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Fire Side and Steam Side Incompatibility

What is fire side/steam-side incompatibility? The solution for slagging of a furnace exit is to improve combustion in the burner belt, and therefore reduce the FEGT (Furnace Exit Gas Temperature) Right? Note Figure No. 1 which shows optimized (fire side) combustion in the burner belt. By increasing the rate of combustion in the burner belt (up to the limits of acceptable NO_x production) furnace waterwall heat absorption is increased and the flue gases leaving the furnace are lower.

Combustion must be complete here for minimal slagging and fouling, maximum efficiency and reliability.

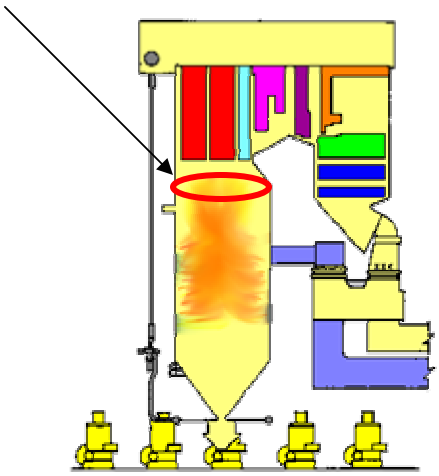
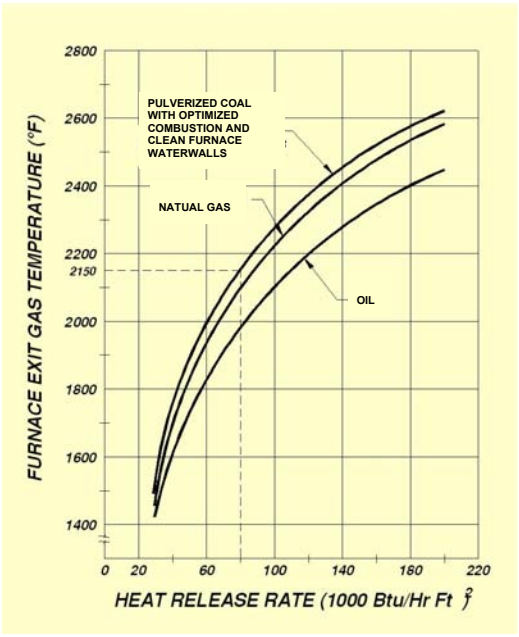


Figure No. 1

Typical "FEGT" With Optimized Furnace Combustion



Note: A typical 70's design furnace will be about 80,000Btu/ft^2/hr heat release.

Figure No. 2

A typical furnace exit gas temperature should be in the range of 2,100°F to 2,250°F. If the ash softening fusion temperature is say, 2,100°F, of course we would not want peak flue gas temperatures of say 2,400°F; which may well exceed the ash fluid temperature. So, the "Fire Side Solution" is to apply the 13 Essentials and optimize the burner belt combustion performance. Note Figure No. 2 which shows the expected natural furnace exit gas temperature for a given furnace heat release rate. This is, of course, providing

that combustion is optimized in the burner belt (meaning, minimal secondary combustion above the burner belt.)

Balancing the fuel and air inputs will usually lower the FEGT. Also, optimizing combustion will lower the peak temperatures of the flames in the upper furnace. All of this is good for boiler efficiency, unit heat rate, reliability and capacity. Well that is, providing that design steam temperatures are achieved.

It is easy to see the advantages of "Optimized Combustion" and the consequent advantages to heat-rate, capacity, reliability and environmental performance. However, for maximum steam cycle efficiency every operator and plant engineer knows that design steam temperatures are an absolute **MUST**. Superheater and reheater surface must be adequate to produce design steam temperatures of 1,005°F SH and 1,005°F RH (or 1050/1050°F if 1050°F is the design turbine inlet steam conditions).

When the fire side is optimized for minimum slagging and fouling, and design steam temperatures cannot be attained, we call this a Steam Side – Fire Side Incompatibility.

If full design steam temperatures can not be achieved with an FEGT of 2,100 – 2,250˚F, or the temperature that is compatible with the ash fusion temperatures, then there is insufficient superheater and or reheater surface. Therefore, if there is insufficient surface, then achieving full steam temperatures is accomplished by forcing the FEGT higher than desirable based on ash slagging and fouling considerations. For example, note Figure No. 3 and 4:

Typical Flue Gas Temperature Profiles

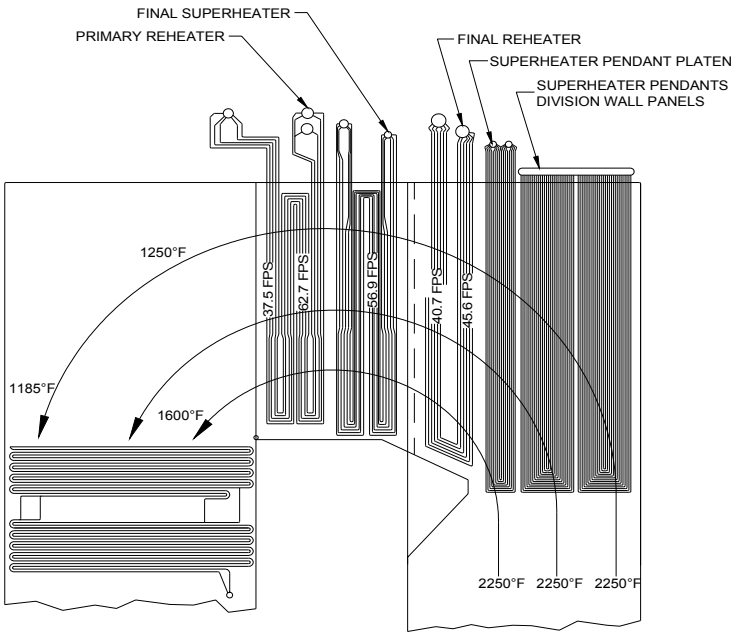
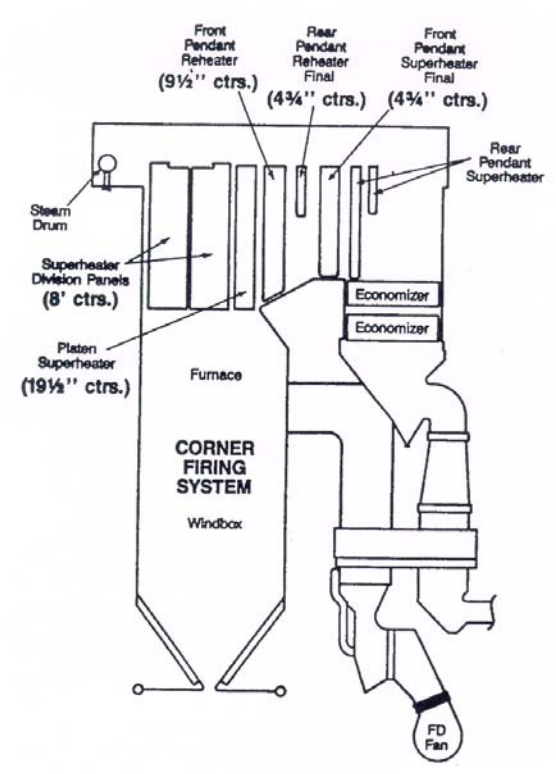


Figure No. 3



Typical Tube Spacing for a 500MW PC Boiler.

The Tube spacing of all boilers become progressively more restrictive as the heat transfer process changes from "Radiant" in the furnace to "convective" heat transfer in the back pass.

Figure No.4

Combustion should be completed before the hot flue gases pass over the division wall panels, or over the platen superheater. The platen superheater assemblies in the example, Figure No. 4, are spaced at 19 ½" centers. Heavy cinders can be removed by long retractable sootblower lances with high velocity nozzles, and up to 275 psig of blowing steam or compressed air blowing medium. However, a split second later in the gas flow path, the rear pendant reheater pendants are on 4 ¾" centers. These can foul quite readily with sticky ash. Therefore, it is desirable that once the flue gases pass through or over such closely spaced surface, that the ash should be cooled to a couple of hundred degrees below the ash softening temperature. This is illustrated in Figure No. 5 below.

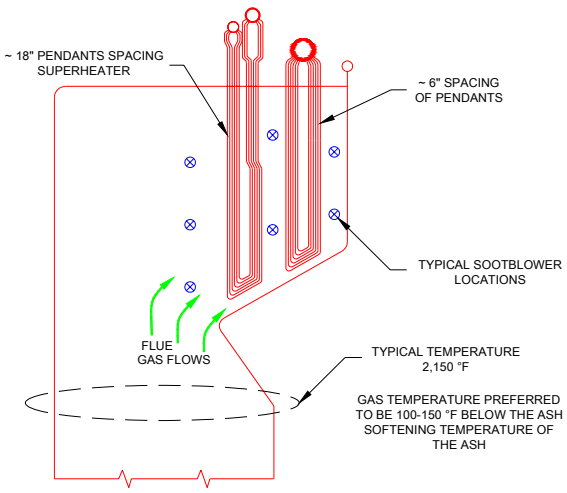
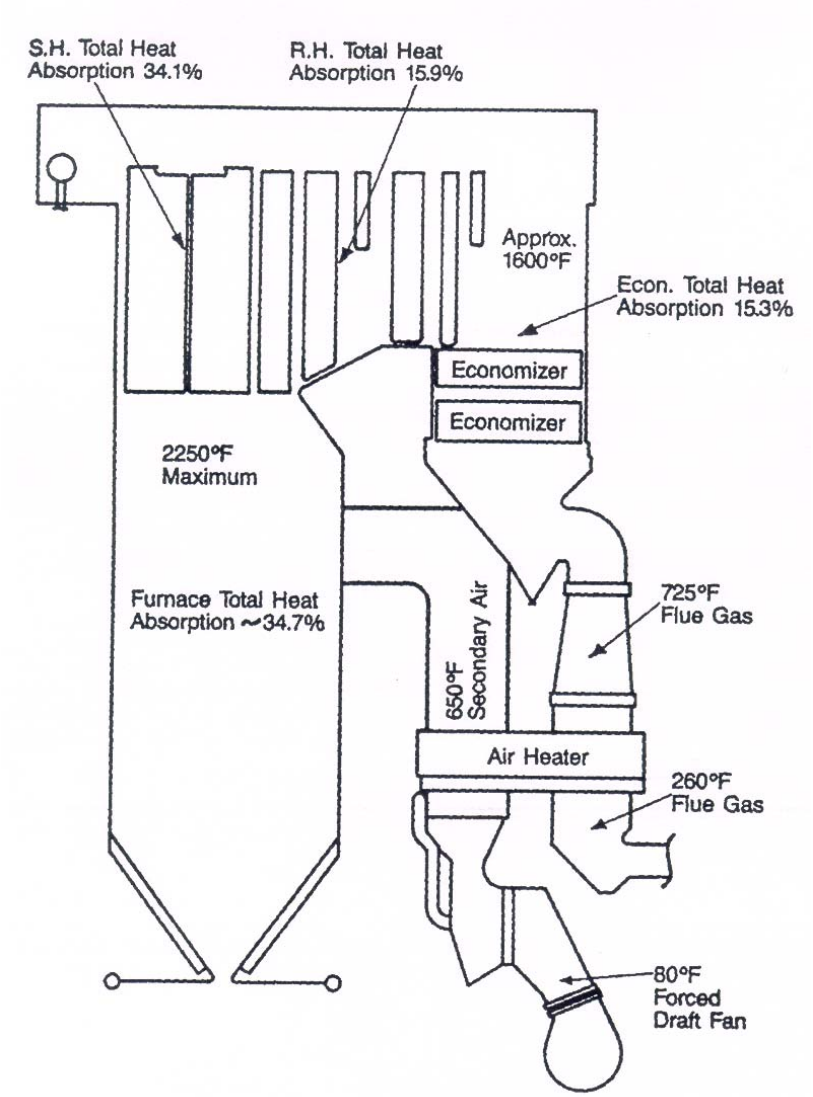


Figure No. 5

The point of this discussion is, that what should be accomplished for the Best "Fire-Side" slagging and fouling performance, can Result in unacceptable steam temperatures. Here is an example of a 500MW boiler with this fire side/steam side incompatibility:

A 500MW western coal fired utility boiler
With fire side/steam side incompatibility



	Temp.˚F	Enthalpy BTU/#
Feedwater	490	476
PSIA Econ Outlet	630	654
2750 Drum Water	684	768
Drum Steam	684	1058
Primary S.H. Steam	760	1244
Spray Water	325	296
Desuper Heater Outlet	740	1217
Fianl Superheater	1005	1454
Boiler Overall Expected Efficiency		**88.40%**

Figure No. 6 – Design Data

APPROX. TOTAL BOILER HEAT ABSORPTIONS AT 550MW

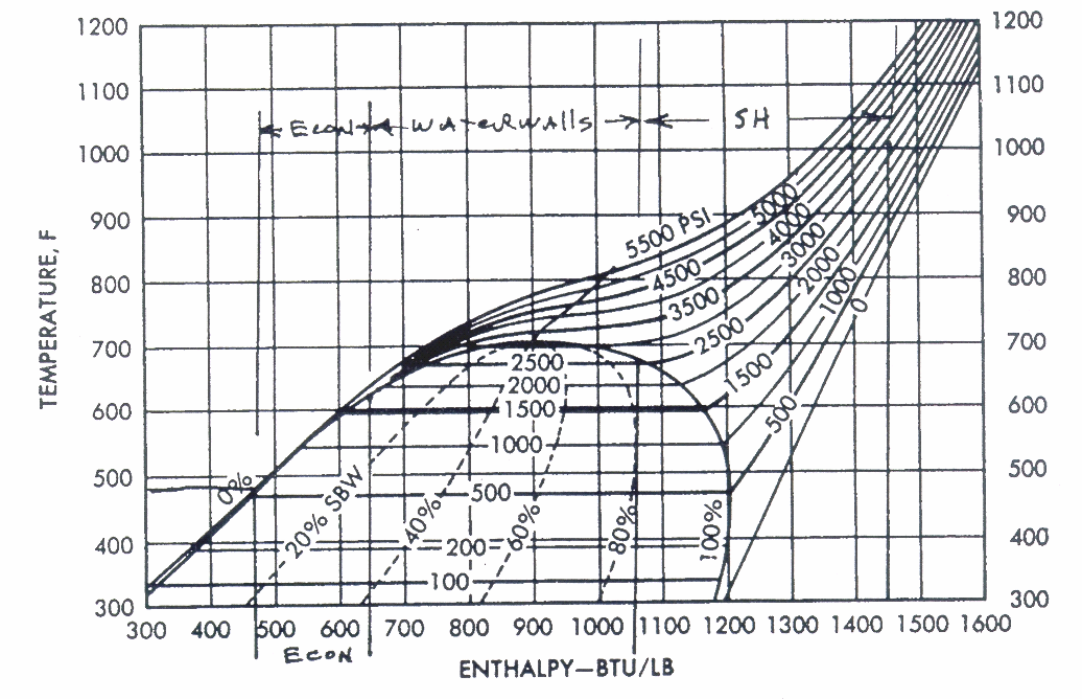


Figure No. 7

Preferred furnace side or flue gas temperatures to provide the foregoing steam conditions are shown to be a maximum furnace exit "peak" temperature of about 150°F below the minimum ash softening temperature. Shown pictorially……

PREFERRED TEMPERATURES

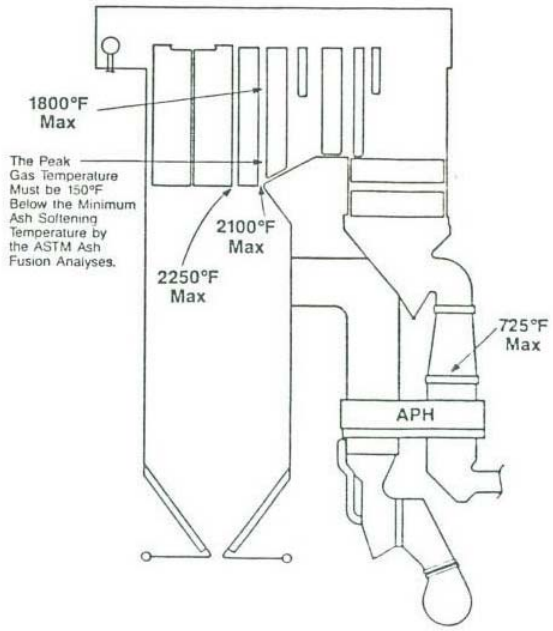


Figure No. 8

Insufficient superheater and/or reheater heat absorption surface requires that the FEGT be “forced” above the temperatures that are satisfactory from “Fire Side Comfort”.

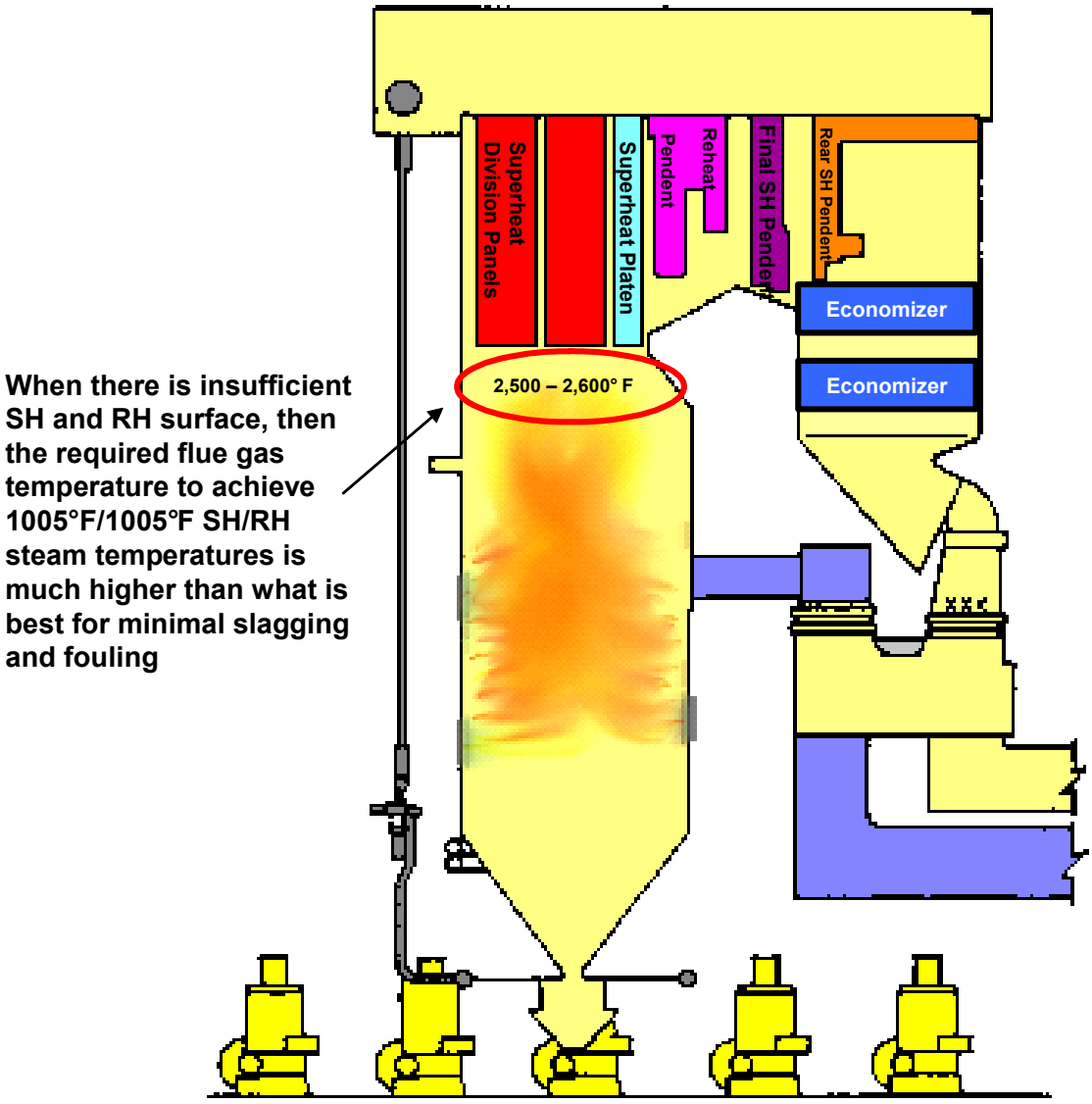


Figure No. 9

This is commonly found, and we thought sharing this with our readers would be helpful. The correction is simple from a technical viewpoint. Simply add more surface. In the example boiler, more superheater surface could be added to the rear superheater pendants; also the front superheater platen and/or superheater division panels.

However, there have been obstacles to doing that, such as NSR, financial constraints and others. There are some tricks of the trade that can be utilized. Such as, advanced technology sootblowers, kicker walls to more effectively utilize the upper furnace height gas temperatures and more. Note on Figure 3 the lower temperature gas flow stream is usually found near the roof tubes. This is the basis of how kicker walls improve steam

temperatures by kicking the high temperature flue gas streams higher to flow over more SH and RH surface.

How is fire side/steam side incompatibility identified?

The best way we know to do it, is to conduct a comprehensive diagnostic test, as outlined in Figure No. 10.

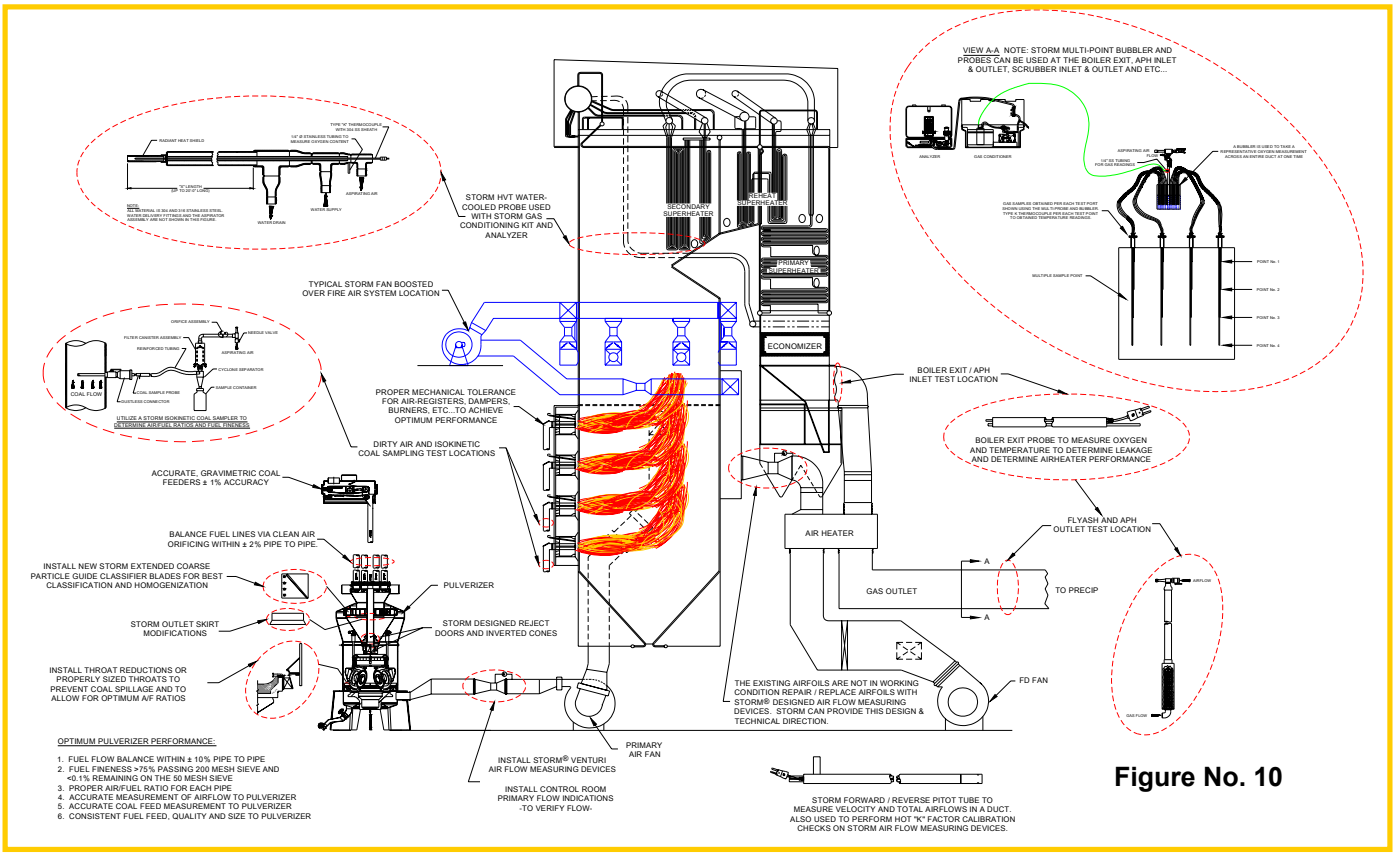


Figure No. 10

This diagnostic test outline has been covered in previous newsletters and publications. Most of these are on our website at www.stormeng.com or you can email or call us for specific questions.

Wishing you all the Best for the Fall Outage Season,

Sincerely,

Richard F. Storm

Dick Storm
Senior Consultant

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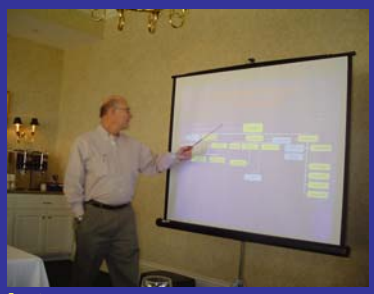
Storm Winter Seminar



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