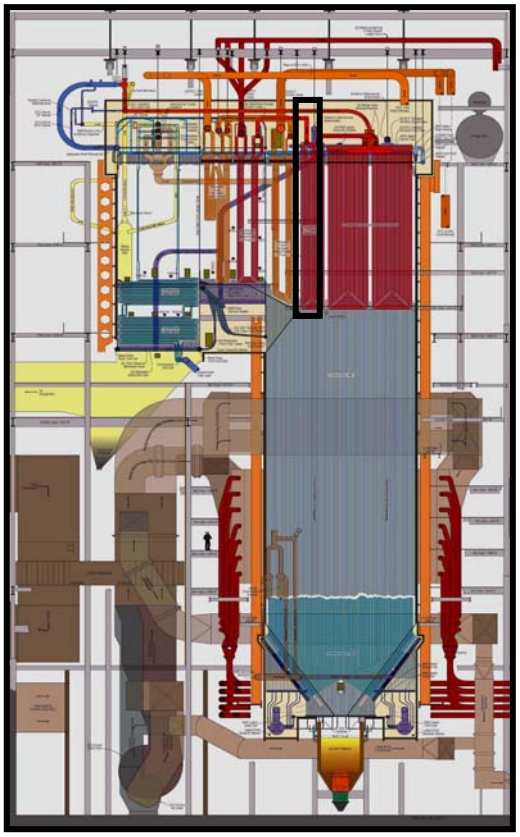
DESIGN UPGRADE OF AN INTERMEDIATE SECONDARY SUPERHEATER

July 22, 2005 Rev. Nov. 26, 2007

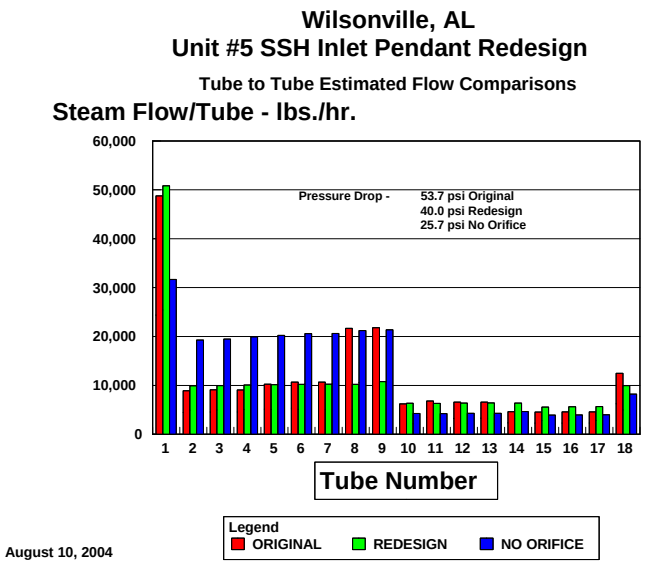
Large Southeastern U.S. Utility - Unit No. 5
Wilsonville, AL

Commercial Operation	1974
Electrical Generation	883 MWe
Main Steam Flow lbs./hr.	6,351,470
SH Outlet Pressure	3750 psig
SH/RH Steam Temp.	1000/1000 F
Type of Firing	Pulverized Coal
Boiler Manufacturer	Combustion Engineering



This unit had been experiencing reduced reliability, related to tube metal failures in the lower bends and leading edge tubes. This electric utility felt that it was important to utilize higher grades of alloys throughout this intermediary bank, in order to minimize the failure rates and increase boiler availability. UT examination of the tubing indicated that these elements were reaching their useful life, thereby mandating a complete replacement irrespective of upgrade considerations.

While the bid specification defined the required alloy – TP-347H, tube OD, and thickness for each row, bidders were encouraged to offer alternatives that would provide added value to the customer.



As is our normal engineering practice for such potential upgrades, we begin by analyzing the flow distribution, during the proposal phase, using computer modeling techniques based on the original design. Comparing these results to actual operating data assists in validating our model results and refining the overall model itself.

Our analysis revealed some flow unbalances within the original design. This was not a problem if we had simply substituted the TP-347H alloy using the original wall thickness. Unfortunately, this option was not economically feasible for the customer and did not allow us to capitalize on the improved material properties of this selected grade of stainless.

Ultimately, we concluded that we would present this key customer with an optimum design that provided 1.) conservatism with respect to life from an erosion/corrosion standpoint using slightly thicker TP-347H tube materials than required by ASME code 2.) utilize those metal selections to partially balance the flow, and 3.) achieve final flow balances through the use of machined orifices in the DMW (dissimilar metal weld) spool pieces at the pendant inlet tube connections.

Our traditional preference is to avoid the use of orifices to assist in circuit balancing, as orifices have some inherent problems. Those problems include the potential for varying flow characteristics over time from erosion and wear, as well as potential for pluggage from scale and other foreign objects. Lastly, several of the OEMs have experienced field difficulties causing downtime, when the orifices were not properly sized.

CTI POWER

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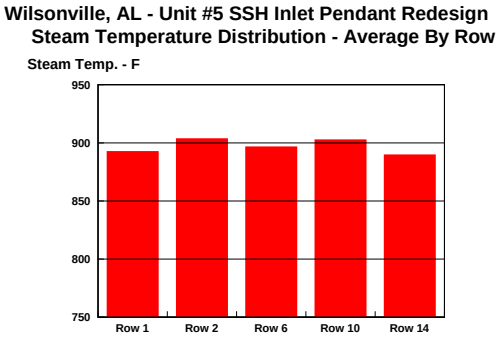
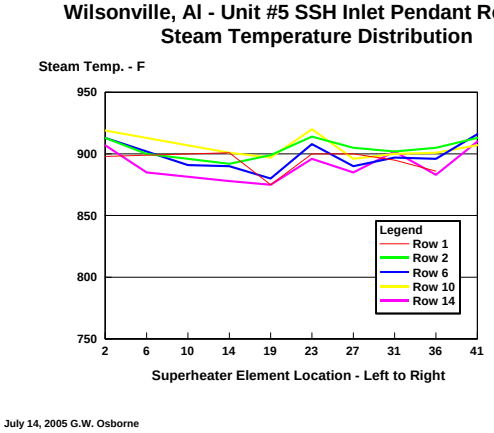
In consultation with the customer, we developed a modified design, which we believe has mitigated some of the adverse characteristics of the usual flat plate or drilled header orifice. In this instance, we incorporated a 30 degree inlet and outlet taper with approximately a 6" long DMW transition spool piece. The inner diameter of the spool piece was engineered to accomplish the final flow balancing required.

Even though much engineering time was expended to prepare and verify this design, the proof was in the actual operation of this unit and achieving relatively uniform temperatures at the pendant outlet.

Plant personnel installed temporary thermocouples on the pendant outlet legs on 10 of the 42 elements across the width and on 5 of the 18 tube circuits within each element. The tubes within each element that were selected coincided with the location of each change in the machined dimensions of the inlet orifices.

Installation of these redesigned elements was completed in early June, 2005. During the unit re-start, over 1800 metal temperature readings were recorded on the outlet legs, as a means of checking the redesign efforts. The results of this data are reflected in the adjacent graphical analysis. As expected there is some side-to-side steam temperature unbalance in the boiler, which can be attributed to firing + fuel/air unbalances. Variations of steam temperatures within each element are of greater interest and indicate that steam temperatures between circuits ranged between plus or minus 10 F.





Prior to re-start, no fit-up or quality issues were reported with this newly redesigned superheater, which is now operating to the customer's satisfaction.

In the process, we have also helped to reduce the overall project cost. What can we help you accomplish at your power plant?

Note: This customer has requested that we not publish their name in this document, but is more than willing to answer any questions with respect to this project & CTI's performance. Customer contact information may be obtained by calling Gerry Osborne at (814) 866-6267 or Ron Romanski at (800) 972-0217.

Solution Annealing of the Lower Pendant Loops