# Boiler Tube Failures

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Date:

steag

# Layout of the presentation

- ✓Introduction to Boiler tube failures
- ✓Statistics of tube failures
- ✓Cost of tube failures
- ✓Types of tube failures and failure mechanisms
- ✓Factors influencing tube failures
- ✓Tube failure detection techniques
- ✓Guide lines for the prevention and control of tube leaks
- ✓Best practices to prevent tube leaks

# Boiler Pressure Component failure

One of the most complex, critical, and vulnerable systems in fossil power generation plants is the boiler pressure components.

Boiler pressure component failures have historically contributed to the highest percentage of lost availability.

Failures have been related to

- ✓poor original design,
- ✓fabrication practices,
- ✓fuel changes,
- ✓operation, maintenance, and
- ✓cycle chemistry.

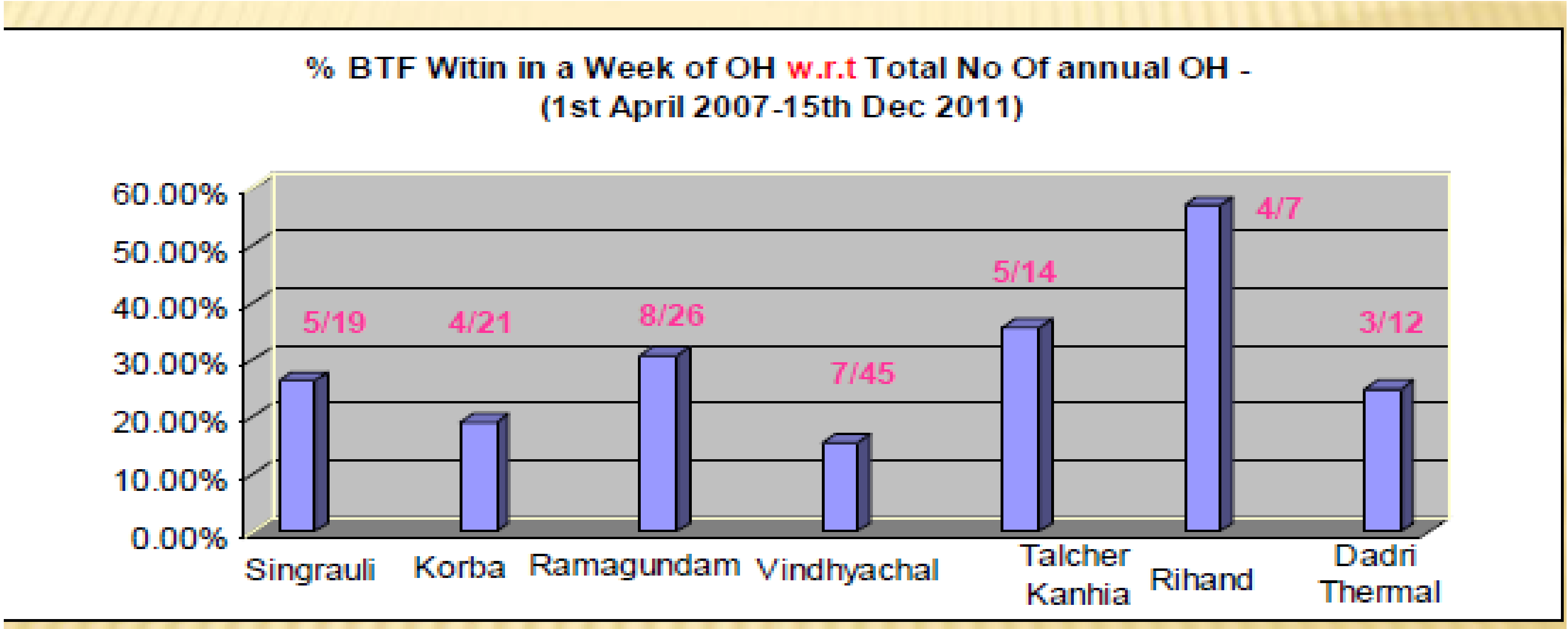
# Statistics [source CEA]

**Boiler tube failures continue to be the major cause of forced outages.**

**Statistically these are responsible for an overall availability loss of 6% of the units**

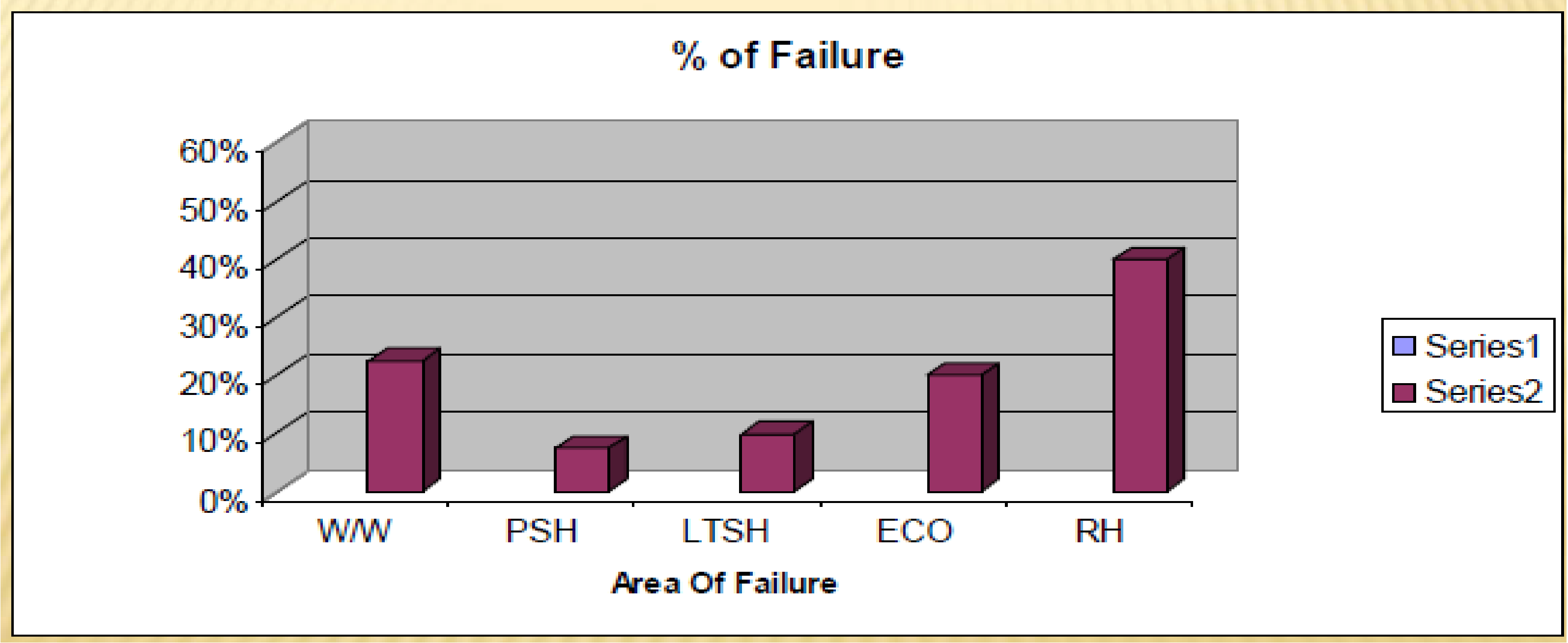
| Capacity (MW) | Total No. of Units Reviewed | Water Wall | | Superheater | | Economiser | | Reheater | |
|---|---|---|---|---|---|---|---|---|---|
| | | Total No. of Units involved | Total No. of Outages | Total No. of Units involved | Total No. of Outages | Total No. of Units involved | Total No. of Outages | Total No. of Units involved | Total No. of Outages |
| 500 | 33 | 21 | 46 | 16 | 20 | 11 | 11 | 9 | 18 |
| 250 | 13 | 6 | 9 | 3 | 5 | 1 | 1 | 1 | 1 |
| 200/210 | 160 | 106 | 265 | 62 | 110 | 68 | 129 | 52 | 103 |
| 140/150 | 11 | 7 | 40 | 4 | 15 | 4 | 16 | 1 | 2 |
| 120 | 21 | 12 | 25 | 14 | 50 | 11 | 50 | 8 | 20 |
| 110 | 40 | 24 | 83 | 22 | 65 | 18 | 56 | 15 | 38 |
| 100 | 11 | 5 | 13 | 5 | 49 | 5 | 7 | 0 | 0 |
| 70/80 | 6 | 5 | 50 | 4 | 6 | 3 | 8 | 0 | 0 |
| 62.5/67.5 | 23 | 17 | 73 | 5 | 5 | 9 | 13 | 0 | 0 |
| 60 | 25 | 8 | 35 | 12 | 27 | 8 | 24 | 2 | 2 |
| 50/57.5 | 24 | 5 | 11 | 3 | 6 | 7 | 15 | 2 | 2 |
| 20/40 | 13 | 2 | 4 | 2 | 3 | 3 | 7 | 1 | 1 |
| Grand total | **380** | **218** | **654** | **152** | **361** | **148** | **337** | **91** | **187** |

# Boiler tube failures post overhaul




Source-internet

# Boiler tube failure zones




Source-internet

# Cost of boiler tube failures

- The cost of boiler tube failures is comprised of three main components; the cost of the repair, the cost of start up oil to return unit to service, and the cost of lost production.

- A rule of thumb for repair costs of 200000 per day out of service+ cost of material

- Average loss of availability of 1% translates to approximately 3.6 days out of service per leak.

- Start up oil costs 150KL @ 7500000/per startup.

**Plus**

- Loss of generation[depends on the size of the unit]

- Morale of the O&M staff
- Morale of the stake holders

## Prominent reasons for tube failures

# Prominent reasons

**Poor water quality.** With increases in operating pressure, feedwater quality becomes even more critical.

**Coal quality.** Using a different type of coal for emission or economic reasons has adversely affected the capability, operability, and reliability of boiler and boiler auxiliaries

**Cycling operation.** Many base-load-designed boilers have been placed into cycling duty,which has a major impact on the boiler reliability as indicated by occurrences of serious corrosion fatigue in water-touched circuitries, economizer inlet header shocking, thick-wall header damages, and others.

- **NOx emission.** Deep staging combustion for NOx reduction has produced serious waterwall fire corrosion for high sulfur-coal firing, especially in supercritical units.

- **Age-ing.** A large percentage of existing fossil-fired units are exceeding “design life” without plans for retirement. These vintage units are carrying major loads in power generation.

# Economizer effects

Finned economizer tube is such a location due to the double difficulties of poor/impossible access for thickness measurement and shielding.

Economizer tube bends close to casing walls are another such location.

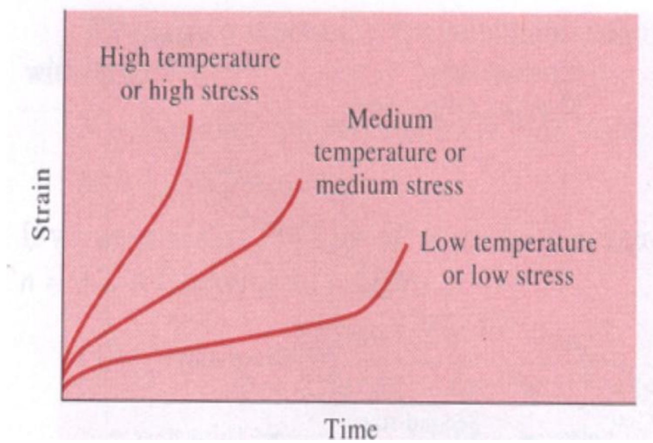
# Typical Failure mechanisms

# Boiler Pressure Component Failure Mechanisms

The boiler tubes are under high pressure and/or high-temperature conditions.

They are subject to potential degradation by a variety of mechanical and thermal stresses and environmental attack on both the fluid and fireside.

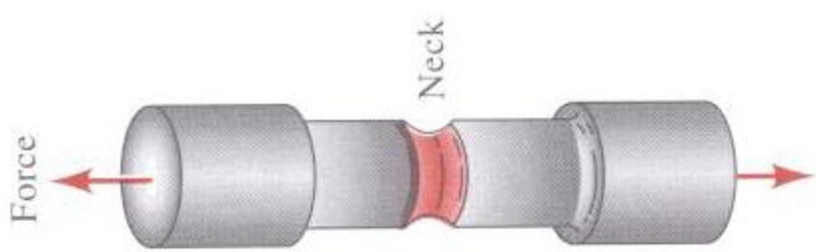
Mechanical components can fail due to creep, fatigue, erosion, and corrosion

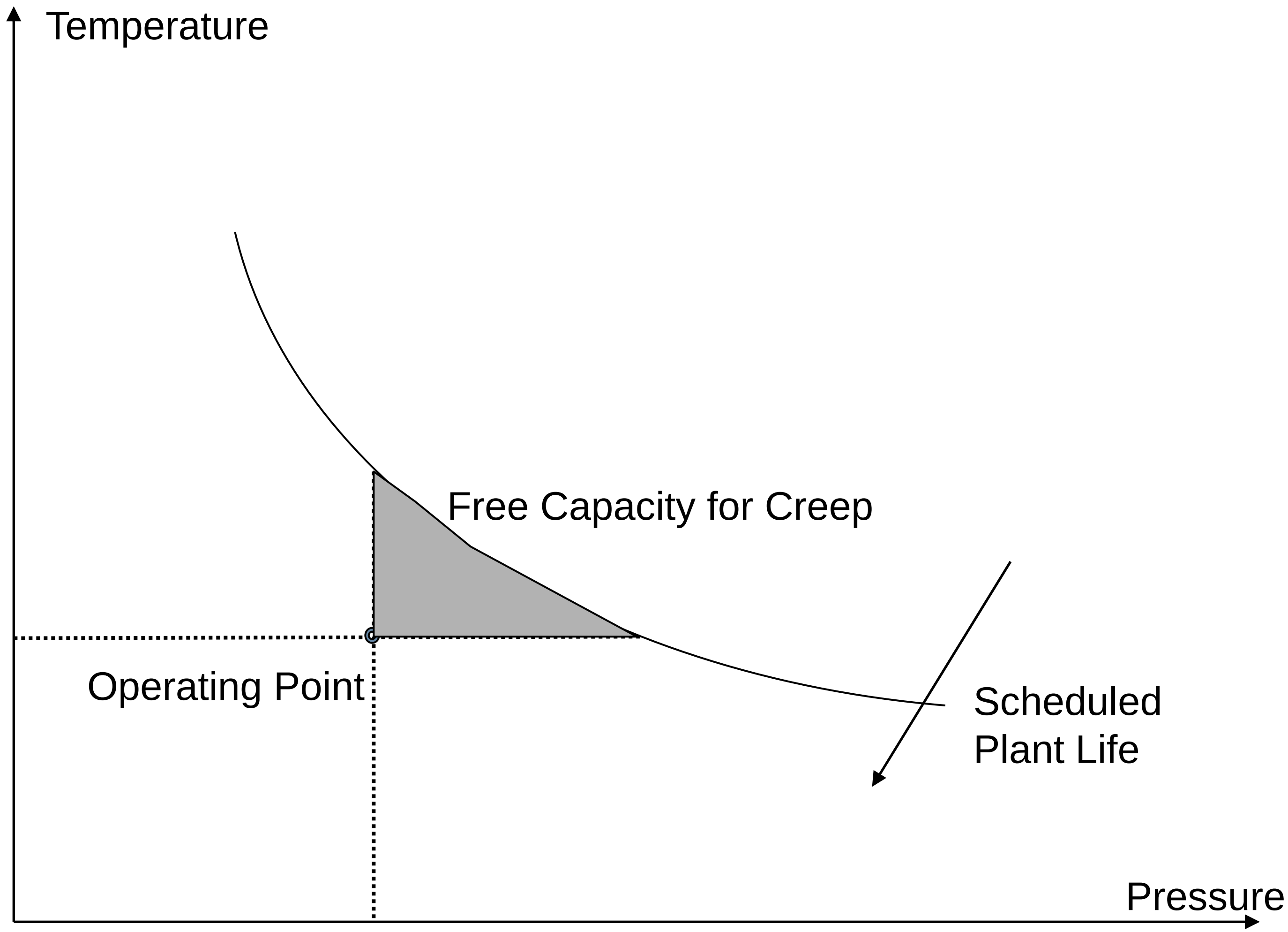



**Creep**

Creep is a time-dependent deformation that takes place at elevated temperature under mechanical stresses.

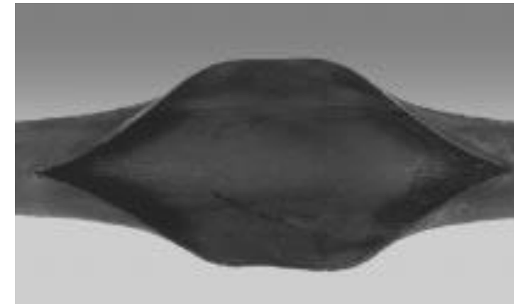
such failure results in overheating or overstressing the tube material beyond its capabilities for either a short-term or a long-term period.




Temperature
Free Capacity for Creep
Operating Point
Scheduled
Plant Life
Pressure

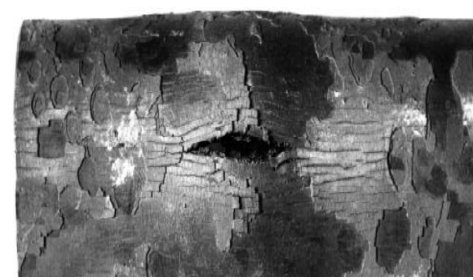
# Creep failures-Overheating

**Short-term Overheat** Failure results in a ductile rupture of the tube metal,
It is characterized by "fish mouth" opening in the tube where the fracture surface is a thin edge.



***Causes: Short-term overheat failures are most common during boiler start*** up. Failures result when the tube metal temperature is extremely elevated from a lack of cooling steam or water flow

**Long-term Overheat** Tube metal often has heavy external scale build-up and secondary cracking.



Super heater and reheat super heater tubes commonly fail after many years of service, as a result of creep.

During normal operation, alloy super heater tubes will experience increasing temperature and strain over the life of the tube until the creep life is expended.
Furnace water wall tubes also can fail from long-term overheat.

# Fatigue

SR1

Fatigue is a phenomenon of damage accumulation caused by cyclic or fluctuating stresses, which are caused by mechanical loads, flow-induced vibration.

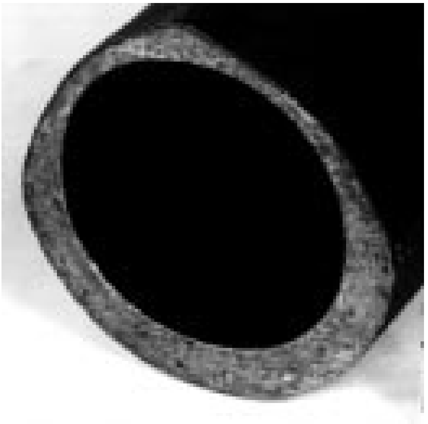
components are subjected to cyclic temperature and flow fluctuations *restrict*

*thermal expansion.* Thermal fatigue is classified in two categories, corrosion fatigue and thermal fatigue.

**Corrosion fatigue**, —the fluctuations in circulation of water in the boiler tube
**Thermal fatigue**: frequent starts and stops

Typically occurs at areas such as header ligaments, welded attachments , tube stub welds, circumferential external surface cracking of water wall tubes in supercritical units, and fabrication notches.

# Erosion and corrosion



**Erosion** is metal removal caused by particles striking the metal's surface.

Various mechanisms, such as fly ash erosion, soot blowing erosion, falling slag erosion, and coal particle erosion can cause erosion on the boiler tubes.

Fly ash erosion, is a significant boiler tube failure concern, occurs in the regions with high local flue gas velocities, with high ash loading, and with abrasive particles such as quartz

**Corrosion*:*** Deterioration and loss of material due to chemical attack.

There are two basic categories in boiler tubes:

- **Internal corrosion**: hydrogen damage, acid phosphate corrosion, caustic gouging, and pitting
- **External corrosion**: water wall fireside corrosion, super heater (SH)/re heater (RH) fireside corrosion, and ash dew point corrosion

# Internal Corrosion-Hydrogen Damage

**Hydrogen damage** is most commonly associated with excessive deposition on ID tube surfaces, coupled with a boiler water low pH excursion.

Water chemistry is upset, which can occur from condenser leaks, particularly with salt water cooling medium, and leads to acidic (low pH) contaminants that can be concentrated in the deposit.

Under-deposit releases atomic hydrogen which migrates into the tube wall metal, reacts with carbon in the steel (decarburization) and causes inter granular separation.

# Waterwall Fireside Corrosion

**Causes: Corrosion occurs on external surfaces of waterwall tubes when the**

combustion process produces a reducing atmosphere (substoichiometric).

This is common in the lower furnace of process recovery boilers in the pulp and paper industry.

For conventional fossil fuel boilers, corrosion in the burner zone usually is associated with coal firing.

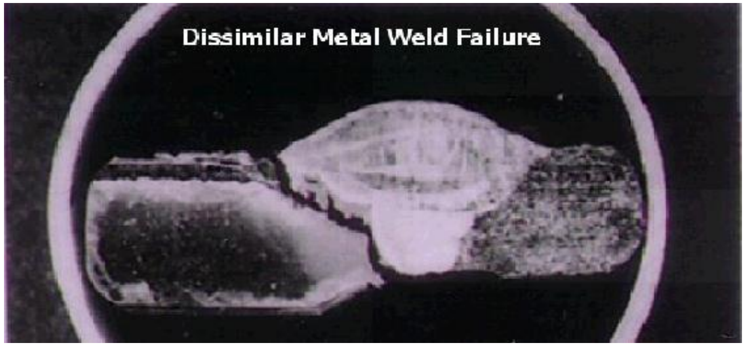
Improper burners or operating with staged air zones to control combustion are more susceptible to larger local regions possessing a reducing atmosphere, resulting in increased corrosion rates.

# Dissimilar Metal Weld (DMW) Failure

**Dissimilar Metal Weld (DMW) Failure**
Material fails at the ferritic side of the weld, along the weld fusion line. A failure tends to be catastrophic in that the entire tube will fail across the circumference of the tube section.

**Causes: DMW describes the butt weld where an autenitic (stainless steel)** material joins a ferritic alloy, such as SA213 T22, material.

These failures are attributed to several factors: high stresses at the austenitic to ferritic interface **due to differences in expansion properties of the two materials**, excessive external loading stresses and thermal cycling, and creep of the ferritic material.




# Waterside Corrosion Fatigue

**Causes: Tube damage occurs due to the combination of thermal fatigue and** corrosion. Corrosion fatigue is influenced by boiler design, water chemistry, boiler water oxygen content and boiler operation.

Leads to the breakdown of the protective magnetite on the ID surface of the boiler tube.

The loss of this protective scale exposes tube to corrosion.

The locations of attachments and external weldments, such as buckstay attachments, seal plates and scallop bars, are most susceptible.

The problem is most likely to progress during boiler start-up cycles.

## Factors influencing Boiler Tube failures

# Boiler Tube Failure Influence Factors

| | Design | Operation | Maintenance |
|---|---|---|---|
| Creep | x | xxx | x |
| Fatigue | xxx | xx | |
| Erosion | x | xxx | xx |
| Corrosion | xx | xxx | |
| x = weak influence, xx = medium influence, xxx = strong influence | | | |

| Water-Touched Tubes | Design | Operation | Maintenance |
|---|---|---|---|
| Corrosion fatigue | xxx | xx | |
| Flash erosion | x | xxx | xx |
| Hydrogen damage | | xxx | |
| Acid phosphate corrosion | | xxx | |
| Caustic gouging | | xxx | |
| Fireside corrosion in coal-fired units | | xxx | |
| Thermal fatigue in supercritical waterwalls | xxx | xx | |
| Thermal fatigue of economizer inlet headers | xx | xxx | |
| Erosion corrosion (economizer inlet headers) | | xx | |
| Sootblower erosion | x | xx | xxx |
| Short-term overheating | | xx | xx |
| Low-temperature creep | xx | | |
| Chemical cleaning damage | | | xxx |
| Fatigue in water-cooled circuits | xxx | xxx | |
| Pitting in water-cooled tubes | x | xxx | |
| Coal particle erosion | | x | xx |
| Falling slag damage | x | xx | x |
| Acid dewpoint corrosion | | xx | |
| Steam-touched tubes | | | |
| Long-term overheating/creep | xx | xxx | |
| Fireside corrosion in coal-fired units | xxx | xx | |
| Fireside corrosion in oil-fired units | | xxx | |
| Dissimilar metal welds | xxx | x | |
| Short-term overheating | | xxx | xxx |

# Critical considerations during design of Boiler

Material selection deficiencies in the design

- Material and fabrication flaws
- Welding flaws

The primary consideration in material choice is a function of expected tube temperature of operation.

**Economizers and waterwall** sections are usually constructed with a **mild or medium carbon** steel,

**Low alloy ferritic steels** are used for most **superheater** and **reheater** sections, with **austenitic stainless steels** specified for the **highest-temperature** circuits or corrosion performance.

Each manufacturer specifies a maximum operating temperature for each material, based on laboratory oxidation experiments. The ASME code is based on the mid-wall tube temperature.

# Metal temperature limits

| Tube Steel Type | ASME Spec. No. | ASME[1] Max °F (°C) | B&W[2] Max. °F (°C) | C-E[3] Max. °F (°C) | Riley[4] Max. °F (°C) |
|---|---|---|---|---|---|
| Carbon steel | SA-178C | 1000 (538) [5,6] | 950 (510) | 850 (454) | 850 (454) |
| | SA-192 | 1000 (538) [5,6] | 950 (510) | 850 (454) | 850 (454) |
| | SA-210-A1 | 1000 (538) [5,6] | 950 (510) | 850 (454) | 850 (454) |
| Carbon moly | SA-209-T1 | 1000 (538) [7] | -- | 900 (482) | 900 (482) |
| | SA-209-T1a | 1000 (538) [7] | 975 (524) | -- | -- |
| Chrome moly | SA-213-T11 | 1200 (649) | 1050 (566) | 1025 (552) | 1025 (552) |
| | SA-213-T22 | 1200 (649) | 1115 (602) | 1075 (580) | 1075 (580) |
| Stainless steel | SA-321-321H | 1500 (816) | 1400 (760) | -- | 1500 (816) |
| | SA-213-347H | 1500 (816) | -- | 1300 (704) | -- |
| | SA-213-304H | 1500 (816) | 1400 (760) | 1300 (704) | -- |

Notes:

# Material and Fabrication Flaws

**Material flaws** include defects introduced into the tube during its manufacture, fabrication, storage, and/or installation

Such defects might include:

- Forging laps
- Inclusions or laminations in the metal
- Lack of fusion of the welded seams
- Deep tool marks or scores from tube piercing, extrusion, or rolling operations
- Gouges, punctures, corrosion, impact dents

Failures tend to be more predominant in high-temperature sections because of the interaction of flaws with the higher stress in these locations

**Lap defects** are crevices in steel that are closed but not metallurgically bonded. They may occur in seamless tubes as a consequence of the presence of internal voids or cracks in the ingot from which the tube was formed.

Lap defects can also be caused by faulty methods of steel rolling in the steel mill.

## Control of Boiler tube leak during

## Design, Erection, Commissioning, operation and Maintenance stages

# Design stage

- ❖Adequate furnace sizes
- ❖Addressing Left-right unbalance in gas temperature
- ❖ Addressing Left-right unbalance in gas flow
- ❖Material selection
- ❖Gas velocity in horizontal and 2nd pass
- ❖Lay out for maintenance approach
- ❖ Identification of tube/ assemblies experiencing high metal temperature & installation of thermocouples in these tubes/ assemblies
- ❖Selection of Boiler configuration to have uniform gas velocity

# Engineering and Erection stage

❖Prepare sound tube material procurement and technical specifications

❖clearly specify applicable code and standards, QA/QC requirements, additional material and fabrication requirements (NDE, heat treatment, and welding procedures)

❖ • Conduct design reviews—including system analysis, thermal-hydraulics, and critical mechanical detail design—and material selection to ensure that reliability is considered.

❖ • If a new material is to be used, use conservative procedures and processes in the fabrication of components.

❖Caution should also exercised when using any new fabrication or welding processes.

❖ • Perform source inspection during fabrication and installation, including NDE of tube material and tubing stock and in-process control of the fabrication processes.

❖ • Document weld locations and locations with changed tube material and tube sizes.

# Manufacturing and erection stage aspects

**Quality checks** during manufacturing

- Quality of shop weld joints

**ERECTION STAGE**

❖Alignment of coils/ panels

❖Uniform spacing between coils/ panels

❖Uniform spacing between coil & wall at the front, rear,left and right

❖Erection of clamps, attachments, supports and hangers

❖Quality of site weld joints

❖Thruness of coils & panels

❖Completion of all attachment weldings before Hydrotest

❖Removal of temporary supports/ structures

# Commissioning and Operation stage

**Commissioning stage**

Removal of temporary supports/ structures

- Hydro test of complete pressure parts
- Quality of Alkali boil out
- Quality of Acid cleaning
- Quality of Steam blowing
- CAVT
- Repeat CAVT after correction

**Operation stage**

- Temperature excursions
- Drum level control
- Furnace pressure control
- Optimisation of soot blowing
- FG $O_2$ at Eco. Outlet
- Wind box pressure
- PF fineness
- PF balancing
- Air flow through mills
- Furnace cooling

Dissolved $O_2$ in feed water

- Silica in Drum water & steam
- pH value of feed water & steam

## Techniques to detect boiler tube leaks

# NDT TECHNIQUES

**D-metering:** Conventional

**Extensive Dye penetrate test**

Liquid Dye Penetrate Test is the simplest NDT method to identify flaws & cracks which are open to surface in boiler tubes and attachments joints.

**Oxide scale measurement:**

Oxide scale formation inside the tubes of RH and final super heaters where steam touches 540 deg. C is a temperature phenomenon.

Liner relationship exists between the thickness of oxide scale and temp & time.

Thickness measurement reveals the temperature which the tube had been exposed during the operation.

knowing the temp the remaining life of the tube using LMP (Larson Miller Parameter). Can be evaluated

## Modern techniques for flaw detection

# RFET and LFET--MAGNETIC TECHNIQUE

**Remote Field Electromagnetic Technique** (RFET) can be used to detect, ID or OD flaws on the hot side half of the boiler water wall tubes.

No surface preparation is needed in this technique more than high pressure water cleaning.

It uses a low frequency signal which diffuses through the tube wall twice before being detected by the receiver. Anomalies at any location along the energy transmission path cause change to both the amplitude and phase of the signal, thereby enabling the detection of defects

**Low Frequency Electromagnetic Technique** (LFET) is used for tube scanning

120 deg of tube circumference can be scanned and can be used for water wall tubes form inside furnace. OD scanning of super header & Reheater and even economiser can also be done using this technique.

The technique operates by injecting a low frequency magnetic field into the plate and using scanner-mounted pickup coils to detect the induced AC magnetic field in the plate material. In the presence of wall loss and pitting, a measurable distortion is introduced to the induced field that can be detected using the pickup coils on the scanner

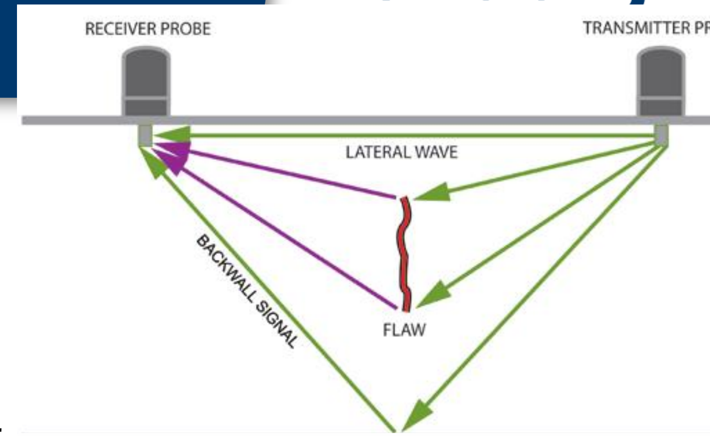
# Time of Flight Diffraction

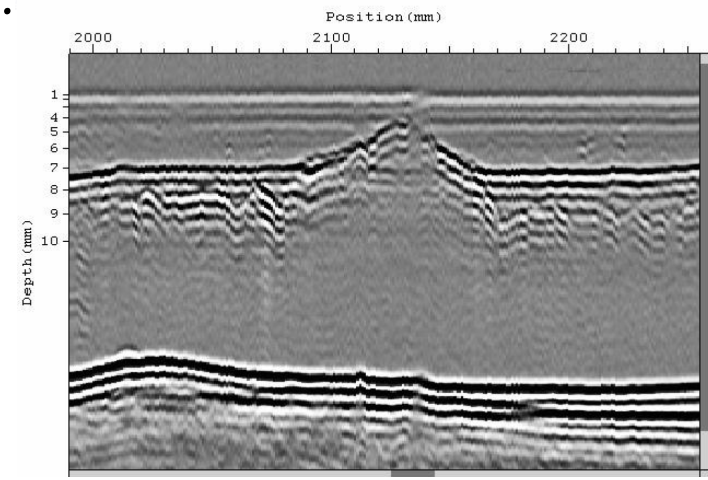
The TOFD (Time of Flight Diffraction) technique is ultrasonic inspection method for detection of flaws in thick wall components like headers & pipe joints.

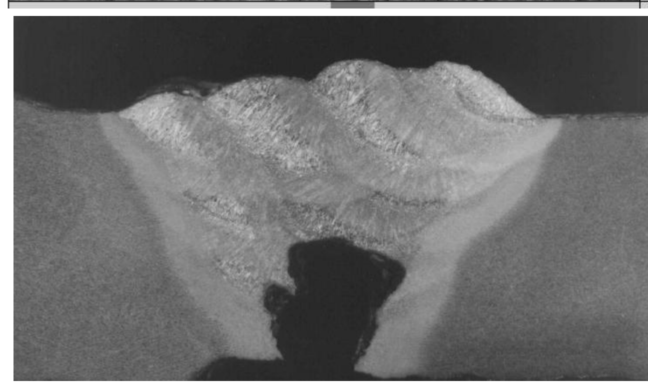
In TOFD technique transmitter & receiver are placed on equal distances of weld joint and are focused at the joint. The transmitter sends compression waves into the material towards receiver.

where thickness is more than 6mm & dia 80 mm.

Verify the cracks & lack of fusion which are not detectable with radiography.



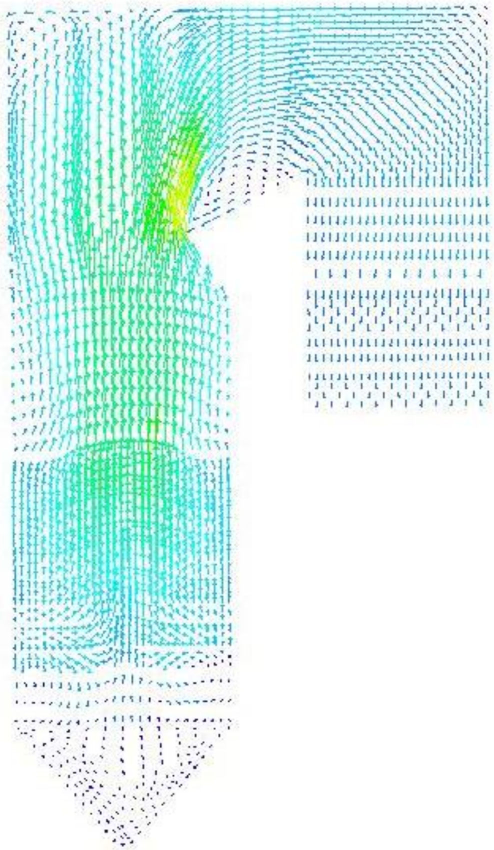



# CFD Modeling and CAVT testing

**CAVT TESTING.**

The purpose of CAVT (Cold Air Velocity Test) is to predict the flow profile of flue gas flow by manually measuring the velocity of cold air inside the boiler at pre defined locations

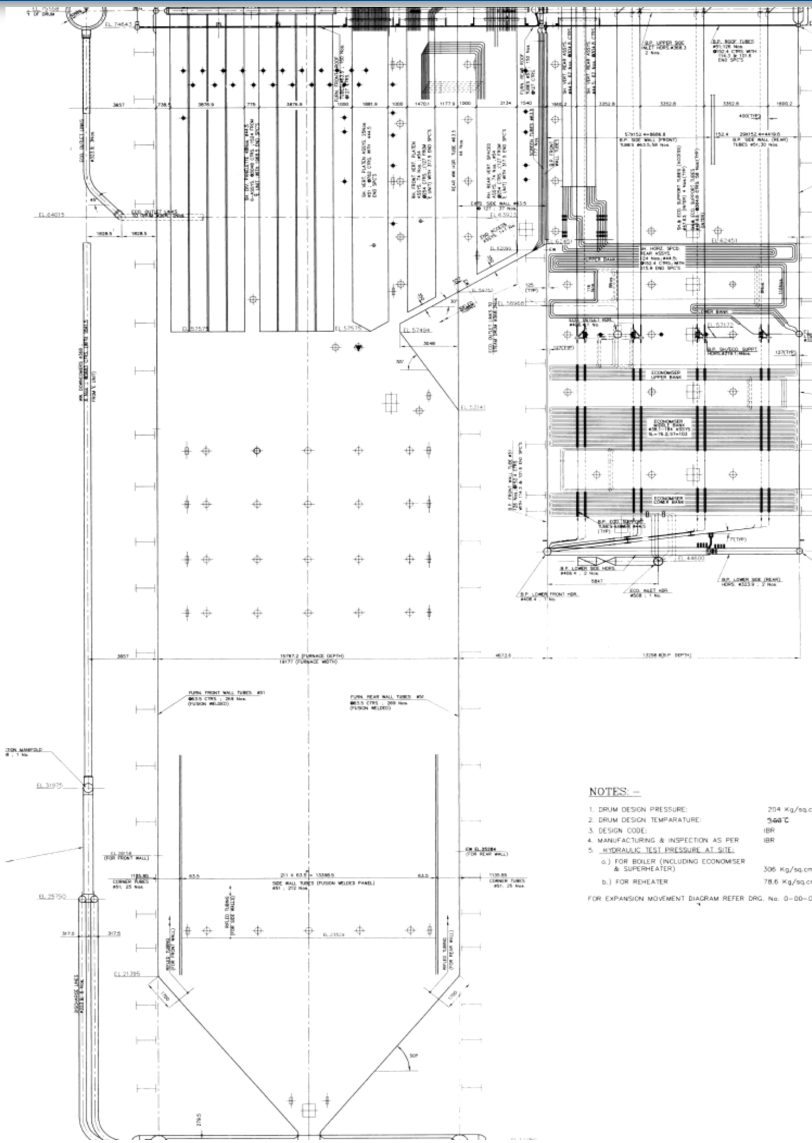
**CFD Modeling**

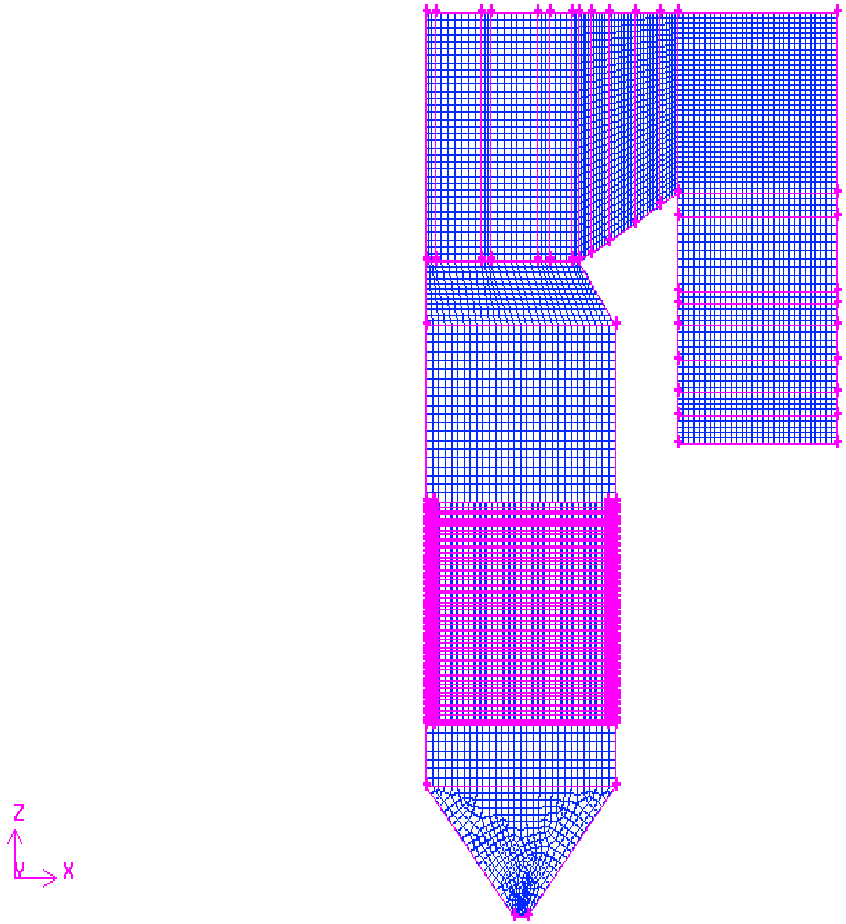


**THERMOGRAPHY OF WATER WALL TUBES**

water walls of furnace can be checked by THERMOGRAPHY for any suspected chocking/blockage of tube below the goose neck area after overhauling of boiler.

# CFD Modeling



# Advance Inspection techniques

**ROBOTIC INSPECTION USING MAGNETIC FLUX.**

This technique can be used to find out thickness loss in water wall tubing and other areas.

**BOROSCOPIC INSPECTION**

The internal surface of header which is inaccessible can be inspected by Boroscope.

This technique is called Fibroscopy. Headers exposed to temperature cycling may experience internal cracking due to thermal fatigue. Mostly this initiates and is most severe in the legaments between the adjacent tube stub bore holes.

This technique is useful to examine the internal scaling.

# Monitoring Techniques

**a. TEMPERATURE EXCURSION MONITORING.**
Monitoring of temp excursion of PI SH & RH area and trending

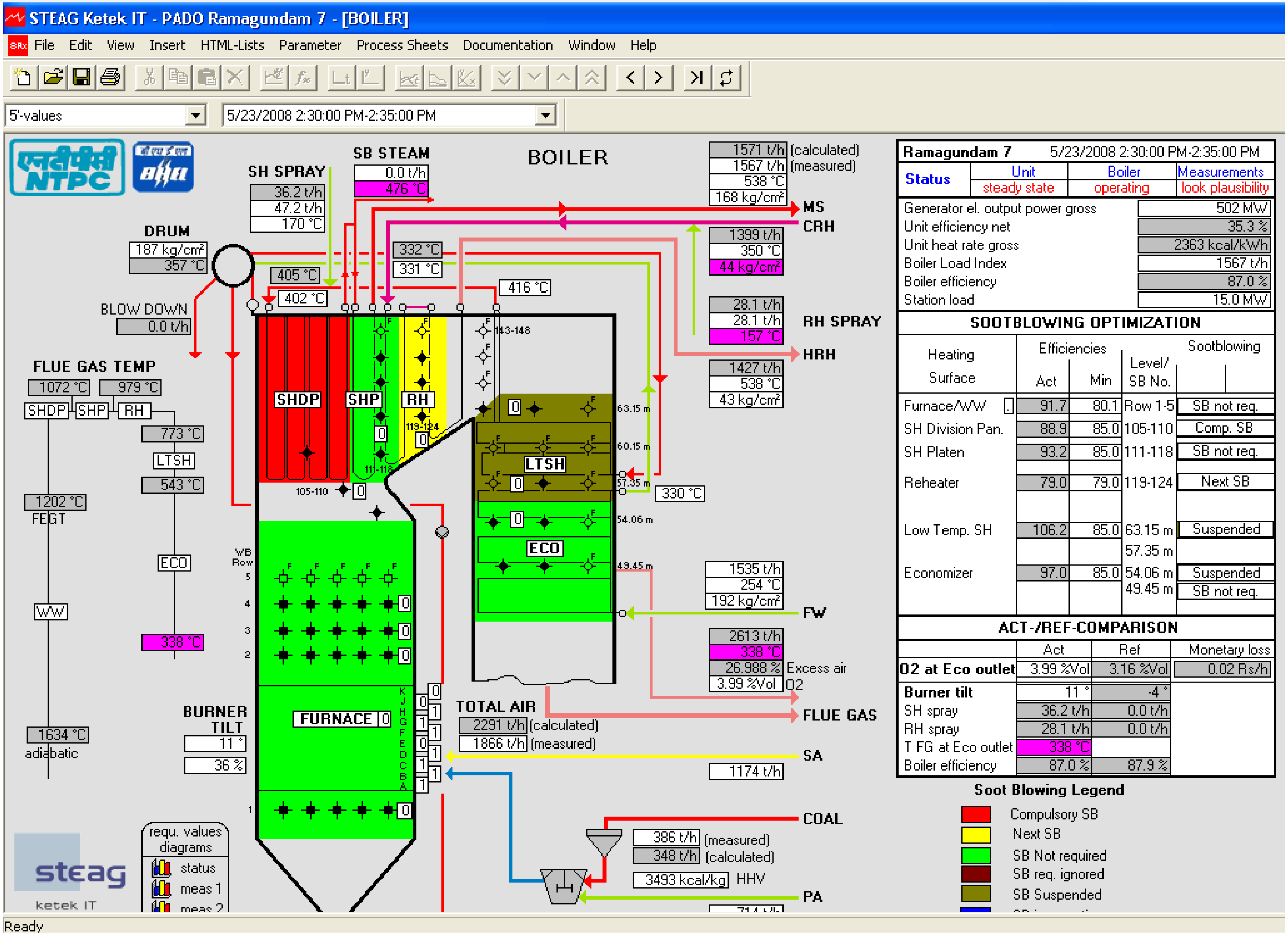
**b. FIVE CORE CHEMICAL PARAMETERS (pH,Na,DO,NH3&PO4)**
Operation Engineers & Chemists are required to monitor 5 core chemical parameters shift wise daily. These are water & steam pH. Sodium in saturated Steam, Dissolved oxygen in dearator & condenser, ammonia in water and phosphate in drum.

**c. DISSOLVED OXYGEN IN CONDENSER/DEARATOR.**
Level of dissolved oxygen in dearator & condenser is to be regularly checked and actions are to be taken to bring down within limits. Reducing Oxygen level in condensate water reduces corrosive action. It has been experienced that attachment failures & weld joint defect failures are reduced by maintaining low DO.

**d. ASLD INSTALLATION(**Acoustic Steam Leak Detection )
In order to have early detection of BTL and stoppage of unit at early stage to reduce secondary damages particularly in RH, Pl SH & div SH area,

It has been experienced that in the units where ASLD is not installed secondary damages causes heavy loss of generation due increased time of repair.

# PADO


STEAG Ketek IT - PADO Ramagundam 7 - [BOILER]
File Edit View Insert HTML-Lists Parameter Process Sheets Documentation Window Help
5'-values
5/23/2008 2:30:00 PM-2:35:00 PM
BOILER
SH SPRAY
36.2 t/h
47.2 t/h
170 °C
SB STEAM
0.0 t/h
476 °C
1571 t/h (calculated)
1567 t/h (measured)
538 °C
168 kg/cm²
MS
CRH
1399 t/h
350 °C
44 kg/cm²
DRUM
187 kg/cm²
357 °C
BLOW DOWN
0.0 t/h
RH SPRAY
28.1 t/h
28.1 t/h
157 °C
HRH
1427 t/h
538 °C
43 kg/cm²
FLUE GAS TEMP
1072 °C
979 °C
SHDP
SHP
RH
773 °C
LTSH
543 °C
1202 °C
FEGT
ECO
WW
338 °C
1634 °C
adiabatic
BURNER TILT
11 °
36 %
FURNACE
LTSH
ECO
330 °C
1535 t/h
254 °C
192 kg/cm²
FW
2613 t/h
338 °C
26.988 % Excess air
3.99 %Vol O2
TOTAL AIR
2291 t/h (calculated)
1866 t/h (measured)
FLUE GAS
SA
1174 t/h
COAL
386 t/h (measured)
348 t/h (calculated)
3493 kcal/kg HHV
PA
Ramagundam 7 5/23/2008 2:30:00 PM-2:35:00 PM
Status
Unit steady state
Boiler operating
Measurements look plausibility
Generator el. output power gross 502 MW
Unit efficiency net 35.3 %
Unit heat rate gross 2363 kcal/kWh
Boiler Load Index 1567 t/h
Boiler efficiency 87.0 %
Station load 15.0 MW
SOOTBLOWING OPTIMIZATION
Heating Surface
Efficiencies Act Min
Level/ SB No.
Sootblowing
Furnace/WW 91.7 80.1 Row 1-5 SB not req.
SH Division Pan. 88.9 85.0 105-110 Comp. SB
SH Platen 93.2 85.0 111-118 SB not req.
Reheater 79.0 79.0 119-124 Next SB
Low Temp. SH 106.2 85.0 63.15 m Suspended
57.35 m
Economizer 97.0 85.0 54.06 m Suspended
49.45 m SB not req.
ACT-/REF-COMPARISON
Act Ref Monetary loss
O2 at Eco outlet 3.99 %Vol 3.16 %Vol 0.02 Rs/h
Burner tilt 11 ° -4 °
SH spray 36.2 t/h 0.0 t/h
RH spray 28.1 t/h 0.0 t/h
T FG at Eco outlet 338 °C
Boiler efficiency 87.0 % 87.9 %
Soot Blowing Legend
Compulsory SB
Next SB
SB Not required
SB req. ignored
SB Suspended
requ. values diagrams
status
meas 1
Ready

# Life time monitoring

steag

- The life time monitoring module calculates the remaining life of thick components in boiler.

- This depends upon how stressful the life of equipment has been so far in terms of temperature and pressure which effect fatigue and creep.

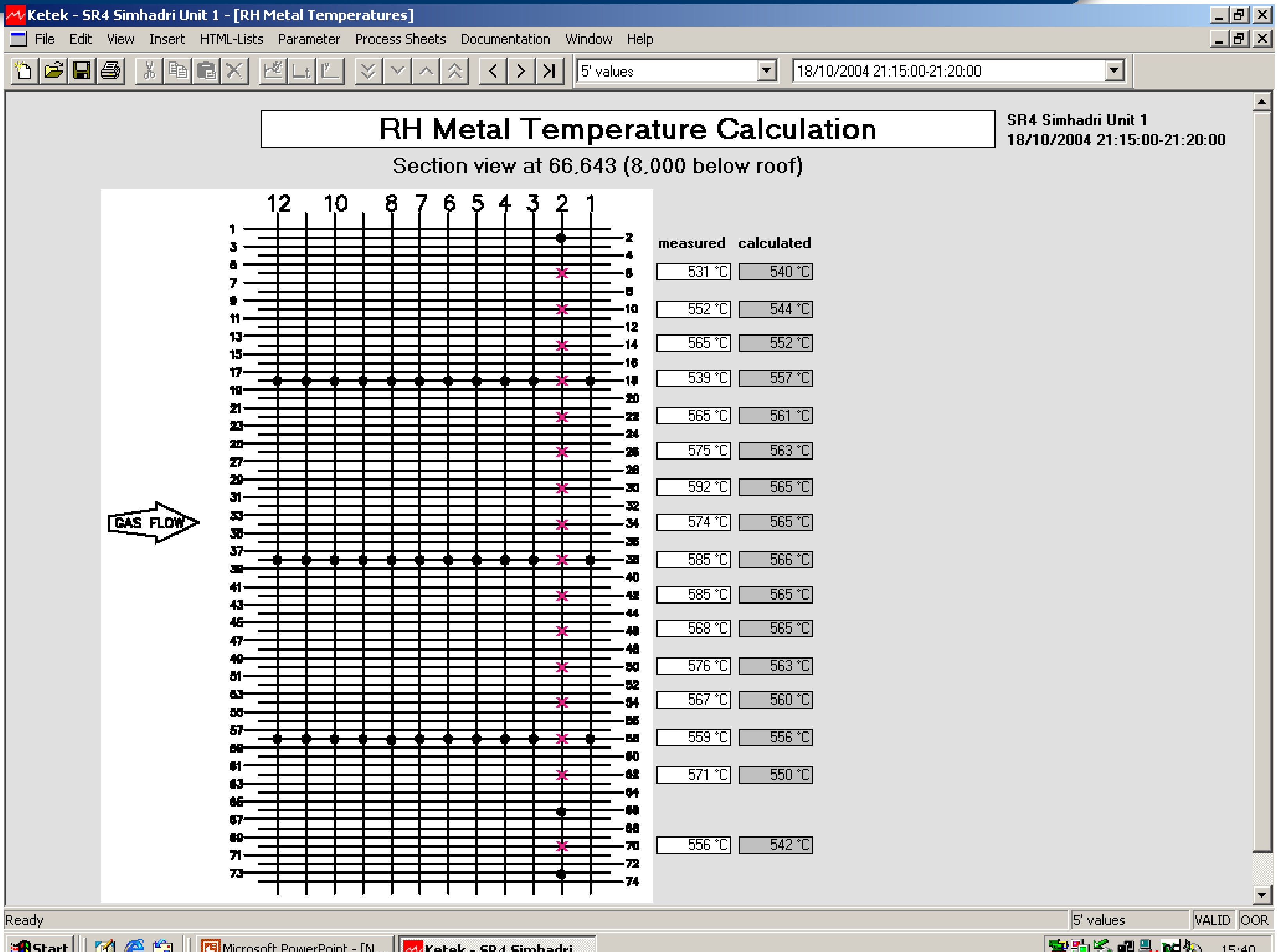
| | online (since 07.2003) | offline (until 07.2003) |
|---|---|---|
| Observed time: | 2488.7 h | |
| Shut down time: | 772.8 h | |

| No. | Component | Shut down | Degradation Fatigue | Creep | Total |
|---|---|---|---|---|---|
| 1 | Drum 1/top | 8.4h | 0.006% | 0.277% | 0.283% |
| 2 | Drum 1/bot | 8.4h | 0.008% | 0.317% | 0.324% |
| 3 | HRH 1/t-top | 359.1h | 0.000% | 0.009% | 0.009% |
| 4 | HRH 1/t-bot | 359.1h | 0.000% | 0.010% | 0.010% |
| 5 | HRH 1/m-bot | 359.1h | 0.000% | 0.046% | 0.046% |
| 6 | HRH 1/l-top | 359.1h | 0.000% | 0.024% | 0.024% |
| 7 | HRH 1/l-bot | 359.1h | 0.000% | 0.046% | 0.046% |
| 8 | MSH 1/t-top | 47.7h | 2.505% | 0.143% | 2.648% |
| 9 | MSH 1/t-bot | 47.7h | 2.505% | 0.518% | 3.023% |
| 10 | MSH 1/m-bot | 47.7h | 1.218% | 2.063% | 3.281% |
| 11 | MSH 1/l-bot | 47.7h | 1.218% | 2.063% | 3.281% |
| 12 | YP 1/lbb | 359.1h | 0.000% | 0.326% | 0.326% |
| 13 | YP 1/lba | 47.7h | 0.381% | 3.445% | 3.826% |

List of large load change

List of remaining peaks

# Metal temperature monitoring



## Operation and Maintenance guidelines for arresting Boiler Tube leaks

# Actions to be taken to prevent & control Boiler Tube Failures

steag

✓During overhauling of Steam Generator, Internal Washing of 1st and 2nd pass should be carried out so that proper scanning of tubes can be carried out.

✓Intensive 'D' metering of boiler tubes at pre-determined locations to be carried out & comparison w.r.t. to last overhaul should be done, especially in wear prone areas.

✓The limit of 20% reduction in thickness due to fly ash erosion must be adhered to, for replacement of worn out portion of boiler tubes.

✓ DPT of attachment welds should be carried out, especially in Pent House.

✓100% radiography of weld its during overhaul & also during tube failure repair is to be carried out.

✓Platen S/H, R/H & Final super heater Coils must be checked for overheating during over hauling. During operation of units, the metal temperature excursions in above area should be avoided and monitored by Operation Department and should be discussed in daily Planning meeting.

✓5. For determining the fire side corrosion and internal corrosion of furnace tubes, samples from each corner of furnace must be sent to R & D in each unit overhaul.

# Guide lines to control tube leaks

✓To avoid failures of DMW joints, DPT of all DMW joints must be carried out in each overhaul. At random radiography (5%) of DMW joints should be carried out.

✓To reduce secondary damages due to tube failure, Operation staff is required to check for any steam leak sound through peep holes at least once in a shift. Also, in case of increase in DM make-up and furnace draft fluctuation, boiler furnace / 2nd pass should be checked.

✓Lowering of extreme LHS & RHS Eco. Coils in economizer hopper for thorough inspection of coils, As erosion on RHS at NCPS (Th) is more than LHS,3 pairs of extreme RHS coil and 2 pairs of LHS coils should be lowered down & worn out tubes to be replaced.

✓Inspection of Steam cooled side walls after lowering down of Eco. Coils

# Guide lines  to control tube leaks

✓Inspection of LTSH coils by lifting up the extreme LHS/RHS coils and replacement of worn out portion of tubes.

✓Inspection of eco. hanger tubes for fly ash erosion and replacement of worn out portion of tubes

✓Inspection of extended Steam Cooled Wall (LHS/RHS) in arch area for fly ash erosion and replacement of worn out portion of tubes.

✓Second pass manhole bends especially on RHS are usually found worn out in various overhauls and should be replaced if required.

✓Re-heater & Platen S/H Steam cooled spacer tube bends on both sides are normally found eroded & should be replaced if required in each overhaul..

# Guide lines  to control tube leaks

✓ Inspection of wall blower area of furnace for steam erosion and replacement of worn out portion of tubes.

✓Burner corner panel tubes are found eroded due to fly ash carryover in secondary air. These tubes must be replaced in capital overhaul.

✓Intensive shielding should be done in following wear prone areas :

a) Water wall screen tubes-2 rows on extreme ends.
b) LTSH exit tube 900 bends
c) LTSH terminal tubes near SHH-9
d) Eco. Hanger tubes -5 rows extreme LHS & RHS.
e) LTSH screen tubes -5 rows extreme LHS & RHS

# Best practices in coal fired power stations to arrest Boiler  tube leaks

# Measures to control Boiler tube leaks

1. CONTROLLING THE TUBE METAL TEMPs WITHIN DESIGN VALUE BY SACRIFICING THE STEAM TEMPERATURES (PROCESS)
2. ENSURING THE SOOT BLOWER HOME POSITION (PROCESS)
3. MAINTAINING WB TO FURNACE DP AS PER DESIGN (PROCESS)
4. PERIODIC CHECKING OF SADC POSITION, WHICH IS MAIN CONSTITUTE IN METAL EXCURSIONS (PROCESS)
5. PERIODIC LRSB OPERATION TO AVOIDING OVER HEATING(PROCESS)
6. WALL BLOWERS PRESSURE SETTING ONCE IN EVERY SIX MONTHS (PROCESS)

# Measures to control Boiler tube leaks

1. FORMATION OF PERFORMANCE OPTIMISATION GROUP, WHICH GUIDES THE MEASURES TO BE TAKEN TO BTL. GROUP COMPRISES OF OPERATION, O&E, BMD, C&I, CHEMISTRY AND CHP (O&E)
2. PROVIDING PROTECTION SHIELDS OVER TOP BANKS OF ECO AND LTSH AREA, VERTICAL HANGING TUBES OF REAR WALLS (BMD)
3. CHANGING OF COAL BURNER IN EVERY OVERHAUL, WHICH PLAYS KEY ROLE IN COMBUSTION (BMD)
4. MAX PERCENTAGE TUBE THICKNESS SURVEY IN EVERY OVERHAUL (BMD, FQA)
5. MAINTAINING CHEMISTRY PARAMETERS OF FEED, CONDENSATE AND STEAM AND VERY CLOSE MONITORING OF PARAMETERS TO AVOID WATER CORROSION (EFFECT OF SEA WATER) (CHEM)

# Measures to control Boiler tube leaks

MAINTAIN C&I LOOPS ARE VERY ACURATE, ESPECIALLY DRUM LEVEL CONTROLLER AND METAL TEMP (C&I)

12. PERIODIC CHECKING OF MILL FINENESS TO AVOID SECONDARY COMBUSTION (O&E,RM)
13. CHANGING OF HIGH GRADE METALS IN REHEATER ZONE WITH SS AND T91 MATERIALS (BMD)
14. MAINTAINING BOTTOM ASH HOPPER LEVEL AROUND 450MM DOWN TO NORMAL VALUE TO AVOID SPALSHING OF SEA WATER ON BOTTOM SIDE OF WATERWALLS (AHM, BMD)
15. CONTROLLING THE EXCESS AIR TO AVOID HIGH VELOCITY AND HIGH FG EXIT TEMP (PROCESS)
16. DURING COMMISSIONG STATE, FLUSHING AND CHEMICAL CLEAINGS PLAYS IMPORTANT ROLE TO CLEAR ANY BLOCKAGES IN THE CIRCUIT. OTHERWISE, THESE BLOCKAGES WILL LEAD TO TUBE FAILURE(OVERHEATING) (COMNG)
17. PROVIDING THERMAL DRAIN IN SOOT BLOWER STEAM LINE (C&I)

## Approach methodology to prevent Boiler Tube leaks

# Approach for the control of BTL because of Fly ash erosion