

1. ULTRA LOW NOx BURNER AND FUEL TRAINS:

This specification is best suited for heat inputs in the range of 30 million Btu/h per burner through 430 million Btu/h per burner. The burner assembly will be a proven design developed specifically for Ultra Low-NOx emissions. Basis of design shall be the Zeeco Free JetTM burner.

* 1. PERFORMANCE/OPERATION
		1. Main flame characteristics:
			1. Flame shall be stable with no blow off or flashback.
			2. Flame shall be confined to the furnace (no carryover to the backpass).
			3. Flame shall not impinge on the furnace tubes. Impingement is defined per the ABMA as the substantially continuous contact upon a surface by flame which results in formation of hard carbonaceous deposits which may result in localized incomplete combustion. Flame impingement is a condition of firing a fuel which may cause failure and/or excessive maintenance of combustion chamber wall surfaces.
			4. Flame geometry shall be consistent between each burner in a multi-burner system.
		2. Burner shall remain stable operating with a lead/lag control scheme.
		3. Burner shall be capable of 8:1 turndown on fuel oil.
		4. Burner shall be capable of increased turndown on gas (18 or 20:1) to be used during hot standby.
		5. Burner shall be low excess air design (15%).
		6. Igniter flame shall be stable on natural gas. Igniter shall be capable of lighting off both gas and oil with single igniter.
		7. Main flame on gas and oil shall ignite at turndown rate.
		8. Light Oil Atomization: during cold start up with no steam available, burner light off shall be with compressed air atomization supplied by plant compressor.
		9. Burner shall be designed for continuous long term operation on both natural gas and fuel oil as applicable.
		10. Natural gas shall be supplied at a minimum regulated pressure of 10 psig to the inlet of the fuel train. If unregulated, fuel shall be supplied at a minimum pressure of 15 psig.
		11. Fuel oil shall be supplied at 170 psig minimum to the inlet of the fuel train.
	2. FLUE GAS EMISSION LIMITS:
		1. Carbon Monoxide (CO): Shall not exceed 100 ppm.
		2. Smoke (Opacity): Shall not exceed 1 on the Ringelmann Scale (20% opacity).
		3. For natural gas firing with ambient combustion air, Nitrous Oxides (NOx) emissions shall not exceed 0.036 lb/MMBtu without FGR or 0.012 lb/MMBtu with a maximum of 20% FGR
		4. For light oil firing with ambient combustion air, NOx emissions shall not exceed 0.12 lb/MMBtu without FGR or 0.06 lb/MMbtu with a maximum of 20% FGR.
	3. STATIONARY AIR SIDE REGISTER ASSEMBLY DESIGN
		1. The burner shall be an axial flow type with no swirl entering the burner. The axial parallel airflow is required to control the flame envelope and provide even heat flux within the furnace
		2. The burner shall be a fixed air register design with no moving parts thereby only requiring an absolute minimum of operator and maintenance attention.
		3. Burner body will have a conical air inlet and will be directly mounted to the boiler front wall. The air register and cone shall be manufactured from welded sectional pieces that ensure smooth flow.
		4. The burner shall utilize an air swirler to create a recirculation zone and stabilize the core flame. A preset ratio of tangential to axial momentum shall be used to effectively produce the required flame shape for a given furnace geometry.
		5. The burner shall utilize heavy gauge construction of all components for the assurance of rugged design, durability and an extended life of trouble free operation.
		6. The air register shall be manufactured from carbon steel plate having a minimum thickness of not less than 1/8”.
		7. A minimum of two (2) 2” viewports shall be provided on the burner front plate with an unobstructed view of the main and igniter flames. Viewports shall be interchangeable with flame scanner mounts.
		8. A minimum of one (1) 2” flame scanner mount (two (2) required for dual fuel) shall be provided on the burner front plate with an unobstructed view of the main and igniter flames. Flame scanner mounts shall be interchangeable with viewports.
		9. Flame scanner mounts shall be supplied as gimbal type with maximum movement and adjustment for flame sighting and alignment.
		10. All external carbon steel surfaces to be surface prepped per SSPC-SP-6 and painted with multi-purpose epoxy basecoat and polyurethane topcoat.
		11. Modulating or gear driven air register type burners are not acceptable.
		12. The air register assembly shall be of the turbulence free axial flow type and shall have no moving parts. RADIAL DOOR REGISTERS OR LOUVER DOOR TYPE BURNERS ARE NOT ACCEPTABLE.
		13. The air register shall be aerodynamically designed to produce a smooth flow of turbulence free, axial flowing air that will, due to reduced friction and vibration, result in minimum register draft losses. This is a feature that directly relates to reducing horsepower requirements for the FD fan.
		14. For multi-burner applications with common windbox, each burner will be fitted with an on/off pneumatically operated air slide mechanism. This mechanism must operate in an ON/OFF manner and shall NOT be used to modulate airflow to the burner.
		15. The pneumatically operated air slide assembly for primary and secondary air shut-off shall be furnished complete with:
			1. One (1) only – air slide tracks and rollers
			2. One (1) only – air slide
			3. One (1) only – pneumatically operated double action air cylinders
			4. One (1) only – mounting brackets
			5. One (1) only – dual coil solenoid operated pilot valve with speed control
			6. One (1) only – insertion limit switch
			7. One (1) only – retraction limit switch
		16. On multi-burner units the ability to maintain precise combustion control by being able to provide accurately measured primary and secondary airflow passing through the register is required.
	4. THROAT REFRACTORY
		1. For single burner applications, the burner throat shall be precast converging refractory tile. A divergent throat that results in loss of air mixing velocity and that leads the air flow to widen at burner outlet and cause flame impingement on side walls will not be accepted on single burner units.
		2. The precast tile shall extend into the furnace using ledge flame stabilization technology for in-furnace flame anchoring. For optimal flame stabilization, it should be shaped in a “Wedding cake” type configuration with a minimum of two (2) ledges.
		3. Burner precast throat tile shall be constructed of at least 60% alumina castable refractory and be rated for a continuous service of not less than 3,000oF.
	5. PRIMARY AIR SWIRLER
		1. The primary air swirler shall be of the turbine blade type and designed and sized to match the aerodynamics of the air register assembly. The air swirler blades shall be of a radius design, not a flat blade or single bend style.
		2. The air swirler shall be designed to impart a rotational swirl of combustion air in the primary combustion air zone only. The swirler must provide the means of achieving the flame stability and through mixing of the fuel and combustion air. The rotational swirl shall create an annular vortex that causes re-circulation of hot gases in the primary combustion zone of the furnace. This vortex of swirling air is necessary to stabilize the flame front and create a well-defined heat flux zone that will not produce hot spots within the furnace.
		3. The matched design of the swirler and burner register shall be a critical aspect towards the complete elimination of combustion-induced vibrations within the boiler.
		4. The swirler shall create a strong flame front that is established and anchored at a fixed point within the furnace directly in front of the swirler face. The starting point of the flame front shall not move during changes in the firing rate. This important phenomenon provides stable flame positioning for positive scanning and nuisance free reliable operation.
		5. The air swirler shall be centered in the air register at the furnace end.
		6. The air swirler shall be fabricated from high alloy heat resistant stainless steel.
		7. The air swirler shall be mounted to the center fire gas burner.
	6. GASEOUS FUEL INJECTION:
		1. The gaseous fuel injection assembly shall NOT use on-line field adjustable fuel injection components. This will eliminate the possibility of changing the parameters/settings, which could affect the emissions after commissioning has been satisfactory completed.
		2. The burner shall have two (2) fuel injection systems, a primary core flame system sized for no more than 30% of MCR burner heat input and a second fuel injection array outside the air stream for the remainder of the fuel.
		3. Each of the fuel injection systems must have its own flow control valve to modulate the burner heat input ratios throughout the firing range.
		4. The secondary outer fuel injection array shall use Free JetTM technology to promote internal flue gas recirculation within the combustion chamber to reduce thermal NOx. The array shall use a minimum of 10 single hole individual risers spaced for optimal furnace gas induction. The maximum riser size shall be ½” in order to minimize furnace radiation heating effects.
		5. The gas ring shall be fabricated from ASTM A36 steel or higher. Inlet connections, gas carrier tube shall be A105/A106 or higher. Outer array gas injection risers shall be 304 SST. The riser tips shall be castings of high-grade heat resistant stainless steel.
		6. The assembly shall be supplied complete with a high grade stainless steel flexible hose at the gas connections to compensate for thermal expansion and a pressure gauge to monitor gas pressure at the burner.
		7. On multi-burner systems when individual burner control valves are not used each assembly shall be supplied with a fuel balancing butterfly valve to be located at the inlet of each manifold. The valve will be used for fuel trim purposes.
		8. Components of the Gas Fuel Carriage Assembly - Each Fuel Gas Carriage Assembly will be complete with:
			1. Two (2) only – inlet manifolds and flanges
			2. One (1) only – center gas carrier tube
			3. One (1) only – center fired gas injector
			4. One (1) only – outer gas ring
			5. Minimum of ten (10) – outer array single hole individual risers/tips
			6. Two (2) only – pressure gauges
			7. One (1) only – stainless steel braided flexible hose
			8. Two (2) only – fuel balancing valves (multi-burner without individual control valves)
	7. IGNITER
		1. For NOx emission requirements below 0.018 lb/MMBtu a CLASS III SPECIAL high capacitance direct spark igniter is required.
		2. For NOx emission requirements above 0.018 lb/MMBtu a CLASS III interrupted design is acceptable.
			1. This can be either a raw gas or premix design
			2. Either High Tension (HT), or High Energy (HE) ignition is acceptable.
			3. CLASS III SPECIAL high capacitance direct spark igniter is an option.
	8. COMBUSTION AIR AND FLUE GAS RECIRCULATION SYSTEM
		1. It should be noted that the combustion air flowing through any burner system constitutes a nominal 94% of the total mass flow through the system. The actual fuel only constitutes a nominal 6%. Therefore, it is imperative that serious consideration be given to customizing the design of the windbox equipment that delivers and distributes the combustion air to each burner’s register inlet.
		2. The airflow distribution entering the burner(s) must meet the following criteria:
			1. Peripheral distribution of entry air around the burner must be within +/-15% of average for the burner.
			2. All swirl entering the burner must be eliminated
			3. On a multi-burner system, the air mass flow distribution between burners must be within +/-5%
			4. On a multi-burner system, the FGR mass flow distribution (when applicable) between burners must be within +/-2% FGR.
		3. Correct windbox design is essential to acquiring optimum and efficient combustion. Correct and accurate design can only be accomplished in a truly representative manner by first completing the aerodynamic studies of the airflow patterns that will occur within any proposed system that utilizes an existing windbox. Therefore, the burner vendor shall construct and test a physical scale model of the windbox system to prove the design sizing of the existing windbox to be adequate. Computer simulation is not the preferred method of reliably achieving this technical data.
		4. The windbox shall be fitted with fixed internal airflow control elements or baffle plates located to minimize draft loss and to eliminate any swirl of the combustion air entering the register.
		5. The location of such baffles shall be based upon the model study technique of analog simulation methods using a dynamic mixture of air and tracer bubbles. The burner manufacturer shall have a proprietary model shop facility and be capable of providing the physical modeling technique that will determine the precise location of each fixed baffle.
		6. The use of perforated metal screens or mechanical movable turning vanes shall not be used, since none of these methods provide satisfactory uniform air flow distribution.
		7. The use of an opposed blade damper with even number of blades at the windbox inlet is acceptable on multi burner units with individual windboxes. These dampers are to be used only for on/off operation, not burner airflow modulation.
		8. Airflow shall be controlled by a forced draft fan with inlet damper which can be used in conjunction with a variable speed drive for optimal air turndown.
		9. Provide induced type FGR system if necessary to achieve specified NOx limits. FGR system shall include manual FGR damper, mixing box, and automated fresh air damper.
		10. Damper/VFD shall be designed to provide accurate control of excess air with minimum hysteresis.
		11. Silencer shall be provided with FD fan to reduce sound levels to allowable limits.
	9. FLAME SCANNER DESIGN
		1. The flame scanner shall be an integrated style UV scanner, whereby the amplifier is integral with the flame sensor in the same housing.
		2. The flame scanner shall be capable of ambient temperatures up to 75C and have an environmental housing rating of NEMA4X.
		3. The flame scanner tuning controls shall consist the ability for the gain adjustment, flicker frequency adjustment and flame stability adjustment.
		4. The flame scanner mounting nipple shall have an integral sealing window good for 60 PSI, locking ring to secure scanner to the sight tube and have a heat insulator/electrical isolator all in one 3 ½” long assembly.
		5. For local indication, the Flame scanner shall have a Flame-On LED, Flame-Off LED and a bar graph flame signal readout display.
		6. For BMS integration and remote indication, the flame scanner shall have a

N.O. flame relay contact, a N.C. flame relay contact and a 4-20mA output.

* + 1. Note: For boiler applications with more than 8 burners, the flame scanner specification can be open to achieve proper flame detection of target burner, and flame discrimination of background radiation

sources.

* 1. OIL ATOMIZER ASSEMBLY
		1. Oil Burner: shall utilize an internal mix type atomizer with constant or constant-differential pressure atomizing media system. Burner shall be designed for either steam or air atomization. A parallel tube design shall be utilized for fuel oil / atomizing media. Oil tip design shall be of Low NOx, staged fuel type. Oil unit receiver coupling with hydraulic style quick disconnect attachments for both oil and atomizing media shall be used. A design using a ball check assembly with a potential leakage is not preferred.
		2. The oil gun atomizer assembly shall be capable of maintaining a stable and clean flame pattern over the entire range of operation and shall be suitable for trouble free operation during swinging load conditions.
		3. For constant differential pressure type system, the atomizer nozzle (sprayer plate) design shall incorporate a mixing chamber that produces a finely atomized oil spray for efficient combustion and reduced particulate formation.
		4. For constant pressure type system, the atomizer nozzle shall be of a single piece Y-Jet design that produces a finely atomized oil spray for efficient combustion and reduced particulate formation.
		5. The atomizer shall be a high efficiency media assist design, using only

0.05 to 0.15 lb air or steam per lb of fuel fired

* + 1. For optimum results, the oil pressure at the burner shall be 150 psig in order to provide a reliable 8:1 turndown capability when firing heavy fuel oil.
		2. The assembly shall be supplied complete with a high grade stainless steel flexible hose at the oil and atomizing media connection to compensate for thermal expansion or movement, along with two pressure gauges to monitor atomizing media and oil pressures at the burner.
		3. The components of the oil burner assembly that shall be supplied for each burner assembly are:
			1. One (1) only – atomizing nozzle assembly with securing cap nut
			2. One (1) only – atomizing sprayer plate (for differential pressure type)
			3. One (1) only – oil unit receiver coupling with hydraulic style quick disconnect attachments
			4. One (1) only – stainless steel braided flexible hoses (oil connection)
			5. One (1) only – stainless steel braded flexible hose (atomizing media connection)
			6. Two (2) only – hydraulic style quick disconnects
			7. Two (2) only – pressure gauges
	1. FUEL SKIDS
		1. Burner Access: fuel skid, control system, and other devices shall be arranged to not interfere with removal and replacement of burner parts.
		2. Fuel Skid Access: All devices shall be accessible for maintenance or repair.
		3. The single burner and/or multiple burner system shall be designated in accordance with the standards contained in the latest edition of NFPA 85 “Prevention of Furnace Explosions in Fuel Oil and Natural Gas Fired Multiple Burner Boilers”. All applicable components (per NFPA 85) of the burner system shall be UL approved as well as being able to meet the approval requirements of Factory Mutual
		4. Fuel skids shall have a standalone frame sufficiently stable and robust to allow damage free transportation and installation. Fuel skid frame shall be free standing and self-supporting.
		5. Fuel skid frame shall be hot dipped galvanized for maximum corrosion resistance. External carbon steel surfaces to be surface prepped per SSPC-SP-6 and painted with multi-purpose epoxy basecoat and polyurethane topcoat.
		6. Poly lined U bolts shall be used to attach piping to frame, thereby minimizing scratching and corrosion points.
		7. Instrument Airline shall be constructed of 304 stainless steel piping and valves with 316 stainless steel 3/8” tubing and fittings.
		8. Automated valves shall be electro-pneumatically actuated. BSVs shall be ball type valves. FCVs shall be globe or ball valve type
		9. FCVs shall have 4-20mA and/or HART communication position feedback signal.
		10. On multi-burner systems it is preferred that each burner shall be supplied with two individual control valves to be located at the inlet of the two manifolds
		11. Minimum 5% of butt welds shall be RT per welder.
		12. All lifting lugs shall be 100% PT or MT.
		13. All stainless-steel alloys shall be 100% PMI
		14. All individual spools shall be 100% hydrostatically pressure tested. 100% fully assembled fuel skids shall be pneumatically pressure tested.
		15. All fuel skid wiring shall be 100% point to point verified.
		16. No cast iron or yellow metal valves permitted in fuel lines for B31.1 or B31.3 rated systems.
		17. Noise emanating from fuel skid shall not exceed 85 dBA at 3 feet
		18. Fuel Skid minimum fabrication. ASME B31.1 Valve Train Construction:
			1. Piping 2” and under shall be A-106 seamless pipe, schedule 80, socket welded end connections, 3000lb fittings
			2. Piping 2 ½” and larger will be A-106 seamless pipe, schedule 40, CL150 flanged or butt-welded connections