Panel	Panel Joints	Original WPS	Modified PWHT#1	Modified PWHT#2
S03-S04	204	204	91	47
S04-S05	204	204	89	37
S07-S08	108	108	99	13
S08-S08T0	108	108	103	1
Total	624	624	382	98

Modified Procedure # I: Root + Hot Pass TIG + ARC & PWHT at 750-760 deg C
Modified Procedure # II: Root + Hot Pass TIG + ARC & 2 PWHT at 750-760 deg C

Observations of T23 Joints Failure

- Presently T23 Jts of Only Membrane Panels (Roof Panels & Extended Back Pass Panels) are failing where Fins being used.
- Presently only Field Joints are failing after Boiler Light up and subject to High temperature condition.
- Difficulties in providing Shop methodology / conditions at site during welding & Post Weld Heat Treatment (PWHT) etc.
- Joints evaluated showing high hardness > 260HV are being subjected to repeated PWHT till permissible limit is achieved

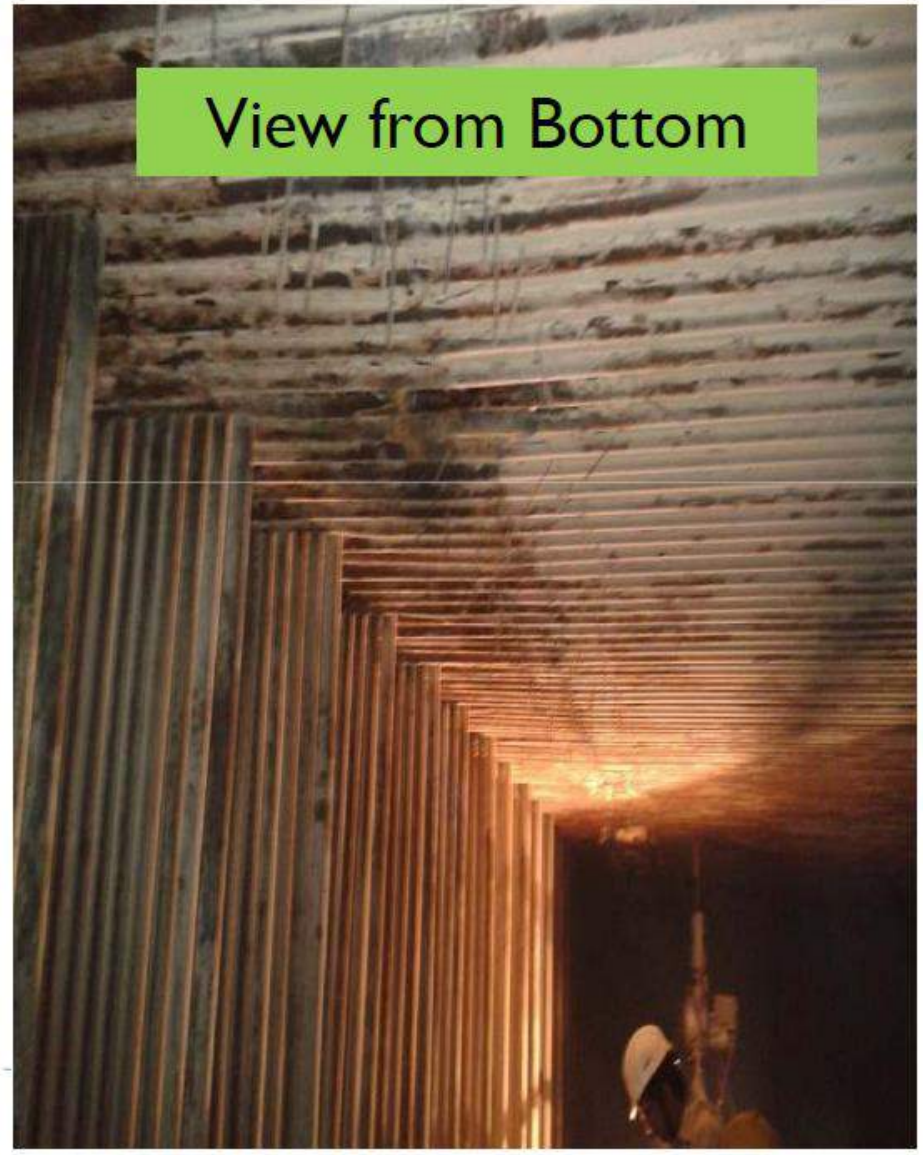
Details of T23 joints failure

Panel	After SB	After Sync	After Full load	Failure on same tubes
S03-S04	9	16	47	42
S04-S05	13	16	37	16
S07-S08	10	13	13	20
S08-S08T0	25	14	1	0
Total	57	59	98	78

- Failure was attributed to high hardness
- Inappropriate post weld heat treatment.

View of Roof Panels

View from Top



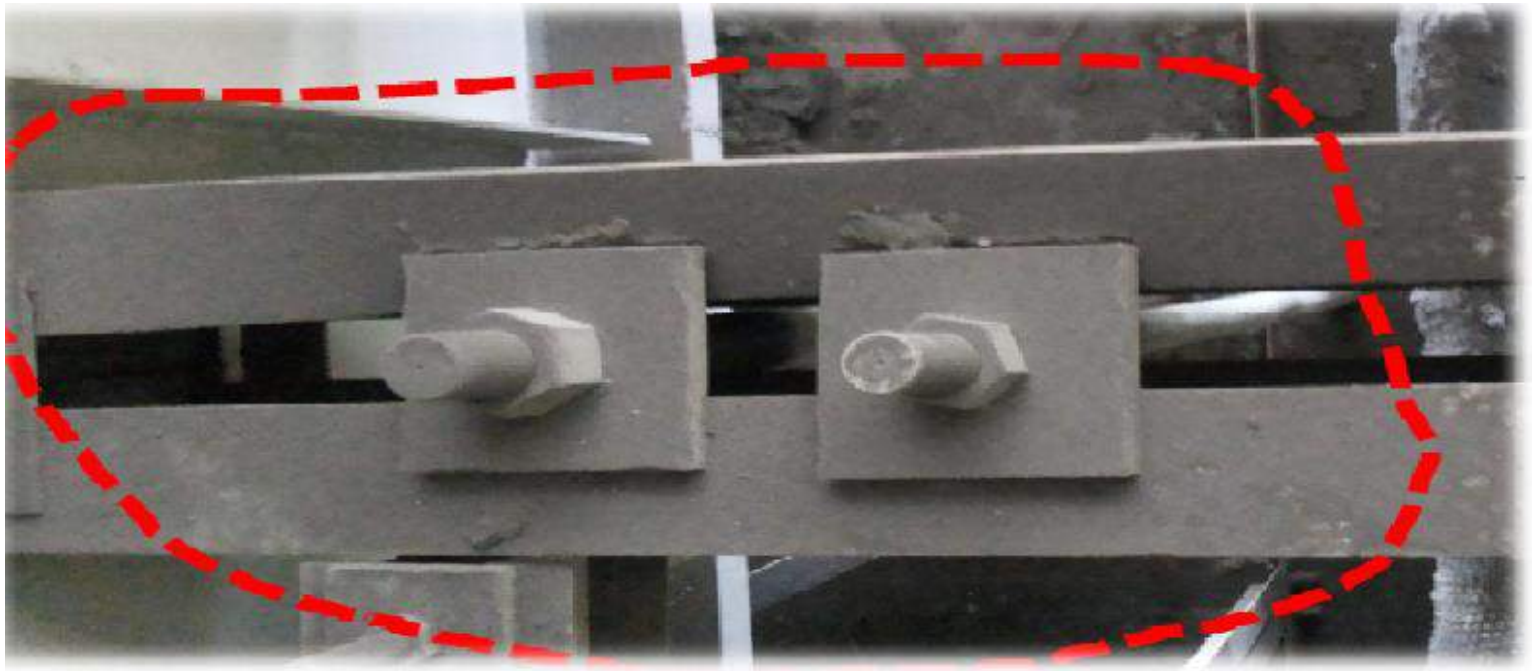
View from Bottom

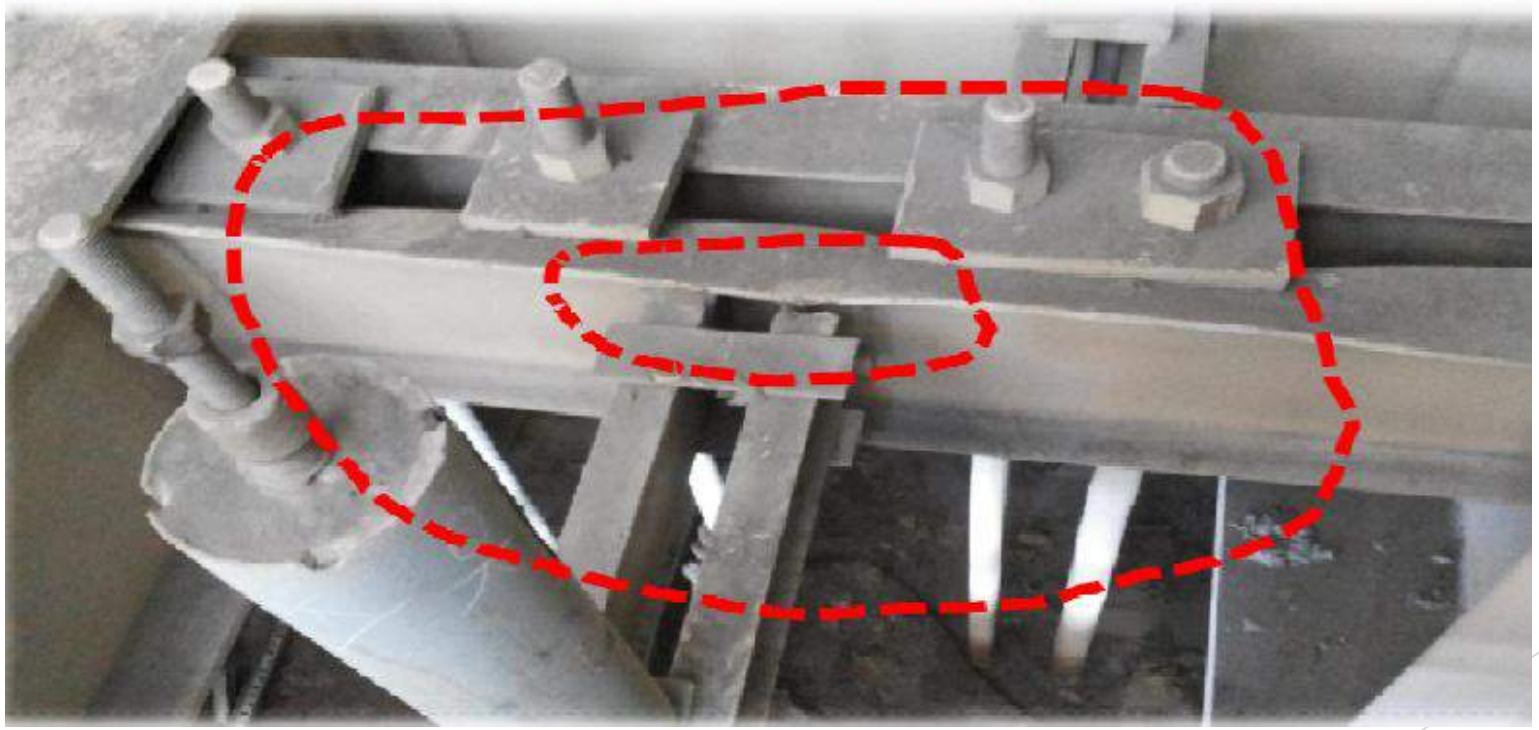
PWHT Procedure

Description	Procedure#1 (WPS:1052)	Modified Procedure#1	Modified Procedure# 2
RT	Single shot	Double shot	Double shot after removal of fins
PWHT	PWHT After Fin Welding in one go	PWHT After Fin Welding in one go	PWHT-1
			Fin Welding
			PWHT-2
PWHT Temp	720-745°C	750-770°C	750-760°C
PWHT Rate of Heating/ Cooling	110°C/Hr		
PWHT Holding Time	30 minutes		
Welding Pre-Heat Temp	150°C	200°C	200°C
Welding	By TIG then SMAW	Root + Hot Pass TIG+ SMAW	Root + Hot Pass TIG+ SMAW
Procedure Approval date		Nov'13	25th Dec'13

Washer Replacement of Boiler Suspension system:

- During initial operation of the unit twisting of rolled beam supporting the furnace, was observed.
- During the designing of suspension system, back to back channel arrangement was replaced with I- Section, with same size of washer plate.
- This resulted in load being transferred on the flange in place of web in the beams.
- The twisted rolled beams needed hot correction
- All **370 nos** of washer plated were replaced





Super critical units –NTPC Experience

Major Issues Faced During Commissioning

1. Wet to Dry mode changeover

2. Electro Hydraulic Safety Valves SPTD (Steam Pressure Test Device) location changed from boiler 92 m to 83 m, as controllers were getting malfunctioned due to high temperature at 92 m

3. Black start up line

   Black startup line was installed to maintain separator storage tank level, with this line we could complete steam blowing without taking any TG side systems in service

4. During steam blowing due to blockage in CRH & LP Bypass drains steam blowing was interrupted

Later on blocked drains were cleared and modification was carried out to separate High pressure (Main steam) & Low pressure (CRH, HRH, LP bypass) drains into separate header.

5. Procedure for setting of high pressure spring loaded safety valves installed in separator & main steam systems was not available with the vendor.

A method of testing & setting of these safety valves with Trevi's kit was devised by NTPC commissioning team

Issues Faced During Operation

- High water wall temperature during initial start up from 200 to 350 MW

  Problem was related to mismatch between feed water flow and fuel firing

  The matter was resolved by fine tuning Feed water auto loop

- Frequent failure of LP bypass diffuser plate during LP bypass operation after turbine tripping from full load.

  The issue was resolved by migrating to ***enthalpy*** based control from conventional logic

Maintenance and Spares Management

- Advanced Maintenance Practices

SIPAT SUPERCRITICAL BOILER – Materials for Pressure Parts.

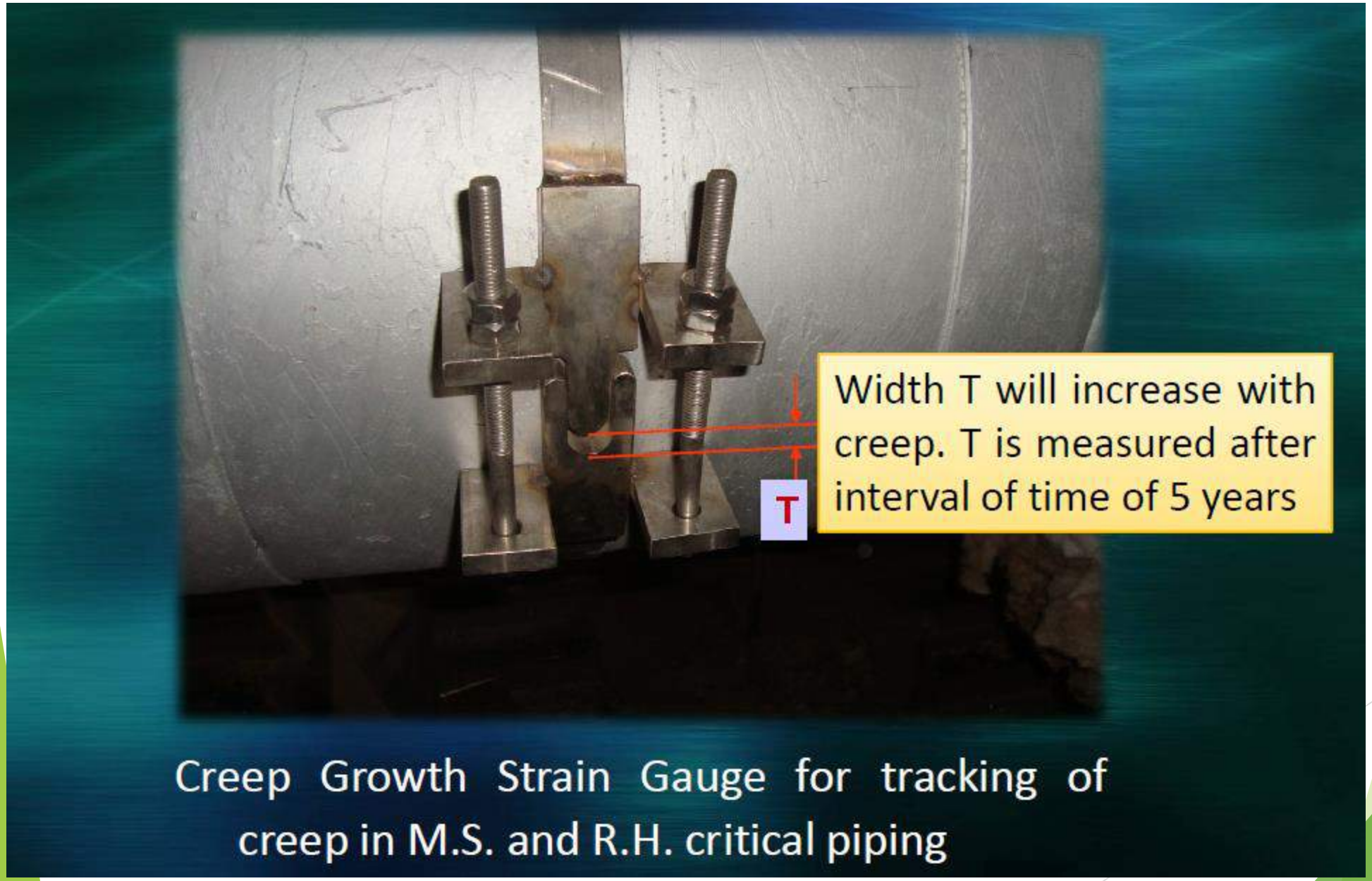
Item	Section	Material Specification
Water Wall	Tubing	SA213-T22
Superheater	Header & Piping	SA335 - P12
		SA335 - P91
	Tubing	SA213-T12
		SA213-T23
		SA213-T91
		SA213-T92
Reheater	Header & Piping	SA106-C
		SA335 - P12
		SA335 - P91
	Tubing	SA210Gr.C
		SA213-T12
		SA213-T23
		SA213-T91
		SUPER 304H
Economiser	Header & Piping	SA106-C
	Tubing	SA210-C
Separator Storage Tank		SA302-C

SIPAT SUPERCRITICAL BOILER – Operation & Maintenance

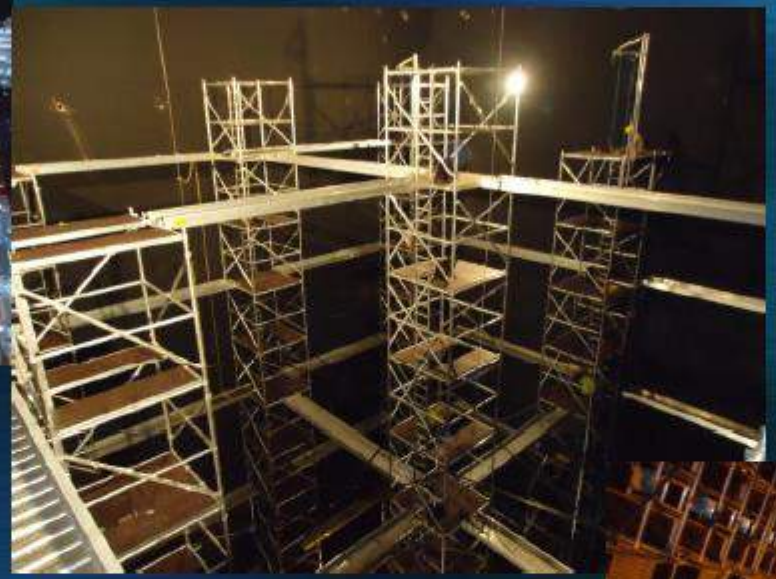
- Boiler tube joints & membranes/fins repair by **ONLY GTAW welding** process
- Use of state of art tools for attending boiler tube leakage.
- Boiler expansion monitoring during startup and loading.
- Soot blowing during startup and in each shift during normal operation.
- Close Monitoring of Furnace tube metal temperature excursion during startup and low load.
- Use of Software for analysis of creep, oxide layer thickness measurement and its analysis for calculating life of tubes etc.
- Use of advance tools such as Videoscope for checking blockage inside boiler tubes, pipelines, turbine etc.

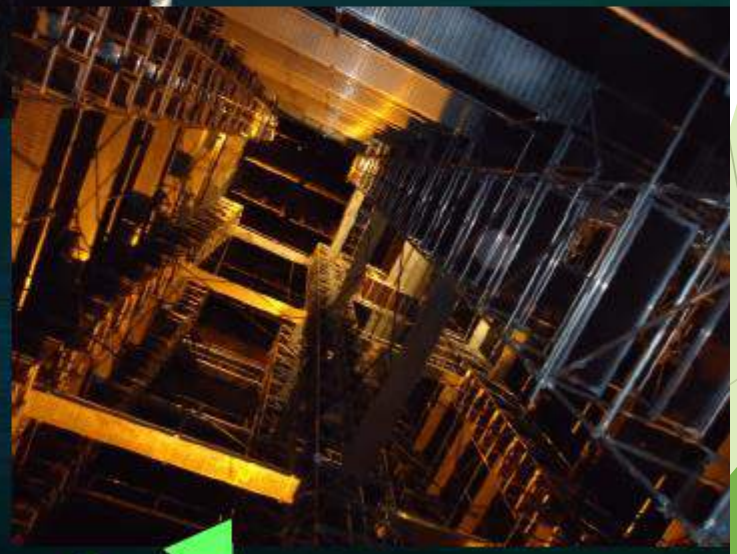
Special features

Hydraulic Safety Valves in SH and RH ensures steam pressure maintained within limits during transient conditions.



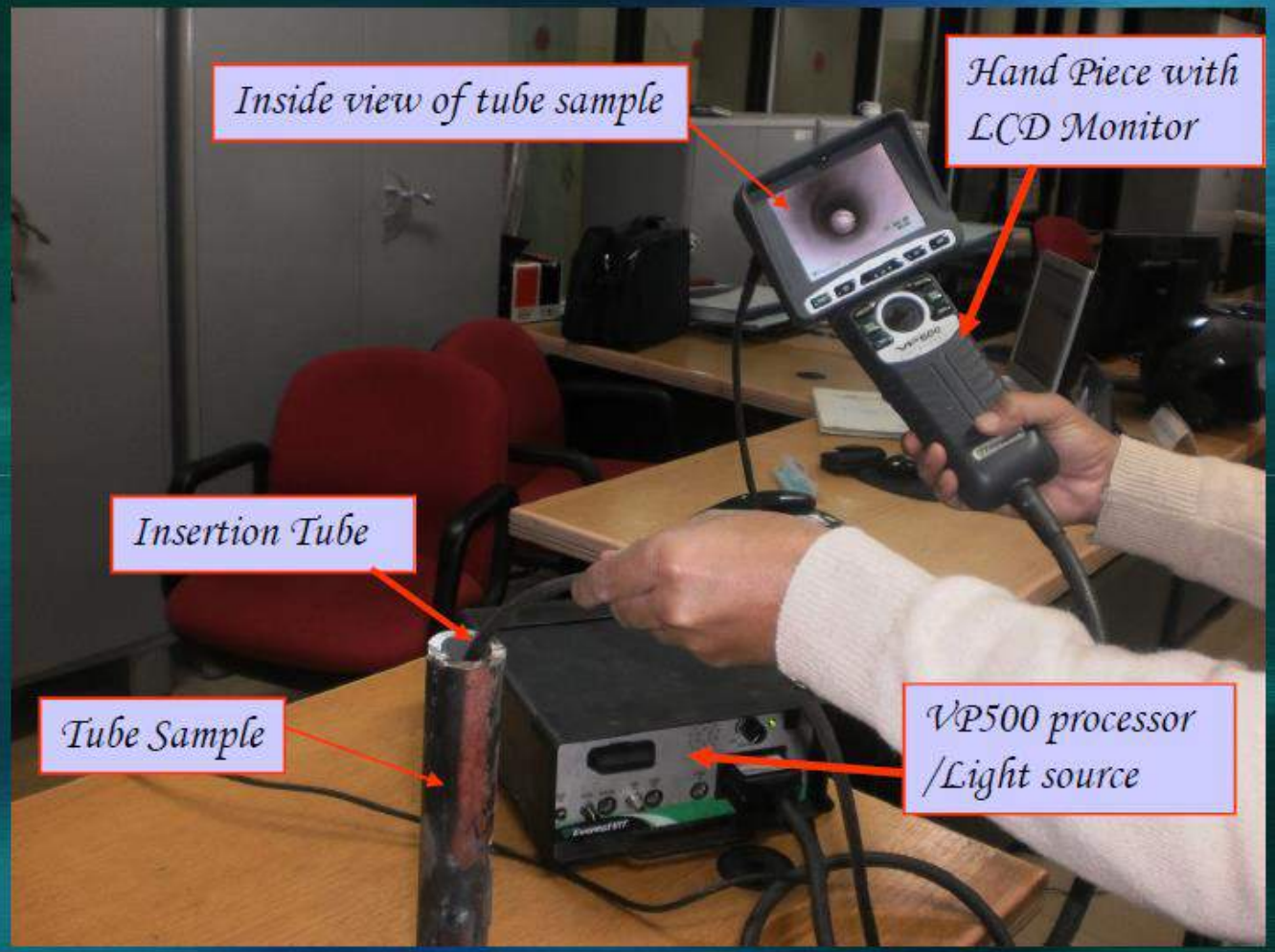
Creep Growth Strain Gauge for tracking of creep in M.S. and R.H. critical piping





- Use of tailor made aluminum quick erect scaffolding resulting in fast erection of scaffolding with minimum manpower.
- Various stages of erection of aluminum Quick Erect Scaffolding in Boiler.

SIPAT SUPERCRITICAL BOILER – Operation & Maintenance



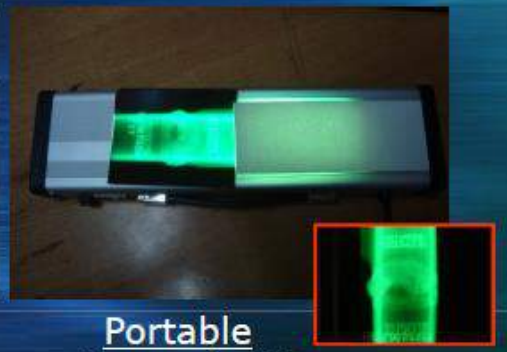
VideoProbe for checking foreign materials in boiler tubes, turbine, headers etc.

SIPAT SUPERCRITICAL BOILER – Operation & Maintenance

Use of state of art tools for Boiler maintenance.

Tube Beveling M/c

Saber Saw for cutting of tube & fins



Portable Radiography film viewer

V/v Lapping M/c

Angle grinders (pneumatic)

Panel Cutting Saw

Mot. Hyd. Tube bending M/c

Furnace Temperature Mapping

Acoustic Pyrometer :

- Furnace temperature monitoring system using the acoustic principles. It measures the flue gas temperature inside the furnace using the principle – velocity of sound in a gas depends on the temperature of the gas. The sound is created by the Transmitter – propagates through the hot flue gas and collected in the receiver. The sound wave travel time between the Transmitter and Receiver is measured to ascertain the average FG temperature in that zone.
- Total 22 paths /zones of measurement in each unit. Each measurement data accusation time is 5 sec
- Can measure temperature in the range of 1 deg C to 1927 deg C at an accuracy level of (+, -) 1.5 %
- Pyrometer installation : 2nd pass : Below Econimiser coil: 33 mtr elev. – 06 nos

  1st pass : Water wall : 55 mtr – 06 nos , 65 mtr- 02 nos, 75 mtr – 02 nos

Advantages :

a) Identification of BAD burners and improper fuel/air ratio.

b) Monitoring of excessive temp. in SH and RH zones.

c) Detection of direct flame impingement on water wall.

d) Identifies improper fuel distribution between Mills in service.

e) can help in optimizing combustion efficiencies.

Boiler Workstation :

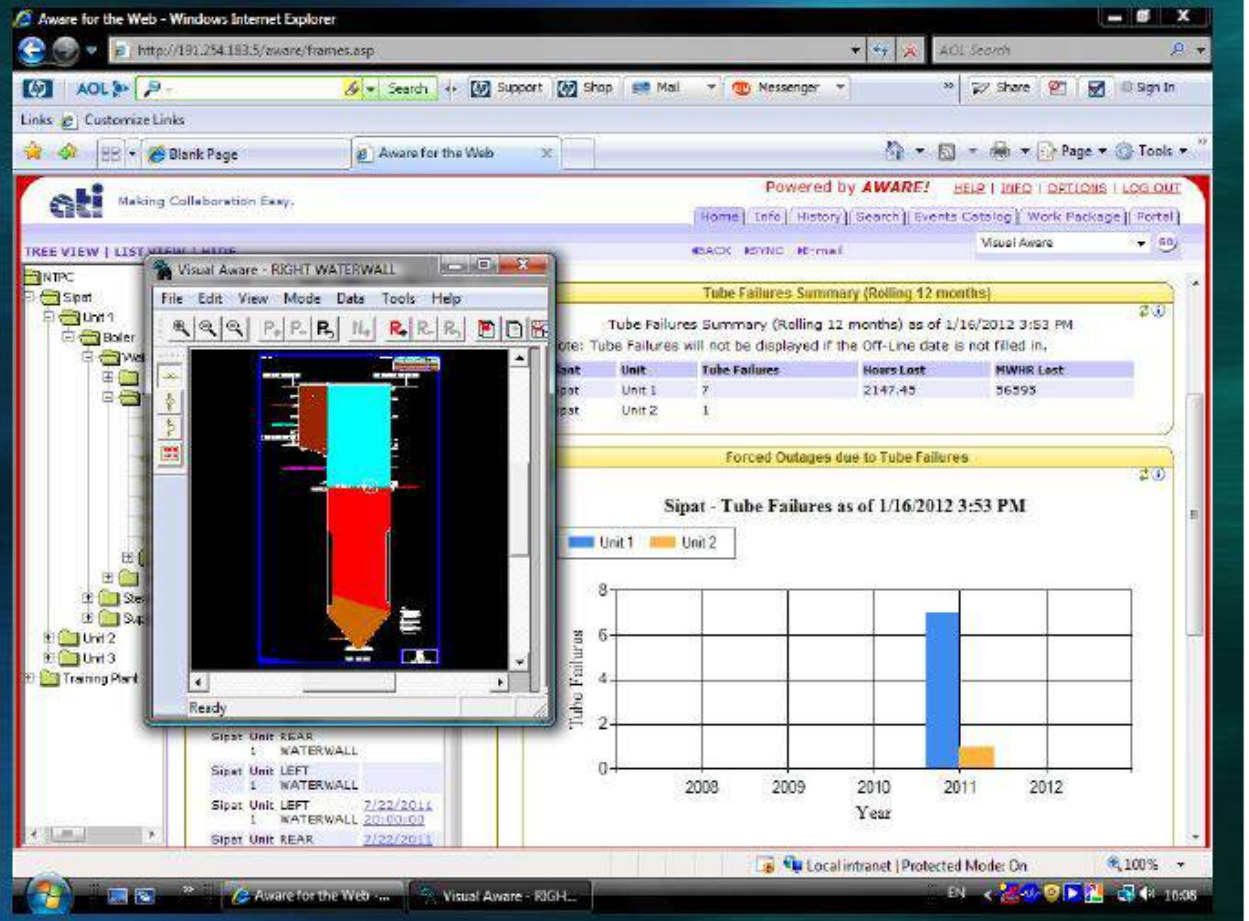
- The work station has two components :

- Aware software for recording of failures in boiler in terms of tube failure, panel replacement etc, recording of tube thickness and other NDT data. Use pressure parts auto CAD drawings to log those failure data with suitable color coding. Generation of different MIS for further analysis and future action plan.

- The use of portable Digital Ultrasonic Flaw Detector (using ultrasonic technology) to measure and to trend and characterization of IOT in tubes of high temperature zone. Use of these IOT data along with tube thickness, tube temperature for complete oxide layer characterization of the pressure parts item using LIFECODE software module for remaining life analysis.

SIPAT SUPERCRITICAL BOILER – Operation & Maintenance

- AWARE software module exclusively for boiler
- Use of Handheld Mobile Aware helps to capture inspection findings electronically during inspection itself ,thereby saving time for data entry and analysis.



Mitigation of Issue of High Cost of Imported Spares--- In House Development of Spares by Reverse Engineering

Development of material details:

After identification of vendors, material related data is collected.

Due to limited availability of spares and their high cost of procurement, for any data collection activity , non-destructive method of data collection is to be used.

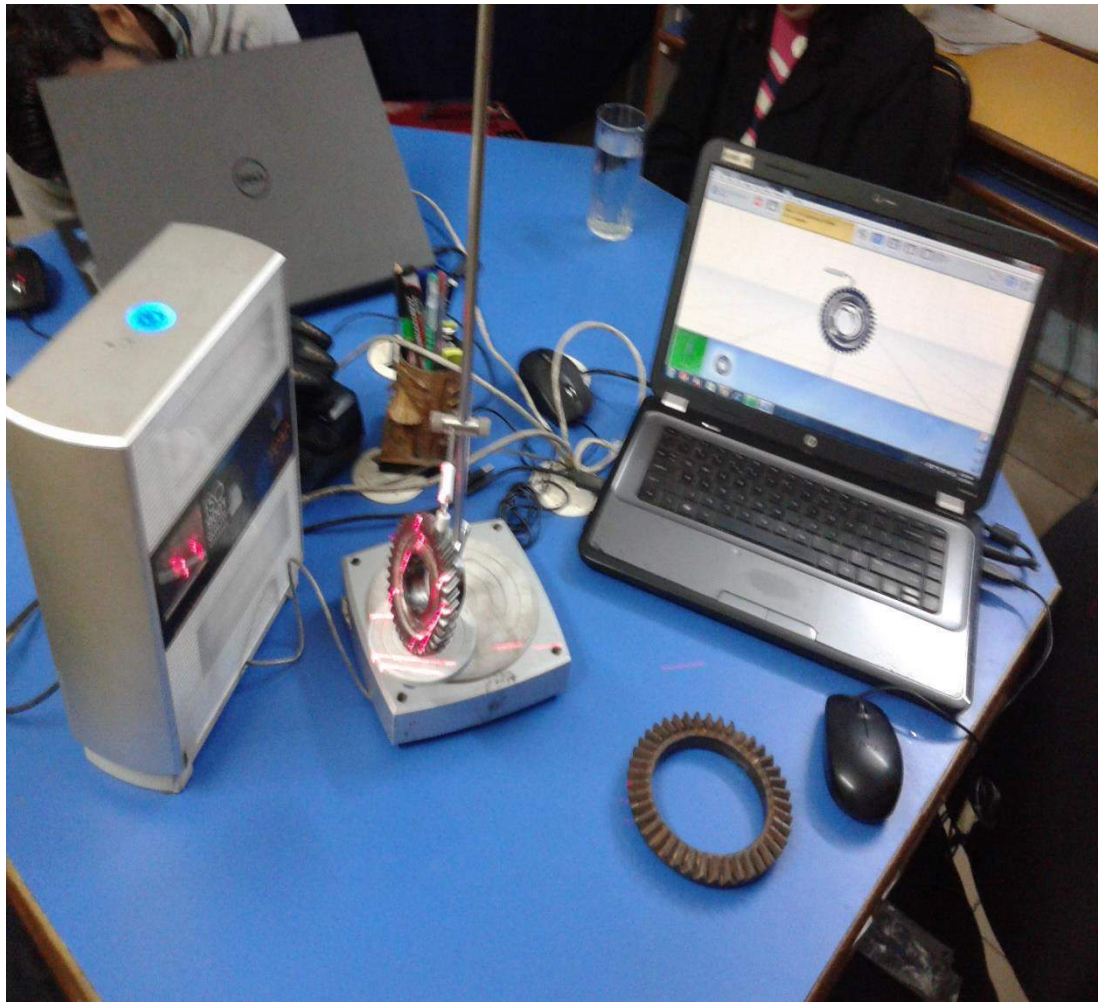
As no dimensional drawing and material of construction details are available, scientific tools would be utilized to gather this data.

From available GA drawings, dimensions of mating components can be checked & verified.

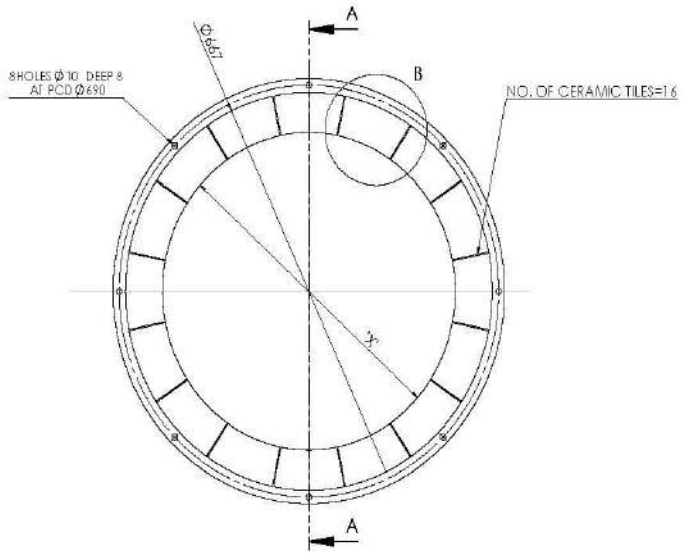
Mitigation of Issue of High Cost of Imported Spares--- In House Development of Spares by Reverse Engineering

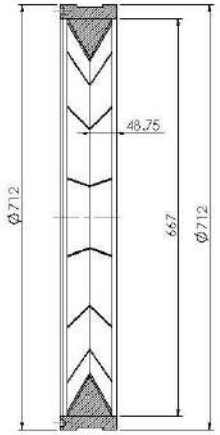
XRF Analyzer for Identifying Material Composition of Spares

3-D Laser Scanning



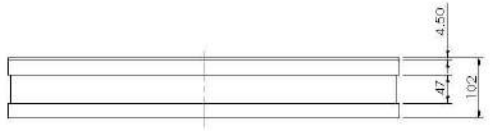
With the help of 3-D Scanning, all the dimension and intricate details are captured by scanner and CAD re-production is made

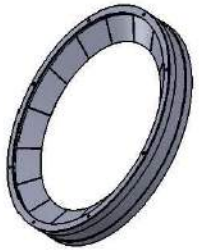


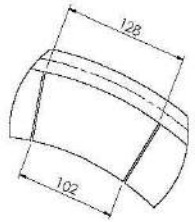


SECTION A-A
SCALE 1 : 7

S. NO.	ORIFICE DIA(X)
1	511.2
2	523.9
3	555.6
4	536.6
5	546.1
6	625.5
7	647.7
8	533.4
9	587.4
10	552.5
11	501.7
12	517.5
13	603.3
14	584.2
15	520.7
16	590.6
17	539.8
18	514.4
19	542.9
20	577.9







DETAIL B
SCALE 1 : 4

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH:
TOLERANCES:
LINEAR:
ANGULAR:

FINISH:

DEBUR AND BREAK SHARP EDGES

DO NOT SCALE DRAWING

DIVISION

NTPC
SIPAT SUPER THERMAL POWER PROJECT

	NAME	SIGNATURE	DATE
DRAWN			
CHKD			
APPVD			
MFG			
Q.A			

MATERIAL:

WEIGHT:

TITLE:
CERAMIC LINED STATIC ORIFICE OF COAL PIPING 3X660 MW SIPAT ST - I UNITS

DWG NO:
NTPC/SIPAT/BMD/MILL/STAGE-1/047

A3

SCALE:1:8

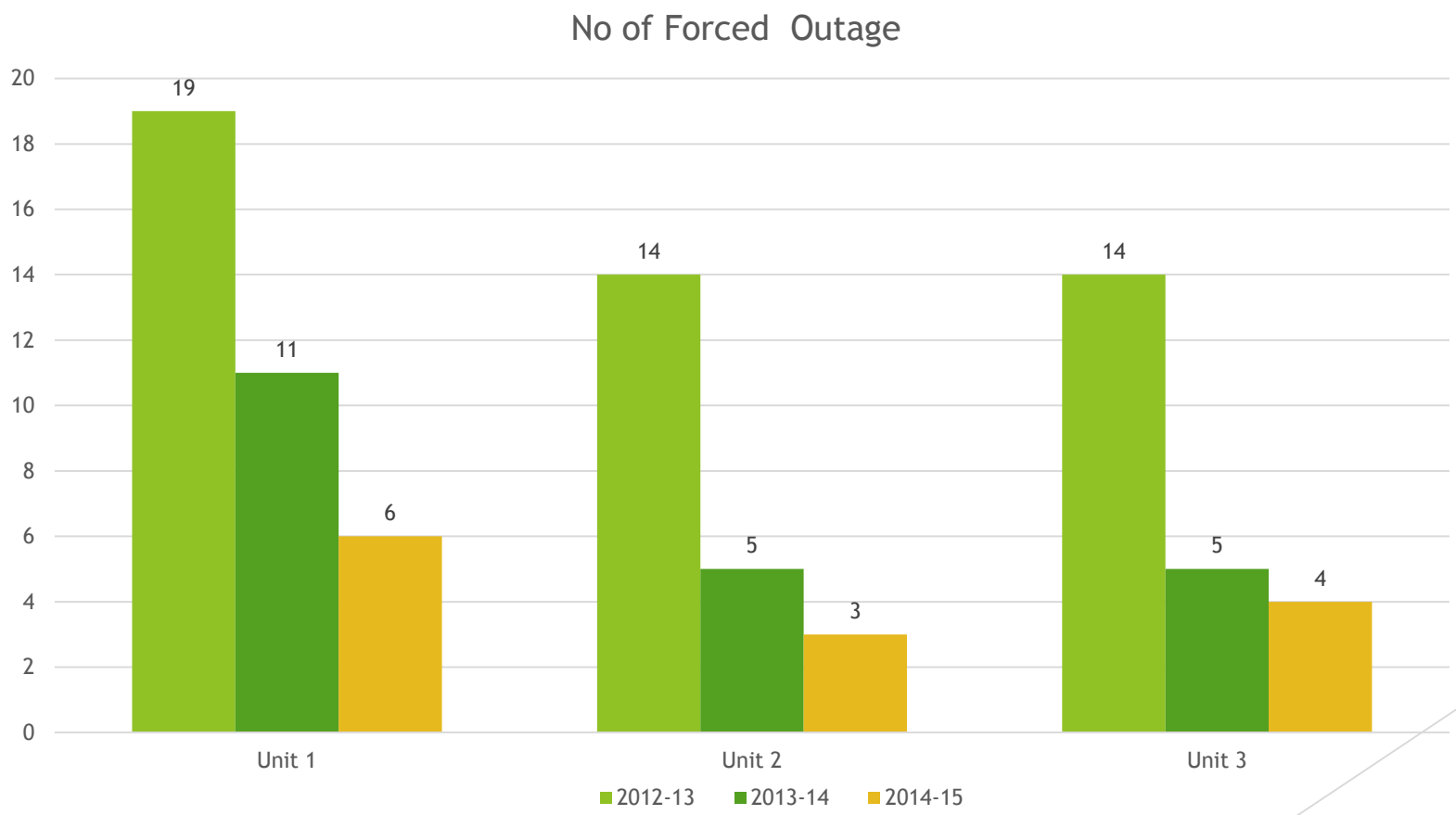
SHEET 1 OF 1

SIPAT STAGE # 1 PERFORMANCE
FY 2014-15

DESCRIPTION	UNIT # 1	UNIT # 2	UNIT # 3	TOTAL
GENERATION (MUs)	4,975.11	4,126.62	5,237.82	14,339.55
LOADING FACTOR (%)	90.82	93.43	91.67	91.87
FORCED OUTAGE (%)	1.40	1.32	0.77	1.16
AVAILABILITY FACTOR %)	94.75	76.39	98.82	89.99

No of Forced Outage

Sipat



POINTS TO PONDER

1. In Boiler pressure parts advanced alloys such as SUPER 304H, T92, T23 etc., are widely used, which are not readily available in Indian as well as international market

   The maintenance procedure for those advanced metals are much more complicated involving stringent PWHT & complete TIG welding, compared to conventional ones. These procedures often contribute to higher maintenance down time.

   With better maintenance practice with advanced tools and by sharing of knowledge with other SC boiler users these downtime can be significantly reduced.

2. As on date procurement of spares for supercritical boilers from Indian market is difficult as very few vendors have such capability – also economy is an issue for them as no of users are few at present.

   Procurement of spares for supercritical boilers from international vendors involve high lead time.

   With the advent of more players in SC technology in manufacturing and as well as in user , the availability and cost issues of critical spares will be resolved

3. Trained expert services are not readily available in our country for servicing of specialized equipments like Electro Hydraulic Safety Valves. The experts are to be tied up with foreign vendors with a time schedule .

   In house expertise based in India is required to be developed by SC boiler manufacturer / supplier for providing expert services without any time delay at competitive rate.

Continued..

4. Trained operation manpower for operating supercritical units should be in place before initial synchronization. Operation philosophy of SC units is entirely different from that of subcritical units.

   These SC units are very sensitive to fluctuations in major parameters like feed water flow, coal flow and operating pressure.

   Effective mechanism for training and development of operation engineer through proper technical inputs like interactive sessions on operating procedures and exposure to control philosophy (ABC) is implemented in Sipat.

   A 660 MW simulator (replica of Sipat – 1) is commissioned (at PMI, Noida) before the commissioning of first unit of Sipat. On later stage another simulator center has come up inside the plant premises which not only provides training for engineers at Sipat & also caters to other NTPC plants

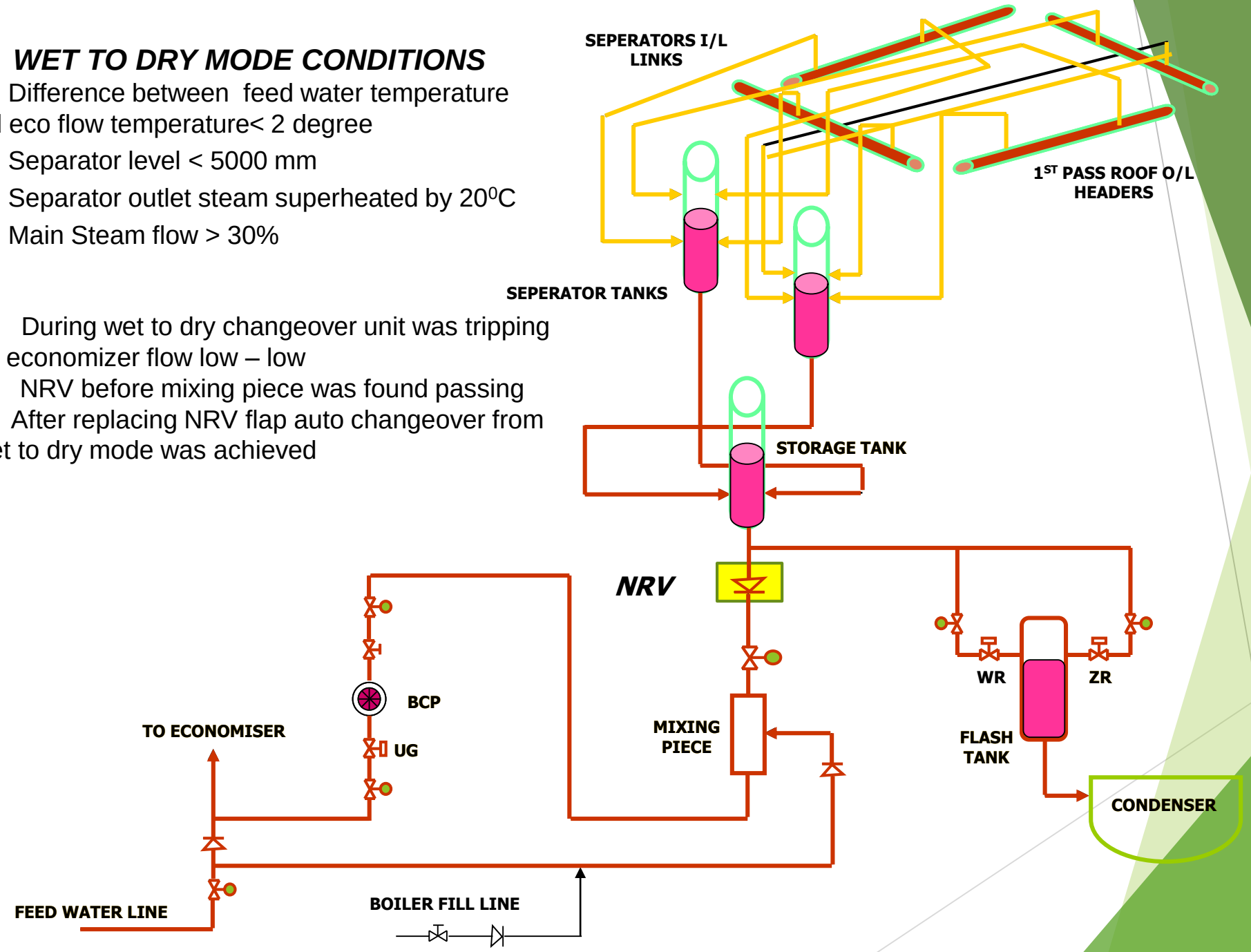
   Operation & Maintenance staff are sent for training at manufacturers facility for getting hands on experience on the operation and maintenance practices at Korean power generating stations


THANK YOU

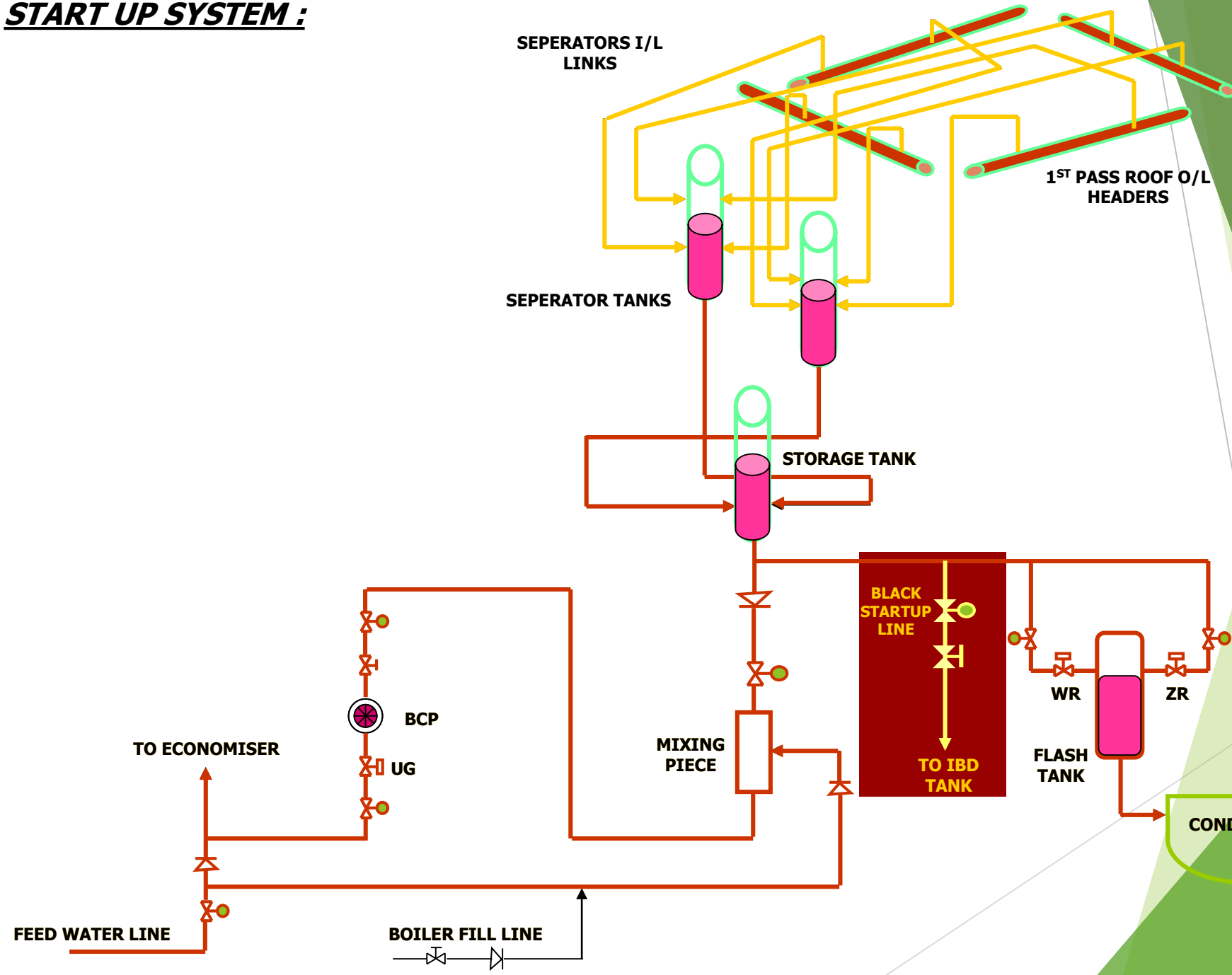
WET TO DRY MODE CONDITIONS

- ✓ Difference between feed water temperature and eco flow temperature< 2 degree
- ✓ Separator level < 5000 mm
- ✓ Separator outlet steam superheated by 20^0C
- ✓ Main Steam flow > 30%

- ✓ During wet to dry changeover unit was tripping on economizer flow low – low
- ✓ NRV before mixing piece was found passing
- ✓ After replacing NRV flap auto changeover from wet to dry mode was achieved



START UP SYSTEM :



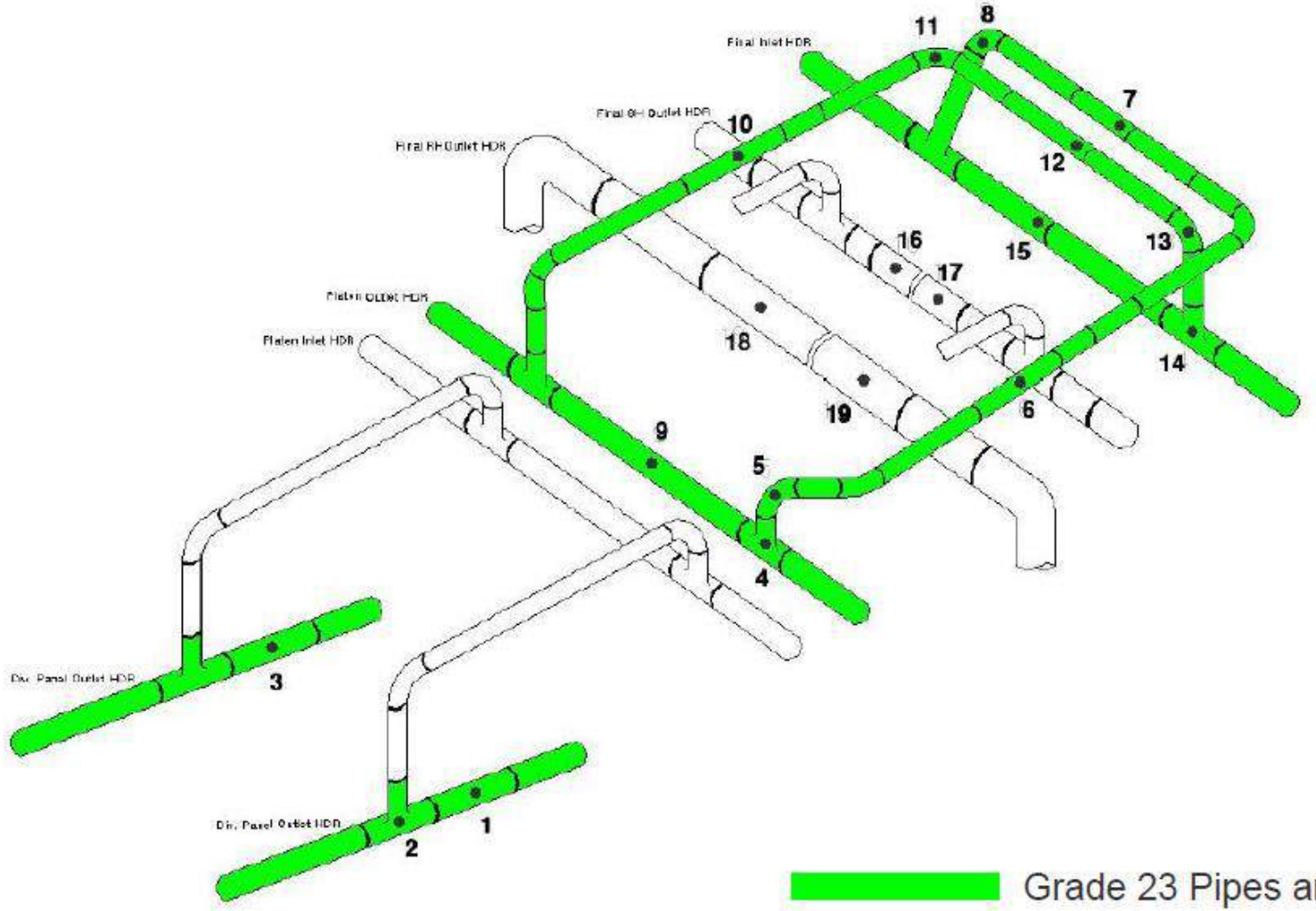
On load Floating of Spring Loaded Safety valves with Trevi Test kit

- **Main steam line safety vlvs (4 nos)**
- 1st safety vlv (2 nos) – set pr 272.9 ksc
- 2nd safety vlv (2 nos) - set pr 275.6 ksc
- Following parameters were maintained.
- Load : 500 MW
- MS pr / temp : 210 ksc / 539 deg C
- Separator pr / temp : 222 ksc / 389 deg C
- Unit is kept on load at steady MS pressure of 210 ksc
- A pressure differential of 62-65 ksc depending upon the set point of different vlvs were applied with the help of Trevi Test kit and all 4 nos of MS line vlvs were set one by one.

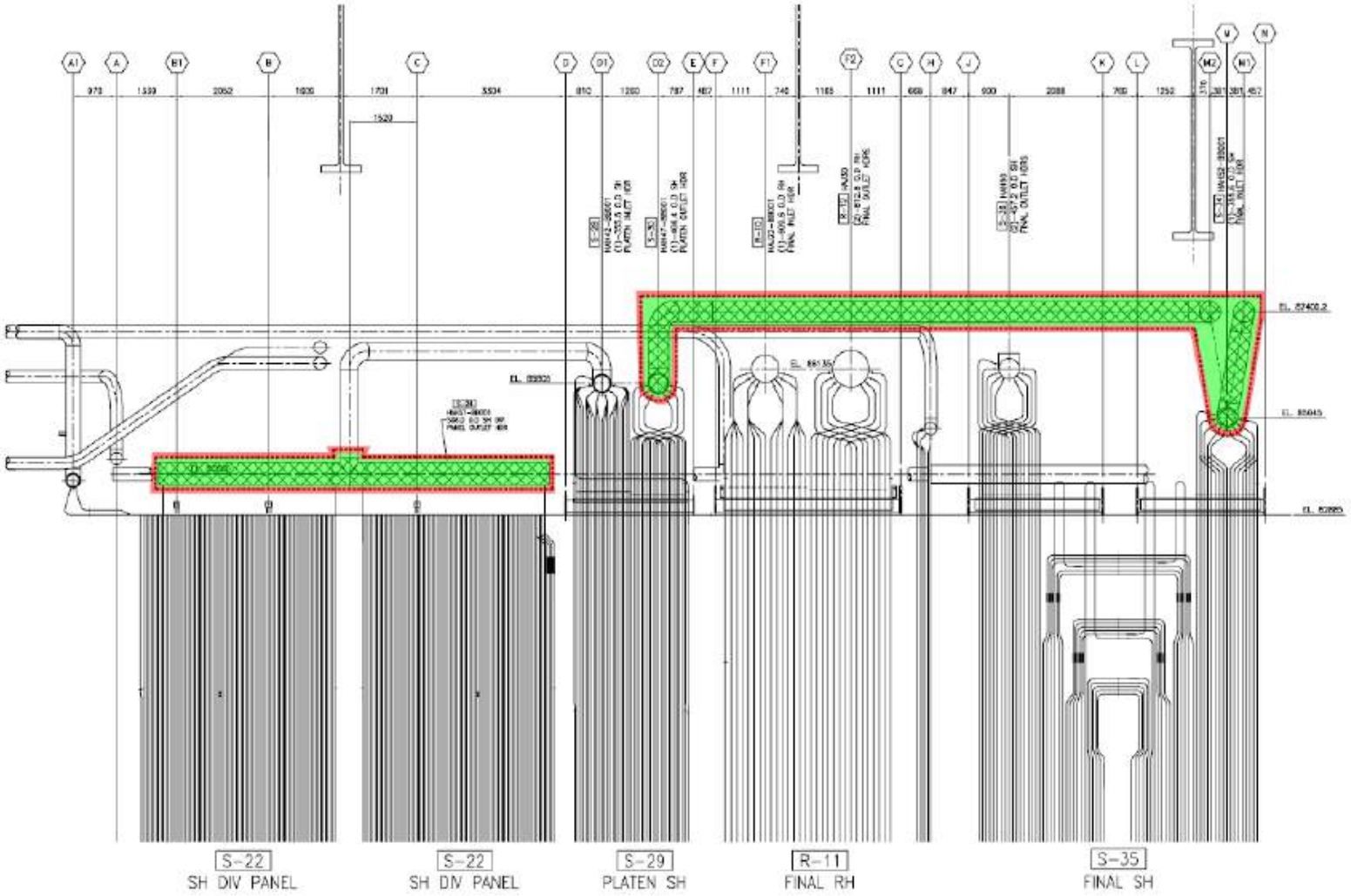
On load Floating of Spring Loaded Safety valves with Trevi Test kit

Separator vlvs (6 nos)

- 1st safety vlv (2 nos) – set pr 294.9 ksc
- 2nd safety vlv (4 nos) - set pr 302.6 ksc
- Unit load was raised to 575 MW and following parameters were maintained.
- Load : 575-580 MW
- Separator pr / temp : 256 ksc / 397 deg C
- MS pr / temp : 242 ksc / 540 deg C
- Unit was kept in Turbine follow mode with constant initial pr and a steady MS pr of 242 ksc was maintained so as to maintain sep pr at around 256 ksc.
- A pr differential of 40-48 ksc depending upon the set point of different vlvs were applied with the help of Trevi Test kit and all 6 nos of vlvs on both separators were set one by one.



Grade 23 Pipes and Fittings



Grade 23 Pipes and Fittings

After Hydraulic Test done in the month of Oct'13, it was decided to do Radiography and PMI of all the 624 affected joints (Roof & Extended Pass Floor & Side Panels) with a view to resolve the issue permanently.

Pressure Part Area	Method of Testing	Date of Testing	Total No. of Failures
EXT. BP	Radiography	Oct'13- Nov'13	40
Furnace Roof	Radiography	Oct'13- Nov'13	127
EXT. BP	PMI	27.10.2013	100
Total			267

T23 Joints failure details

SN	Ckt.	Total Jts.	Spool Provided avoiding repeatition	Joints After Spool Replacement	Spool Replacement Detail			
					After SB	After Synch	After Full Load	Total
1	S03-S04	204	121	325	67	16	103	186
2	S04-S05	204	128	332	62	16	102	180
3	S07-S08	108	101	209	85	13	50	148
4	S08- S08TO	108	104	212	95	14	50	158
	TOTAL	**624**	**454**	**1078**	**57**	**59**	**305**	**682**