Operational Experience with a High Fouling Biomass Fuel

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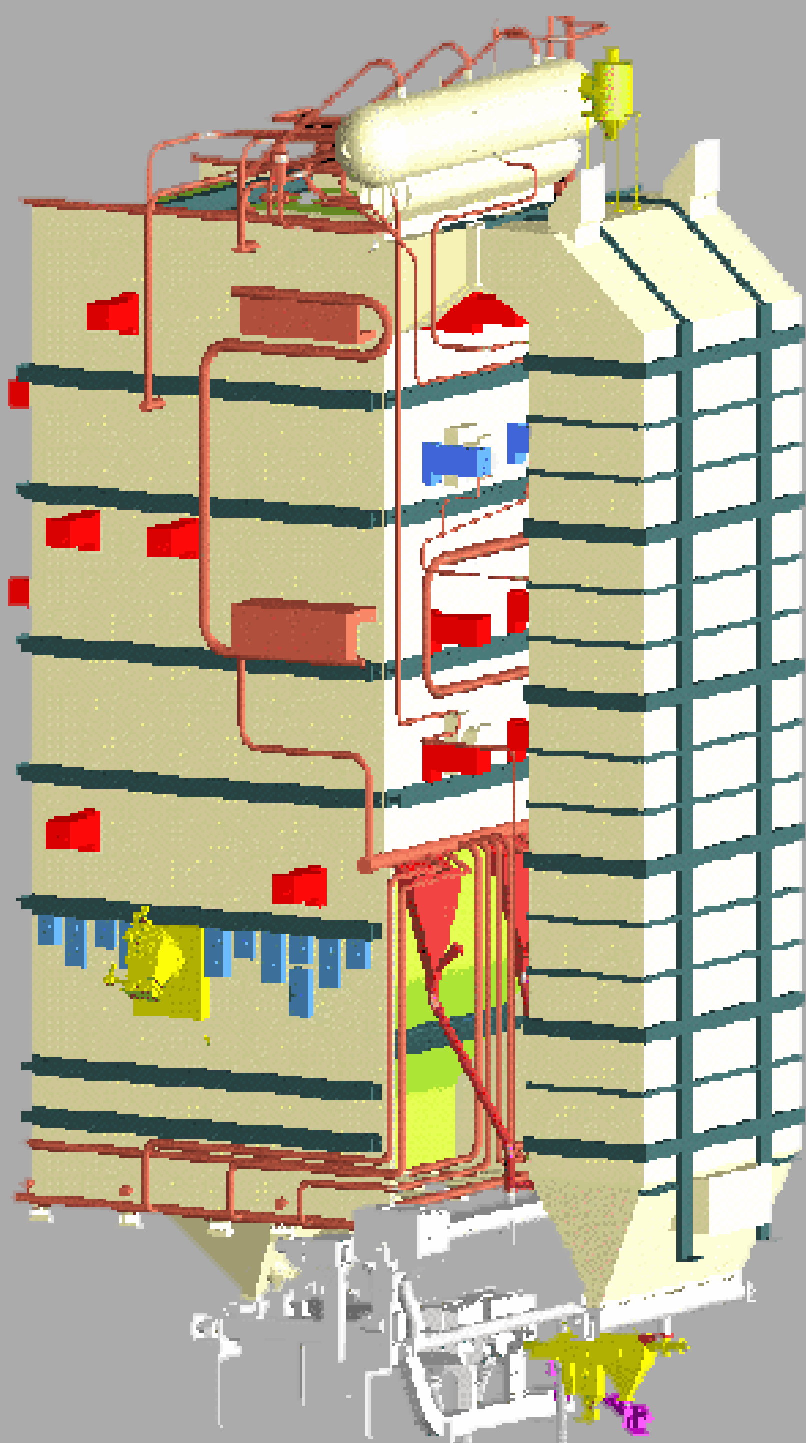
Design Fuel – Poultry Litter

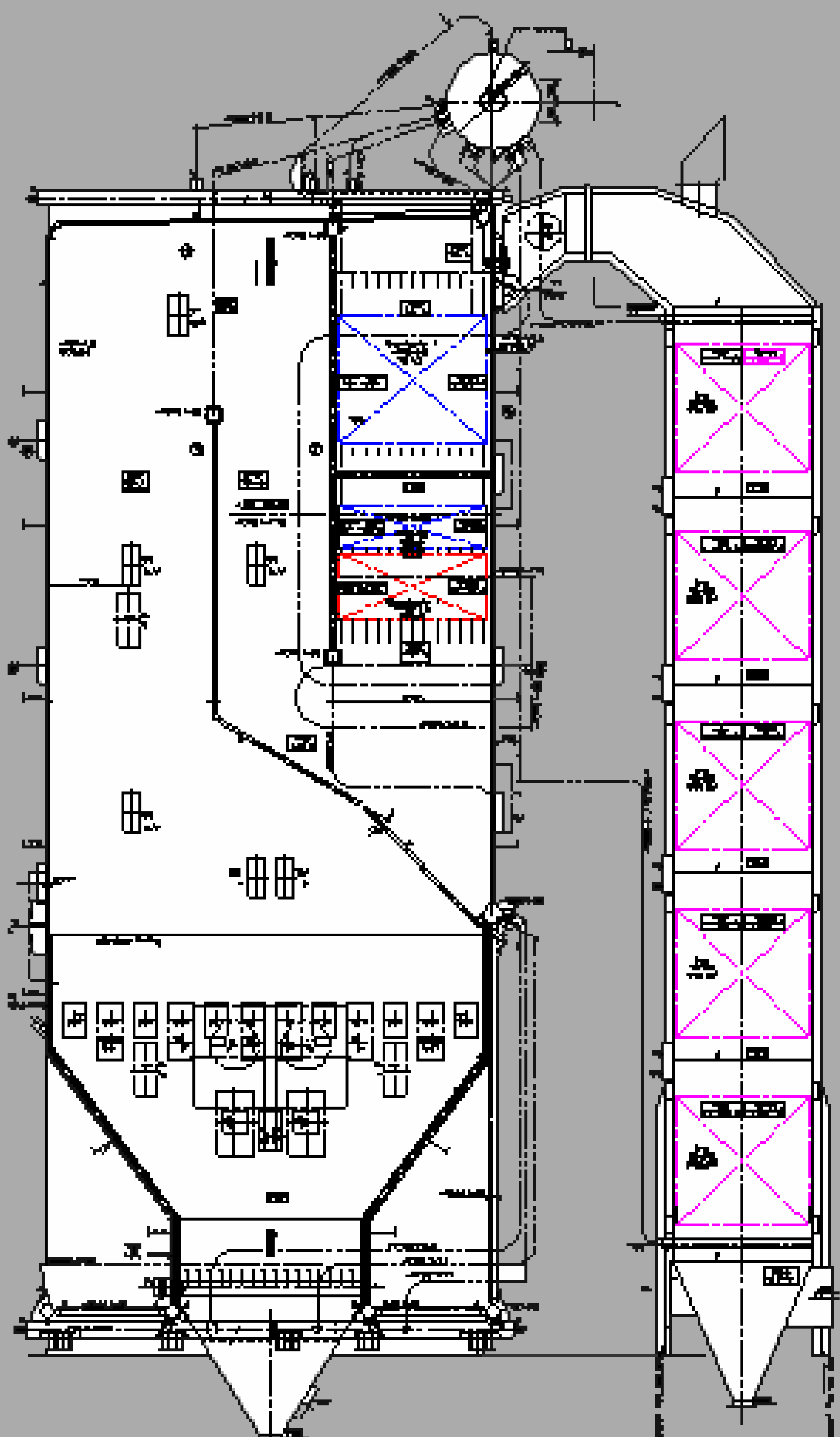
Gross Calorific Value	12.12 kJ/kg	(7.59 – 13.63) kJ/kg
Total Moisture	30%	(20 – 45) %
Ash	14.9%	(11 – 17) %
Carbon	42.4%	(38 – 44) %
Sulphur	0.6%	(0.2 – 0.8) %
Chlorine	0.5%	(0.4 – 0.6) %

Atmospheric Fluidised Bed Combustor (AFBC)



Maximum Continuous Rating	40.6 MW_{TH}
Design Steam Flow	46.6 te/h
Steam Pressure	62 bar(a)
Steam Temperature	460^{O}C
Feedwater Temperature	110^{O}C
Boiler Efficiency	89.5%
Fuel Mass Flow Rate	13.83 te/h
Annual Fuel Consumption	110,000 te/yr
Bed Temperature	650 – 850^{O}C
Freeboard Temperature	850 – 950^{O}C

Boiler Design Basis



- Bottom Supported construction
- Membrane Wall Furnace
- Integral Refractory-Lined Fluidised Bed
- Open pattern Air Distributor
- Sub-Stoichiometric bed combustion
- Two-Pass Radiant Zone
- Counter Flow Primary Superheater
- Parallel Flow Secondary Superheater
- Inter-stage Spraywater Attemporation
- Steaming Economiser
- Balanced Draught
- Flue Gas Recirculation

Furnace Refractory Fouling

- 3.04 x 6.04 metre Bubbling Fluidised Bed
- 90mm thick Silicon Carbide refractory lining
- 480 Bubble Caps in open pattern Air Distributor
- 750^{O}C routine Bed Temperature aim

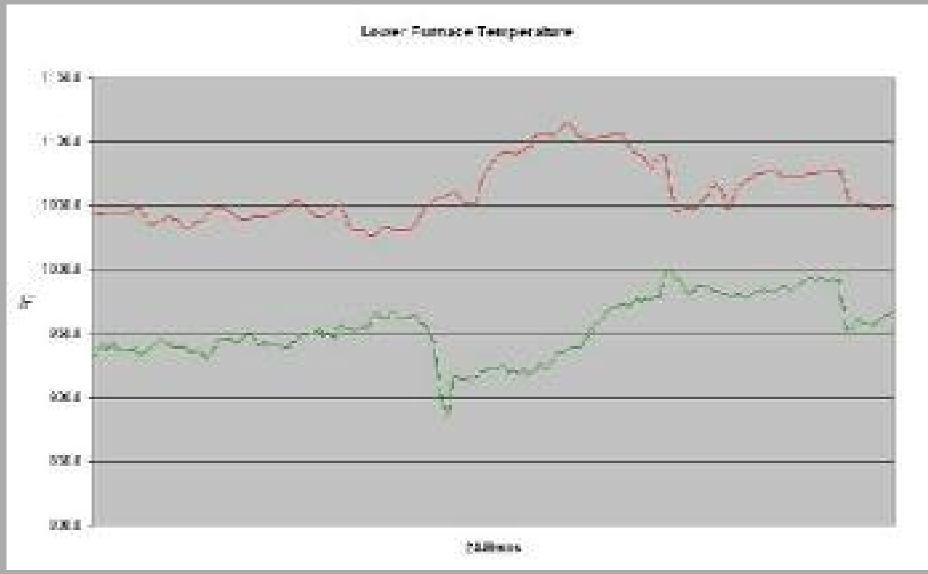
Fuel ash agglomeration experienced under sustained high power

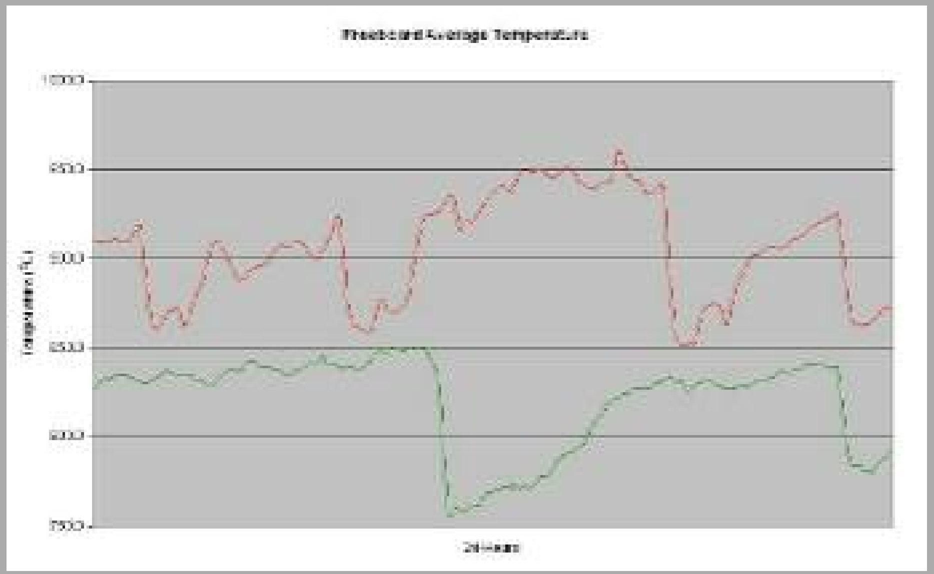
Furnace Wall Fouling

- 6.3 x 7.5 metre x 17.0 metre high furnace
- 278^{O}C operating temperature

Progressively fouling under-load

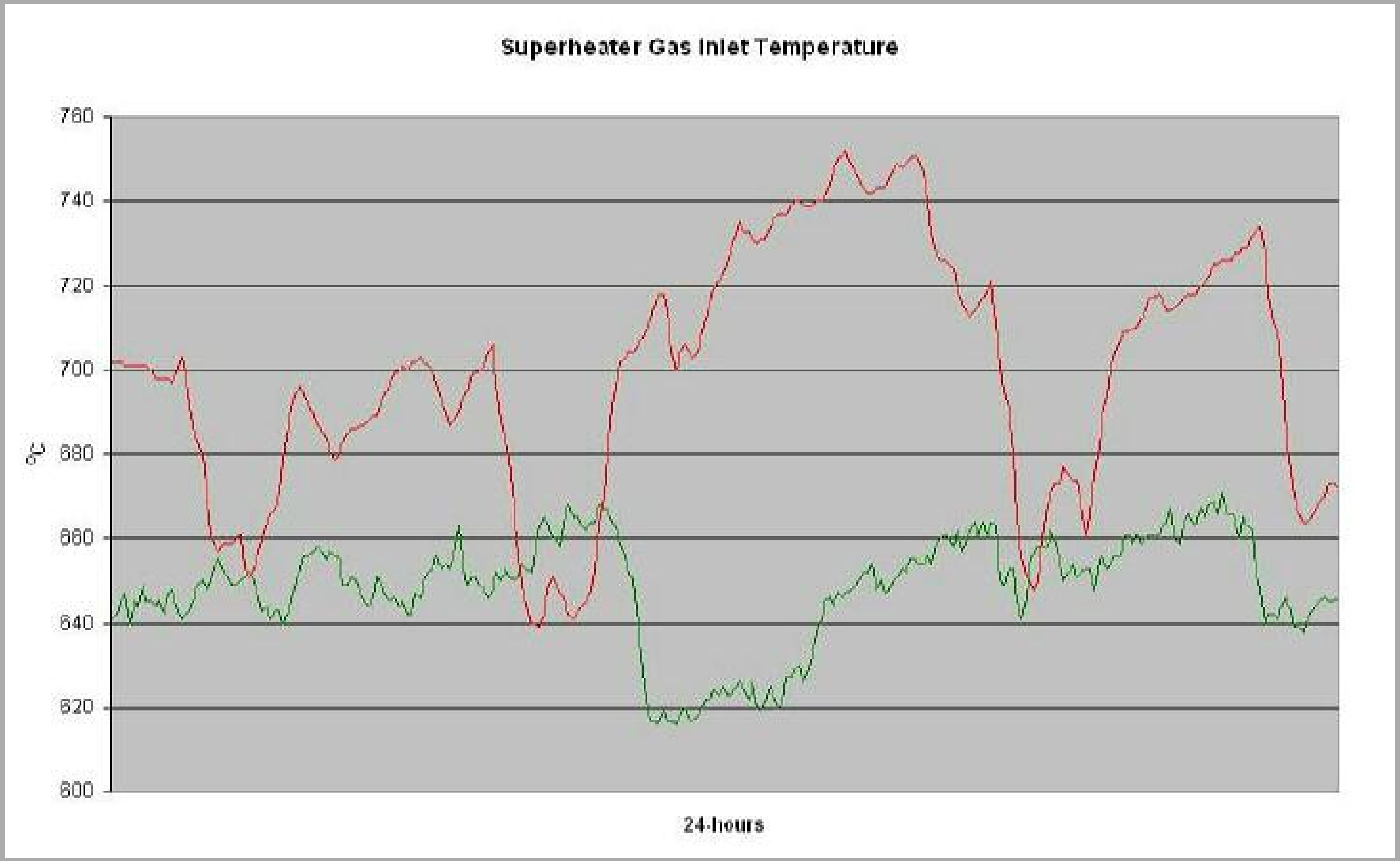
57mm O.D. tubes on 100mm pitch





Secondary Superheater Fouling

Elevated furnace exit temperatures quickly become critical at the flue gas inlet to the Secondary Superheater



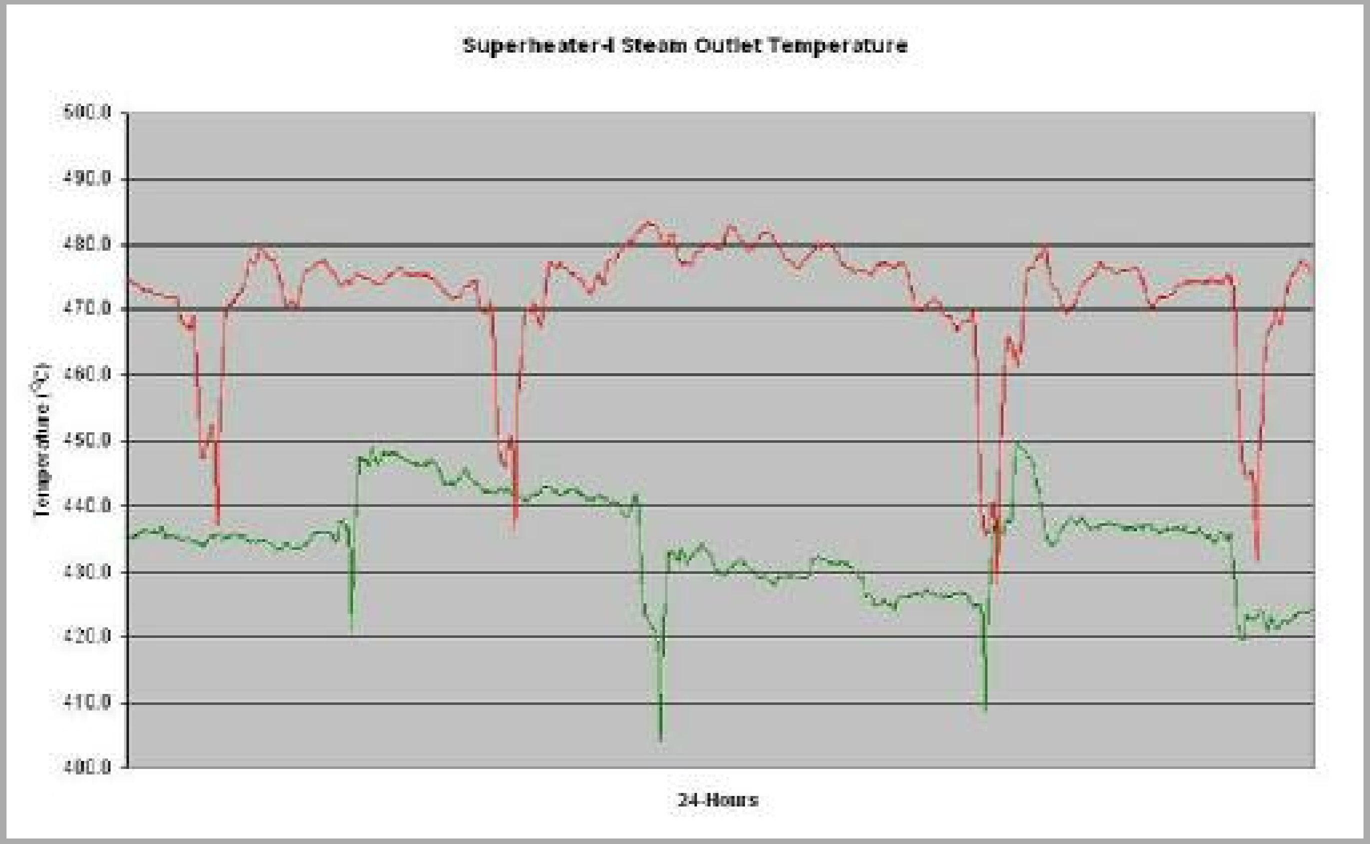
Secondary Superheater Fouling

High Superheater gas inlet temperatures lead to fused alkali metal deposits:

- Potassium Sulphate
- Potassium Chloride

38mm O.D. tubes on 100mm pitch

Superheated Steam Temperatures



Increasing surface temperatures subsequently lead to downstream migration of fouling from the Secondary to the Primary Superheaters

S/H-I steam outlet temp > S/H-II

A useful indicator of the extent of surface fouling

Convective Surface Fouling
High Power

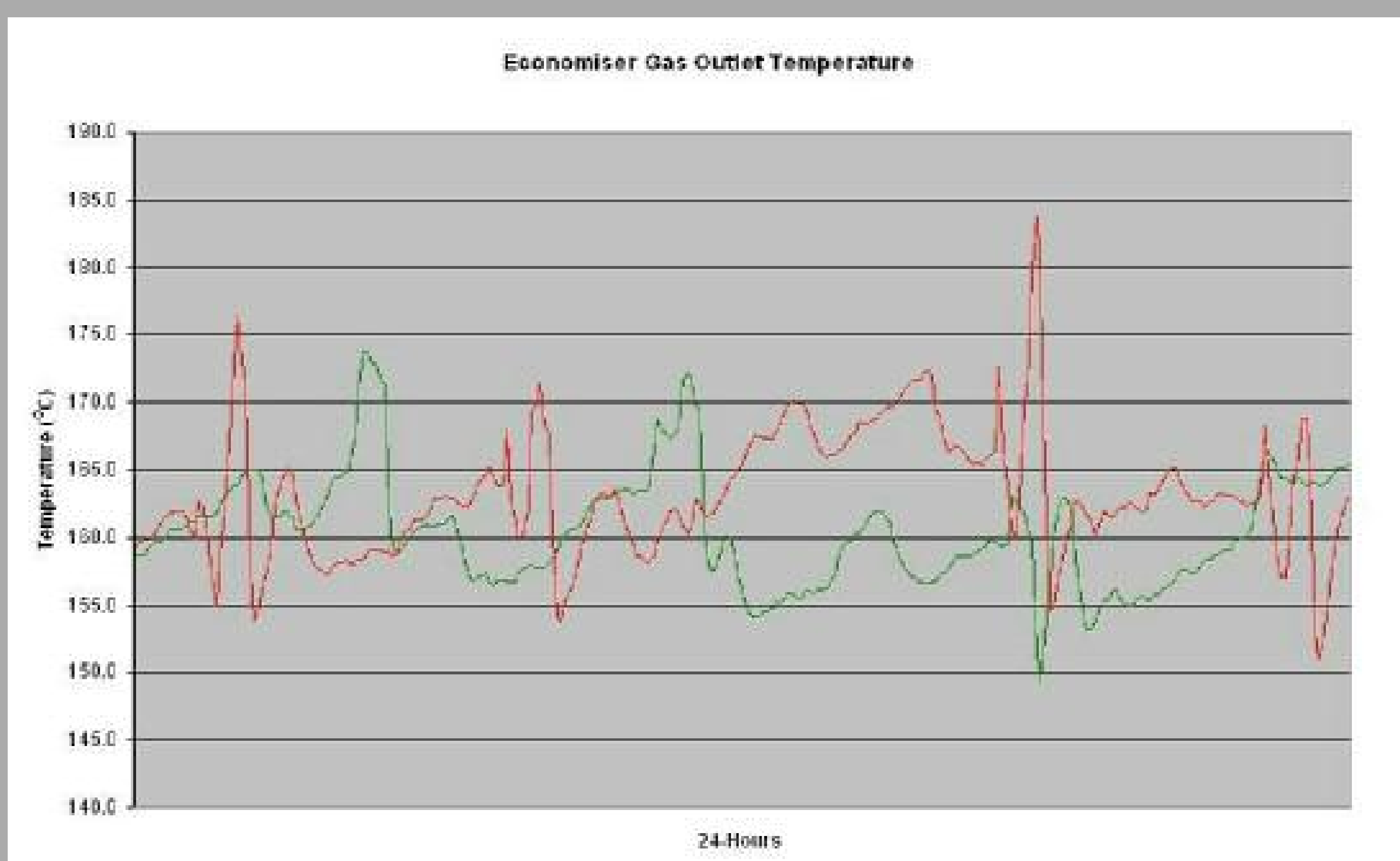
In the extreme, water-cooled surfaces are equally likely to be affected

Boiler exit screen – 76mm O.D. tubes

Economiser Fouling

Again, this is principally dictated by surface temperature

With the Economisers operating between 110^{O}C – 278^{O}C, friable deposits generally continue to be easily removed by steam sootblowers on a 6-hourly cleaning cycle



38mm O.D. tubes on 80mm pitch

Superheater Support Fouling

Surface geometry is equally important:

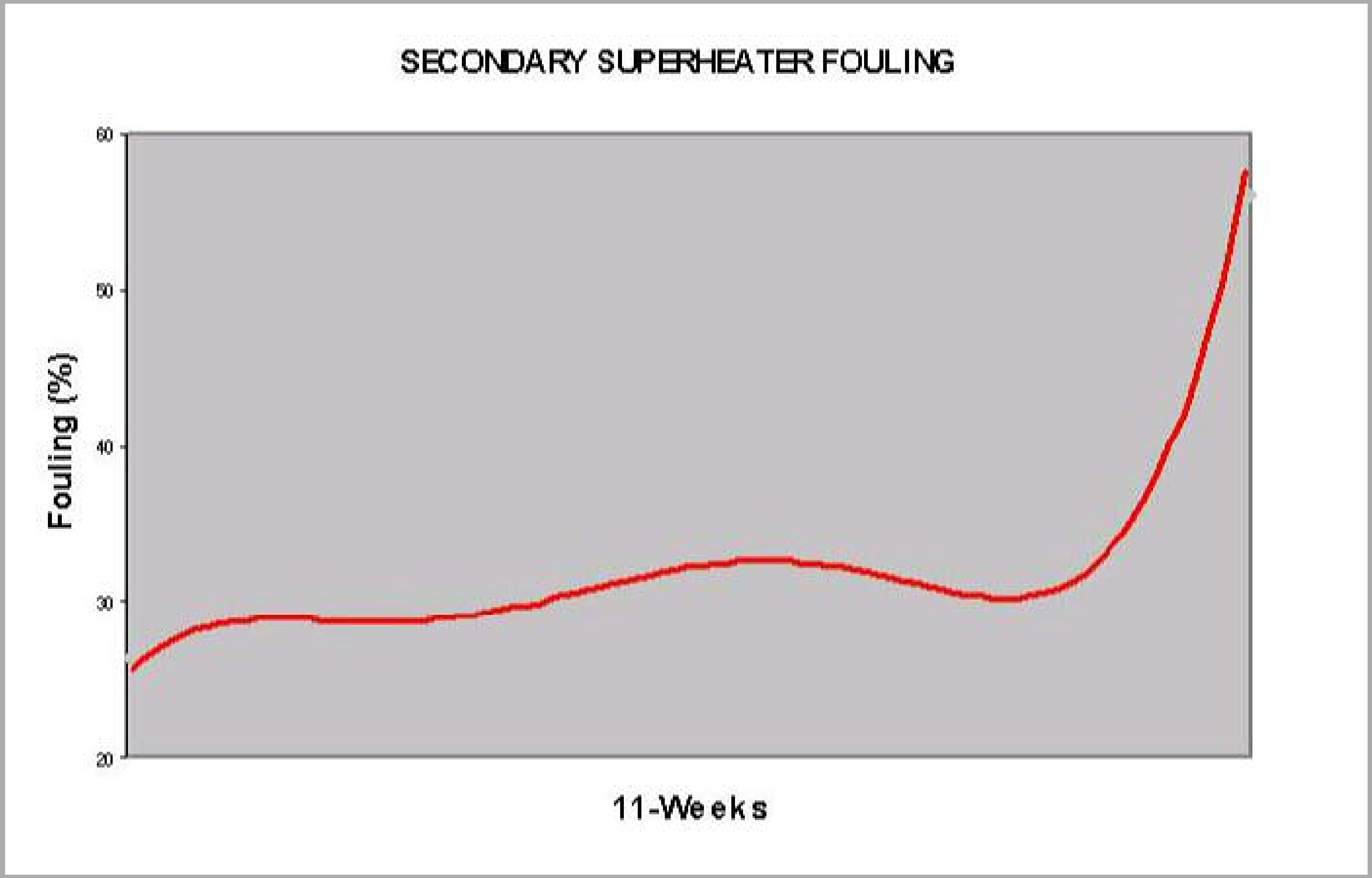
- Saturated steam cooled superheater hangers
- 278^{O}C operating temperature
- But exposed to maximum flue gas temperature

Susceptible to heavy fouling only at temperature concentrators

38mm O.D. tubes on 200mm pitch

Superheater Fouling Trend

The pattern of fouling is entirely predictable:



The duration of the operating cycle is dictated wholly by the rate of deposition versus the efficiency of on-load cleaning systems

Ultimately this is controlled by boiler operating power, hence peak furnace exit temperature

Secondary Superheater Fouling Low Power

Low power and reduced flue gas temperatures lead to deposits that can be more readily controlled by on-load cleaning

Sootblowing Erosion

Repeated sootblowing leads to rapid tube surface erosion

Sootblower Corrosion

Un-cooled surfaces are exposed to rapid corrosion:

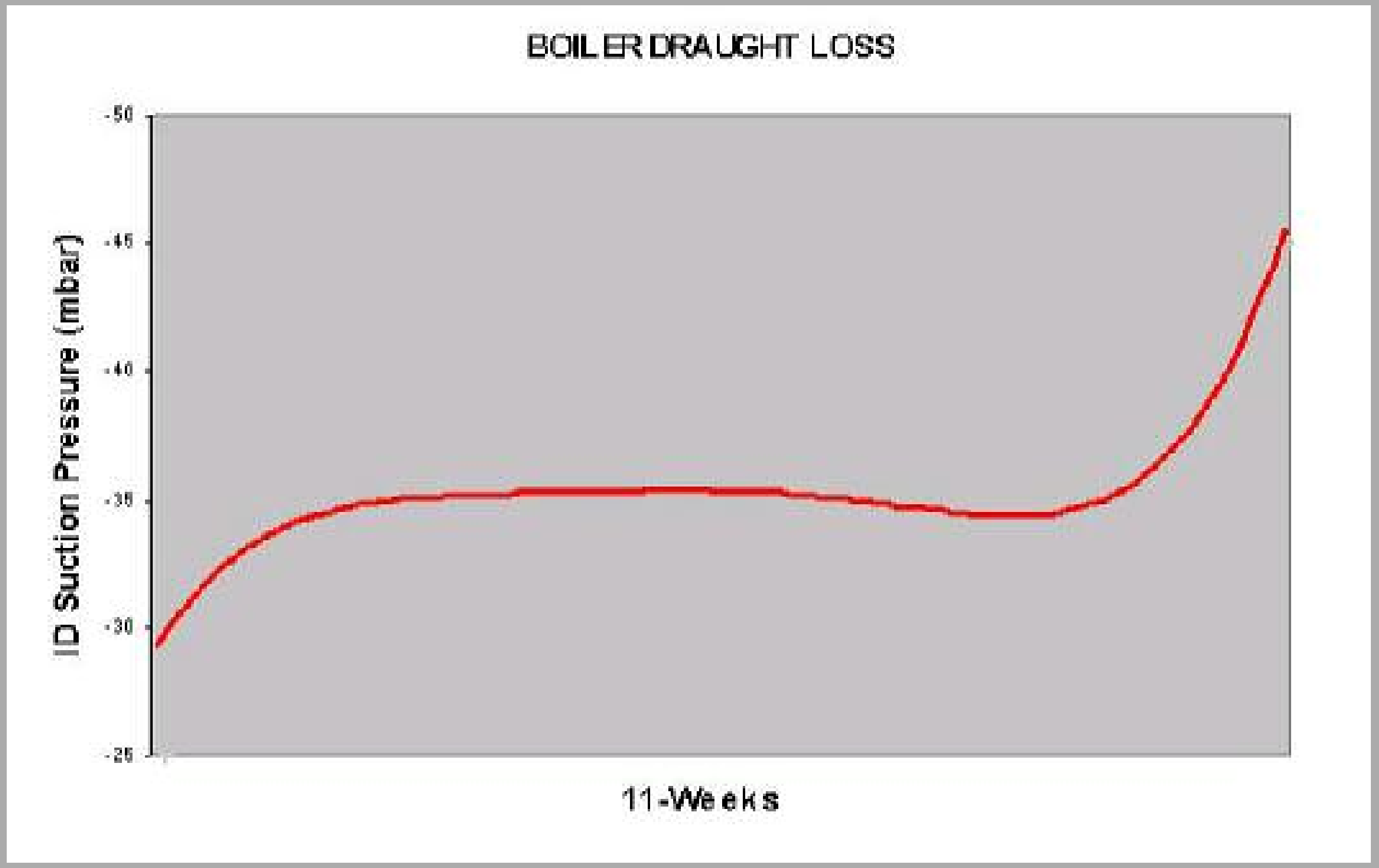
Hastelloy C22 Sootblower lance at S/H-II gas inlet

Severe corrosion after < 12-months service life

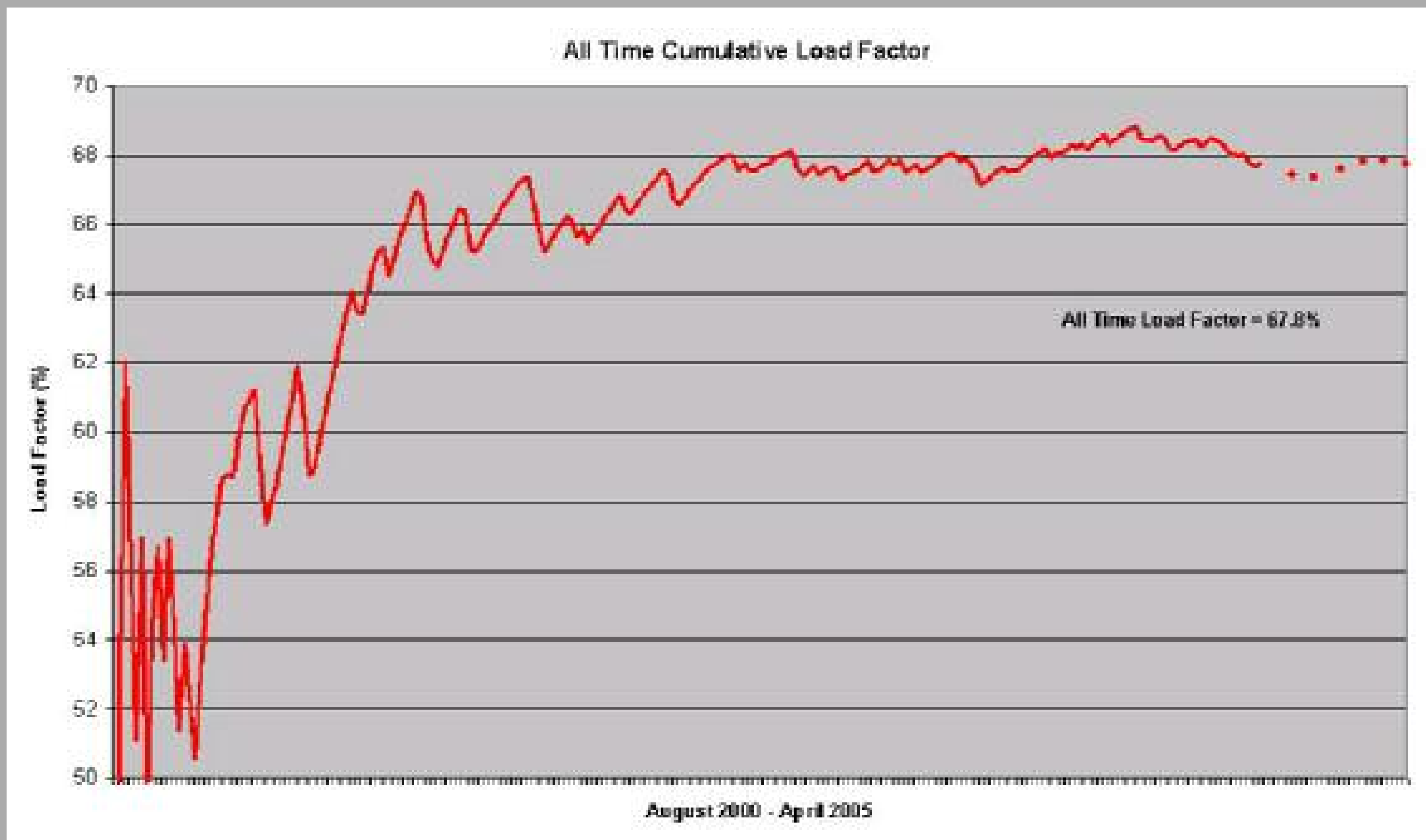
Superheater Draught Loss

Even at reduced power, on-load cleaning is not entirely successful in mitigating fouling

Flue gas path blockage inevitably occurs, accelerated by any nuisance trip event

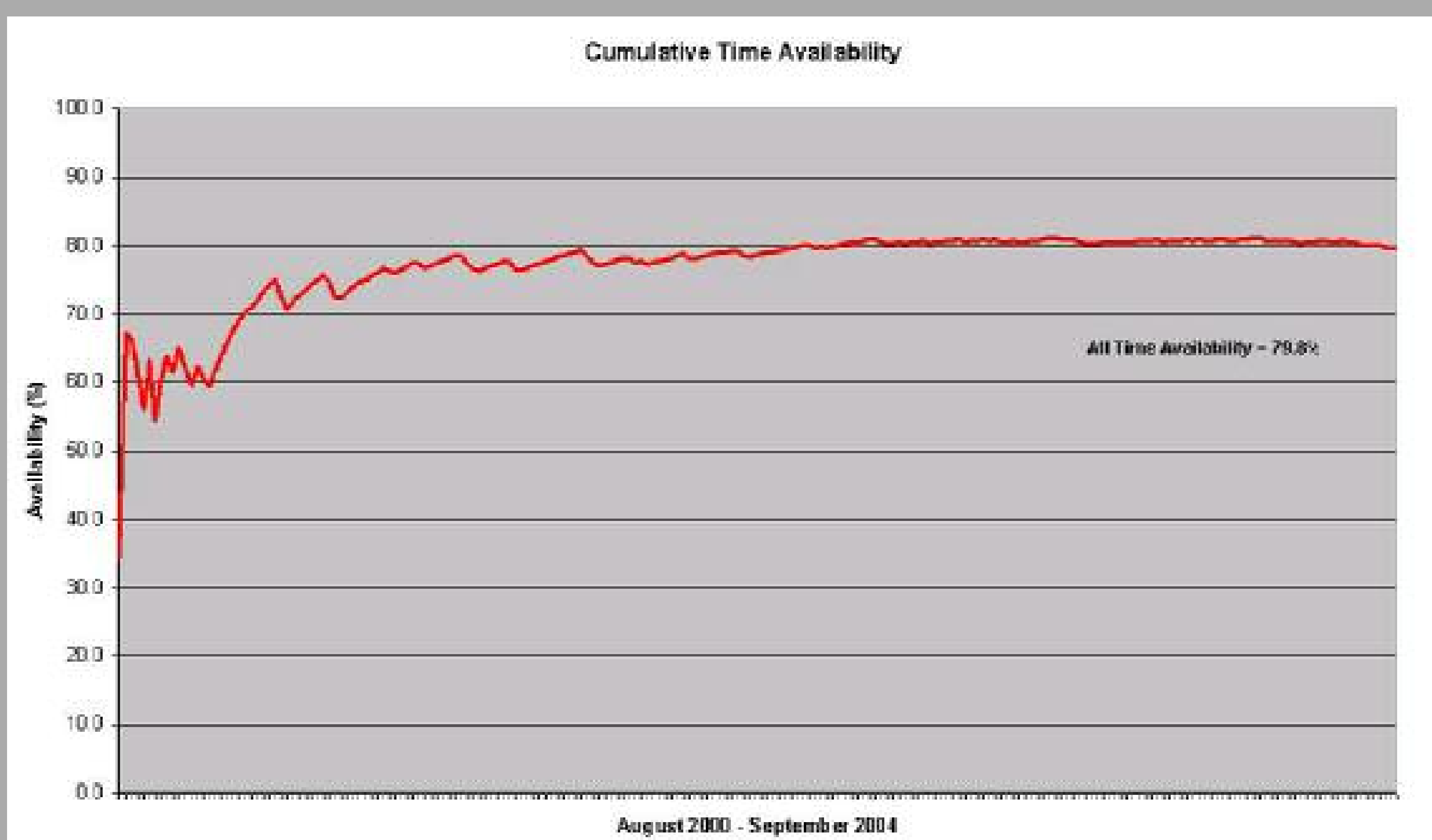


Cumulative Plant Performance



Load Factor:

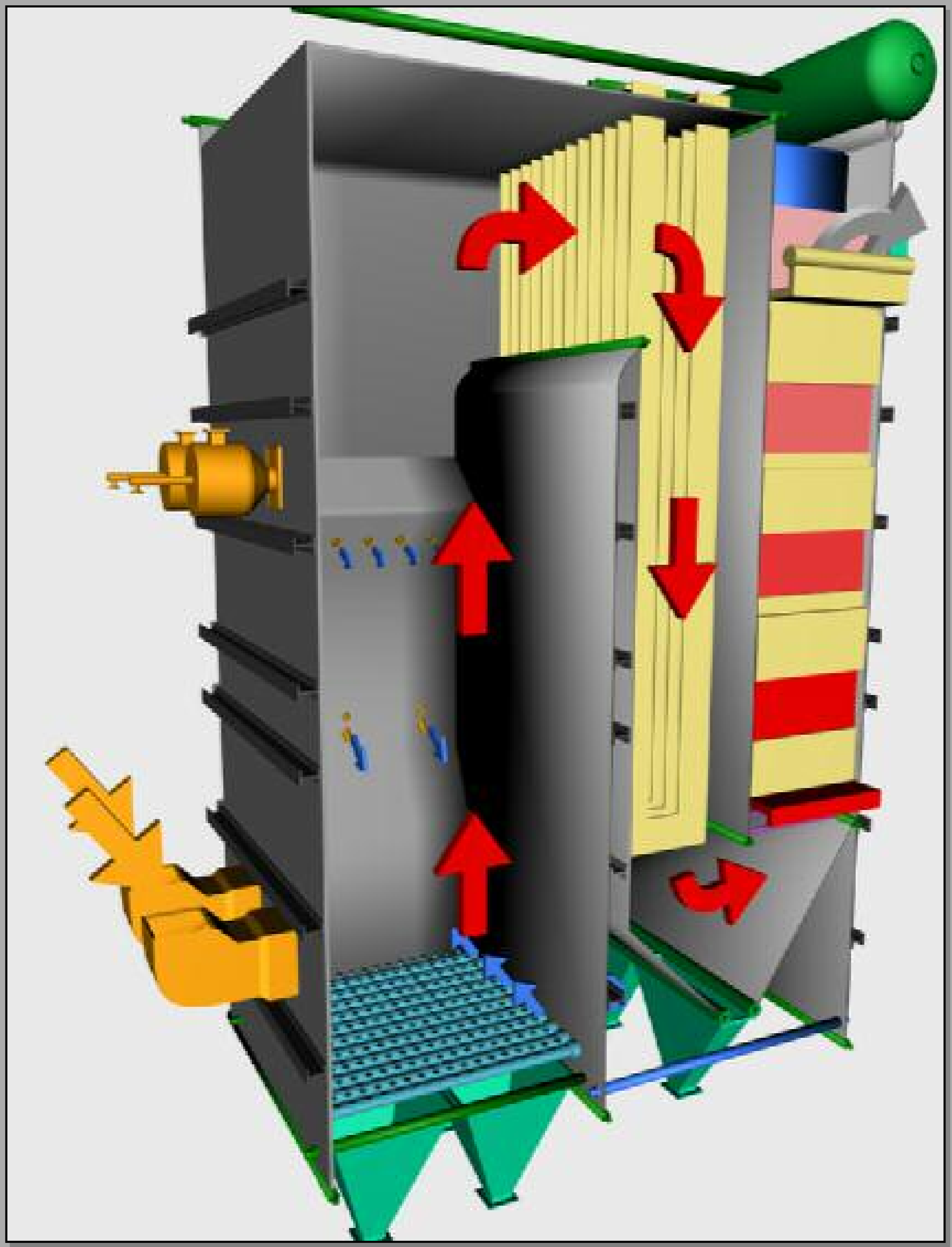
67.8% versus >90% design



Availability:

79.8% versus >95% design

Proposed Design Changes



- Elimination of refractory slopes
- Extended support firing at start-up
- On-load water washing of Furnace
- Large Platen superheating surface
- Increased tube pitch
- Fully retractable sootblowers