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LE, LEx and GLE Burner and Reaction Chamber Storage, Assembly and Initial Firing Information

Unless otherwise specified, all LE, LEx and GLE burners and reaction chambers are manufactured with a low porosity dense castable material. All refractories in the burners and reaction chambers have been wet-cured and oven-dried to approximately 500° F during manufacture. Fives North American Combustion, Inc. offers the option to pre-fire burners and reaction chambers to 1800° F prior to shipment. This removes all mechanical and chemical water from the refractory in a time and temperature controlled method. The top level assembly drawing will note if the pre-firing was performed.

Special LE, LEx and GLE burners specified to be manufactured with high porosity light weight material MUST be pre-fired prior to shipping.

<u>STORAGE</u>:

It is recommended that all burners and reaction chambers remain in their original packaging until they are ready for assembly and installation. This includes leaving thread protectors and caps in place to prevent foreign objects from entering the parts. While stored, the equipment should be covered with water repellent material to protect from sources of significant moisture such as rain or snow. Parts stored in areas where the temperature is below 60° F should be slowly warmed prior to firing.

<u>Standard Oven Dried:</u>

Burners and reaction chambers which have been oven dried may be stored in areas where temperatures are below freezing as mechanical water has been removed. It is safe to store equipment in this condition for several years. Follow the Initial Firing Schedule to slowly remove chemical water prior to putting into production.

<u>Optional Pre-fire Dryout:</u>

Pre-fired dryout is the process by which all mechanical and chemical water is removed from the refractory, allowing the material to reach its maximum strength. Burners and reaction chambers which have been pre-fired may be stored in areas where temperatures are below freezing. It is safe to store equipment in this condition for several years. The Initial Firing Schedule on pages 3 and 4 describes the Pre-fire dryout process. If a pre-fired chamber is accidently exposed to rain, snow or other significant amounts of moisture, the chamber must undergo the ramps and holds at 300° F and 500° F as described in the Initial Firing process.

ASSEMBLY:

CAUTION: PRIOR TO ASSEMBLY, ENSURE THAT ALL HOISTS AND ACCESSORIES ARE RATED FOR DUTY SUFFICIENT TO COMPLETE REQUIRED WORK.

Reaction chambers can be supplied either as one piece or as two piece assemblies including forward and rear sections. For installation of one piece reaction chambers, proceed to step 8 after unpacking.

1. Remove debris and any packing material that is not required for storage. Air and gas inlets should remain covered until interconnect piping is installed to prevent foreign material from entering the burner. Hardware and gasket materials may be found inside the burner combustion air inlet for assemblies that were not assembled prior to shipment. Compare materials found to parts identified on the assembly drawings to ensure you have all required parts.

2. Inspect mating flanges and other mounting areas on burner and reaction chamber interface sections.

3. If your assembly includes a two piece reaction chamber, move the Forward Reaction Chamber (outlet) section to a cradle or other suitable assembly fixture using appropriate lifting methods. For vertical assembly, the section can be positioned outlet down on a smooth, dry and level surface. The outlet should be protected from dirt and moisture. Often a yellow “x” is painted at what will be the 12:00 location (as installed) on both chamber sections and the burner body to indicate the designed alignment.

4. Install seal ring, rope gasket, drop warp or bolt hole tape at locations specified on the reaction chamber assembly drawing. Be sure the sealing or insulating material is installed in such a manner as to prevent a leak path for hot gases. If sealing ring (fiber) gaskets are supplied in sections, pre-fit the sections by laying pieces end to end prior to adhering to the refractory. The sections should be the same width and form a complete circle. Refer to the assembly drawing section view to determine the correct surface for the gasket. Measure the outside and inside diameters and compare to what is listed on the assembly drawing. Trimming of the fiber will not be required. Tape may be used to hold pieces together while locating the ring concentrically to refractory diameter. Spray adhesive or a small bead of high temperature RTV should be used to adhere the fiber to the refractory or flange face. If Gortex tape is supplied, tape should be applied to a clean flange surface at a smaller diameter than the bolts in an area which will be in contact with the mating flange. Overlap the ends to prevent leakage. If bolt hole tape or similar material is supplied, use adhesive to hold material such that it covers the bolt holes. Use an awl or ball-peen hammer to make openings in the material.

5. Consult appropriate assembly drawing to determine proper alignment of saddle pads, locator pins or any other attachment and support mechanisms. Look for a yellow “x” to ensure proper alignment of the sections.

6. Using appropriate lifting methods, place the rear section reaction chamber in the proper location as illustrated on the assembly drawing.

7. Apply thread lubricant to bolt or stud threads. Use washers and nuts as specified on the reaction chamber assembly drawing. Be sure the entire reaction chamber assembly is adequately supported prior to removing lifting mechanism.

8. Sealing material such as bolt hole tape, Gortex or high temperature silicone (RTV) is required between the reaction chamber mounting plate and customer equipment. This material as well as fasteners may not be included with the equipment. Prepare customer equipment or reaction chamber mounting flange with proper sealing material prior to lifting the reaction chamber.

9. If desired, the burner may be assembled to the reaction chamber prior to mounting the reaction chamber to customer's equipment. This is not recommended for larger or two-piece reaction chambers.

10. Using appropriate lifting methods move and install the reaction chamber assembly in its permanent mounting location. Use thread lubricant, nuts and appropriate methodology to secure the reaction chamber.

11. Install seal ring, rope gasket or bolt hole tape as specified on the burner and reaction chamber assembly drawing. See Item #4 for tips on proper installation.

12. Consult appropriate assembly drawing to determine proper orientation of saddle pads, locator pins or any other attachment and support mechanisms. Look for a yellow “x” to ensure proper alignment of the sections.

13. After securing the reaction chamber, lift and place burner assembly in the proper location as illustrated on the assembly drawing.

14. Apply thread lubricant to bolt or stud threads. Use washers and nuts as specified on the burner and reaction chamber assembly drawing. Be sure the entire assembly is adequately supported prior to removing the lifting mechanism.

15. All piping must be clean and free of debris prior to connecting to burner.

16. Follow instructions for proper piping installation and control wiring.

17. If no permanent temperature measuring equipment is installed, temporary instrumentation is recommended for dryout.

INITIAL FIRING INFORMATION:

Measuring the reaction chamber refractory temperature is recommended during the initial firing of the system and for subsequent cold restarts if feasible. It is recommended that a bare wire thermocouple junction be placed on the refractory surface near the reaction chamber exit. The exposed thermocouple junction should be covered with a small piece of insulating blanket to shield it from direct flame. The insulation must be weighted to remain in place during firing. Alternately, a removable thermocouple may be inserted through a sample port near the exit of the reaction chamber. The probe should be long enough to measure the temperature of the combustion products hot mix at the chamber exit. If the temperature of the inside surface of the refractory or the hot mix near the discharge of the reaction chamber cannot be measured, a defined procedure including excess air rates and length of time is required for at least the first heat up. The Combustion Hot Mix method may be used when flame lengths will exceed the length of the reaction chamber. This includes LE and GLE assemblies, or LEx burners having standard or short reaction chambers.

A chamber that has been fired, either by the optional factory pre-firing or having been in service, and has not been exposed to significant moisture should follow the “Cold Restart” instructions below. If a pre-fired assembly has been exposed to significant moisture before or after installation, or during maintenance, follow the instructions for ramp and hold at 300° F and 500° F described in the Initial Firing process. When in doubt, the slow ramp and hold process should be followed.

Using Combustion Hot Mix Temperatures as an alternative to Measurement of Hot Face Temperature

The excess air values and corresponding hot mix temperatures listed below are based on 120° F combustion air and Natural Gas. These can be used for prefiring the burner and reaction chamber as recommended where: the excess air measured is for burner air and fuel only (no process air); and if the combustion system air and fuel flow measurement instrumentation’s correct function and accuracy has been verified. Obtaining hot mix temperatures below 600° F may require operation with pilot only. Values not listed as “hold” temperatures are included for reference to assist with ramp rates.reference to assist with ramp rates.

Percent Excess Air	Approximate Hot Mix Temperature
2750%	300º F
1230%	500º F
750%	700º F
510%	900º F
325%	1200º F
225%	1500º F
160%	1800º F
130%	2000º F

Initial Firing

Note: If at any time during the firing cycle "steaming" is observed, hold the temperature constant until the "steaming" dissipates, then resume the remaining schedule beginning from the time the "steaming" hold began.

1. Begin the dryout by lighting the burner pilot and increasing pilot gas flow as needed for the desired refractory or hot mix temperature. If "glowing" of the pilot or its connection boss occurs during firing, a small fan or other air supply directed upon the hot area should be used to keep the pilot cool during extended operation. As temperature requirements increase, light the radial burner to increase the input.

2. If temporary thermocouples cannot be installed in the reaction chamber refractory or at its exit, the process or other system temperatures may be used (with appropriate allowances for temperature losses) to infer the reaction chamber refractory temperatures. As an alternate, the burner hot mix temperature may be predicted by the overall fuel to air ratio as described previously. Remember, it is the temperature inside the reaction chamber that needs to be maintained, not an overall process temperature.

3. The following time and temperature schedule is recommended :

3 hour ramp	from 60° F to 300° F
6 hour soak	at 300° F
3 hour ramp	from 300° F to 500° F
6 hour soak	at 500° F
9 hour ramp	to 1200° F (75° F per hour)
6 hour soak	at 1200° F [1]
8 hour ramp	to 1800° F (75° F per hour)
6 hour soak	at 1800° F
X hour ramp	to operating temperature (100° F per hour) [2]

12 hour (minimum) cooling period from maximum temperature to ambient at a maximum of 150° F per hour unless starting production

[1] This soak period may be eliminated when the application does not require cyclic operation or when prefiring will not exceed 2000° F.

[2] No soak period required. Note that typical LEx, LE and GLE applications are expected to operate with hot mix temperatures lower than 2800° F and the lean fuel-to-air ratio required to achieve the design maximum hot mix temperature is intended to be an operating limit for the particular system. Only exceed 2600° F after consultation with Fives North American on the specific operational settings for the system. In no case exceed 2800° F for Standard Dense Castable or 3000° F for High Temperature, Low Cement Castable as damage to both burner internals and refractories may result.

NOTE: Pre-firing refractory results in permanent linear change to the material. Cracking in both longitudinal and circumferential directions up to 3/16" wide may be observed after the chamber is cooled. When the chamber is reheated during operation, the refractory will expand, decreasing the width of these cracks. Rapid heat and cool cycles will increase cracking and decrease the life expectancy of the refractory.

Initial Firing after Optional Pre-fire Dryout or Cold Restart

Cold restart is defined as starting the burner system when the reaction chamber refractory is below 1000° F. The refractory is assumed to be 60° to 90° F prior to lighting.

1. Light the burner and hold at low fire.

2. Increase burner firing rate such that the reaction chamber refractory will reach 400° F in one (1) hour. For chambers below 60° F, ramp to 400° F at a rate of 100° F per hour.

3. Increase temperature set point by 300° to 400° F per hour until process temperature is achieved.

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