to be considered free from all dangers and hazards inherent in handling and firing of fuel.

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.

Because of state, local, or other applicable codes, there are a variety of electric controls and safety devices which vary considerably from one boiler to another. This manual contains information designed to show how a basic burner operates.

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.

It is recommended that a boiler room log or record be maintained. Recording of daily, weekly, monthly and yearly maintenance activities and recording of any unusual operation will serve as a valuable guide to any necessary investigation. Most instances of major boiler damage are the result of operation with low water. We cannot emphasize too strongly the need for the operator to periodically check his low water controls and to follow good maintenance and testing practices. Cross-connecting piping to low water devices must be internally inspected periodically to guard against any stoppages which could obstruct the free flow of water to the low water devices. Float bowls of these controls must be inspected frequently to check for the presence of foreign substances that would impede float ball movement.

The waterside condition of the pressure vessel is of extreme importance. Waterside surfaces should be inspected frequently to check for the presence of any mud, sludge, scale or corrosion.

It is essential to obtain the services of a qualified water treating company or a water consultant to recommend the proper boiler water treating practices.

The operation of this equipment by the owner and his or her 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.

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CHAPTER 1 Introduction

1.1 - Introduction

The Cleaver-Brooks M5M Boiler is a packaged steel boiler consisting of a pressure vessel, gas premix burner, forced draft fan with variable speed drive, C-B Falcon controls, and associated components. The boiler is designed for high or low pressure steam or hot water generation with fuel input ranging from 2,000,000 to 6,000,000 BTU/Hr.

The pressure vessel is constructed in accordance with the ASME Boiler and Pressure Vessel Code.

The M5M is a watertube construction with welded membrane waterwalls arranged so that the products of combustion travel the length of the furnace, reverse direction, then pass between the furnace waterwalls and the convection waterwalls.

The boiler and any related equipment installed by others are to be in compliance with the regulations of local codes governing such equipment. Prior to installation the proper authorities having jurisdiction are to be consulted and any necessary permits obtained.

FIGURE 1-1. M5M Boiler

FIGURE 1-2. Cutaway view showing gas flow

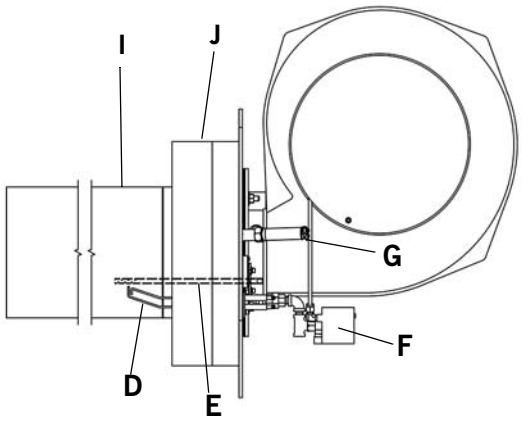
1.2 - The Burner

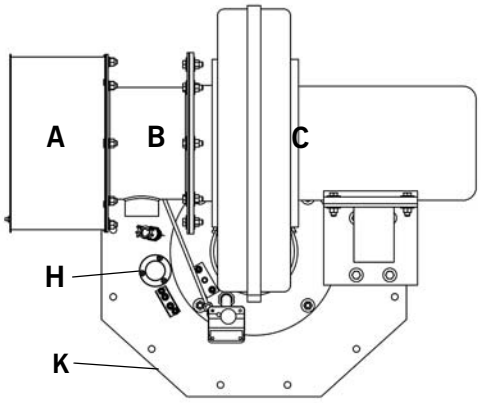
The burner utilizes a premix venturi, self-regulating fuel train, variable speed blower modulation, and Fecralloy metal fiber burner head.

Modulating combustion air fan provides 5:1 turndown.

Combustion canister of the burner is constructed of a Fecralloy-metal fiber for solid body radiation of the burner flame, which provides low emissions.

All M5M boilers have the burner assembly readily accessible for inspection and maintenance.





A - Inlet air filter
B - Venturi
C - Combustion air blower
D - Ignition electrode
E - Pilot

F - Combustion air proving switch
G - UV scanner
H - Sight glass
I - Burner Canister
J - Insulation/Refractory
K - Burner Mounting Plate

FIGURE 1-3. M5M Burner

1.3 - Gas Train

The gas train assembly is provided in accordance with UL/c-UL certification and complies with ASME CSD-1. The gas train assembly is factory assembled and wired.

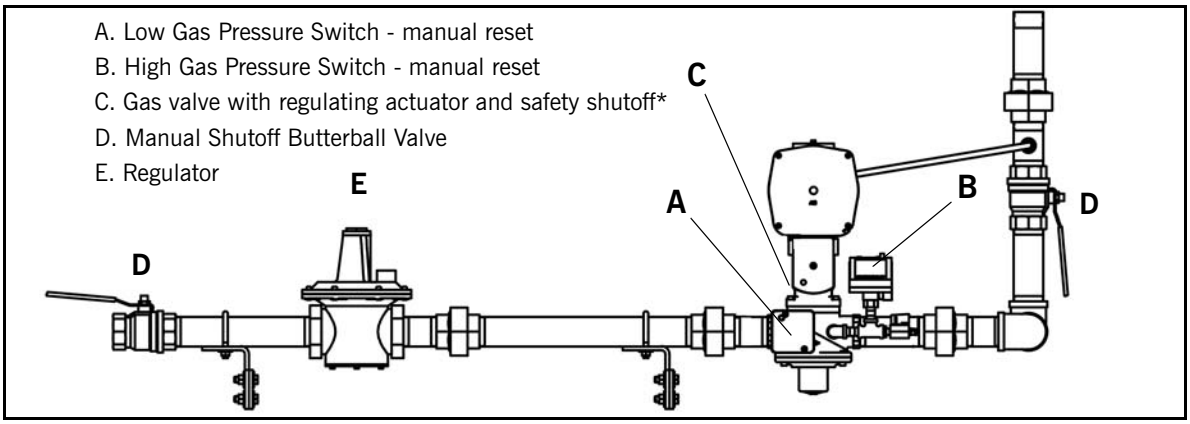


FIGURE 1-4. Gas Train

The main **Gas Valve** admits main flame gas through the venturi to the burner. Gas flow is a function of air flow and responds to the pressure differential across the venturi resulting from changing fan speeds.

The **Low Gas Pressure Switch** is a pressure actuated switch that is closed whenever main gas line pressure is above a preselected pressure. Should the pressure drop below this setting the switch contacts will open causing main gas valve(s) to close. The **High Gas Pressure Switch** is a pressure actuated switch that is closed whenever main gas line pressure is below a preselected pressure. Should the pressure rise above this setting the switch contacts will open causing main gas valve(s) to close.

The manual **"Butterball"** valves are for manually opening or closing the gas train upstream and downstream of the main gas valve.

The main gas pressure **Regulator** reduces incoming gas pressure to provide a constant downstream pressure at a level selected to produce a steady dependable flame yielding highest combustion efficiency.

Test Cocks allow testing for leakage across the main gas valve.

*Second SSOV with proof of closure is standard on size 6000.

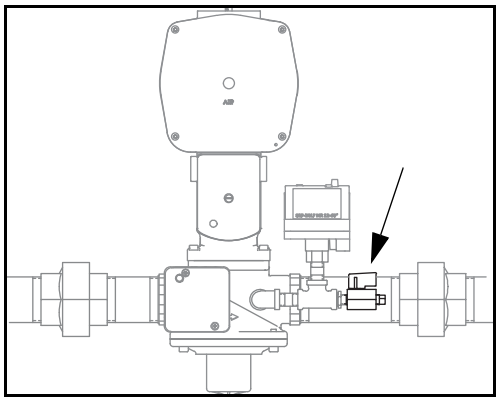


FIGURE 1-5. Leak Test Cock

1.4 - Pilot Train

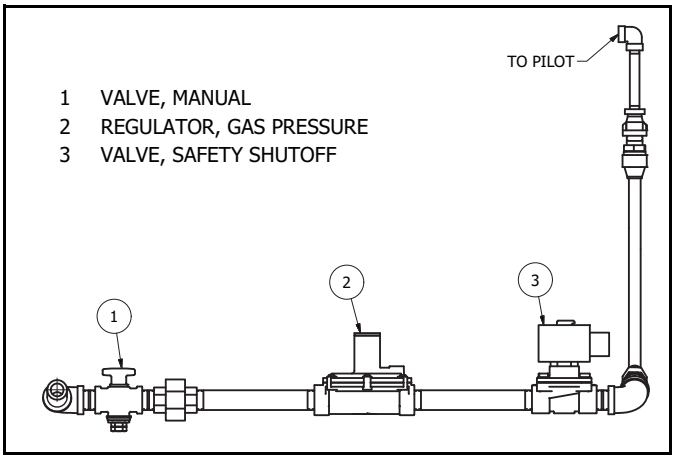


FIGURE 1-6. Pilot Gas Train

The **Pilot Valve** is a solenoid valve energized to open during ignition period to admit fuel to pilot. It is closed after main flame is established.

The **Pilot Pressure Regulator** adjusts gas pressure to a value that assures a satisfactory pilot.

The **Pilot Shutoff Cock** manually opens or closes the pilot gas supply.

1.5 - Controls (Falcon)

The Falcon control (standard) is an integrated burner management and modulation control with a touch-screen display/operator interface.

The controller is capable of the following functions:

- PID load control.
- Burner sequencing with safe start check, pre-purge, pilot ignition, and post purge.
- Electronic ignition.
- Flame Supervision.
- Safety shutdown with time-stamped display of lockout condition.
- Variable speed control of the combustion fan.
- Supervision of low and high gas pressure, air proving, high limit, and low water.
- First-out annunciator.
- Real-time data trending.
- (3) pump/auxiliary relay outputs (Hot Water units)
- Modbus communication capability.
- Outdoor temperature reset (Hot Water units)
- Remote firing rate or setpoint control (Hot Water units)
- Setback/time-of-day setpoint
- Lead/Lag for up to 8 boilers

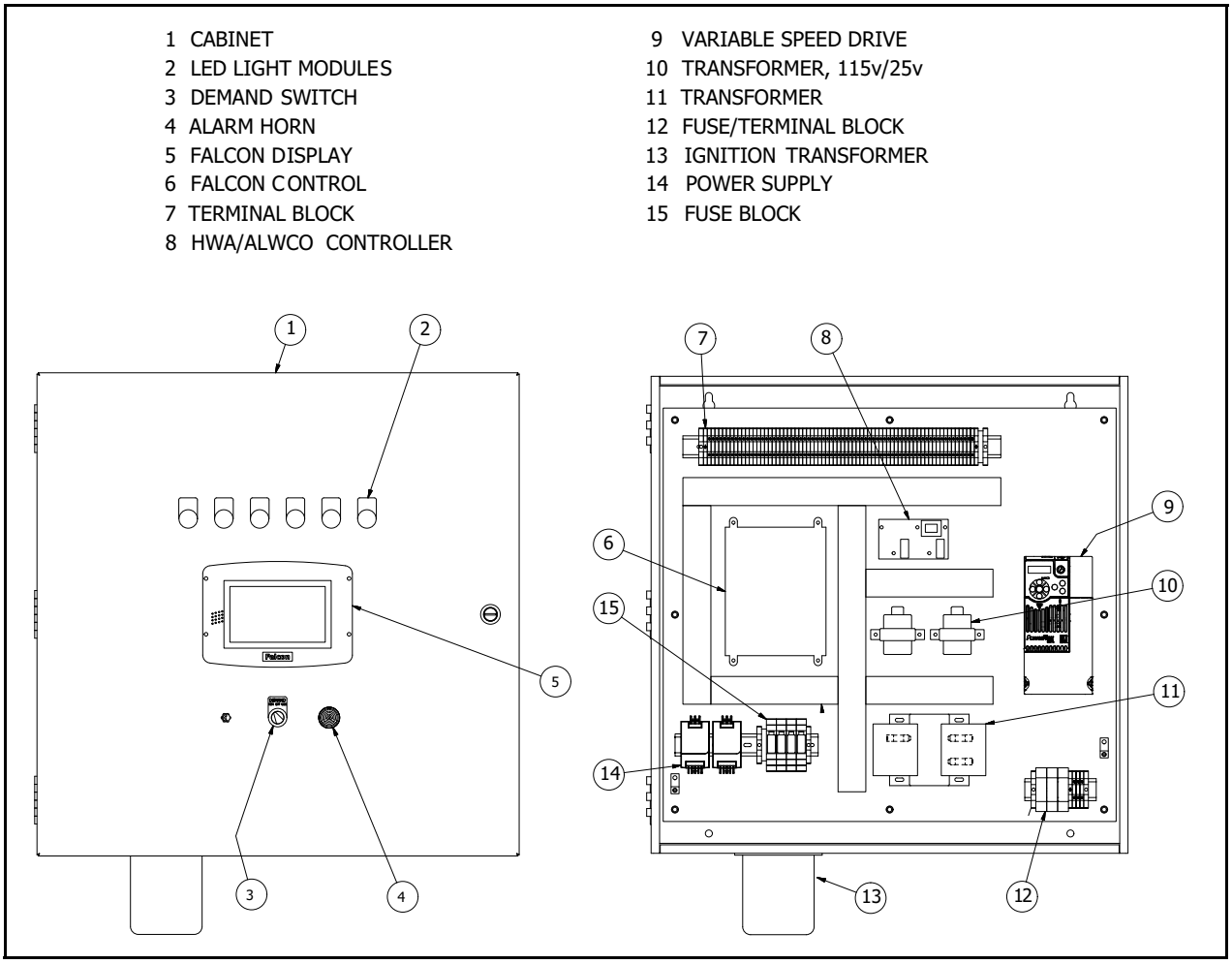


FIGURE 1-7. M5M Control Cabinet (Falcon control)

The C-B Falcon **Display** allows configuration, operation, and monitoring of the boiler through a touchscreen HMI. Refer to Commissioning section for more information on parametrization, basic operator functions, Falcon annunciation, and other features.

The **Selector Switch** is a 3-position switch (REMOTE-OFF-LOCAL) for manually choosing the boiler demand source. With the burner enabled (using the HMI burner switch), when the selector switch is in the appropriate position and a demand is present, the boiler will start.

The **ALWCO reset** switch (standard for steam boilers) manually resets the ALWCO device (required after an aux. low water lockout).

The standard **Indicator Light** package provides indication for Alarm, Low Water, Fuel Valve, Demand, and for steam units High Water and High Steam Pressure.

The control panel interior houses the terminals, fuses, power supplies, and transformers for the control electrical system, as well as the C-B Falcon controller itself.

1.6 - Controls (LMV/RWF50)

The M5M can be optionally equipped with a Siemens LMV3 series control and RWF50 modulating control in lieu of the Falcon control/display system. Features include:

- 8 digit backlit display with multifunction buttons (AZL23 display, used with LMV3)
- 9 point combustion curve
- Return-to-Pilot feature
- RWF50 is a compact pressure/temperature controller with integral display and 4-20mA output.

1 CABINET
2 LED LIGHT MODULES
3 MODULATING CONTROL
4 LMV DISPLAY
5 DEMAND SWITCH
6 ALARM HORN
7 TERMINAL BLOCK
8 HWA/ALWCO CONTROLLER
9 VARIABLE SPEED DRIVE
10 TRANSFORMER, 115v/25v
11 TRANSFORMER
12 FUSE BLOCK
13 IGNITION TRANSFORMER
14 POWER SUPPLY
15 FUSE BLOCK
16 LMV CONTROL

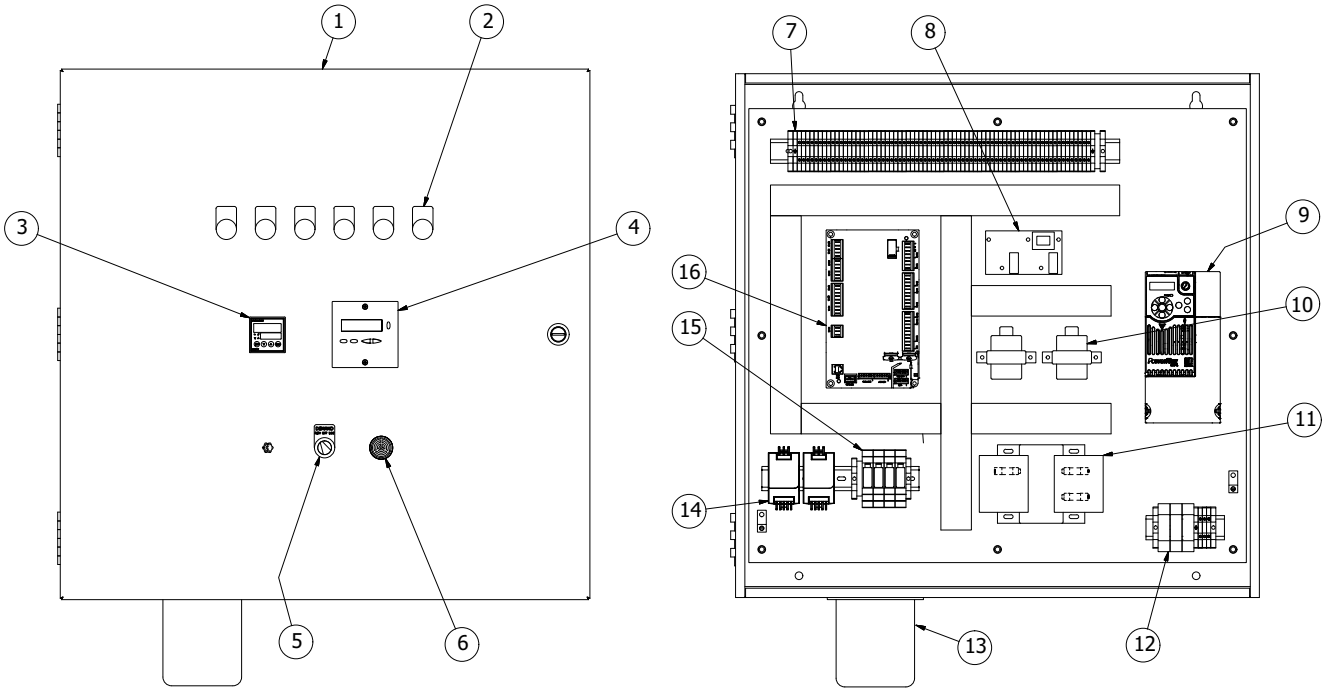


FIGURE 1-8. M5M Control Cabinet (Siemens controls)

1.7 - Component/Connection Locations

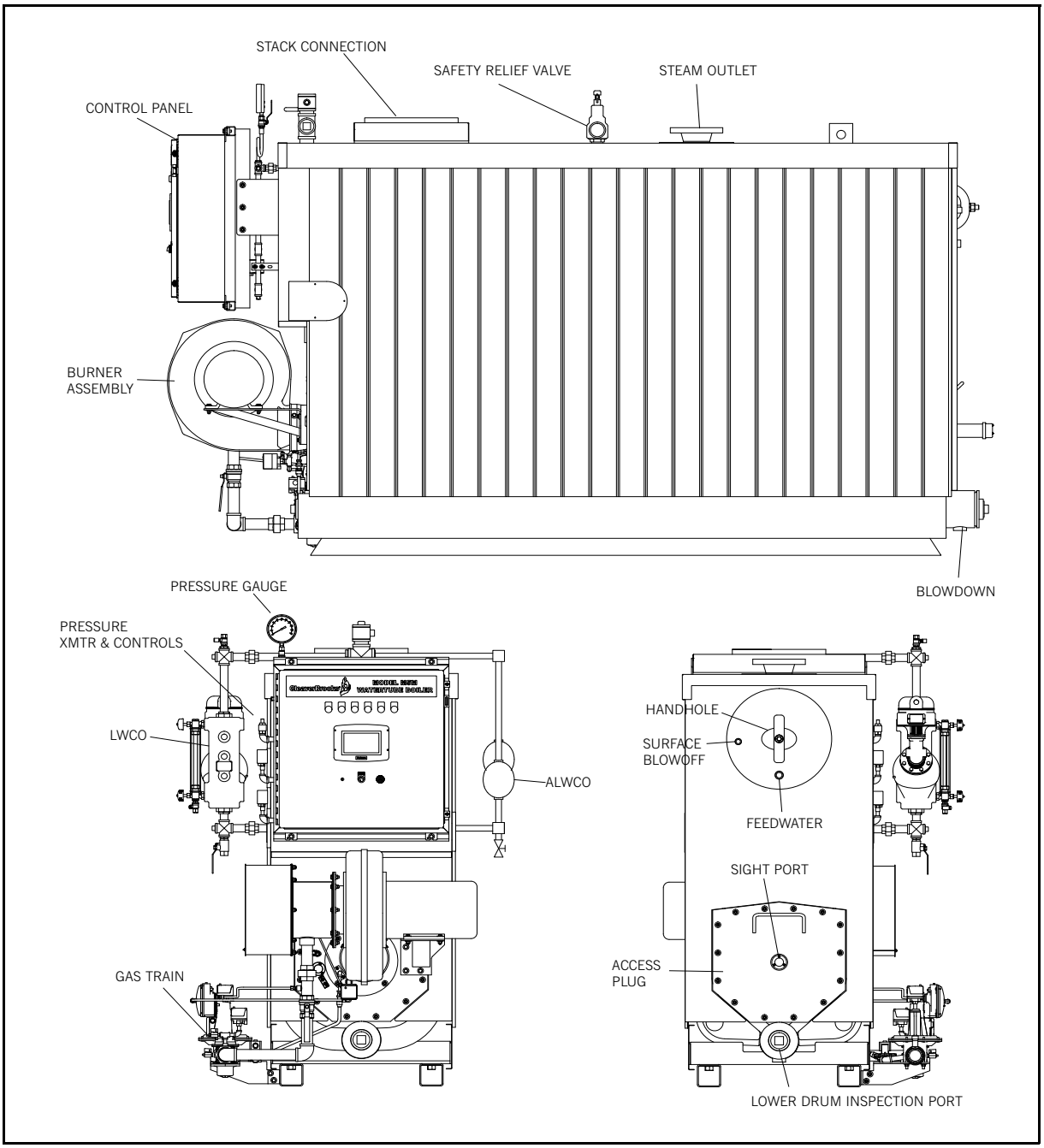


FIGURE 1-9. M5M Component/Connection Locations (steam)

Operating Limit Control: Pressure (Steam Boilers) or Temperature (Hot Water Boilers)

Breaks a circuit to stop burner operation on a rise of boiler pressure or temperature above a selected setting.

Steam Controls

High Limit Control: Pressure (Steam Boilers) or Temperature (Hot Water Boilers)

Breaks a circuit to stop burner operation at a preselected pressure or temperature above the Operating Limit Control setting. This control must be manually reset to restore the circuit.

Low Water Cutoff (LWCO)/Pump Control: Steam Boilers

A float operated control responding to water level in the boiler as seen in the gauge glass. It performs two distinct functions:

1. Stops firing of the burner if the water level drops below a pre-determined operating point. In addition, there is an auxiliary low water cutoff that requires manual reset to start the burner after a low water shutdown.
2. Starts and stops the feedwater pump (if used) to maintain water at the proper operating level.

Low Water Cutoff: Hot Water Boilers

Breaks a circuit to stop burner operation if the water level in the boiler drops below a safe operating point.

Water Level Glass: Steam Boilers

For visually determining water level. Assembly includes water gauge glass, gauge glass shutoff cock, and try cocks.

Water Gauge Glass Drain Valve: Steam Boilers

Provided to flush the gauge glass.

Pressure Gauge: Steam

Indicates boiler's internal pressure.

Temperature/Pressure Gauge: Hot Water

A compound gauge that indicates the boiler's internal water temperature and water pressure.

Safety or Relief Valve

Safety valve(s) are used on steam boilers to relieve the generator of pressures higher than the designed pressure or the pressure designated by the purchaser. Relief valve(s) are used on hot water generators for the same purpose.

Installation of safety and relief valves and their escape and drain piping must conform to ASME code requirements.

Warning

Only the manufacturer or manufacturer's representative should adjust or repair safety and relief valves.

Combustion Air Proving Switch

A pressure sensitive switch, actuated by air pressure, whose contacts close to prove sufficient pressure of combustion air from the forced draft fan.

Variable Speed Drive

Modulating combustion air fan speed is controlled by a Variable Speed Drive mounted in the control cabinet.

CHAPTER 2

Installation

2.1 - Lifting and Moving the Boiler

Cleaver-Brooks Model M5M boilers are equipped with two lifting lugs located on the boiler's upper drum. These lugs should be used to lift the boiler. The boiler should not be lifted by the base, or moved by pushing, prying or pulling on the boiler casing or the burner.

Suitable equipment adequate to safely lift and support the weight of the boiler within the restrictions of the chain angles should be on hand when the boiler arrives at the site. If roller dollies are used to transport the boiler, they should be positioned under the base rails at the lifting lugs. If pipes or other rollers are used to move the boiler, the boiler must be supported by at least three evenly spaced rollers at all times.

TABLE 2-1. M5M Boiler Weights

Capacity (MBTU/hr)	2000	2500	3000	3500	4000	4500	5000	6000
Shipping Weight (lb)	3,100	3,700	3,700	4,100	4,100	4,700	4,700	5,400
Operating Weight (lb) - Steam	3,644	4,450	4,450	5,041	5,041	5,862	5,862	6,758
Operating Weight (lb) - HW	3,900	4,792	4,792	5,458	5,458	6,366	6,366	7,342

⚠ Caution

In order to avoid damage to the unit, lifting or moving the boiler should only be done by experienced, suitably equipped personnel.

2.2 - The Boiler Room

Placement of the Boiler

The boiler must be installed on a noncombustible floor. If the floor is not level, piers or a raised pad slightly larger in length and width than the boiler base dimensions will make boiler installation and leveling easier. Installation on a raised pad or piers will make boiler drain connections more accessible. The floor, pad, or piers must be of sufficient load bearing strength to safely support the operating weight of the boiler and any additional equipment installed with it. Approximate operating weights for M5M series boilers are in Table 2-1.

After the boiler is in place, it must be leveled. Both side-to-side and front-to-back level can be verified by using the vertical connection between the upper and lower drums at the back of the boiler as a reference. If shims are required to level the boiler, the weight of the boiler must be evenly distributed at all points of support.

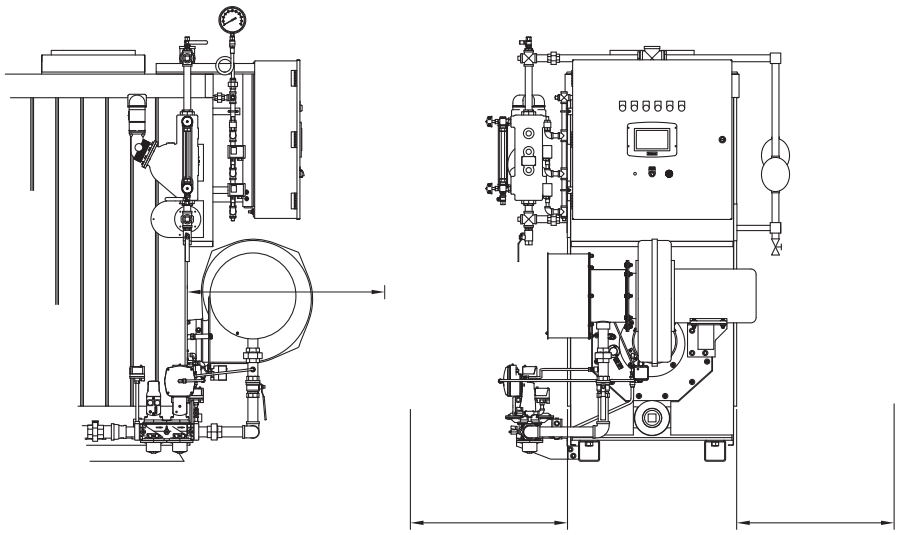
Clearances

The boiler must be installed so that all components remain accessible for inspection, cleaning, or maintenance. Field-installed piping and electrical connections to the burner or boiler must be arranged so as to avoid interfering with removal of the casing panels or with the burner and burner door as they are moved.

Adequate clearance to walls or other obstructions is required for casing removal and tube replacement. In addition to maintaining clearances to walls or obstructions for inspection or maintenance purposes, boiler surfaces that become heated during operation require a minimum clearances to combustible materials.

TABLE 2-2. Minimum clearance for boiler maintenance (inches)

Boiler size	2000	2500	3000	3500	4000	4500	5000	6000
Front clearance	20	20	24.5	24.5	30.5	30.5	39	39
Sides	30	30	30	30	30	30	30	30
Rear	30	30	30	30	30	30	30	30



2.3 - Combustion Air Supply

A positive means of supplying a volume of outside air adequate for complete fuel combustion in the boiler and proper ventilation of the boiler room must be provided.

The amount of air required, and the duct and air supply opening areas, are determined by maximum fuel input rating of the burner and the altitude of the installation. Air inlets must be sized in accordance with applicable engineering guidelines and regulatory code.

The burner for each boiler must be supplied with adequate volume of uncontaminated air to support proper combustion and equipment ventilation. Air shall be free of chlorides, halogens, fluorocarbons, construction dust or other contaminants that are detrimental to the burner or boiler heating surfaces.

Combustion air can be supplied by means of conventional venting, that is, with combustion air drawn from the area immediately surrounding the boiler (boiler room is neutral or slightly positive pressure), or with a direct vent to outside the boiler room where air is drawn directly from the exterior of the building. Regardless of the method, all installations must comply with NFPA 54 (National Fuel Gas Code - NFGC) for U.S. installations and CAN/CSA B149/.1 and B149.2 for Canadian installations.

Engineered Design - When determining boiler room air requirements for the boiler, the "Engineered Design" method may be used. Following this method, consideration must be given to the size of the boiler room, airflow, and air velocity as follows:

Two permanent air supply openings in the outer walls of the boiler room are recommended. Locate one at each end of the boiler room, preferably below a height of 7 feet. This allows air to sweep the length of the boiler. Refer to Figure B3 - 4.

Air supply openings can be louvered for weather protection, but they should not be covered with a fine mesh wire, as this type of covering has poor air flow qualities and is subject to clogging with dirt and dust.

A vent fan in the boiler room is not recommended as it could create a slight vacuum under certain conditions and cause variations in the quantity of combustion air. This can result in unsafe burner performance.

It is forbidden to have the total area of the air supply openings at less than one square foot.

2.3.1 - Sizing the boiler room air supply openings

Size the openings by using the formula (Area in ft^2 = cfm_a/fpm_a), where cfm_a = cubic feet per minute of air; fpm_a = feet per minute of air.

(1)

Amount of air required (cfm):

Combustion Air = Maximum boiler horsepower (bhp) times 8 cfm.

Ventilation Air = Maximum boiler horsepower (bhp) times 2 cfm.

Total Air = 10 cfm per bhp (up to 1000 feet elevation, add 3% more per 1000 feet of added elevation).

(2)

Acceptable air velocity in the boiler room (fpm):

From floor to 7 feet high = 250 fpm.

Above 7 feet from boiler room floor = 500 fpm.

(3)

Example of required air openings (Engineered Method):

Determine the area of the boiler room air supply openings for (2) size 4500 Model 5 boilers at 750 feet elevation; each have a rating of 107 boiler horsepower. The air openings will be 5 feet above the floor level.

The total boiler horsepower (bhp): 107 x 2 = 214 bhp.

From (1) above, total air required = 214 bhp x 10 = 2140 cfm.

Air Velocity: From (2) above = 250 fpm.

Area required: From the formula in E above, 2140 cfm/250 fpm = 8.56 square feet total.

Area opening: 8.56 divided by 2 = 4.28 ft^2 per opening (2 required).

Consult local codes, which may supersede these requirements.

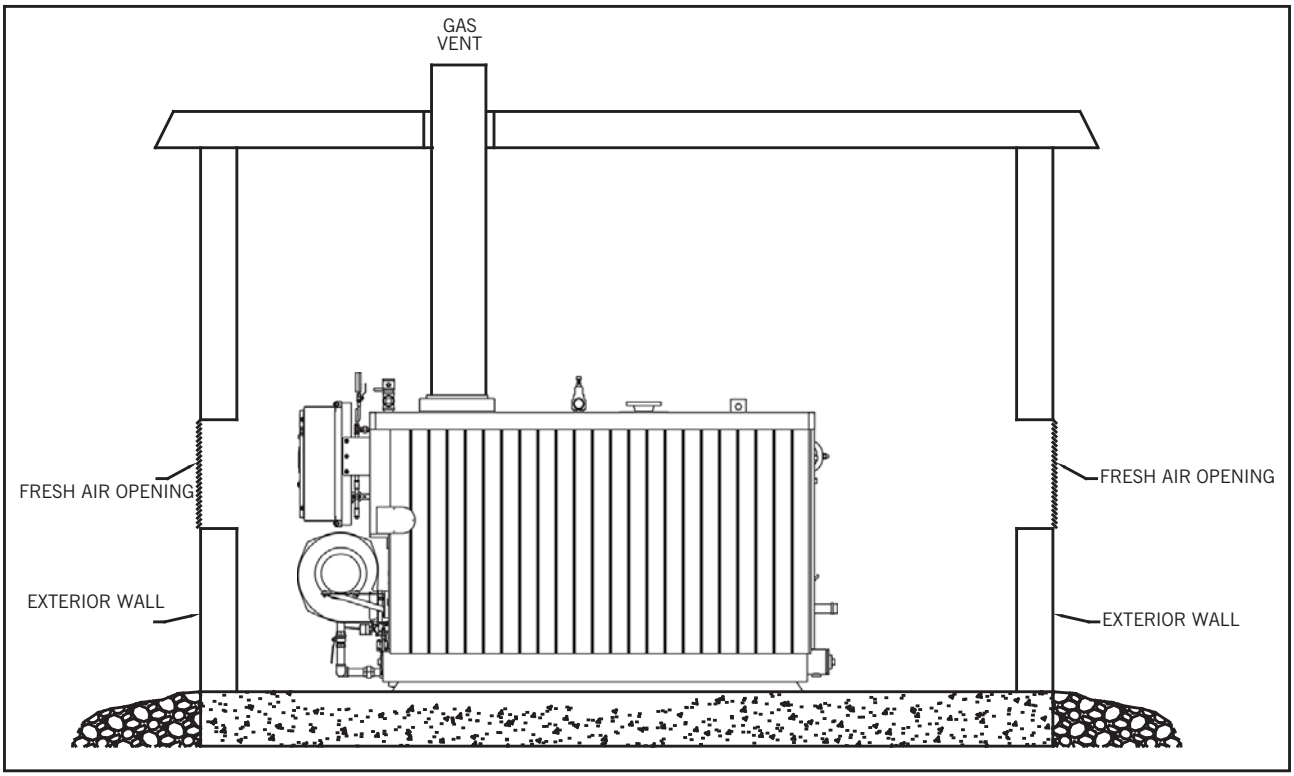


FIGURE 2-1. Boiler Room Air Flow - "Engineered Design"

2.4 - Connections and System Requirements

Drain connections are provided at the front and/or rear of the bottom drum. A drain valve and piping, piped to a safe point of discharge must be installed. A gate or ball valve meeting the minimum service requirements for the installation is suitable for this application. In no case, however, should the drain or blowoff valve have a pressure rating less than 30 psi, and a temperature rating less than 250 °F.

NOTE: All connections made to the boiler must be arranged so that all components remain accessible for inspection, cleaning, or repairs.

The relief valve is a very important safety device and deserves attention accordingly. The purpose of the valve(s) is to relieve pressure buildup over the design pressure of the vessel. The size, rating, and number of valves on a boiler are determined in accordance with the ASME and other codes. The proper installation of a valve is of primary importance to its service life.

⚠ Warning

Incorrect or improper installation of the relief valve may affect valve operation. Only certified personnel such as the relief valve manufacturer's representative should adjust or repair the boiler relief valves. Failure to heed this warning could result in serious personal injury or death.

⚠ Caution

Care must be exercised in the installation of a relief valve to ensure that the valve functions as designed. Apply only a moderate amount of pipe compound to male threads. Avoid over-tightening, as this may distort valve seating surfaces. Use only flatted wrenches on the flats of the valve.

Do not paint, oil, or otherwise cover any interior or working parts of the relief valve.

A relief valve does not require any lubrication or protective coating to work properly.A relief valve must be mounted in a vertical position. Discharge piping must be properly piped to drains to prevent buildup of back pressure and accumulation of foreign material around the valve seat area.

The discharge piping must be properly arranged and supported so that its weight does not bear upon the valve. The discharge piping from the relief valve(s) should be as short and direct as possible and must be routed to a point of safe discharge.

Discharge piping from relief valves, blowdown valves, and other drains must be arranged so that all components remain accessible for inspections, cleaning, or maintenance. Relief valves and their discharge piping are to be installed to conform to ASME code requirements.

⚠ Warning

Discharge piping from relief valves, blowdown valves, and other drains must be routed to a safe point of discharge, so that discharge of hot water or steam cannot cause serious personal injury or death or damage to property.

System Connections (Steam Boiler)

Connection to the main steam header is made at the flanged nozzle projecting upward from the top drum. A suitable stop valve is required, by ASME Code, to be installed between the boiler and main steam header if multiple boilers are tied to the header. This valve should be located as close as possible to the boiler to facilitate venting and pressure testing. A suitably rated gate valve is recommended for this purpose. Local codes frequently address this area, care should be taken to ensure compliance.Feedwater is introduced at the designated connection at the rear of the boiler. The feedwater supply should provide sufficient pressure to meet the minimum flow requirements shown in the Appendix, Table 5. The feedwater piping should also include suitably rated stop and check valves.

System Connections (Hot Water Boiler)

Connection to the system header or supply line is made at the flanged fitting at the upper drum front. The system connection for return flow to the boiler is located at the back of the bottom drum.

Stop valves should be installed between each boiler and the system and return lines. The stop valves should be located as close to the boiler as possible to provide for draining or pressure testing the boiler without draining the system. Lug-style butterfly valves meeting the service requirements of the system are suitable for this location.

⚠ Caution

Make certain that supply and return stop valves are fixed in the open position at all times when the burner is firing, in order to avoid damage to the equipment.

Circulation (Hot Water Boiler)

A hot water boiler, as an integral part of a larger hot water system, requires proper circulation of water within certain limits of temperature, flow, and pressure in order to attain maximum efficiency, economy, and length of service. All valves, piping, pumps, and receivers should be installed in accordance with prevailing codes and practices and the manufacturer's recommendations.

Air Removal (Hot Water Boiler)

Any dissolved gases that may be released in the boiler will collect at the top of the drum, where they will escape through the air vent tapping. This tapping, on the top center line of the upper drum, should be connected to the expansion or compression tank.

A. Individual Zone Circuits: Many systems employ a main circulating pump (located in the boiler room) for each zone. Pump size and capacity can vary from zone to zone depending on the zone location, total heat load, number of branches, head, and type and quantity of heat users or radiation equipment in the zone. Each one can be operated independently of the others. Each zone pump takes suction from a common supply header and the zone returns empty into a common return header. There may or may not be smaller, secondary pumps out in the zone itself.

B. Primary Loop Circuit: A common system employs one main or primary supply header and one common return header, usually connected by means of a radiation device in a remote hallway or other non-critical area. Individual zone take-offs from the common supply header feed the various zones. Individual zone returns empty into the common return header such that all of the zones are in parallel with respect to the two headers. The supply header usually decreases in size as it passes the zone take-offs, and the return header increases in size as it picks up the zone returns. There may or may not be smaller, secondary pumps out in the zone itself.

2.5 - Gas Piping

The local gas company should be consulted for requirements and authorization for installation and inspection of gas supply piping. Installation of gas supply piping and venting must be done in accordance with all applicable engineering guidelines and regulatory codes. All connections made to the boiler must be arranged so that all components remain accessible for inspection, cleaning, and maintenance.

General - The Model 5 boiler requires appropriate gas supply pressure and volume for proper operation and long burner life. The gas requirements specified in this section must be satisfied to ensure efficient and stable combustion. Installation must follow these guidelines and of the local authorities that have installation jurisdiction.

Gas Train Components - Model 5 boilers are equipped with a gas train that meets the requirements of UL as standard. These components also comply with the recommendations of FM, XL GAP (formerly IRI/GE GAP) and ASME CSD-1. The gas train and its components have been designed and tested to operate for the highest combustion efficiency.

Gas Pressure Requirements - For proper and safe operation, each Model 5 boiler requires a stable gas pressure supply.

Gas Piping - Model 5 units are standardly equipped with a gas pressure regulator. If upstream pressure to the standard regulator will be greater than 1 psig, an additional upstream regulator should be provided with a pressure relief valve.

For buildings or boiler rooms with gas supply pressure exceeding 28" w.c., a “full lockup” type regulator is recommended along with proper overpressure protection. In addition to the regulator, a plug type or “butterball” type gas shutoff cock should be provided upstream of the regulator for use as a service valve. This is also required to provide positive shutoff and isolate the boiler gas train during gas piping tests.

Drip legs are required on any vertical piping at the gas supply to each boiler so that any dirt, weld slag, or debris can deposit in the drip leg rather than into the boiler gas train. The bottom of the drip leg should be removable without disassembling any gas piping. The connected piping to the boiler should be supported from pipe supports and not supported by the boiler gas train or the bottom of the drip leg.

All gas piping and components to the boiler gas train connection must comply with NFPA 54, local codes, and utility requirements as a minimum. Only gas approved fittings, valves, or pipe should be used. Standard industry practice for gas piping is normally Schedule 40 block iron pipe and fittings.

Gas Supply Pipe Sizing - For proper operation of a single unit or multiple units, we recommend that the gas pipe be sized to allow no more than 0.3" w.c. pressure drop from the source (gas header or utility meter) to the final unit location. The gas supplier (utility) should be consulted to confirm that sufficient volume and normal pressure are provided to the building at the discharge side of the gas meter or supply pipe. (For installations of new

boilers into an existing building, gas pressure should be measured with a manometer to ensure sufficient pressure is available).

A survey of all connected gas using devices should be made. If appliances other than the boiler are connected to the gas supply line, then a determination should be made of how much flow volume (cfh = cubic feet per hour) will be demanded at one time and the pressure drop requirements when all appliances are operating.

The total length of gas piping and all fittings must be considered when sizing the gas piping. Total equivalent length should be calculated from the utility meter or source to the final connection. The following tables will serve as a guideline. The data in these tables is from the NFPA source book, 2006 edition.

TABLE 2-3. Gas line capacity - Schedule 40 metallic pipe

Pipe Size							
Nominal	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"
Actual I.D.	1.049	1.380"	1.610"	2.067"	2.469"	3.068"	4.026"
Length in feet	**Maximum Capacity in Cubic Feet of Gas per Hour (cfh)						
10	514	1,060	1,580	3,050	4,860	8,580	17,500
20	363	726	1,090	2,090	3,340	5,900	12,000
30	284	583	873	1,680	2,680	4,740	9,660
40	243	499	747	1,440	2,290	4,050	8,290
50	215	442	662	1,280	2,030	3,590	7,330
60	195	400	600	1,160	1,840	3,260	6,640
70	179	368	552	1,060	1,690	3,000	6,110
80	167	343	514	989	1,580	2,790	5,680
90	157	322	482	928	1,480	2,610	5,330
100	148	304	455	877	1,400	2,470	5,040
125	131	269	403	777	1,240	2,190	4,460
150	119	244	366	704	1,120	1,980	4,050
175	109	209	336	648	1,030	1,820	3,720
200	102	185	313	602	960	1,700	3,460

**Fuel: Natural Gas

**Inlet Pressure: Less than 2.0 psi

**Pressure Drop: 0.30" w.c.

**Specific Gravity: 0.60

TABLE 2-4. Gas line capacity - Schedule 40 metallic pipe

Pipe Size							
Nominal	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"
Actual I.D.	1.049"	1.380"	1.610"	2.067"	2.469"	3.068"	4.026"
Length in feet	**Maximum Capacity in Cubic Feet of Gas per Hour (cfh)						
10	678	1,390	2,090	4,020	6,400	11,300	23,100
20	466	957	1,430	2,760	4,400	7,780	15,900
30	374	768	1,150	2,220	3,530	6,250	12,700
40	320	657	985	1,900	3,020	5,350	10,900
50	284	583	873	1,680	2,680	4,740	9,600
60	257	528	791	1,520	2,430	4,290	8,760
70	237	486	728	1,400	2,230	3,950	8,050
80	220	452	677	1,300	2,080	3,670	7,490
90	207	424	635	1,220	1,950	3,450	7,030
100	195	400	600	1,160	1,840	3,260	6,640
125	173	355	532	1,020	1,630	2,890	5,890
150	157	322	482	928	1,480	2,610	5,330
175	144	296	443	854	1,360	2,410	4,910
200	134	275	412	794	1,270	2,240	4,560

**Fuel: Natural Gas
**Inlet Pressure: Less than 2.0 psi
**Pressure Drop: 0.50" w.c.
**Specific Gravity: 0.60

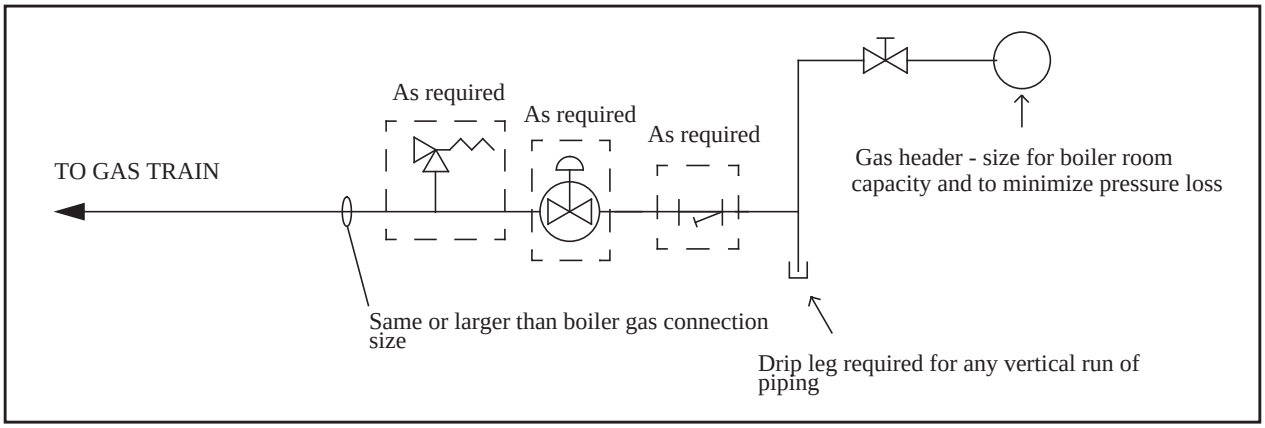


FIGURE 2-2. Piping from gas header (typical)

2.6 - Electrical Connections

Electrical supply to the boiler must be of proper voltage and phase, as inscribed on the burner or electrical panel nameplate. All connections made to the boiler must comply with code requirements and must be arranged so that all components remain accessible for inspection, cleaning, or maintenance. When wiring this boiler, refer to the wiring diagram (WD) prepared by Cleaver-Brooks for this particular installation.

2.7 - Stack and Breeching

The flue connection (breeching) between the boiler and the chimney must be no smaller in diameter than the flue vent opening provided on the boiler. The proper sizing of stacks and breeching is required in order to maintain the proper flue gas velocity with a static draft condition (0" Water Column) at the boiler flue vent.

There should be no long horizontal runs in the flue pipe, and all horizontal pipes should be pitched away from the boiler at least 1/4" per foot. A drain connection should be provided at all low spots, as shown in Fig. 3-3. Round breeching or stacks generally are more efficient than square or rectangular shapes and should be used when possible.

The maximum load on the flue vent connection and the top casing of the M5M boiler must be limited to 200 pounds of vertical load, with no side load.

⚠ Caution

The top casing of the M5M series boiler should not be used as a work platform. Imposing vertical loads on the top casing in excess of 200 pounds may result in structural damage to the boiler casing and possible leakage of products of combustion to surrounding spaces.

The Model 5 boiler operates with a positive vent pressure and a vent gas temperature that is non-condensing. Therefore, the stack must be a positive pressure design.

Proper design and installation of the flue gas venting is critical to efficient and safe operation of the burner. The vent should be designed with proper supports and clearances from combustible materials. Use insulated vent pipe spacers where the vent passes through walls and roofs.

The design of the stack and breeching must provide the required draft at each boiler stack connection. Although constant pressure at the flue gas outlet is not required, it is necessary to size the breeching and stack to limit flue gas pressure variations. Consideration of the draft must be given where lengthy runs of breeching are employed or unusually high stacks. Please note: the allowable pressure range for design of the stack and breeching is negative 0.25" w.c. (-62 Pa) to a positive 0.25" w.c. (+62 Pa) for proper light offs and combustion. NOTE: This pressure range does not pertain to the boiler room, that is, the boiler room must be neutral or slightly positive, never negative when using air from the boiler room for combustion.

Multiple Boiler Connections

When multiple boilers are to be connected to a common breeching, the breeching must be designed and constructed so as to maintain required flue gas velocity and draft conditions. Horizontal breeching is recommended in order to prevent condensation that may form in the breeching from returning to the boiler.

When two or more Model 5 boilers are connected to a common breeching/stack, one should evaluate the affects of pressure variations that may occur during boiler sequencing while boilers are firing. It may be determined that some type of mechanical draft system be employed to ensure proper draft at each boiler is maintained.

2.8 - Water Requirements

Water Quality

Good water quality in the boiler is essential. Close attention to water quality will pay dividends in the form of proper operation, longer life, less downtime, and prevention of costly repairs. The water used to fill the boiler or to make up for system losses should be free of dissolved oxygen or corrosive gases, sediments or other contaminants and should be at a minimum temperature of 70 degrees Fahrenheit. The exclusive use of clean, properly treated make-up water in the boiler will yield maximum efficiency and the longest possible trouble-free life from the pressure vessel.

TABLE 2-5. Water Quality Requirements

Parameter	Boiler Water Limit
pH	8.3 - 10.5
Iron	0.1 ppm
Oxygen	0.1 mg/liter
Specific Conductivity	2000 μmho/cm
Suspended Solids	300 ppm
Total Hardness	0 ppm as CaCO3

⚠ Caution

If the boiler is to be used for temporary heat, as for example in new construction, properly treated water still must be used. Failure to do so can cause damage to the boiler.

Water Treatment

Maintaining boiler water quality generally requires proper feedwater treatment before and after introduction of water into the boiler. The selection of pretreatment processes depends upon the water source, its chemical characteristics, the amount of makeup water needed, system operation practices, and so on. Treating methods include filtering, softening, demineralizing, deaerating, and preheating. After treatment involves chemical treatment of the boiler water.

Steam boilers have critical water quality limits, which must be observed in order to ensure optimum steam purity and boiler life expectancy.

A properly sized water meter should be installed in a raw water makeup line in order to accurately determine the amount of water admitted to the boiler.

Pressure Test of Boiler and System Piping

All new boilers and systems must be checked for leaks. Fill the boiler and system with clean water. Pressure should be increased to a point just below the relief valve setting or as required. Check for leaks in the system and boiler fittings, including the internal tube-to-drum connections, at this elevated pressure.

Boilout of a New Boiler

An internal cleaning procedure (boilout) is vital to the efficiency and proper operation of the boiler and the system and is required before the unit is put into service. The internal surfaces of the newly installed boilers may contain oil, grease, or other contaminants which, if not removed, can adversely affect system performance. In extreme instances, contamination could cause localized reduction of heat transfer and result in overheating of pressure vessel surfaces.

See Chapter 3, Waterside Care, for a step-by-step procedure.

System Cleaning

Certain extraneous materials do find their way into the system during construction. The most common materials are: Pipe dope, thread cutting oils, soldering flux, rust preventatives or slushing compounds, core sand, welding slag, and sand or clays from the job site. To obtain optimum performance, the system should be cleaned and flushed. Cleaning a hot water system is accomplished in much the same manner as cleaning the boiler and may be done at the same time.

For more information on system cleaning, consult a qualified professional.

2.9 - Installation Checklist

This installation checklist should be used as an aid to ensure that the boiler is ready for start-up. The list includes those items that have been found to cause delays in start-up. Attention to these items will assist in bringing the equipment on line without needless delay or additional service charges. Installation must be completed before start-up can be scheduled. With all aspects of the boiler installation addressed and complete, your local Cleaver-Brooks Service Representative should be contacted for start-up. Mark the appropriate space for each item on the checklist. The installation should not be considered complete until all boxes have been checked yes or no.

GENERAL

Yes No

___ ___ 1. Are all Cleaver-Brooks supplied items in good operating condition? If not, note here.

___ ___ 2. Is the burner fuel and pilot supply piping properly installed?

___ ___ 3. If dual-fuel is specified, are both fuels available for start-up?

___ ___ 4. Where required, will qualified operators for the boiler or burner be present for start-up?

___ ___ 5. Will operating personnel be available for training during start-up?

___ ___ 6. Will a person be available at all times to assist the service technician with miscellaneous tasks in the boiler room?

___ ___7. A full capacity load (sufficient for high fire fuel/air ratio adjustment) will be required for complete burner adjustment. Can this load be absorbed by the system, and have provisions been made to put a full load on the boiler during start-up?

BOILER

Yes No

___ ___ 8. Is the boiler and/or auxiliary equipment installed in accordance with manufacturer's and insurer's requirements and applicable insurance and regulatory codes?

___ ___ 9. Has all system piping to and from the boiler been completed?

___ ___ 10. Is the relief valve(s) properly installed?

___ ___ 11. Is the relief valve discharge piping properly installed with no weight or strain on the valve(s)?

___ ___ 12. Is the boiler drain valve(s) installed properly?

___ ___ 13. Are boiler drain and relief valves piped to a place of safe discharge, and are the drain lines installed in accordance with all applicable regulatory codes?

___ ___ 14. Is the return water temperature thermometer installed in the system return fitting?

ELECTRICAL

Yes No

___ ___ 15. Is the available power supply (voltage and phase) correct (per the burner data plate information?

___ ___ 16. Have all electrical connections been made for boiler and all auxiliary equipment?

___ ___ 17. Have emergency and safety devices been installed in accordance with regulatory codes?

___ ___ 18. Have all boiler field-wired connections been made according to the wiring diagram supplied by Cleaver-Brooks for this particular installation?

GAS FUEL

Yes No

___ ___ 22. Have all gas lines been pressure tested according to local codes, then purged of air?

___ ___ 23. Is gas pressure and volume sufficient for the boiler(s) at maximum demand firing rate, as stated on the burner nameplate?

___ ___ 24. Are gas pressure gauges installed and are they indicating proper gas pressure upstream of the regulator?

___ ___ 25. Are gas vents including vent valves, properly piped to a point of safe discharge? Has insurance inspection, if required, been completed?

CHAPTER 3

Waterside Care

3.1 - Overview

This chapter will primarily examine the waterside care of the pressure vessel.

The type of service that your boiler performs has an important bearing on the amount of waterside care it will require. The subject of water supply and treatment cannot be adequately covered in this manual. Nevertheless, it is of primary importance. Feedwater equipment should be checked and ready for use. See that all valves, piping, boiler feed pump, and receiver are installed in accordance with prevailing codes and practices.

The careful observance of water requirements for both steam and hot water boilers is critical to boiler life and length of service. Constant attention to this area will pay dividends in the form of longer life, less down time, and prevention of costly repairs.

Care taken in placing the pressure vessel into initial service is vital. The waterside of new boilers and new or remodeled steam or hot water systems may contain oil, grease, or other foreign matter. A method of boiling out the vessel to remove these accumulations is described later in this chapter.

The operator should become familiar with this chapter before attempting to place the unit into operation.

The boiler, as a part of a hot water system, requires proper circulation. The system must be operated as intended by its designer to avoid severe, possibly damaging, stresses occurring to the pressure vessel.

3.2 - Construction

All Cleaver-Brooks boilers are built to ASME Code requirements and may be identified by the Code symbol stamped on the pressure vessel: {S} indicates power boilers, {H} indicates heating boilers.

Heating boilers are defined as low pressure steam boilers for operation at pressures not exceeding 15 psi and/or hot water boilers operating at pressures not exceeding 160 psi and/or temperatures not exceeding 250° F, and manufactured to the ASME Heating Boiler Code.

Power boilers are steam boilers designed for pressures in excess of 15 psi or high temperature water boilers operating in excess of 250° F, and manufactured to the ASME Power Boiler Code.

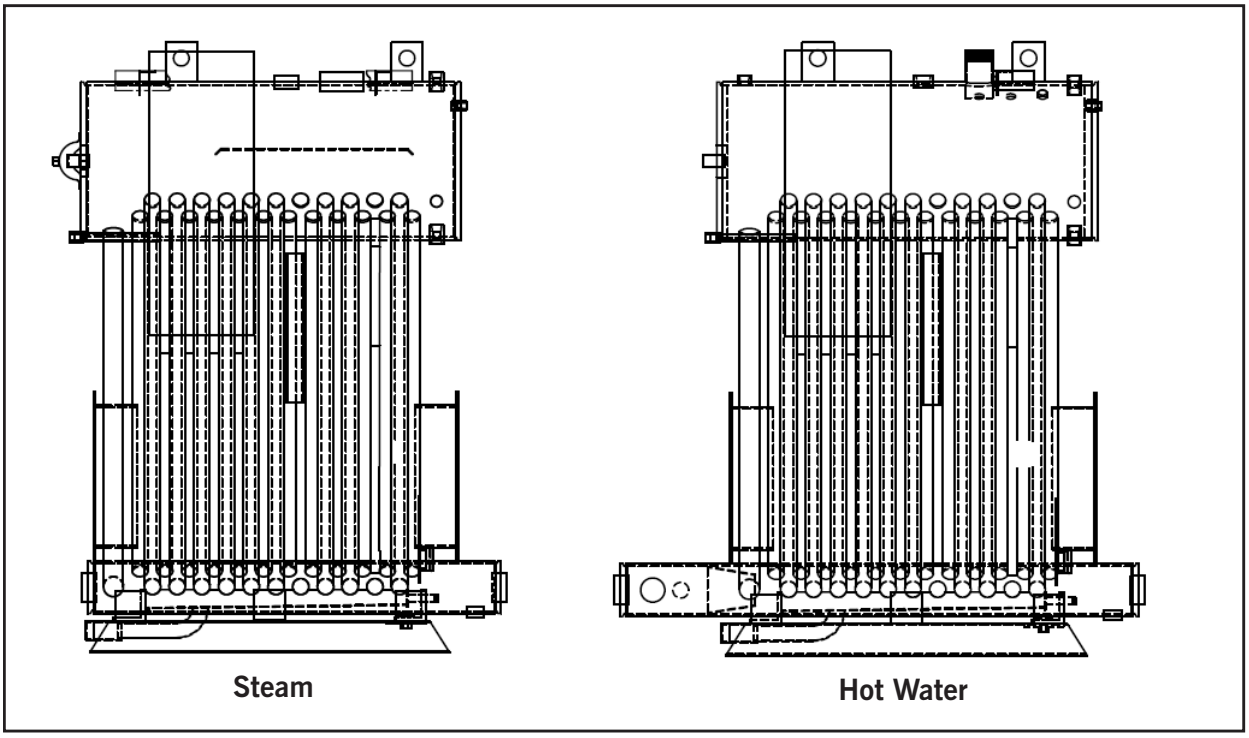


FIGURE 3-1. M5M Pressure Vessel

3.3 - Water Requirements

3.3.1 - Steam Boiler

Requirement	Description
Feed Pump Operation	Make certain that all valves in the water feed line are open BEFORE turning on the pump motor to prevent possible damage to feed pump mechanism. After opening valves, momentarily energize feed pump motor to establish correct pump rotation. With correct rotation, close boiler feed pump entrance switch. Pump should shut down when water level reaches proper level. Feedwater pumps must have adequate capacity to maintain water level under all operating conditions. Check feedwater pumps periodically and maintain as necessary to prevent unexpected breakdowns.
Minimum Boiler Water Temperature	The minimum recommended boiler water temperature is 180° F. If the temperature of the flue gas is reduced to the dew point, the condensed water can cause corrosion in the boiler fireside and in the breeching. This condensation problem is more severe on the unit which operates intermittently because it is oversized for the actual load. This is not a matter which can be controlled by boiler design, since an efficient boiler extracts all the possible heat from the combustion gases. However, this problem can be minimized by maintaining boiler water temperatures above 180° F.

⚠ Caution

Prior to operating a pump, carefully check alignment of flexible coupling if one is used on the pump. A properly aligned coupling will last a long time and provide trouble-free mechanical operation.

⚠ Caution

Fire a cold unit slowly to avoid undue stressing of pressure vessel parts. To assist in this, all hot water boilers are equipped with a minimum 10 minute low fire hold before the boiler can increase its firing rate.

3.3.2 - Hot Water Boiler

Requirement	Description
Air Removal	All Cleaver-Brooks hot water boiler outlet connections include a dip tube which extends into the top drum. This dip tube reduces the possibility of any air (which may be trapped at the top of the drum) entering the system. Any oxygen or air that may be released in the boiler will collect or be trapped at the top of the drum and will find its way out of the boiler through the air vent tapping. This tapping, on the top center line of the drum, should be piped into the expansion or compression tanks.
Continuous Flow	It is essential that the system be piped and the controls arranged so that there will be water circulation through the boiler under all operating conditions. Constant circulation through the boiler eliminates the possibility of stratification and results in more even water temperature to the system. A blend pump is included as standard on Model 5 hot water boilers.
Multiple Boiler Installation	When multiple boilers of equal or unequal sizes are used, care must be taken to insure adequate flow through each. If balancing cocks or orifice plates are used, a significant pressure drop (for example, 3 psi to 5 psi) must be taken across the balancing device to determine required flow rates. If care is not taken to insure adequate flow through the boilers, wide variation of firing rate between them and possible long term damage can result.
Pressure Drop	There will be a pressure drop of less than 6 feet head (1 psi = 2.31 ft. hd.) through all standardly equipped Cleaver-Brooks boilers operating in any system which has more than 20° F temperature drop. this drop will vary with boiler size and temperature change. Consult factory for specific information.
Pressure	The design of the system and the usage requirements will often dictate the pressure exerted upon the boiler. Some systems are pressurized with air or with an inert gas, such as nitrogen. Caution must be exercised to make sure that the proper relationship of pressure to temperature exists with the boiler so that all of its internal surfaces are fully wetted at all times. For this reason, the internal boiler pressure (as indicated on the water pressure gauge) must be held to the level as displayed on the Pressure-Temperature Chart for Hot Water Generators. When initially firing a newly installed boiler or when cutting an existing boiler into an operating system, the boiler or boilers to be cut into operation MUST be pressurized equal to the system and/or other boilers prior to cutting in.

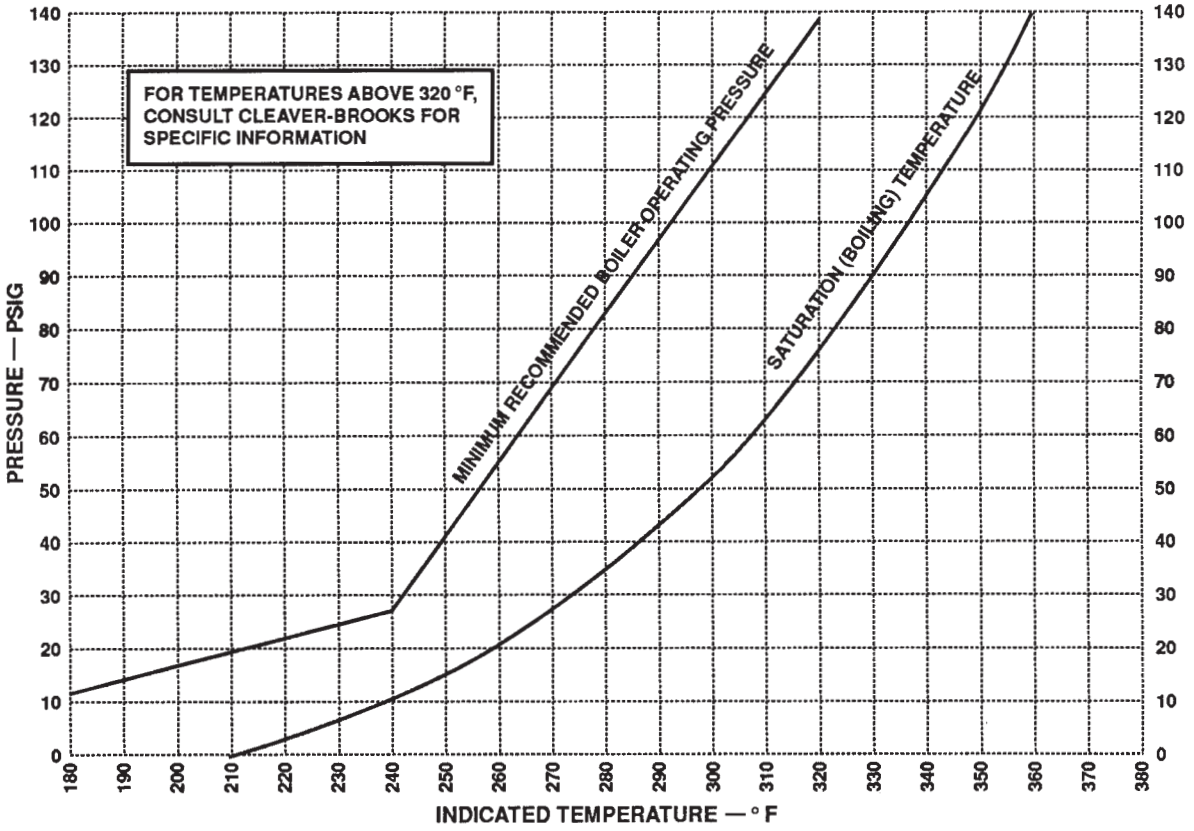


FIGURE 3-2. Pressure-Temperature Chart for Hot Water Boilers

3.4 - Water Treatment

Maximum effectiveness and long trouble-free life of pressure vessels, at the lowest cost consistent with good engineering and operating practice, are functions of properly treated boiler feedwater. The recommendations of a water consultant or a reliable water treatment company must be strictly followed to prevent the presence of unwanted solids and corrosive gases.

Objectives of water treatment in general are:

- Prevention of hard scale deposits or soft sludge deposits, which impair the rate of heat transfer and can lead to overheated metal and costly downtime and repairs.
- Elimination of corrosive gases in the supply or boiler water.
- Prevention of intercrystalline cracking or caustic embrittlement of boiler metal.
- Prevention of carryover and foaming.

The accomplishment of these objectives generally requires proper feedwater treatment before and after introduction of water into the boiler. The selection of pre-treatment processes depends upon the water source, its chemical characteristics, amount of make-up water needed, plant operating practices, etc. These treating methods include filtering, softening, de-mineralizing, deaerating and pre-heating. After-treatment involves chemical treatment of the boiler water.

Because of the variables involved, no one 'boiler compound' can be considered a 'cure-all' nor is it advisable to experiment with homemade treating methods. Sound recommendations and their employment should be augmented by a periodic analysis of the feedwater, boiler water, and condensate.

The internal or waterside surfaces of the pressure vessel should be inspected with sufficient frequency to determine the presence of any contamination, accumulations of foreign matter, or corrosion and/or pitting. If these conditions are detected the water consultant or feedwater treating company should be consulted for advice on corrective action.

It is recommended that a properly sized water meter be installed in the raw water make-up line to accurately determine the amount of raw water admitted to the boiler (steam or hot water) to aid the water treatment program in maintaining proper waterside conditions.

The general feeling exists that a hot water boiler does not require water treatment, but this is a false assumption. The recommendations of a reliable water treating company or a water consultant should be followed rigidly. Even though hot water boilers generally operate on a closed system and blowdown is seldom practiced, the need remains to be alert to system water losses. A water meter is recommended for water make-up lines.

3.5 - Cleaning

3.5.1 - Hot Water and Steam Piping

Steam and water piping systems connected to the boiler may contain oil, grease, or foreign matter. These impurities must be removed to prevent damage to pressure vessel heating surfaces. On steam systems the condensate should be wasted until tests show the elimination of undesirable impurities. During the period that condensate is wasted, attention must be given to the treatment of the raw water used as make up so that an accumulation of unwanted materials or corrosion does not occur. Follow the advice of your water treating company.

On hot water systems, chemical cleaning is generally necessary and the entire system should be drained after treatment. Consult water treatment companies for recommendations, cleaning compounds, and application procedures.

3.5.2 - Pressure Vessel

The waterside of the pressure vessel must be kept free of grease, sludge, and foreign material. Such deposits if present will not only shorten the life of the pressure vessel and interfere with efficient boiler operation and functioning of control or safety devices, but might possibly cause unnecessary and expensive rework, repairs, and down time.

The pressure vessel and the steam and return lines or hot water piping represent, in effect, a closed system. Although the steam and return (condensate) lines or the hot water piping system may have been previously cleaned, it is possible that:

- Cleaning has been inadequate.
- Partial or total old system is involved.
- conditions may prevent adequate cleaning of piping.

The installation and operating conditions to which the boiler will be subjected must be considered and the cleaning of the waterside of the pressure vessel must be provided during the course of initial start-up.

The pressure vessel waterside must be inspected on a periodic basis. This will reveal true internal conditions and serve as a check against conditions indicated by chemical analysis of the boiler water. Inspection must be made three months after initial starting and at regular six month intervals thereafter. The frequency of further periodic inspections will, however, depend upon the internal conditions found.

If any unwanted conditions are observed, a water consultant or water treating company must be contacted for recommendations.

Any sludge, mud, or sediment found must be flushed out. The effectiveness of the blowdown practiced on steam boilers will be verified and scheduling or frequency of blowdown may have to be revised. The need for periodic draining or washout will also be indicated.

Any oil or grease present on the heating surfaces must be removed promptly by a boil-out with an alkaline detergent solution.

3.6 - Boil Out (steam boilers)

⚠ Caution

Temperature of initial fill of water for hydrostatic tests, boil-out, or for normal operation should be approximately 70° F or as close to ambient as possible.

The internal surfaces of a newly installed boiler may have oil, grease, or other protective coatings used in manufacturing. These coatings must be removed since they lower the heat transfer rate and could cause overheating of heating surfaces. Before boiling out procedures may begin, the burner must be ready for firing. The operator must be familiar with the procedure outlined under burner operation.

Your water consultant or water treating company will be able to recommend a cleaning or boil-out procedure. In the event such service is unavailable or as yet unselected, the following information bay be of assistance.

Suggested procedure for boiling out new units prior to initial firing:

Tri-sodium phosphate and caustic soda are the suggested chemicals for cleaning of boilers. One pound of each chemical should be used for every 50 gallons of water.

1. When dissolving the chemicals, warm water should be put into a suitable container. Slowly introduce the dry chemical into the water stirring at all times until the chemical is completely dissolved. Add the chemical slowly and in small amounts to prevent excessive heat and turbulence.

⚠ Caution

Use of a suitable face mask, goggles, rubber gloves, and protective garments is strongly recommended when handling or mixing caustic chemicals. Do not permit the dry material or the concentrated solution to come in contact with skin or clothing.

2. An overflow pipe should be attached to one or the top drum openings and routed to a safe point of discharge. A water relief or safety valve tapping is usually used.
3. Safety valves must be removed before adding the boil-out solution so that neither it nor the grease which it may carry will contaminate these valves. Use care in removing and re-installing valves.
4. All valves in the piping leading to or from the system must be closed to prevent cleaning solution from getting into the system.

5. Fill pressure vessel with clean water until the tops of the tube openings in the upper drum are covered. Add the cleaning solution and then fill to the top.
6. The boiler should then be fired intermittently at a low rate sufficient to hold solution just at the boiling point. Boil the water for at least 5 hours. Do not produce steam pressure.
7. Allow a small amount of fresh water to enter the boiler to create a slight overflow that will carry off surface impurities.
8. Continue boiling and overflow until the water clears.
9. Stop the burner and drain the boiler using caution that the hot water is discharged with safety.
10. Remove cover plate in the upper drum and the inspection plugs in the lower drum and wash the waterside surfaces thoroughly using a high pressure water stream.
11. Inspect surfaces and if not clean repeat the boil-out.
12. After closing openings and re-installing safety or relief valve(s), fill the boiler and fire until water is heated to at least 180° F to drive off any dissolved gases which might otherwise corrode the metal.

The above procedure may be omitted in the case of units previously used or known to be internally clean, however, consideration must be given to the possibility of contaminating materials entering the boiler from the system.

On a steam system the condensate should be wasted until tests show the elimination of undesirable impurities. During the period that condensate is wasted, attention must be given to the treatment of the raw water used as make up so that an accumulation of unwanted materials or corrosion does not occur. Follow the advice of your water treating company.

Table 3-1 M5M Boiler Water Capacity

Boiler Model			2000	2500	3000	3500	4000	4500	5000	6000
Water volume (gallons US)	Steam	Standard	65.3	90.0	90.0	112.9	112.9	139.4	139.4	163.0
		Low Water Volume	31.9	43.8	43.8	54.6	54.6	68.0	68.0	74.7
	HW		96	131	131	163	163	200	200	233
Water volume (Imperial gallons)	Steam	Standard	54.4	74.9	74.9	94.0	94.0	116.1	116.1	135.7
		Low Water Volume	26.6	36.5	36.5	45.5	45.5	56.6	56.6	62.2
	HW		79.94	109.08	109.08	135.70	135.70	166.50	166.50	194.01

3.7 - Washing Out (Hot Water Boilers)

In a hot water system the boiler may be cleaned with the entire system or may be isolated for cleaning. The entire system should be drained after any chemical treatment. Consult a water treatment company for recommendations, cleaning compounds, and application procedures.

No later than 3 months after initially placing the boiler into operation and thereafter as conditions warrant, the pressure vessel should be drained after being properly cooled to near ambient temperature. Handhole cover or closure plates in the upper drum and handhole covers in the lower drum removed and internal waterside surfaces inspected for corrosion, pitting, or formation of deposits.

In theory, a hot water system and boiler that has been initially cleaned, filled with treated water, and with no make-up water added will require no further cleaning or treatment. However, since the system (new or old) may allow entrance of air and unnoticed or undetected leakage of water, introductions of raw water make-up or air may lead to pitting, corrosion, and formation of sludge, sediment, scale, etc., on the pressure vessel waterside.

If there is any doubt, the pressure vessel waterside should be inspected no later than 3 months after initially placing the boiler into operation and periodically thereafter as indicated by conditions observed during inspections.

3.7.1 - Flushing of Pressure Vessel Interior

Upon completion of inspection, the pressure vessel interior should be flushed out as required with a high pressure hose. If deposits are not fully removed by such flushing, this may require immediate consultation with your water consultant or feedwater treatment company, and in extreme cases, it may be necessary to resort to acid cleaning. Professional advice is recommended if acid cleaning is required.

These inspections will indicate the effectiveness of the feedwater treatment. The effectiveness of treatment, the water conditions, and the amount of fresh water make-up required are all factors to be considered in establishing frequency of future pressure vessel washout periods. Subsequent inspections will indicate the effectiveness of the water treating program as well as the suitability of the intervals between washouts. The feedwater consultant or water treatment company service should include periodic pressure vessel inspection and water analysis.

3.8 - Blowdown (steam boilers)

Boiler water blowdown is the removal of some of the concentrated water from the pressure vessel and its replacement with feedwater so that a lowering of the concentration in the boiler water occurs.

Solids are present in the feedwater even though this water is treated prior to use with external processes that are designed to remove unwanted substances which contribute to scale and deposit formations. However, none of these processes are in themselves capable of removing all substances and regardless of their high efficiency, a small amount of encrusting solids will be present in the boiler water.

Solids become less soluble in the high temperature of the boiler water and tend to crystallize and concentrate on heating surfaces. Internal chemical treatment is, therefore, required to prevent the solids from forming harmful scale and sludge.

Scale has a low heat transfer value and acts as an insulation barrier. This retards heat transfer, which not only results in lower operating efficiency and consequently higher fuel consumption, but, more importantly, can cause overheating of boiler metal.

This can result in tube failures or other pressure vessel metal damage causing boiler down time and costly repairs.

Scale is caused primarily by calcium and magnesium salts and silica. Any calcium and magnesium salts in the boiler water are generally precipitated by the use of sodium phosphate along with organic materials to maintain these precipitates or ‘sludge’ in a fluid form. The solids such as sodium salts and suspended dirt do not readily form scale, but as the boiler water boils off as relatively pure steam, the remaining water is thicker with the solids. If this concentration is permitted to accumulate, foaming and priming will occur and the sludge can cause harmful deposits that bring about overheating of the metal.

The lowering or removal of this concentration requires the use of boiler water blowdown. Intermittent manual (bottom) blowdown and continuous (surface) blowdown are the two principal types.

3.8.1 - Bottom Blowdown

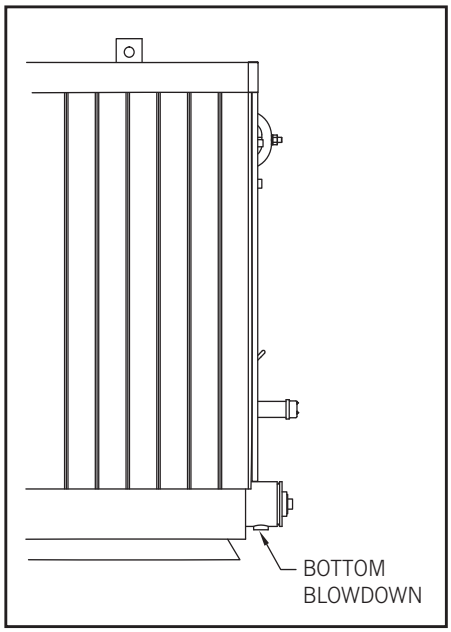
> **⚠ Caution**
>
> Boiler and water column blowdown must be performed on a regular basis to ensure that concentrated solids are removed from the boiler and in order to avoid damage to the equipment.

Manual or sludge blowdown is necessary for the operation of the boiler regardless of whether or not continuous blowdown is employed.

The blowdown tapping is located in the bottom drum. In addition to lowering the dissolved solids in the pressure vessel water, blowdown also removes a portion of the sludge which accumulates in the lower drum.

Equipment generally consists of a quick opening valve and a shutoff valve. These, along with the necessary piping, are not normally furnished with the boiler, but supplied by others. All piping must be to a safe point of discharge. Piping must be properly supported and free to expand.

Most blow-off lines are provided with two valves, generally a quick opening valve nearest the boiler and a slow opening globe type valve downstream. Two slow opening valves or tandem valves may be used. Valves will vary depending upon pressure involved and make or manufacture.



If a quick opening valve and a globe type or slow opening valve are in combination, the former is normally opened first and closed last with blowing down accomplished with the globe or slow opening valve. If seatless valves are installed, follow the manufacturer's recommendations.

When opening the second or downstream valve, crack it slightly to allow the lines to warm up, then continue opening slowly.

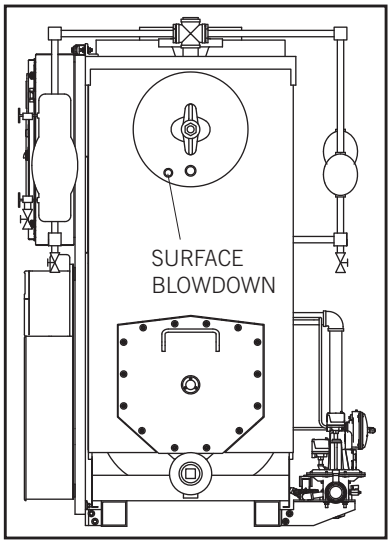
The length of each blow should be determined by actual water analysis. Lowering the water in the gauge glass approximately 1/2" is often acceptable as a guide to adequate blow, however, this should not be interpreted as a rule since water analysis procedures should prevail. If the glass cannot be viewed by the party operating the valve, another operator should watch the glass and direct the valve operator.

Close the downstream (slow opening) valve first and as fast as possible. Then close the valve next to the boiler. Slightly crack the downstream valve and then close it tightly.

A blow-off valve must not be left open; the operator must never leave until the blowdown operation is completed and the valves closed.

3.8.2 - Continuous Blowdown

Continuous blowdown is used in conjunction with a surface blow-off tapping and is the continuous removal of concentrated water.



The surface blow-off opening, located in the rear head of the upper drum, is slightly below the working water level for the purpose of skimming surface sediment, oil, or other impurities from the surface of the pressure vessel water.

A controlled orifice valve is used to allow a continual — yet controlled — flow of concentrated water.

Periodic adjustments are made to the valve setting to increase or decrease the amount of blowdown in accordance with test analysis.

The flow control valve and piping are generally provided by others. All piping must be to a safe point of discharge.

When continuous blowdown is utilized, intermittent blowdown is primarily used to remove suspended solids or sludge. The continuous blowdown removes sediment and oil from the surface of the water along with prescribed amount of dissolved solids.

When surface or continuous blowdown is not utilized, manual blowdown is used to control the dissolved or suspended solids in addition to the sludge.

In practice, the valve(s) of the bottom blowdown are opened periodically in accordance with an operating schedule and/or chemical control tests. From the standpoint of control, economy, and results, frequent short blows are preferred to infrequent lengthy blows. This is particularly true when suspended solids content of the water is high. With the use of frequent short blows a more uniform concentration of the pressure vessel water is maintained.

In cases where the feedwater is exceptionally pure, or where there is a high percentage of return condensate, blowdown may be employed less frequently since less sludge accumulates in the pressure vessel. When dissolved and/or suspended solids approach or exceed pre-determined limits, manual blowdown to lower these concentrations is required.

3.8.3 - Additional Considerations

It is generally recommended that steam boilers be blown down at least once in every eight hour period, but this may vary depending upon water and operating conditions. The blowdown amounts and a schedule should be recommended by a water treating company or a water consultant.

A hot water boiler does not normally include a tapping for surface blowdown but does have a drain opening in the lower drum. Blowdown is not commonly practiced with a hot water system, however, it may be necessary depending upon the condition of the system, variable water, and make-up. The need remains to be alert to system water losses and the corresponding amount of raw water make-up. A water meter with a small flow rate is recommended for water make-up lines.

Blowdown is most effective at a time when generation of steam is at the lowest rate since feedwater input then is also low, providing a minimum dilution of the boiler water with low concentration feedwater.

Make sure blow-off piping and tank, if used, are in proper operating condition and discharge vents clear of obstruction, and that waste is piped to a point of safe discharge. The valve installation must be in accordance with applicable codes.

3.9 - Periodic Inspection

Insurance regulations or local laws will require a periodic inspection of the pressure vessel by an authorized inspector. Sufficient notice is generally given to permit removal from service and preparation for inspection.

When shutting down, the load should be reduced gradually and the pressure vessel cooled at a rate that avoids damaging temperature differentials that can cause harmful stresses. Vessels should not normally be drained until all pressure is relieved, again to prevent uneven contraction and temperature differentials. Draining the unit too quickly may cause the baking of deposits that may be present on the heating surfaces. Some heat, however, may be desirable to dry out the interior of the boiler.

If the internal inspection is being made at the request of an authorized inspector, the inspecter may desire to observe the conditions prior to cleaning or flushing of waterside surfaces.

Handhole openings are located in the drum heads. These openings provide access and permit waterside inspection of the drum.

The handhole plates should be tightened securely to prevent leakage. Always use a new gasket when resealing. Make sure that seating surfaces are clean. Snugging the nut after a warm-up period will help provide a tight seal.

Be certain that proper gaskets are available along with any other items needed to place the unit back into operation after inspection.

Have available information on the boiler design, dimensions, generating capacity, operating pressure or temperature, time in service, defects found previously, and any repairs or modifications. Also have available for reference records of previous inspections.

Be prepared to perform any testing required by the inspector, including hydrostatic.

After proper cooling and draining of the vessel, flush out the waterside with a high pressure water hose. Remove any scale or deposits form the waterside surfaces and check for internal or external corrosion and leakage.

The fireside surfaces should also be thoroughly cleaned so that metal surfaces, welds, joints, etc., plus any previous repairs, can be readily checked.

Be sure that steam valves, system valves, (hot water) feedwater valves, blow-off valves, all fuel valves, valves to expansion tanks, and electrical switches are shut off prior to opening the inspection cover or removing plugs. Flashlights rather than extension cords are recommended as a safety factor. Cleaners should preferably work in pairs.

Clean out the low water cut-off piping, the water level controls, and cross connecting piping. Replace water gauge glass and clean out water cocks and tri cocks.

Also check and clean drain and blowdown valves and piping.

Check all water and steam piping and valves for leaks, wear, corrosion, and other damage. Replace or repair as required.

3.10 - Circulating Pump (hot water units)

3.10.1 - Lubrication

Pump Bearings - Re-lubrication is required at the start of each heating season, or every three months for continuous service. Re-lubricate with 1 teaspoon of oil (B&G#20 weight non-detergent oil, or an SAE 20 non-detergent or 10W-30 oil). More frequent lubrication may be required under adverse conditions such as high ambient temperatures. Less frequent lubrication is required if oil overflows from the reservoir.

Motor Bearings - Lubricate through the two motor oilcups according to the lubrication decal. At the time of installation the motor bearings use approx. 12 drops each. At re-lubrication intervals fill each motor bearing with approx. 6-8 drops. More or less frequent re-lubrication may be required depending on the installation conditions.

NOTE: Over-oiling can cause motor mount deterioration and may cause spillage onto surrounding surfaces. Deteriorated motor mounts will lead to misalignment and excessive coupler wear.

⚠Caution

Do not run the pump dry – seal damage may occur. Failure to follow these instructions could result in moderate personal injury and/or property damage.

3.10.2 - Inspection

Inspect the pump regularly for leaking seals, worn gaskets, and loose or damaged components. Replace or repair as required.

CHAPTER 4

Commissioning - Falcon Controls

4.1 - Operating Conditions

- The installation site should be as free as possible from vibration, dust, and corrosive media.
- The controllers should be located as far as possible from sources of electromagnetic fields, such as frequency converters or high-voltage ignition transformers.
- Control panel must be connected to earth ground.

4.2 - Filling Boiler

The boiler should be filled with water to the proper operating level using water of ambient temperature. For steam units, open the vent valve and fill the boiler slowly to allow entrapped air to escape. Do not close the vent valve until water is visible in the gauge glass. In hot water applications the entire system should be filled and vented.

Make sure that feedwater treated according to site requirements is available. Check to ensure that no leaks appear at any pipe connections and correct if water leaks are noticed.

4.3 - Control Setpoints

Preliminary settings of the burner/boiler safety controls are necessary for the initial starting of the boiler. After the burner has been properly set, minor adjustments to these controls may be necessary for the particular installation. For initial starting, set the following controls accordingly:

1. Operating and High Limit controls - Set the dial @ maximum.
2. Combustion Air Proving Switch - Set the dial @ minimum.
3. Low Gas Pressure Switch - Set the dial @ minimum.
4. High Gas Pressure Switch - Set the dial @ maximum.

Depress all manual reset buttons for all controls prior to starting.

Note: Ensure that the post-startup checkout procedure (section 4.10.10) is observed following commissioning.

4.4 - Falcon Boiler / Burner Controller

The Model M5M is standardly equipped with the Falcon boiler control system. Primary controller functions include:

- Flame supervision
- Burner sequencing
- Heating/modulation control
- Hot water system pump control
- High Limit temperature control
- Thermowell-mounted NTC temperature sensors to provide measured process variable signals to the controller.

FIGURE 4-1. **Control panel**

Additional features include:

- User-friendly touchscreen interface
- Modbus communication capability
- Alarm/lockout messaging with history (last 15 messages)
- Annunciation
- Outdoor reset
- Central Heating and Domestic Hot Water loop contro (hot water units)l
- Password protection of configurable parameters
- Time of Day (dual setpoint) control
- High Stack Temperature limit
- Remote reset
- Lead/Lag sequencing and modulation
- (3) configurable pump relays
- Remote modulation/remote setpoint
- Frost protection
- Warm weather shutdown

Please review the tables within this Commissioning section to familiarize yourself with the functions and parameters of the Controller. Also see Appendices A and B for details on control configuration and operation.

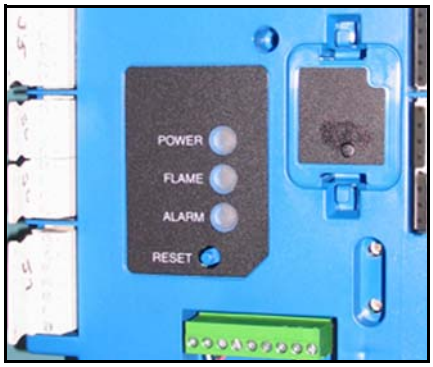


FIGURE 4-2. **Falcon LEDs and reset**

The Model M5M is factory tested. Nevertheless, all burner safety controls should be checked upon installation, prior to initial firing. **Failure to verify burner control functioning could result in severe bodily injury or death.**

FIGURE 4-3. Falcon Display/Operator Interface

4.5 - Falcon Display/Operator Interface

The Falcon display/operator interface is control panel mounted for convenient access to all operating controls.

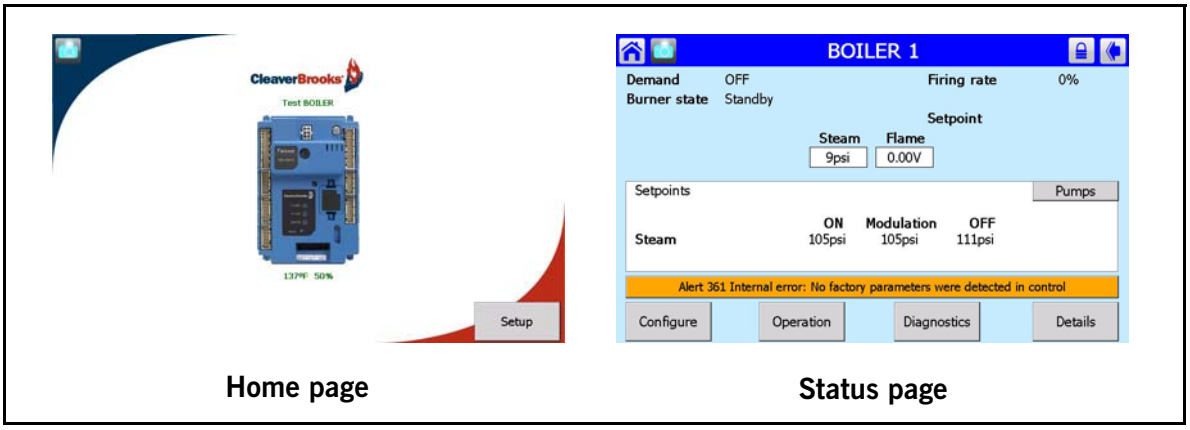
4.5.1 - Home Page

Apply power to the boiler. The Home page will appear on the Falcon display.

Each Falcon in the system is represented on the Home page by an icon and name.

4.5.2 - Status Page

Pressing the Falcon icon takes the user to the Status page, which summarizes boiler status and allows navigation to the configuration, operational, and diagnostic areas of the Falcon interface.



Home page **Status page**

The **Demand** display will show one of the following:

Burner enable off
Off (burner switch on but no demand)
Steam (steam boilers) **or Central Heat**
Domestic Hot Water (if configured)

Burner state shows the currently active step in the burner operating sequence.

The central portion of the display can be toggled between the following:

Pumps shows the on/off status of boiler and system pumps.
Modulation shows fan speed RPM settings for Demand, Limited, and Override rates
Setpoints shows the ON, Modulation, and OFF temperature setpoints.

4.5.3 - Operation Page

The operation page (<Color>FIGURE 4-4.) displays the Falcon running operation, including setpoint and firing rate values. From this page the user can change setpoints, manually control the boiler's firing rate, manually turn pumps on, view annunciation information, and switch between heating loops (Central Heat and Domestic Hot Water). If a password is required to change any of the settings on this page, the user can press the Login button to enter the password.

The burner is enabled from this page by turning the <Burner switch> screen button ON.

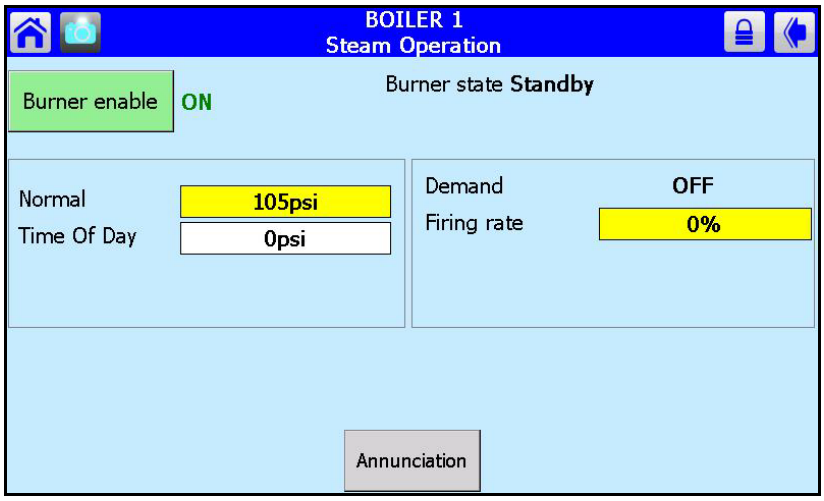


FIGURE 4-4. Operation Page

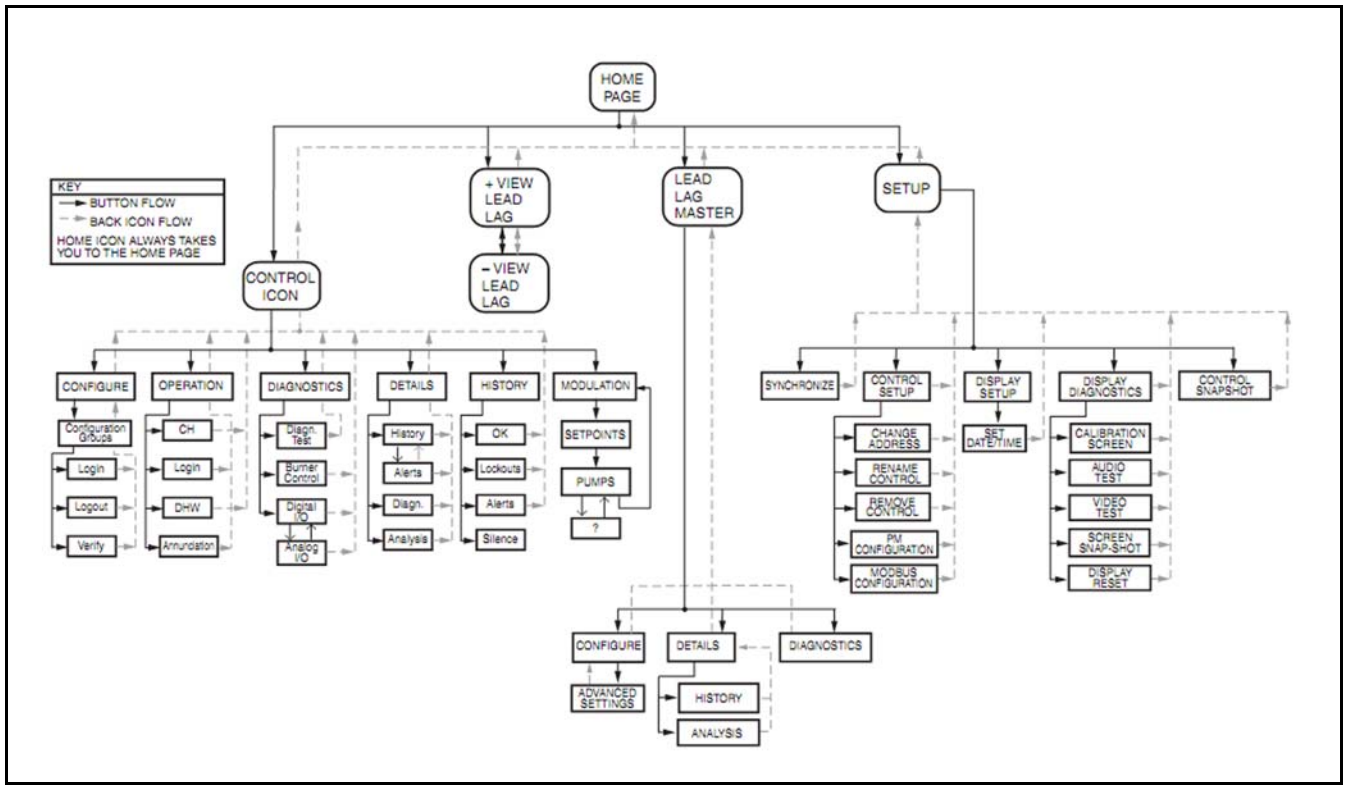


FIGURE 4-5. Falcon Display/Interface page flow

4.5.4 - Lockouts, Holds, and Alerts

To assist in monitoring boiler operation, the Falcon control system employs messages of three types: **Lockouts**, **Holds**, and **Alerts**.

- **Lockouts** and **Holds** indicate interruptions in boiler operation, whether occurring as part of the normal operating sequence or due to an abnormal condition. Lockouts require a manual reset to continue operation, while Holds do not. A Hold will automatically clear when the hold condition is removed or satisfied.

The 15 most recent Lockouts are stored in Falcon memory and may be accessed through the Lockout History. Holds are not logged in memory.

Note: *Before attempting to restart the boiler after a Lockout, identify and correct the Lockout condition.*

- **Alerts** indicate conditions or events which, while not preventing boiler operation, may nevertheless be of interest in evaluating boiler performance or operating conditions. Examples include certain operator actions, out-of-range configuration data, controller internal status reports (e.g. timers, counters, memory read/write activity), and recycle events. Alerts require no operator acknowledgment and are for informational purposes only.

The most recently occurring message (Lockout, Hold, or Alert) is displayed in the alarm banner on the Status screen (see <Color>FIGURE 4-6.). Press this banner to access the Alert or Lockout History, where a list of the most recently occurring Alerts/Lockouts can be viewed.

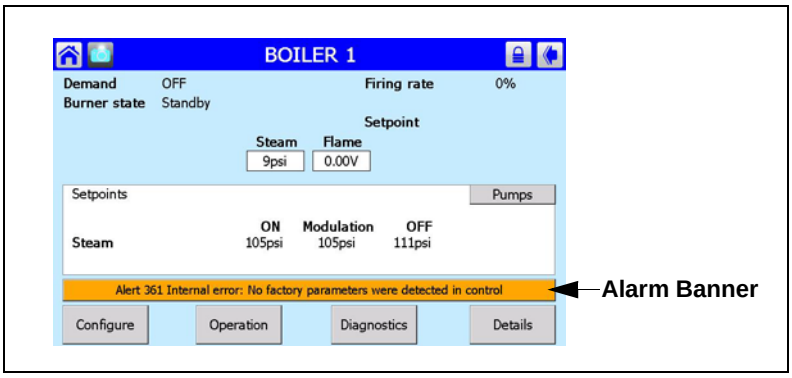


FIGURE 4-6. Alarm Banner

To obtain more information for a particular message, press that item in the respective history list. For Alerts, burner cycle and hours of operation at the time of occurrence will be displayed. For Lockouts, in addition to cycle and hours the screen will show on/off status of all interlocks at the time of the lockout. This information can be used to help pinpoint the cause of a particular Lockout.

See also Section 5 - **Service and Maintenance**.

4.6 - Controller Configuration

The Falcon controller should be factory configured for the specific M5M boiler model. Prior to starting the boiler, verify that the factory default settings are correct for your application. Please refer to C-B default settings, **APPENDIX A**, and make any changes at this time if needed.

Falcon configuration is organized into the following functional groups:

- System Identification & Access
- CH - Central Heat ConfigurCation
- Outdoor Reset Configuration
- DHW - Domestic Hot Water Configuration
- Modulation Configuration
- Pump Configuration
- Statistics Configuration
- Anti-condensation Configuration
- Frost Protection Configuration
- Annunciation Configuration
- Burner Control Interlocks
- Burner Control Timings & Rates
- Burner Control Ignition
- Burner Control Flame Failure

4.6.1 - Changing Falcon Parameter Settings

See APPENDIX A for Falcon parameter list

To access the Falcon configuration menu, press <Configure> on the Status page.

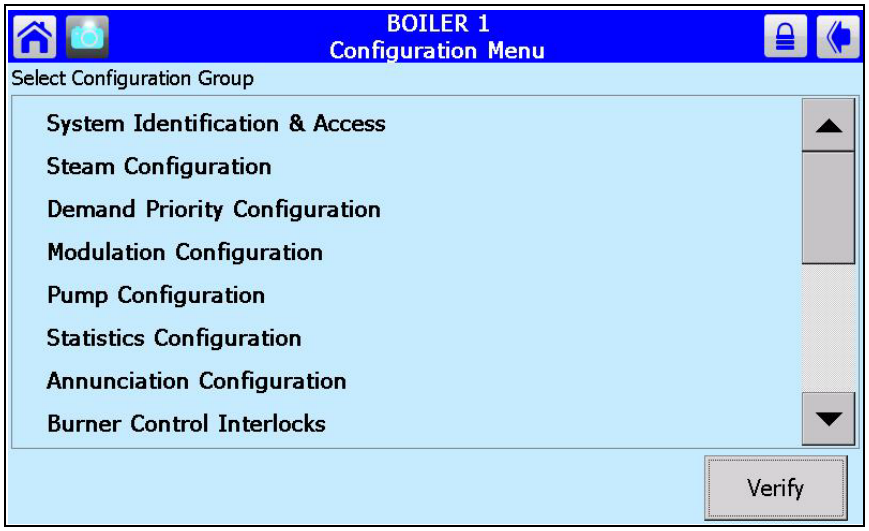


FIGURE 4-7. Configuration Menu

Some parameters require a password entry before allowing changes. The <Login> button will appear when any password-protected parameter is displayed on the screen. Default service level password is 9220.

Press <Login> to display the alphanumeric keyboard. Enter password and press <OK>

Change parameter settings by selecting the parameter on the page. A dialog box appears with controls allowing the user to change the selected value. Press <Clear> to clear the current value. Enter the new value and press <OK> (press <Cancel> to leave the parameter unchanged).

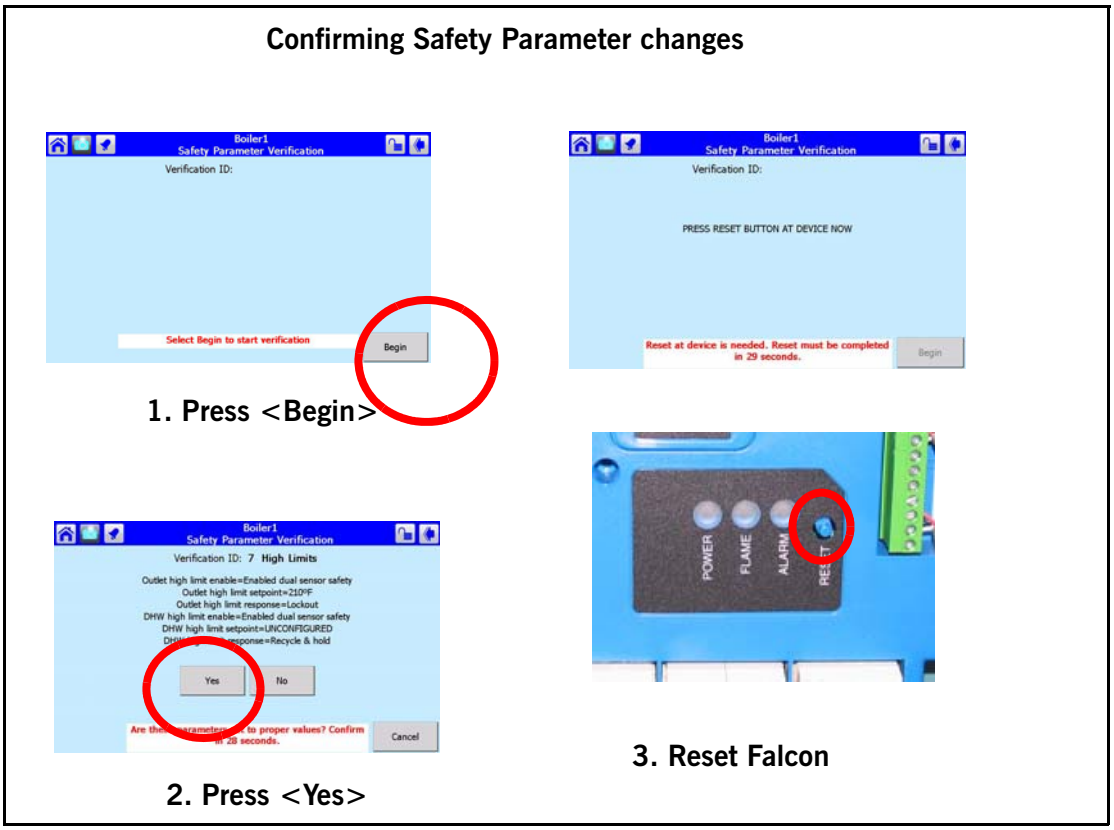
Safety Parameters

When configuring safety parameters an additional verification step is required to confirm the changes.

1. When a safety parameter is changed, the Safety Parameter Verification page will appear. Press <Begin> to continue.
2. The affected parameter group will be displayed, showing current parameter values and a prompt, “Are these parameters set to proper values?”. Press <Yes> to continue.
3. The screen will indicate RESET DEVICE NOW. Open the control panel and press the RESET button on the Falcon controller (press and hold for 3 seconds).

RESET must be pressed within 30 seconds to save changes.

Note: When changing multiple safety parameters, the verification steps do not need to be completed immediately.



4.6.2 - Program Module

Falcon parameter information (non-safety parameters only) can be uploaded/ downloaded using the optional Program Module (PIM). When the Program Module is installed, its features are accessible from the Falcon Setup page. Starting from the Home page, press <SETUP>, then <PROGRAM MODULE>.

FIGURE 4-8. PIM

4.7 - Variable Speed Drive Settings

The Variable Speed Drive is pre-configured at the factory. Should it become necessary to change the drive's configuration, see **APPENDIX C - Variable Speed Drive Parameters** for parameter list; if necessary refer also to the Allen-Bradley PowerFlex user manual.

4.8 - Burner Sequence

In addition to providing modulation control, the Falcon is responsible for flame supervision and burner sequencing.

Basic burner sequencing:

1. Heat request detected (Setpoint minus On Hysteresis); LCI limits and demand detected (terminals J6 3 and J8 3).
2. After a system Safe Start Check, the Blower (fan) is switched on after a dynamic ILK switch test (if enabled).
3. After the ILK input is energized, 10 sec. allowed for IAS input (combustion air proving) to energize, and purge rate proving fan RPM is achieved - prepurge time is started.
4. When 30 sec. purge time is complete, the purge fan RPM is changed to the lightoff speed.
5. As soon as the fan-rpm is equal to the light-off RPM, the Trial for Ignition (4 sec.) or Pre-Ignition Time is started (depending on configuration).
6. Pre-Ignition Time will energize the ignitor and check for flame.
7. Trial for Ignition.
8. The ignition and the gas valve are switched on.
9. The ignition is turned off 5 seconds into pilot ignition.
10. The fan is kept at the lightoff rate during the stabilization timer, if any.
11. Before the release to modulation, the fan is switched to minimum RPM for the CH Forced Rate and Slow Start Enable, if the water is colder than the threshold.
12. Release to modulation.
13. At the end of the heat request the burner is switched off and the fan stays on until post purge is complete.
14. A new request is blocked for the forced off time set by the Anti Short Cycle (if enabled).
15. The pump stays on during the pump overrun time (if enabled).
16. At the end of the pump overrun time the pump will be switched off.

4.9 - Fan Speed Settings

Because the input is determined by the fan speed, fan speed settings may have to be modified for the particular application, for high altitudes, or when using direct vent combustion. The default fan speed settings are intended for typical applications for the various boiler sizes. Please contact your authorized Cleaver-Brooks representative for proper settings in high altitude and direct vent combustion applications.

4.10 - Initial start-up procedure

⚠ Warning

Before initial startup, check for blockages in the flue venting or vent terminations. Inspect the burner and furnace for any contamination or blockages.

4.10.1 - Gas Train and Piping

The M5M burner is equipped with a combination servo-regulated gas valve and venturi mixing unit. The gas valve consists of a single body and regulating actuator with safety shutoff. The blower speed is controlled by the Falcon

with airflow directly proportional to the speed of the fan. The airflow creates a drop in pressure due to the venturi effect. The modulating controller of the valve actuator senses air pressure change and accordingly brings about a change in the gas flow proportional to the air pressure. The gas follows the airflow in a set ratio, so that fuel always matches the air as the burner firing rate increases or decreases.

1. Check the gas delivery system to be sure it is properly piped and wired.
2. Review available gas supply pressure to ensure that it is compatible with the M5M's gas train and regulator. Refer to Table 4-1 for minimum required supply pressure and maximum allowable supply pressure.
3. To bleed air from the supply pipe, open the manual gas shut off valve upstream of the burner gas train and bleed air from the piping by loosening the union in the upstream piping.
4. The burner and its gas connection must be leak tested before placing the boiler into operation.
5. Gas Pressure Regulator - Using the adjusting screw on the main gas regulator, adjust the gas valve inlet pressure to within the recommended levels in Table 4-1.

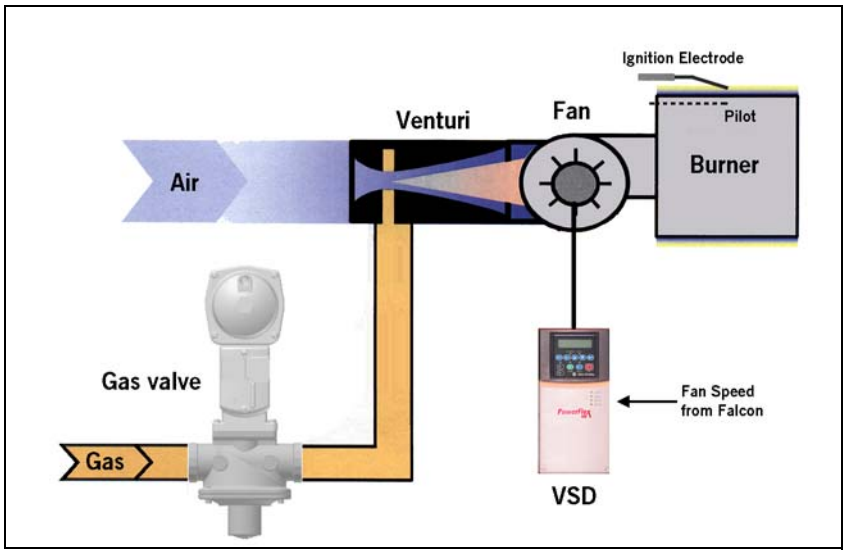


FIGURE 4-9. **Premix Burner Technology - Full Modulation**

Table 4-1 M5M Gas Pressure Requirements

Boiler Model	Minimum pressure required at gas train connection	Max. pressure*
2000	17" WC	2 PSI
2500	17" WC	2 PSI
3000	17" WC	2 PSI
3500	21" WC	2 PSI
4000	21" WC	2 PSI
4500	24" WC	2 PSI
5000	28" WC	3 PSI
6000	28" WC	3 PSI

*Upstream regulator required for higher gas supply pressures

4.10.2 - Power-Up

1. Ensure the boiler is properly wired for the available power supply. Refer to the wiring diagram provided with the boiler.
2. Verify the voltage to ensure it is within specifications.

4.10.3 - Operation Check: Gas Valve, Gas Pressure Switches, Combustion Air Proving Switch, Ignition Fail

Before initial firing of the burner, the gas valve, Low Gas Pressure Switch (LGPS), High Gas Pressure Switch (HGPS), and Combustion Air Proving Switch (CAPS) should be checked for proper operation.

- Before proceeding, review **Section 4.3 - Control Setpoints** for initial LGPS, HGPS, and CAPS settings.

Note: Close the downstream manual gas shut-off valve before checking pressure switches and CAPS.

While performing the following safety checks, use the Falcon Annunciation screen to monitor the status of the circuits involved. Press <Annunciation> on the Operation page to access this screen.

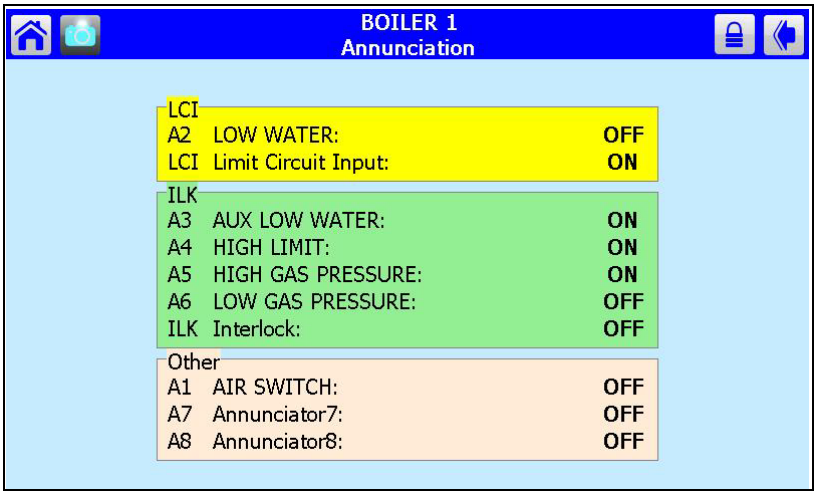


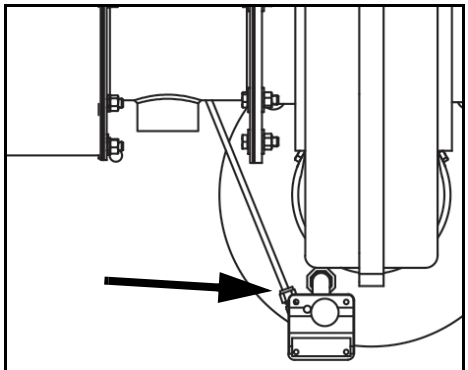
FIGURE 4-10. Annunciation Screen

LGPS

1. To check the Low Gas Pressure Switch, first close the upstream manual shutoff valve (both manual shutoff valves should now be closed).
2. Start the burner and wait 10 seconds during purge for CAPS to be made.
3. Turn the LGPS setting to maximum.
4. Open the test cock to bleed the gas line.
5. The controller should lock out. The screen will indicate **Lockout 67 ILK OFF**.
6. Reset the controller and change the LGPS setting back to minimum to proceed.

CAPS

1. Initiate burner sequence.
2. During purge cycle, set Combustion Air Proving Switch to its maximum setting.
3. The Falcon should lock out on an airflow failure. The display will show **Lockout 65 Interrupted Airflow Switch OFF**.



CAPS low pressure connection

Note: If the CAPS fails to open even when set to maximum, test by disconnecting the low-pressure line to the switch and initiating burner sequence. The switch should now break during the purge cycle. Reconnect low-pressure side after a successful CAPS check.

4. Following a successful CAPS check, dial the CAPS back to its minimum setting and reset the Falcon.

HGPS and GAS VALVE

1. Open the upstream manual shutoff valve and wait a few moments for gas pressure to rise.
2. Lower the switch setting to minimum.
3. Initiate burner sequence. During the main flame establishing period, verify gas valve LEDs energize, indicating both safety shutoff valves open.
4. The Falcon should lock out on an interlock failure (Lockout 67).
5. Reset Falcon.
6. Open the downstream manual shutoff valve to clear the lockout condition.
7. Dial the HGPS back to its maximum setting and reset.

IGNITION FAILURE CHECK

1. Close the downstream shutoff valve and attempt to start the burner. The Falcon should lock out, indicating **Lockout 109 Ignition Failure**.

After making the above operation checks, re-open the downstream manual shut-off valve.

4.10.4 - PIlot Tests

PILOT FAIL CHECK

Close the gas pilot shutoff valve. Also shut off main fuel supply. Attempt to start the burner. There should be an ignition spark, but no pilot flame. The Falcon will lock out, indicating pilot failure.

Reset the Falcon, open the pilot shutoff valve, and re-establish fuel supply before continuing.

PILOT HOLD TEST

On the Falcon display, go to Configure>Ignition and turn <Pilot Hold> to ON. Open the manual valve on the pilot gas train, keeping the downstream main gas valve closed. Initiate the burner sequence. The burner will go through prepurge and will go to trial for pilot ignition. Once the pilot is lit, check for flame signal on the Falcon display and visually inspect the pilot flame through the sight port on top of the boiler. Once a good pilot flame has been established, open the downstream main gas shutoff valve and turn the Pilot Hold setting to OFF. The Falcon will proceed to main flame trial for ignition.

4.10.5 - Low Water Cutoff Check

1. Hold down the LOW WATER RESET-TEST switch for 3 seconds.
2. Check Annunciation screen. The ILK section (Interlock circuit) should show **A3 LOW WATER: OFF**
3. Press RESET-TEST switch once to reset.

4.10.6 - Low and High Fire Adjustments

All M5M boilers are factory tested firing natural gas at an altitude of 1000 ft ASL. Operating under different conditions may require re-adjustment of the gas valve.

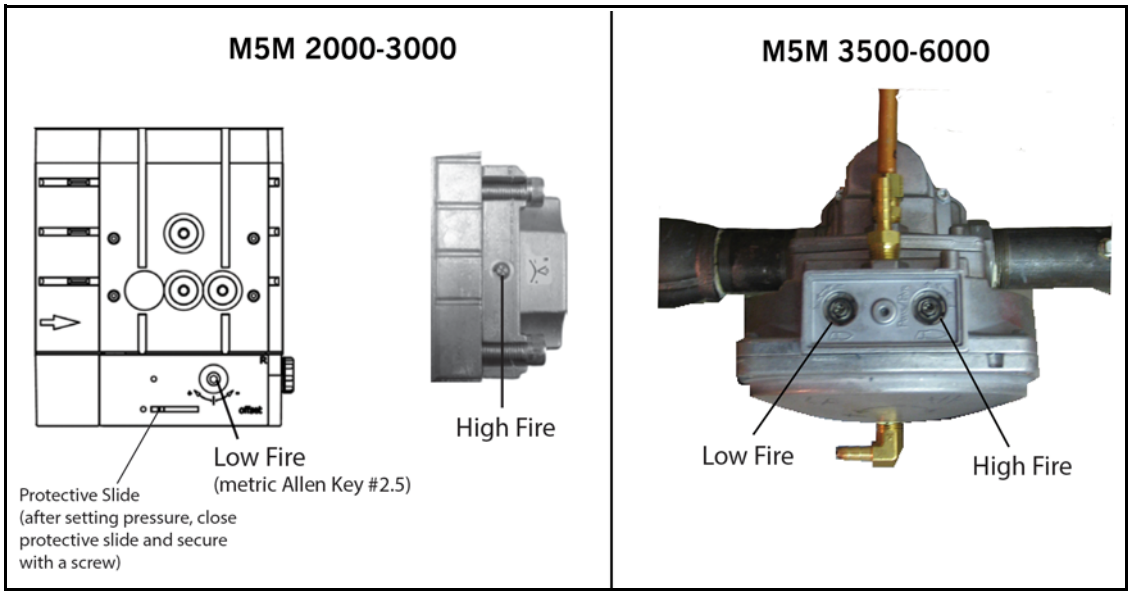


FIGURE 4-12. Gas Valve adjustment

Refer to **Appendix D** or **E** depending on make of gas valve for further information on valve setup, operation, and testing.

4.10.7 - Modulation OFF point

Prior to setting combustion, the Modulation OFF point should be adjusted upward to avoid nuisance shutdowns while the burner is under manual control.

4.10.8 - Setting Combustion

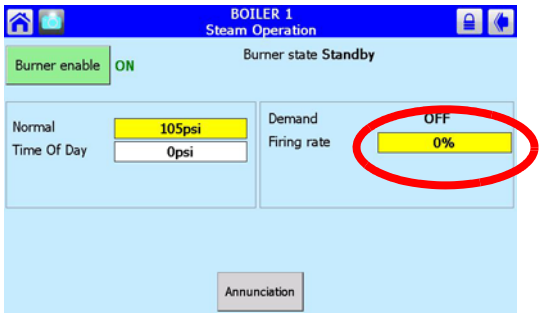
Note: A Combustion Analyzer is required to properly set up the Model M5M burner. Do not attempt to fire and adjust the burner without this equipment.

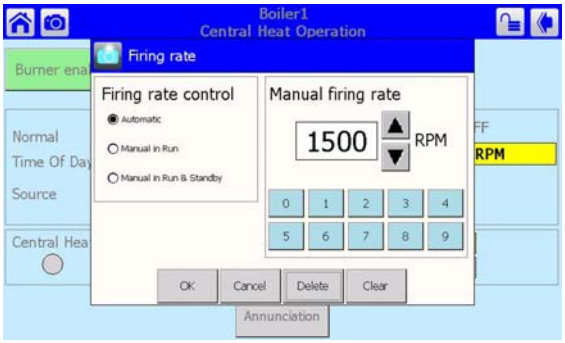
Note: Ensure boiler is filled with water prior to burner startup.

NOTE: Install the combustion analyzer probe as close as possible to the boiler vent connection. Sampling too far from the boiler vent can produce false readings due to air diluting the flue gas.

The burner does not have need of linkages for fuel/air adjustment, nor is a separate manual-auto switch provided for burner positioning. All firing rate adjustments are accomplished via the Falcon Control. Setting combustion will require manually modulating the burner via the Falcon from low fire to high fire two or more times to ensure a consistent air/fuel ratio.

Manual Modulation - use the procedure below to change the burner firing rate manually.





1. On the Falcon Operation screen, press the Firing rate display.

2. A numeric keypad will appear, showing the current firing rate.

3. Press <Clear> to clear the current value.

4. Enter the desired RPM setting using the numeric keypad.

5. Press <OK>. The display will return to the Operation screen and the burner will modulate to the chosen firing rate.

To set combustion:

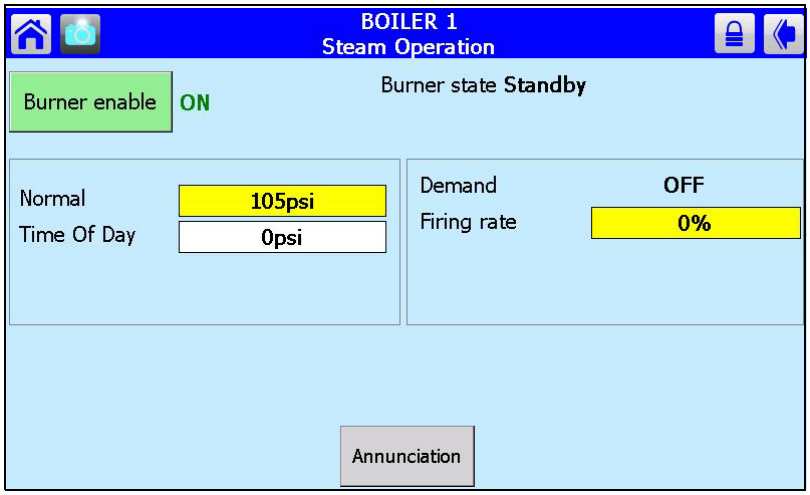


FIGURE 4-13. Operation screen

1. Check inlet gas pressure and reset low gas pressure switch.
2. At Operation screen set firing rate to low fire. Review burner sequence before proceeding.
3. Turn LOCAL/REMOTE switch to LOCAL.
4. Initiate burner firing sequence. The burner switch is accessed via the Falcon Operation page. If the burner does not ignite, adjust choke counterclockwise slightly until you can see a slight yellow flame at the burner during ignition. Clockwise adjustments to the low-fire offset screw may also be tried. Check that gas pressure to gas valve inlet is sufficient to fire burner (see Table 4-1 for gas pressure requirements).
5. After burner lights, maintain in low fire position. At low fire, using main choke on gas valve and a combustion analyzer set O2 level within 3-8% O2.
6. Manually modulate the burner to high fire. Adjust the gas choke if necessary to obtain desired O2% (6% - 7%).
7. Modulate to low fire and fine tune offset screw to obtain desired O2% (6% - 7%).

Verify adjustments by modulating back and forth between low and high fire.

While setting combustion observe gas pressure at low fire and at high fire. Ensure pressure is within limits shown in Table 4-1.

4.10.9 - Limit Controls Check

Steam Boilers

The operating (OLC) and high pressure limit (HLC) controls areexternally mounted to the control panel. The setting of the OLC should be slightly higher than the configured set point plus the hysteresis off value set in the CB Falcon control. The setting of the HLC should be slightly higher than the OLC. For example:CB Falcon set point = 100.0 psig, Hysteresis Off = 5.0 psi; OLC could be set to 110 psig, HLC set to 120 psig. Specific settings are determined by application and system control scheme.The OLC and HLC can be tested while the boiler is producing steam

by adjusting the switch setting downward. A lockout should result when the switch setting is at or just below the current steam pressure. Readjust each switch (and reset HLC) after testing.

Hot Water Boilers

The Modulation Off (operating limit) and High Limit functions can be tested while the boiler is operating by adjusting the respective setting downward and allowing the boiler outlet temperature to rise. The Modulation Off point is the sum of the Modulating setpoint and the Hysteresis Off value. The Modulation On point is the setpoint minus the Hysteresis On value.

When the boiler's outlet temperature exceeds either of these settings, the boiler will shut down. When the operating limit is exceeded, the boiler will automatically recycle upon the outlet temperature dropping below the on point. When the High Limit is exceeded, a lockout should result requiring a manual reset of the control after the temperature has dropped below the high limit setting.

Before testing the High Limit, temporarily set the Modulation OFF point higher than the High Limit setting.

Restore Modulation OFF and High Limit to operational settings after testing.

Specific settings are determined by application. Maximum High Limit for Model M5M is 250 deg F.

The High Limit setting is considered a safety parameter. Any changes made will require a password login and reset of the Falcon.

4.10.10 - Post start-up checkout procedure

1. Ensure proper air venting to expansion tank (hot water units).
2. Verify the ability of the flame system to detect and respond to a loss of flame. This can be done by removing the flame sensor cable. For a successful test the boiler should shut down and the gas safety shutoff valve close with the display indicating a lockout condition. Reconnect the cable to the flame detector.
3. Set high gas pressure switch to 50% higher than operating gas pressure at low fire. Set low gas pressure switch to 50% lower than operating gas pressure at low fire.
4. Check the draft on the outlet stack on each boiler, compare to acceptable limits (-.25 to +.25" W.C.) and record in start up form. Operating outside of acceptable limits could result in light off and flame failure problems.
5. Switch to automatic operation and monitor flue gas to ensure consistent excess air.
6. Reassemble all panels and covers that were removed and replace any plugs that were removed to check gas pressure.
7. Verify gas pressures remain within limits shown in Table 4-1.
8. Provide instructions to owner and operators on operation, safety and maintenance of the equipment.
9. Provide instructions to owner and operators on proper water treatment guidelines and procedures.

4.10.11 - Boil Out (new boilers)

See 3.6 — Boil Out of a New Unit

4.11 - Falcon Control Functions and Customer Interface

Following is a brief overview of the Falcon control features on M5M boilers. Please refer to the Falcon Control manual for more detailed explanations.

- Set Point
- Time-of-Day (TOD) Set Point
- Hysteresis On and Hysteresis Off
- PID modulation control
- Remote Enable and Remote 4-20mA Input
- Remote Modulation
- Remote Set Point
- Rate Limiting/Override
- Configurable pump/auxiliary relay contacts
- Annunciator
- Diagnostics
- Lockout/Alarm History
- Trend Analysis
- Modbus communications
- Lead/Lag Control for up to 8 boilers
- DHW demand priority

Set Point, TOD Set Point, Hysteresis On, Hysteresis Off, and PID load control

The set point is the value that the boiler's PID load control attempts to maintain in order to meet system demand. The modulating set point can be adjusted at the Operation page or under the Steam (Central Heat) Configuration parameter group. No password is required to change the set point. To change the set point at the Operation page, press the set point value next to "Normal". Clear the current value and enter the new value. Press <OK> to establish the new set point.

The Time-of-Day (TOD), or setback, set point is an alternative set point that is enabled when a remote contact connected to terminals J10-2 & J10-3 is closed (Refer to Figure 2-10 M5M wiring diagram). When the circuit is open, the boiler control reverts back to the normal set point. The TOD set point can be adjusted at either the Operation page or under the Steam (Central Heat) Configuration parameter group. Service level password login may be required to change this parameter.

The hysteresis on and hysteresis off points can only be changed under the Steam (Central Heat) Configuration parameter group and require a login with the Service level password. Hysteresis on is the differential below the current set point at which the boiler will restart following an off cycle. Hysteresis off is the differential above the current set point at which the boiler will cycle off – effectively the boiler's operating limit. These two parameters apply to both the normal and TOD set points. To minimize the frequency of cycling the boiler on and off, the values of either, or both, of these settings may be increased. Default settings for Hysteresis on and off are 5 deg F and 15 deg F, respectively.

The PID (Proportional-Integral-Derivative) load control operates on the demand source's modulation rate. Under Steam (Central Heat) configuration, the PID gain values can be adjusted to match the desired modulation response. The default gain value settings of P=25, I=25 & D=0 have proven to work well with typical single boiler heating applications.

Decreasing the PID gain values slows down the controller's response to a change in load demand. Increasing the gain values causes more aggressive control, though setting the values too high can lead to 'overshoot' and unnecessary cycling.

Remote Enable and Remote 4-20mA Input

Remote enable and Remote 4-20mA input allow the boiler to be sequenced and/or controlled from a separate boiler room controller or building management system. The 3-position Demand switch at the front of the control panel determines whether the boiler is off, in local, or under remote control. When in the "LOC" (local) position, the boiler operates on its own set point and ignores any remote signal connections. When in the "REM" (remote) position, the boiler can be enabled and modulated by remote discrete and analog (4-20mA) inputs, respectively. When in the "OFF" position, the boiler will not operate.

Refer to Figure 2-10 in this manual or to your specific boiler wiring diagram for remote enable and remote 4-20mA input connections. For simple remote on-off sequencing, only terminals 24 and 25 (Falcon J8-1 & J8-3) need to be connected to dry enable contacts at the remote controller. When terminal 25 (demand input) is energized, the demand is enabled. The boiler then operates on its local set point and PID modulating control settings.

For **remote modulation** (firing rate) control, both the remote enable and remote 4-20mA input connections must be made. The default setting for the 4-20mA remote input is "Local". This setting should be verified under the Falcon control's Steam (Central Heat) configuration group, "Central Heat>Modulation>Modulation Rate Source". For remote modulation this parameter should be set to "S2 (J8-6) 4-20 mA with sensor on-off.

To avoid nuisance operating limit shut downs of the boiler, the Falcon's normal operating set point should be adjusted to a value that is greater than the system header set point.

With demand present and completion of a successful trial for ignition sequence, the boiler will modulate according to the 4-20mA input signal provided: 4mA = minimum modulation rate (low fire); 20mA = maximum modulation rate (high fire). The boiler will continue to modulate until the demand is removed, the operating limit is reached, LCI is opened (e.g. low water condition), or a Falcon lockout alarm occurs (e.g. ILK opens on a High Limit trip).

To configure the boiler for **remote set point** control, navigate to the Falcon control's Steam (Central Heat) configuration group. Change the setting of "Central Heat Configuration>Set Point>Set Point Source" to "S2 (J8-6) 4-20mA". Next, the span of the 4-20mA needs to be established. The "20mA water temperature" parameter determines the value for 20mA; "4mA water temperature" determines the value for 4mA.

Depending on the quality of the remote input signal, the modulation rate or operating set point may fluctuate slightly because of small changes in the measured current signal or because of induced noise. Under the Modulation configuration group, the "4-20mA input Hysteresis" setting may need to be adjusted to avoid undesired fluctuations in the either the modulation rate or operating set point. The default setting is 0.2mA and can be increased to essentially filter out small fluctuations of the input signal. It may take some trial and error to establish the optimum input hysteresis setting for a particular system.

If at any time the remote 4-20mA input signal is disconnected, the Falcon control will indicate "OPEN" or "LOCAL" under the 4-20mA input value at the operation screen. The boiler will then operate on its local set point and PID modulation control. Once the 4-20mA signal is reestablished, the boiler will resume operation under remote control.

Rate Limiting/Override

For safety reasons or to accommodate special operating conditions, the Falcon incorporates a number of control functions that either limit the modulation range or set the firing rate to a specific value. These functions include **Delta T** limiting, **Slow Start**, and **Forced Rate**. See Appendix A for a complete listing of control functions with detailed descriptions and parametrization instructions.

Delta T limiting is designed to reduce the firing rate in case of an excessive difference between the inlet and outlet temperatures caused by a mismatch between water flow rate and boiler firing rate. Sensor connections to the Falcon are at J8-4 and -5 (inlet temperature) and J8-8,-9, and -10 (outlet temperature). Delta T limiting includes an **Inversion Detection** mode which when enabled becomes active in case the inlet temperature is higher than the outlet temperature (indicating reverse water flow through the boiler).

Forced Rate limiting causes the burner to stay at a fixed firing rate for a fixed time period immediately after lightoff, following the Run Stabilization period (if any). The forced rate period is optionally followed by a Slow Start function that limits the ramp-up speed of the firing rate whenever the water is colder than a user-specifiable threshold. Slow Start can help reduce set point overshoot, high limit trips, and frequent cycling.

Configurable Pump/Aux Relay Contacts

The Falcon Pump/Aux Relay outputs are configurable by means of six pre-configured Pump Control Blocks. Each control block is configured for a specific application:

1. Central Heat Pump
2. Boiler Pump (for primary/secondary pumping)
3. DHW pump
4. System Pump
5. “Aux 1 Pump” - used for a boiler isolation valve
6. “Aux 2 Pump” - used for a boiler Start Permissive Interlock

Each pump control block has seven parameters (for details see Falcon Lead Lag appendix):

Pump Options (2 parameter blocks) - determine pump on/off conditions
Start Delay - if burner is just starting up, timer will delay pump turning on
Overrun Time - keeps the pump running for a short time after the input turns off or demand is satisfied
Output Connection - selects Pump A, B, or C (refer to WD, Figure 2-10)
Cycle Count - one cycle counter for each pump output; can be reset if a pump is replaced
Pump Control - selects Auto or Manual control

A Pump Exercise routine helps to prevent pumps from freezing up due to long periods of inactivity. Configurable parameters are Pump Exercise Interval (days) and Pump Exercise Time (minutes). Any pump that remains off for the Pump Exercise Interval will be turned on for the duration given by Pump Exercise Time.

The relays may be configured for various other functions, including freeze protection, isolation valves, damper interlocks, operating status, etc.

Annunciator

The Annunciator monitors the Falcon control circuit to provide fault and status messages, and also provides first out annunciation for interlock lockouts. Eight inputs are available in addition to the Interlock, Load Control, and Pre-Ignition Interlock inputs, totaling 11 monitored points. Annunciator points can be accessed via the Falcon display Operation screen.

Lead/Lag Control (up to eight boilers)

Multiple Falcon units can be connected in a lead/lag system. Controllers in a lead/lag configuration communicate over the Falcon's MB2 Modbus network.

One Falcon in the lead/lag network hosts the Lead Lag Master function, which coordinates the activities of the Slave units (individual Falcons, including the one hosting the Master) via Modbus. The Master uses its host controller's header sensor to receive control input information and to maintain the optimum setpoint. An outdoor temperature sensor can also be connected for Lead Lag outdoor reset control.

Boiler sequencing, on/off staging, and firing rate allocation are user-configurable.

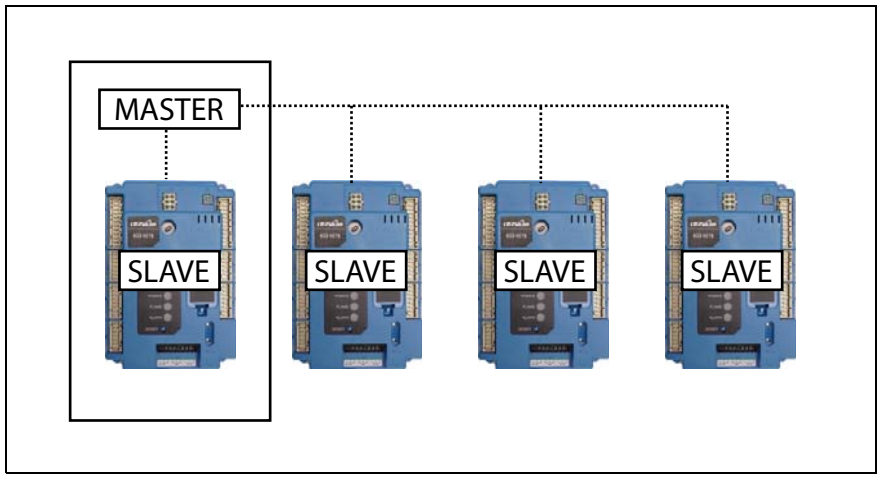


FIGURE 4-14. **Falcon Lead/Lag**

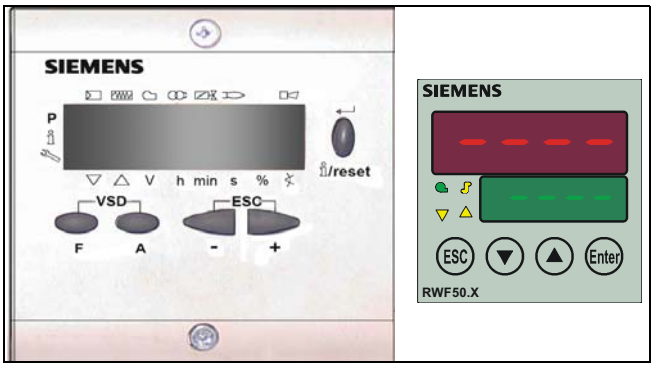
Refer to the Falcon Lead/Lag appendix in this manual for additional information.

Modbus Communication

For remote enable / remote setpoint (see above) and for remote monitoring through a building EMS, the Falcon uses the Modbus communication protocol. For more information on Modbus setup and implementation, see the Falcon Lead Lag manual 750-322.

CHAPTER 5

Commissioning - LMV/ RWF50 Controls



This section covers boilers equipped with RWF50 and LMV controls. In these applications, the RWF50 is the modulating control. Combustion settings and flame safeguard functions are performed by the LMV.

5.1 - Operating Conditions

- The installation site should be as free as possible from vibration, dust, and corrosive media.
- The controllers should be located as far as possible from sources of electromagnetic fields, such as frequency converters or high-voltage ignition transformers.
- Control panel must be connected to earth ground.

5.2 - Filling Boiler

The boiler should be filled with water to the proper operating level using water of ambient temperature. For steam units, open the vent valve and fill the boiler slowly to allow entrapped air to escape. Do not close the vent valve until water is visible in the gauge glass. In hot water applications the entire system should be filled and vented.

Make sure that feedwater treated according to site requirements is available. Check to ensure that no leaks appear at any pipe connections and correct if water leaks are noticed.

5.3 - Control Setpoints

Preliminary settings of the burner/boiler safety controls are necessary for the initial starting of the boiler. After the burner has been properly set, minor adjustments to these controls may be necessary for the particular installation. For initial starting, set the following controls accordingly:

1. Operating and High Limit controls - Set the dial @ maximum.

2. Combustion Air Proving Switch - Set the dial @ minimum.
3. Low Gas Pressure Switch - Set the dial @ minimum.
4. High Gas Pressure Switch - Set the dial @ maximum.

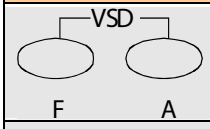
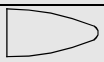
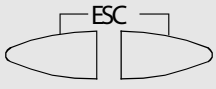
Depress all manual reset buttons for all controls prior to starting.

5.4 - Operating the AZL unit

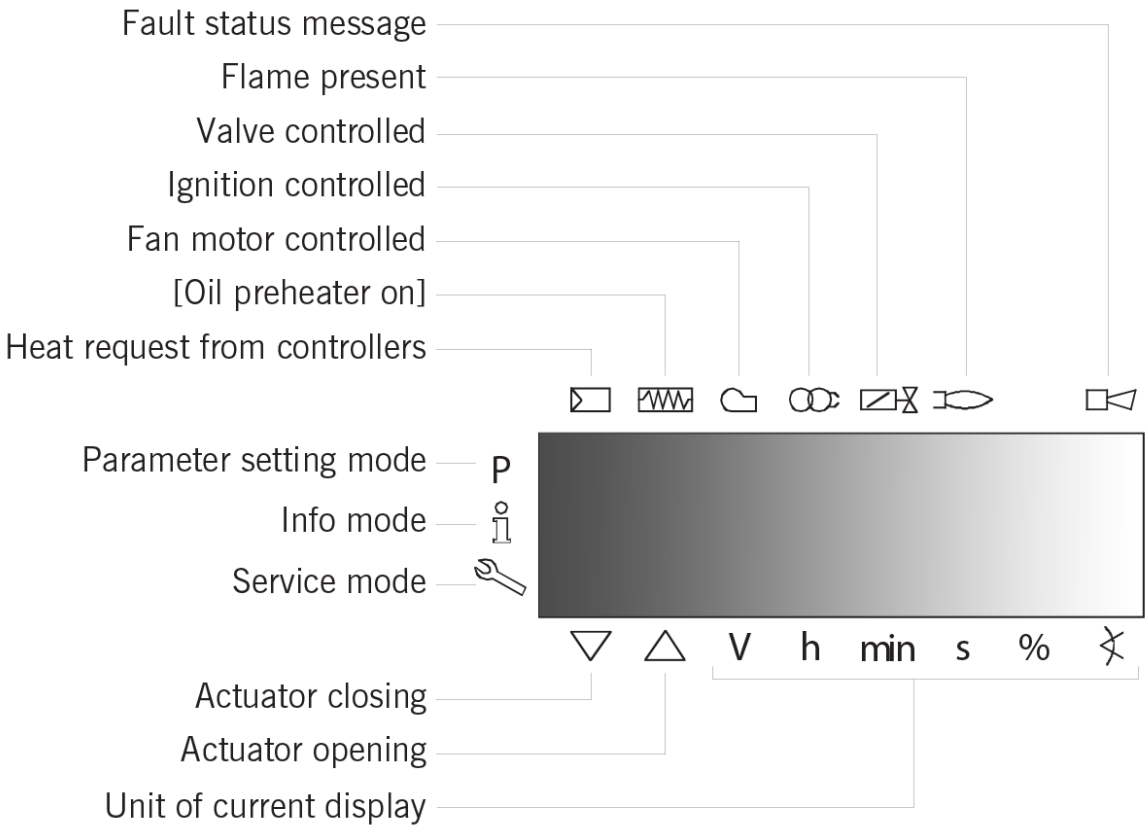
The LMV control is accessed by means of the AZL keypad/display.

Functions of the various keys are described below.

5.4.1 - Keypad Functions

Button	Function
	Buttons A and F: VSD function - For changing to parameter setting mode P (press simultaneously F and A plus - or +)
	Info and Enter button - For navigating in info or service mode * Selection (symbol flashing) (press button for <1 s) * For changing to a lower menu level (press button for 1…3 s) * For changing to a higher menu level (press button for 3…8 s) * For changing the operating mode (press button for >8 s) - Enter in parameter setting mode - Reset in the event of fault - One menu level down
	"-" button - For decreasing the value - For navigating during curve adjustments in info or service mode
	"+" button - For increasing the value - For navigating during curve adjustments in info or service mode
	+ and - button: Escape function (press - and + simultaneously) - No adoption of value - One menu level up

5.4.2 - Display Symbols

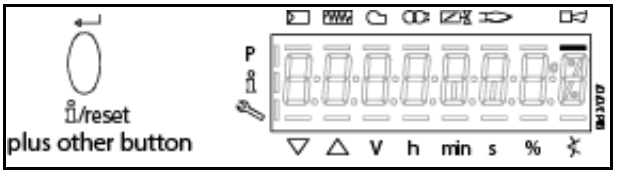


The brightness of the display can be adjusted from 0...100% using parameter 126.

The Model M5M is factory tested. Nevertheless, all burner safety controls should be checked upon installation, prior to initial firing. **Failure to verify burner control functioning could result in severe bodily injury or death.**

5.5 - Special functions

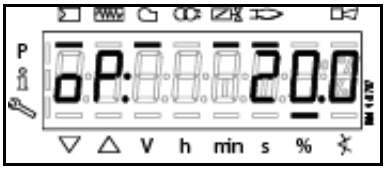
5.5.1 - Manual lockout



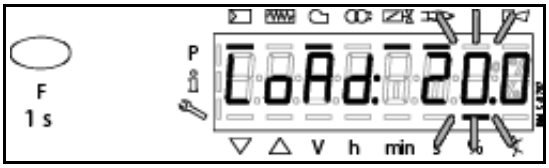
Press i/reset simultaneously with any other button. The controller switches instantly to the lockout position, irrespective of the operating position. The display shows the fault status message, except when in parameter setting mode.

5.5.2 - Manual control (manual request for output)

Burner is in operation. The display shows oP: on the left, the percentage of the current output on the right. Example: oP: 20.0

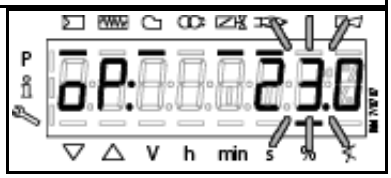


Press F for 1 s. The display shows LoAd:, the current output flashes.

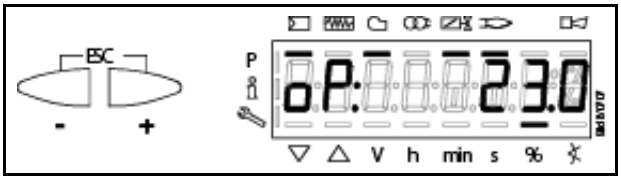


Press - or + to adjust the required manual output. Example: oP: 23.0

Release F. The current manual output flashes, indicating that manual control is activated.

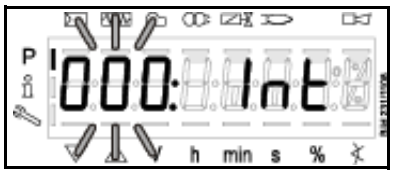


Press ESC for 3 s to return to automatic mode. The output no longer flashes. The display shows oP: on the left, the percentage value on the right. Example: oP: 23.0

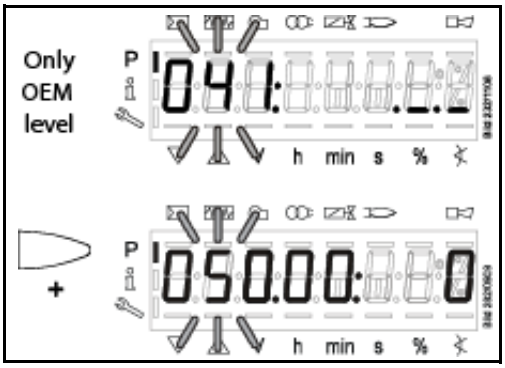


5.5.3 - Backup

Parameter 000: flashes. Display: Parameter 000: flashes, Int does not.



Press i/reset to go to parameter group 041. Display: Parameter 041: flashes, ._._ does not.



Press + to select parameter 050 Display: Parameter 050. flashes, index 00: and value 0 do not.

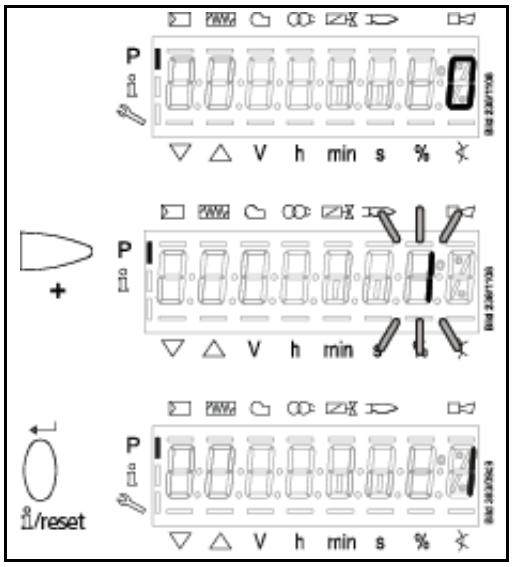
Press i/reset to select parameter bAC_UP Display: Parameter bAC_UP

Press i/reset to select the backup process. Display: Value 0

Press + to shift the value in change mode 1 position to the left. Display: Value 1 flashes

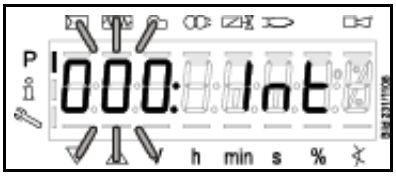
Note: To detect potential display errors, the value is displayed 1 place shifted to the left.

Press i/reset to activate the backup process. Display: 1 appears



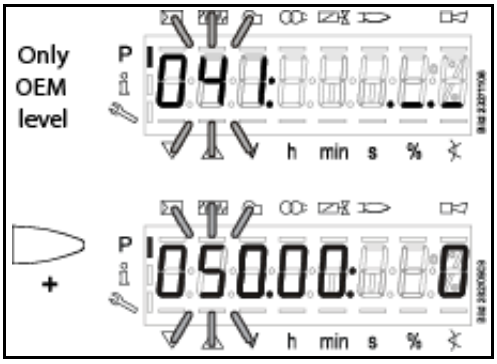
5.5.4 - Restore

Parameter 000: flashes. Display: Parameter 000: flashes, Int does not.



Press i/reset to go to parameter group 041. Display: Parameter 041: flashes, ._._ does not.

Press + to select parameter 050 Display: Parameter 050. flashes, index 00: and value 0 do not.



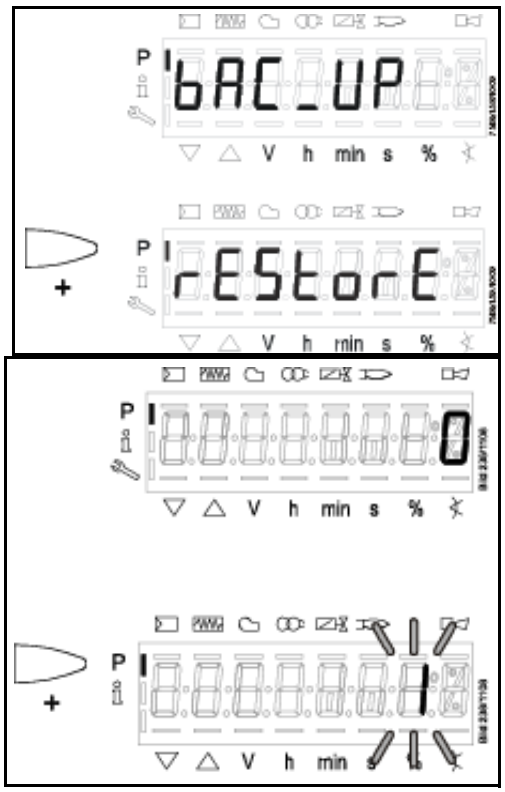
Press i/reset to go to parameter bAC_UP Display: Parameter bAC_UP

Press + to select parameter rEStorE Display: Parameter rEStorE

Press i/reset to select the restore process. Display: Value 0

Press + to shift the value in change mode 1 position to the left. Display: Value 1 flashes.

Note: To detect potential display errors, the value is displayed 1 place shifted to the left.



5.6 - LMV Basic Operation

5.6.1 - Normal display

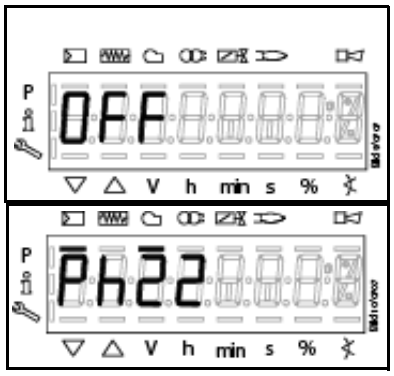
Normal display is the standard display in normal operation, representing the highest menu level. From the normal display, you can change to the info, service or parameter level.

5.6.2 - Display in standby mode

Note OFF flashes when the Manual OFF function, the manual output, or controller OFF is activated.

5.6.3 - Display during startup / shutdown

The unit shown is in phase 22. The controller calls for heat. Note the bars below the heat request and blower motor symbols. The individual program phases and controlled components are displayed in accordance with the program sequence.



Timed program phases will show the remaining running time until end of the phase is reached - the unit shown is in phase 30 with 12 seconds remaining in that phase.

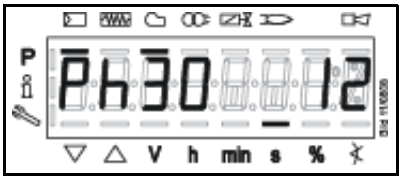


TABLE 1. List of phase displays

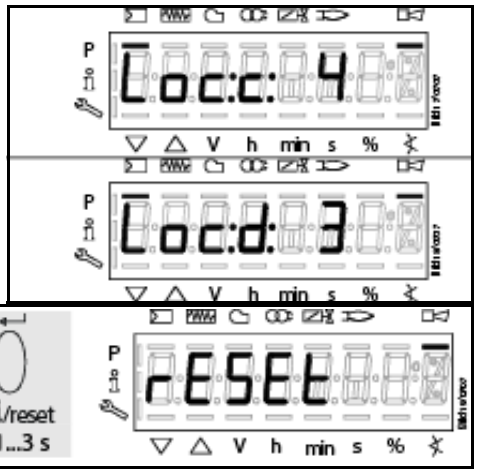
Phase	Function
Ph00	Lockout phase
Ph01	Safety phase
Ph10	Home run
Ph12	Standby (stationary)
Ph22	Fan ramp up time (fan motor = ON, safety valve = ON)
Ph24	Traveling to the prepurge position
Ph30	Prepurge time
Ph36	Traveling to the ignition position
Ph38	Preignition time
Ph39	Valve proving filling time (test of pressure switch-min when fitted between fuel valves V1 and V2)
Ph40	1st safety time (ignition transformer ON)
Ph42	1st safety time (ignition transformer OFF)
Ph44	Interval 1
Ph50	2nd safety time
Ph52	Interval 2
Ph60	Operation 1 (stationary)
Ph62	Max. time low-fire (operation 2, preparing for shutdown, traveling to low-fire)
Ph64	Switching back to pilot: Modulation to ignition load
Ph65	Switching back to pilot: Interval 2 waiting time
Ph66	Switching back to pilot: Reactivation of ignition + pilot
Ph67	Switching back to pilot: Shutdown of main valves
Ph68	Switching back to pilot: Pilot mode waiting phase
Ph69	Switching back to pilot: Pilot mode waiting phase for burner startup
Ph70	Afterburn time
Ph72	Traveling to the postpurge position
Ph74	Postpurge time (no extraneous light test)
Ph78	Postpurge time (t3) (abortion when load controller ON)
Ph80	Valve proving test evacuation time
Ph81	Valve proving test time atmospheric pressure, atmospheric test
Ph82	Valve proving filling test, filling
Ph83	Valve proving time gas pressure, pressure test
Ph90	Gas shortage waiting time

5.6.4 - Display of operating position

Display oP stands for «Operating position reached». Modulating mode: Current output in %

5.6.5 - Fault messages

5.6.5.1 Display of errors (faults) with lockout

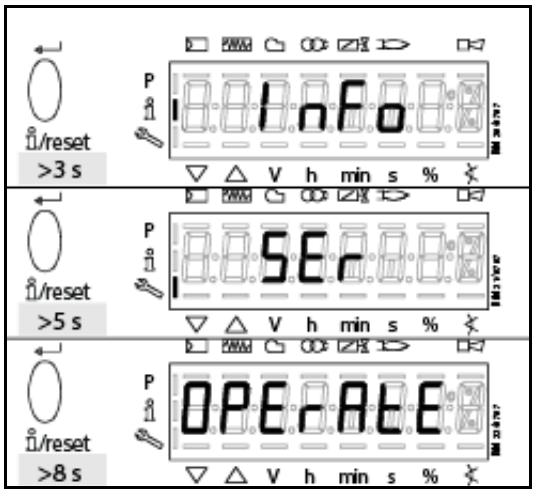


The display shows Loc:, the bar under the fault status message appears. The unit is in the lockout position. The display shows current error code c: alternating with diagnostic code d: (refer to Flash code list). Example: Error code 4/diagnostic code 3

5.6.5.2 Reset

When pressing i/reset for 1...3 s, rESEt appears on the display. When the button is released, the controller is reset. If the i/reset button is pressed for a time other than the time indicated above, a change to the previous menu is made. Exception If an error occurred while setting the curve, a change back to the parameter setting level is made.

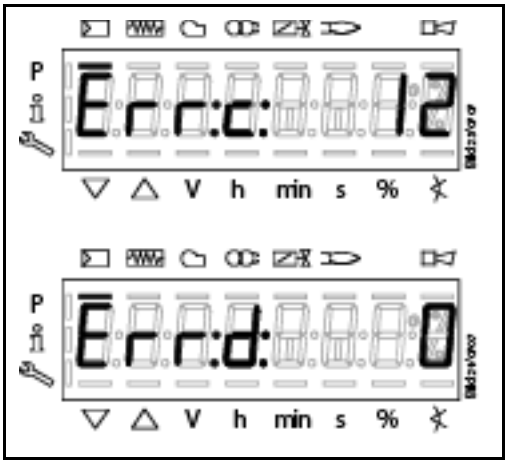
5.6.5.3 Activating info / service mode from lockout



When pressing i/reset for >3 s, the display shows InFo, SEr and then OPErAtE. When the button is released, a change to info / service mode is made.

5.6.5.4 Error with safety shutdown

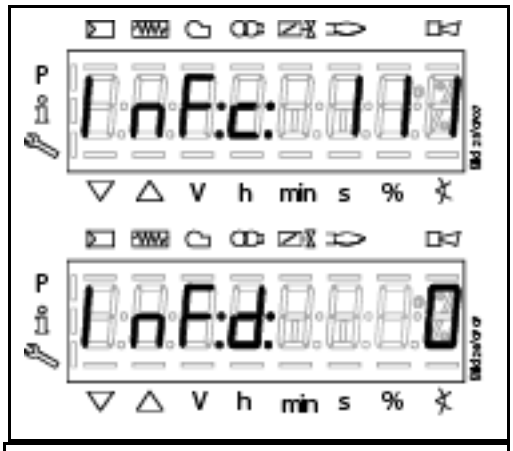
The display shows Err:. The unit initiates safety shutdown. The display shows current error code c: alternating with diagnostic code d:. Press i/reset to return to the normal display. Example: Error code 12 / diagnostic code 0



5.6.5.5 General information

For events which do not lead to shutdown the display shows InF, with error code c: alternating with diagnostic code d:. Press i/reset to return to the display of phases. Example: Error code 111 / diagnostic code 0

Note: For meaning of the error and diagnostic codes, refer to Error Code List. When an error has been acknowledged, it can still be read out from the error history.

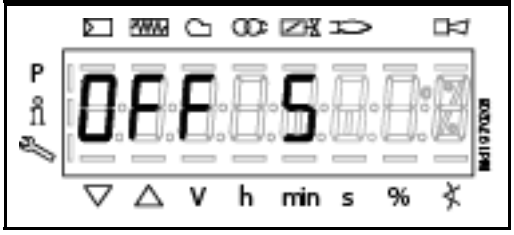


5.6.5.6 Start prevention

A non-programmed or not completely parameterized unit, or a unit whose operating mode was reset or changed, displays OFF UPr.

5.6.5.7 Safety loop

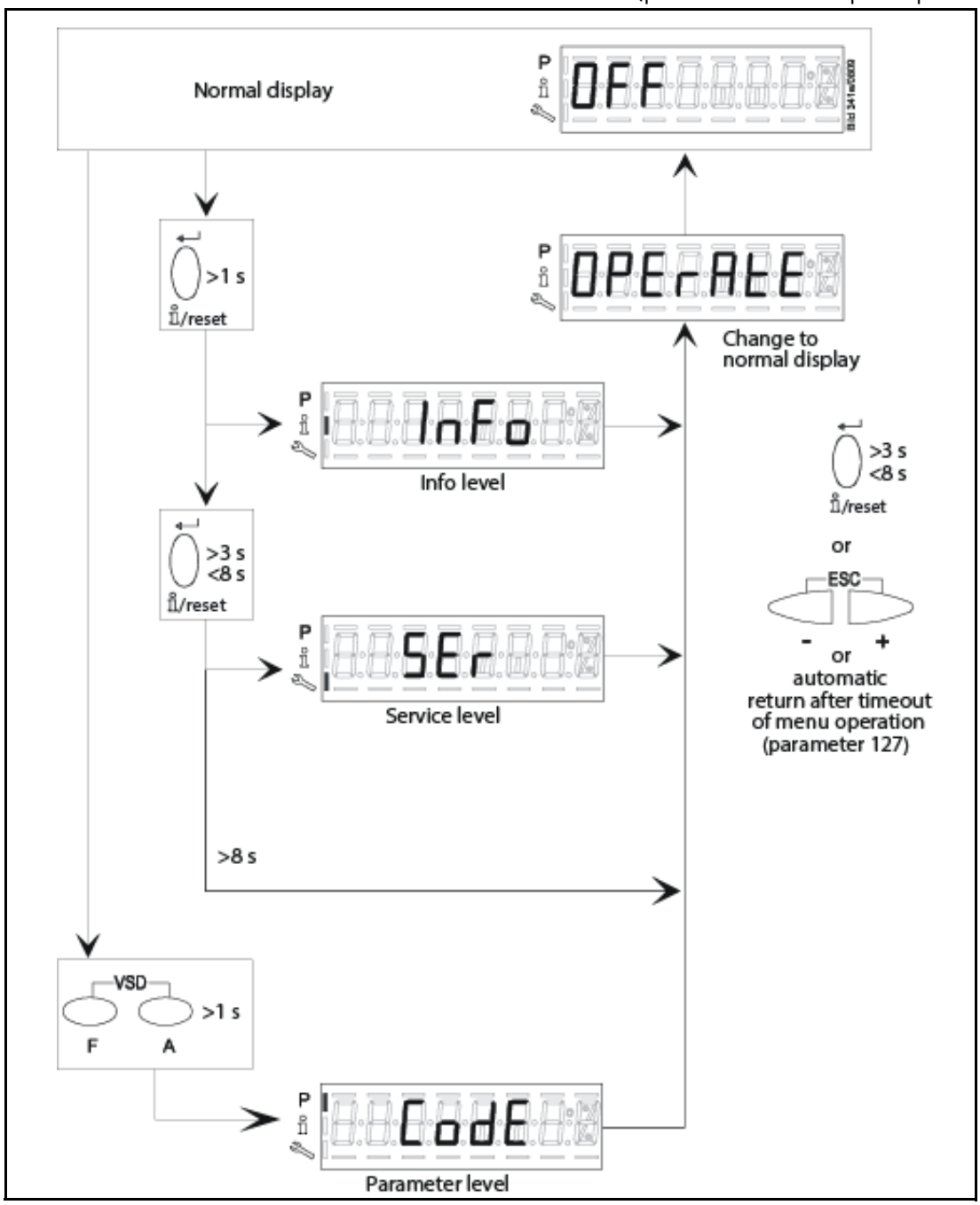
A unit whose safety loop and / or burner flange contact is open with a controller ON signal present, displays OFF S.



5.7 - Menu Structure

5.7.1 - Assignment of levels

The various levels can be accessed via different button combinations (parameter level requires password).



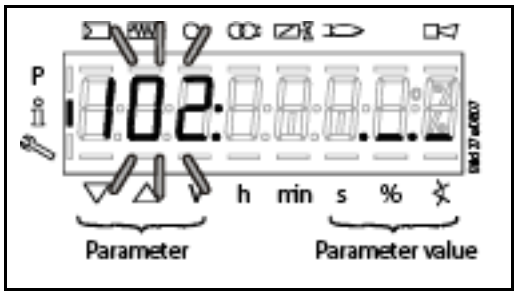
5.8 - Info level

The info level displays information about the controller and about operation in general.

Note: On the info level, you can display the next or the previous parameter by pressing + or - . Instead of pressing +, you can also press i/reset for <1 s.

Note: Press ESC or i/reset for >3 s to return to the normal display.

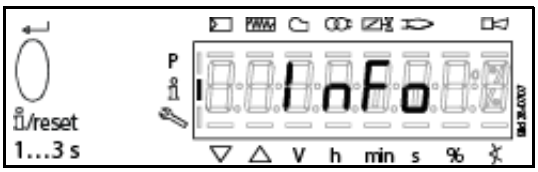
Note: No change of values on the info level! If the display shows _._._ below the parameter value, the value may consist of more than 5 digits. The value is displayed by pressing i/reset for >1 s and <3 s. Press i/reset for >3 s or press ESC to return to the selection of the parameter (parameter no. flashes).



No.	Parameter
Info level	
167	Fuel volume resettable (m^3, l, ft^3, gal)
162	Operating hours resettable
164	Startups resettable
176	Switching back to pilot switching cycles
163	Operating hours when unit is live
166	Total number of startups
113	Burner identification
107	Software version
108	Software variant
102	Identification date
103	Identification number
104	Preselected parameter set: Customer code
105	Preselected parameter set: Version
143	Reserve
End	

5.8.1 - Display of info level

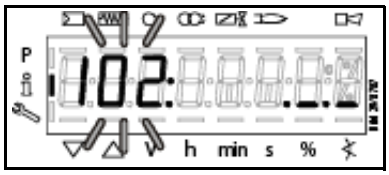
Press i/reset until InFo appears. When releasing i/reset, you are on the info level.



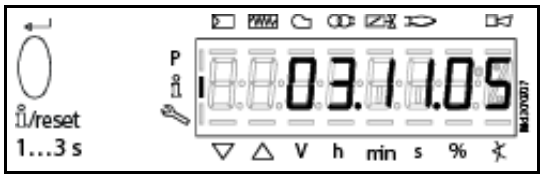
5.8.2 - Display of info values (examples)

5.8.2.1 Identification date

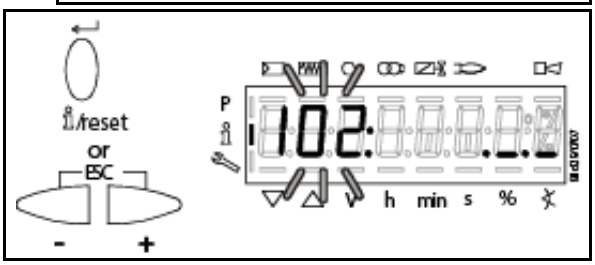
The display shows parameter 102: flashing on the left, characters ._._ on the right. Example: 102: ._._



Press i/reset for 1…3 s to show the identification date TT.MM.JJ. Example: Identification date 03.11.05



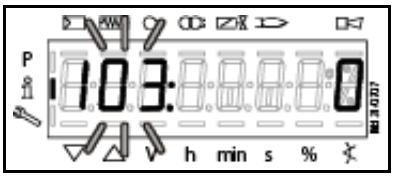
Press i/reset for >3 s or ESC to return to the display of parameters.



To the next parameter 

5.8.2.2 Identification number

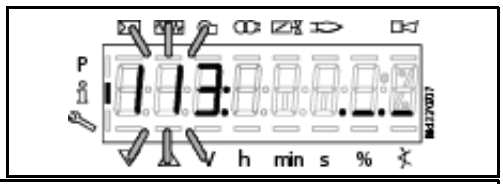
The display shows parameter 103: flashing on the left, identification number 0 on the right. Example: 103: 0



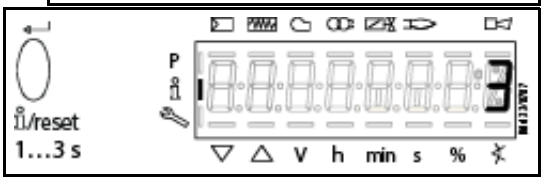
Press '+' or i/reset for the next parameter and '-' for the previous parameter.

5.8.2.3 Burner identification

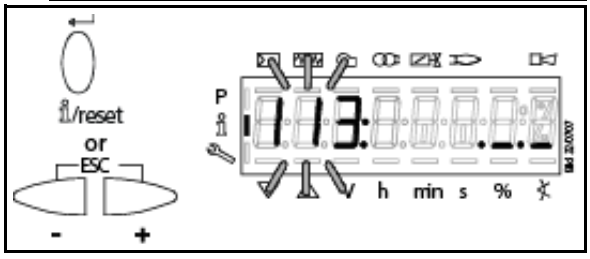
The display shows parameter 113: flashing on the left, characters ._._ on the right. Example: 113: ._._



Press i/reset for 1…3 s to show the burner's identification. Default setting: - - - - - - - - Example: 3



Press i/reset or ESC to return to the display of parameters.

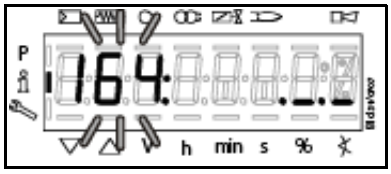


The burner's identification can be set on the parameter level!

 To the next parameter

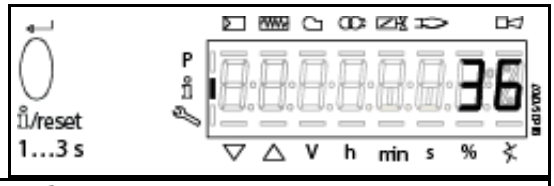
 Back to the previous parameter

5.8.2.4 Number of startups resettable

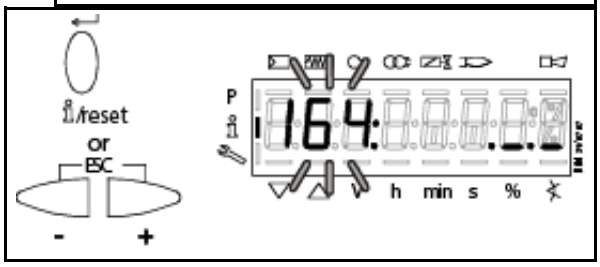


The display shows parameter 164: flashing on the left, characters ._._ on the right, since display of the number of startups may comprise more than 5 digits. Example: Parameter 164: ._._

Press i/reset for 1…3 s to show the number of startups (resettable). Example: 36



Press i/reset or ESC to show parameter 164 flashing again.

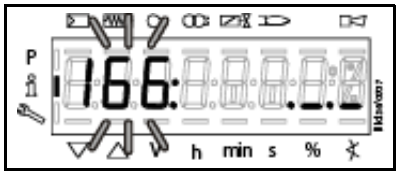


The number of startups can be reset on the parameter level!

To the next parameter

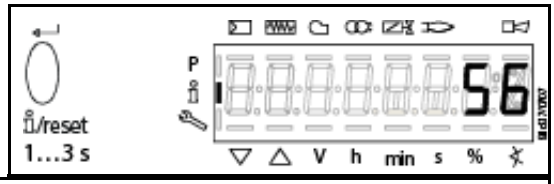
Back to the previous parameter

5.8.2.5 Total number of startups

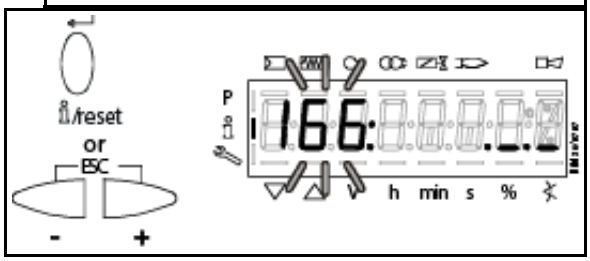


The display shows parameter 166: flashing on the left, characters ._._ on the right, since the display of the total number of startups may comprise more than 5 digits. Example: Parameter 166: ._._

Press i/reset for 1…3 s to show the total number of startups. Example: 56



Press i/reset or ESC to return to the display of parameters.

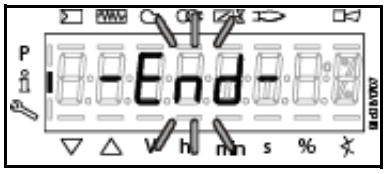


To the next parameter

Back to the previous parameter

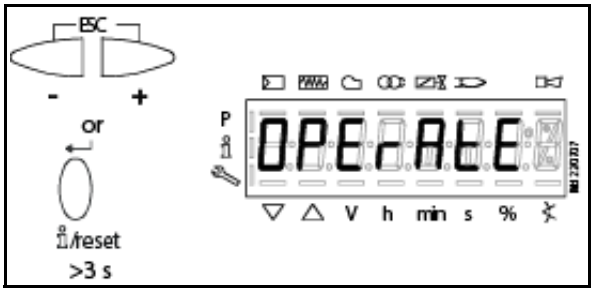
5.8.2.6 End of info level

When this display appears, you have reached the end of the info level. The display shows – End – flashing.

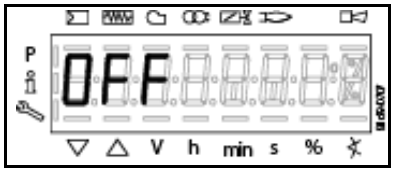


To the start of the info level; Back to the previous parameter

Press i/reset for >3 s or ESC to return to the normal display. OPErAtE appears for a short moment.



When this display appears, you are back on the normal display and you can change to the next level mode.



5.9 - LMV Service level

The service level is used to display information about errors including the error history and information about the LMV control.

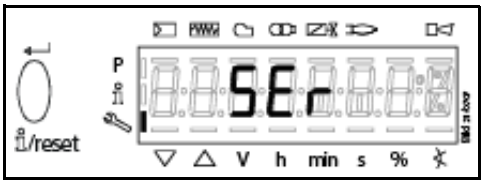
Note: When on the service level, you can press - or + to display the next or the previous parameter. Instead of pressing +, you can also press i/reset for <1 s.

Note: Press ESC or i/reset for >3 s to return to the normal display.

Note: No change of values on the service level. If characters are displayed by the parameter, the value may consist of more than 5 digits. Press i/reset for >1 s and <3 s to display the value. Press i/reset for >3 s or ESC to return to the selection of the parameter (flashing).

5.9.1 - Display of service level

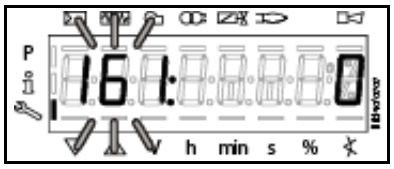
Press i/reset for >3 s until SEr appears. When releasing/reset, you are on the service level.



No.	Parameter
Service level	
954	Flame intensity
960	Actual flow rate (fuel throug hput in m^3/h, l/h, ft^3/h, gal/h)
121	Manual output Undefined = automatic operation
922	Incremental position of actuators Index 0 = fuel Index 1 = air
936	Standardized speed
161	Number of faults
701 . . . 725	Error history: 701-725.01.Code

5.9.2 - Display of service values (example)

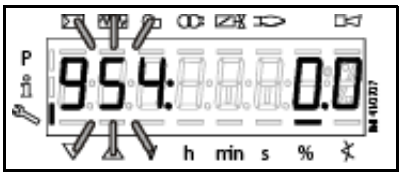
5.9.2.1 Number of faults



The display shows parameter 161: flashing on the left, the number of faults that occurred thus far on the right 0. Example: Parameter 161: 0

Press '+' or i/reset for the next parameter and '-' for the previous parameter.

5.9.2.2 Intensity of flame



The display shows parameter 954: flashing on the left. On the right, the flame's intensity is displayed as a percentage. Example: 954: 0.0

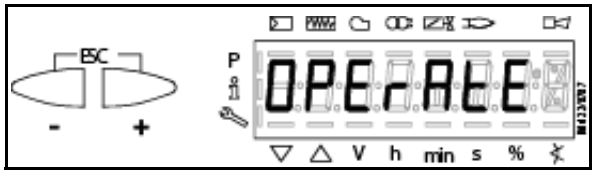
Press '+' or i/reset for the next parameter and '-' for the previous parameter.

5.9.2.3 End of service level

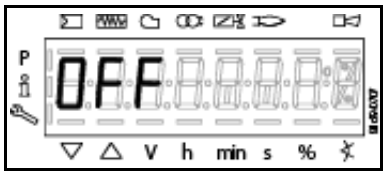
When this display appears, you have reached the end of the service level. Display – End – appears flashing.

Press '+' or i/reset for the next parameter and '-' for the previous parameter.

Press ESC to return to the normal display. OPErAtE appears for a short moment.



When this display appears, you are back on the normal display and you can change to the next level mode.



5.10 - Parameter level

The parameters stored in the LMV control can be displayed or changed on the parameter level. A password is required.

⚠ Caution

Caution! Parameters and settings may only be changed by qualified personnel. If parameters are changed, responsibility for the new parameter settings is assumed by the person who – in accordance with the access rights – has made parameter changes on the respective access level.

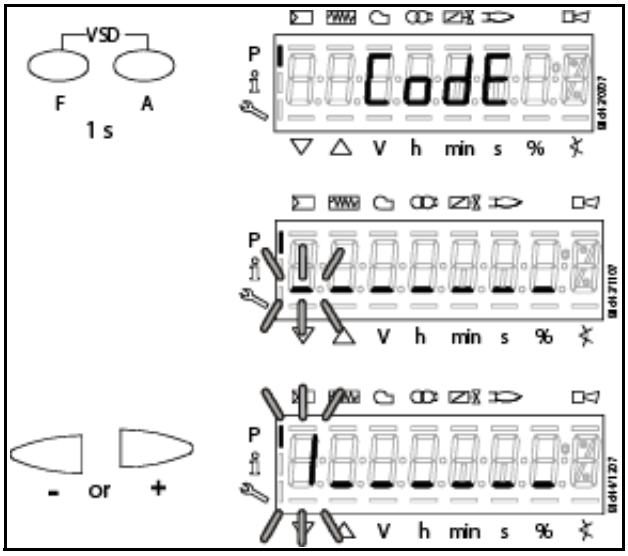
5.10.1 - Entry of password

The service password consists of 4 characters.

Press button combination F - A to display CodE.

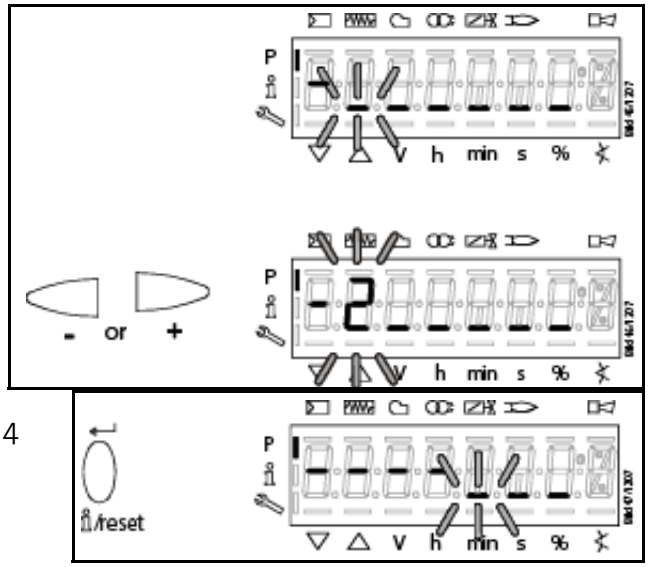
When releasing the buttons, 7 bars appear, the first of which flashes.

Press - or + to select a number or letter.

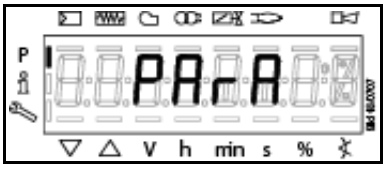


Press /reset to confirm the value. The value entered changes to a minus sign (–). The next bar starts flashing.

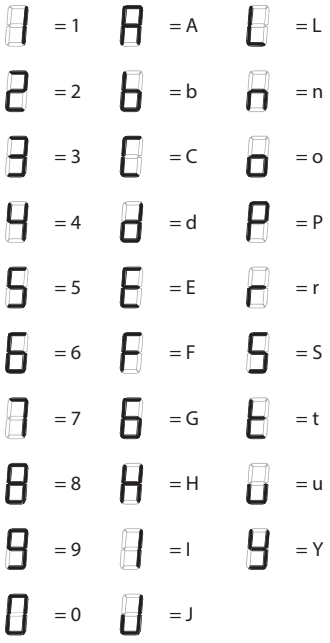
After entry of the last character, the password must be confirmed by pressing i/reset. Example: Password consisting of 4 characters.



As a confirmation of correct entry, PArA appears for a maximum of 2 seconds.



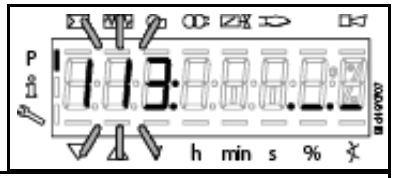
For entry of passwords or burner IDs, the following numbers and letters can be used:



5.10.2 - Entry of burner identification

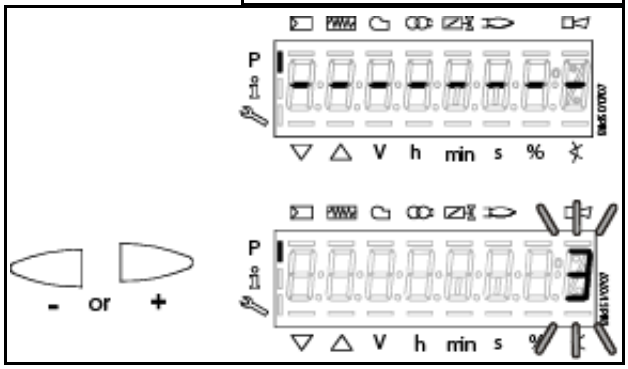
The burner's identification is entered like a password (character by character), but from right to left and ending with «_».

Parameter 113: flashes. Press i/reset to go to editing mode.



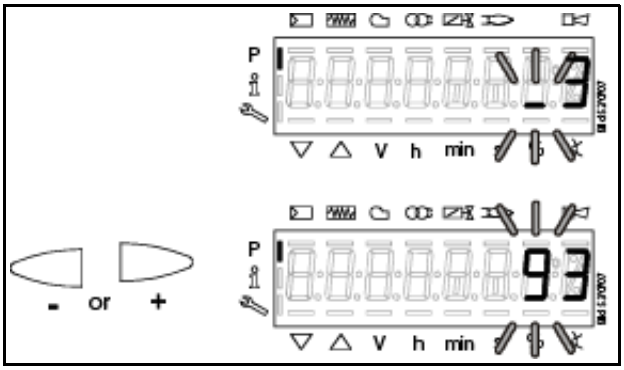
You are on the display for undefined burner identification. 8 bars appear.

Press - or + to select a number. Example: Number 3 flashes.

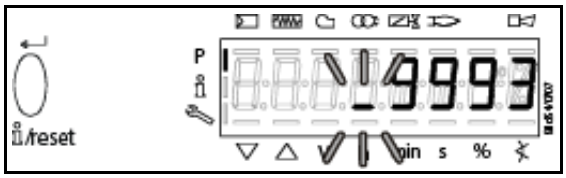


Press i/reset to confirm the value. Make the entry number by number.

Press - or + to select the next number. Example: Number 9 flashes.

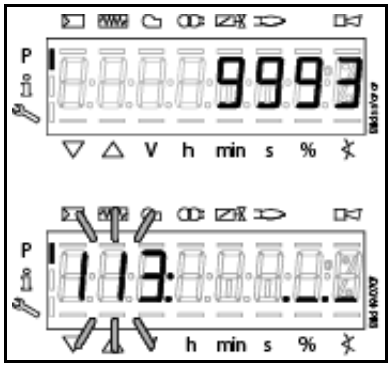


After entry of the last number, burner identification must be confirmed by pressing i/reset.

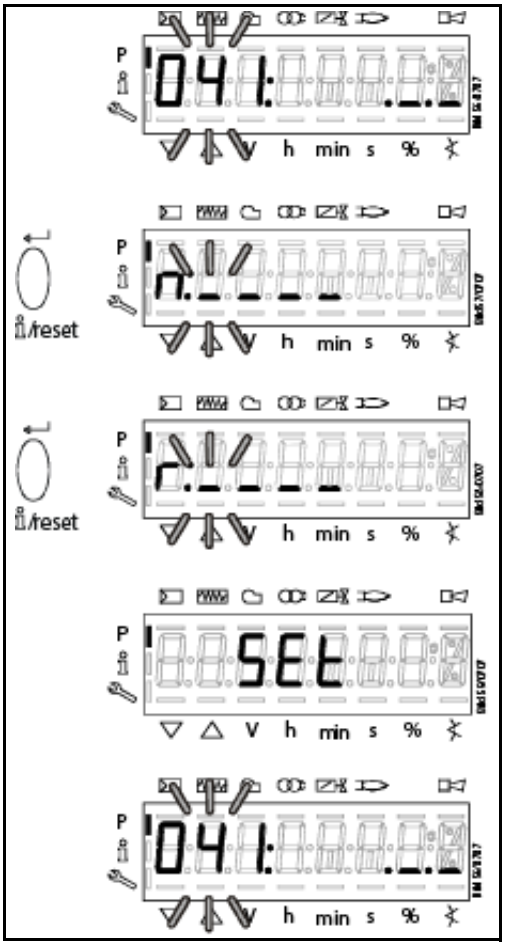


The display no longer flashes. Example: Burner identification 9993

Press ESC to return to the parameter level. PArAmeter 113: for burner identification.



5.10.3 - Change of service password



Parameter 041: flashes. Press i/reset to go to level c: for password changes.

Letter n: for new. Proceed as described in chapter Entry of password and enter the new password (4 characters). After entry of the last character, the password must be confirmed by pressing i/reset.

Letter r: for repeat. Proceed as described in chapter Entry of password and repeat entry of the new password. After entry of the last character, the password must be confirmed by pressing i/reset.

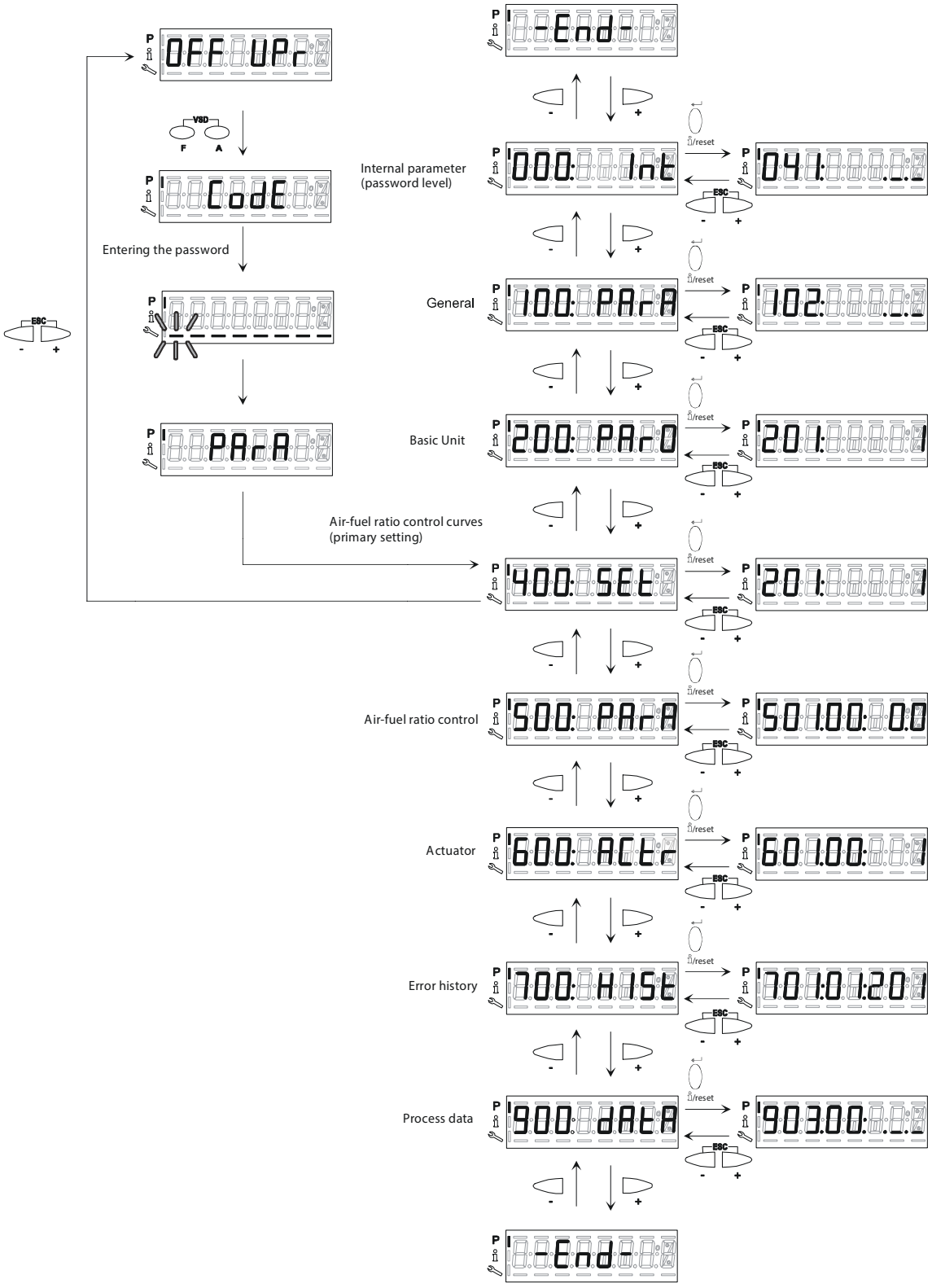
SEt confirms that the new password has been saved.

Parameter 041: flashes again.

5.10.4 - Using the parameter level

The parameters stored in the LMV unit can be displayed and changed on the parameter level. Normally, all parameters have been set at the factory – with the exception of those for air-fuel ratio control. A description of parameter level 400, which is used for setting the fuel-air ratio curve, is given in chapter below.

5.10.5 - Structure of parameter levels



5.10.6 - Parameters without index, with direct display

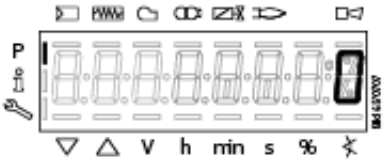
Using the example of parameter 208: Program stop

PArAmeter level 200: for basic units.

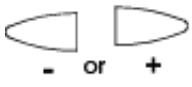
Press i/reset to go to menu level 200:

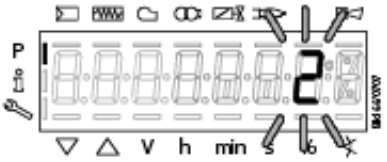
Press + to select «Program stop». Display: Parameter 208: flashes, value 0 does not.

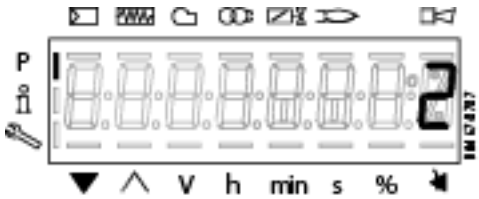
Press i/reset to go to editing mode. Display: Program stop time set Here: Value 0 corresponding to program stop deactivated.



Press - or + to select the required program stop time. 0 = deactivated 1 = PrePurgP (Ph24) 2 = IgnitPos (Ph36) 3 = Interv1 (Ph44) 4 = Interv2 (Ph52) Example: 2 IgnitPos (Ph36)

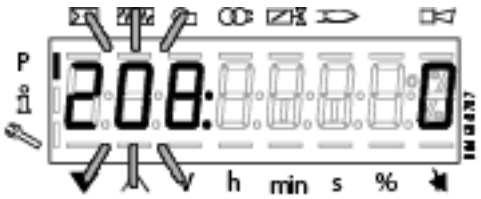






Press i/reset to return to editing mode. The value set is adopted.

Note: To detect potential display errors, the value is displayed 1 place shifted to the right.



Press ESC to return to the parameter level.

Display: Parameter 208: flashes, value 0 does not.

Press ESC to return to the parameter level. PArAmeter 208: flashes, value 2 does not.

Press ESC to return to the parameter level. PArAmeter 200: for basic units.

To the next parameter level	+	-	Back to the previous parameter level

5.10.7 - Parameters without index, with no direct display (with parameters having a value range >5 digits)

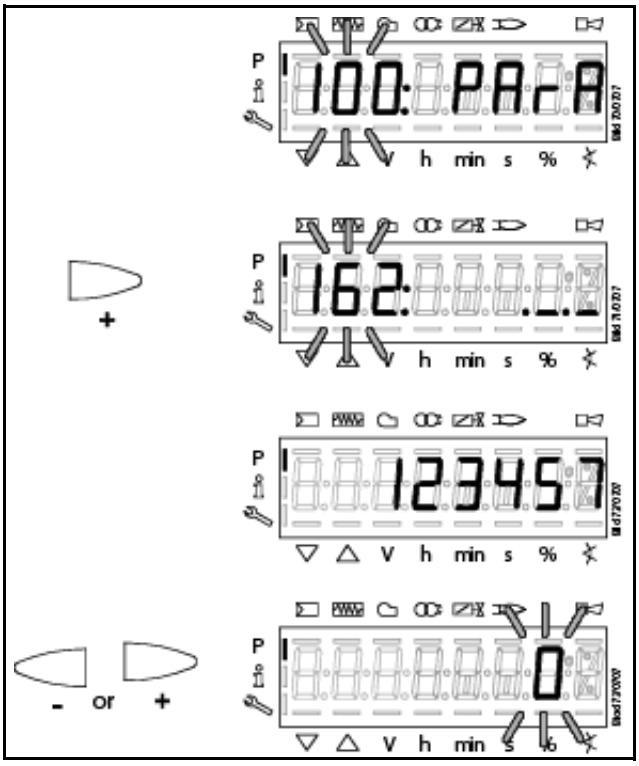
Using the example of parameter 162: Operating hours resettable

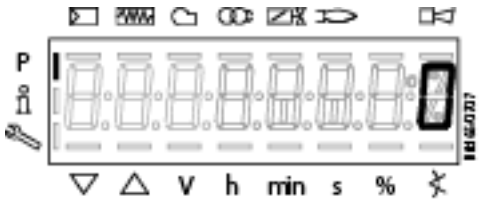
PArAmeter level 100: for general. Press i/reset to go to menu level 100.

Press + to select «Operating hours resettable». Display: Parameter 162: flashes, characters ._._ do not.

Press i/reset to go to editing mode. Display: 123457

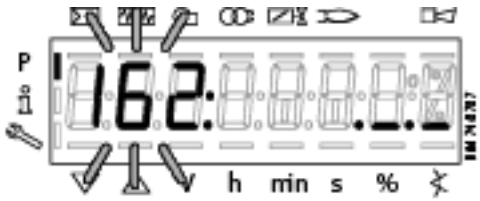
You can press - or + to set the number of operating hours to 0. Display: Operating hours 0 flashes.





Press i/reset to return to editing mode. The value set is adopted.

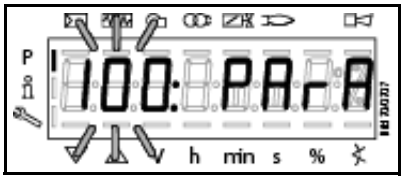
Note: To detect potential display errors, the value is displayed 1 place shifted to the right.



Press ESC to return to the parameter level.

Display: Parameter 162: flashes, characters ._._ do not.

Press ESC to return to the parameter level. PArAmeter 100: for general.



5.10.8 - Parameters with index, with direct display

Using the example of parameter 501: No-flame positions fuel actuator

PArAmeter level 500: for air-fuel ratio control.

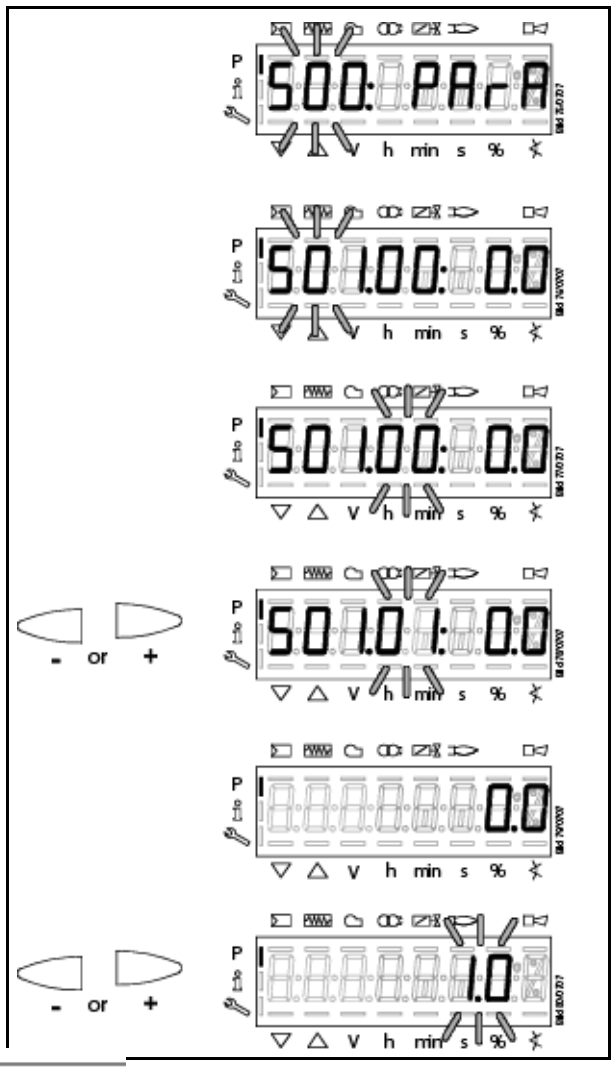
Press i/reset to go to menu level 500:. Display: Parameter 501. flashes, index 00: and value 0.0 do not.

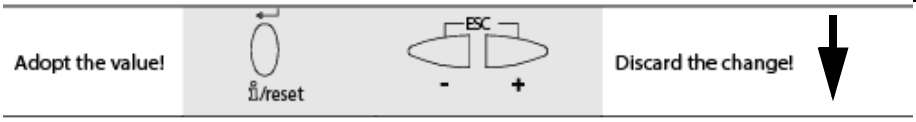
Press i/reset to go to the index. Display: Parameter 501. does not flash, index 00: flashes, value 0.0 does not.

Press - or + to select the required index. .00 = home position .01 = prepurge position .02 = postpurge position Display: Index 01: for prepurge position flashes, value 0.0 does not.

Press i/reset to go to editing mode. Display: Value 0.0

Press - or + to select the required prepurge position. Example: 1.0





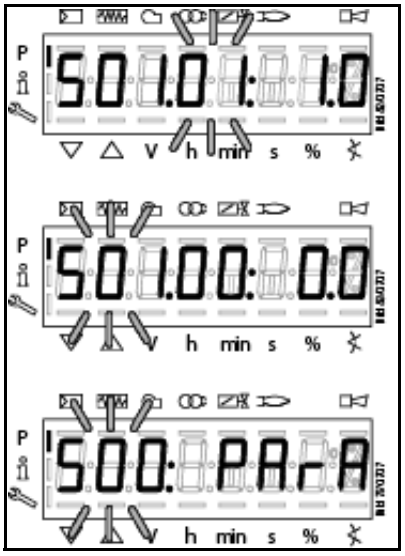
Press i/reset to return to editing mode. The value set is adopted.

Note: To detect potential display errors, the value is displayed 1 place shifted to the right. Display: Value 1.0

Press ESC to return to the index.

Display: Parameter 501. does not flash, index 01: flashes, value 0.0 has not changed and does not flash.

Press ESC to return to the index. PArAmeter 501: does not flash, index 01: flashes, value 1.0 does not.

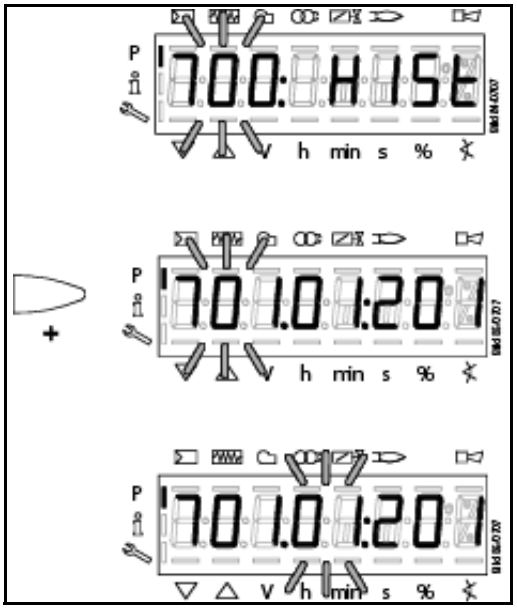


Press ESC to return to the parameter level. Display: Parameter 501 flashes, index 00: and value 0.0 do not.

Press ESC to return to the parameter level. PArAmeter 500: for air-fuel ratio control.

5.10.9 - Parameters with index, with no direct display

Using the example of parameter 701: Errors



HIStorie 700: for error history. Press i/reset to go to the parameter level.

Press + to select parameter 701. Display: Parameter 701. flashes, index 01: and value 201 do not.

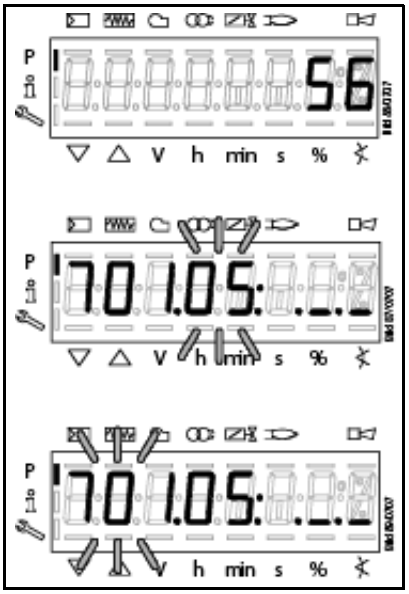
Press i/reset to go to index 01:. Display: Parameter 701. does not flash, index 01: flashes, value 201 does not.

+ To the next index

- Back to the previous index

Press + to select the index: .01 = error code .02 = diagnostic code .03 = error class .04 = error phase .05 = startup counter .06 = output. Example: Parameter 701., index 05: for startup counter, diagnostic code ._._

Press i/reset to go to display mode. Display: Value 56

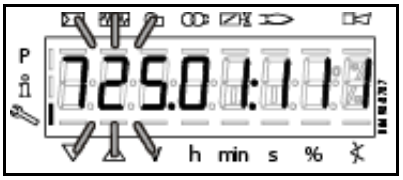


Press ESC to return to the index. Display: Parameter 701. does not flash, index 05: flashes, characters ._._ do not.

Press ESC to return to the parameter level. Display: Parameter 701. flashes index 05: does not, characters ._._do not.

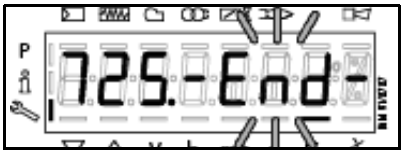
To the next older error

Parameters cover the period of time back to the last error since history was deleted (max. to parameter 725.). Example: Parameter 725., index 01:, error code 111



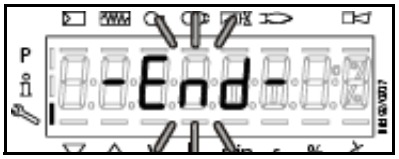
To the next parameter

Back to the previous parameter

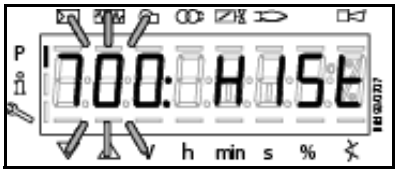


When this display appears, you have reached the end of the error history index. Display – End – appears flashing.

Press ‘+’ or i/reset for the next parameter and ‘-’ for the previous parameter.



When this display appears, you have reached the end of the error history. Display – End – appears flashing. Press ESC to return to the parameter level. HISt 700: for error history



Press ‘+’ or i/reset for the next parameter and ‘-’ for the previous parameter.

Note: If you wish, you can delete the error history via parameter 130. To delete the display, set the parameter to 1 and then to 2. The error history is deleted when the parameter has returned to 0.

5.11 - Initial Startup

5.11.1 - VSD/Fan Speed settings

The Variable Speed Drive is pre-configured at the factory. Should it become necessary to change the drive's configuration, VSD parameters can be viewed and changed using the drive's integral keypad/display. See **APPENDIX C - Variable Speed Drive Parameters** for parameter list; if necessary refer also to the Allen-Bradley PowerFlex 525 user manual.

Because the input is determined by the fan speed, fan speed settings may have to be modified for the particular application, for high altitudes, or when using direct vent combustion. The default fan speed settings are intended for typical applications for the various boiler sizes. Please contact your authorized Cleaver-Brooks representative for proper settings in high altitude and direct vent combustion applications.

⚠ Warning

Before initial startup, check for blockages in the flue venting or vent terminations. Inspect the burner and furnace for any contamination or blockages.

5.11.2 - Gas Train and Piping

The M5M burner is equipped with a combination servo-regulated gas valve and venturi mixing unit. The gas valve consists of a single body and regulating actuator with safety shutoff. Combustion airflow is directly proportional to the speed of the fan. The airflow creates a drop in pressure due to the venturi effect. The modulating controller of the valve actuator senses air pressure change and accordingly brings about a change in the gas flow proportional to the air pressure. The gas follows the airflow in a set ratio, so that fuel always matches the air as the burner firing rate increases or decreases.

1. Check the gas delivery system to be sure it is properly piped and wired.
2. Review available gas supply pressure to ensure that it is compatible with the M5M's gas train and regulator. Refer to Table 4-1 for minimum required supply pressure and maximum allowable supply pressure.
3. To bleed air from the supply pipe, open the manual gas shut off valve upstream of the burner gas train and bleed air from the piping by loosening the union in the upstream piping.
4. The burner and its gas connection must be leak tested before placing the boiler into operation.
5. Gas Pressure Regulator - Using the adjusting screw on the main gas regulator, adjust the gas valve inlet pressure to within the recommended levels in Table 4-1.

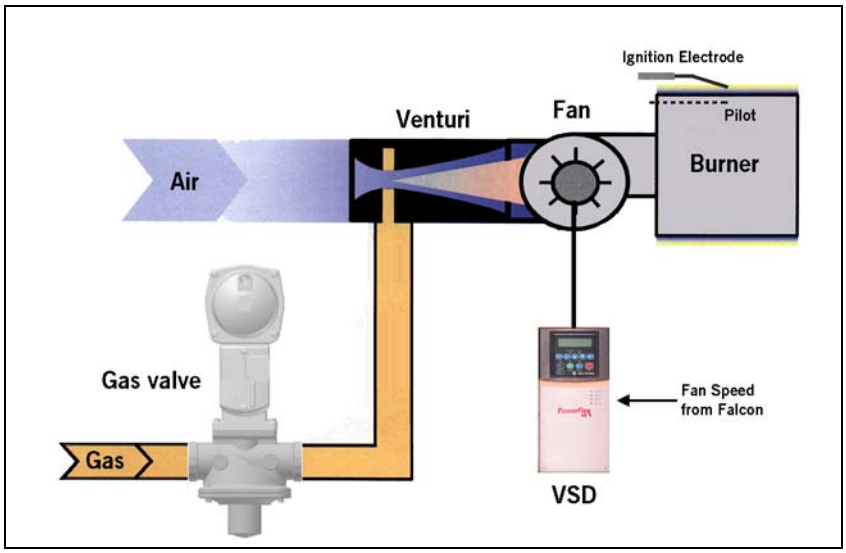


FIGURE 5-1. **Premix Burner Technology - Full Modulation**

Table 5-1 M5M Gas Pressure Requirements

Boiler Model	Minimum pressure required at gas train connection (inches WC)	Max. pressure*
2000	17" WC	2 PSI
2500	17" WC	2 PSI
3000	17" WC	2 PSI
3500	21" WC	2 PSI
4000	21" WC	2 PSI
4500	24" WC	2 PSI
5000	28" WC	3 PSI
6000	28" WC	3 PSI

*Upstream regulator required for higher gas supply pressures

5.11.3 - Power-Up

1. Ensure the boiler is properly wired for the available power supply. Refer to the wiring diagram provided with the boiler.
2. Verify the voltage to ensure it is within specifications.

5.11.4 - Operation Check: Gas Valve, Gas Pressure Switches, Combustion Air Proving Switch, Ignition Fail

Before initial firing of the burner, the gas valve, Low Gas Pressure Switch (LGPS), High Gas Pressure Switch (HGPS), and Combustion Air Proving Switch (CAPS) should be checked for proper operation.

- Before proceeding, review **Section 5.3 - Control Setpoints** for initial LGPS, HGPS, and CAPS settings.

Note: Close the downstream manual gas shut-off valve before checking pressure switches and CAPS.

LGPS

1. To check the Low Gas Pressure Switch, first close the upstream manual shutoff valve (both manual shutoff valves should now be closed).
2. Start the burner and wait 10 seconds during purge for CAPS to be made.
3. Turn the LGPS setting to maximum.
4. Open the test cock to bleed the gas line.
5. The controller should lock out.
6. Reset the controller and change the LGPS setting back to minimum to proceed.

CAPS

1. Initiate burner sequence.
2. During purge cycle, set Combustion Air Proving Switch to its maximum setting.

The controller should lock out on an airflow failure.

Note: If the CAPS fails to open even when set to maximum, test by disconnecting the low-pressure line to the switch and initiating burner sequence. The switch should now break during the purge cycle. Reconnect low-pressure side after a successful CAPS check.

3. Following a successful CAPS check, dial the CAPS back to its minimum setting and reset the controller.

HGPS and GAS VALVE

1. Open the upstream manual shutoff valve and wait a few moments for gas pressure to rise.
2. Lower the switch setting to minimum.
3. Initiate burner sequence. During the main flame establishing period, verify gas valve LEDs energize, indicating both safety shutoff valves open.
4. The controller should lock out on an interlock failure.
5. Reset controller.
6. Open the downstream manual shutoff valve to clear the lockout condition.

Dial the HGPS back to its maximum setting and reset.

IGNITION FAILURE CHECK

1. Close the downstream shutoff valve and attempt to start the burner. The controller should lock out on an ignition failure.

After making the above operation checks, re-open the downstream manual shut-off valve.

5.11.5 - Pilot Fail Check

Close the gas pilot shutoff valve. Also shut off main fuel supply. Attempt to start the burner. There should be an ignition spark, but no pilot flame. The controller will lock out, indicating pilot failure.

Reset the controller, open the pilot shutoff valve, and re-establish fuel supply before continuing.

5.11.6 - Low Water Cutoff Check

1. Hold down the LOW WATER RESET-TEST switch for 3 seconds.
2. Check display for low water fault message.

3. Press RESET-TEST switch once to reset.

5.11.7 - Low and High Fire Adjustments

All M5M boilers are factory tested firing natural gas at an altitude of 1000 ft ASL. Operating under different conditions may require re-adjustment of the gas valve.

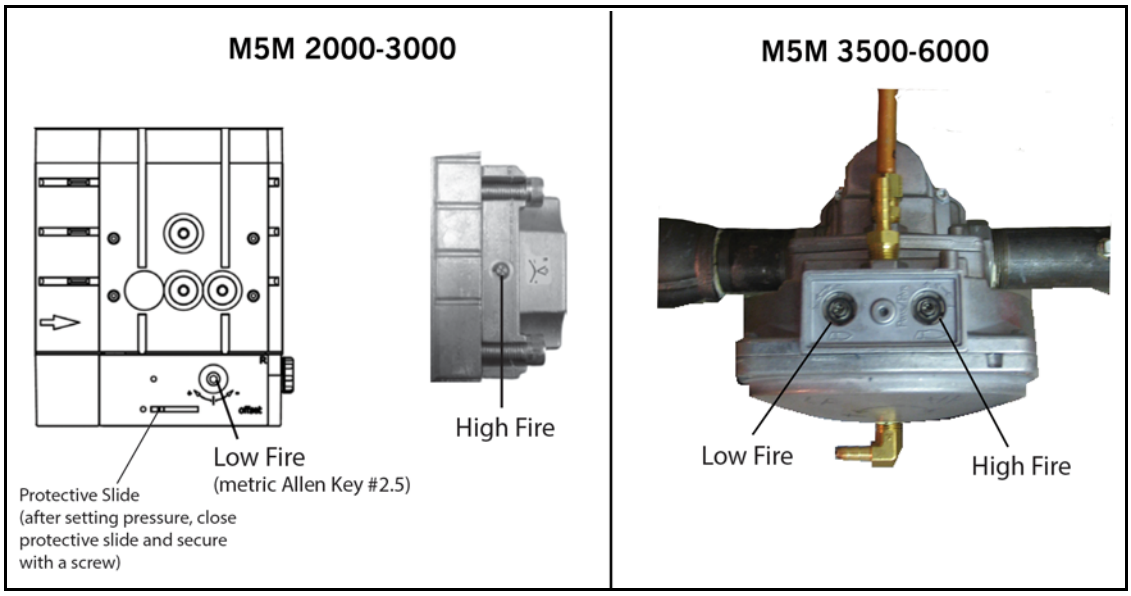


FIGURE 5-3. Gas Valve adjustment

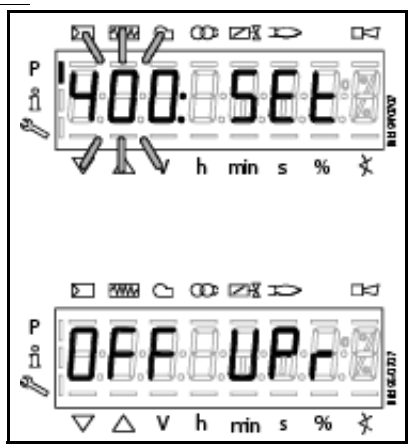
Refer to **Appendix D** or **E** depending on make of gas valve for further information on valve setup, operation, and testing.

5.11.8 - Modulation OFF point

Prior to setting combustion, the Modulation OFF point should be adjusted upward to avoid nuisance shutdowns while the burner is under manual control.

5.12 - Setting Combustion

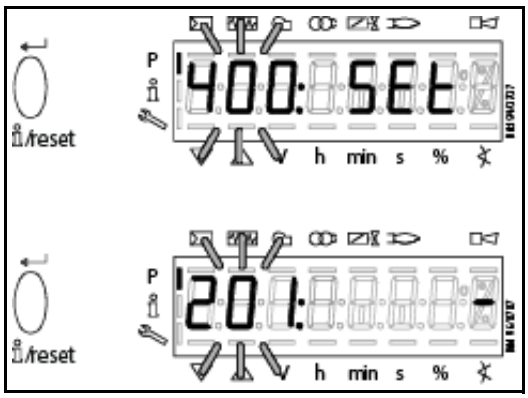
The display shows 400: flashing on the left, SEt appears on the right.



An unprogrammed unit or a unit whose operating mode has been reset or changed displays OFF UPr.

For initial commissioning, change to the parameter level. The settings can then be made on parameter level 400.

Press i/reset to select parameter 400 for initial commissioning and for setting air-fuel ratio control.



Press i/reset to go to the settings for air-fuel ratio control and parameter 201 for selecting the operating mode. 201: appears flashing.

5.12.1 - Setting curvepoints P0 and P9

Display P0 appears flashing. Curvepoint for ignition load.

Keep A depressed. You are now in setting P0 of air actuator A for ignition position P0.

Press simultaneously A and - or + to set ignition position P0 of the air actuator. Example: 22.0

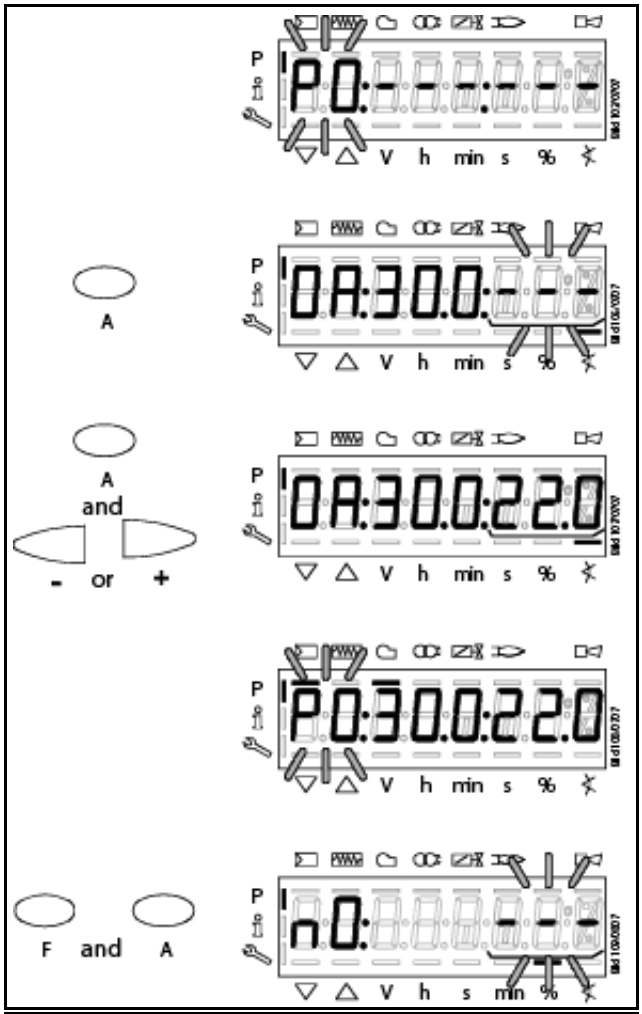
Release A. The selected value is adopted. Example: 22.0

Keep F and A depressed. You are now in setting n0, speed n is for ignition position n0

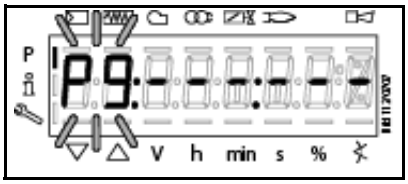
Press simultaneously F and A and - or + to adjust speed n0 of the load controller. Example: 20.0

Release F and A. The selected value is adopted. Example: 20.0

To the next curvepoint



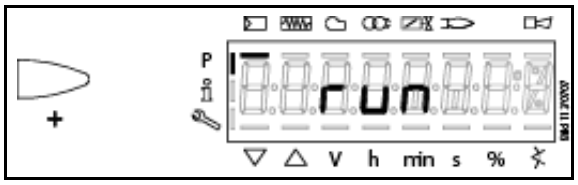
Press '+'. P9 appears flashing. Curvepoint for high-fire. Same procedure as with P0. Note: If '-' is pressed first, the display jumps to 90!



To the next curvepoint

Back to the previous curvepoint

Press '+'. The display shows "run" (indicating the unit is ready for setting the curve parameters).

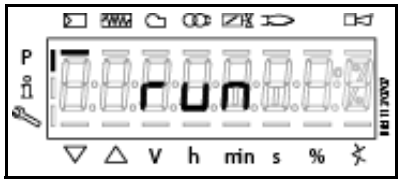


Note: When pressing i/reset, you are given the choice of proceeding with "warm settings" or, by pressing ESC, with "cold settings".

5.12.2 - Warm settings for modulating mode

Note: With "warm settings", the burner is started up after pressing the Info button. Air-fuel ratio control can now be accurately set while the flame is present. When traveling along the precalculated curve to high-fire point P9, all intermediate curvepoints (P2...P8) must be set. Automatic operation is released when – after reaching P9 – the curve settings are quit by pressing ESC. If the curve settings are aborted earlier (ESC or shutdown due to fault), start prevention OFF UPr continues to be active until all points are set. If required, the gas pressure can be set at the high-fire point. In case the gas pressure is changed, all points must be checked by traveling along the curve downward and – if required – must be readjusted.

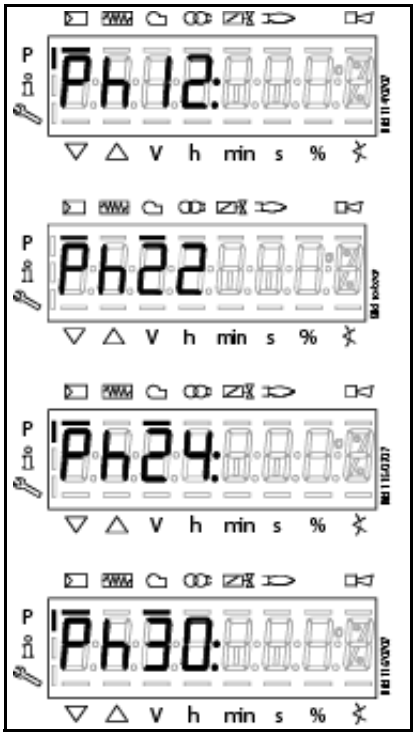
When "run" is displayed, the unit is ready for setting the combustion curve parameters.



When there is a request for heat.

Note: If, during the time the curve is parameterized, an error occurs which leads to safety shutdown, parameterization of the curve is quit.

Phase Standby (stationary)



Phase Fan ramp up (fan motor = ON, safety valve = ON)

Phase Traveling to prepurge position

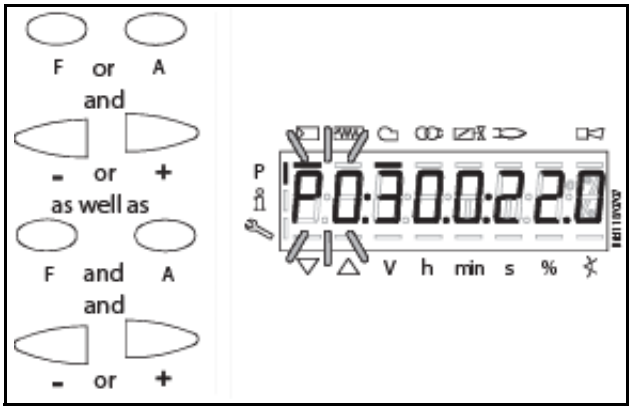
Phase Prepurging

Phase Traveling to ignition position

Wait until the burner is operating and symbol ▼ or ▲ is no longer highlighted! The startup sequence stops in phase 36 Traveling to ignition position. The ignition position can be adjusted under cold conditions.

Ignition position P0 can only be set after symbol ▼ or ▲ is no longer highlighted. Keep A depressed, and for VSD F and A.

Press - or + to adjust the value. When symbol ▼ or ▲ is no longer highlighted, the next curvepoint P1 can be selected with +.



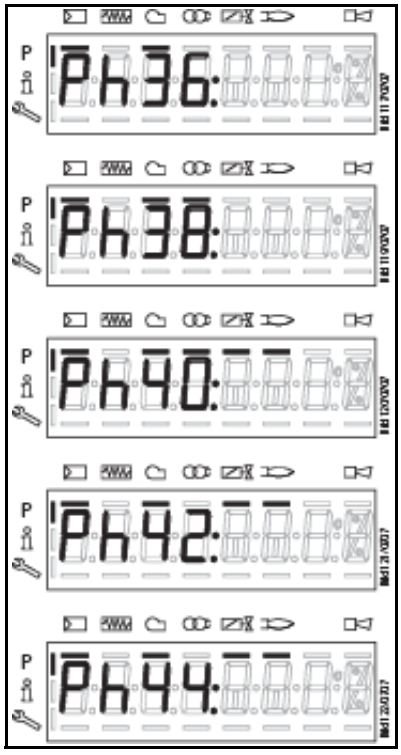
Phase Traveling to ignition position

Phase Preignition

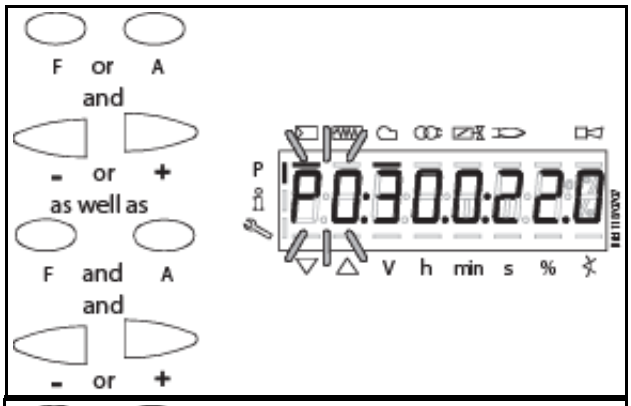
Phase 1st safety time (ignition transformer ON)

Phase 1st safety time (ignition transformer OFF), preignition time OFF

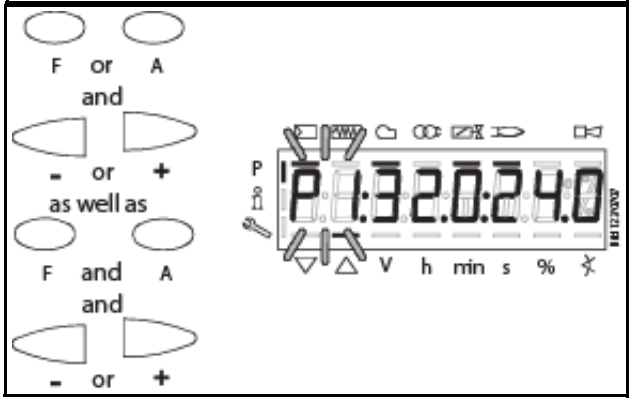
Phase Interval 1



Ignition position P0 can only be set when symbol ▼ or ▲ is no longer highlighted. For fuel, keep F depressed, for air A, and for VSD F and A. Press - or + to adjust the value. When symbol ▼ or ▲ is no longer highlighted, the next curvepoint P1 can be selected with + .



Low-flame position P1 can only be set when symbol ▼ or ▲ is no longer highlighted. The value is adopted from P0. For fuel, keep F depressed, for air A, and for VSD F and A Press - or + to adjust the value. When symbol ▼ or ▲ is no longer highlighted, the next curvepoint P2 can be selected with + .



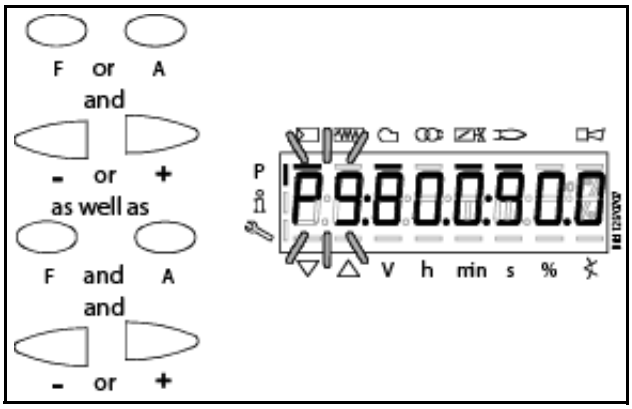
To the next curvepoint

Back to the previous curvepoint

When changing from P1 to P2 for the first time, curvepoints P2…P8 automatically calculated and saved. CALC appears for a short moment.

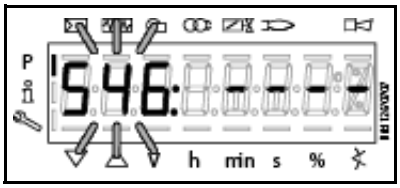
Note: Curvepoints P2 to P8 are automatically computed as a straight line between P1 and P9.

High-fire position P9 can only be set when symbol ▼ or ▲ is no longer highlighted. If required, readjust the gas pressure. For fuel, keep F depressed, for air A, and for VSD F and A Press - or + to adjust the value. When symbol ▼ or ▲ is no longer highlighted, the next curvepoint P8 can be selected with - .



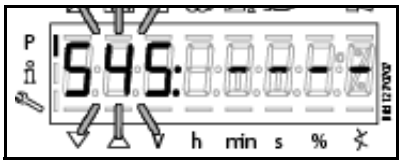
After setting the high-fire point (P9), either a change to parameter 546 (automatic operation) can be made (ESC) or all curvepoints can be run through in the reverse order. If the gas pressure is changed, all curvepoints must be checked and – if required – readjusted.

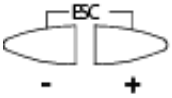
The maximum capacity is displayed. If the display shows - - - -, the maximum capacity has not yet been specified. The system can be run up to 100%. You can press /reset to go to editing mode, enabling you to change the maximum capacity.



To the next parameter

The minimum capacity is displayed. If the display shows - - - -, the minimum capacity has not yet been entered. The system can be run down to 20%. You can press i/reset to go to editing mode, enabling you to change the minimum capacity.

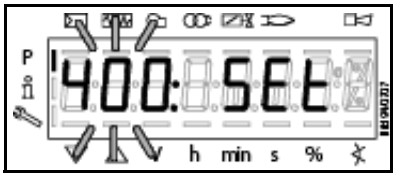


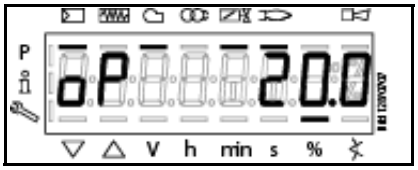


Completing parameterization of the curve

Back to the previous parameter

When symbol ? or ? is no longer highlighted, you can press ESC a second time.





The warm settings for air-fuel ratio control by the LMV37.4... are now completed.

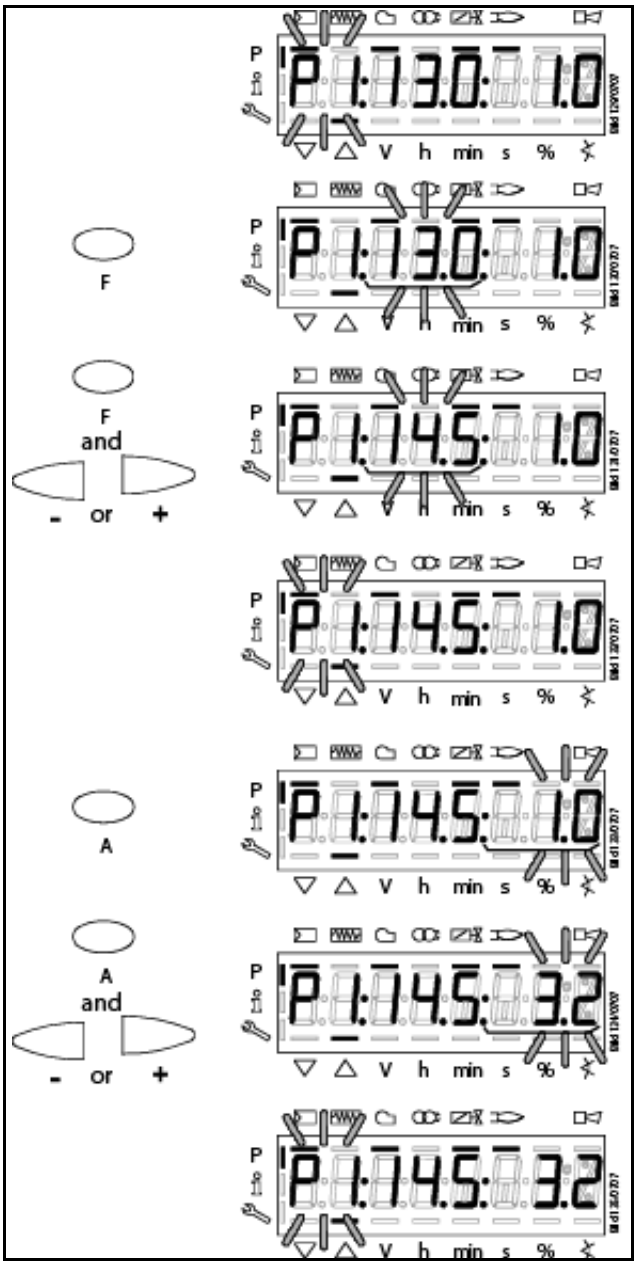
5.12.3 - Editing the curvepoints

Note: To check the change on the burner, a curvepoint change in the cold settings necessitates a new approach of all curvepoints in the warm settings. After changing the curvepoint, OFF UPr appears on the normal display of the AZL2...

To the next curvepoint

To select the curvepoint

The selected curvepoint is displayed.



Keep F depressed. The fuel actuator has been selected for editing.

Keep F depressed and press - or + to adjust the fuel actuator. In the case of warm settings, the actuator follows directly the adjustments made. The changes are saved.

After releasing F , the curvepoint is selected again.

Keep A depressed. The air actuator has been selected for editing

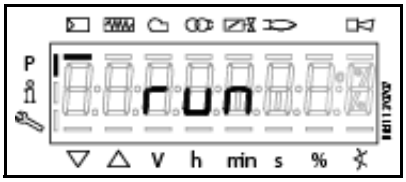
Keep A depressed and press - or + to adjust the air actuator. In the case of warm settings, the actuator follows directly the adjustments made. The changes are saved.

After releasing A, the curvepoint is selected again.

 To the next curvepoint  Back to previous curvepoint

5.12.4 - Interpolation of curvepoints

Identification of start for setting the curve parameters.

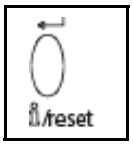


Example 1 = gas modulating

P0, P1 and P9 are set as described:	Curvepoint	Value 1 fuel	Value 2 air
	P0	30.0	22.0
	P1	32.0	24.0
	P9	80.0	90.0

P2 through P8 have automatically been calculated:	Curvepoint	Value 1 fuel	Value 2 air
	P2	38.0	32.3
	P3	44.0	40.5
	P4	50.0	48.8
	P5	56.0	57
	P6	62.0	65.3
	P7	68.0	73.5
	P8	74.0	81.8

P5 shall now be changed:



Keep F or A depressed. Example: F

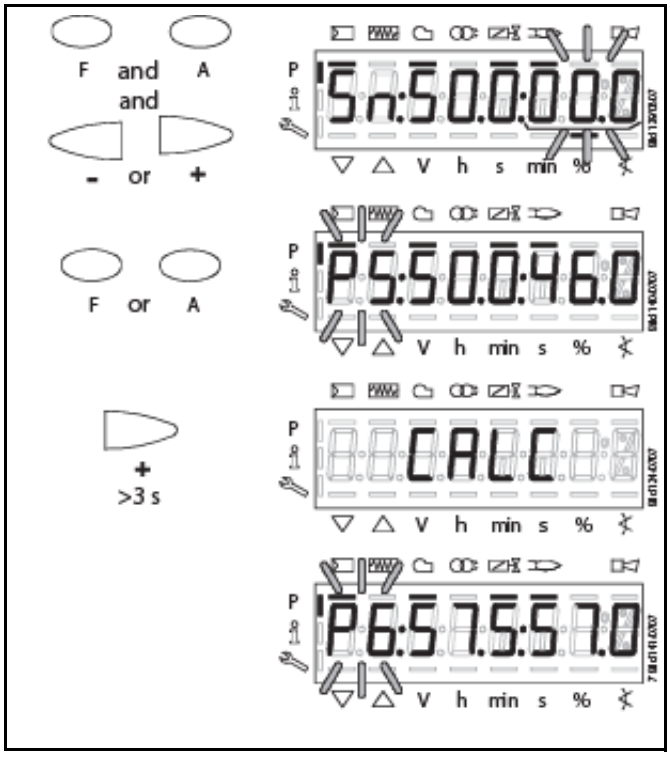
Press - or + to change the value as required. Example: 50.0

Press - or + to change the value as required. Example: 00.0

Release F or A . The required value is adopted. Example: P5:50.0:46.0

Keep + depressed for >3 s. CALC appears.

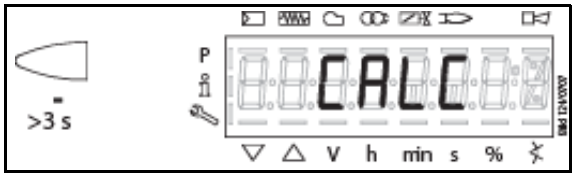
The display jumps to P6.



All curvepoints from P5 to P9 have now been automatically recalculated (linear interpolation):

Curvepoint	Value 1 fuel	Value 2 air
P5	50.0	46.0
P6	57.5	57.0
P7	65.0	68.0
P8	72.0	79.0
P9	80.0	90.0

Keep '-' depressed for >3 s. CALC appears.

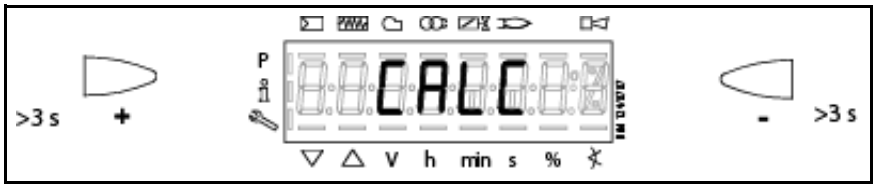


The display jumps to P4.

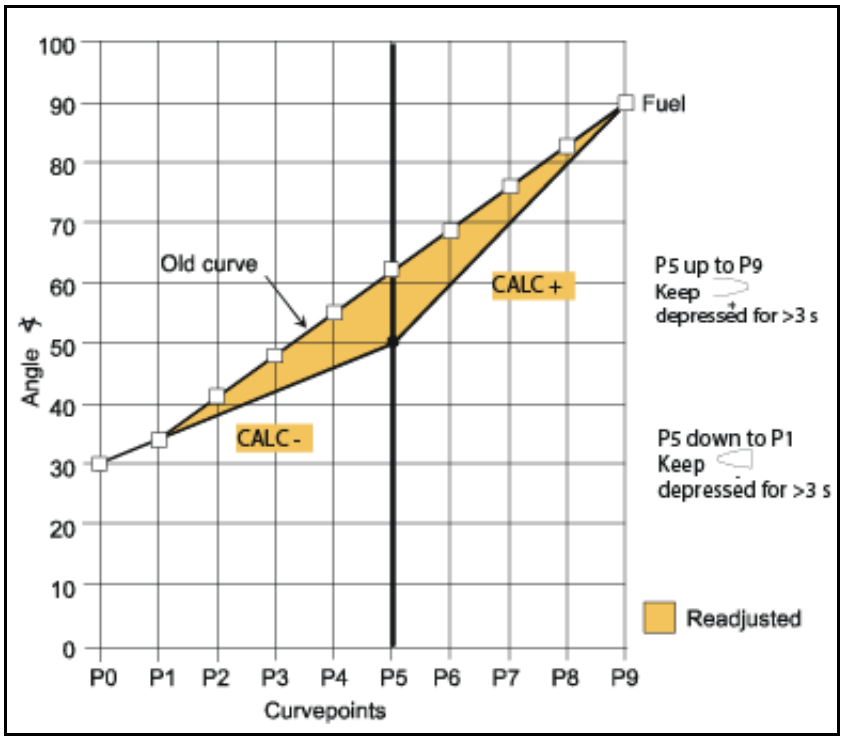
All curvepoints from P1 to P5 have now been automatically recalculated (linear interpolation):

Curvepoint	Value 1 fuel	Value 2 air
P5	50.0	46.0
P4	45.5	40.0
P3	41.0	35.0
P2	36.5	29.5
P1	32.0	24.0

If it is not only the current curvepoint that shall be changed, but all other curvepoints in the direction of travel as well, a new straight line from the current curvepoint to P9 (press +) or P1 (press -) can be calculated by a long push on - or + .



Note: Due to interpolation, a number of curvepoints change. To be able to make a check on the burner itself, the changed curvepoints must be approached in the warm settings. If these curvepoints have not yet been completely approached, OFF UPr appears on the normal display of the AZL



5.13 - Commissioning: Final Steps

After combustion setup the following procedures should be performed before placing the biiler into service.

5.13.1 - Limit Controls Check

Steam Boilers

The operating (OLC) and high pressure limit (HLC) controls areexternally mounted to the control panel. The setting of the OLC should be slightly higher than the configured set point plus the hysteresis off value set in the controller. The setting of the HLC should be slightly higher than the OLC. For example: set point = 100.0 psig, Hysteresis Off = 5.0 psi; OLC could be set to 110 psig, HLC set to 120 psig. Specific settings are determined by application

and system control scheme.The OLC and HLC can be tested while the boiler is producing steam by adjusting the switch setting downward. A lockout should result when the switch setting is at or just below the current steam pressure. Readjust each switch (and reset HLC) after testing.

Hot Water Boilers

The Modulation Off (operating limit) and High Limit functions can be tested while the boiler is operating by adjusting the respective setting downward and allowing the boiler outlet temperature to rise. The Modulation Off point is the sum of the Modulating setpoint and the Hysteresis Off value. The Modulation On point is the setpoint minus the Hysteresis On value.

When the boiler's outlet temperature exceeds either of these settings, the boiler will shut down. When the operating limit is exceeded, the boiler will automatically recycle upon the outlet temperature dropping below the on point. When the High Limit is exceeded, a lockout should result requiring a manual reset of the control after the temperature has dropped below the high limit setting.

Before testing the High Limit, temporarily set the Modulation OFF point higher than the High Limit setting.

Restore Modulation OFF and High Limit to operational settings after testing.

Specific settings are determined by application. Maximum High Limit for Model M5M is 250 deg F.

5.13.2 - Post start-up checkout procedure

1. Ensure proper air venting to expansion tank (hot water units).
2. Verify the ability of the flame system to detect and respond to a loss of flame. This can be done by removing the flame sensor cable. For a successful test the boiler should shut down and the gas safety shutoff valve close with the display indicating a lockout condition. Reconnect the cable to the flame detector.
3. Set high gas pressure switch to 50% higher than operating gas pressure at low fire. Set low gas pressure switch to 50% lower than operating gas pressure at low fire.
4. Check the draft on the outlet stack on each boiler, compare to acceptable limits (-.25 to +.25" W.C.) and record in start up form. Operating outside of acceptable limits could result in light off and flame failure problems.
5. Switch to automatic operation and monitor flue gas to ensure consistent excess air.
6. Reassemble all panels and covers that were removed and replace any plugs that were removed to check gas pressure.
7. Verify gas pressures remain within limits shown in Table 4-1.
8. Provide instructions to owner and operators on operation, safety and maintenance of the equipment.
9. Provide instructions to owner and operators on proper water treatment guidelines and procedures.

5.13.3 - Boil Out (new boilers)

See 3.6 — Boil Out of a New Unit

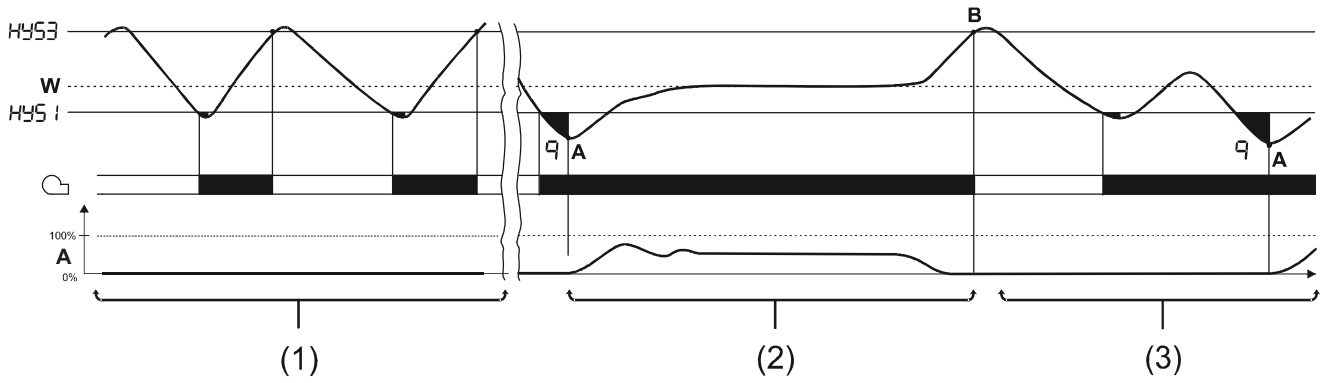
5.14 - RWF50 Modulating Control

The RWF50 is the burner modulation control for the M5M, and is where modulation setpoints are configured and stored.

5.14.1 - Burner Modulating Control Sequence

Area (1) Thermostat function active.

Area (2) The RWF50.3 as a modulating controller provides control to the adjusted setpoint. Angular positioning is ensured via the analog output in the form of a standard signal.



Area (3) If the actual value exceeds the upper switch-off threshold HYS3 in spite of the lowest heating stage, the controller switches the burner off (B). The controller only starts low-fire operation when the actual value falls below switch-on threshold HYS1 again. If the response threshold (q) is exceeded, the controller switches to high-fire operation (A).

5.14.2 - Burner Shutdown

In the event of a sensor failure at the analog input InP1, the controller cannot monitor the actual value. Burner shutdown will automatically be triggered to guard against overheating.

Functions:

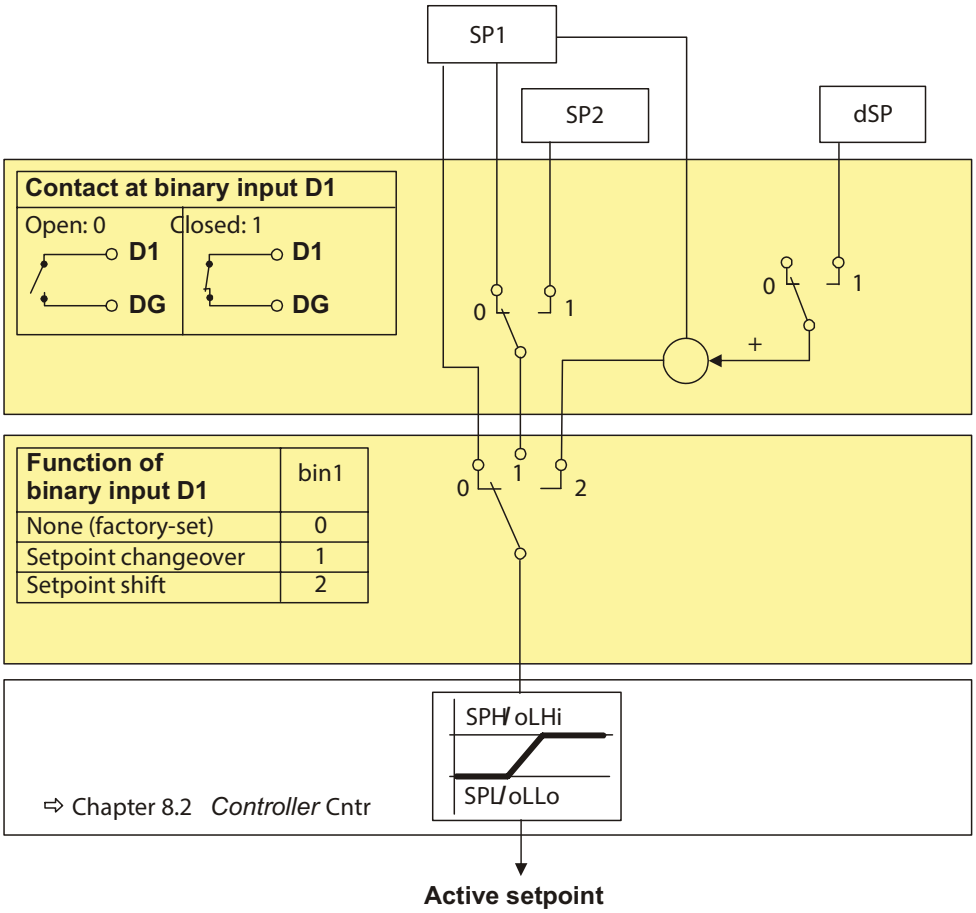
- Burner off
- 3-position output for closing the controlling element
- Self-setting function is ended
- Manual control is ended

5.14.3 - Predefined Setpoint

The setpoint is predefined within the selected setpoint limits via the buttons or the ACS411 software. Using an external contact, the setpoint can also be shifted or changed over.

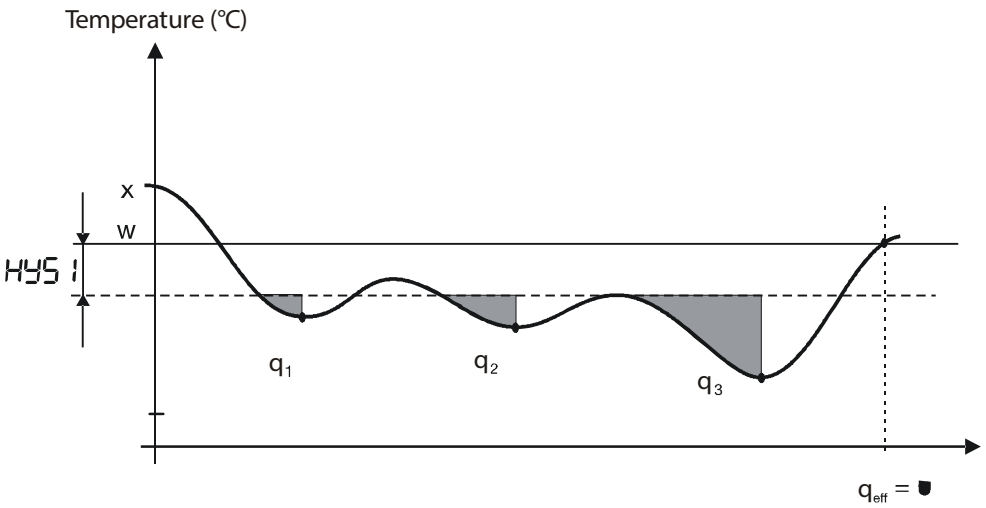
Depending on the function selected for the binary input, the effective controller setpoint can change between setpoint SP1 and setpoint SP2 or can be shifted by the amount of dSP. A contact at binary input D1 controls the changeover or shift.

The values for setpoints SP1, SP2 and dSP are to be entered at the operating level.



5.14.4 - Response Threshold (q)

The response threshold (q) defines for what period of time and how much the actual value is allowed to drop before the system switches to high-fire operation. An internal mathematical calculation using an integration function determines the sum of all areas qeff = q1 + q2 + q3 as shown in the graph. This takes place only when the control deviation (x-w) falls below the value of switch-on threshold HYS1. If the actual value increases, integration is stopped. If qeff exceeds the preset response threshold (q) (can be adjusted at the parameter level), this causes the second burner stage to switch on or – in the case of the 3-position controller/modulating controller – the controlling element to open. If the current boiler temperature reaches the required setpoint, qeff is reset to 0.



In contrast to time-dependent switching on, load-dependent switching on offers the advantage of capturing the dynamics of the actual value. Also, monitoring the progression of the actual value during the change from low-fire to high-fire ensures low switching frequencies to reduce wear and to extend running times.

5.14.5 - Cold Start of Plant

Note! Functions Cold Start of Plant and Thermal shock protection (TSS) are interlocked. Only one function can be activated, but never both at the same time.

When a heating system is switched off for a longer period of time, the actual value will drop of course.

To achieve a faster control response, the controller immediately starts in high-fire operation as soon as the control deviation (x-w) drops below a certain limit value.

This limit is calculated as follows: Limit value = 2 x (HYS1-HYS3)

In that case, the response threshold (q) is inactive, independent of operating mode and controlled variable (temperature or pressure).

5.14.6 - Thermal Shock Protection

Note! Functions Cold Start of Plant and Thermal shock protection (TSS) are interlocked. Only one function can be activated, but never both at the same time.

The controller comes with thermal shock protection (TSS) deactivated; it can be activated at the configuration level.

The function is automatically activated when the actual value drops below the adjustable limit value rAL (exceeds the adjustable limit value with the cooling controller). In that case, the setpoint is approached via a ramp function. Gradient and slope of the ramp rASL are adjustable. The setpoint ramp has a symmetrical toler-

ance band toLP. If, during the startup phase, the actual value leaves the tolerance band, the setpoint ramp is stopped until the actual value returns to a level within the tolerance band. The startup phase is ended when the setpoint of the ramp function reaches the final setpoint SP1.

Note! When thermal shock protection (TSS) is active, the controller operates in low-fire operation. The response threshold (q) is active.

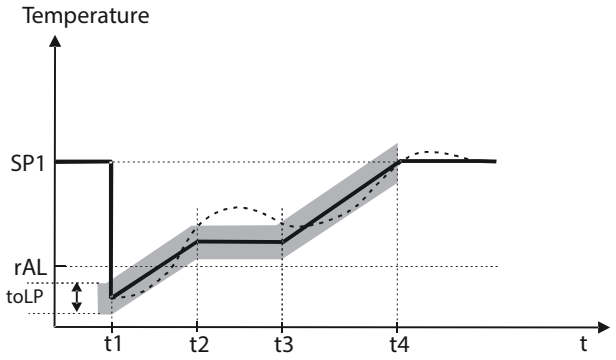


Figure 15: Thermal shock protection (TSS)

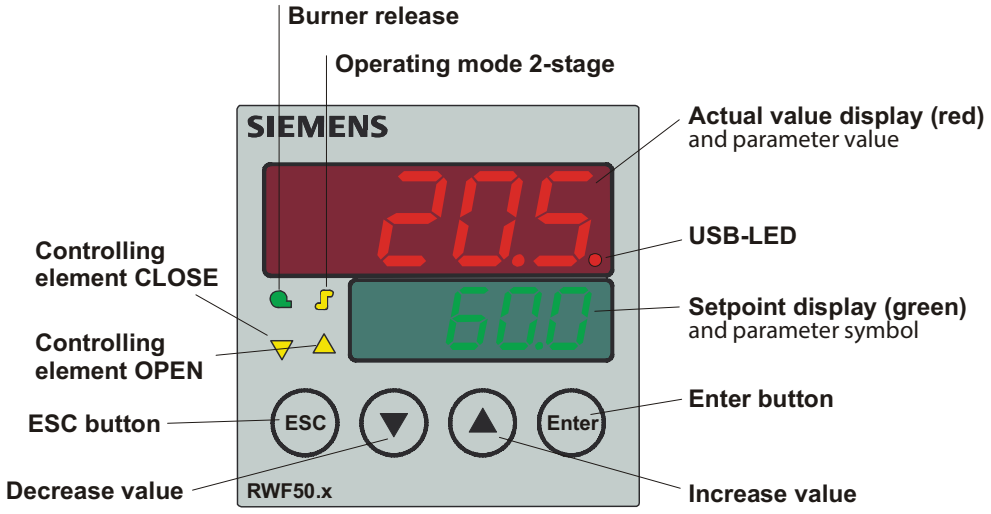
Key

Setpoint (w)

Actual value (x)

5.15 - RWF50 Operation

5.15.1 - RWF50 Display and Buttons

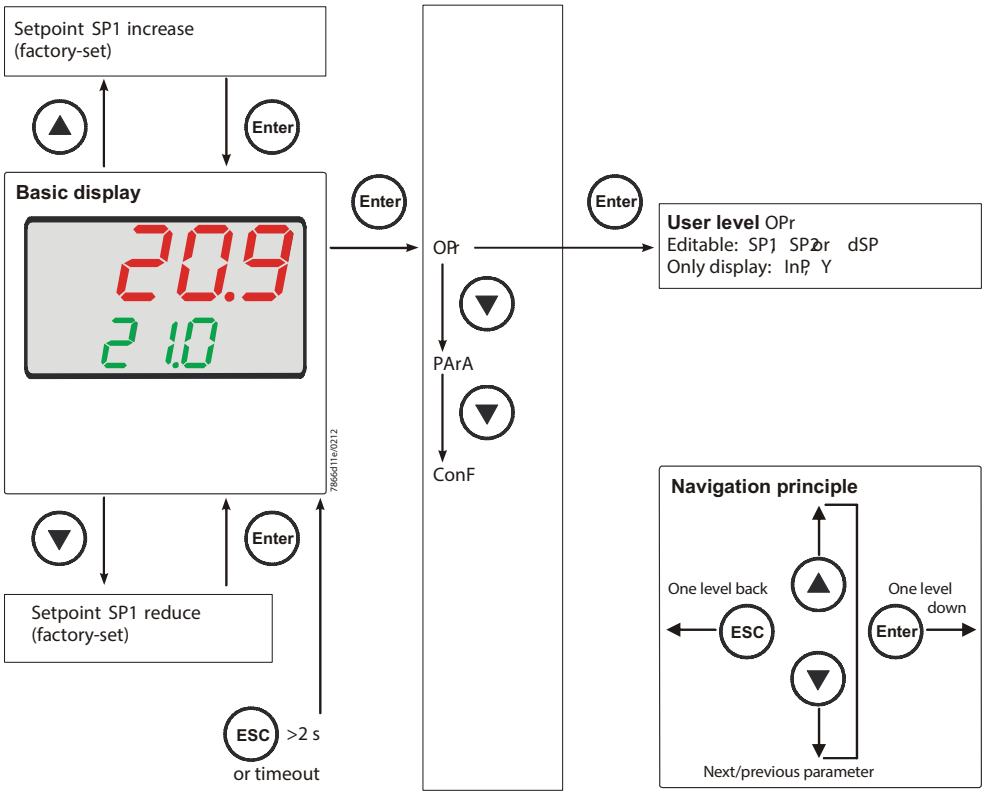


The two 7-segment displays (red and green) show hyphens and all LEDs light up for about 5 seconds. The upper display (red) shows the actual value. The lower display (green) shows the setpoint.

When entering parameters, the parameter symbol at the bottom (green) and the set value at the top (red) appear. The actual value is shown on the upper display (red) and tUnE flashes on the setpoint display (green).

When the burner is under manual control, the setpoint display (green) shows HAnd flashing.

When switching power on, the displays show hyphens for about 5 seconds. The state that follows is called normal display. Default display is the actual value and the current setpoint. Other values can be displayed at the configuration level or via PC software ACS411. Manual control, self-setting, the user, parameter and configuration levels can be activated from here.



5.15.2 - User Level

This level is started from the basic display. Setpoints SP1, SP2 or dSP can be altered. The values of InP (analog input) and Y (current angular positioning between 0...100%) can be displayed.

Changing the setpoints:

* From the basic display, press Enter so that OPr appears
* Press Enter so that SP1 appears
* Press Enter and SP1 flashes
* Press ▲ or ▼ to adjust the required setpoint and press Enter to confirm

User level will time out after 180 seconds.

5.15.3 - Manual Control of Modulation

Note! Manual control can only be activated if a demand for heat exists (relay K1 is energized). If demand is met (relay K1 de-energized) during manual control, manual control is deactivated.

* Change angular positioning by pressing ▲ or ▼
* Adopt flashing new angular positioning by pressing Enter

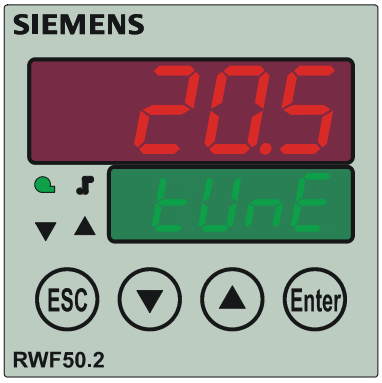
  Per default, the analog output delivers the current angular positioning.
* Return to automatic operation by keeping ESC depressed for 5 seconds

Note! When activating manual control, angular positioning is set to 0 until another entry is made.

5.15.4 - Starting the self-setting function

Start * Press ▲ + ▼ for 5 seconds

Cancel * Cancel with ▲ + ▼



When **tUnE** stops flashing, the self-setting function has been ended.

The parameters calculated by the controller are automatically adopted!

Note!
It is not possible to start **tUnE** in manual control or low-fire operation.

5.15.5 - Software version & display test

Press Enter + ▲ to display the currently loaded RWF50 software version. Press Enter + ▲ again and all display segments and LEDs will light up. The display will flash for about ten seconds.

5.16 - Parameterization

The PArA level accesses parameters for adjusting controller performance once the boiler has been placed into service. To access:

* Press Enter so that OPr appears
* Press ▼ so that PArA appears
* Press Enter so that the first parameter of the parameter level is displayed

Parameters are shown on the lower (green) display and their respective values on the upper (red) display.

Parameter	Display	Value range	Factory setting
Proportional band [1]	Pb1	1...9999 digit	10
Derivative time	dt	0...9999 s	80
Integral action time	rt	0...9999 s	350
Dead band (neutral zone) [1]	db	0.0...999.9 digit	1
Controlling element running time	tt	10...3000 s	15
Switch-on threshold Heating controller [1]	HYS1	-1999...0.0 digit	-5
Switch-off threshold stage II Heating controller [1]	HYS2	0.0... HYS3digit	3
Switch-off threshold Heating controller [1]	HYS3	0.0...9999 digit	5
Response threshold	q	0.0...999.9	0

[1] Setting of decimal place has an impact on this parameter

5.17 - Configuration

Most settings at the ConF level will have been made at the factory. Should thermal shock protection need to be activated it can be done here. Go to ConF>rAFC.

Parameter	Value/ selection	Description
Function FnCt Function	**0** 1 2	**Switched off** Gradient Kelvin/minute Gradient Kelvin/hour Note! With **FnCt** = 1 or 2, *Thermal shock protection* (TSS) is automatically activated as soon as the actual value drops below the adjustable absolute limit value **rAL**.
Ramp slope rASL Ramp slope	**0.0...** 999.9	Slope of ramp slope (only with functions 1 and 2)
Tolerance band ramp toLP Tolerance band ramp	**2 x |HYS1| = 10**...9999	Width of tolerance band (in K) about the setpoint (only with function 1 and 2) Smallest possible factory setting: **2 x |HYS1| = 10 K** To monitor the actual value in connection with thermal shock protection (TSS), a tolerance band can be laid about the setpoint curve. If the limit values are crossed, the ramp is stopped.
Note! In the event of a faulty sensor or manual control, the ramp function is stopped. The outputs behave the same way they do when the measuring range is crossed (configurable). Functions *Cold start of plant* and *Thermal shock protection (TSS)* are interlocked. Only one function can be activated, but never both at the same time.		
Limit value rAL Ramp limit	**0**...250	**Heating controller:** If the actual value lies below this limit value, the setpoint is approached in the form of a ramp until final setpoint SP1 is reached.

5.17.1 - Display configuration

The information displayed is selectable for upper and lower displays. Also configurable are the timeout for return to basic display, decimal points, and locking of display access levels.

Parameter	Value/ selection	Description
Upper display diSU Upper display		Display value for upper display
	0	Switched off
	1	**Analog input** InP1
	4	Controller's angular positioning
	6	Setpoint
	7	End value with thermal shock protection
Lower display diSL Lower display		Display value for lower display
	0	Switched off
	1	Analog input InP1
	4	Controller's angular positioning
	6	**Setpoint**
	7	End value with thermal shock protection
Timeout tout	0... **180**... 255	Time (s) on completion of which the controller returns automatically to the basic display, if no button is pressed
Decimal point dECP Decimal point	**0**	**No decimal place**
	1	One decimal place
	2	Two decimal places If the value to be displayed cannot be shown with the programmed decimal point, the number of decimal places is automatically reduced. If the measured value drops again, the number of decimal places is increased until the programmed value is reached
Locking of levels CodE	**0**	**No locking**
	1	Locking of configuration level
	2	Locking of parameter level
	3	Locking of keyboard

CHAPTER 6

Maintenance

6.1 - Overview

While each boiler is tested for correct operation before shipment from the factory, variable conditions such as burner characteristics of the fuel used and operating load conditions may require further adjustment after installation to assure maximum operating efficiency and economy. Prior to placing the boiler into initial service, a complete inspection should be made of all controls, connecting piping, wiring and all fastenings such as nuts, bolts, and setscrews to be sure that no damage or mis-adjustments occurred during shipment and installation.

A well planned maintenance program avoids unnecessary down time or costly repairs, promotes safety and aids boiler code and local inspectors. An inspection schedule with a listing of procedures should be established. It is recommended that a boiler room log or record be maintained. Recording of daily, weekly, monthly, and yearly maintenance activities provides a valuable guide and aids in obtaining optimum service from Cleaver-Brooks equipment.

This chapter details adjustment and inspection procedures plus specialized maintenance where required. It cannot cover all of the phases involved in a complete maintenance program.

Even though the boiler has electrical and mechanical devices that make it automatic or semi-automatic in operation, these devices require systematic and periodic maintenance. No “automatic” feature relieves the operator from the normal responsibilities of upkeep and maintenance.

Good housekeeping helps maintain a professional appearing boiler room. Only trained and authorized personnel should be permitted to operate, adjust, or repair the boiler and its related equipment. The boiler room should be kept free of all material and equipment not necessary to the operation of the boiler or heating system.

Being alert to an unusual noise, improper gauge reading, leaks, etc. can make the operator aware of a developing malfunction and prompt corrective action that may prevent extensive repairs or unexpected down time. Any steam, water, or fuel leaks should be repaired as soon as they are noticed. These are wasteful as well as hazardous. Include in the program preventive maintenance measures such as regularly checking the tightness of connections, locknuts, setscrews, packing glands, etc.

The air-fuel ratio should be checked often since this will alert the operator to losses in combustion efficiency which do not produce visible flame changes. Variations in fuel composition from one time to another may require

readjustment of the burner. A combustion analysis should be used to adjust fuel input for maximum operating efficiency and economy.

See also Chapter 3 **Waterside Care** for additional maintenance requirements.

6.2 - Periodic Inspection

Insurance regulations or local laws normally require a periodic inspection of the pressure vessel by an authorized inspector.

Inspections of this type are usually, though not necessarily, scheduled for periods of normal boiler down time such as an off season. This major inspection can often be used to accomplish maintenance replacements or repairs that cannot easily be done at other times. This also serves as a good basis for establishing a schedule for annual, monthly, or other periodic maintenance programs.

While this inspection pertains primarily to the waterside and fireside surfaces of the pressure vessel, it provides the operator an excellent opportunity for detailed inspection of all components of the boiler including piping, valves, pumps, gaskets, refractory, etc. Comprehensive cleaning, spot painting or repainting, and the replacement of expendable items should be planned for and taken care of during this time. Any major repairs or replacements that may be required should also, if possible, be coordinated with this period of boiler shutdown.

Replacement spare parts, if not on hand, should be ordered sufficiently prior to shutdown.

Cleaver-Brooks boilers are designed, engineered, and built to give long life and excellent service on the job. Good operating practices and conscientious maintenance and care will obtain efficiency and economy from their operation and contribute to long years of performance.

6.3 - Burner Maintenance

On an annual basis the boiler vessel and burner combustion system must be checked and cleaned. This work is to be carried out by an authorized Cleaver-Brooks Service Technician.

1. Close off the gas supply to the boiler and disconnect electrical power at the primary switch box.
2. Remove the gas train and set aside.
3. Disconnect the electrical connections to the blower assembly.
4. Disconnect scanner, ignition, and pilot cables.
5. Remove air filter (or direct vent coupling if supplied).
6. Remove the nuts securing the blower to the adapter plate.
7. The blower can now be removed.
8. The burner head can be separated by removing the nuts and washers holding the adapter plate to the dry oven.

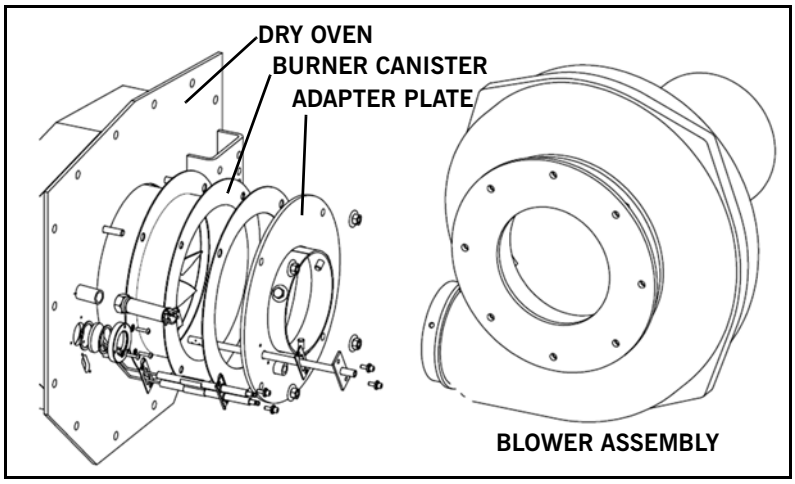


FIGURE 6-1. **Burner/blower assembly**

Check the burner head for any damage, burn marks or perforations. If damage is found replace the damaged parts. If the canister is in good condition clean out any dirt and contaminates with a vacuum cleaner inside and out, alternating with compressed air to dislodge any debris.

With the burner head and blower removed the fire side can be accessed for all service requirements.

Check ignition electrodes for deposits and proper gap. Clean or replace as needed.

Inspect the pressure vessel and combustion area for any damage or contamination. If dirt or contaminates are found it is recommended that the tubes be washed with a high-pressure power washer.

Label all wires prior to disconnection when servicing controls. Wiring errors can cause improper and dangerous operation. Verify proper operation after servicing.

6.4 - Reassembly

1. Assembly is the reverse of the above instructions.
2. Burner gaskets should be replaced; see recommended spare parts list.
3. Replace combustion air filter if dirty. Remove filter retaining rod and install new CB approved filter media; see recommended spare parts list. Replace rod to hold filter in place.

6.5 - Ignition and flame detection systems

Ignition Electrode

The ignition electrode should be replaced annually, or more frequently if conditions require. Inspect the electrode periodically for signs of fouling, displacement, or other damage.

Observe the dimensions below when replacing:

1/8” gap between ignitor electrode and ground electrode.

1” from ignitor electrode to the burner canister.

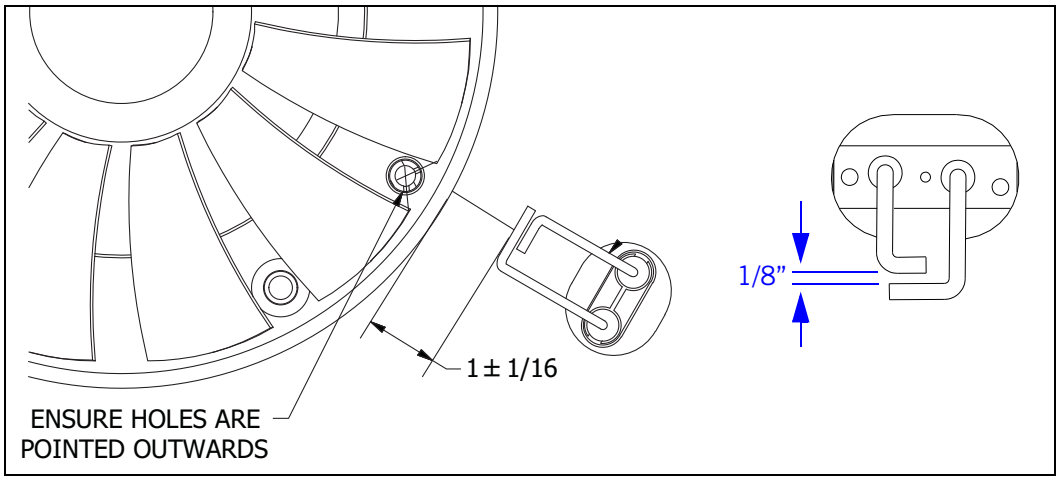


FIGURE 6-2. **Electrode spacing M5M**

Pilot and UV Scanner

Maintenance of the UV scanner consists of periodic inspection and cleaning. To inspect, unscrew the UV flame detector from the bracket. Check to ensure that the flame viewing lens is clear and free of dust or debris. Wipe with a clean rag if necessary.

When replacing the scanner, verify an unobstructed line of sight through the scanner bracket to the burner canister.

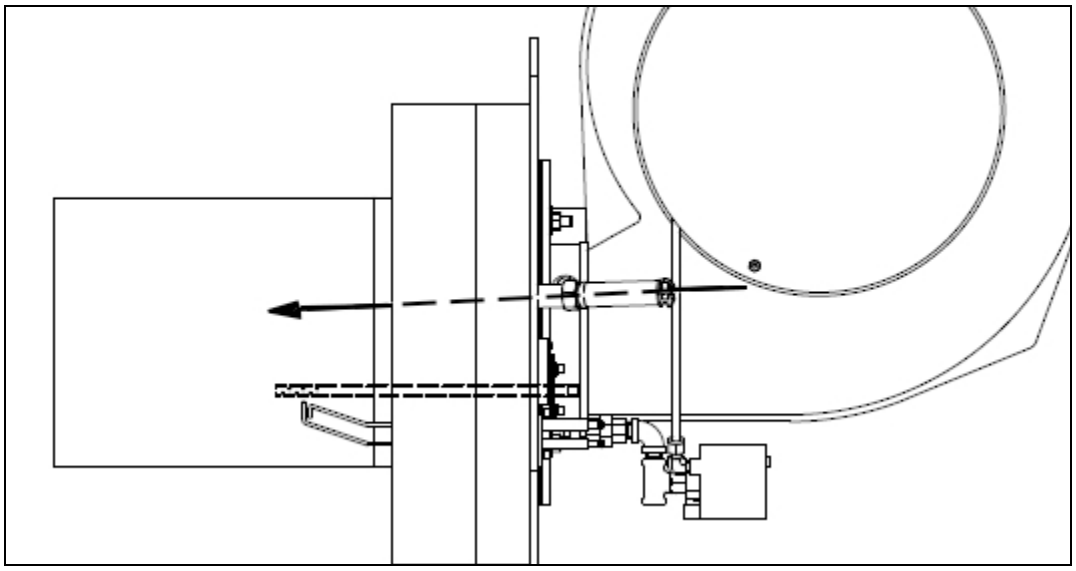


FIGURE 6-3. **UV Scanner**

The M5M uses an interrupted gas pilot in lieu of direct spark ignition. Ensure pilot is installed with the holes facing outward (towards the burner can).

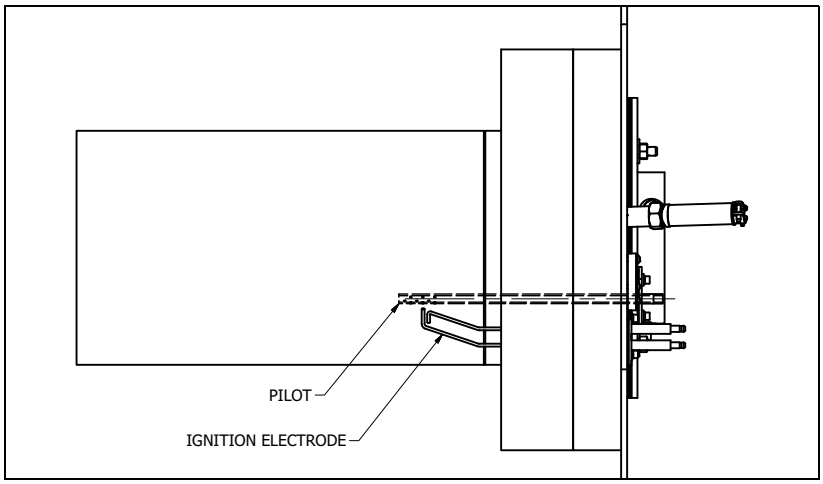


FIGURE 6-4. Pilot Tube

6.6 - Fireside Cleaning

Soot and non-combustibles are effective insulators and if allowed to accumulate will reduce heat transfer to the water and increase fuel consumption. Soot and other deposits can be very moisture absorbent and may attract moisture to form corrosive acids which will deteriorate fireside metal.

Cleanout should be performed at regular and frequent intervals, depending upon load, type, and quality of fuel, internal boiler temperature, and combustion efficiency. A stack temperature thermometer can be used as a guide to cleanout intervals, since an accumulation of soot deposits will raise the flue gas temperature.

In extreme cases, soot or other combustion deposits may be present in the furnace area. These will have to be removed by brushing or scraping. Entry to this area is gained through the access door. Brush-out or vacuum any loosened deposits.

Inspect the refractory and repair or maintain as outlined in the refractory section.

The vent connection stack should be cleaned at regular intervals. Commercial firms are available to perform this work. The stack should be inspected for damage and repaired as required.

The fireside should be thoroughly cleaned prior to any extended lay-up of the boiler. Depending upon circumstances, a protective coating may be required.

6.7 - Preparation for Extended Lay Up

A boiler used for heating or seasonal loads or for stand-by service may have an extended period of non-use. Special attention must be given so that neither waterside nor fireside surfaces are allowed to deteriorate from corrosion.

There are two methods of storage — wet and dry. Your water consultant or feedwater treating company can recommend the better method, depending upon circumstances in a particular installation. Section VII of the ASME Code also contains information relating to laying up a boiler.

6.7.1 - Dry Storage

Dry storage is generally employed when the boiler will be out of service for some time or when freezing temperatures may occur. In this method, the boiler must be thoroughly dried, since any moisture will cause corrosion. Both waterside and fireside surfaces must be clean of all scale and deposits, soot, etc. Steps must be taken to eliminate moisture by placing moisture absorbing material, such as quicklime or silica-gel, on trays inside the drums and furnace. These trays should not be completely filled with the material, so that the corrosion liquid gathered in them does not overflow onto the boiler surfaces. Refractories should be brushed clean and wash-coated. Fireside surfaces may be sprayed or coated with an anti-corrosive material. All openings to the pressure vessel must be shut tightly. Feedwater and steam valves should be closed. Damper and vents should be closed to prevent air from reaching fireside surfaces. Periodic inspection must be made and the absorption materials renewed.

Care Must be taken to remove all of the moisture absorbing material before any attempt is made to refill the boiler. Serious damage can result otherwise. As a precaution it is recommended that warning signs be conspicuously posted. These signs can be similar to the following:

Important

Moisture absorption material has been placed in the waterside and furnace areas of this boiler. This material must be removed before any water is placed in the boiler and before the burner is fired. Inspect periodically and replace with fresh and/or regenerated materials.

6.7.2 - Wet Storage

Wet storage is generally used for a boiler held in standby condition or in a case where dry storage is not practical. The possibility of freezing temperatures must be considered. Care must be taken to protect metal surfaces. Variables preclude definite recommendations, however, it is suggested that after the vessel is drained and cleaned that it be refilled to overflowing with treated water. If deaerated water is not available, the boiler should be fired to boil the water for a short period of time. Additional chemicals may be suggested by the water consultant to minimize corrosion. Internal water pressure should be maintained at greater than atmospheric pressure. Nitrogen is often used for this purpose. Fireside surfaces must be thoroughly cleaned and refractories should be wash-coated. It is advisable, if feasible, to occasionally circulate the water to prevent stratification and to insure that fresh inhibitor is in contact with all surfaces. If additional chemicals are added for this idle period, more frequent blowdowns may be required when the boiler is returned to service to rapidly reduce the chemical composition to normal operating levels.

During storage, steps should be taken to protect the exterior components from the possibility of rust or corrosion. These parts should be coated with a rust inhibitor and protected from moisture and condensation. Operating controls, regulators. valves, etc. should be drained and dried. Electrical equipment should likewise be protected. Keeping the control circuit energized may prevent condensation from forming in the control cabinet or on the flame safeguard control.

6.8 - Troubleshooting

Lockout Conditions

1. Observe lockout code and description - refer to Falcon appendix if necessary.
2. After determining lockout condition, investigate possible causes.
3. When cause is diagnosed, remedy condition.
4. Reset control. Boiler should be able to start normally.
5. If lockout recurs, further investigation is required. Repeat steps 1 through 4 as needed. If necessary, contact your CB service representative for technical support.

EXAMPLE: Lockout 79 Outlet Temperature High Limit

1. Before resetting control to clear lockout, check for sufficient water flow through boiler. Possible sources of insufficient flow include closed water valves, insufficient pump speed, air trapped in boiler (inadequate air venting), or modulation set point and off point close to outlet high limit setting.

   The Falcon system display/interface provides extensive boiler diagnostic data at the time of lockout that can help in determining the source of a problem. This information is accessed through the Lockout History.
2. Remedy condition that caused lockout to occur.
3. Reset control by pressing <Clear Lockout> from the Lockout History screen.

Light-off Problems

Check electrode positioning according to Section **5.3** above.

The dimensions on the ignition electrodes are not easily adjustable - bending the rods can cause damage to the insulation material. In addition, a bent electrode will return to its original shape when heated. If an ignitor or flame rod is out of specification, replacement is generally required. Clean or replace as necessary.

Also see **Troubleshooting Chart** below.

Troubleshooting Chart

Symptom/Fault Indication	Possible Causes
Erratic display/controller behavior	Faulty electrical ground - Check ground terminals in control panel. System should be grounded firmly to metal casing. External ground wiring may be necessary.
Touch screen not working properly	Screen out of calibration - from Falcon home page, go to Setup/Advanced Setup/Diagnostics. Under “Touch Screen” press <Calibrate> and follow instructions on screen.
Burner can failure; High Gas Pressure lockouts	Incorrect gas pressure: • Check regulated gas pressure and ensure it agrees with recommended. Check other equipment connected to gas main - regulator and gas supply piping sizings should be based on all appliances being ON. • A dedicated, properly sized gas pressure regulator is required for each boiler. • Customer connection should reduce to boiler gas train.

Symptom/Fault Indication	Possible Causes
Lightoff problems	• Wrong gas pressure. Check regulated gas pressure and ensure it agrees with recommended. Check other equipment connected to gas main - regulator and gas supply piping sizings should be based on all appliances being ON. • Incorrect fan speed settings - increase fan speed by 100 RPM increments until successful lightoff occurs. • Bad cable connections (ignition or flame rod) • Electrodes fouled or improperly spaced - electrodes should be cleaned or replaced and spacing adjusted. • Debris on burner canister. To clean the unit, remove the burner can and blow compressed air from the outside in. Vacuum up the residue. • Electrical ground problem
Outlet Temperature High Limit lockout	• Insufficient water flow through boiler - closed water valves, insufficient pump speed • Air trapped in boiler • Modulation set point and off point too close to outlet high limit setting
Interrupted Air Switch lockout	• Blower not running • Blocked blower inlet • CAPS switch defective or improperly wired
Loss of flame	• Debris on burner • Blocked condensate drain • Combustion improperly set • Flame scanner soiled, obstructed, or out of position

6.9 - Extended Shutdown

When shutting down the boiler for an extended period of time, use the following general guidelines:

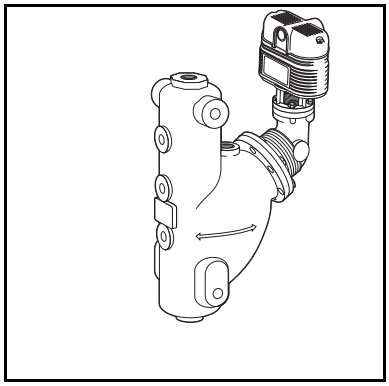
1. Turn the demand switch to the OFF position.
2. Close all main fuel valves.
3. If the boiler operates in a damp environment, cover electrical components in plastic to protect from moisture.

To restart after an extended period, follow the initial startup instructions in Chapter 4.

6.10 - Emergency Shutdown

In case of emergency, shut down the boiler by turning the demand switch to the OFF position. Shut off the main manual fuel shutoff valves on the fuel supply line. The unit can also be shut down with the main electrical power disconnect. Inspect and troubleshoot the boiler before attempting to restart.

6.11 - Water Level Controls



The water level control has two float actuated internal switches. One switch is connected to the burner limit circuit and will stop the burner if a low water condition occurs. On a steam boiler the other switch is connected to the feedwater circuit to energize a water pump or feeder valve to maintain water at the proper operating level.

The control is of the automatic reset type and will remake the limit circuit when the water level is restored. Some applications require that a control be equipped with a manual reset mechanism that must be manually reset before the burner can be restarted. This is usually accomplished with the use of a second or auxiliary control with this feature.

Low water cutoff devices are generally set by the original manufacturer and no attempt should be made to adjust these controls to alter the point of low water cutoff or point of pump cut-in or cut-out. If a low water device should become erratic in operation or if its setting changes from previously established levels, check for reasons and correct, repair, or replace the device as required.

The need to periodically check water level controls cannot be over emphasized. Most instances of major boiler damage are the result of operating with low water.

On steam boilers the head mechanism of the low water cutoff device(s) should be removed from the bowl at least once a month to check and clean the float ball, the internal moving parts, and the bowl or water column.

At the same time, remove the pipe plugs from the column, tees or crosses to make sure the cross connecting piping is clean and free of obstructions. Controls must be mounted in a plumb position for proper performance. Determine that piping is vertically aligned after shipment and installation and throughout the life of the equipment.

Water level controls normally function for long periods of time which may lead to laxity in testing on the assumption that normal operation will continue indefinitely. Testing of the controls, especially on steam boilers, should be followed on a definite planned schedule. The control's operation may be checked by stopping the water supply to the boiler while the burner is operating at low fire. While under constant attendance allow the water to lower at a normal rate. If a control does not break the circuit to stop the burner at the proper point then SHUT DOWN THE BURNER IMMEDIATELY. Repair or replace the control at once.

A scheduled blowdown of the water controls on steam units should be maintained.

On a hot water boiler it is impractical to perform daily and monthly maintenance of the low water cutoff devices. However, it is essential to remove the operating mechanism from the bowl annually or more frequently, if possible, to check and clean the float ball, internal moving parts, and the bowl housing. Also check any cross connecting piping to make certain that it is clean and free of obstruction. It is not practical to blowoff or drain the low water cutoff devices, since the entire water content of the system would become involved. Many hot water systems are fully closed and any loss of water will require make-up and additional feedwater treatment that might not otherwise be necessary.

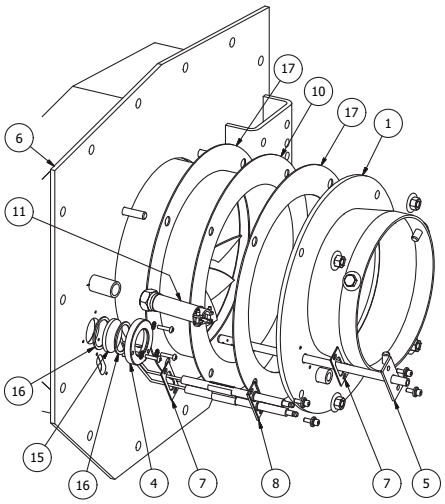
6.12 - Water Gauge Glass

A blowdown cock is provided on the lower gauge glass fitting and a daily blowdown is recommended. The glass should be removed every 3 months and checked, while cool, for etching, thinning, or damage. If any defects are found, replace the glass immediately to avoid the possibility of breakage in service. Do not over tighten water gauge glass fittings. Check try cocks and gauge cocks for freedom of operation and clean as required. Proper alignment of gauge glass cocks is essential to prevent mechanical strain on the glass.

CHAPTER 7

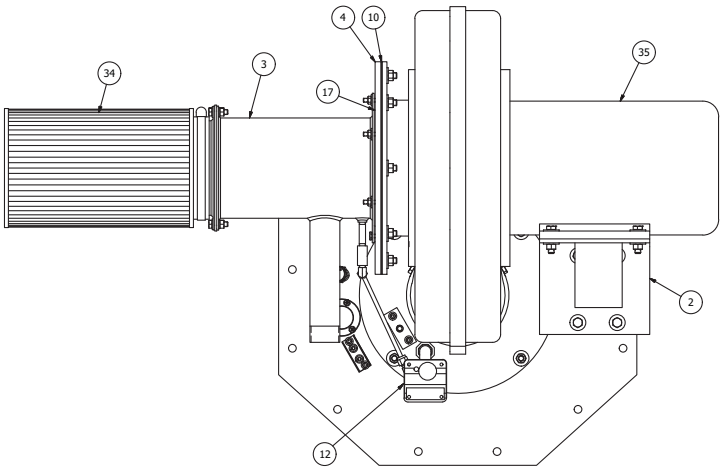
Parts

7.1 - Burner Assembly



ITEM	QTY	2000-3000	3500	4000	4500-6000	DESCRIPTION
1	1	001-01570-000		001-01572-000		ADAPTER, DRY OVEN TO BLOWER
4	1	065-00879-000				RETAINER, SIGHT PORT
5	1	090-09917-000				TUBE, GAS PILOT
6	1	279-00799-000				DRY OVEN ASSEMBLY
7	2	380-01032-000				GASKET, ELECTRODE
8	1	380-01061-000				ELECTRODE, DUAL, IGNITION
10	1	SEE TABLE				BURNER CAN
11	1	817-01743-000				SCANNER ASSEMBLY - UV
15	1	851-00026-000				SIGHT GLASS, PYREX
16	2	853-00213-000				SIGHT GLASS GASKET
17	2	853-09355-000				BURNER GASKET

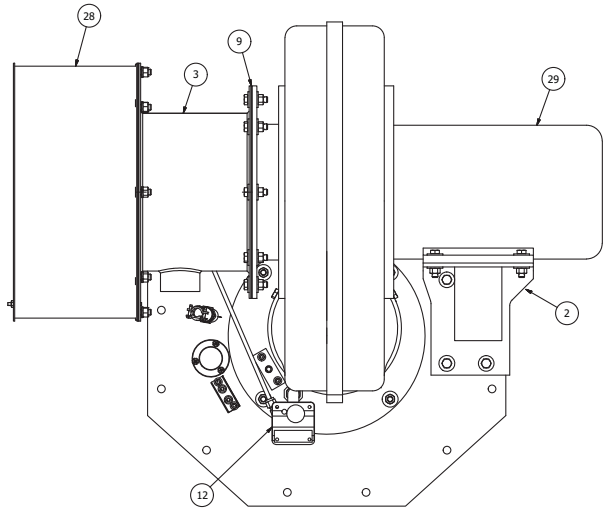
ITEM 10 BURNER CANISTER				
2000-2500	3000-3500	4000-4500	5000	6000
380-01154-000	380-01131-000	380-01155-000	380-01159-000	380-01132-000



2000-3000

ITEM	QTY	2000	2500	3000	DESCRIPTION
2	1	008-09852-000	008-09623-000	008-09710-000	BRACKET, SUPPORT
3	1	048-00811-000			VENTURI
4	1	059-11174-000	059-11175-000		PLATE, ADAPTER
10	1	380-01121-000		380-01121-000	GASKET, BLOWER INLET
12	1	817-03468-000			COMB. AIR PROVING SW.
17	1	853-01476-000			O-RING
34	1	880-02502-000			KIT, AIR FILTER
35	1	SEE TABLE			BLOWER, COMB. AIR

ITEM 35 COMBUSTION AIR BLOWER		
2000	2500	3000
894-05702-000	894-05558-000	894-05780-000



3500-6000

ITEM	QTY	3500-4000	4500-6000	DESCRIPTION
2	1	SEE TABLE		BRACKET, SUPPORT, MOTOR
3	1	SEE TABLE		VENTURI ASSEMBLY
9	1	380-01129-000		GASKET, BLOWER INLET
12	1	817-03468-000		COMBUSTION AIR PROVING SWITCH
28	1	880-06273-000	880-06272-000	KIT, AIR FILTER
29	1	SEE TABLE		BLOWER, COMBUSTION AIR

ITEM 2 MOTOR SUPPORT BRACKET				
3500	4000	4500	5000	6000
008-09710-000	008-09624-000	008-09849-000	008-09624-000	008-09711-000

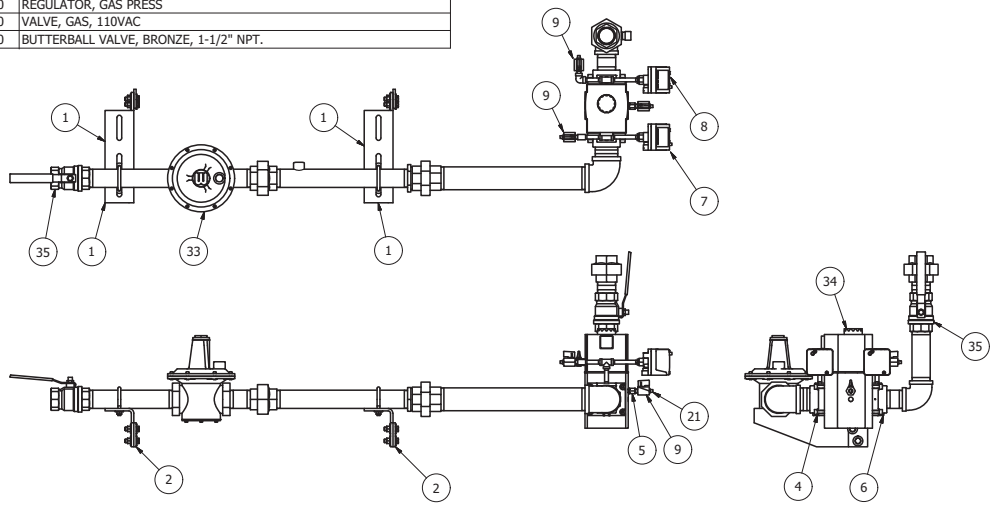
ITEM 3 VENTURI		
3500	4000	4500-6000
048-00895-000	048-00899-000	048-00897-000

ITEM 29 COMBUSTION AIR BLOWER				
3500	4000	4500	5000	6000
894-05722-000	894-05682-000	894-05675-000	894-05682-000	894-05562-000

7.2 - Gas Train

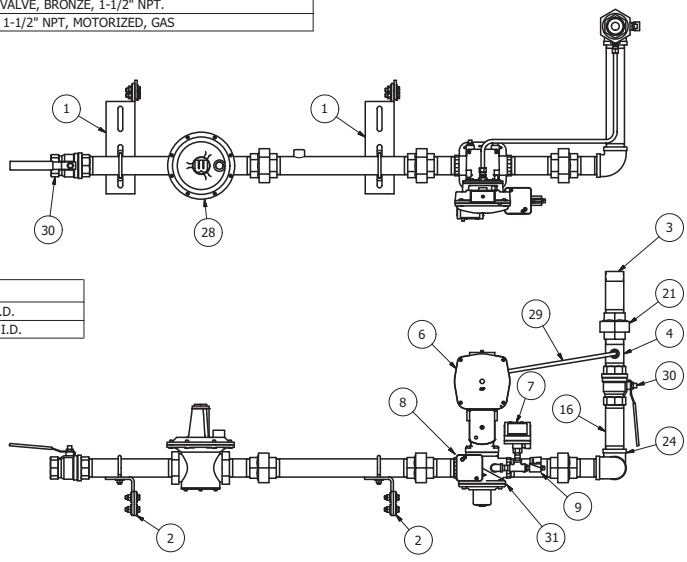
ITEM	QTY	PART NO	DESCRIPTION
1	2	008-02352-000	BRACKET, GAS TRAIN
2	2	008-03333-000	BRACKET, M5 BASE RAIL STUB
4	1	800-00102-000	ADAPTER, PIPE, 2" NPT. WITHOUT SHUTTER
5	1	800-00103-000	ADAPTER, 1/8 BSPT (MALE) x 1/8" NPT (FEMALE)
6	1	800-00104-000	ADAPTER, PIPE, 1-1/2" NPT. WITH SHUTTER, O-RING AND SCREWS
7	1	817-02416-000	LGPS, 3-21"WC RANGE, MR, 1/4" NPT MOUNT
8	1	817-02420-000	PRESSURE SWITCH, 3-21"WC RANGE, MR, 1/4" NPT MOUNT
9	3	825-00239-000	LEAKAGE TEST COCK, 1/8" NPT.
33	1	918-00540-000	REGULATOR, GAS PRESS
34	1	940-07482-000	VALVE, GAS, 110VAC
35	2	941-01946-000	BUTTERBALL VALVE, BRONZE, 1-1/2" NPT.

2000-3000



ITEM	QTY	PART NO	DESCRIPTION
1	2	008-02352-000	BRACKET, GAS TRAIN
2	2	008-03333-000	BRACKET, M5 BASE RAIL STUB
3	1	SEE TABLE	ORIFICE
6	1	797-07871-000	ACTUATOR, SIEMENS SKP75.011U1
7	1	817-02417-000	HGPS, 12-60"WC RANGE, MR, 1/4" NPT MOUNT
8	1	817-02418-000	LGPS, 12-60"WC RANGE, MR, 1/4" NPT MOUNT
9	1	825-00239-000	LEAKAGE TEST COCK, 1/8" NPT.
28	1	918-00540-000	REGULATOR, GAS PRESS
29	1	939-00413-000	TUBING, ALUMINUM, 3/8" O.D. x .035" WALL x 25-3/4" LG.
30	2	941-01946-000	BUTTERBALL VALVE, BRONZE, 1-1/2" NPT.
31	1	949-00461-000	VALVE BODY, 1-1/2" NPT, MOTORIZED, GAS

3500-5000

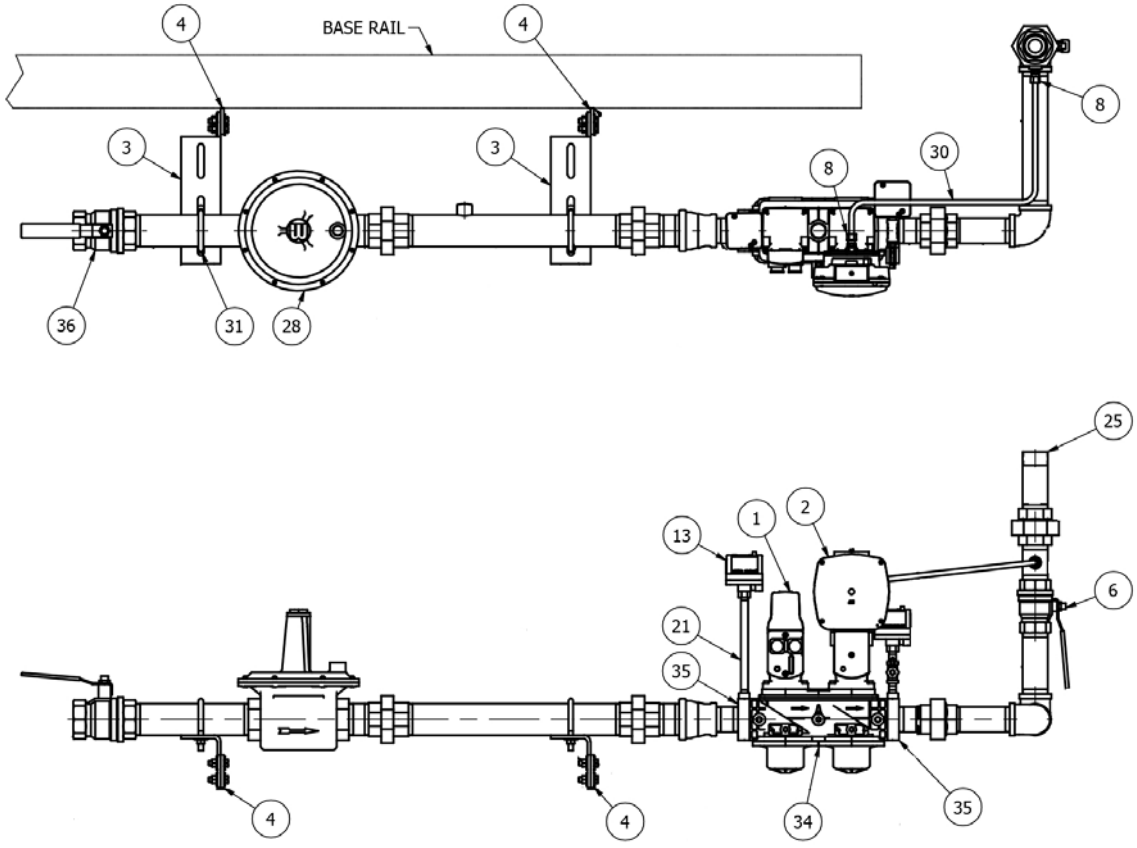


BOILER SIZE	ITEM 3	DESCRIPTION
3500-4000	048-00896-000	ORIFICE, 0.81" I.D.
4500-5000	048-00906-000	ORIFICE, 0.935" I.D.

(*Gas Train* continued)

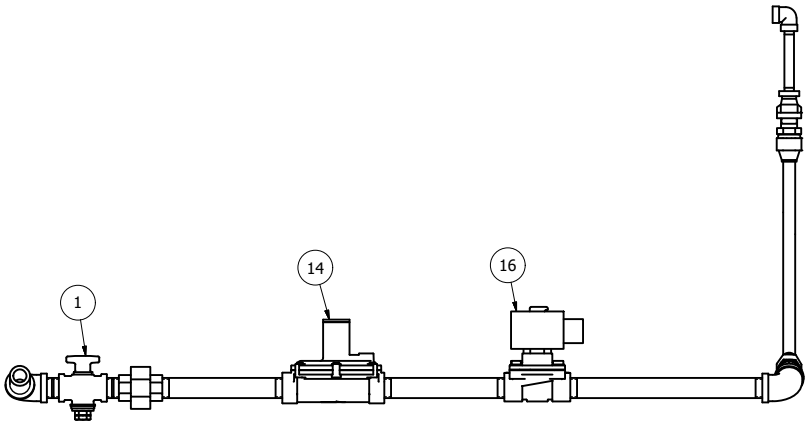
ITEM	QTY	PART NO	DESCRIPTION
1	1	945-00236-000	ACTUATOR, GAS VALVE, W/ POC
2	1	797-07943-000	ACTUATOR
3	2	008-02352-000	BRACKET, GAS TRAIN
4	2	008-03333-000	BRACKET, M5 BASE RAIL STUB
8	2	845-00022-000	CONNECTOR, COMP, BRASS
11	1	817-02417-000	HGPS
12	2	825-00239-000	LEAKAGE TEST COCK, 1/8" NPT.
13	1	817-02418-000	LGPS
25	1	048-00898-000	ORIFICE, 1.065" I.D.
28	1	918-00653-000	REGULATOR, GAS PRESSURE
30	1	939-00413-000	TUBING, ALUMINUM
31	2	841-01135-000	U-BOLT, 2" PIPE SIZE
34	1	949-00447-000	VALVE BODY, GAS, 1-1/2"
35	2	849-01585-000	VALVE END, THREADED, 1-1/2" NPT
36	1	941-01947-000	VALVE, BUTTERBALL, 2" NPT.

6000

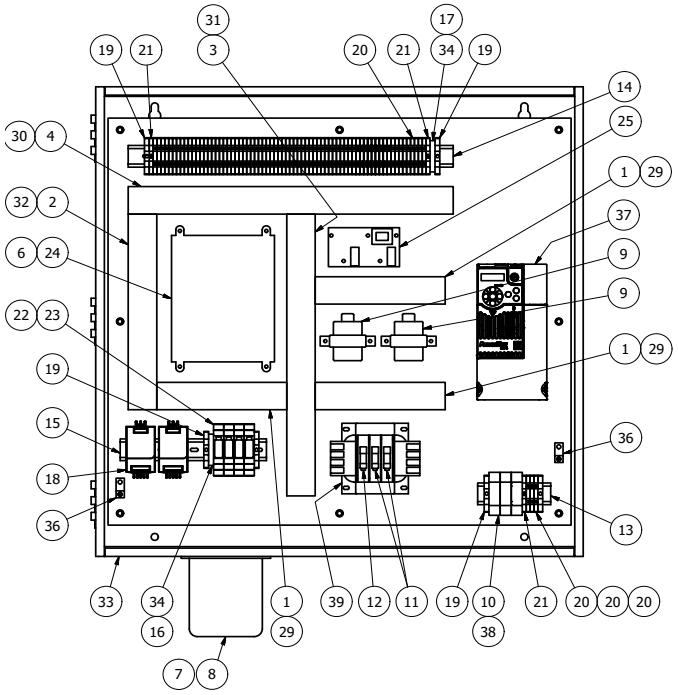


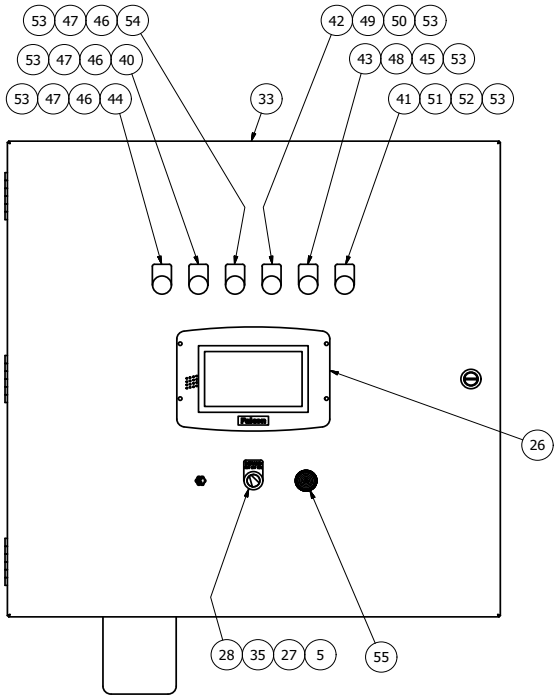
7.3 - Pilot Train

ITEM	QTY	PART NO	DESCRIPTION
1	1	825-00178-000	COCK, GAS SERVICE, TEE HEAD, 1/2" NPT, BRONZE
14	1	918-00356-000	REGULATOR, GAS PRESSURE, 1/2" NPT, 2-6" WC
16	1	948-00197-000	VALVE, SOLENOID,1/2" NPT, NC, 0-50PSI



7.4 - Control Panel, Falcon Steam





ITEM	QTY	PART NO.	DESCRIPTION
1	3	019-01345-000	COVER, 1-1/2" W X 8" LG DUCT
2	1	019-01345-000	COVER, 1-1/2" W X 12-1/2" LG DUCT
3	1	019-01345-000	COVER, 1-1/2" W X 18" LG DUCT
4	1	019-01345-000	COVER, 1-1/2" W X 20" LG DUCT
5	1	118-03922-000	NAME PLATE, DEMAND REM-OFF-LOC
6	1	826-00211-000	CABLE, UV SCANNER
7	2	826-00344-000	CABLE, IGNITION
8	1	832-00118-000	TRANSFORMER,IGNITION,115V PRI,10000V SEC,60 HZ
9	2	832-00235-000	TRANSFORMER, 115v/25v
10	1	832-01188-000	FUSE BLOCK, THREE POLE
11	2	SEE TABLE	FUSE, (PRIMARY)
12	1	SEE TABLE	FUSE, (SECONDARY)
13	1	832-01951-000	DIN MOUNTING RAIL, 4-1/2" LG.
14	1	832-01951-000	DIN MOUNTING RAIL, 20" LG.
15	1	832-01951-000	DIN MOUNTING RAIL, 9" LG.
16	1	832-02045-000	FUSE, 1 AMP, 5x20mm
17	1	832-02051-000	FUSE, 2 AMP, 5x20mm
18	2	832-02179-000	POWER SUPPLY, 10-12 VDC OUTPUT, 3.0 A, 115 VAC
19	6	832-02248-000	RETAINING END ANCHOR
20	73	832-02326-000	TERMINAL BLOCK
21	3	832-02328-000	TERMINAL, GROUNDING
22	4	833-03532-000	ELECTRICAL-RELAY, DPDT,115VAC COIL
23	4	833-03534-000	BASE,RELAY,8-PIN,DIN RAIL MOUNTING
24	1	833-10725-000	CONTROLLER, BOILER, STEAM
25	1	833-04095-000	CONTROLLER, RELAY, LOW LEVEL, HWA/ALWCO
26	1	833-05105-000	DISPLAY, SYSTEM INTERFACE
27	4	836-01136-000	CONTACT BLOCK
28	1	836-01148-000	SWITCH, SELECTOR, 3 POSITION
29	3	848-00797-000	WIRING DUCT, 1-1/2" W X 2" H X 8" LG.
30	1	848-00797-000	WIRING DUCT, 1-1/2" W X 2" H X 20" LG.
31	1	848-00797-000	WIRING DUCT, 1-1/2" W X 2" H X 18" LG.
32	1	848-00797-000	WIRING DUCT, 1-1/2" W X 2" H X 12-1/2" LG.
33	1	848-01093-000	CABINET, NEMA 1, 30"H X 30"W X 8-5/8"D, W/SUB-PANEL
34	2	848-01321-000	FUSE BLOCK, SINGLE POLE
35	1	881-00348-000	LATCH, PLASTIC
36	2	884-00078-000	TERMINAL, SCRULUG, #14 THRU #4 AWG
37	1	SEE TABLE	CONTROLLER, VSD
38	3	SEE TABLE	FUSE, (BLOWER)
39	1	SEE TABLE	TRANSFORMER, 500VA (CCT)

CCT SELECTION			
MODEL	ITEM #11	ITEM #12	ITEM #39
208V	832-01810-000	832-01908-000	832-01801-000
240V	832-01810-000	832-01908-000	832-01802-000
380V	832-01809-000	832-01908-000	832-01910-000
480V	832-01808-000	832-01908-000	832-01802-000
575V	832-01805-000	832-01908-000	832-01911-000

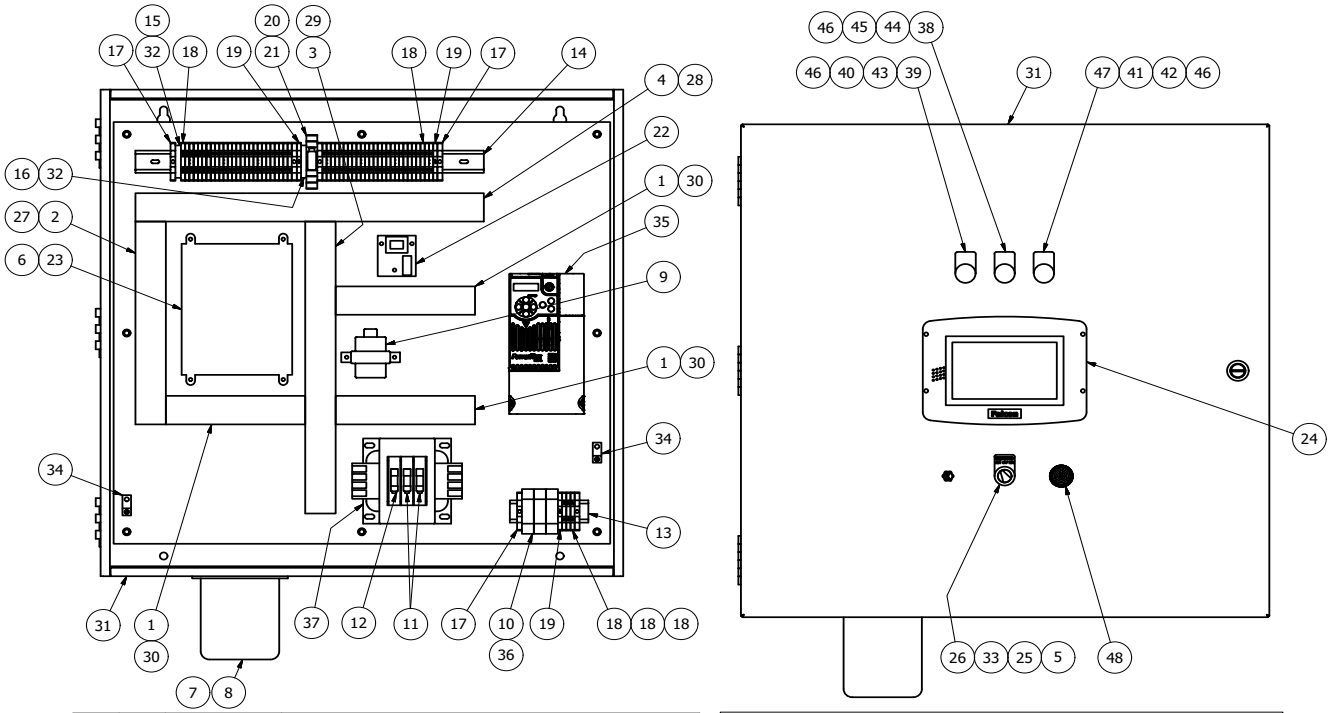
LIGHT PACKAGE/ALARM HORN OPTION			
ITEM	QTY	PART NO.	DESCRIPTION
40	1	118-03922-000	NAME PLATE, HIGH STEAM PRESSURE
41	1	118-03922-000	NAME PLATE, POWER ON
42	1	118-03922-000	NAME PLATE, LOW WATER
43	1	118-03922-000	NAME PLATE, FUEL VALVE
44	1	118-03922-000	NAME PLATE, HIGH WATER
45	1	881-00349-000	LED LIGHT MODULE, GREEN
46	3	881-00350-000	PILOT LIGHT, RED
47	3	881-00351-000	LED LIGHT MODULE, RED
48	1	881-00352-000	PILOT LIGHT, GREEN
49	1	881-00353-000	PILOT LIGHT, AMBER
50	1	881-00354-000	LED LIGHT MODULE, AMBER
51	1	881-00357-000	PILOT LIGHT, WHITE
52	1	881-00358-000	LED LIGHT MODULE, WHITE
53	6	881-00348-000	LATCH, PLASTIC
54	1	118-03922-000	NAME PLATE, ALARM
55	1	817-03571-000	ALARM HORN

VSD SELECTION (208/240 VAC)			
MODEL	MOTOR HP	ITEM #37	ITEM #38 FUSE (AMPS)
2000	2	833-10726-000	15/12
2500	2	833-10726-000	15/12
3000	3	833-10727-000	20/17.5
3500	3	833-10727-000	20/17.5
4000	5	833-10728-000	25
4500	5	833-10728-000	25
5000	5	833-10728-000	25
6000	7.5	833-10729-000	35

VSD SELECTION (380/480 VAC)			
MODEL	MOTOR HP	ITEM #37	ITEM #38 FUSE (AMPS)
2000	2	833-10721-000	7/6
2500	2	833-10721-000	7/6
3000	3	833-10722-000	10/9
3500	3	833-10722-000	10/9
4000	5	833-10723-000	15/12
4500	5	833-10723-000	15/12
5000	5	833-10723-000	15/12
6000	7.5	833-10724-000	20

VSD SELECTION (575/600 VAC)			
MODEL	MOTOR HP	ITEM #37	ITEM #38 FUSE (AMPS)
2000	2	833-10720-000	5
2500	2	833-10720-000	5
3000	3	833-10719-000	7
3500	3	833-10719-000	7
4000	5	833-10678-000	10
4500	5	833-10678-000	10
5000	5	833-10678-000	10
6000	7.5	833-10679-000	15

7.5 - Control Panel, Falcon Hot Water



ITEM	QTY	PART NO.	DESCRIPTION
1	3	019-01345-000	COVER, 1-1/2" W X 8" LG DUCT
2	1	019-01345-000	COVER, 1-1/2" W X 12-1/2" LG DUCT
3	1	019-01345-000	COVER, 1-1/2" W X 18" LG DUCT
4	1	019-01345-000	COVER, 1-1/2" W X 20" LG DUCT
5	1	118-03922-000	NAME PLATE, DEMAND REM-OFF-LOC
6	1	826-00211-000	CABLE, UV SCANNER
7	2	826-00344-000	CABLE, IGNITION
8	1	832-00118-000	TRANSFORMER,IGNITION,115V PRI,10000V SEC,60 HZ
9	1	832-00235-000	TRANSFORMER, 115v/25v
10	1	832-01188-000	FUSE BLOCK, THREE POLE
11	2	SEE TABLE	FUSE, (PRIMARY)
12	1	SEE TABLE	FUSE, (SECONDARY)
13	1	832-01951-000	DIN MOUNTING RAIL, 4-1/2" LG.
14	1	832-01951-000	DIN MOUNTING RAIL, 20" LG.
15	1	832-02045-000	FUSE, 1 AMP, 5x20mm
16	1	832-02051-000	FUSE, 2 AMP, 5x20mm
17	6	832-02248-000	RETAINING END ANCHOR
18	55	832-02326-000	TERMINAL BLOCK
19	3	832-02328-000	TERMINAL, GROUNDING
20	1	833-03532-000	ELECTRICAL-RELAY, DPDT,115VAC COIL
21	1	833-03534-000	BASE,RELAY,8-PIN,DIN RAIL MOUNTING
22	1	833-03547-000	CONTROLLER, LWCO
23	1	833-04097-000	FALCON CONTROLLER, HYDRONIC
24	1	833-05105-000	DISPLAY, SYSTEM INTERFACE
25	4	836-01136-000	CONTACT BLOCK
26	1	836-01148-000	SWITCH, SELECTOR, 3 POSITION
27	1	848-00797-000	WIRING DUCT, 1-1/2" W X 2" H X 12-1/2" LG.
28	1	848-00797-000	WIRING DUCT, 1-1/2" W X 2" H X 20" LG.
29	1	848-00797-000	WIRING DUCT, 1-1/2" W X 2" H X 18" LG.
30	3	848-00797-000	WIRING DUCT, 1-1/2" W X 2" H X 8" LG.
31	1	848-01093-000	CABINET, NEMA 1, 30"H X 30"W X 8-5/8"D, W/SUB-PANEL
32	2	848-01321-000	FUSE BLOCK, SINGLE POLE
33	1	881-00348-000	LATCH, PLASTIC
34	2	884-00078-000	TERMINAL, SCRULUG, #14 THRU #4 AWG
35	1	SEE TABLE	CONTROLLER, VSD
36	3	SEE TABLE	FUSE, (BLOWER)
37	1	SEE TABLE	TRANSFORMER, 1000VA (CCT)

CCT SELECTION			
MODEL	ITEM #11	ITEM #12	ITEM #37
208V	832-01815-000	832-01817-000	832-01912-000
240V	832-01815-000	832-01817-000	832-01803-000
380V	832-01878-000	832-01817-000	832-01913-000
480V	832-01809-000	832-01817-000	832-01803-000
575V	832-01811-000	832-01817-000	832-01914-000

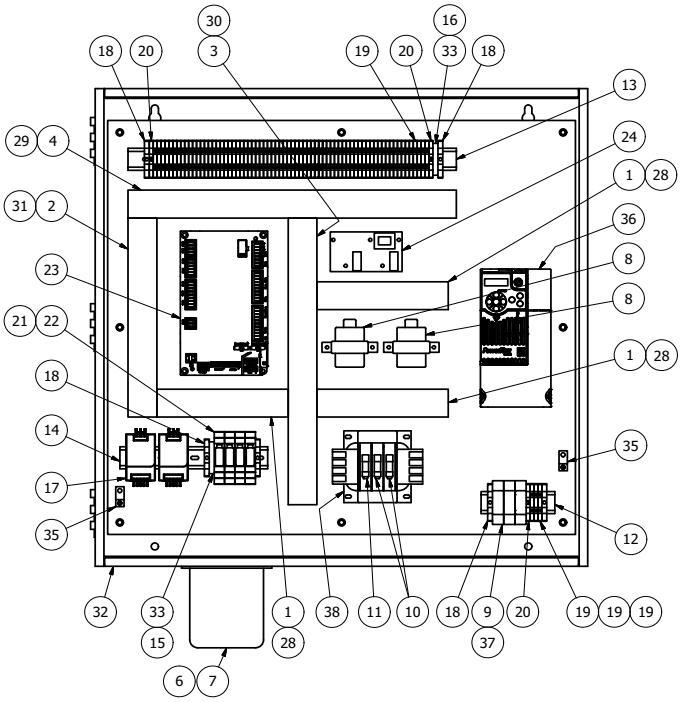
LIGHT PACKAGE/ALARM HORN OPTION			
ITEM	QTY	PART NO.	DESCRIPTION
38	1	118-03922-000	NAME PLATE, POWER ON
39	1	118-03922-000	NAME PLATE, FUEL VALVE
40	1	881-00349-000	LED LIGHT MODULE, GREEN
41	1	881-00350-000	PILOT LIGHT, RED
42	1	881-00351-000	LED LIGHT MODULE, RED
43	1	881-00352-000	PILOT LIGHT, GREEN
44	1	881-00357-000	PILOT LIGHT, WHITE
45	1	881-00358-000	LED LIGHT MODULE, WHITE
46	3	881-00348-000	LATCH, PLASTIC
47	1	118-03922-000	NAME PLATE, ALARM
48	1	817-03571-000	ALARM HORN

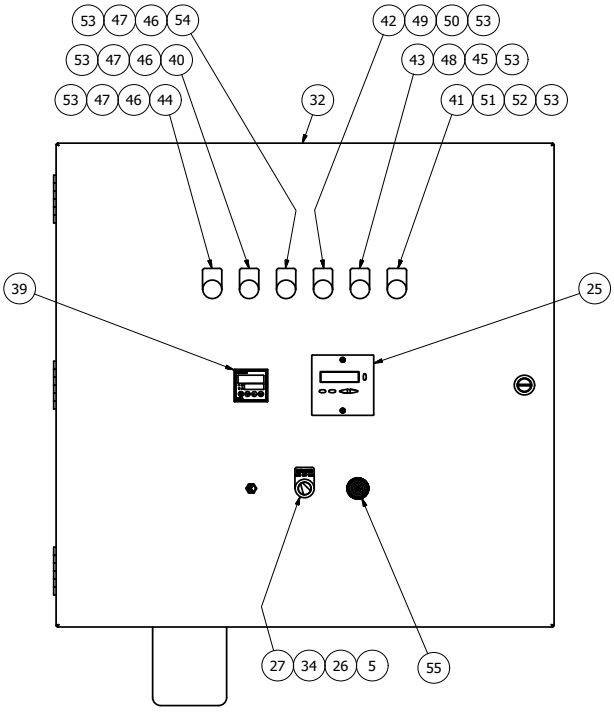
VSD SELECTION (208V/240V)			
MODEL	MOTOR HP	ITEM #35	ITEM #36 FUSE (AMPS)
2000	2	833-10726-000	15/12
2500	2	833-10726-000	15/12
3000	3	833-10727-000	20/17.5
3500	3	833-10727-000	20/17.5
4000	5	833-10728-000	25
4500	5	833-10728-000	25
5000	5	833-10728-000	25
6000	7.5	833-10729-000	35

VSD SELECTION (380V/480V)			
MODEL	MOTOR HP	ITEM #35	ITEM #36 FUSE (AMPS)
2000	2	833-10721-000	7/6
2500	2	833-10721-000	7/6
3000	3	833-10722-000	10/9
3500	3	833-10722-000	10/9
4000	5	833-10723-000	15/12
4500	5	833-10723-000	15/12
5000	5	833-10723-000	15/12
6000	7.5	833-10724-000	20

VSD SELECTION (575V/600V)			
MODEL	MOTOR HP	ITEM #35	ITEM #36 FUSE (AMPS)
2000	2	833-10720-000	5
2500	2	833-10720-000	5
3000	3	833-10719-000	7
3500	3	833-10719-000	7
4000	5	833-10678-000	10
4500	5	833-10678-000	10
5000	5	833-10678-000	10
6000	7.5	833-10679-000	15

7.6 - Control Panel, LMV Steam





ITEM	QTY	PART NO.	DESCRIPTION
1	3	019-01345-000	COVER, 1-1/2" W X 8" LG DUCT
2	1	019-01345-000	COVER, 1-1/2" W X 12-1/2" LG DUCT
3	1	019-01345-000	COVER, 1-1/2" W X 18" LG DUCT
4	1	019-01345-000	COVER, 1-1/2" W X 20" LG DUCT
5	1	118-03922-000	NAME PLATE, DEMAND REM-OFF-LOC
6	2	826-00344-000	CABLE, IGNITION
7	1	832-00118-000	TRANSFORMER,IGNITION,115V PRI,10000V SEC,60 HZ
8	2	832-00235-000	TRANSFORMER, 115v/25v
9	1	832-01188-000	FUSE BLOCK, THREE POLE
10	2	SEE TABLE	FUSE, (PRIMARY)
11	1	SEE TABLE	FUSE, (SECONDARY)
12	1	832-01951-000	DIN MOUNTING RAIL, 4-1/2" LG.
13	1	832-01951-000	DIN MOUNTING RAIL, 20" LG.
14	1	832-01951-000	DIN MOUNTING RAIL, 9" LG.
15	1	832-02045-000	FUSE, 1 AMP, 5x20mm
16	1	832-02051-000	FUSE, 2 AMP, 5x20mm
17	2	832-02179-000	POWER SUPPLY, 10-12 VDC OUTPUT, 3.0 A, 115 VAC
18	6	832-02248-000	RETAINING END ANCHOR
19	73	832-02326-000	TERMINAL BLOCK
20	3	832-02328-000	TERMINAL, GROUNDING
21	4	833-03532-000	ELECTRICAL-RELAY, DPDT,115VAC COIL
22	4	833-03534-000	BASE,RELAY,8-PIN,DIN RAIL MOUNTING
23	1	833-09334-000	CONTROLLER, SIEMENS LMV37
24	1	833-04095-000	CONTROLLER, RELAY, LOW LEVEL, HWA/ALWCO
25	1	833-05450-000	CONTROLLER, PROGRAM DISPLAY, SIEMENS #AZL23.00x9
26	4	836-01136-000	CONTACT BLOCK
27	1	836-01148-000	SWITCH, SELECTOR, 3 POSITION
28	3	848-00797-000	WIRING DUCT, 1-1/2" W X 2" H X 8" LG.
29	1	848-00797-000	WIRING DUCT, 1-1/2" W X 2" H X 20" LG.
30	1	848-00797-000	WIRING DUCT, 1-1/2" W X 2" H X 18" LG.
31	1	848-00797-000	WIRING DUCT, 1-1/2" W X 2" H X 12-1/2" LG.
32	1	848-01093-000	CABINET, NEMA 1, 30"H X 30"W X 8-5/8"D, W/SUB-PANEL
33	2	848-01321-000	FUSE BLOCK, SINGLE POLE
34	1	881-00348-000	LATCH, PLASTIC
35	2	884-00078-000	TERMINAL, SCRULUG, #14 THRU #4 AWG
36	1	SEE TABLE	CONTROLLER, VSD
37	3	SEE TABLE	FUSE, (BLOWER)
38	1	SEE TABLE	TRANSFORMER, 500VA (CCT)
39	1	817-05288-000	CONTROLLER, SIEMENS RWF50.30A9

CCT SELECTION			
MODEL	ITEM #10	ITEM #11	ITEM #38
208V	832-01810-000	832-01908-000	832-01801-000
240V	832-01810-000	832-01908-000	832-01802-000
380V	832-01809-000	832-01908-000	832-01910-000
480V	832-01808-000	832-01908-000	832-01802-000
575V	832-01805-000	832-01908-000	832-01911-000

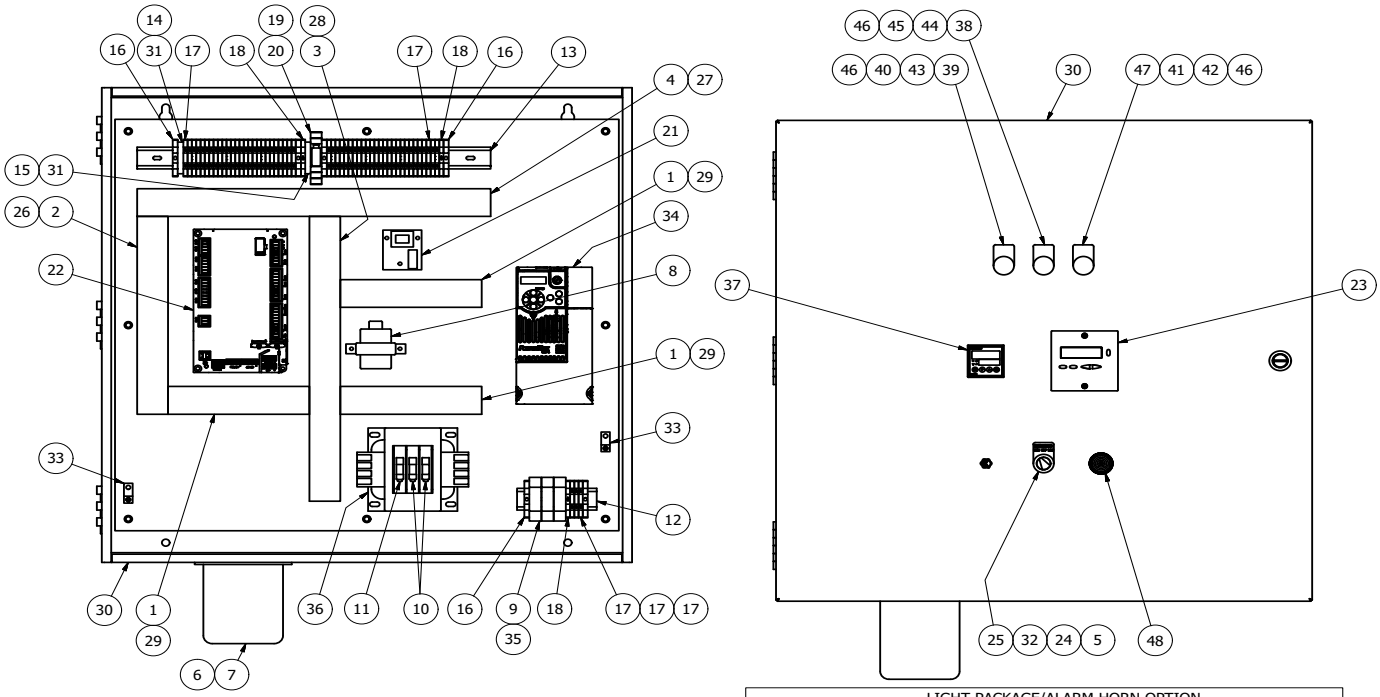
LIGHT PACKAGE/ALARM HORN OPTION			
ITEM	QTY	PART NO.	DESCRIPTION
40	1	118-03922-000	NAME PLATE, HIGH STEAM PRESSURE
41	1	118-03922-000	NAME PLATE, POWER ON
42	1	118-03922-000	NAME PLATE, LOW WATER
43	1	118-03922-000	NAME PLATE, FUEL VALVE
44	1	118-03922-000	NAME PLATE, HIGH WATER
45	1	881-00349-000	LED LIGHT MODULE, GREEN
46	3	881-00350-000	PILOT LIGHT, RED
47	3	881-00351-000	LED LIGHT MODULE, RED
48	1	881-00352-000	PILOT LIGHT, GREEN
49	1	881-00353-000	PILOT LIGHT, AMBER
50	1	881-00354-000	LED LIGHT MODULE, AMBER
51	1	881-00357-000	PILOT LIGHT, WHITE
52	1	881-00358-000	LED LIGHT MODULE, WHITE
53	6	881-00348-000	LATCH, PLASTIC
54	1	118-03922-000	NAME PLATE, ALARM
55	1	817-03571-000	ALARM HORN

VSD SELECTION (208/240 VAC)			
MODEL	MOTOR HP	ITEM #36	ITEM #37 FUSE (AMPS)
2000	2	833-10726-000	15/12
2500	2	833-10726-000	15/12
3000	3	833-10727-000	20/17.5
3500	3	833-10727-000	20/17.5
4000	5	833-10728-000	25
4500	5	833-10728-000	25
5000	5	833-10728-000	25
6000	7.5	833-10729-000	35

VSD SELECTION (380/480 VAC)			
MODEL	MOTOR HP	ITEM #36	ITEM #37 FUSE (AMPS)
2000	2	833-10721-000	7/6
2500	2	833-10721-000	7/6
3000	3	833-10722-000	10/9
3500	3	833-10722-000	10/9
4000	5	833-10723-000	15/12
4500	5	833-10723-000	15/12
5000	5	833-10723-000	15/12
6000	7.5	833-10724-000	20

VSD SELECTION (575/600 VAC)			
MODEL	MOTOR HP	ITEM #37	ITEM #37 FUSE (AMPS)
2000	2	833-10720-000	5
2500	2	833-10720-000	5
3000	3	833-10719-000	7
3500	3	833-10719-000	7
4000	5	833-10678-000	10
4500	5	833-10678-000	10
5000	5	833-10678-000	10
6000	7.5	833-10679-000	15

7.7 - Control Panel, LMV Hot Water



ITEM	QTY	PART NO.	DESCRIPTION
1	3	019-01345-000	COVER, 1-1/2" W X 8" LG DUCT
2	1	019-01345-000	COVER, 1-1/2" W X 12-1/2" LG DUCT
3	1	019-01345-000	COVER, 1-1/2" W X 18" LG DUCT
4	1	019-01345-000	COVER, 1-1/2" W X 20" LG DUCT
5	1	118-03922-000	NAME PLATE, DEMAND REM-OFF-LOC
6	2	826-00344-000	CABLE, IGNITION
7	1	832-00118-000	TRANSFORMER,IGNITION,115V PRI,10000V SEC,60 HZ
8	1	832-00235-000	TRANSFORMER, 115v/25v
9	1	832-01188-000	FUSE BLOCK, THREE POLE
10	2	SEE TABLE	FUSE, (PRIMARY)
11	1	SEE TABLE	FUSE, (SECONDARY)
12	1	832-01951-000	DIN MOUNTING RAIL, 4-1/2" LG.
13	1	832-01951-000	DIN MOUNTING RAIL, 20" LG.
14	1	832-02045-000	FUSE, 1 AMP, 5x20mm
15	1	832-02051-000	FUSE, 2 AMP, 5x20mm
16	6	832-02248-000	RETAINING END ANCHOR
17	55	832-02326-000	TERMINAL BLOCK
18	3	832-02328-000	TERMINAL, GROUNDING
19	1	833-03532-000	ELECTRICAL-RELAY, DPDT,115VAC COIL
20	1	833-03534-000	BASE,RELAY,8-PIN,DIN RAIL MOUNTING
21	1	833-03547-000	CONTROLLER, LWCO
22	1	833-09334-000	CONTROLLER, SIEMENS LMV37
23	1	833-05450-000	CONTROLLER, PROGRAM DISPLAY, SIEMENS #AZL23.00x9
24	4	836-01136-000	CONTACT BLOCK
25	1	836-01148-000	SWITCH, SELECTOR, 3 POSITION
26	1	848-00797-000	WIRING DUCT, 1-1/2" W X 2" H X 12-1/2" LG.
27	1	848-00797-000	WIRING DUCT, 1-1/2" W X 2" H X 20" LG.
28	1	848-00797-000	WIRING DUCT, 1-1/2" W X 2" H X 18" LG.
29	3	848-00797-000	WIRING DUCT, 1-1/2" W X 2" H X 8" LG.
30	1	848-01093-000	CABINET, NEMA 1, 30"H X 30"W X 8-5/8"D, W/SUB-PANEL
31	2	848-01321-000	FUSE BLOCK, SINGLE POLE
32	1	881-00348-000	LATCH, PLASTIC
33	2	884-00078-000	TERMINAL, SCRULUG, #14 THRU #4 AWG
34	1	SEE TABLE	CONTROLLER, VSD
35	3	SEE TABLE	FUSE, (BLOWER)
36	1	SEE TABLE	TRANSFORMER, 1000VA (CCT)
37	1	817-05288-000	CONTROLLER, SIEMENS RWF50.30A9

CCT SELECTION			
MODEL	ITEM #10	ITEM #11	ITEM #36
208V	832-01815-000	832-01817-000	832-01912-000
240V	832-01815-000	832-01817-000	832-01803-000
380V	832-01878-000	832-01817-000	832-01913-000
480V	832-01809-000	832-01817-000	832-01803-000
575V	832-01811-000	832-01817-000	832-01914-000

LIGHT PACKAGE/ALARM HORN OPTION			
ITEM	QTY	PART NO.	DESCRIPTION
38	1	118-03922-000	NAME PLATE, POWER ON
39	1	118-03922-000	NAME PLATE, FUEL VALVE
40	1	881-00349-000	LED LIGHT MODULE, GREEN
41	1	881-00350-000	PILOT LIGHT, RED
42	1	881-00351-000	LED LIGHT MODULE, RED
43	1	881-00352-000	PILOT LIGHT, GREEN
44	1	881-00357-000	PILOT LIGHT, WHITE
45	1	881-00358-000	LED LIGHT MODULE, WHITE
46	3	881-00348-000	LATCH, PLASTIC
47	1	118-03922-000	NAME PLATE, ALARM
48	1	817-03571-000	ALARM HORN

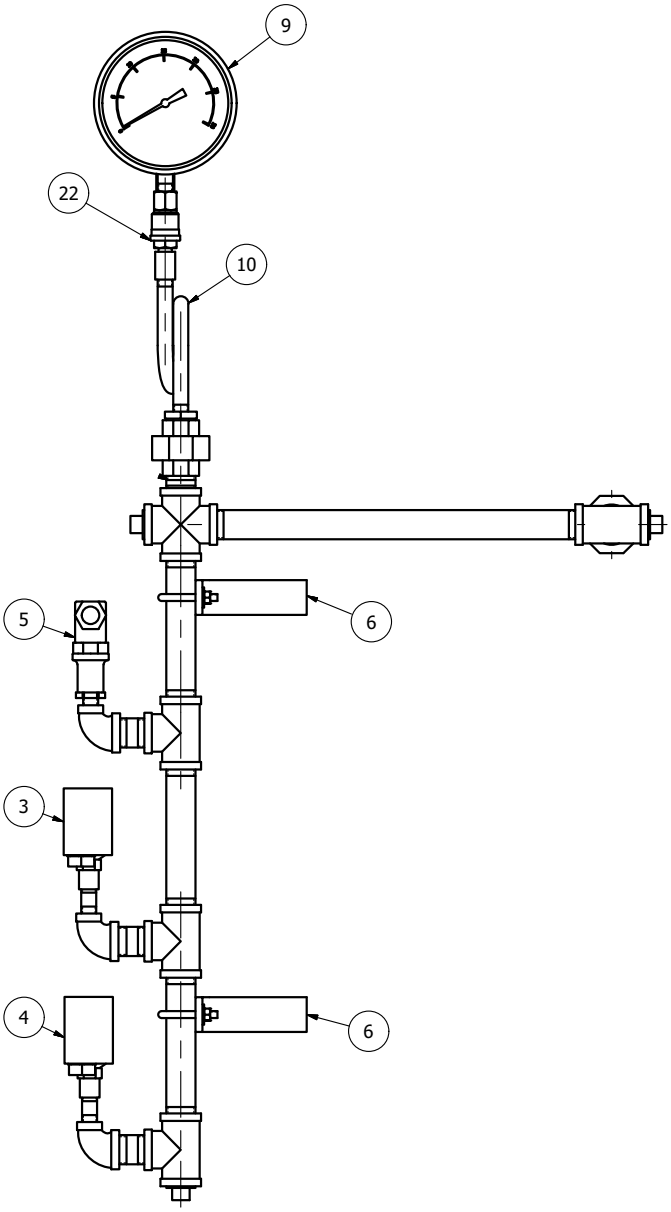
VSD SELECTION (208V/240V)			
MODEL	MOTOR HP	ITEM #34	ITEM #35 FUSE (AMPS)
2000	2	833-10726-000	15/12
2500	2	833-10726-000	15/12
3000	3	833-10727-000	20/17.5
3500	3	833-10727-000	20/17.5
4000	5	833-10728-000	25
4500	5	833-10728-000	25
5000	5	833-10728-000	25
6000	7.5	833-10729-000	35

VSD SELECTION (380V/480V)			
MODEL	MOTOR HP	ITEM #34	ITEM #35 FUSE (AMPS)
2000	2	833-10721-000	7/6
2500	2	833-10721-000	7/6
3000	3	833-10722-000	10/9
3500	3	833-10722-000	10/9
4000	5	833-10723-000	15/12
4500	5	833-10723-000	15/12
5000	5	833-10723-000	15/12
6000	7.5	833-10724-000	20

VSD SELECTION (575V/600V)			
MODEL	MOTOR HP	ITEM #34	ITEM #35 FUSE (AMPS)
2000	2	833-10720-000	5
2500	2	833-10720-000	5
3000	3	833-10719-000	7
3500	3	833-10719-000	7
4000	5	833-10678-000	10
4500	5	833-10678-000	10
5000	5	833-10678-000	10
6000	7.5	833-10679-000	15

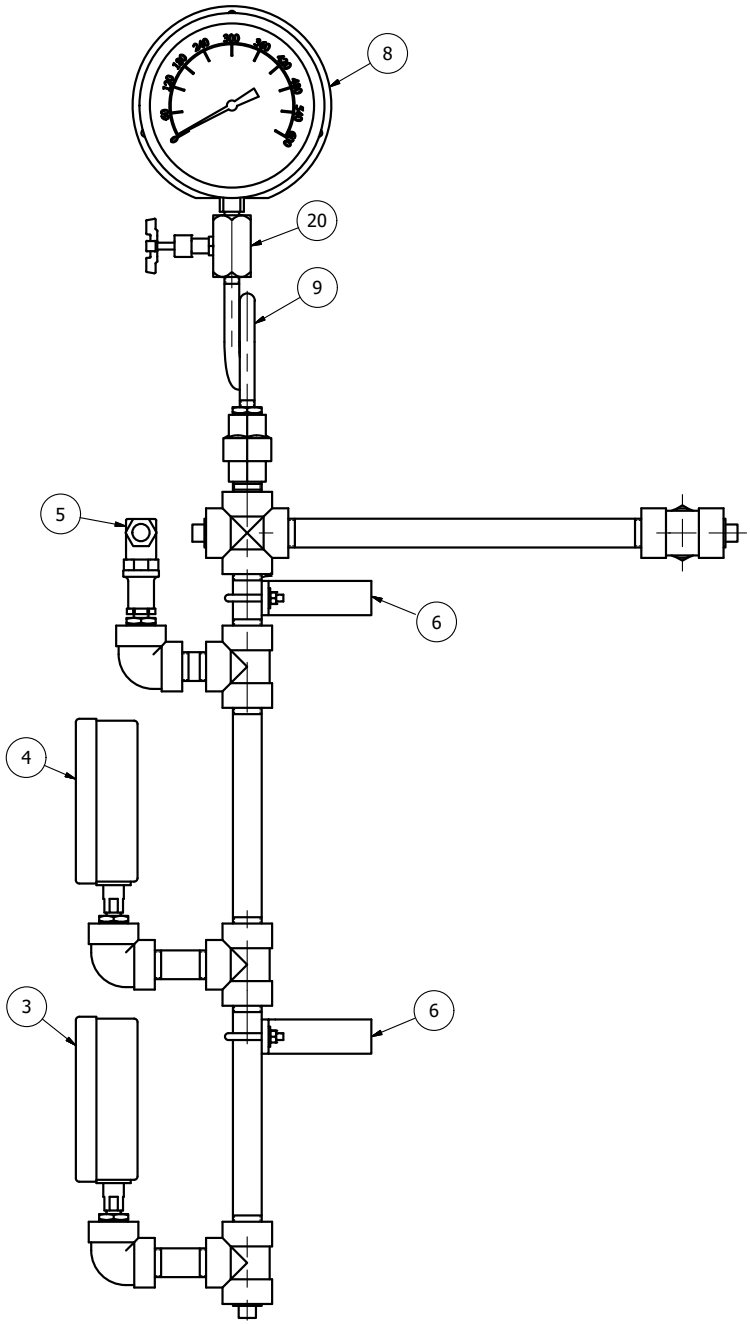
7.8 - Pressure Controls 15#/150#/250# Steam

ITEM	QTY	15 PSI	150PSI	250PSI	DESCRIPTION
3	1	817-04094-000	817-04092-000	817-04149-000	PRESSURE CONTROL, HIGH LIMIT
4	1	817-04095-000	817-04093-000	817-04147-000	PRESSURE CONTROL, OP. LIMIT
5	1	817-04841-000	832-03725-000	832-03845-000	PRESSURE TRANSMITTER
6	2	841-01120-000	841-01120-000	841-01120-000	U-BOLT, 3/4" PIPE
9	1	850-00119-000	850-00122-000	850-00400-000	GAUGE, PRES
10	1	854-00040-000	854-00040-000	854-00040-000	SIPHON, PIGTAIL, 1/4" NPT.
22	1	941-00055-000	941-00055-000	941-02656-000	VALVE, BALL



7.9 - Pressure Controls 350#/500# Steam

ITEM	QTY	250 PSI	500 PSI	DESCRIPTION
3	1	817-04173-000	817-04173-000	CONTROL, PRESSURE, OPERATING LIMIT
4	1	817-04174-000	817-04174-000	CONTROL, PRESSURE, HIGH LIMIT
5	1	832-03794-000	832-03794-000	PRESSURE TRANSMITTER
6	2	841-01120-000	841-01120-000	U-BOLT
8	1	850-00400-000	850-00952-000	GAUGE, PRESS.
9	1	854-00040-000	854-00040-000	SIPHON, PIGTAIL
20	1	941-00956-000	941-00956-000	VALVE, NEEDLE



APPENDIX A

Control Parameters - Falcon

Table A-1: Falcon Steam

Parameter Group	Parameter Name	Access*	Min Range	Default Setting	Max Range	Parameter Units	Modbus Register (dec)
System ID & Access	Burner name	User		BOILER 1		20 chars	183
System ID & Access	Installation data	Service		SERIAL NUMBER		20 chars	184
System ID & Access	OEM identification	Service		FALCON 833-1072		20 chars	185
System ID & Access	Service password	Read Only		9220		20 chars	190
Central Heat Configuration	CH enable	User		Disabled			208
Central Heat Configuration	CH demand switch	Service		B:STAT terminal			209
Central Heat Configuration	CH modulation sensor	Service		C:Modulation from Inlet S1 (J8-4) sensor			210
Central Heat Configuration	CH P gain	Service		10			216
Central Heat Configuration	CH I gain	Service		10			217
Central Heat Configuration	CH D gain	Service		0			218
Central Heat Configuration	CH hysteresis step time	Service		1m 0s		mmm ss	219
Central Heat Configuration	CH pressure setpoint	User	0	100	142.5	psig	220
Central Heat Configuration	CH pressure on hysteresis	Service		5		psig	221
Central Heat Configuration	CH pressure off hysteresis	Service		5		psig	222
Central Heat Configuration	CH TOD pressure setpoint	User		80		psig	542
Central Heat Configuration	CH setpoint source	Service		A:Local setpoint is used			578
Central Heat Configuration	CH modulation rate source	Service		A:Local modulation (PID) is used			580
Central Heat Configuration	CH has priority over LL	Service		No/False/Off			582
Central Heat Configuration	CH 4mA steam pressure	Service		0		psig	585
Central Heat Configuration	CH 20mA steam pressure	Service	0	135	150	psig	586
Central Heat Configuration	CH hot standby enable	User		Disabled			588
Modulation Configuration	Modulation output	OEM		C:Analog 4-20mA			192
Modulation Configuration	CH maximum modulation rate	Service		100%		% | RPM	193
Modulation Configuration	Minimum modulation rate	OEM		20%		% | RPM	195
Modulation Configuration	CH forced rate	Service		30%		% | RPM	199
Modulation Configuration	CH forced rate time	Service		0m 0s		mmm ss	200
Modulation Configuration	Firing rate control	User		B:Manual rate during Run			204
Modulation Configuration	Manual firing rate	User		20%		% | RPM	205
Modulation Configuration	Analog output hysteresis	Service		10		1 per 0.1C err	206
Modulation Configuration	CH slow start enable	Service		Disabled			477
Modulation Configuration	Slow start degrees	Service		20°F (11.1°C)			480
Modulation Configuration	Rate assigned to 0V/4mA (Min mod > 80%)	Service		100%		0 to 100%	534
Modulation Configuration	Analog input hysteresis	User		.2		mA (10ths OK)	543
Modulation Configuration	Analog rate tracking	Service		A:Analog rate tracking disabled			667
Pump Configuration	CH pump output	User		A:No pump assignment			272
Pump Configuration	CH pump control	User		A:Automatic pump control			273
Pump Configuration	CH pump overrun time	User		0m 0s		mmm ss	274
Pump Configuration	Boiler pump output	User		C:Pump assigned to terminal B			281
Pump Configuration	Boiler pump control	User		A:Automatic pump control			282
Pump Configuration	Boiler pump overrun time	User		3m 0s		mmm ss	283
Pump Configuration	Auxiliary 1 pump output	User		D:Pump assigned to terminal C			284
Pump Configuration	Auxiliary 1 pump control	User		A:Automatic pump control			285
Pump Configuration	System pump output	User		D:Pump assigned to terminal C			287
Pump Configuration	System pump control	User		A:Automatic pump control			288
Pump Configuration	System pump overrun time	User		15m 0s		mmm ss	289
Pump Configuration	Pump exercise interval	User		0		Days	290
Pump Configuration	Pump exercise time	User		0m 0s		mmm ss	291
Pump Configuration	CH pump start delay	User		0m 0s		mmm ss	292
Pump Configuration	Boiler pump start delay	User		0m 10s		mmm ss	293
Pump Configuration	System pump start delay	User		0m 0s		mmm ss	294
Pump Configuration	Auxiliary 1 pump start delay	User		0m 0s		mmm ss	295
Pump Configuration	CH pump options 1	User		0x0000			296
Pump Configuration	CH pump options 2	User		0x0000			297
Pump Configuration	Boiler pump options 1	User		0x0022			300
Pump Configuration	Boiler pump options 2	User		0x4004			301
Pump Configuration	System pump options 1	User		0x0220			302

Table A-1: Falcon Steam (Continued)

Parameter Group	Parameter Name	Access*	Min Range	Default Setting	Max Range	Parameter Units	Modbus Register (dec)
Pump Configuration	System pump options 2	User		0x8200			303
Pump Configuration	Auxiliary 1 pump overrun time	User		5m 30s		mmm ss	752
Pump Configuration	Auxiliary 1 pump options 1	User		0x0222			753
Pump Configuration	Auxiliary 1 pump options 2	User		0x4202			754
Pump Configuration	Auxiliary 2 pump output	User		B:Pump assigned to terminal A			755
Pump Configuration	Auxiliary 2 pump control	User		A:Automatic pump control			756
Pump Configuration	Auxiliary 2 pump start delay	User		0m 0s		mmm ss	757
Pump Configuration	Auxiliary 2 pump overrun time	User		3m 0s		mmm ss	758
Pump Configuration	Auxiliary 2 pump options 1	User		0x0003			759
Pump Configuration	Auxiliary 2 pump options 2	User		0x4202			760
Statistics Configuration	Burner cycle count	Read Only		0		Cycles	128
Statistics Configuration	Burner run time	Read Only		0		Hours	130
Statistics Configuration	CH pump cycle count	Service		0		Cycles	132
Statistics Configuration	System pump cycle count	Service		0		Cycles	136
Statistics Configuration	Boiler pump cycle count	Service		0		Cycles	138
Statistics Configuration	Auxiliary 1 pump cycle count	Service		0		Cycles	140
Statistics Configuration	Auxiliary 2 pump cycle count	Service		0		Cycles	146
Annunciation Configuration	Annunciation enable	Read Only		Enabled			304
Annunciation Configuration	Annunciator 1 location	Read Only		E:Other annunciation			306
Annunciation Configuration	Annunciator1 short name	Read Only		A1		3 chars	307
Annunciation Configuration	Annunciator 1 long name	Read Only		AIR SWITCH		20 chars	309
Annunciation Configuration	Annunciator 2 location	Service		C:LCI circuit			319
Annunciation Configuration	Annunciator2 short name	Service		A2		3 chars	320
Annunciation Configuration	Annunciator 2 long name	Service		LOW WATER		20 chars	322
Annunciation Configuration	Annunciator 3 location	OEM		D:Interlock circuit			332
Annunciation Configuration	Annunciator3 short name	OEM		A3		3 chars	333
Annunciation Configuration	Annunciator 3 long name	OEM		AUX LOW WATER		20 chars	335
Annunciation Configuration	Annunciator 4 location	OEM		D:Interlock circuit			345
Annunciation Configuration	Annunciator4 short name	OEM		A4		3 chars	346
Annunciation Configuration	Annunciator 4 long name	OEM		HIGH LIMIT		20 chars	348
Annunciation Configuration	Annunciator 5 location	OEM		D:Interlock circuit			358
Annunciation Configuration	Annunciator5 short name	OEM		A5		3 chars	359
Annunciation Configuration	Annunciator 5 long name	OEM		HIGH GAS PRESSURE		20 chars	361
Annunciation Configuration	Annunciator 6 location	OEM		D:Interlock circuit			371
Annunciation Configuration	Annunciator6 short name	OEM		A6		3 chars	372
Annunciation Configuration	Annunciator 6 long name	OEM		LOW GAS PRESSURE		20 chars	374
Annunciation Configuration	Annunciator 7 location	User		A:No annunciation for this terminal			384
Annunciation Configuration	Annunciator7 short name	Read Only		HFS		3 chars	385
Annunciation Configuration	Annunciator 7 long name	Read Only		High Fire Switch		20 chars	387
Annunciation Configuration	Annunciator 8 location	Read Only		A:No annunciation for this terminal			397
Annunciation Configuration	Annunciator8 short name	Read Only		LFS		3 chars	398
Annunciation Configuration	Annunciator 8 long name	Read Only		Low Fire Switch		20 chars	400
Annunciation Configuration	PII short name	OEM		PII		3 chars	410
Annunciation Configuration	PII long name	OEM		Pre-Ignition ILK		20 chars	412
Annunciation Configuration	LCI short name	Service		LCI		3 chars	422
Annunciation Configuration	LCI long name	Service		LIMIT CIRCUIT		20 chars	424
Annunciation Configuration	ILK short name	OEM		ILK		3 chars	434
Annunciation Configuration	ILK long name	OEM		Interlock		20 chars	436
Interlocks	Purge rate proving	OEM		B:Prove via HFS terminal			229
Interlocks	Lightoff rate proving	OEM		B:Prove via LFS terminal			230
Interlocks	Interlock open response	Read Only		A:Lockout			238
Interlocks	Interrupted air switch enable	OEM		C:Enable IAS during purge && ignition			246
Interlocks	LCI enable	OEM		Enabled			248
Interlocks	PII enable	OEM		Disabled			249
Interlocks	ILK bounce detection enable	OEM		Enabled			253
Safety Timing	Prepurge rate	OEM		85%		% | RPM	196
Safety Timing	Postpurge rate	OEM		45%		% | RPM	198
Safety Timing	Standby rate	OEM		20%		% | RPM	207

Table A-1: Falcon Steam (Continued)

Parameter Group	Parameter Name	Access*	Min Range	Default Setting	Max Range	Parameter Units	Modbus Register (dec)
Safety Timing	Prepurge time	OEM		1m 0s		mmm ss	231
Safety Timing	Run stabilization time	OEM		0m 10s		mmm ss	235
Safety Timing	Postpurge time	OEM		0m 15s		mmm ss	236
Ignition Configuration	Lightoff rate	OEM		20%		% | RPM	197
Ignition Configuration	Ignition source	OEM		B:External ignition			224
Ignition Configuration	Igniter on during	OEM		B:On in first half of PFEP			226
Ignition Configuration	Pilot type	OEM		A:Interrupted (off during Run)			227
Ignition Configuration	Preignition time	OEM		0m 0s		mmm ss	232
Ignition Configuration	PFEP	OEM		C:10 seconds			233
Ignition Configuration	MFEP	OEM		B:5 seconds			234
Ignition Configuration	Flame threshold	OEM		.8		10ths (V or uA)	250
Flame Failure	Ignite failure response	OEM		D:Retry N times, then lockout			239
Flame Failure	Ignite failure retries	OEM		D:Retry 1 time			240
Flame Failure	Ignite failure delay	OEM		1m 0s		mmm ss	241
Flame Failure	MFEP flame failure response	Read Only		A:Lockout			242
Flame Failure	Run flame failure response	Read Only		A:Lockout			243
System Configuration	Temperature units	User		A:Fahrenheit			178
System Configuration	Antishort cycle time	User		1m 0s		mmm ss	179
System Configuration	Power up with lockout	OEM		Enabled			181
System Configuration	Burner switch	User		Yes/True/On			203
System Configuration	BLR HSI function	OEM		A:Blower motor			225
System Configuration	Flame sensor type	OEM		D:UV power tube, ignore ignitor UV			228
System Configuration	Forced recycle interval time	OEM		0h 0m		min	254
System Configuration	Fan speed error response	OEM		A:Lockout			255
System Configuration	Inlet connector type	OEM		G:0-150 psi			608
System Configuration	S2 connector type	OEM		H:4_20_MA			609
System Configuration	Outlet connector type	OEM		C:10K dual safety			610
System Configuration	Stack connector type	OEM		C:10K dual safety			613
System Configuration	Pressure correction offset	Service		0			616
System Configuration	Low fire cutoff time	Service		NoValue		mmm ss	617
System Configuration	Use STAT with EnviraCOM remote stat	OEM		Disabled			629
System Configuration	Line frequency	OEM		A:60 Hz			630
System Configuration	Safety configuration options	OEM		0x0001			631
Lead Lag Configuration	Lead lag master enable	User		A:no Lead Lag master			545
Lead Lag Configuration	Lead lag hysteresis step time	User		0m 0s		mmm ss	551
Lead Lag Configuration	Lead lag P gain	User		10			552
Lead Lag Configuration	Lead lag I gain	User		10			553
Lead Lag Configuration	Lead lag D gain	User		0			554
Lead Lag Configuration	Lead lag operation switch	User		Yes/True/On			555
Lead Lag Configuration	Lead lag CH demand switch	User		A:CH loop is disabled			556
Lead Lag Configuration	Lead lag CH setpoint source	User		A:Local setpoint is used			557
Lead Lag Configuration	Lead lag modulation sensor	User		D:Modulation from S2 (J8-6) 4-20mA sens.			558
Lead Lag Configuration	Lead Lag Modbus port	User		A:Unassigned Modbus port			569
Lead Lag Configuration	Base load common	User		80%		0 to 100%	572
Lead Lag Configuration	Lead selection method	User		A:rotate in sequence order			574
Lead Lag Configuration	Lag selection method	User		A:rotate in sequence order			575
Lead Lag Configuration	Lead lag add stage method 1	User		B:Use error threshold to add stage			714
Lead Lag Configuration	Lead lag add stage detection time 1	User		0m 30s		mmm ss	716
Lead Lag Configuration	Lead lag add stage rate offset	User		0%		-100% to 100%	719
Lead Lag Configuration	Lead lag add stage interstage delay	User		0m 30s		mmm ss	722
Lead Lag Configuration	Lead lag drop stage method 1	User		C:Use firing rate to drop stage			723
Lead Lag Configuration	Lead lag drop stage detection time 1	User		0m 30s		mmm ss	725

Table A-1: Falcon Steam (Continued)

Parameter Group	Parameter Name	Access*	Min Range	Default Setting	Max Range	Parameter Units	Modbus Register (dec)
Lead Lag Configuration	Lead lag drop stage rate offset	User		10%		-100% to 100%	728
Lead Lag Configuration	Lead lag drop stage interstage delay	User		0m 30s		mmm ss	731
Lead Lag Configuration	Lead rotation time	User		1h 0m		min	733
Lead Lag Configuration	Force lead rotation time	User		0h 0m		min	734
Lead Lag Configuration	Lead lag pressure setpoint	User		100		psig	738
Lead Lag Configuration	Lead lag pressure TOD setpoint	User		80		psig	739
Lead Lag Configuration	Lead lag pressure on hysteresis	User		5		psig	740
Lead Lag Configuration	Lead lag pressure off hysteresis	User		5		psig	741
Lead Lag Configuration	Lead lag add stage pressure error threshold	User		5		psig	742
Lead Lag Configuration	Lead lag drop stage pressure error threshold	User		5		psig	743
Lead Lag Configuration	Lead lag 4 mA steam pressure	Service		0		psig	745
Lead Lag Configuration	Lead lag 20 mA steam pressure	Service	0	135	150	psig	746
Lead Lag Configuration	Lead lag slave enable	User		A:Disabled			544
Lead Lag Configuration	Slave mode	User		B:Equalize runtime			564
Lead Lag Configuration	Fan during off cycle rate	User		20%		% | RPM	567
Lead Lag Configuration	Slave sequence order	User		0		1 to 8	568
Lead Lag Configuration	Lead lag slave demand to firing delay	User		2m 0s		mmm ss	570

Table A-2: Falcon Hot Water

Parameter Group	Parameter Name	Access*	Min range	Default Setting	Max. Range	Parameter Units	Modbus Register (dec)
System ID & Access	Boiler name	Service		BOILER 1			183
System ID & Access	Installation data	Service		SERIAL NUMBER			184
System ID & Access	OEM identification	Read Only		FALCON 833-04097			185
System ID & Access	Installer Password	Service		9220			190
System ID & Access	Factory Data	Read Only					191
System ID & Access	Modbus Address	Service	0	1	250		
Central Heat Configuration	CH enable	User		Enabled			208
Central Heat Configuration	CH demand switch	Service		B:STAT terminal			209
Central Heat Configuration	CH modulation sensor	Service		A:Modulation from Outlet (S3S4) sensor			210
Central Heat Configuration	CH setpoint	User	130	150	230	oF	211
Central Heat Configuration	CH TOD setpoint	User	130	130	230	oF	212
Central Heat Configuration	CH on hysteresis	Service		5	60	oF	213
Central Heat Configuration	CH off hysteresis	Service		15	60	oF	214
Central Heat Configuration	CH outdoor reset enable	Service		Disabled			215
Central Heat Configuration	CH P gain	Service		25			216
Central Heat Configuration	CH I gain	Service		10			217
Central Heat Configuration	CH D gain	Service		0			218
Central Heat Configuration	CH hysteresis step time	Service		0m 0s		mmm ss	219
Central Heat Configuration	CH setpoint source	Service		A:Local setpoint is used			578
Central Heat Configuration	CH modulation rate source	User		A:Local modulation (PID) is used			580
Central Heat Configuration	CH has priority over LL	Service		No/False/Off			582
Central Heat Configuration	CH 4 mA water temperature	Service		130	194	oF	583
Central Heat Configuration	CH 20 mA water temperature	Service		210	230	oF	584
Outdoor Reset Configuration	CH ODR max outdoor temperature	Service		80		oF	512
Outdoor Reset Configuration	CH ODR min outdoor temperature	Service		0		oF	513
Outdoor Reset Configuration	CH ODR low water temperature	Service		80		oF	514
Outdoor Reset Configuration	CH ODR boost time	Service		30m 0s		mmm ss	515
Outdoor Reset Configuration	CH ODR boost maximum off point	Service		180	230	oF	516
Outdoor Reset Configuration	CH ODR boost step	Service		0°F (0°C)		oF	522
Outdoor Reset Configuration	Minimum boiler water temperature	Service	130	130		oF	526
Domestic HW Configuration	DHW enable	User		Disabled			448
Domestic HW Configuration	DHW demand switch	User		A:Modulation sensor only			449
Domestic HW Configuration	DHW has priority over CH	Service		Yes/True/On			450
Domestic HW Configuration	DHW has priority over LL	Service		Yes/True/On			451
Domestic HW Configuration	DHW priority override time	Service		30m 0s		mm ss	452
Domestic HW Configuration	DHW setpoint	User	130	180	230	oF	453
Domestic HW Configuration	DHW TOD setpoint	User	130	130	230	oF	454
Domestic HW Configuration	DHW on hysteresis	Service		5	80	oF	455
Domestic HW Configuration	DHW off hysteresis	Service		15	80	oF	456
Domestic HW Configuration	DHW P gain	Service		25			457
Domestic HW Configuration	DHW I gain	Service		10			458
Domestic HW Configuration	DHW D gain	Service		0			459
Domestic HW Configuration	DHW hysteresis step time	Service		1m 0s		mmm ss	460
Domestic HW Configuration	DHW modulation sensor	Service		F:Auto Mod from DHW (S6)or Outlet (S3S4)			461
Domestic HW Configuration	DHW priority source	Service		B:DHW heat demand			463
Domestic HW Configuration	DHW storage enable	Service		Disabled			504
Domestic HW Configuration	DHW priority method	Service		B:Drop DHW after priority time expires			509
Domestic HW Configuration	DHW demand ON temperature	User		NoValue			510
Domestic HW Configuration	DHW demand OFF temperature	User		NoValue			511
Modulation Configuration	Modulation output	Read Only		C:Analog 4-20mA			192
Modulation Configuration	CH maximum modulation rate	Service	0	100%	100%	%	193
Modulation Configuration	DHW maximum modulation rate	Service	0	100%	100%	%	194
Modulation Configuration	Minimum modulation rate	Service	0	10%	100%	%	195
Modulation Configuration	CH forced rate	Service	0	35%	100%	%	199
Modulation Configuration	CH forced rate time	Service		1m 0s		mmm ss	200
Modulation Configuration	DHW forced rate	Service	0	35%	100%	%	201
Modulation Configuration	DHW forced rate time	Service		0m 0s		mmm ss	202
Modulation Configuration	Firing rate control	User		A:Automatic firing			204

Table A-2: Falcon Hot Water (Continued)

Parameter Group	Parameter Name	Access*	Min range	Default Setting	Max. Range	Parameter Units	Modbus Register (dec)
Modulation Configuration	Manual firing rate	User	0	30%	100%	%	205
Modulation Configuration	CH slow start enable	Service		Enabled			477
Modulation Configuration	DHW slow start enable	Service		Disabled			478
Modulation Configuration	Slow start ramp	Service	0	5%	100%	% per min	479
Modulation Configuration	Slow start degrees	Service		20		oF	480
Modulation Configuration	Rate assigned to 0V/4mA (Min mod > 80%)	User		100%		0 to 100%	534
Modulation Configuration	Analog input hysteresis	Service		.2		mA	543
Modulation Configuration	Analog rate tracking	User		A:Analog rate tracking disabled			667
Pump Configuration	CH pump output	Service		A:No pump assignment			272
Pump Configuration	CH pump control	Service		A:Automatic pump control			273
Pump Configuration	CH pump overrun time	Service		5m 0s		mmm ss	274
Pump Configuration	CH pump frost protection overrun time	Service		60m 0s		mmm ss	275
Pump Configuration	DHW pump output	Service		A:No pump assignment			276
Pump Configuration	DHW pump control	Service		A:Automatic pump control			277
Pump Configuration	DHW pump overrun time	Service		1m 0s		mmm ss	278
Pump Configuration	DHW pump frost protection overrun time	Service		60m 0s		mmm ss	279
Pump Configuration	DHW pump start delay	Service		1m 0s		mmm ss	280
Pump Configuration	Boiler pump output	Service		C:Pump assigned to terminal B			281
Pump Configuration	Boiler pump control	Service		A:Automatic pump control			282
Pump Configuration	Boiler pump overrun time	Service		5m 0s		mmm ss	283
Pump Configuration	Auxiliary 1 pump output	Service		D:Pump assigned to terminal C			284
Pump Configuration	Auxiliary 1 pump control	Service		A:Automatic pump control			285
Pump Configuration	System pump output	Service		A:No pump assignment			287
Pump Configuration	System pump control	Service		A:Automatic pump control			288
Pump Configuration	System pump overrun time	Service		15m 0s		mmm ss	289
Pump Configuration	Pump exercise interval	Service		0		Days	290
Pump Configuration	Pump exercise time	Service		0m 0s		mmm ss	291
Pump Configuration	CH pump start delay	Service		0m 10s		mmm ss	292
Pump Configuration	Boiler pump start delay	Service		0m 10s		mmm ss	293
Pump Configuration	System pump start delay	Service		0m 0s		mmm ss	294
Pump Configuration	Auxiliary 1 pump start delay	Service		0m 20s		mmm ss	295
Pump Configuration	CH pump options 1	Service		0x0324			296
Pump Configuration	CH pump options 2	Service		0xC048			297
Pump Configuration	DHW pump options 1	Service		0x0048			298
Pump Configuration	DHW pump options 2	Service		0x4190			299
Pump Configuration	Boiler pump options 1	Service		0x0002			300
Pump Configuration	Boiler pump options 2	Service		0x4009			301
Pump Configuration	System pump options 1	Service		0x0360			302
Pump Configuration	System pump options 2	Service		0x8009			303
Pump Configuration	Auxiliary 1 pump overrun time	Service		5m 30s		mmm ss	752
Pump Configuration	Auxiliary 1 pump options 1	Service		0x0262			753
Pump Configuration	Auxiliary 1 pump options 2	Service		0x4019			754
Pump Configuration	Auxiliary 2 pump output	Service		B:Pump assigned to terminal A			755
Pump Configuration	Auxiliary 2 pump control	Service		A:Automatic pump control			756
Pump Configuration	Auxiliary 2 pump start delay	Service		0m 0s		mmm ss	757
Pump Configuration	Auxiliary 2 pump overrun time	Service		3m 0s		mmm ss	758
Pump Configuration	Auxiliary 2 pump options 1	Service		0x0003			759
Pump Configuration	Auxiliary 2 pump options 2	Service		0x4000			760
Statistics Configuration	Burner cycle count	Read Only		0		Cycles	128
Statistics Configuration	Burner run time	Read Only		0		Hours	130
Statistics Configuration	CH pump cycle count	Service		0		Cycles	132
Statistics Configuration	DHW pump cycle count	Service		0		Cycles	134
Statistics Configuration	System pump cycle count	Service		0		Cycles	136
Statistics Configuration	Boiler pump cycle count	Service		0		Cycles	138
Statistics Configuration	Auxiliary 1 pump cycle count	Service		0		Cycles	140
Statistics Configuration	Auxiliary 2 pump cycle count	Service		0		Cycles	146
High Limits	Outlet high limit setpoint	Service	32	240	250	oF	464
High Limits	Outlet high limit response	Read Only		A:Lockout			465
High Limits	DHW high limit enable	Service		A:No high limit			474

Table A-2: Falcon Hot Water (Continued)

Parameter Group	Parameter Name	Access*	Min range	Default Setting	Max. Range	Parameter Units	Modbus Register (dec)
High Limits	DHW high limit setpoint	Service	32	NoValue	250	oF	475
High Limits	DHW high limit response	Service		B:Recycle && hold			476
High Limits	Outlet high limit enable	Read Only		B:Dual sensor safety high limit			484
Stack Limit	Stack limit enable	Service		A:No stack high limit			466
Stack Limit	Stack limit setpoint	Service		250	266	oF	467
Stack Limit	Stack limit response	Service		A:Lockout			468
Stack Limit	Stack limit delay	Service		5m 0s		mmm ss	469
Delta-T Limits	Delta-T inlet/outlet enable	Service		D:Enable both Delta-T and inversion			470
Delta-T Limits	Delta-T inlet/outlet degrees	Service		50		oF	471
Delta-T Limits	Delta-T response	Service		C:Recycle && delay with retry limit			472
Delta-T Limits	Delta-T delay	Service		5m 0s		mmm ss	473
Delta-T Limits	Delta-T retry limit	Service		3	100		485
Delta-T Limits	Delta-T rate limit enable	Service		Enabled			486
Delta-T Limits	Delta-T inverse limit time	Service		5m 0s	30m 0s	mmm ss	487
Delta-T Limits	Delta-T inverse limit response	Service		C:Recycle && delay with retry limit			488
T-rise Limit	Outlet T-rise enable	Service		Disabled			481
T-rise Limit	T-rise degrees	Service		10		oF	482
T-rise Limit	T-rise delay	Service		3m 0s		mmm ss	483
T-rise Limit	T-rise response	Service		C:Recycle && delay with retry limit			492
T-rise Limit	T-rise retry limit	Service		10			493
Anticondensation Configuration	CH anticondensation enable	Service		Disabled			496
Anticondensation Configuration	CH anticondensation setpoint	Service		130	230	oF	497
Anticondensation Configuration	DHW anticondensation enable	Service		Enabled			499
Anticondensation Configuration	DHW anticondensation setpoint	Service		130	230	oF	500
Anticondensation Configuration	Anticondensation > Forced rate	User		Yes/True/On			502
Anticondensation Configuration	Anticondensation > Slow start	User		Yes/True/On			502
Anticondensation Configuration	Anticondensation > Outlet limit	User		No/False/Off			502
Anticondensation Configuration	Anticondensation > Stack limit	User		No/False/Off			502
Anticondensation Configuration	Anticondensation priority	Service					502
Anticondensation Configuration	Anticondensation > Delta-T	User		No/False/Off			502
Anticondensation Configuration	Frost protect anticondensation enable	Service		Disabled			503
Frost Protection Configuration	CH frost protection enable	Service		Disabled			528
Frost Protection Configuration	DHW frost protection enable	Service		Disabled			529
Frost Protection Configuration	Outdoor frost protection setpoint	Service		32		oF	530
Frost Protection Configuration	LL frost protection enable	Service		Disabled			532
Frost Protection Configuration	LL frost protection rate	Service	0	20%	100%	%	533
Annunciation Configuration	Annunciation enable	Read Only		Enabled			304
Annunciation Configuration	Annunciator 1 location	OEM		E:Other annunciation			306
Annunciation Configuration	Annunciator1 short name	OEM		A1			307
Annunciation Configuration	Annunciator 1 long name	OEM		AIR SWITCH			309
Annunciation Configuration	Annunciator 2 location	Service		A:No annunciation for this terminal			319
Annunciation Configuration	Annunciator2 short name	Service		A2			320
Annunciation Configuration	Annunciator 2 long name	Service		AUX LOW WATER			322
Annunciation Configuration	Annunciator 3 location	OEM		D:Interlock circuit			332
Annunciation Configuration	Annunciator3 short name	OEM		A3			333
Annunciation Configuration	Annunciator 3 long name	OEM		LOW WATER			335
Annunciation Configuration	Annunciator 4 location	OEM		D:Interlock circuit			345
Annunciation Configuration	Annunciator4 short name	OEM		A4			346
Annunciation Configuration	Annunciator 4 long name	OEM		HIGH AIR PRESSURE			348
Annunciation Configuration	Annunciator 5 location	OEM		D:Interlock circuit			358
Annunciation Configuration	Annunciator5 short name	OEM		A5			359
Annunciation Configuration	Annunciator 5 long name	OEM		HIGH GAS PRESSURE			361
Annunciation Configuration	Annunciator 6 location	OEM		D:Interlock circuit			371
Annunciation Configuration	Annunciator6 short name	OEM		A6			372
Annunciation Configuration	Annunciator 6 long name	OEM		LOW GAS PRESSURE			374
Annunciation Configuration	Annunciator 7 location	Service		A:No annunciation for this terminal			384
Annunciation Configuration	Annunciator7 short name	Service		HFS			385
Annunciation Configuration	Annunciator 7 long name	Service		HIGH FIRE SWITCH			387
Annunciation Configuration	Annunciator 8 location	Service		A:No annunciation for this terminal			397
Annunciation Configuration	Annunciator8 short name	Service		LFS			398

Table A-2: Falcon Hot Water (Continued)

Parameter Group	Parameter Name	Access*	Min range	Default Setting	Max. Range	Parameter Units	Modbus Register (dec)
Annunciation Configuration	Annunciator 8 long name	Service		LOW FIRE SWITCH			400
Annunciation Configuration	PII short name	OEM		PII			410
Annunciation Configuration	PII long name	OEM		Pre-Ignition ILK			412
Annunciation Configuration	LCI short name	OEM		LCI			422
Annunciation Configuration	LCI long name	OEM		Limit Circuit Input			424
Annunciation Configuration	ILK short name	OEM		ILK			434
Annunciation Configuration	ILK long name	OEM		Lockout Interlocks			436
Interlocks	Purge rate proving	Service		B:Prove via HFS terminal			229
Interlocks	Lightoff rate proving	Service		B:Prove via LFS terminal			230
Interlocks	Interlock open response	Read Only		A:Lockout			238
Interlocks	Interrupted air switch enable	OEM	{ xBCx }	C:Enable IAS during purge && ignition			246
Interlocks	LCI enable	Read Only		Enabled			248
Interlocks	PII enable	OEM		Enabled			249
Interlocks	ILK bounce detection enable	Service		Enabled			253
Safetey Timing	Prepurge rate	Service	60	65%	100%	%	196
Safetey Timing	Postpurge rate	Service	40	50%		%	198
Safetey Timing	Standby rate	Service	0	35%	100%	%	207
Safetey Timing	Prepurge time	Service	0m 30s	0m 30s		mmm ss	231
Safetey Timing	Run stabilization time	Service		0m 10s		mmm ss	235
Safetey Timing	Postpurge time	Service	0m 15s	0m 15s		mmm ss	236
Ignition Configuration	Lightoff rate	Service	0	25%	50%	%	197
Ignition Configuration	Ignition source	Read Only		B:External ignition			224
Ignition Configuration	Igniter on during	Read Only		B:On in first half of PFEP			226
Ignition Configuration	Pilot type	Read Only		A:Interrupted (off during Run)			227
Ignition Configuration	Preignition time	Service		0m 0s		mmm ss	232
Ignition Configuration	PFEP	Read Only		C:10 seconds			233
Ignition Configuration	MFEP	OEM		B:5 seconds			234
Ignition Configuration	Flame threshold	OEM	.5	.8	5	10ths (V or uA)	250
Flame Failure	Ignite failure response	Service		A:Lockout			239
Flame Failure	Ignite failure retries	Service		D:Retry 1 time			240
Flame Failure	Ignite failure delay	Service		0m 30s	60m 0s	mmm ss	241
Flame Failure	Run flame failure response	Read Only		A:Lockout			243
System Configuration	Temperature units	Service		A:Fahrenheit			178
System Configuration	Antishort cycle time	Service		0m 0s		mmm ss	179
System Configuration	Power up with lockout	OEM		Enabled			181
System Configuration	Burner switch	User		No/False/Off			203
System Configuration	BLR HSI function	Read Only		A:Blower motor			225
System Configuration	Flame sensor type	Service		D:UV power tube, ignore ignitor UV			228
System Configuration	Forced recycle interval time	Service		0h 0m		min	254
System Configuration	Fan speed error response	Service		A:Lockout			255
System Configuration	Inlet connector type	Read Only		D:10K single non-safety			608
System Configuration	S2 connector type	OEM		H:4_20_MA			609
System Configuration	Outlet connector type	Read Only		C:10K dual safety			610
System Configuration	S5 connector type	Service		D:10K single non-safety			611
System Configuration	DHW connector type	Service		D:10K single non-safety			612
System Configuration	Stack connector type	Service		A:connector unconfigured			613
System Configuration	Outdoor temperature correction offset	User		0			615
System Configuration	Low fire cutoff time	User		0m 30s		mmm ss	617
System Configuration	Outdoor temperature source	Service		A:unconfigured			626
System Configuration	Warm weather shutdown enable	Service		A:Warm weather shutdown disabled			627
System Configuration	Warm weather shutdown setpoint	Service		100		oF	628
System Configuration	Line frequency	Service		C:auto detect 48 through 63 Hz			630
System Configuration	Safety configuration options	OEM		0x0001			631
System Configuration	Burner off inhibit time	User		NoValue		mmm ss	639
Fan Configuratiosn	Fan min duty cycle	Service		10		0-100%	264
Lead Lag Configuration	Lead lag master enable	Service		A:no Lead Lag master			545
Lead Lag Configuration	Lead lag CH setpoint	User	130	150	230		546
Lead Lag Configuration	Lead lag CH TOD setpoint	User	130	130	230		547
Lead Lag Configuration	Lead lag on hysteresis	Service		5		oF	549

Table A-2: Falcon Hot Water (Continued)

Parameter Group	Parameter Name	Access*	Min range	Default Setting	Max. Range	Parameter Units	Modbus Register (dec)
Lead Lag Configuration	Lead lag off hysteresis	Service		15		oF	550
Lead Lag Configuration	Lead lag hysteresis step time	Service		0m 0s		mmm ss	551
Lead Lag Configuration	Lead lag P gain	Service		20			552
Lead Lag Configuration	Lead lag I gain	Service		15			553
Lead Lag Configuration	Lead lag D gain	Service		0			554
Lead Lag Configuration	Lead lag operation switch	User		No/False/Off			555
Lead Lag Configuration	Lead lag CH demand switch	Service		B:STAT terminal			556
Lead Lag Configuration	Lead lag CH setpoint source	Service		A:Local setpoint is used			557
Lead Lag Configuration	Lead lag modulation backup sensor	Service		B:Use Outlet sensor from lead boiler			559
Lead Lag Configuration	Lead lag CH 4 mA water temperature	Service		80		oF	560
Lead Lag Configuration	Lead lag CH 20 mA water temperature	Service		180		oF	561
Lead Lag Configuration	Lead Lag Modbus port	Service		C:Use MB2 port for Lead Lag messaging			569
Lead Lag Configuration	Base load common	Service		45%		0 to 100%	572
Lead Lag Configuration	Lead selection method	Service		A:rotate in sequence order			574
Lead Lag Configuration	Lag selection method	Service		A:rotate in sequence order			575
Lead Lag Configuration	Lead lag DHW demand switch	User		A:DHW loop is disabled			704
Lead Lag Configuration	Lead lag DHW setpoint	User		180		oF	705
Lead Lag Configuration	Lead lag DHW has priority over CH	User		Yes/True/On			706
Lead Lag Configuration	Lead lag add stage method 1	Service		C:Use firing rate threshold to add stage			714
Lead Lag Configuration	Lead lag add stage detection time 1	Service	1m 0s	3m 0s		mmm ss	716
Lead Lag Configuration	Lead lag add stage error threshold	Service		5		oF	718
Lead Lag Configuration	Lead lag add stage rate offset	Service		0%		-100% to 100%	719
Lead Lag Configuration	Lead lag add stage interstage delay	Service	3m 0s	10m 0s		mmm ss	722
Lead Lag Configuration	Lead lag drop stage method 1	Service		C:Use firing rate to drop stage			723
Lead Lag Configuration	Lead lag drop stage detection time 1	Service	1m 0s	3m 0s		mmm ss	725
Lead Lag Configuration	Lead lag drop stage error threshold	Service		10		oF	727
Lead Lag Configuration	Lead lag drop stage rate offset	Service		-3%		-100% to 100%	728
Lead Lag Configuration	Lead lag drop stage interstage delay	Service	3m 0s	10m 0s		mmm ss	731
Lead Lag Configuration	Lead rotation time	Service		120h 0m		min	733
Lead Lag Configuration	Force lead rotation time	Service		168h 0m		min	734
Lead Lag Configuration	Lead lag DHW TOD setpoint	User	130	170		oF	735
Lead Lag Configuration	Boiler off options	Service		A:boiler off options disabled			736
Lead Lag Configuration	All boilers off threshold	Service		210		oF	737
Lead Lag Configuration	Lead lag slave enable	Service		A:Disabled			544
Lead Lag Configuration	Slave mode	Service		B:Equalize runtime			564
Lead Lag Configuration	Fan during off cycle rate	Service		0%		%	567
Lead Lag Configuration	Slave sequence order	Service		0		1 to 8	568
Lead Lag Configuration	Lead lag slave demand to firing delay	Service	1m 0s	3m 0s		mmm ss	570
Lead Lag Configuration	LL CH ODR max outdoor temperature	Service		80	140	oF	517
Lead Lag Configuration	LL CH ODR min outdoor temperature	Service		0	140	oF	518
Lead Lag Configuration	LL CH ODR low water temperature	Service		80	230	oF	519
Lead Lag Configuration	LL CH ODR boost time	Service		0m 0s		mmm ss	520
Lead Lag Configuration	LL CH ODR boost maximum off point	Service		180		oF	521
Lead Lag Configuration	LL CH ODR boost step	Service		0		oF	524
Lead Lag Configuration	LL CH ODR minimum water temperature	Service		80	230	oF	527
Lead Lag Configuration	Lead lag CH outdoor reset enable	Service		Disabled			548

*Access Levels:

Read Only = parameter not configurable

OEM = manufacturer only

Service = password required (default password is 9220)

User = no password required

APPENDIX B

Control Parameters - LMV / RWF50

APPENDIX C

Variable Speed Drive Parameters

APPENDIX D

Dungs Gas Valve

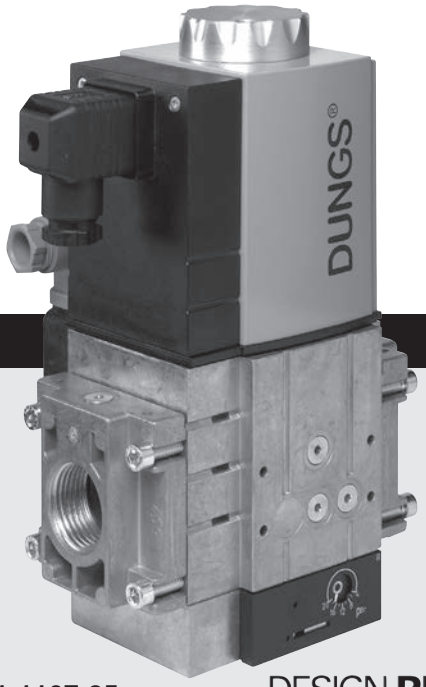
(M5M 2000 - 3000)

MBC-SE 1000/2500/4000
GasMultiBloc®
Combined servo pressure regulator and safety shut-off valves
Installation Instructions

USA CDN

DUNGS®
Combustion Controls

Table of Contents



Approvals

UL Listed / Recognized Component:
File No. MH16727 to UL 429

CSA Certified File No.157406 to
ANSI Z21.21 / CSA 6.5 with C/I marking
ANSI Z21.18 / CSA 6.3

FM APPROVED

FM 7400 Approved

Commonwealth of Massachusetts Approved Product Approval code G1-1107-35

DESIGN PLUS

Attention

The installation and maintenance of this product must be done under the supervision of an experienced and trained specialist. Never perform work if gas pressure or power is applied, or in the presence of an open flame.

Check the ratings in the specifications to make sure that they are suitable for your application.

Please read the instruction before installing or operating. Keep the instruction in a safe place. You find the instruction also at www.dungs.com If these instructions are not heeded, the result may be personal injury or damage to property.

Safety first O.K.

On completion of work on the safety valve, perform a leakage and function test.

Any adjustment and application-specific adjustment values must be made in accordance with the appliance-/boiler manufacturers instructions.

IFGC CSA UL ANSI NFPA

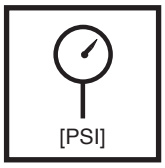
This product is intended for installations covered by, but not limited to, the following fuel gas codes and standards: NFPA 54, IFGC (International Fuel Gas Code), or CSA B149.1 (for Canada) or the following equipment codes and standards: CSD-1, UL 795, NFPA 37, ANSI Z83.4/CSA 3.7, ANSI Z83.18, ANSI Z21.13/CSA 4.9, or CSA B149.3 (for Canada).

Explanation of symbols

1, 2, 3 ... = Action
• = Instruction

Specification

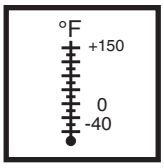
MBC- Two normally closed safety shutoff valves with integrated servo regulator in one housing. Fast opening, fast closing.

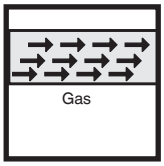


Safety Valve Max. Operating Pressure
MOP = 5 PSI (360 mbar)

Regulator Operating Pressure Ratings
S22/S82: p_{in} = 6 - 147 in. W.C.
S302: p_{in} = 14 - 147 in. W.C.
S02: p_{in} = 4 - 41 in. W.C.
N: p_{in} = 4 - 41 in. W.C.

Regulator Outlet Pressure Ranges
S22: p_{out} = 1.6 - 8 in. W.C.
S82: p_{out} = 2 - 32 in. W.C.
S302: p_{out} = 12- 122 in. W.C.
S02: p_{out} = 0 ± 0.8 in. W.C.
N: p_{out} = 0 ± 0.8 in. W.C.

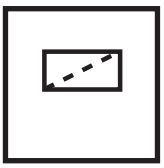




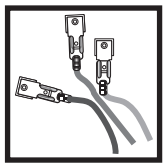
Ambient Temperature (CSA)
-40 °F ... +140 °F
(-40 °C … +60 °C)
Ambient Temperature (UL)
+5 °F ... +140 °F
(-15 °C … +60 °C)

Gases
Dry, natural gas, propane, butane; other noncorrosive gases. A "dry" gas has a dew point lower than +15 °F and its relative humidity is less than 60 %.
Materials in contact with Gas
Housing: Aluminium, Steel, free of nonferrous metals. Sealings on valve seats: NBR-based rubber.

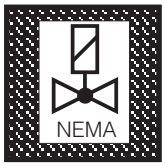
Electrical Ratings
110 - 120 VAC / 50 - 60 Hz;
24 VAC / 50 - 60 Hz; 12 VDC, 24 VDC
Operating time
100 % duty cycle
Cycle Rate
Maximum 60 cycles/hr (30 s on/off)



Filter
installed in the housing upstream V1
50 micron

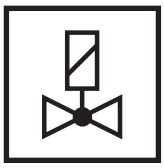


Electrical Connection
DIN-connector with 1/2" NPT conduit connection for UL Versions.
Order separately for CSA Versions
Power Consumption with all coils energized
see table below



Enclosure Rating
NEMA Type 12 / IP54

Vent Limiting Device and Vent Line Connection
The MBC has an internal, factory installed vent limiter re ANSI Z21.18/ CSA 6.3. Venting required unless otherwise accepted by the authority having jurisdiction.



Classification of Valve V1 and V2
Safety Shutoff Valve: UL 429,
ANSI Z21.21 • CSA 6.5 C/I Valves
Closing Time (Valve 1 & Valve 2)
< 1 s
Opening Time (Valve 1 & Valve 2)
< 1 s

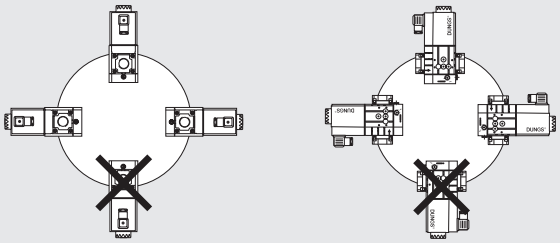
Power Consumption Table

Valve Body Size	Rated voltage	Inrush $P_{max.}$ [VA] for t = 3 s	Inrush current peak (A)	Holding $P_{max.}$ [VA] Operation	Recommended power of supply transformer (VA)
MBC 1000	12 VDC	140	20.1	16	DC battery
MBC 2500		160	20.1	20	DC battery
MBC 4000		–	–	–	–
MBC 1000	24 VDC	130	13.4	16	DC battery
MBC 2500		160	13.4	20	DC battery
MBC 4000		200	2.8	30	DC battery
MBC 1000	24 VAC*	120	14.7	20	250
MBC 2500		160	13.9	20	300
MBC 4000		–	–	–	–
MBC 1000	120 VAC*	120	3.1	16	250
MBC 2500		180	3.0	20	300
MBC 4000		250	2.4	25	300

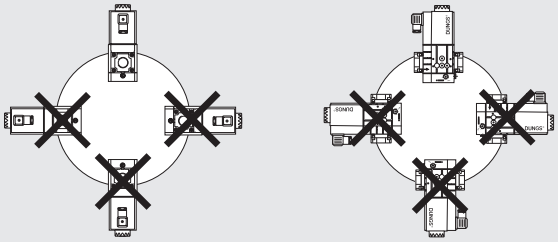
*Power supply should compensate for the inrush current, and wire gauge should be considered. In order to absorb voltage spikes during inrush, an electrolytic capacitor (4700 µF) between MBC and transformer is recommended.

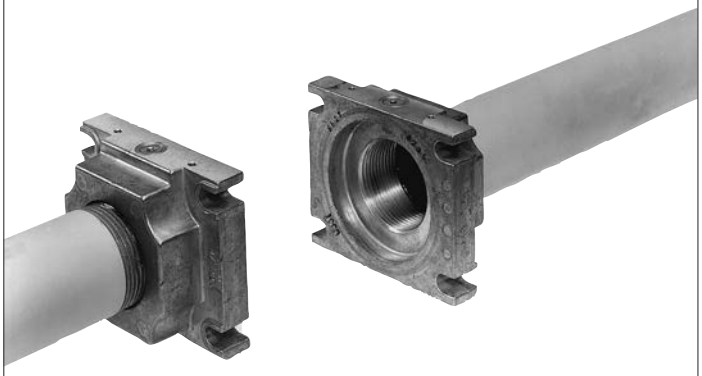
Mounting

Installation position
SE Versions ending in S22/S82/S302



Installation position
SE Versions ending in S02





If the flow is not in the same direction of the arrows, the valves will not operate properly.

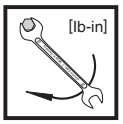
Setup

1. Examine the MBC valve for shipping damage.
2. The main gas supply must be shutoff before starting the installation.
3. The inside of the MBC valve, the flanges, and piping must be clean and free of dirt. Remove all dirt and debris before installing the MBC valve. Failure to remove dirt / debris could result in valve damage or improper performance.

Recommended Procedure to Mount the Flanges

1. Unpack the MBC valve and remove the socket cap head screws from white plastic cover.
   For MBC 1000: use 5 mm hex wrench for M6 screws
   For MBC 2500/4000: use 6 mm hex wrench for M8 screws
2. Verify the o-rings and the grooves are clean and in good condition.
3. Install flanges and torque to specification.
4. Clean the mounting surface of the flanges.
5. Mount the flanges to the MBC valve.
6. Tighten the screws in a crisscross pattern. See table for recommended torque!

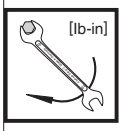
Do not overtighten the screws.
Follow the maximum torque values next page.



Recommended Torque System Accessories	M6	M8	Screw Size
	62 lb-in	134 lb-in	[lb-in]

Recommended Piping Procedure

- Use new, properly reamed and threaded pipe free of chips.
- Apply good quality pipe sealant, putting a moderate amount on the male threads only. If pipe sealant lodges on the valve seat, it will prevent proper operation. If using LP gas, use pipe sealant rated for use with LP gas.
- Do not thread pipe too far. Valve distortion and/or malfunction may result from excess pipe in the valve body.
- Apply counter pressure only a parallel jaw wrench only to the flats on the flange when connecting to pipe.
- Do not overtighten the pipe. Follow the maximum torque values listed below.



Recommended Torque for Piping	1/2”	3/4”	1”	1 1/4”	1 1/2”	2”	NPT pipe
	375	560	750	875	940	1190	[lb-in]

• On completion of work on the MBC valve, perform a leakage test. (See “Valve Leakage Test”)

Painting Valve

- It is not recommended that this valve be painted. Painting covers date codes and other labels that identify this valve.
- If the valve needs to be painted, a paint free of volitile organic componants (VOC’s) must be used. VOC’s can damage valve o-rings, resulting in external gas leakage over time.
- During the painting process, use measures that will allow the valve’s date code and other labeling information to be legible after the paint is dry.
- Painting the valve may damage valve o-rings, resulting in external gas leakage over time.

Protection from Radiant Heat

- Radiant heat must be considered as a heat source that could result in an ambient temperature higher than the rating of this valve.
- Provide proper shielding to protect against radiant heat.

Electrical DIN Connector Ratings

Ambient Temperature Rating: -40°F to +175°F
Electrical Ratings: 120VAC, 24VAC 50/60 Hz, 12 VDC or 24VDC.
Maximum Amperage Rating: 6.0 Amps @ 120VAC.
Enclosure Rating: Type 12
Electrical Wiring Connection: Screw terminals.
Required Wire Specifications:
Type: Stranded, insulated Appliance Wiring Material (AWM) "Hook-Up" wire.
Approvals: UL Recognized Single Conductor, Thermoplastic Insulated Wire, Type AWM. Temperature Rating: At least 75°C (170°F). Voltage Rating: 300 Volts maximum / Single phase. Wire Size: AWG #18 minimum ONLY. No more the AWG #14.

Ratings for conduit and conduit fittings:

Temperature:	At least 75°C (170°F)
Voltage:	300 Volts minimum
Approvals:	UL Listed conduit and conduit fittings
Size:	1/2" Conduit and 1/2" Conduit Fitting.

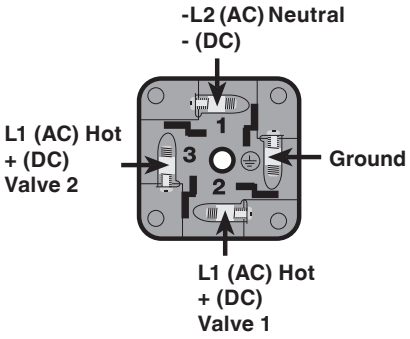
Select one conduit type and its suitable conduit fitting from the following table.

1/2" Conduit Type and Suitable 1/2" Conduit Fitting		
Liquid-tight, Flexible Non-Metallic Conduit (LFNC-B) Type B	ONLY with →	Liquid-tight, non-metallic fitting, Type NM (non-metallic) conduit fitting
Liquid-tight, Flexible Metallic Conduit	ONLY with →	Liquid-tight, metallic fitting, Type FLEX/MC (Flexible/Metal Clad)
Standard thickness, steel or aluminum, Flexible Metal Clad Conduit	ONLY with →	Metallic fitting, Type "squeeze", "set screw", or "screw-in"

Initial Setup:

1. Verify that all power to all wires at the terminals in the nearest conduit body (panel) are disconnected before proceeding.
2. At least 4 wires (1 Safety Ground, 2 Hot and 1 Neutral) are needed for wiring. NOTE: One neutral wire can be used to power both valves.

DIN Connector
screw terminal connections



IMPORTANT: DO NOT make any terminal connections at the nearest conduit body until all terminals in the valve connector are properly wired and the valve connector is properly assembled to the 1/2" flexible conduit.

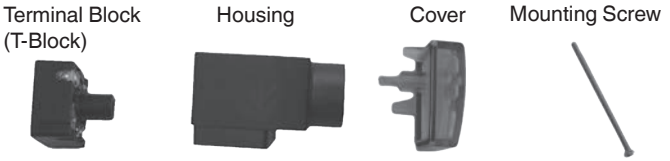
NOTE: Flexible conduit more than 3ft. long must be properly supported and secured, as specified in NFPA 70, Article 350 and 351.

Electrical DIN Connector assembly & wiring

Failure to follow the exact instructions below may result in a valve connector not fitting to valve.

STEPS

1. After selecting the proper number of wires, push the mounting screw completely out from the valve connector and disassemble the remaining 4 parts as shown below:



2. Starting from the 1/2" NPT end of the housing, push the wires under the metal strain relief and through the housing (see FIG. A below). The GREEN (ground) wire should be placed into the far left groove when viewed as shown in FIG. B. The "Neutral (-) " should be placed into the groove next to the GREEN (ground).

Fig. A

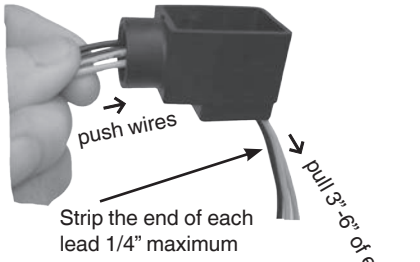
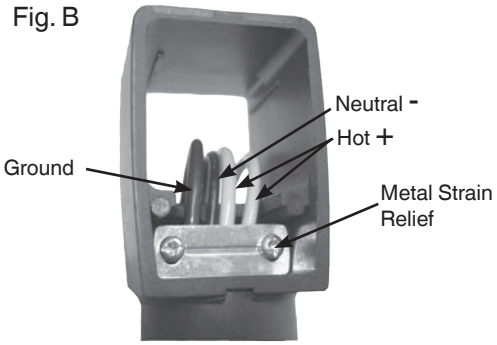
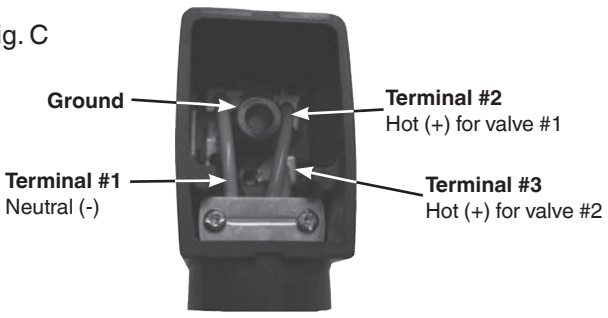


Fig. B



3. Continue to push the wires through the housing until there is at least an extra 3"- 6"available for connecting the wires to the terminals on the T-Block (see FIG. A above).
4. Strip no more than 1/4" of insulation from each wire.
5. Wiring to the correct terminal is critical. The terminals are labeled next to the terminal screws. Terminate each wire to its proper terminal on the T-block. See FIG. C to determine the proper terminals for the valve. NOTE: One neutral is used to power both valves.

Fig. C



The maximum torque for the terminal screws is 4.4 in-lb (0.5 Nm).

6. Pull the wires so that the T-Block is completely pulled into the housing. As the T-Block gets pulled into the housing, the T-Block and the wires must be properly guided into the housing by:

A) Ensuring that the ground (the flat pin of the plug) fits to the front of the housing as shown in FIG. D below,

AND

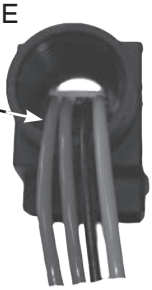
B) Ensuring that the wires lay side-by-side beneath the metal strain relief as shown in Fig. E below,

AND

C) Organizing the wires so that they terminate on the same side of the connector under which they were routed. The wires must NOT crisscross inside the housing to the opposite side from which they are terminated. Fig. C illustrates how the wires terminate on the same side under which they were routed.

Fig. D

Fig. E



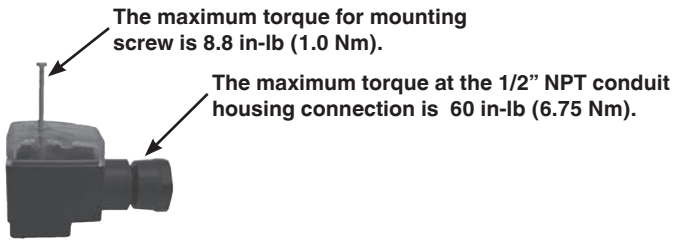
7. Tighten the screws on the metal strain relief.

The maximum torque for each metal strain relief screw is 4.4 in-lb (0.5 Nm).

8. Assemble the appropriate 1/2" flexible conduit and its suitable conduit fitting as specified in the table on page 3.
9. Route the "pig-tailed" wires from the valve connector through the 1/2" conduit and to the nearest conduit body (panel), and then screw the valve connector to the 1/2" conduit fitting (see below for proper torque).

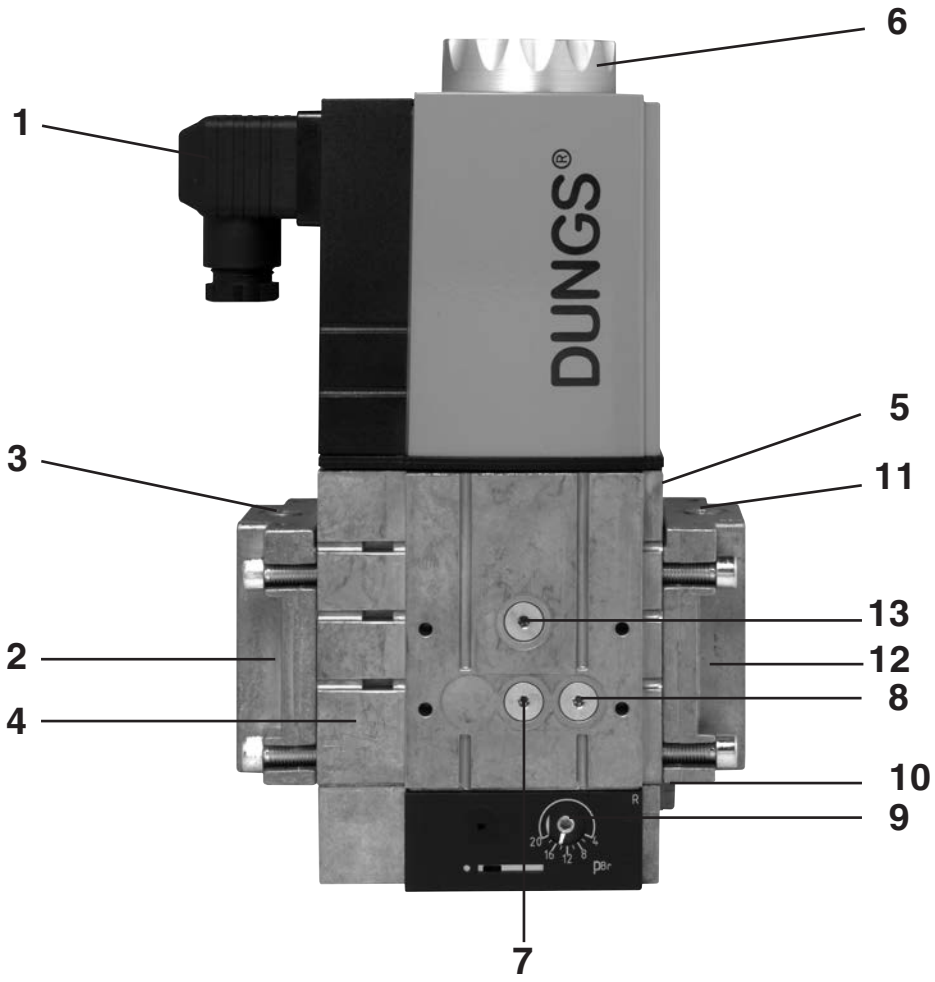
NOTE: It may be necessary to pull the wires at the nearest conduit body to reduce any potential wire slack in the raceway as the valve connector is screwed to the 1/2" conduit fitting.

10. Assemble the cover and mounting screw to the valve connector, and mount the valve connector to the valve coil as shown below.



11. Tighten the mounting screw.
12. Follow NEC (NFPA 70) requirements for proper termination at the nearest conduit body.

MBC Overview & Impulse Lines



Impulse lines must be ordered separately

1	Electrical connection for valves (DIN EN 175 301-803) black
2	Input flange
3	Pressure connection G 1/8 upstream of filter
4	Filter
5	Label / Seriel number
6	Cover
7	Test point connection G 1/8 upstream of V1, possible on both sides
8	Test point connection G 1/8 downstream of V2, optional
9	Regulator Outlet Pressure Adjustment
10	Vent connection / Vent limiter G 1/8
11	G 1/8 pressure connection Burner pressure p_{Br}
12	Output flange
13	Test point connection G 1/8 downstream of V1 and upstream V2, possible on both sides.

External Impulse line (option)
Assembly Instructions

⚠ Impulse line p_{BR} must correspond to ≥ DN 4 (1/8”), PN 1 and they must be made of steel.

Other materials for Impulse lines are only permitted after a certification with the burner / boiler.

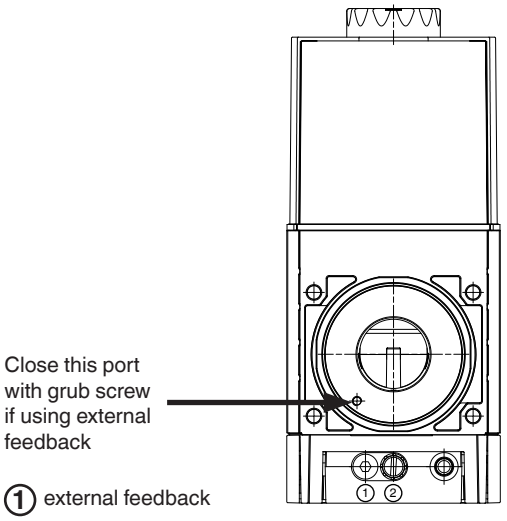
⚠ **Close internal Impulse line with grub screw. See Fig. 1**

⚠ Route Impulse line so that no **condensate** can flow back to the MBC...SE. See Fig. 2

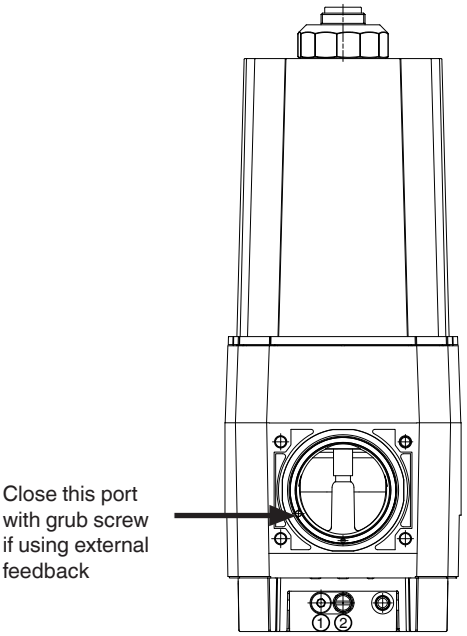
⚠ Secure Impulse line to prevent them from being ripped out and deformed.
Keep Impulse line short!

⚠ Test Impulse line for external leakage. Use leakage spray only if necessary.
Test pressure:
$p_{max.}$ = 40” W.C.

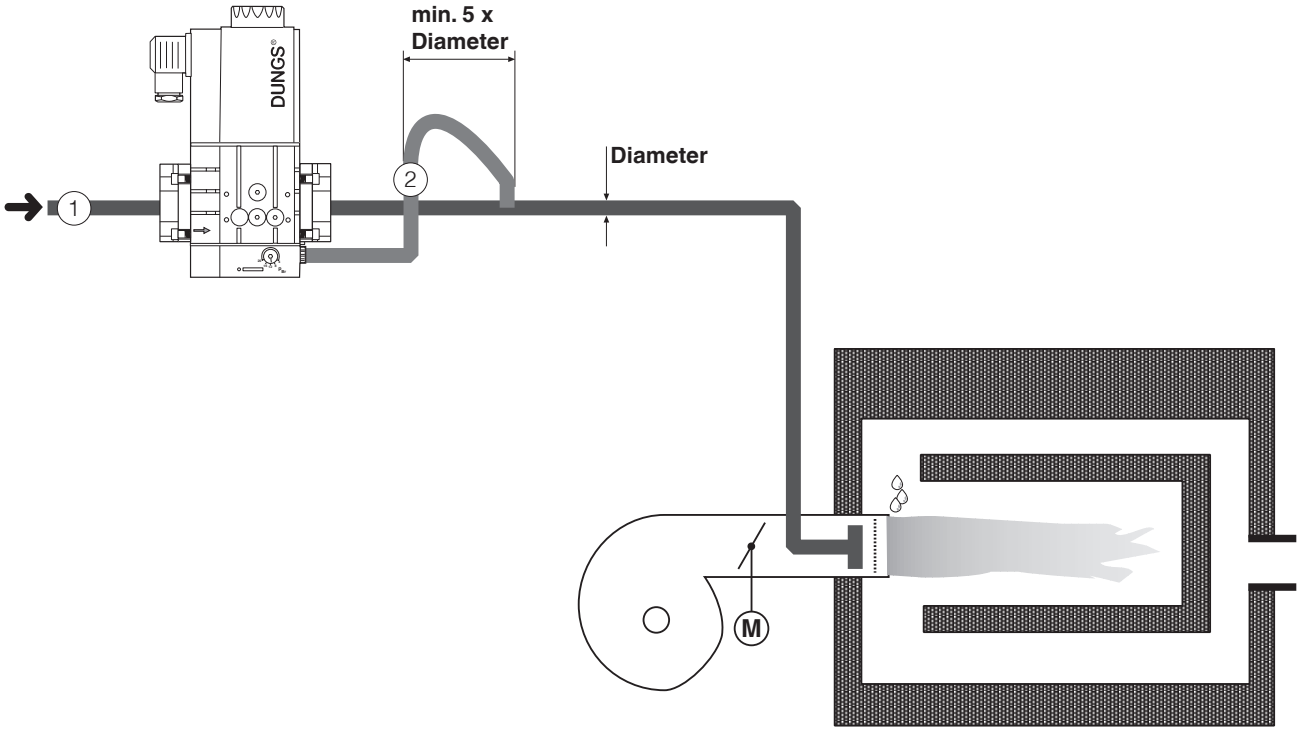
MBC 1000/2500
Fig. 1



MBC 4000



MBC...SE
Recommended Installation of Impulse lines when used (optional)



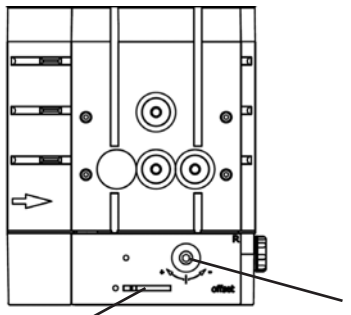
Outlet Pressure Adjustment

MBC...SE S22/82/302

- Open protective slide located at the bottom of the valve.
- See Fig. 1 & 2 for adjustments.

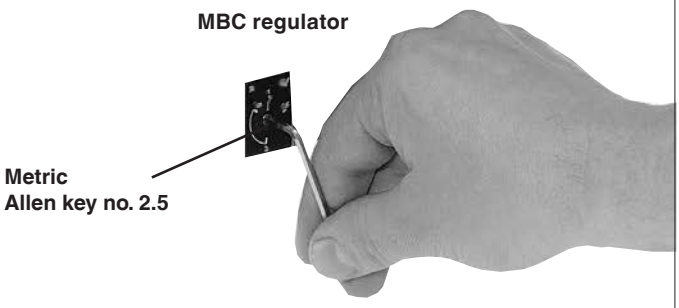
1. Make adjustments while the valve is energized and flame established.
2. Using a 2.5 mm Metric Allen key, adjust the outlet pressure to the gas regulator for the application.
   Turning the adjustment towards lower numbers decreases the outlet pressure.
   Turning the adjustment towards higher numbers increases the outlet pressure.
3. Verify that the outlet pressure and the products of combustion are within the operating range as specified by the original equipment manufacturer.

1



Protective slide
After setting the required pressure setpoint:
1. Close protective slide.
2. Secure protective slide closed position with a screw

2



⚠ Read all instructions in this manual before installing. Perform steps in the order given. Have installed and serviced/ inspected by a qualified service technician, at least annually. Failure to comply could result in severe personal injury, death or substantial property damage.

⚠ A calibrated flue gas analyzer must be utilized to properly adjust appliances featuring DUNGS MBC controls. Failure to properly apply a flue gas analyzer can result in carbon monoxide emissions causing severe personal injury, death or substantial property damage.

⚠ Failure to follow all instructions can result in carbon monoxide emissions causing severe personal injury or death.

MBC...SE S02 & MBC N

1. Open protective slide located at the bottom of the valve.
2. See Fig. 1 & 2 for low fire adjustments.
3. See Fig. 3 for high fire adjustments

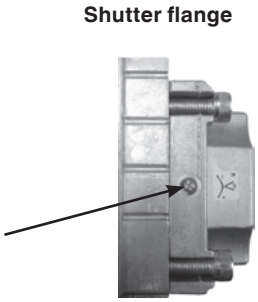
NOTE: There will be a slight delay between the adjustments and the response of the flue gas measuring equipment.

NOTE: Making high fire adjustments can affect the low fire setting, and vice versa. Therefore, modulate the equipment up and down at least three times to double check the low fire and high fire emissions after making adjustments.

High Fire setting using Shutter flange

1. With valve energized and flame established, drive the appliance to high fire.
2. Use a slotted screwdriver to adjust the gas/air ratio concentration for the application.
   Turn the adjustment towards the – symbol to decrease gas flow.
   Turn the adjustment towards the + symbol to increase gas flow.
3. Verify that products of combustion are within the operating range as specified by the original equipment manufacturer.

3



Low Fire setting using MBC regulator

1. With valve energized and flame established, adjust the fan speed to the minimum firing rate for the appliance.
   - It is important to only adjust the low fire gas / air ratio concentration for the application while the appliance is operating at its minimum firing rate.
   - The minimum negative signal to zero governor must be at least -0.2 "WC. This can be measured at the test port downstream both safety shutoff valves with the blower on and running at the minimum firing rate RPM.
   - **NOTE:** Both safety shutoff valves must be closed to read this signal pressure. This will be a negative pressure/vacuum signal.
2. Using a 2.5mm Metric Allen key, adjust the offset pressure to the gas / air ratio concentration for the application.
   Turn the adjustment towards the – symbol to decrease the outlet pressure.
   Turn the adjustment towards the + symbol to increase the outlet pressure.
3. Verify that products of combustion are within the operating range as specified by the original equipment manufacturer.

Changing coil

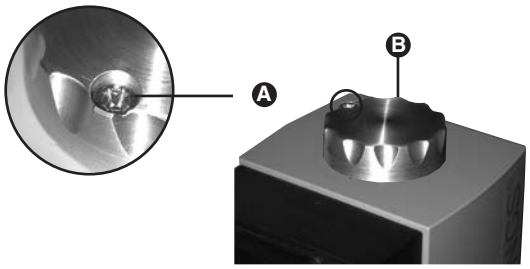
MBC-1000/2500

1. **Shut off gas supply and disconnect power supply!**
2. Undo locking screw A, Fig. 1
3. Remove cover B, Fig. 2
4. Exchange solenoid, Fig. 3

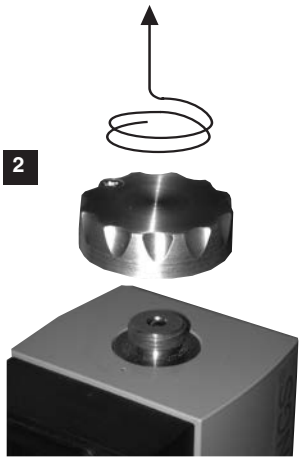
Always observe solenoid No. and voltage!

5. Replace cover B, tighten by hand, Fig. 4
6. Screw in locking screw A to stop, Fig. 5

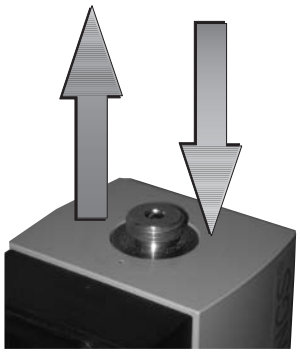
1



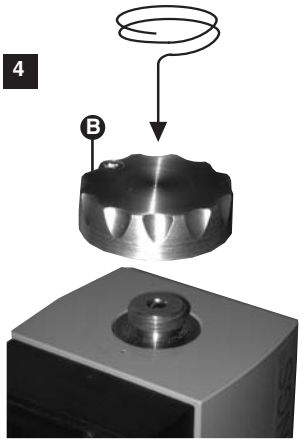
2



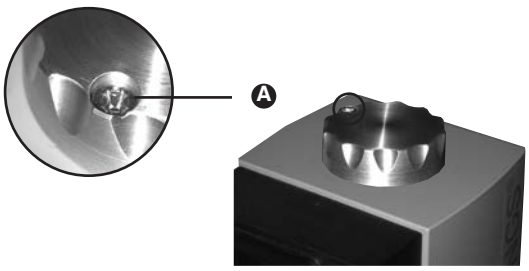
3



4



5



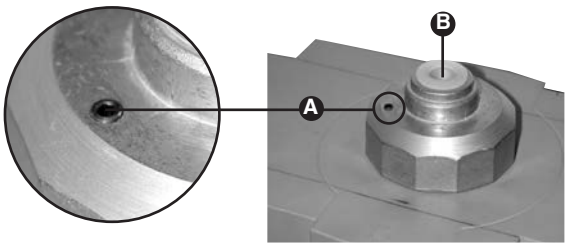
MBC-4000

1. **Shut off gas supply and disconnect power supply!**
2. Undo locking screw A, Fig. 1.
3. Remove cover B, Fig. 2.
4. Carefully lift off solenoid cover, Fig. 3.
5. Disconnect grounding and PCB connectors, Fig. 4.
6. Replace solenoid, Fig. 5

Note:
Coil V1 wire connection black/white
Coil V2 wire connection red/blue
Replacement solenoid is complete assembled.

7. Make electrical connections. Assemble in reverse order.
8. Reattach cover B, tighten securely by hand only, Fig. 6.
9. Tighten lock screw A as far as the stop, Fig. 7.

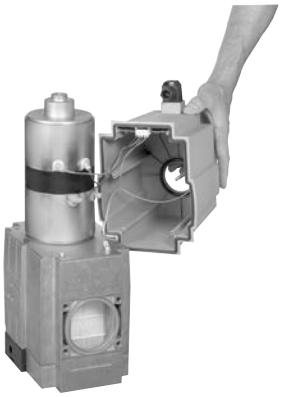
1



2

3

4



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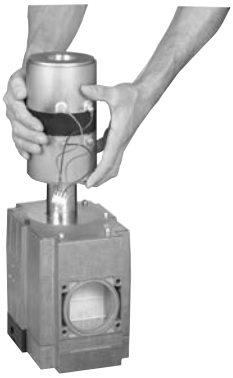

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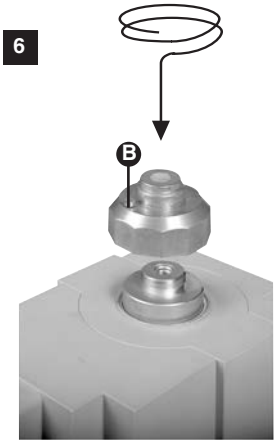

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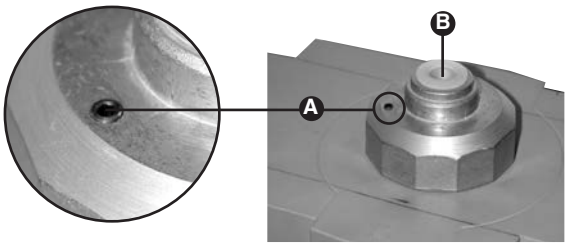


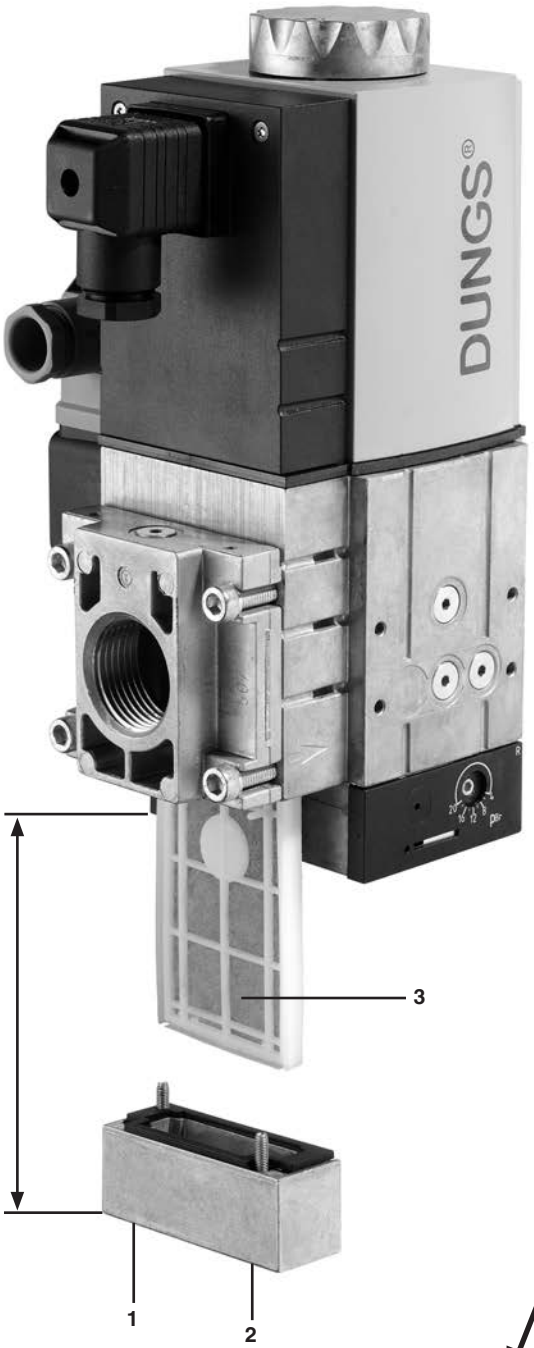
Internal Filter

Inspect the filter at least once a year.
Change the filter, if Δp between pressure connections 1 and 2 > 4" W.C.

Change the filter, if Δp between pressure connections 1 and 2 is twice as high compared to the last inspection.

1. Interrupt gas supply: close upstream ball valve
2. Remove screws 1-2
3. Change filter insert 3
4. Screw in screws 1-2 without using any force and fasten 22 in. lbs (2.5 Nm).
5. Perform leakage and function test, p_{max} = 5 PSI

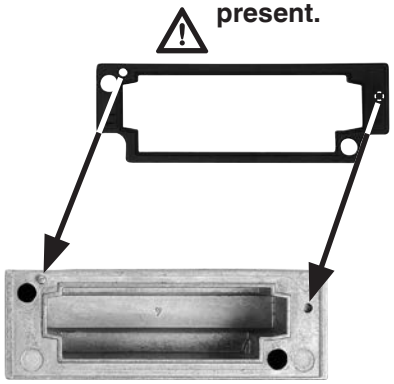
1



Space requirements for fitting filter:

MBC-1000-...: 6"
MBC-2500-...: 7"
MBC-4000-...: 9"

For production date codes May 2007 or newer, this feature is present.

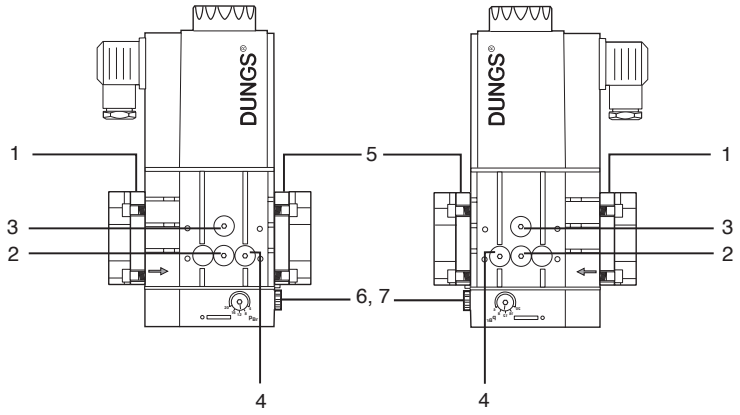


Test Ports

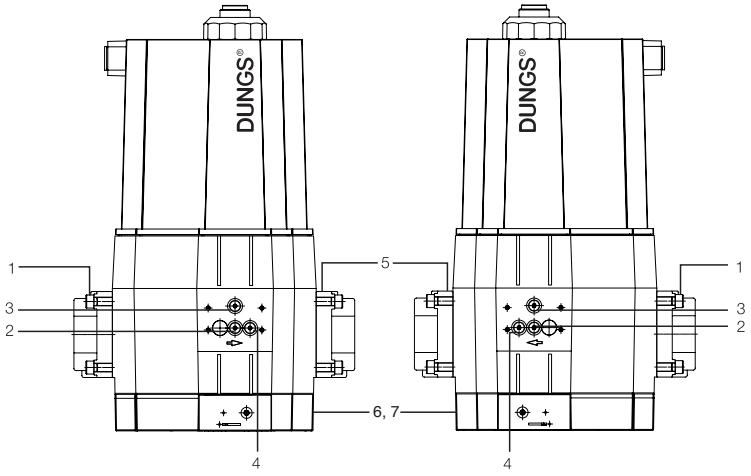
The G ⅛ ISO 228 taps are available on both sides upstream V1, between V1 and V2, downstream V2, and on both flanges. The G ⅛ tes nipple (P/N 219-008) can be screwed in any of these pressure tap ports.

Pressure taps

MBC-1000/2500…

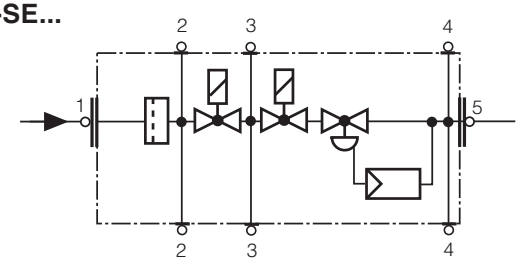


MBC-4000…



6
Air pressure signal
7
Combustion chamber pressure

MBC-SE...



1, 2, 3, 4, 5
G 1/8 Screw plug

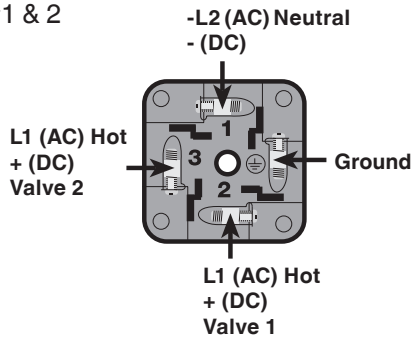
Valve Leakage Decay Test

This test method is an alternative to bubble tightness testing in case there is no manually operated shutoff valve installed downstream of the MBC.

Preparation for leak testing:

1) Ensure that the appliance is not in operation.
2) This test requires:
   - A manometer capable of reading +/- 0.1"WC.
   - A stopwatch.
   - A hose barb connection that fits to manometer and the valve test port.
3) The manual shutoff valve upstream of the MBC must remain open during this test. In addition, the manual shutoff valve downstream of the MBC, if installed, must remain open during this test.
4) The test also requires the ability to open and close safety valve #1 and safety valve #2 independently using the voltage as indicated on the coil.
5) Externally leak test the valve and all piping connected to the valve including the upstream manual shutoff valve and the manometer connection. DUNGS recommends using an all purpose liquid leak detector solution (Snoop™ or a non-aggressive soapy water solution). The presence of bubbles indicates a leak.
6) The DIN connector of the MBC Valve has three connections that provide power to the coil along with a ground connection. Pin numbers indicated on DIN connector.

Pin # 2 = Line voltage Valve #1
Pin # 3 = Line voltage Valve #2
Pin # 1 = Neutral Valve #1 & 2
⏚ = Ground



Procedure for Testing Valve #1

1) Connect a manometer to Port 2 on the side of the MBC
2) Determine the test time according the valve size, as indicated on table 1.
3) Energize valve 2 by powering terminal 3 with the voltage indicated on the coil housing. Ensure that terminal #1 is connected to Neutral and that the safety ground is also connected to ground.
4) Mark the pressure reading on the manometer, which should be zero.
5) With a stopwatch ready, de-energize valve 2 and immediately start the timer. Watch the manometer for pressure change.
6) As soon as the test time expires, determine the amount of pressure rise. Reference table 2 for action to be taken.

Procedure for Testing Valve #2

1) Connect a manometer to Port 2 on the side of the MBC
2) Determine the test time according the valve size, as indicated on table 1.
3) Energize valve 1 by powering terminal 2 with the voltage indicated on the coil housing. Ensure that terminal #1 is connected to Neutral and that the safety ground is also connected to ground.
4) Mark the pressure reading on the manometer, which should be equal to the inlet pressure to the valve.
5) With a stopwatch ready, de-energize valve 1 and immediately start the timer. Watch the manometer for pressure change.
6) As soon as the test time expires, determine the amount of pressure change. Reference table 2 for action to be taken.

After completing the above tests:

1) Remove the manometer, and close Port 2.
2) Use soapy water to leak test all connections including Port 2 to ensure that there are no leaks.

Leakage rates according to UL 429 and ANSI Z21.21			
	Test time (s)	**Allowable leakage (cc/hr)**	**Maximum pressure drop (in. W.C.)**
MBC 1000	4.0	235.0	2.0
MBC 2500	5.0	305.0	2.0
MBC 4000	6.0	470.0	2.0

Analysis of test results		
Pressure drop / rise (in. W.C.)	**Acceptable**	**Test results**
2.0 or less	Yes	Pass
More than 2.0	No	Fail - Immediately replace valve

Valve Leakage Bubble Test (Altern. method)

This leak test procedure tests the external sealing and valve seat sealing capabilities of the MBC automatic safety shutoff valve. Only qualified personnel should perform this test.

It is required that this test be done on the initial system startup, and then repeated at least annually. Possibly more often depending on the application, environmental parameters, and the requirements of the authority having jurisdiction.

Setup

This test requires the following:

A) Test nipples installed in the downstream pressure tap port of each automatic safety shutoff valve to make the required 1/4" hose connection in step 4.

B) A transparent glass of water filled at least 1 inch from the bottom.

C) A proper leak test tube. An aluminum or copper 1/4" rigid tube with a 45˚ cut at the end that is then connected to a 1/4" flexible hose of some convenient length provides for a more accurate leakage measurement.
However, a 45˚ cut at the end of the 1/4" flexible hose will suffice, but it will not likely be as accurate as the rigid tube.

D) For detecting external leakages, an all purpose liquid leak detector solution or a soapy water solution is required.

Leak Test Procedure

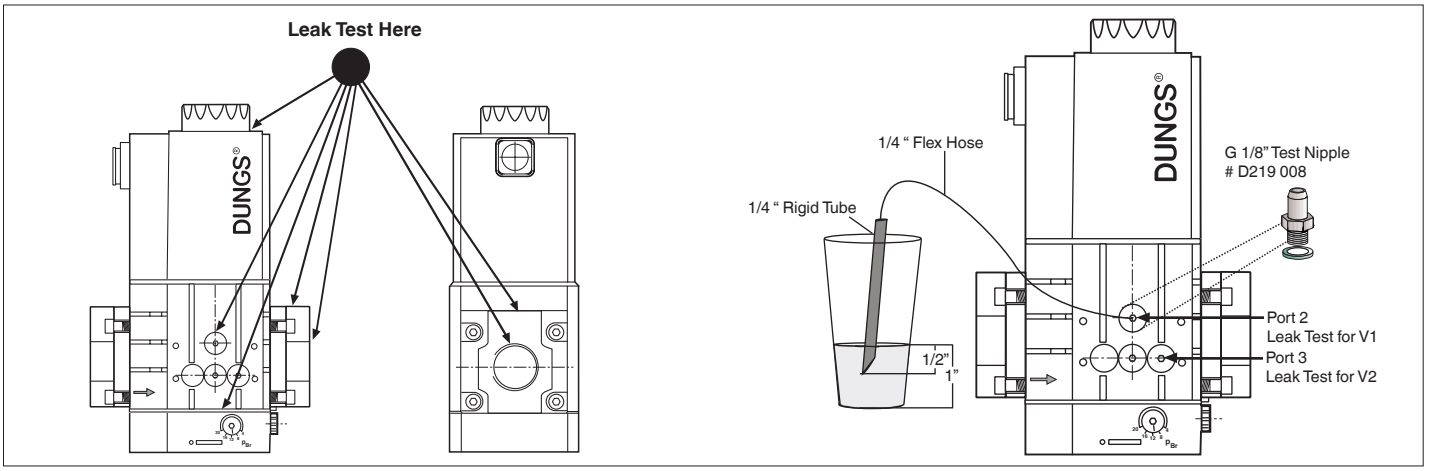
Use the illustration below as a reference.

1. With the upstream ball valve open, the downstream ball valve closed and both valves energized, apply an all purpose liquid leak detector solution to the "External Leakage Test Areas" indicated in the illustration below, to any accessories mounted to the safety valve, and to all gas piping and gas components downstream the equipment isolation valve, and the inlet and outlet gas piping of the automatic safety shutoff valve. The presence of bubbles indicates a leak, which needs to be rectified before proceeding.
2. Then, de-energize the burner system and verify that both automatic safety shutoff valves are closed.
3. Close the upstream and downstream manual ball valve.
4. Using a screwdriver, slowly open the V1 test nipple (port 2) by turning it counter clockwise to depressurize the volume between the two valves, and connect the 1/4" flexible hose to the test nipple.
5. Slowly open the upstream manual ball valve, and then provide for some time to allow potential leakage to charge the test chamber before measuring the valve seat leakage.
6. Immerse the 1/4 in. tube vertically 1/2 in. (12.7 mm) below the water surface. If bubbles emerge from the ¼" tube and after the leakage rate has stabilized, count the number of bubbles appearing during a 10 second period. (See chart below for allowable leakage rates.)
7. Repeat the same procedure for valve V2 (port 3). (Energize terminal 2 on the DIN connector to open valve 1)

After completing the above tests proceed as follows:

8. Verify that the downstream manual ball valve is closed, and both automatic safety shutoff valves are de-energized.
9. Remove the flexible hose, and close all test nipples.
10. With the upstream manual ball valve open, energize both automatic safety shutoff valves.
11. Use soapy water to leak test all test nipples to ensure that there are no leaks.
12. If no leakage is detected, de-energize all automatic safety shutoff valves, and open the downstream manual ball valve.

If leakage values are exceeded, replace valve immediately.

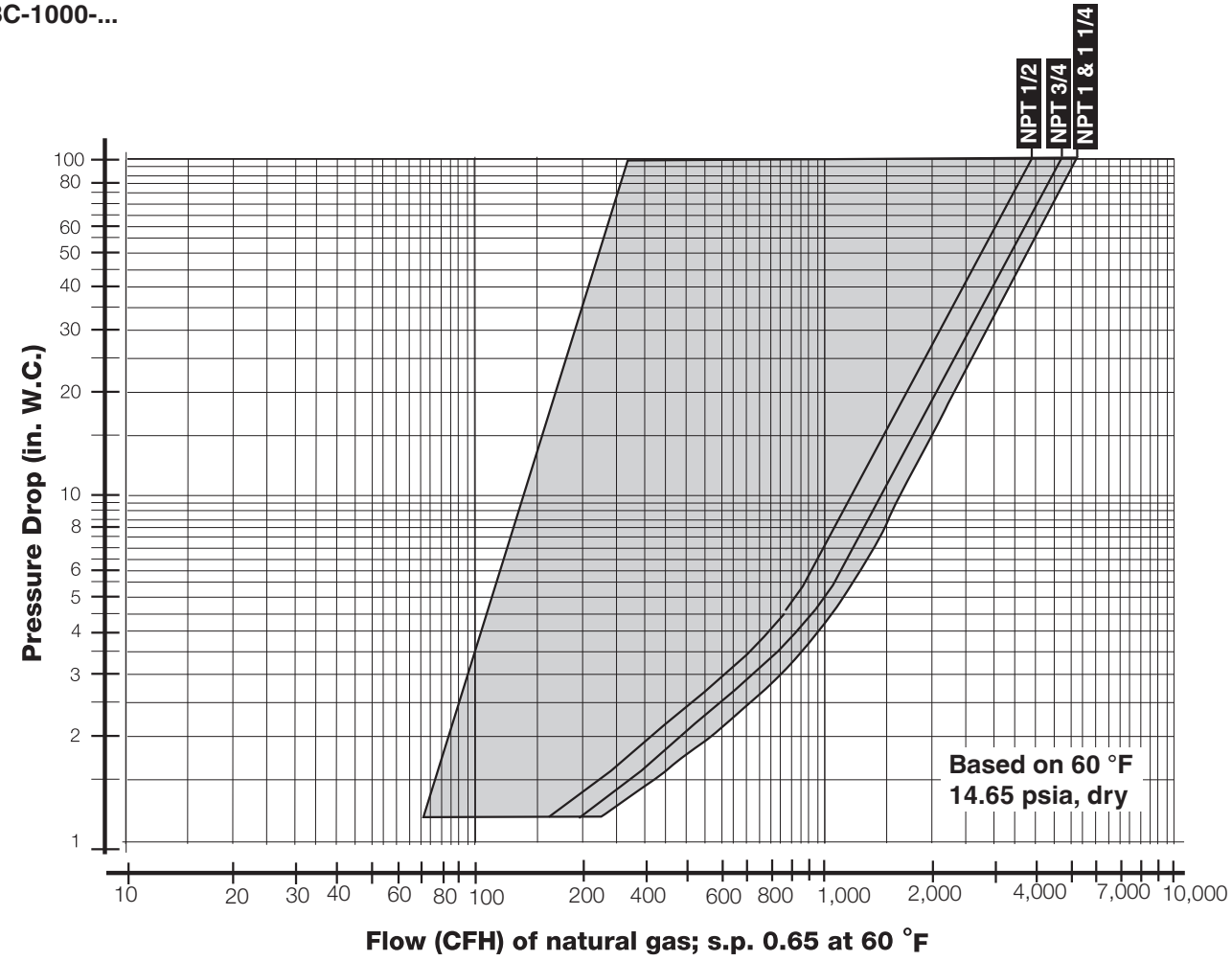


Type	Allowable Valve Seat Leakage* up to 7 PSI inlet	# of Bubbles in 10 s		
		Air	Natural Gas	LP
MBC 1000	235 cc/hr	5	6	4
MBC 2500	305 cc/hr	7	8	6
MBC 4000	470 cc/hr	10	11	9

*Based on air and test conditions per UL 429 Section 29. (Air or inert gas at a pressure of 1/4 psig and also at a pressure of one and one-half times maximum operating pressure differential, but not less than 1/2 psig. This test shall be applied with the valve installed in its intended position.) Volume of bubble defined in Table 2 of FCI 70-2-1998.

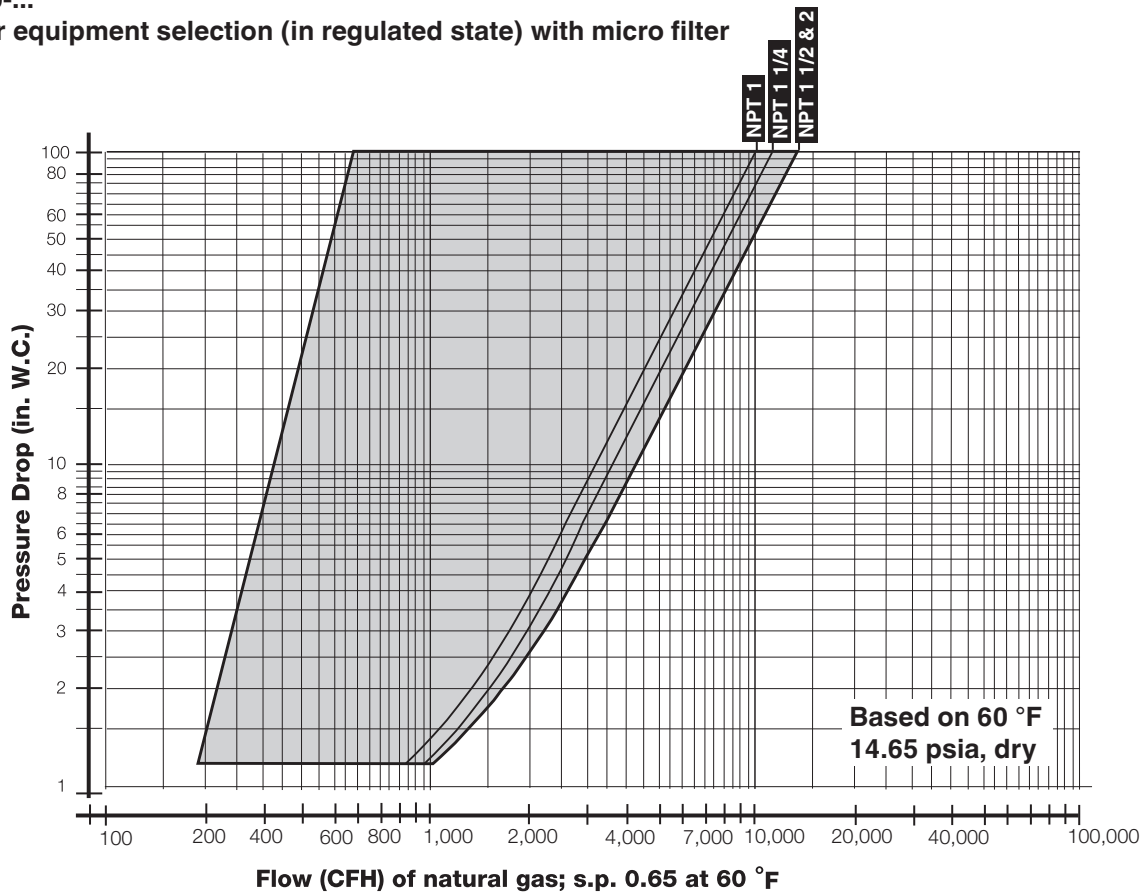
Flow Curve

MBC-1000-...

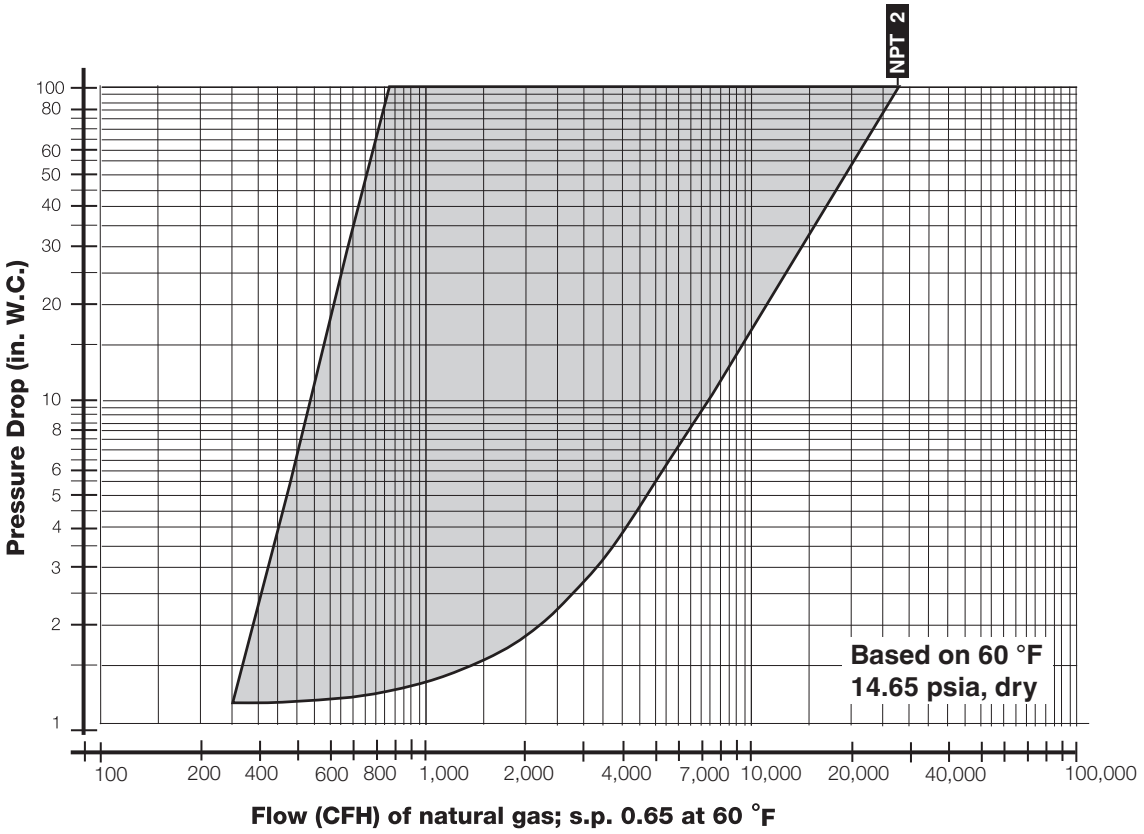


MBC-2500-...

Curves for equipment selection (in regulated state) with micro filter



MBC-4000-...
Curves for equipment selection (in regulated state) with micro filter



Pressure Drop for other Gases

To determine the pressure drop when using a gas other than natural gas, use the flow formula below and f value located in the table below to determine the "corrected" flow rate in CFH through the valve for the other gas used. For example, when using propane, divide the volume (CFH) of propane required for the application by the calculated value f (f = 0.66 for propane). Use this "corrected" flow rate and the flow curve on the next page to determine pressure drop for propane.

Determining equivalent flow through valves using another gas

$$\dot{V}_{\text{gas used}} = \dot{V}_{\text{Natural gas}} \times f$$

$$f = \sqrt{\frac{\text{Density of Natural gas}}{\text{Density of gas used}}}$$

Type of gas	Density [kg/m³]	s.g.	f
Natural gas	0.81	0.65	1.00
Butane	2.39	1.95	0.58
Propane	1.86	1.50	0.66
Air	1.24	1.00	0.80

Accessories & Replacement		
1/4" NPT port 1 or port 2 adapter (reduced port)	225-047	
1/2" NPT port 2 pilot gas adapter (reduced port)	225-043	
G 1/8" Test nipple with gasket	219-008	
Gasket for G 1/8" Test nipple	171-260	
Port 3 pressure switch mounting adapter	214-975	
DUNGS DIN Connector	210-310	Ordered separately on CSA / FM versions
Burkert DIN Connector for UL Listing	253-731	included as standard on UL and UR versions
Conduit Adapter	240-671	for use with 210-310

Valve Description	Flange	NPT P/N	O-ring and bolt kit P/N
MBC 1000	1/2"	222-371	224-093
	3/4"	222-368	224-093
	1"	221-999	224-093
	1 1/4"	231-718	224-093
	1 1/2"	244-021	224-093
MBC 2500/4000	1"	222-369	224-094
	1 1/4"	222-370	224-094
	1 1/2"	222-003	224-094
	2"	221-997	224-094
*Includes two o-rings and two sets of bolts (one set of four bolts for each flange).			
**Includes four bolts and one o-ring.			

Shutter Flanges		
Part description	**MBC 1000**	**MBC 2500 / MBC 4000**
1 " NPT (flange only)	253-205	256-789
1" NPT Flange set (with o-ring and 4 screws)	255-132	256-791
1.5" NPT (flange only)	NA	253-206
1.5" NPT Flange set (with o-ring and 4 screws)	NA	255-133

Replacement Coils				
Valve	**120 VAC**	**24 VAC**	**12 VDC**	**24 VDC**
MBC 1000	250-371	250-680	251-136	252-191
MBC 2500	250-175	250-681	251-226	252-192
MBC 4000	252-613	not available	not available	252-193
Printed wiring board is not replaceable				

Karl Dungs Inc.
3890 Pheasant Ridge Drive NE
Suite 150
Blaine, MN 55449, U.S.A.
Phone 763 582-1700
Fax 763 582-1799
e-mail info@karldungsusa.com
Internet http://www.dungs.com/usa/

Karl Dungs GmbH & Co. KG
P.O. Box 12 29
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e-mail info@dungs.com
Internet http://www.dungs.com

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APPENDIX E

Siemens Gas Valve

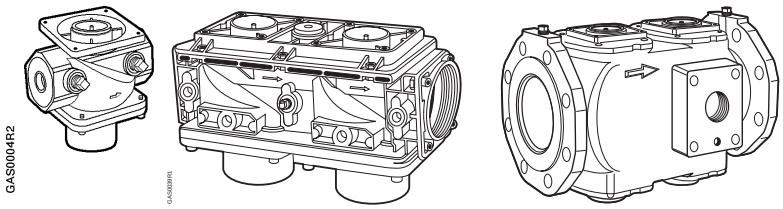
(M5M 3500 - 6000)

SIEMENS

Technical Instructions
Document No. 155-512P25
VG…
August 11, 2005

VG Series

VGG… and VGD… Gas Valves for use with SKP… Electro-hydraulic Actuators



VGG… **VGD20…** **VGD40…**

ISO 9001 and 14000 REGISTERED FIRM

GAS0001H2

UL LISTED

FM APPROVED

Only when assembled to SKP… Series actuators

Description

The normally closed VG… Series of modular single and double-body gas valves combined with SKP… Series electro-hydraulic actuators provide safety shut-off, gas pressure regulation and air/gas ratio control for commercial and industrial gas burners.

Table 1. Legend.

Model Numbers	Body Style	Connection
VGG…	Single	NPT Threaded
VGD…	Double	NPT Threaded or ANSI Flanged

Features

All Models

- UL listed, FM approved, CSA certified, IRI approvable, ISO 9001 and 14000 certified. European, Australian and Japanese approved versions available.
- Stainless steel mesh inlet filter protects the valve seat(s) as well as downstream components.
- 1/4-inch NPT pressure taps on the inlet and outlet. (See Table 2 for details).
- Dual stem guides ensure precise disc alignment and tight shut-off.

VGG… Models

- Contoured valve disc provides smooth release of gas and stable regulating control.
- 3/4-inch NPT port for pilot or vent line connection on 2-1/2 and 3-inch VGG…valves.

VGD20… Models

- Compact VGD20… double-valve bodies consist of two safety shut-off valves in series. The first (inlet) valve has a flat valve disc applicable for safety shut-off function only. The second (outlet) valve has a contoured valve disc for use with pressure regulating actuators (SKP2…, SKP5…, SKP7…).
- A one-inch NPT vent connection between the valves.
- Each VGD20… double-valve requires two threaded mounting flanges (AGAxxU). Each flange includes the necessary installation hardware (bolts, nuts and O-ring). Each mounting flange has a 1/4-inch NPT pressure tap. The flanges can be pre-mounted onto the pipe, and then bolted onto the VGD20… gas valve body. This feature eliminates the use of pipe unions and permits the gas valve assembly to be easily removed from a gas train.
- The overall dimensions of both the 1-1/2-inch and 2-inch AGAxxU flanges are identical. This permits a 1-1/2-inch flange to be mounted on a 2-inch valve body or vice versa.

NOTE: VGD20… valves and AGAxxU threaded flanges must be ordered as separate items (See Table 2).

VGD40… Models

- Compact VGD40… double-valve bodies consist of two safety shut-off valves in series.
- Each individual safety shut-off valve has double seats to achieve high flow.
- Patented seat construction with individual closing spring for each seat to assure reliable shut-off and high close-off pressure rating.
- Full port vent line connection plates are available.

NOTE: VGD40… valves and AGA… vent connection plates must be ordered as separate items (See Table 2).

Application

All VG… valves can be combined with any SKP… Series actuator. The actuator can be mounted while the valve is installed and under pressure.

SKP… regulating actuators are applicable for both low and high supply gas pressure applications, eliminating excessive regulator inventories. Maximum pressure ratings vary with valve size (See Table 2).

All VG… valves perform these functions in combination with each of the following actuators:

SKP15…	Safety shut-off
SKP25…	Safety shut-off and constant pressure regulation or zero governor.
SKP55…	Safety shut-off, pressure regulation and differential pressure air/gas ratio control.
SKP75…	Safety shut-off, pressure regulation and adjustable air/gas ratio control.

Since more than one function can be performed by a single valve, fewer components and fittings are required to assemble a gas train - significantly reducing both the size and weight of the gas train. In addition, smaller diameter gas valves can be used. For details on valve sizing see the Gas Flow Charts (Figures 4 and 5).

CAUTION:

Do not oversize valves equipped with a regulating SKP… actuator. Oversizing may limit turndown and could cause oscillations.

Ordering Information

Gas valves and actuators are ordered separately. For additional SKP… actuator information, see the following Technical Instructions:

SKP15…	155-751P25
SKP25…	155-752P25
SKP55…	155-753P25
SKP75…	155-754P25

Accessories

Manual adjusting throttle attachment AGA61 permits VG… series valves to be used as adjustable limiting orifice valves. Once adjusted, the AGA61 has a provision to be sealed from tampering (See Table 3).

Adapter plate AGA60 permits VG… series valves to be used for modulating flow control when fitted with an SQX… series modulating actuator (See Table 3).

NOTE: The VG… /SQX… valve/actuator combination is designed strictly for modulating flow control and does not provide safety shut-off function.

Table 2. Product Numbers.

Product Number	Size	Maximum Operating Pressure psi	Close-off Pressure psi	Capacity CFH Natural Gas at ΔP=1" W.C.	Number of Test Points, 1/4" NPT		3/4" NPT Port	Valve Body Material
					Inlet	Outlet		
VGG10.154U	1/2" NPT	20	75	327/242◆	2	2	—	Aluminum
VGG10.204U	3/4" NPT	20	75	614/442◆	2	2	—	Aluminum
VGG10.254U	1" NPT	20	75	914/686◆	2	2	—	Aluminum
VGG10.404U	1-1/2" NPT	20	75	2,047/1,643◆	2	2	—	Aluminum
VGG10.504U	2" NPT	15	75	3,511	2	2	—	Aluminum
VGG10.654U	2-1/2" NPT	10	25	5,085	1	1	2-inlet	Cast Iron
VGG10.804U	3" NPT	10	25	6,158	1	1	2-inlet	Cast Iron
*VGD20.403U	1-1/2"	20	30	1,890	Two 1/4-inch and one 1-inch port between valves		—	Aluminum
*VGD20.503U	2"	15	30	2,300			—	Aluminum
*AGA41U	Single 1-1/2" connecting flange with 1/4-inch port for VGD 20.403U						Two (2) needed per valve. Order separately	
*AGA51U	Single 2" connecting flange with 1/4-inch port for VGD 20.503U							
VGD40.065U	2-1/2" NPT	10	75	3,880	1	1	Two 1/4-inch NPT ports between the valves	Aluminum
VGD40.080U	3" NPT	10	75	5,370	1	1		Aluminum
VGD40.100U	4" Flanged	10	30	9,680	1	1		Aluminum
VGD40.150U	6" Flanged	10	30	17,490	1	1		Aluminum

* VGD20… double valves require 2 AGAxxU threaded flanges for installation.

◆ VGG… valves, 1/2- through 1-1/2 inch have reduced flow when used with AGA66 (NEMA 4 kit). Capacities shown are without/with NEMA 4 kit (See Figure 4a).

Table 3. Accessories.

Part Number	Description	Notes
AGA40.6580U	Vent connection plate with 1-1/4" NPT vent connection and 1/4" NPT test port	Order separately. For use with VGD40… only.
AGA40.0100U	Vent connection plate with 2" NPT vent connection and 1/4" NPT test port	
AGA40.0150U	Vent connection plate with 2-1/2" NPT vent connection and 1/4" NPT test port	
AGA60	Adapter for use with SQX… actuators	
AGA61	Manual operation kit, allows VG… valves to be used as adjustable limiting orifice valve.	
AGA66	Sealing gasket to provide NEMA 3, NEMA 3R, and NEMA 4 protection.	

Specifications

Approvals	Agency approvals/standards	UL/429, FM/7400, CSA/AINSI Z21.21/CGA 6.5 Commercial/Industrial IRI approvable Agency marks apply only for VGxxx.xxxU series gas valve bodies assembled with SKPxx.xxxU actuators.
Operating Environment	Maximum operating pressure	See Table 2
	Maximum back pressure (differential)	2.5 psi (150 mbar)
	Close-off pressure	See Table 2
	Permissible gases	Natural gas, propane, butane, air, and other non-corrosive gases.
	Permissible gas temperature	5°F to 140°F (-15°C to 60°C)
	Permissible operating temperature	5°F to 140°F (-15°C to 60°C)
	Mounting	Any position except upside down
Physical Characteristics	Body materials	See Table 2
	Weight	See Tables 4 through 7
Connections	Pipe connections	NPT or ANSI Class 150 flange (See Table 2)
	Pressure and vent taps	See Table 2

Operation

All VG… gas valves are normally closed, two-way valves. The valves have a standard, integral, stainless steel mesh filter (0.8 mm) in the inlet to protect the downstream components against contamination.

VGG… series gas valves have a contoured valve disc for stable regulating control and smooth release of gas (see Figure 1).

VGD20… double valves consist of two valves in series. The first (inlet) valve has a flat valve disc suitable for the safety shut-off function only. The second (outlet) valve has a contoured valve disc for stable regulating control and smooth release of gas (see Figure 2).

VGD40… double valves consist of two valves in series. Each valve has a double seat to achieve high flow (see Figure 3).

All valves have 1/4-inch NPT ports for pressure test connection. The 2-1/2-inch and 3-inch VGG… valves have an additional 3/4-inch NPT port for a pilot connection. The VGD20… valves have a 1-inch NPT port for a vent line connection. The VGD40… valves can be equipped with a full size vent connection plate.

See Table 1 for details on ports and vent connection plates.

Operation, Continued

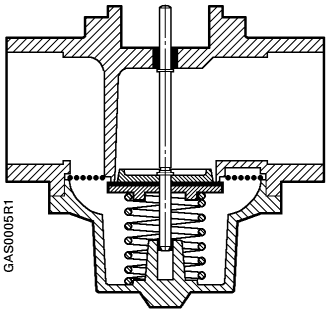


Figure 1. VGG… Models.

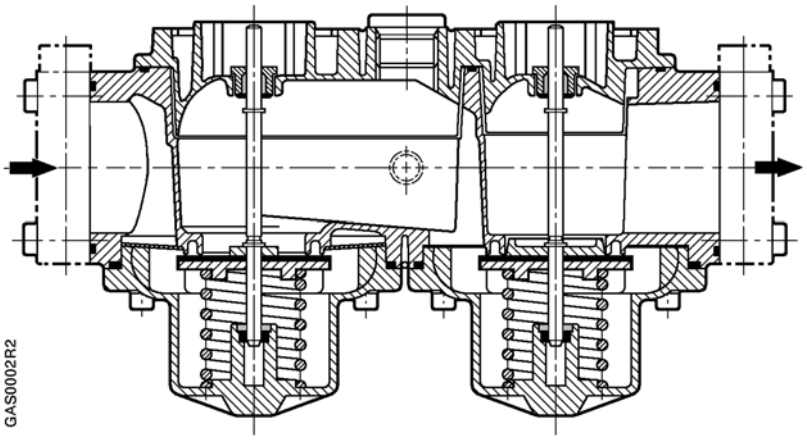


Figure 2. VGD20… Models.

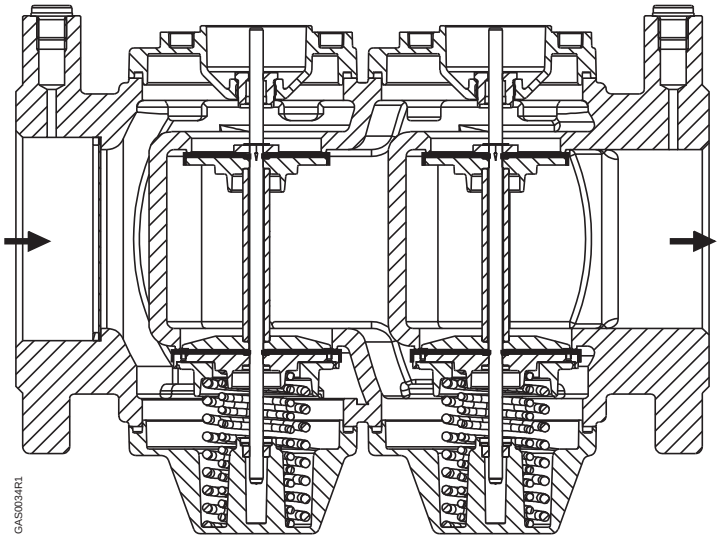


Figure 3. VGD40… Models.

Gas Flow Charts

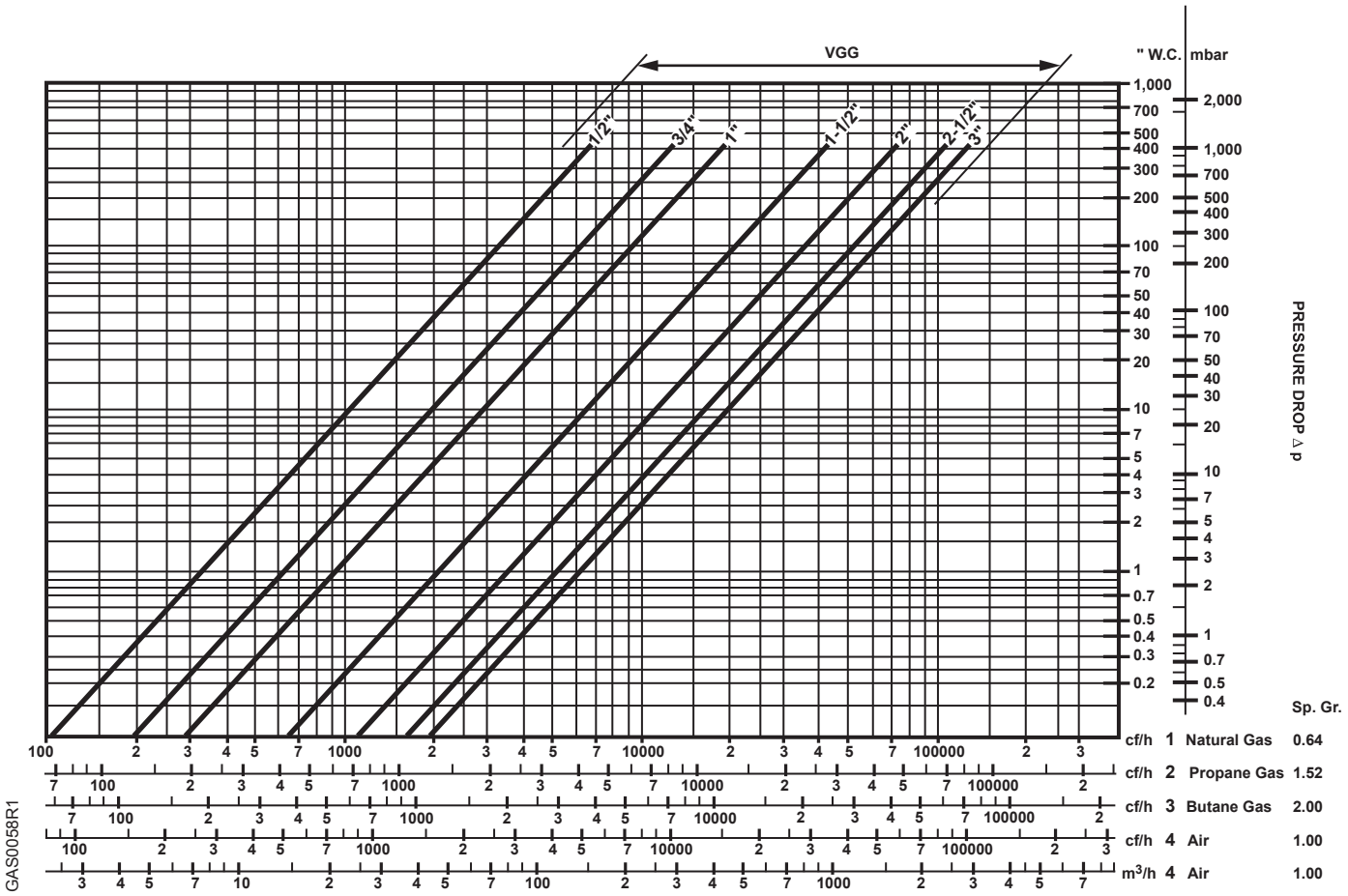


Figure 4. Sizing Single Valves Without NEMA 4 Kit.

NOTE: Pressure drop is for one valve when using an SKPx5…actuator without a NEMA 4 kit (AGA66).

CAUTION:

Do not oversize valves equipped with regulating actuators SKP2…, SKP5… or SKP7… Oversizing may limit turndown and could cause oscillations.

Gas Flow Charts, Continued

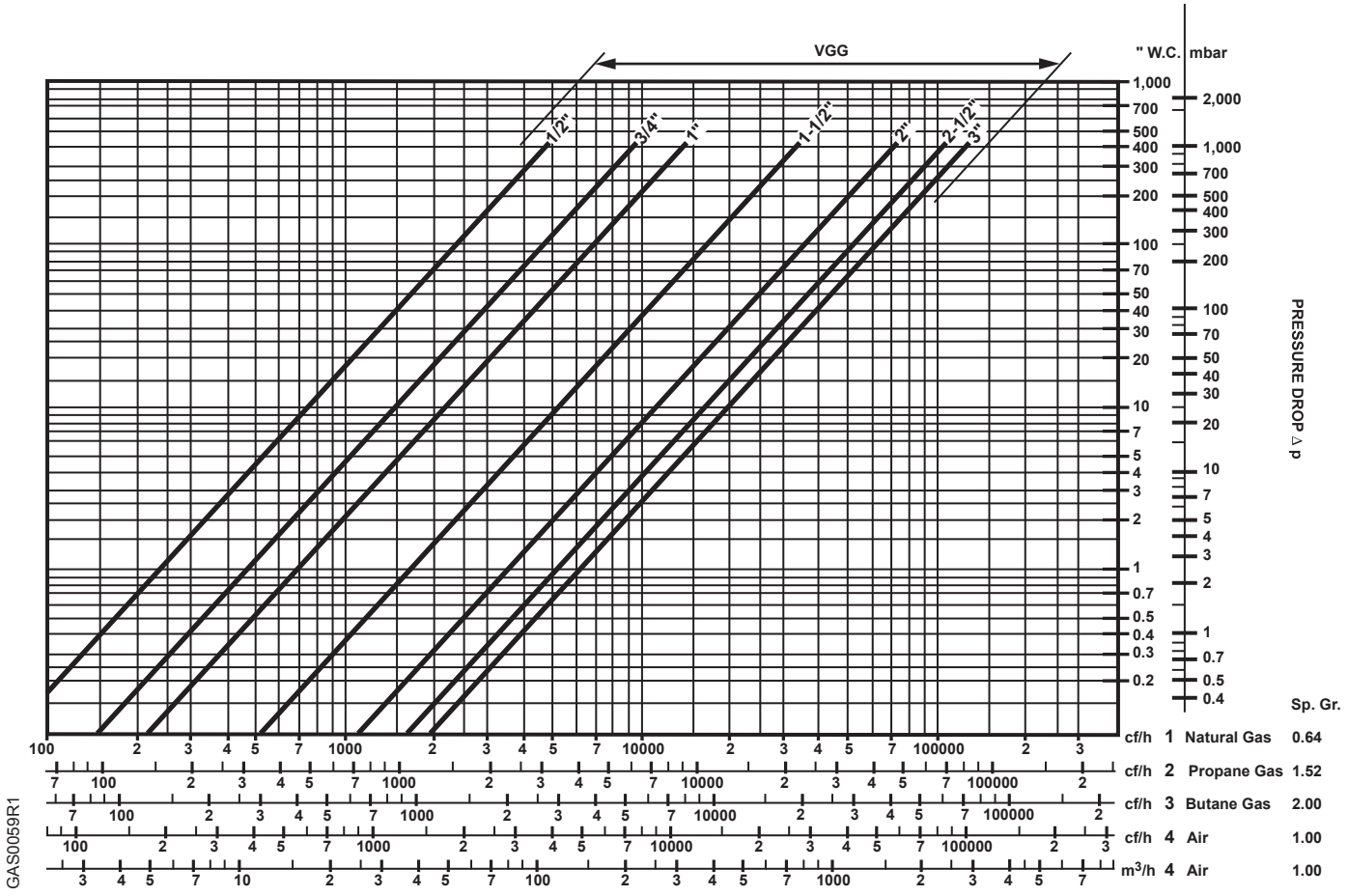


Figure 4a. Sizing Single Valves With a NEMA 4 Kit.

NOTE: Pressure drop is for one valve when using an SKPx5…actuator and a NEMA 4 kit (AGA66).

CAUTION:

Do not oversize valves equipped with regulating actuators SKP2…, SKP5… or SKP7… Oversizing may limit turndown and could cause oscillations.

Gas Flow Charts, Continued

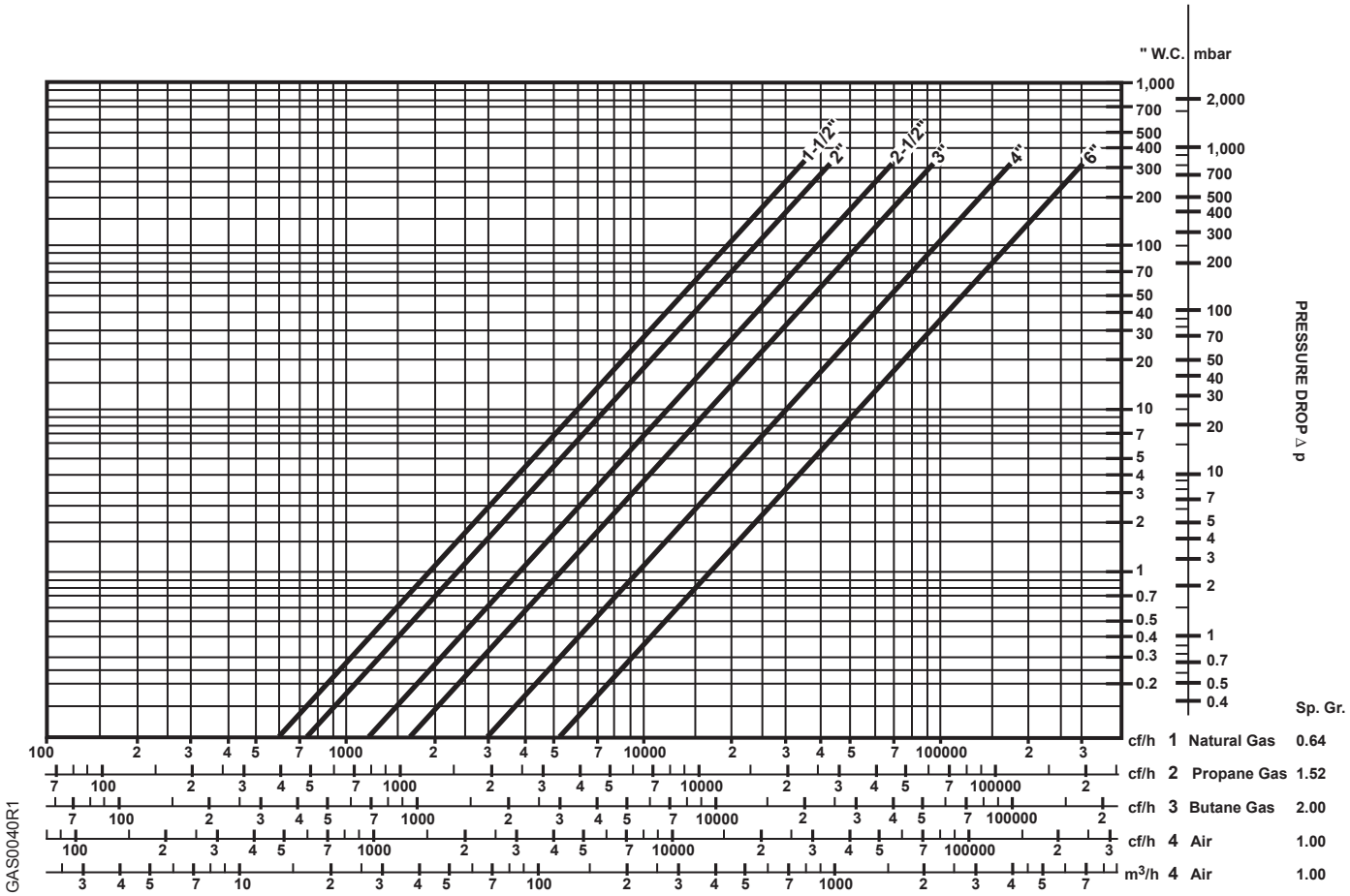


Figure 5. Sizing Double Valves.

NOTE: Pressure drop is total drop across both valves when using an SKPx5… actuator, with or without an AGA66.

CAUTION:

Do not oversize valves equipped with regulating actuators SKP2…, SKP5… or SKP7… Oversizing may limit turndown and could cause oscillations.

Dimensions

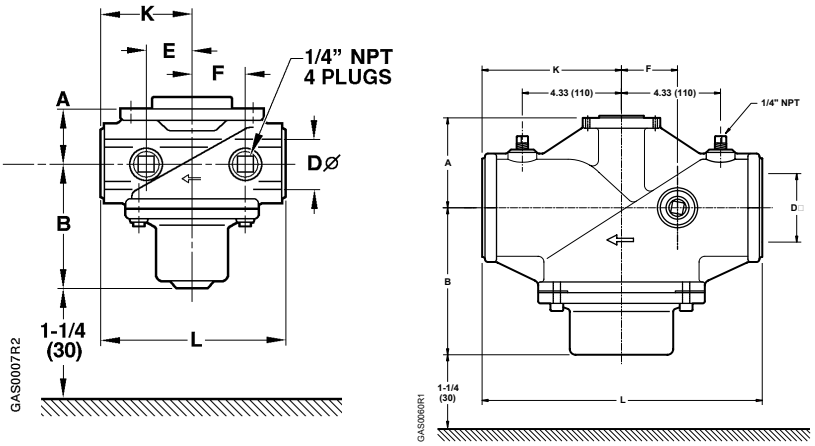


Table 4. VGG… Models.

Valve Model	Nominal Size D Inches	A Inches (mm)	B Inches (mm)	E Inches (mm)	F Inches (mm)	K Inches (mm)	L Inches (mm)	Weight Pounds (kg)
VGG…	1/2	1-1/4 (32)	3-1/8 (79)	1-1/8 (28)	1-7/32 (31)	2-3/16 (55)	4-3/8 (110)	1.65 (0.75)
	3/4	1-1/4 (32)	3-1/8 (79)	1-1/8 (28)	1-7/32 (31)	2-3/16 (55)	4-3/8 (110)	1.65 (0.75)
	1	1-1/4 (32)	3-18 (79)	1-1/8 (28)	1-7/32 (31)	2-3/16 (55)	4-3/8 (110)	1.5 (0.7)
	1-1/2	1-5/8 (41)	4 (102)	1-5/16 (34)	1-5/16 (34)	3 (75)	5-15/16 (150)	3.3 (1.5)
	2	2 (50)	4-1/4 (107)	1-5/16 (34)	1-5/16) (34)	3-3/8 (85)	6-3/4 (170)	4.0 (1.8)
	2-1/2	3-5/8 (92)	6-7/16 (163)	—	2-7/16 (62)	5-11/16 (145)	11-7/16 (290)	32.5 (14.8)
	3	3-15/16 (100)	6-7/16 (163)	—	2-7/16 (62)	6-1/16 (155)	12-3/16 (310)	34 (15.5)

Dimensions, Continued

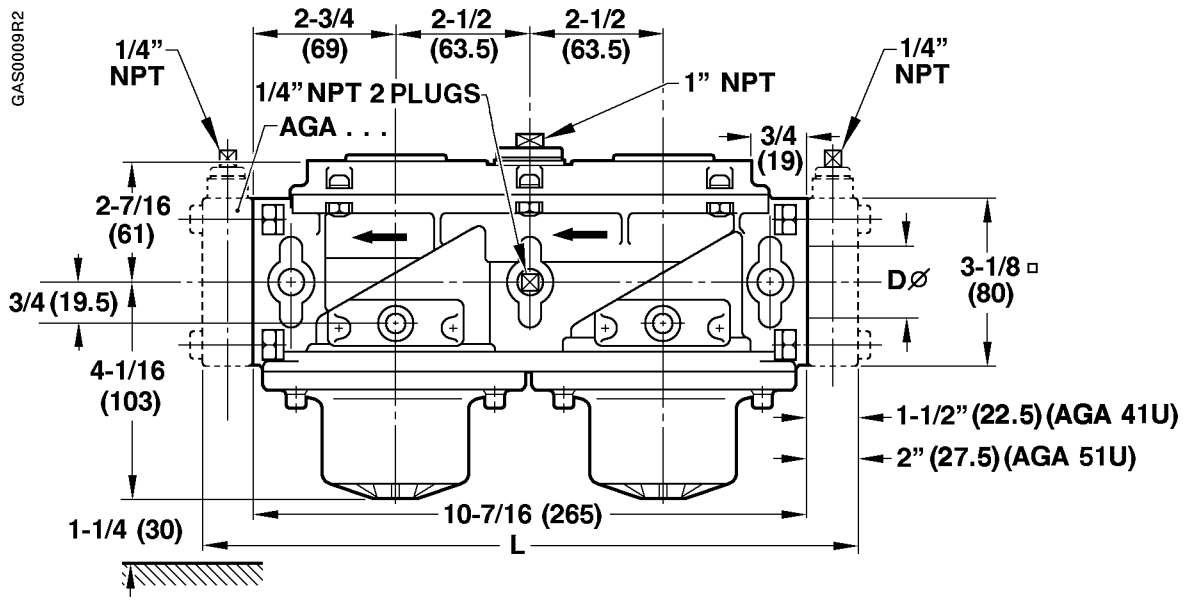


Table 5. VGD20… Models.

Valve Model	Nominal Size D Inches	L Inches (mm)	Weight Pounds (kg)
VGD20…	1-1/2	12-3/16 (310)	7 (3.2)
	2	12-5/8 (320)	6 (3.15)

Dimensions, Continued

Dimensions in Inches (mm)

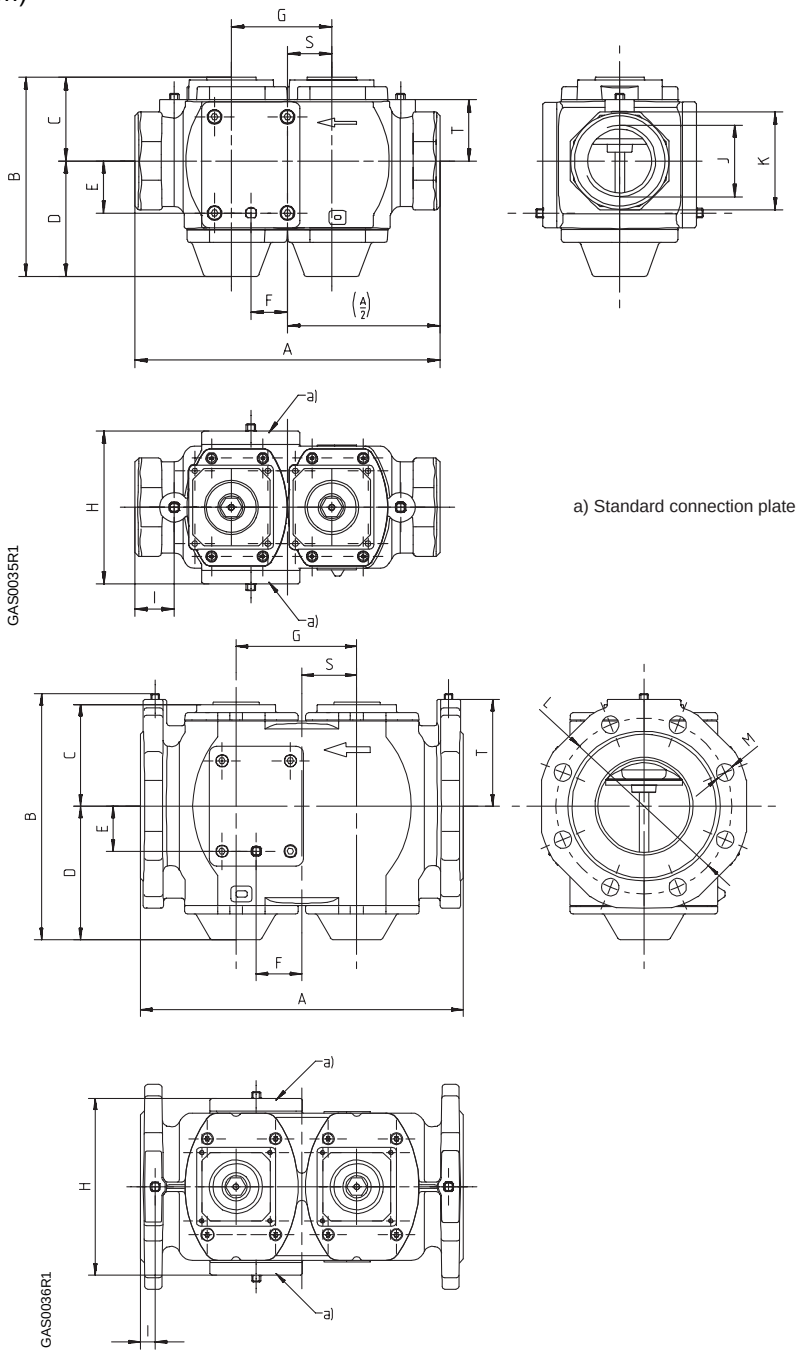


Table 6. VGD40… Models.

Valve Model	A	B	C	D	E	F	G	H	I	J	K *	L	M	S	T
VGD40.065U	12.09 (307)	7.00 (203)	3.25 (83)	4.63 (118)	2.09 (53)	1.46 (37)	4.02 (102)	6.14 (156)	1.57 (40)	2-1/2" NPT	SW 100	—	—	1.77 (45)	2.44 (62)
VGD40.080U	12.87 (327)	8.94 (227)	3.64 (93)	5.18 (132)	1.85 (47)	0.79 (20)	4.21 (107)	6.30 (160)	1.85 (47)	3" NPT	SW 120	—	—	2.34 (60)	2.83 (72)
VGD40.100U	13.78 (350)	10.50 (267)	4.33 (110)	5.70 (145)	1.93 (49)	1.95 (50)	5.16 (131)	7.56 (192)	0.63 (16)	—	—	d=7.50 (191)	d=0.75 (19)	2.34 (60)	4.55 (116)
VGD40.150U	18.90 (480)	13.29 (338)	5.71 (145)	7.40 (188)	2.09 (53)	2.30 (59)	6.61 (168)	10.31 (262)	0.63 (16)	—	—	d=9.49 (241)	d=0.91 (23)	3.54 (90)	5.61 (143)

* Spanner width in millimeters

Dimensions, Continued

Option a) Connection plate with 1/4" NPT plugged pressure test port
b) Vent connection plate with vent line connection and 1/4" NPT plugged pressure test port

Note: Plates a) and b) are interchangeable

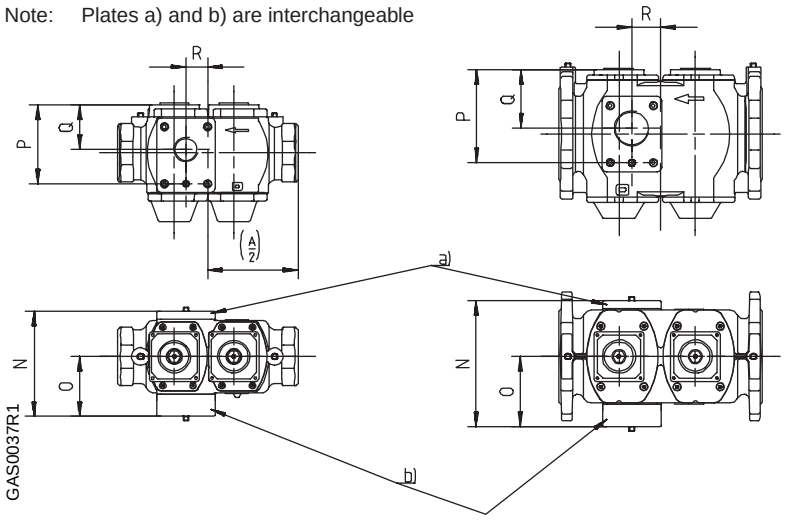
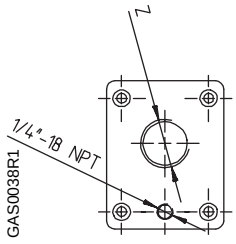


Table 7. VGD40… Dimensions in Inches (Millimeters).

Valve Model	N	O	P	Q	R	Weight Pounds (kg)
VGD40.065U	7.13 (181)	4.06 (103)	5.34 (136)	3.02 (77)	1.46 (37)	16 (7)
VGD40.080U	7.28 (185)	4.13 (105)	5.49 (140)	3.17 (81)	0.79 (20)	19 (3)
VGD40.100U	8.54 (217)	4.76 (121)	6.26 (159)	3.94 (100)	1.95 (50)	29 (13)
VGD40.150U	11.30 (287)	6.14 (156)	7.80 (198)	5.47 (139)	2.30 (59)	53 (24)

Table 8. Vent Connection Plate Dimensions.



	VGD40.065U	VGD40.080U	VGD40.100U	VGD40.150U	Thread Vent Connection Size
AGA40.6580U	X	X			1-1/4" NPT
AGA40.0100U			X		2" NPT
AGA40.0150U				X	2-1/2" NPT

SIEMENS

Technical Instructions
Document No. 155-754
SKP75…U..
July 1, 2005

SKP Series

SKP75…U.. Air/Gas Ratio Controlling Gas Valve Actuator with Safety Shutoff Function

ISO 9001 and 14000 REGISTERED FIRM
GAS9001R2
LISTED
APPROVED

Only when assembled to Series VG… Gas valves

Description

SKP75… pressure regulating electro-hydraulic actuators are used in combination with VG… series gas valve bodies to provide shut-off and air/gas ratio control for industrial and commercial burner applications.

The SKP75… controls the burner manifold gas pressure as a function of the combustion air pressure without the need for an additional constant gas pressure regulator.

Since three functions: safety shut-off, constant pressure regulation, and air/gas ratio control can be performed by a single valve, fewer gas train components and fittings are required. This significantly reduces both the size and weight of the gas train. In addition, smaller diameter gas valves can be used.

The compact SKP75… actuator opens slowly and closes immediately when power is interrupted. The modular design allows the SKP75… to be used in combination with all VG… series gas valves bodies from 1/2-inch to 6-inch in size. The actuator is easily mounted on the square flange of any VG… valve with four pre-mounted screws. A visible position indicator on the front of the actuator displays the entire stroke of the valve. A light indicates when the actuator is powered.

Features

- UL listed, FM approved, CGA and AGA certified, IRI approvable, ISO 9001 certified; European, Australian and Japanese approved versions available.
- Safety shut-off function, pressure regulating function and air/gas ratio control in one compact unit.
- Proof of Closure with Over Travel (POC) versions are available.
- Optional NEMA 4 protection.
- Simplifies commissioning and reduces start-up time.
- Maintains air/gas ratio when the airflow is disrupted.
- Automatic compensation for combustion chamber back pressure fluctuations.
- No mechanical wear or play that causes drifting.

Features, Continued

- Compensation for air temperature fluctuations.
- Visual position indication.
- "Power on" indication light
- Quick connect wiring terminals
- Optional adjustable auxiliary switch available.
- Excellent tracking characteristic.
- Modular design with 360° actuator rotation for easy field wiring and installation.
- Low, 13.5 VA power consumption.

Application

SKP75… series actuators can be combined with 1/2-inch to 6-inch VG… series gas valve bodies. VG… series gas valves must be ordered separately (See *VG…U...Technical Instructions*, P/N 155-512P25).

If the combustion air pressure exceeds the permissible value of 12” or 20” w.c. (See *Specifications*), the pressure must be reduced by means of a pressure reducing T-fitting (See Figure 4, AGA78).

Product Numbers

Table 1.

Product Number[1]	Operating Voltage	Proof of Closure Switch [2]	Auxiliary Switch [2]	Type of Switch
SKP75.011U1	110 to 120 Vac	x	–	SPDT
SKP75.012U1		x	x	SPDT SPDT
SKP75.013U1		–	–	
SKP75.012U2	220 to 240 Vac	x	x	SPDT SPDT
SKP75.013U2		–	–	

1. European, CE certified models are available (see data sheet 7643).
2. Proof of closure and auxiliary switches cannot be field installed.

Accessories

Table 2.

Product Number	Description
AGA66	Sealing gasket to provide NEMA 3, 3R, and 4 protection (for VGG…/VGD…valves)
AGA78	Air pressure reducing T-fitting

Specifications

Agency approvals	As safety shut-off valve	UL/429, FM/7400, ANSI Z21.21/CGA6.5 C/I Agency marks apply only for SKPxx.xxxU actuators assembled with VGxxx.xxxU series gas valve bodies.
Power supply	Operating voltage	110 to 120 Vac +10%-15% 220 to 240 Vac +10%-15%
	Operating frequency	50 to 60 Hz ±6%
	Power consumption	13.5 VA
	Duty cycle	Continuous

Specifications, Continued

Operating environment	Ambient operating temperature	5°F to 140°F (-15°C to 60°C)
	Mounting position	Any position except upside down
	Maximum temperature of air and flue gas at the control connections	140°F (60°C)
	Maximum inlet gas pressure	Same as VG… valve
Physical characteristics	Weight	5.1 lb (2.3 kg)
	Enclosure	NEMA 1, 2, 5 and 12 for indoor use NEMA 3, 3R, and 4 with optional AGA66 gasket
	Dimensions	See Figure 7
	Specification for valve bodies	See gas valve *Technical Instructions* P/N 155-512P25
Connections	Conduit connection	Two 1/2-inch NPSM threaded knock-outs
	Electrical connection	Spring loaded terminals for 14 AWG wires
	Gas/air pressure connections	1/4" NPT (see installation notes)
	Gas pressure test connection	Hose barb with close-off screw
	Combustion chamber pressure test connection	Hose barb with close-off screw
Operating characteristics	Output force	100 lb (450 N)
	Maximum stroke	1 inch (26 mm)
	Opening time for maximum stroke	Varies with valve size, 14 seconds for max. stroke.
	Closing time	<0.8 seconds
Control signal	Reference input signal	Combustion air pressure
	Control characteristic	Integral action
Operation/installation	Setting range of gas to air pressure ratio	0.4:1 to 9:1
	Permissible pressures during operation for accurate control	Min. air presssure: 0.2" w.c. Max. air pressure: with Pg/Pa <2; 20" w.c. Max. air pressure: with Pg/Pa >2; 12" w.c. with higher air pressures use AGA78 Min. downstream gas pressure: 0.4" w.c. Max. downstream gas pressure: 40" w.c.
	Minimum time required for high to low fire load changes	5 seconds
	Maximum sensing line pressure	20 psi
	Maximum sensing line vacuum	3 psi
	Minimum diameter of sensing lines	1/4" inside diameter
	Minimum distance between gas sensing line and gas valve outlet	5 times the pipe diameter
Auxiliary features	Proof of closure switch	Non-adjustable
	Capacity of auxiliary switch	6A/250 Vac resistive; 3A/120 Vac pilot duty
	Setting range of auxiliary switch	40% to 100% of stroke

Operation

(See Figure 1)

Safety Shut-off Function

The electro-hydraulic actuator consists of a cylinder filled with oil, a piston containing an electric oscillating pump and a relief system. When power is supplied to the actuator the relief system closes, and the pump moves oil from the reservoir into the pressure chamber. This action causes the piston to move downward in the cylinder, opening the gas valve. When power to the actuator is interrupted, the relief system opens and the gas valve closes in less than 0.8 seconds.

A position indicator, visible through the transparent portion of the terminal cover, shows the entire stroke range of the actuator. A light, which is visible through the lower left transparent portion of the terminal cover, indicates when the actuator receives power. An optional, non-adjustable SPDT proof of closure over travel switch signals the closed position after the gas valve has closed. An optional SPDT auxiliary switch is adjustable between 40% and 100% of the stroke. The adjustment screw and scale are located on the right side in the terminal box, and are visible through the transparent portion of the terminal cover.

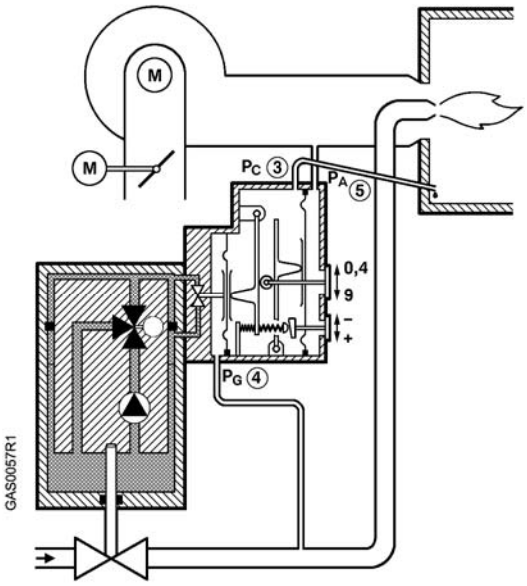


Figure 1. SKP75… Operation.

Regulating Function

During the burner pre-purge period, when the gas valve is closed, only the air pressure acts on the regulator. This causes the air diaphragm to move to the left and close the regulating hydraulic bypass valve. When the actuator is powered, the gas valve begins to open. The downstream gas pressure immediately begins to increase until the downstream gas pressure is in balance with the air pressure (in accordance with the pressure ratio adjusted on the regulator). The bypass valve is now partially open so that the oil flow supplied by the pump is identical to the return flow.

If, for example, heat demand increases, the air damper would open further increasing the air pressure. The air diaphragm would move to the left, causing the bypass valve to close and the gas valve to open further. The opening of the gas valve increases the downstream gas pressure moving the gas diaphragm to the right until balance is restored and the flow supplied by the pump is once again identical to the return flow through the regulator bypass. Unlike conventional direct acting regulators the SKP75… servo operated regulating system displays virtually zero droop (offset) across the turndown range.

Regulating Function, Continued

The gas to air pressure ratio is adjustable from 0.4:1 to 9:1. The setting is visible through a window in the regulator. Once set, the gas to air pressure ratio remains constant over the entire output range. The gas to air flow ratio will remain constant (if the cross sections of the air and gas orifices in the burner head are fixed). The SKP75… is not recommended for use with burners incorporating a sliding/continuously adjustable head arrangement.

Many burner designs, because of reduced mixing energy at the low fire level, require increased excess air at low fire in order to maintain optimum combustion parameters. To accommodate this requirement the SKP75… incorporates a bias adjustment, which allows the characteristic of the regulator to be displaced either towards excess air or reduced air.

NOTE: To avoid oscillation, do not oversize the VG… valve body. (See *Technical Instructions* 155-512P25.)

Installation

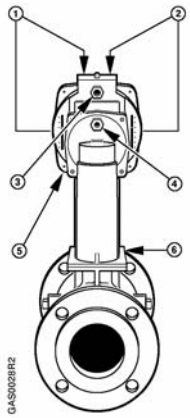
WARNING:

- Personal injury or loss of life may occur if procedures are not followed as specified.
- All installations must be performed by qualified personnel only.
- Do not pull the actuator shaft.
- If minimum gas pressure detection is required, the pressure switch must be mounted upstream of the regulating gas valve to ensure sufficient gas pressure before starting the burner. If maximum gas pressure detection is required, the pressure switch must be mounted downstream of the valve.
- Air proving safety devices normally required to guarantee minimum airflow must also be provided when using the SKP75...
- The gas pressure sensing line connection must be flush with the inner wall of the gas pipe in order to sense turbulence free pressure. The gas sensing line connection should be located at least five pipe diameters downstream of the valve, elbow, coupling, or other flow disturbing fitting. **Do not use the taps on the valve body for the gas sensing line connection since these locations typically have strong turbulence.** The pressure sensing line should be as short as possible to allow the regulator to react to sudden changes.
- The sensing line for the combustion chamber pressure (if needed) must be installed so that condensing flue gases cannot enter into the regulator but run back into the combustion chamber. If necessary, a water separator must be installed.
- All pressure sensing lines must be at least 1/4-inch inside diameter. For air to gas pressure ratios over three, the air and combustion pressure sensing lines must be at least 3/8” inside diameter.
- The AGA66 gasket must be installed between the actuator and the gas valve body to provide NEMA 3, 3R, and 4 protection rating for VGG… and VGD… valves.
- The SKP75… does not work in installations with negative air pressure unless a higher negative chamber pressure is connected to the regulator.

Installation, Continued

- The SKP75… actuator is directly coupled to the VG… series valve body by four pre-mounted. 4 mm Allen key screws.
- The square mounting flange can be rotated in steps of 90° to provide four different mounting positions. The SKP75… actuator can be mounted in any position with the diaphragms vertical, except upside down.
- The actuator can be mounted or replaced while the valve body is under pressure.
- The SKP75… actuator has two knock-outs for the installation of 1/2”-14 NPSM conduit connections.
- When conduit routing is connected, flexible conduit must be used.
- Liquid tight conduit must be used in combination with AGA66 to provide NEMA 3, 3R, and 4 protection.
- The terminal marked GND, located above the wiring terminals, must be connected to the electrical ground.

NOTE: Wiring must meet all relevant electrical codes.



1 Adjustment and indication of the gas-to-air ratio
2 Adjustment and indication of the bias
3 Connection for the combustion chamber pressure sensing line
4 Connection for the gas pressure sensing line
5 Connection for the air pressure sensing line
6 Position indication (on the front).

Figure 2. Connections and Adjustments.

Start-up

Regulator (See Figures 2 and 3)

The pressure ratio and bias adjustment screws are located on top of the regulator under a sealable cover plate. The actual settings can be seen through windows on each side of the regulator.

NOTE: The burner capacity is controlled by the position of the air damper. The combustion quality (air/gas ratio) is controlled by the settings on the regulator (the + and – indications relate to the change in gas flow). Adjustment in clockwise direction decreases the gas flow.

Start-up, Continued

1. Set the gas-to-air ratio to the desired value using adjusting screw 1 (coarse setting).
2. Start the burner and run it at approximately 90% of full capacity.
3. Measure CO_2 or O_2 content in the flue gases and correct the ratio by adjusting screw 1 until optimum values are obtained (fine setting).
4. Return to low fire and measure the CO_2 or O_2 content in the flue gases. If necessary, correct the setting by adjusting screw 2 until optimum values are obtained.
5. Limit the damper position for low fire operation. If considerable bias adjustment was necessary to achieve optimum combustion, repeat the procedure from Step 3.
6. Run the burner to the required high fire position and limit the air damper position.
7. Check the flue gas values at several intermediate output levels. If corrections are necessary, note the following:
   - Adjust the pressure ratio screw 1 at high fire operation only.
   - Adjust the bias screw 2 at low fire operation only.

If the air pressure exceeds the maximum value of 12” or 20” w.c. (See *Specifications*), the pressure must be reduced with a pressure reducing T-fitting (AGA78).

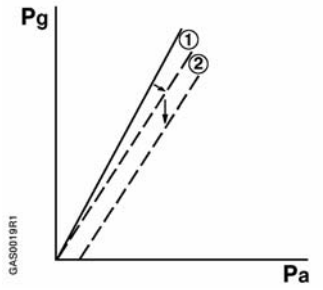


Figure 3. Adjustments.

WARNING:

When firing at maximum burner capacity, ensure that the SKP75… /VG… is not in the fully open position. If this is the case, either the gas valve is sized too small or the gas supply pressure is too low.

Wiring and Switch Adjustment

- The actuator is equipped with spring-loaded wiring terminals for 14 AWG wires.
- Insert one wire into the opening of the terminal while pressing the lever downward with a screwdriver or hard object. Make sure that all strands insert into the opening.
- The actuator has two line and two neutral terminals.
- Adjust the auxiliary switch (if provided) according to the wiring diagram on the label below the terminals (see figure 6). The adjustment screw and scale are located on the right side of the terminal box, and are visible through the transparent portion of the terminal cover.

NOTES: 1. The auxiliary switch is adjustable between 40% and 100% of the stroke. The factory setting is at 40%.

2. The auxiliary switch must not be used for proof of closure detection or other safety interlock functions.

3. The Proof of Closure Switch is non-adjustable.

Service

There are no serviceable parts on the SKP75… series actuators. If inoperative, replace the actuator. Tag wires before servicing.

Pressure Reducing T-Fitting AGA78

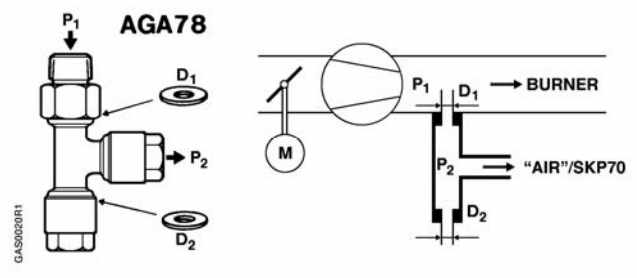


Figure 4. AGA78 Operation.

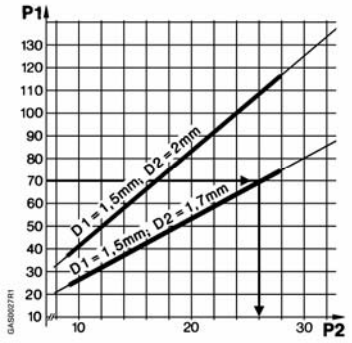


Figure 5. AGA78 Adjustments.

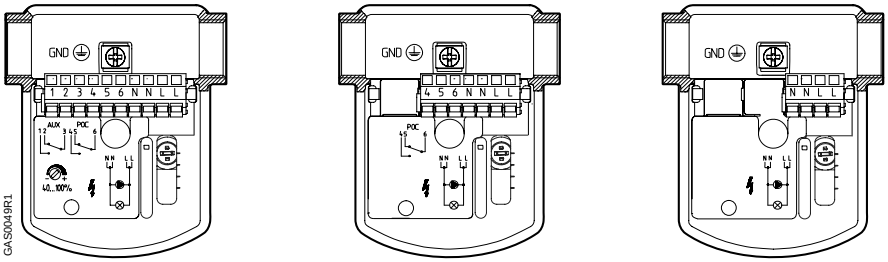
Function

The air is blown out continuously into the atmosphere through the restrictor D_2. The air undergoes a drop in pressure across the restrictor D_1. The relationships are shown in the diagram (Figure 5).

Example: Given p_1 = 70 mbar, D_1 = 1.5 mm, D_2 = 1.7 mm
Find: Pressure signal P_2 for SKP70…
P_2 = 26 mbar

Reducing T-fitting AGA78 is supplied ready for mounting, complete with D_1 = 1.5 mm and D_2 = 1.7 mm. An additional restrictor D_2 with a diameter of 2 mm is included with the actuator.

Terminal Designations



SKP75.012U… **SKP75.011U…** **SKP75.013U..**

Figure 6. Terminal Designations.

Dimensions

(Dimensions in inches; millimeters in parentheses.)

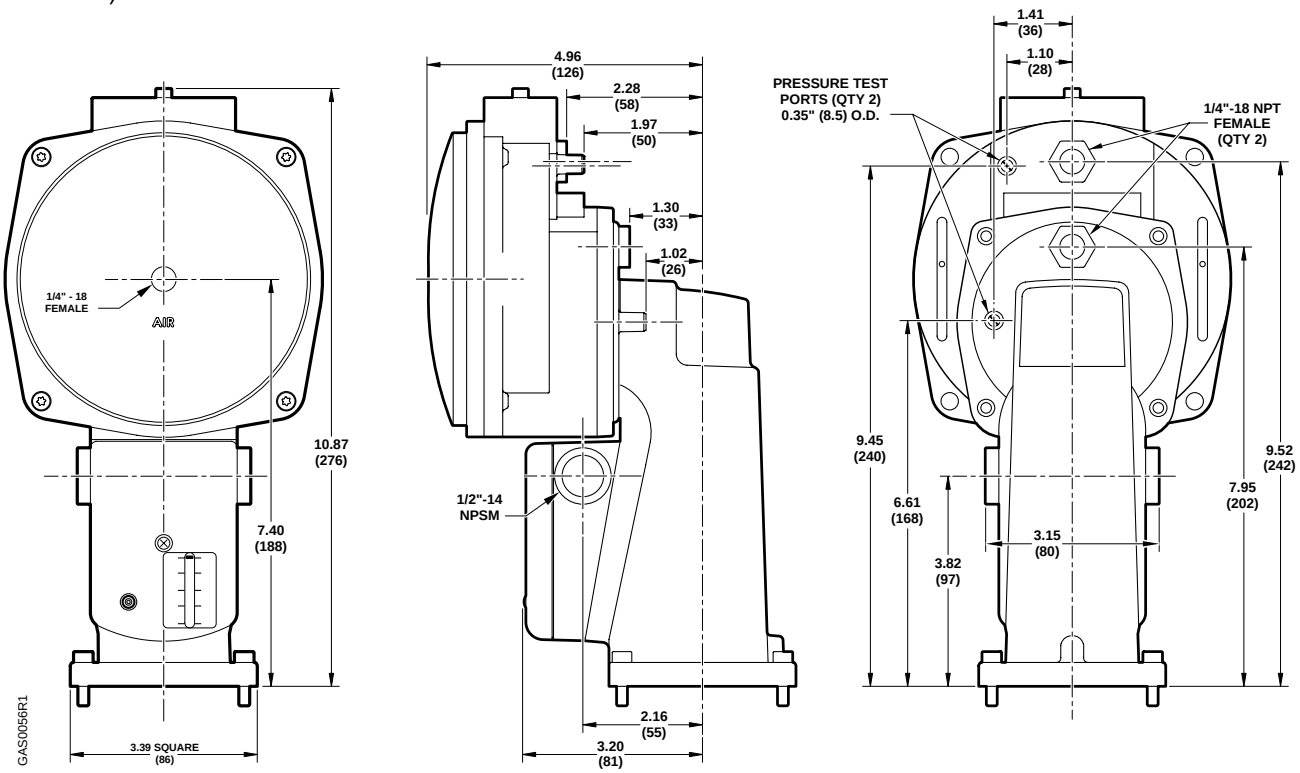


Figure 7. SKP75…U.. Dimensions.

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