POWER Engineering

Conversion to Natural Gas Igniters Reduces Fuel Cost

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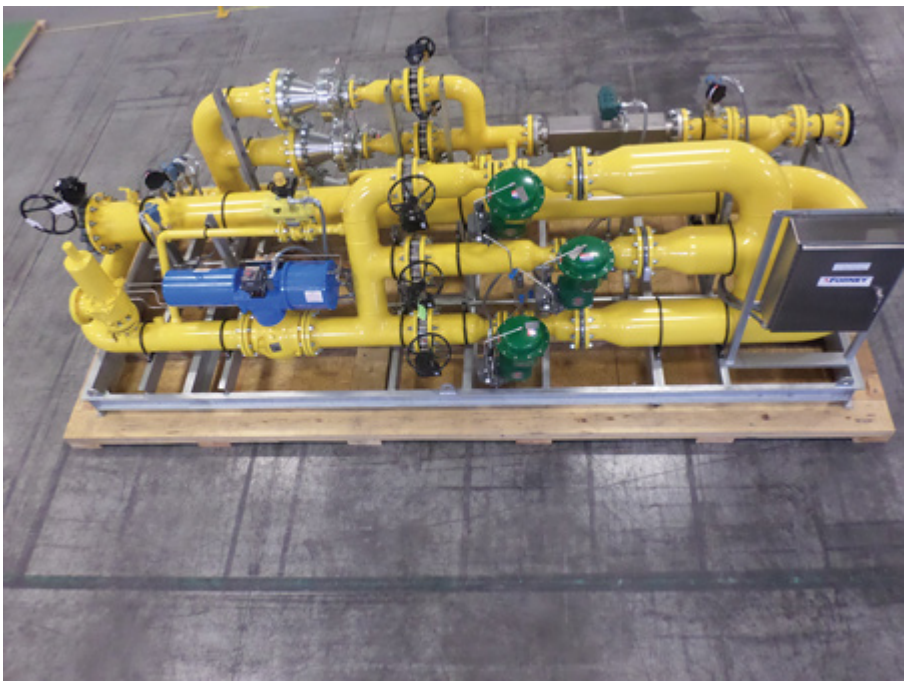
Tampa Electric's generating fleet provides 4,700 MW of power to some 700,000 residential, commercial and industrial customers in west central Florida. About 35% of this capacity, or 1,700 MW, is generated at the Big Bend Power Station in southeastern Hillsborough County. Big Bend operates three Riley Power turbo-fired 4000 MMBtu/h pulverized coal boilers (Units 1, 2, and 3) and one tangentially-fired Combustion Engineering 4300 MMBtu/h pulverized coal boiler (Unit 4). Each boiler uses pulverized coal for main fuel and No. 2 fuel oil for Class 1 oil igniters.

In 2014, Tampa Electric initiated a project to replace the oil igniters with high heat input natural gas igniters, which would reduce fuel costs by eliminating No. 2 fuel oil, and firing igniter gas to achieve full load when one pulverized coal mill is out of service. Also, high heat input natural gas igniters allow each of Tampa Electric's four PC units to potentially operate at 33% of full load when coal mills are out-of-service. With these objectives in mind, Tampa Electric's project team developed specifications for complete natural gas igniter systems, including igniters, warm-up guns, flame detectors, high-energy spark rods, and all required accessories.



Pressure Reducing Station (front view showing pressure control valves).

The Switch Is On – Oil to Gas Igniters

Units 1, 2, and 3 originally paired twenty-four 15-MMBtu/h oil igniters with twenty-four coal burners. These boilers are Wet Bottom Riley Stoker TURBO Furnaces characterized by upper and lower furnace zones separated by a venture-shaped construction. Burners are mounted in the lower furnace on opposite downward facing arches. The igniters provided 360 MMBtu/h of heat input per unit. In converting to natural gas, Tampa Electric specified a total boiler heat input of 1680 MMBtu/h for the new igniters, nearly five times greater than the heat input with the oil igniters.

To achieve this heat input, the project team specified 24 Forney MAXFire® 40 gas igniters and 24 Forney gas guns for each boiler. The igniter/gas gun combination can provide between 20 and 70 MMBtu/h heat input at a natural gas supply of 35 psig. Each igniter uses Forney's flame rod detection system to ensure flame presence and discrimination between coal and gas flame.

Pressure Reducing Station (rear view showing Wye strainer, Coriolis Mass Flow Meter, Pressure Regulators sized for Pin 400 psig/Pout 3-35 psig – Max flow 1,680,000 scfh).

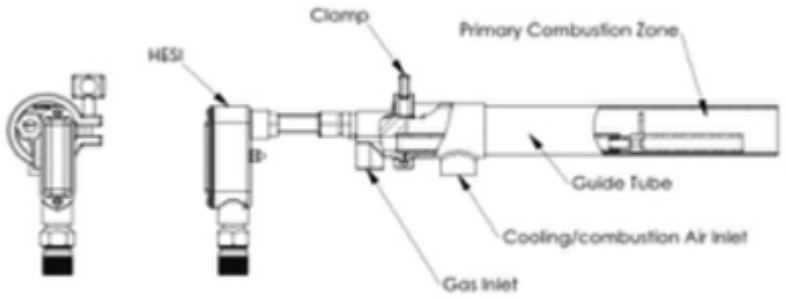
Unit 4 boiler is a Combustion Engineering, tangentially fired, balanced draft dry bottom boiler. It originally used 16 side-fired oil horn igniters, with four igniters at each corner of the tangentially-fired boiler. The boiler had five burner levels in each corner, with one 10 MMBtu/h oil igniter at each of the top three burner levels. The bottom two burner levels shared a 2-MMBtu/h oil igniter in each corner and four 130-MMBtu/h oil-fired warm-up guns, one in each corner. The 16 oil-fired horn igniters plus the four warm-up guns provided a total heat input of 648 MMBtu/h.

For the natural gas igniter conversion project, Tampa Electric specified a total boiler heat input of 1920 MMBtu/h, about three times greater than the heat input with the oil igniters and warm-up guns. To achieve the required heat input for Unit 4, Forney provided 16 gas-fired horn igniters, each designed for 70 MMBtu/h (Figure 3) and four 200-MMBtu/h warm-up gas guns. The 70-MMBtu/h horn igniters are a first-of-a-kind design as horn igniters of this capacity have never been provided. The new horn

igniters went through extensive 3d flow modeling to ensure boiler wall impingement, flame pattern and combustion emissions were optimized.

For the horn igniters, ionization rods were installed with flame amplifiers factory wired to the ignitor junction boxes. For each of the four warm-up guns, Forney provided its new, high temperature, IDD Ultra flame detectors using UV quartz fiber optic cable bundles connecting the detector head to the scanner amplifier cabinet. The IDD Ultra system eliminates maintenance issues associated with shutters and solenoids found in UV tube type detectors.

Gas Igniter



Management and Control

The project team specified and installed over half-a-mile of 12″ natural gas supply piping from the gas yard at the edge of the property up to each of the boilers. Natural gas is supplied to the igniters and warm-up guns from the main natural gas inlet header at Big Bend. To reduce the pressure from 400 psig at the main header to the 35 psig needed at the igniters and warm-up guns, Forney designed, engineered, delivered four pressure reducing stations (one for each of the four units) that included pressure regulating, control, block and vent valves; interconnecting piping; and instrumentation. These stations were factory assembled and mounted on rigid steel frames. During operation at full load, two pressure reducing/pressure control valves are full open (with a third set in standby off-line), providing total flow of 1,680,000 scfh for 12 igniter pairs (24 igniters total) at full load for each units 1, 2 and 3. Under maximum turndown (low load) conditions, these stations are controlled to provide 40,000 scfm for one igniter pair. For unit 4, the total gas flow is 1,920,000 scfh. Photos 1 and 2 show the front and back views of one pressure reducing station.

Gas shutoff is managed using SKOTCH Trifecta igniter gas shutoff valve assemblies with 3-inch fail-closed pneumatic actuators. These assemblies are complete valve systems that provide shutoff, blocking and venting functions in a single housing. This valve selection reduced the total DCS I/O count by approximately 2/3 from that which would be required using individual valve components.

Cooling Air Blower Skid

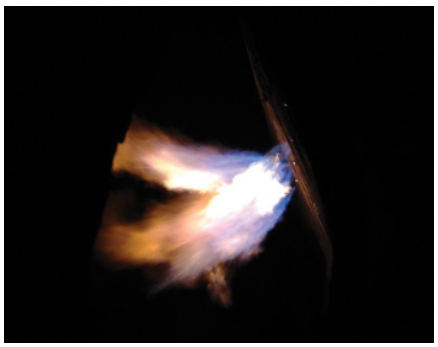
MAXFire Gas Igniter Drawing Showing High Energy Spark Igniter (HESI), Gas and Air Inlets, and Guide Tube.

Each natural gas igniter for Units 1-3 requires cooling/combustion air to support primary combustion during operation. Air flow also is required when the igniters are out of service to cool the igniters and prevent debris from migrating into the end of the guide tube. Forney designed, engineered, and provided four cooling air blower skids, containing air blowers sized for 2300 SCFM at 31″ W.C. (four Units 1,2 and 3) and 360 SCFM at 31″ W.C. (for Unit 4). The blowers, with 480 VAC, 60 Hz, 3-phase TECF motors, were mounted on common skids containing pressure transmitters, fan inlet air silencers, valves and piping

For the unit 4 igniters, cooling/combustion air is supplied by the FD fan via the individual igniter windboxes.

Instrumentation and transmitters for the new igniters and all ancillary equipment were wired to local junction boxes. The control and instrumentation devices enable complete remote control and monitoring by the plant distributed control system (DCS). Hardware from the plant's existing Emerson Ovation DCS was reused to the greatest extent possible.

Maxfire 40



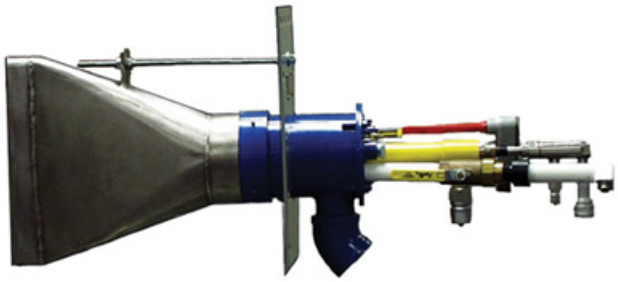
Maxfire 40 over A-Gas gun (igniter/gas gun combination) – Stable natural gas fire on Big Bend Unit 3.

Maintaining Fuel Flexibility

For Units 1-3, the gas igniters were provided with a total guaranteed heat input of 1680 MMBtu/h (70 MMBtu/h x 24 igniters),and for Unit 4 the guaranteed heat input is 1920 MMBtu/h (70 MMBtu/h x 16 igniters + 200 MMBtu/h x 4 warm-up guns). The total combined capacity for the system with all four units firing is 6960 MMBtu/hr. This allows the operators for each Unit to potentially achieve 33% of full load when firing igniter gas only. This provided added fuel flexibility and allowed running at full load when one pulverized coal mill on any Unit is out-of-service.

Tampa Electric's analysis justifying the project, estimates that the switch from No. 2 oil to natural gas for ignition will save its customers $76 million in fuel costs over the life of the units. This will be achieved by eliminating the use of 30,000 barrels year of light oil at the plant while reducing both dependence on foreign oil and emissions.

Horn Igniter



Horn Igniter Showing Gas Gun, High Energy Spark Igniter, and Diffuser Horn.

Summary

Changes in the power sector are compelling significant changes in the management of generating assets. While many coal-fired units are shutting down for economic and emissions-related reasons, others are investing in plant modifications to adapt to new market dynamics and save money for their customers. Tampa Electric's Big Bend Station successfully replaced its oil igniters with high heat input natural gas igniters to acquire the additional fuel flexibility necessary to remain an essential component of the dispatch order in the Southeast.