

## **Diagnostic Testing of an 830 MWg Utility Boiler**

On September 7 and 8, 2006 STEP Combustion performed combustion testing and economizer outlet emissions mapping of an 830 MWg Utility Boiler (Unit #2). The testing was conducted in order to aid in the diagnosis of combustion issues which have resulted in limited generating capacity of the unit.

Testing began with a full economizer outlet emissions map and documentation of operating parameters under typical firing and operating conditions at a Full Load of approximately 786 MWn (Test No. 06907-1). Unit operating data were obtained, along with an economizer outlet emissions grid of O<sub>2</sub>, CO, CO<sub>2</sub>, and NO<sub>x</sub>. Emissions contour plots are provided in Figure 1 attached. As shown, it was observed that high CO emissions were characteristic across the economizer, however levels on the North duct were substantially greater. It was also noted that the unit is currently operating with known hardware problems in 3 of the 32 total burners. Problem descriptions are provided below:

- Burner 1 – No Flame Stabilizer (Swirler) on Burner
- Burner 19 – Some Swirler Vanes Missing
- Burner 22 – ½ of Flame Stabilizer Remaining

Obviously, operating with no flame stabilizer or a severely damaged flame stabilizer can lead to significant combustion related issues. The flame stabilizer produces a low pressure zone along the centerline of the burner which induces a recirculation of combustion gases and results in a stable flame and good combustion characteristics. Without a flame stabilizer in good condition, injected fuel will disperse, uncontrolled, in to areas with little or no excess O<sub>2</sub> and the resulting incomplete combustion can carry-over to the boiler exit.

Subsequent to the initial test condition, the quantity of flue gas recirculation to the windbox was reduced (flue-gas-recirculation is controlled by the GI fan) and another full test was performed. The calculated quantity of flue gas recirculation was reduced from 15% for test 060907-1 to approximately 10% for test 060907-2. Economizer outlet emissions contours for test 06-0907-1 are provided in Figure 2, attached. A comparison of Figures 1 and 2 shows that the excess O<sub>2</sub> and CO contours remained essentially unchanged, while NO<sub>x</sub> increased along the entire duct cross-section.

Flame observations suggested that there might also be issues with atomizer hardware and/or burner 4-way valves. Several burners were highlighted for atomizer changes during the night-shift including:

- Burner 22
- Burner 27
- Burner 16

In setting up for the third and final test an attempt was made to remove burners 1 & 8 from service (Burner 1 had no flame stabilizer). However, when the pair of burners was removed superheat temperatures quickly increased to values above 1010 deg F. Apparently, the additional heat input higher in the furnace (fuel displaced from the burners removed from service), was detrimental to already high superheat temperatures. Accordingly, the burners were returned to service. The final tested configuration closely resembled test number 060907-2, with replaced atomizers in burners 22, 27, and 16 as discussed above. Interestingly, it was found that CO levels in the economizer outlet, did in fact level out to some extent. While the values were still relatively high, North and South duct averages were found

to be much closer than the previous test runs. It is believed that improvements to the overall distribution were realized by replacement of the above fuel oil atomizers.

It is recommended that the missing and damaged flame stabilizers be repaired as soon as possible. It is also recommended that once the swirlers are replaced, an additional test documenting the new operating condition be taken (This will assist in identifying issues in the future).

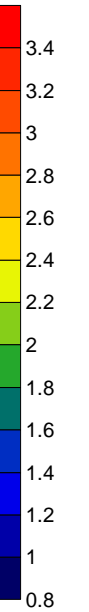
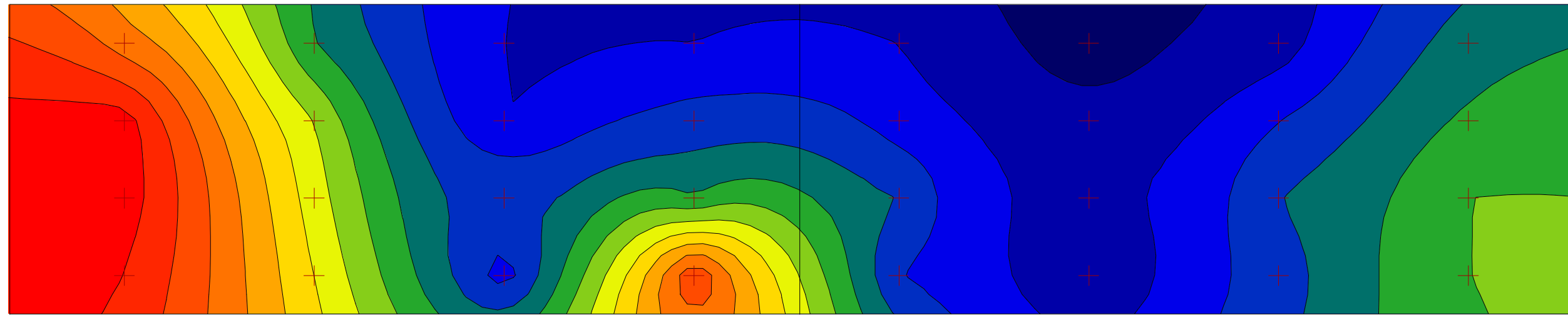
P. Robert Santangeli, P.E.  
Technical Director  
STEP Combustion



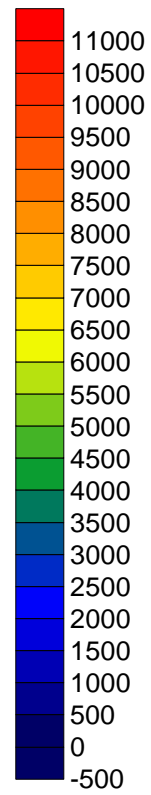
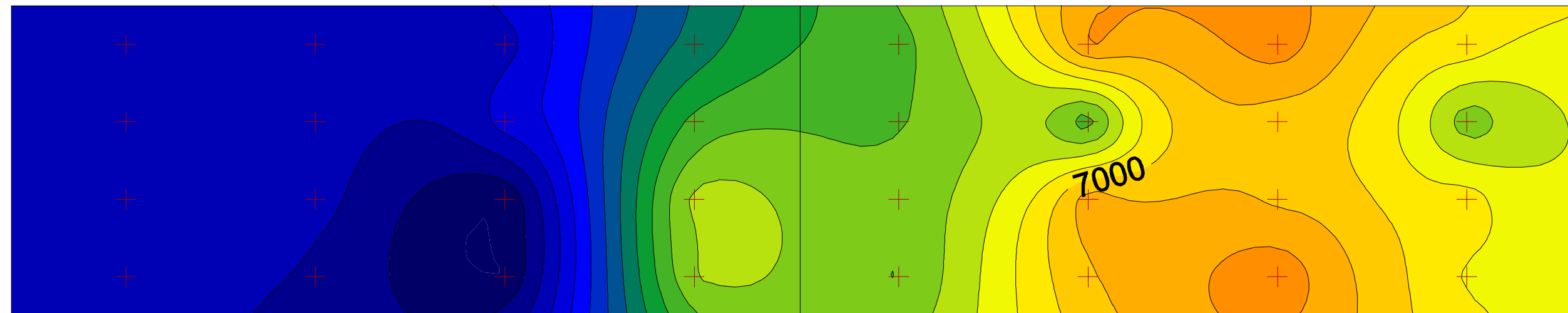
# Unit #2 Diagnostic Testing - September 7, 2006

Test No. 060907-1

O<sub>2</sub>-%



CO-ppm



NO<sub>x</sub>-ppm

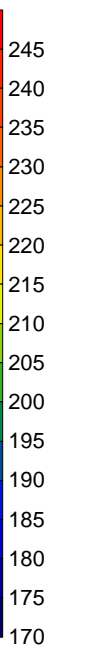
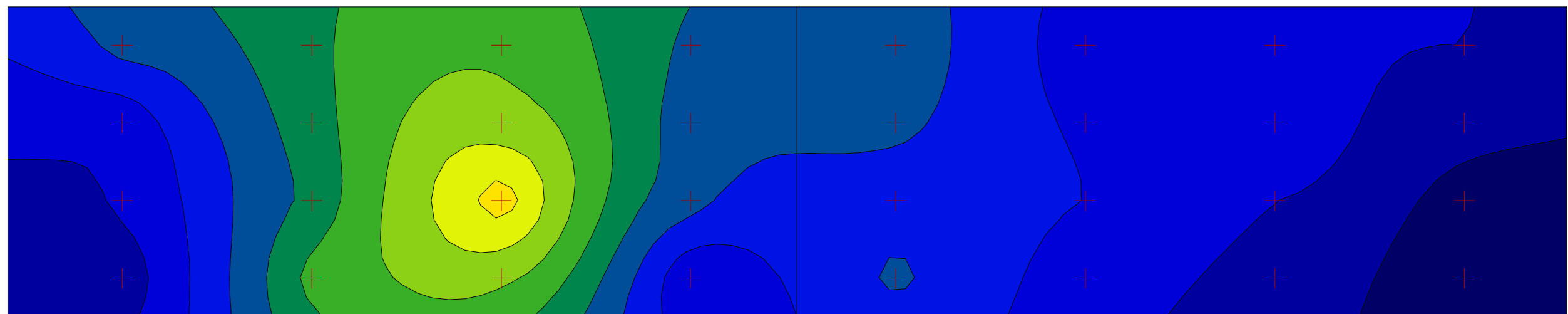
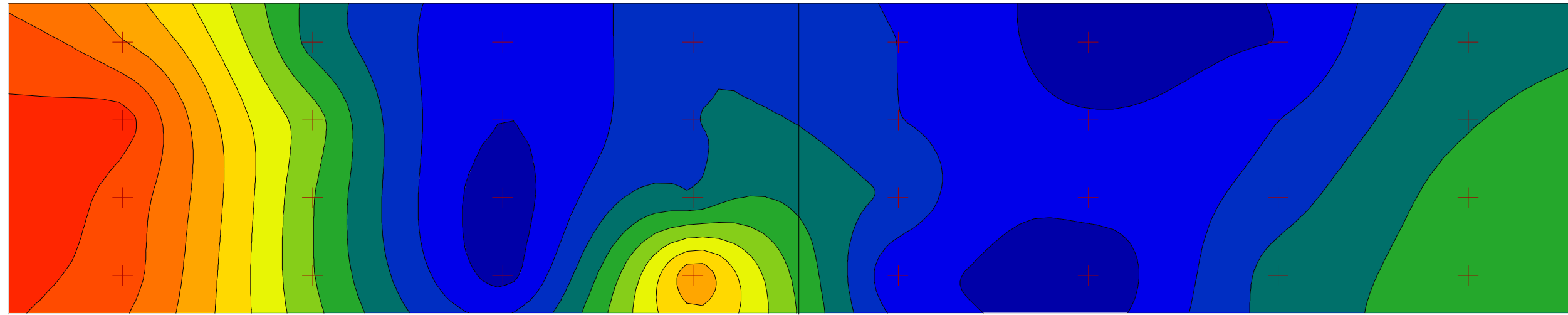


Figure 1

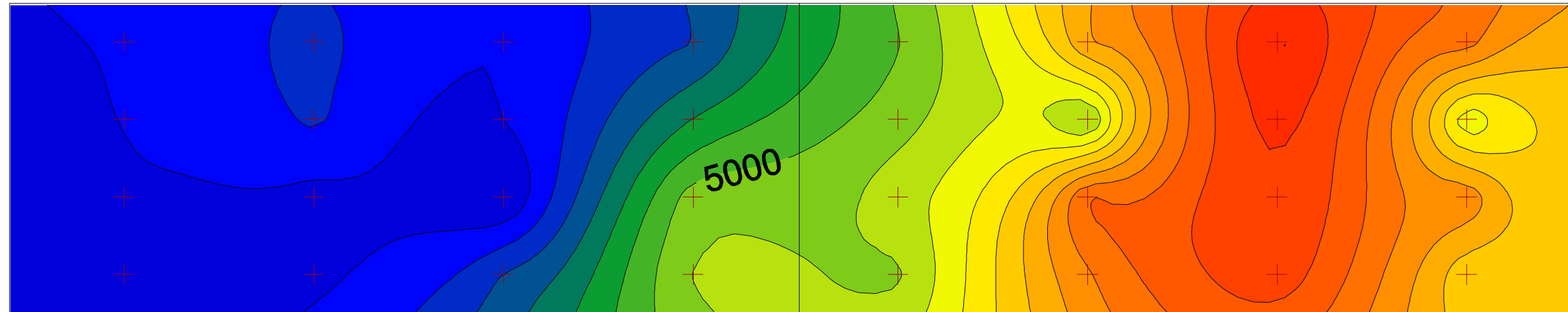


**Unit #2**  
**Diagnostic Testing - September 7, 2006**  
**Test No. 060907-2**

O<sub>2</sub>-%



CO-ppm



NO<sub>x</sub>-ppm

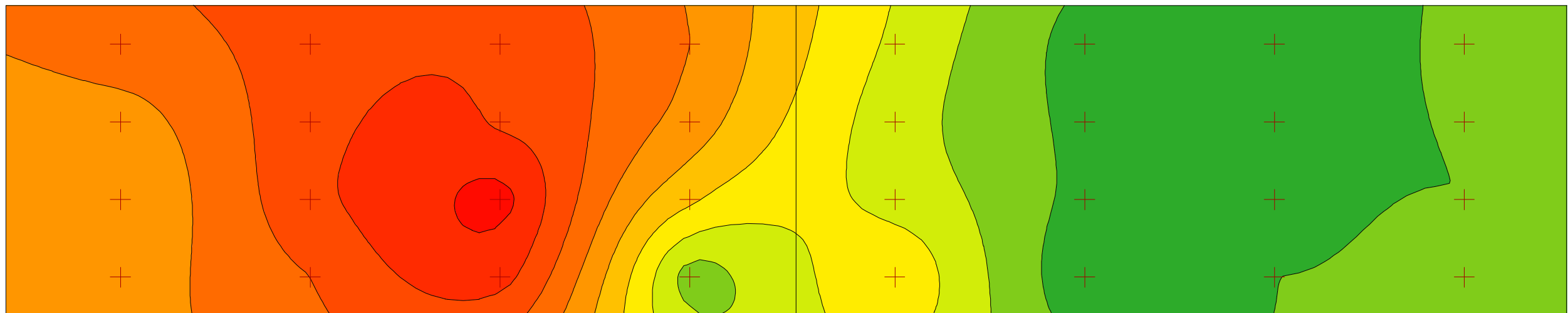


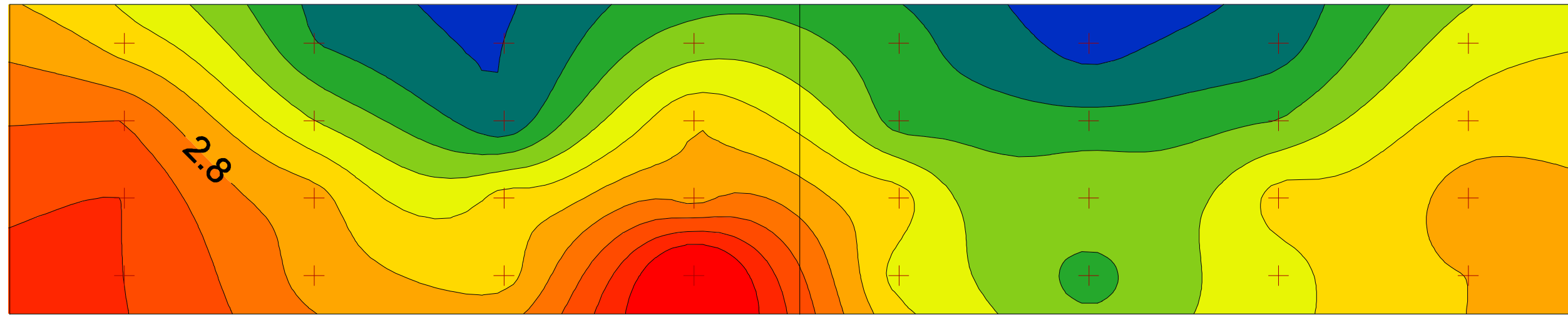
Figure 2



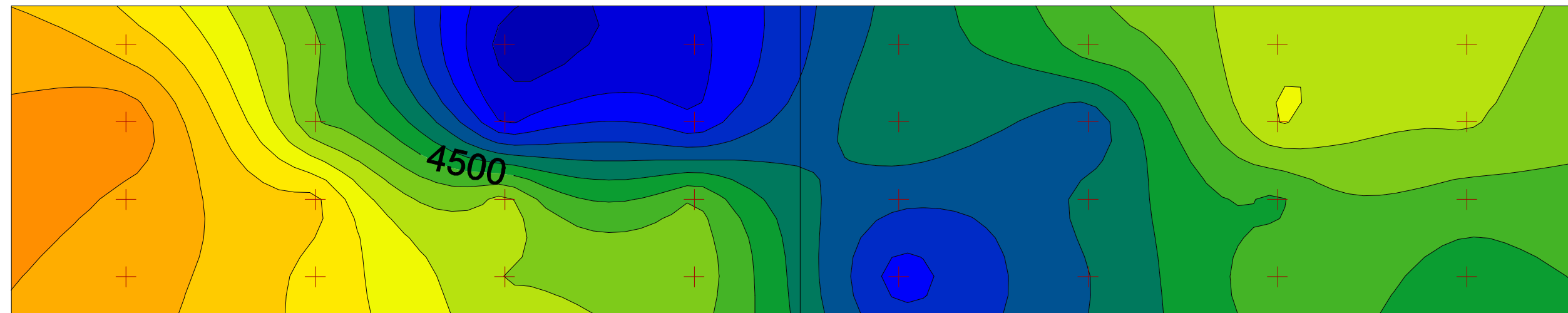
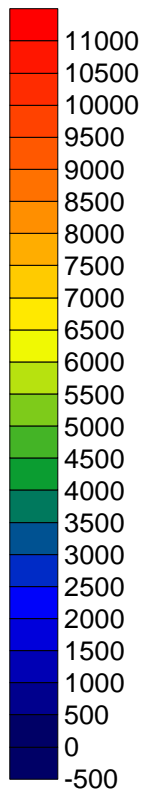
# Unit #2 Diagnostic Testing - September 8, 2006

Test No. 060908-1

O<sub>2</sub>-%



CO-ppm



NO<sub>x</sub>-ppm

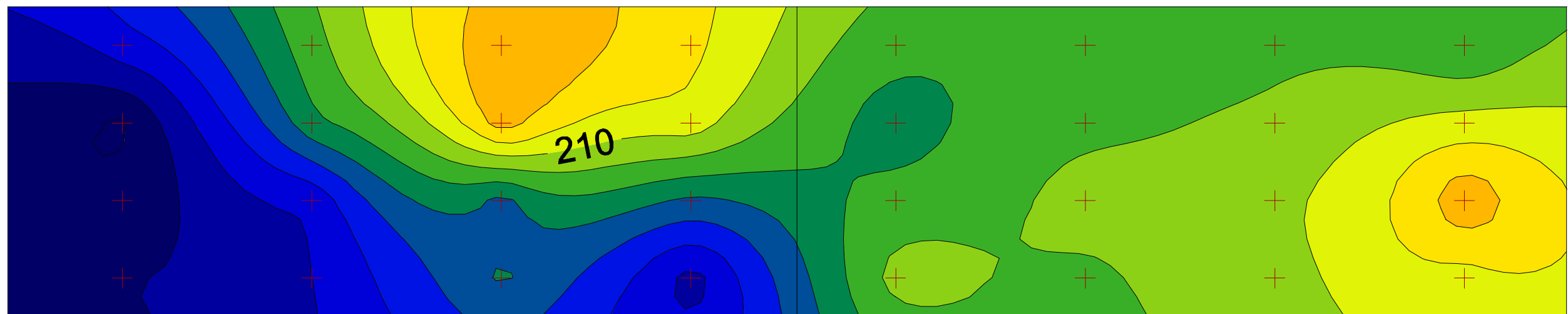
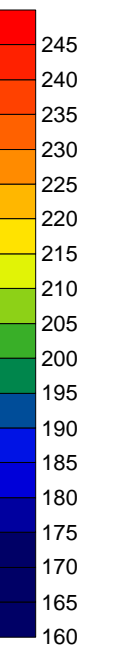


Figure 3