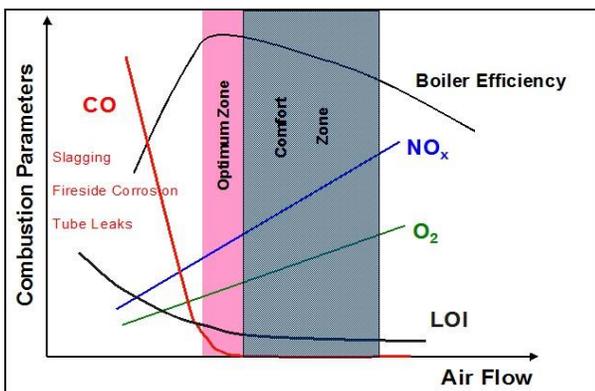


January 22, 2015

## Topic: Boiler Optimization and MATS Compliance testing using Delta Extractive Combustion Monitoring Systems

Today's stringent environmental regulations often require Electric Power Plants to operate at much lower O<sub>2</sub> levels than in the past. Carbon Monoxide is a by-product of incomplete combustion which increases rapidly when poor combustion occurs in a fuel rich environment. Traditionally, in-situ O<sub>2</sub> probes have been used to measure duct O<sub>2</sub> after the combustion zone. This method of measurement can be effective for determining overall low O<sub>2</sub> set point. However, it has proven to be very *ineffective* for burner and combustion tuning. Optimum combustion across the furnace becomes critical under these conditions in order to reduce emissions and increasing efficiency.

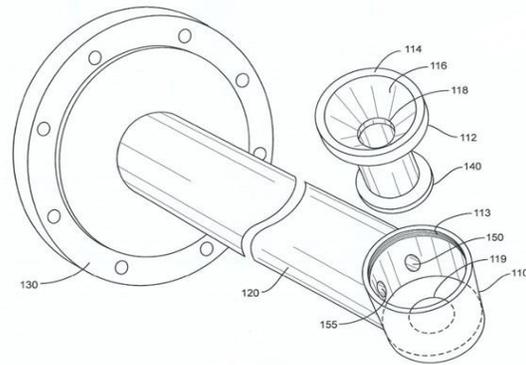
Standard practice has been to install a temporary CO grid in the boiler back-pass, or economizer section. This was due to the lack of availability of a cost effective and reliable multi-point permanent system for measuring Carbon Monoxide on Coal Fired Boilers. Delta Measurement and Combustion Controls uses a Patented Extractive Probe designed to operate in applications that contain heavy particulate and ash loading environments. To date Delta Measurement and Combustion Controls has numerous successful installations on Coal Fired Boilers, as well as Pulp and Paper lime kilns. The Delta system allows for *continuous* combustion tuning and optimization.



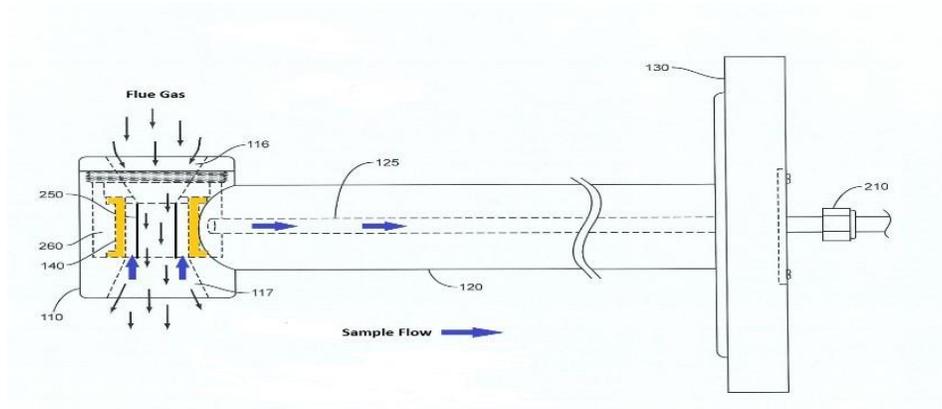
The new MATS regulations require Coal Fired Power Utilities to do periodic boiler tuning and provide documentation to meet the MATS requirements. This paper will show how the Delta System can be used as a primary tool for collecting boiler performance data, and for optimizing combustion. In addition, the paper will outline how the Delta system can accomplish the following results.

- **Continuously operate boiler in optimized combustion zone.**
- **Correct for O<sub>2</sub> error due to in-furnace leakage.**
- **Various length probes can extract from areas conventional O<sub>2</sub> probe cannot.**
- **Reduced boiler slagging.**
- **Improve SCR / SNCR Performance.**
- **Reduce fire side corrosion due to high CO.**
- **Increase boiler efficiency.**
- **Lower flue gas velocities through the furnace and precipitator.**
- **Conduct periodic boiler tuning, and for measuring additional combustion gasses.**

At the heart of the Delta system is the patented extractive probe (*US Patent # 8,146,445*). The probe uses a combination of “slip stream effect” and “particle inertia” to extract a flue gas sample, *without* pulling ash into the sample lines. The patented probe uses a non-heated sample line which resists plugging.



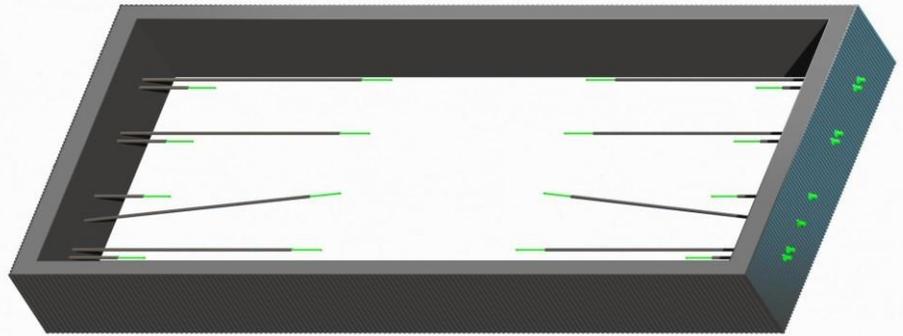
1. As the hot flue gas and ash flow through the center of the probe, the ash is roped and accelerated. The flue sample is extracted through the back of the probe (BLUE ARROWS), against the gas flow, inertia of the particles will keep ash from flowing back into the filter. Within the probe head is a .5 Micron Hastelloy filter, which filters the flue gas prior to entering the sample lines.
2. In addition to the slip stream effect, the probe uses the CV of the sintered filter to pressurize the probe head, and allow for the simultaneous purging of the probe head and sample lines.



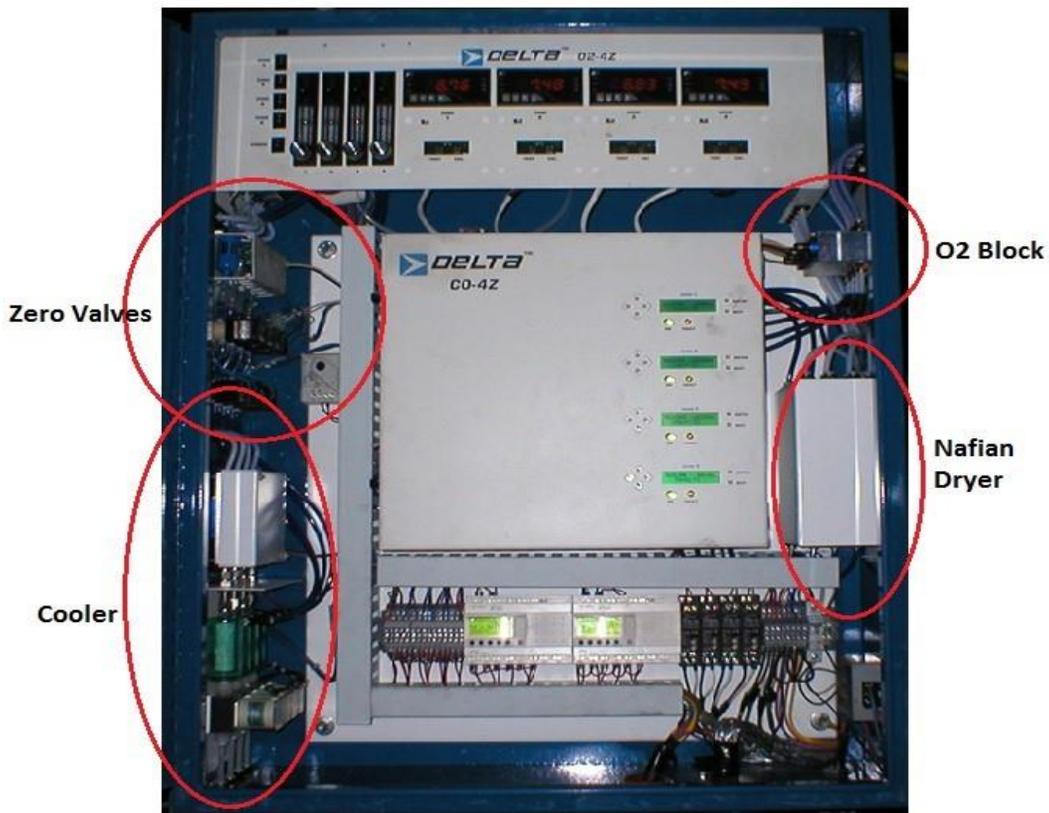
The main advantage the Delta System has over any other technology is that it can operate in the extremely adverse environments of a coal fired boiler. *Reliably operating within the parameters of High Temperatures, Ash Loading and High Sulphur content.* Within the monitoring system *CO* levels are measured using non-dispersive infrared technology, *Gas temperature* using imbedded thermocouples in the probes and *O<sub>2</sub>* is measured using heated zirconium oxide sensors. *NO<sub>x</sub>* measurement will be available in 2015 using Chemiluminescence Technology.

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**5 Turnberry Lane**  
**Sandy Hook, CT 06482**  
**203-270-0337**

Example of a 16 point CO, O<sub>2</sub> and Temperature grid. Longest probes are 22 feet long for extracting samples from the center of a large duct.



### Main components of the Delta Monitoring System



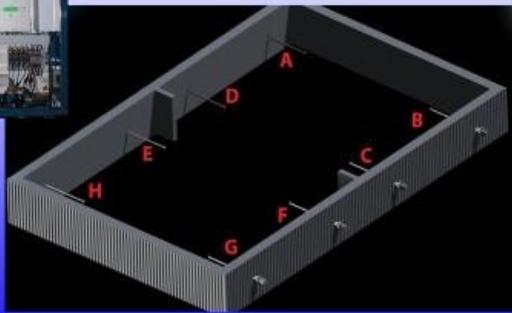
- ✓ Inlet peltier cooler, to lower gas temperature and remove sample moisture in coalescing filter and drain valve.
- ✓ Valve section where the zero valve will sample clean air for zero function every 30 minutes, and isolate valve for monitor isolation during purge.
- ✓ Nafian dryer section for removal of additional moisture prior to measurement with infrared bench.
- ✓ Heated infrared bench, mother boards and pumps for measuring CO.
- ✓ Zirconium Oxide cells for measuring O<sub>2</sub>.

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5 Turnberry Lane  
Sandy Hook, CT 06482  
203-270-0337

An additional advantage of an extractive probe system is that a portable handheld device can be easily connected to the existing probe grid for the analysis of additional gas samples. The system can be fitted with extraction ports, or a handheld device can be connected directly to the probe sample line for measurement. With the addition of the NO analyzer to the system, the Delta Combustion Analyzer will have the capabilities of continuous measurement of CO, O<sub>2</sub>, TC and NO (Optional NO<sub>x</sub>). The three gases that are required for MATS periodic testing. These can be measured on a continuous basis. 4-20mA outputs are provided for each measurement, or a Modbus connection can be added.



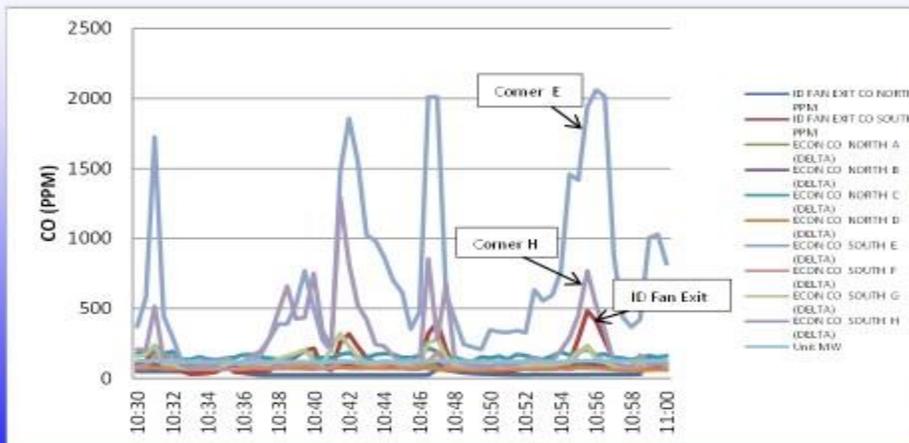
**CO / O<sub>2</sub> Grid on a T-Fired Unit**



When installing the Delta Combustion analyzer in the economizer section of the T-Fired unit, you can identify the corner that is experiencing the High CO and poor combustion. Data can be collected into plant DCS and control systems for Engineering and Operations tuning modifications. System data can also be input into a Neural Network systems for continuous online tuning adjustments

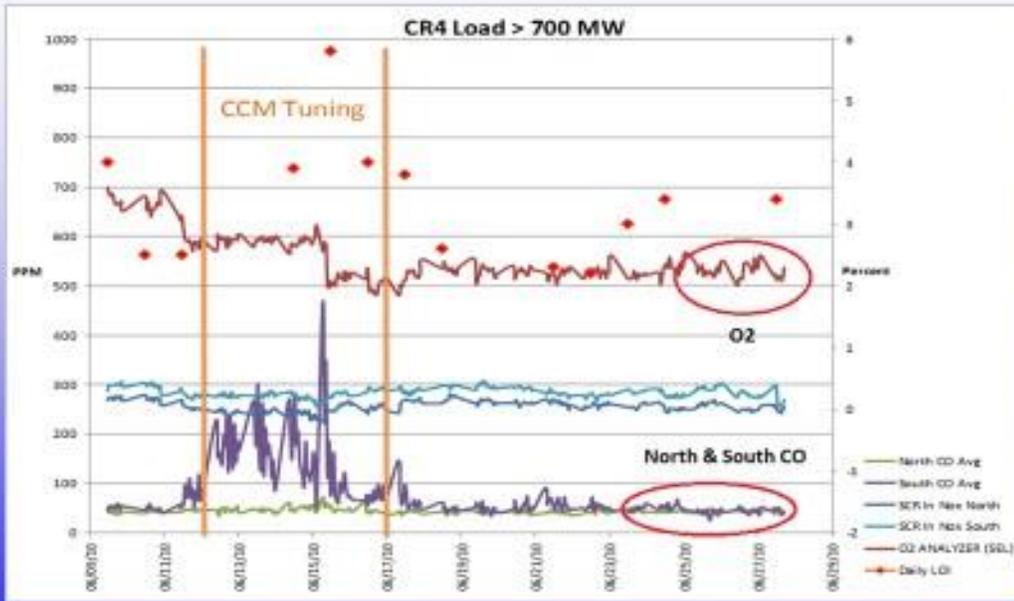


**Locate WHERE CO is being produced**



Below is an example of online tuning of a wall fired unit using a variety of technologies, while reducing excess air, the CO measurements are displayed in the plant DCS. The resulting O<sub>2</sub> levels can be minimized, while also keeping CO levels optimal.

## CCM Tuning



Author: Nicholas Ferri  
Director of Business Development  
EES Corporation

Environmental Energy Services, Corp.  
5 Turnberry Lane  
Sandy Hook, CT 06482  
203-270-0337