

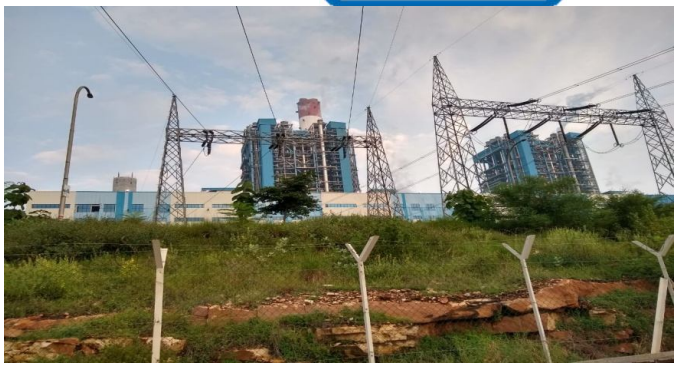

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Cost Optimization by In-House Development in Measurement and Calibration Techniques


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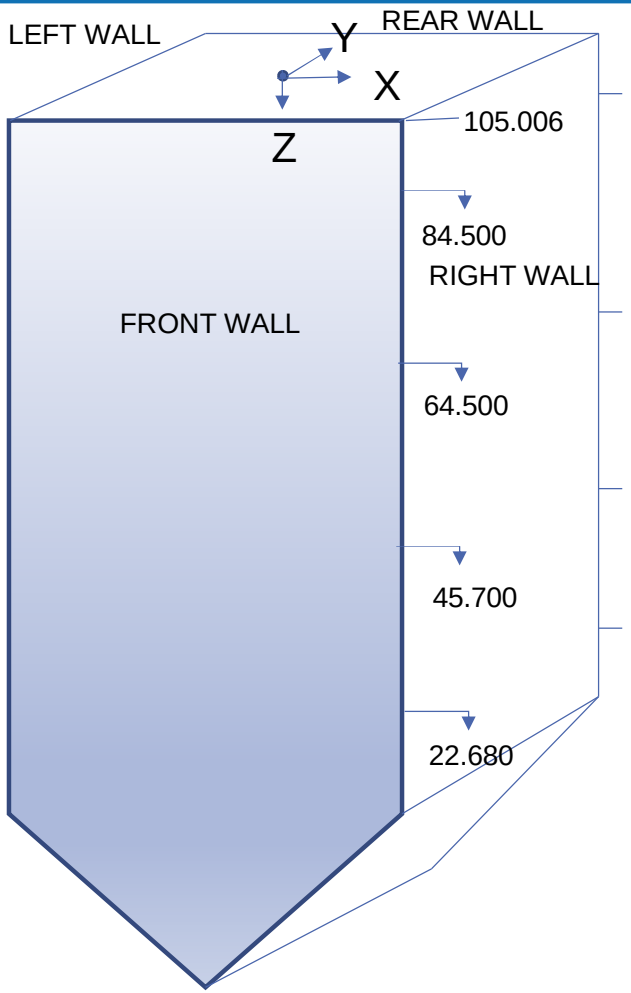
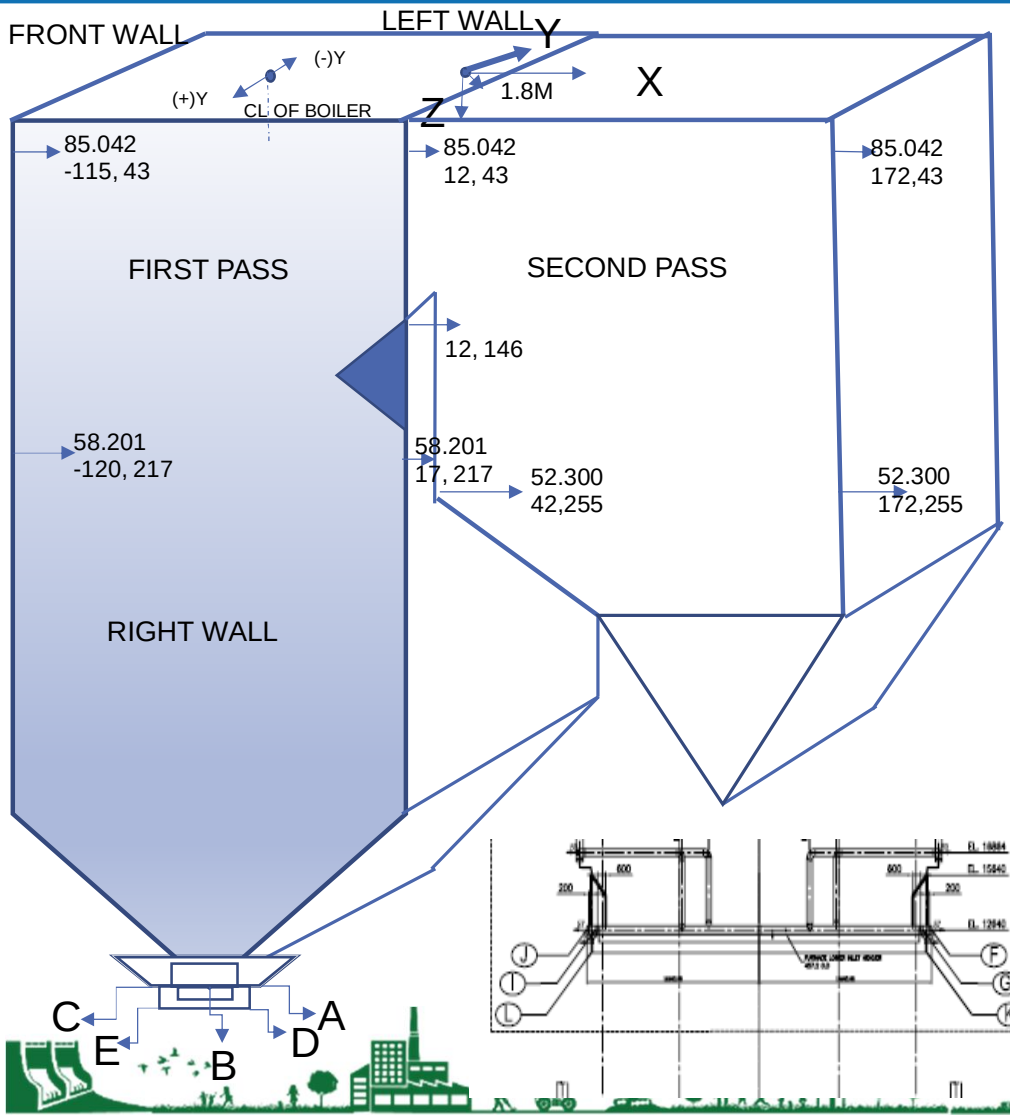
THERMAL EXPANSION IN TOWER TYPE BOILER



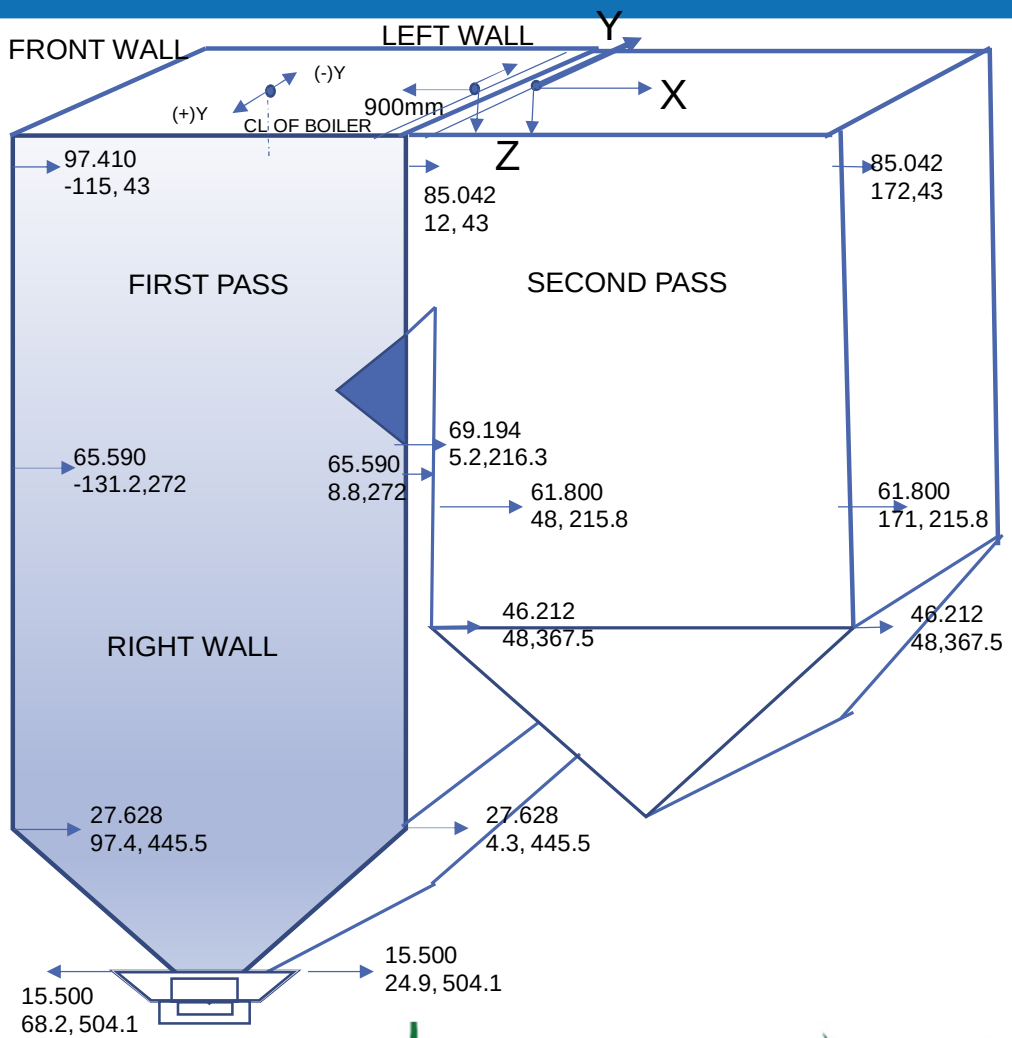
ELEVATION (… TO …) m	DIFF. IN ALT. (m)	EXP IN X-DIR. (mm)	EXP IN Y-DIR. (mm)	EXP IN mm/m IN X,Y DIR	EXP IN Z-DIR (mm)	EXP IN Z-DIR mm/m IN Z- DIR
105.006 -100.390	5.660	/	/		3	0.7
100.390 - 87.100	12.300	56	56	5.66	69	4.97
87.100 - 73.900	13.200	60	60	6.10	146	5.83
73.900 – 58.000	15.900	57	57	5.72	237	5.72
58.000 – 43.813	14.187	57	57	5.72	317	5.64
43.813 – 21.500	22.313	54	54	5.48	429	5.01
21.500 – 9.730	11.770	45	45	4.57	488	5.01

THERMAL EXPANSION IN DOOSAN BOILER



ELEVATION (… TO …) m	LOCATION	EXP IN X-DIR. (mm)	EXP IN Y-DIR (mm)	EXP IN Z-DIR (mm)
12640	A	-24		490
12640	B	-40		490
12640	C	-57		490
12640	D	-30		497
12640	E	-50		497
12640	F		57	
12640	G		54	
12640	I		-54	
12640	J		-57	
12640	K		55	
12640	L		-55	

THERMAL EXPANSION IN GE/ALSTOM/BHEL BOILER

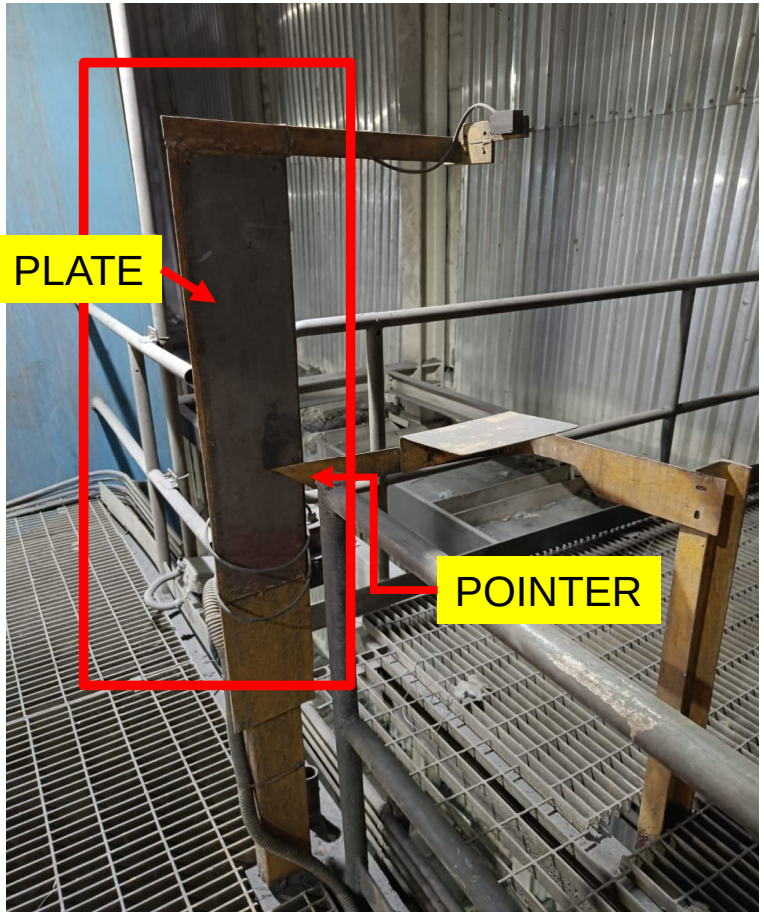


	FIRST PASS		
LOCATION	ESP –X DIR	EXP –Y DIR	EXP Z DIR
105.510	-	-	-
97.410	136.8	73.5	42.9
69.194	115.8	73.5	216.3
65.590	131.2	65.7	272.0
47.58	112.8	73.5	336.8
27.628	97.4	73.5	445.5
15.500	68.2	58.1	504.1

	SECOND PASS		
LOCATION	ESP –X DIR	EXP –Y DIR	EXP Z DIR
61.8	171	74.6	215.8
46.2	171	74.6	367.5

Challenges in Boiler Expansion

- Boiler Expansion :- installed for the measurement of boiler casing and steel movement.
- Boiler Expansion:- local Gauge on a stand which holds the scale on main Building/ Platform and pointer fitted to the steelwork/Waterwall/Header, as appropriate.
- As per NTPC -LMI, Frequency of reading is from startup to full Load after each modification and long shutdown of boiler.
- Lack of attention to Boiler Expansion in the pre-commissioning period can lead to prolonged outages later.



Challenges in Boiler Expansion- Reading

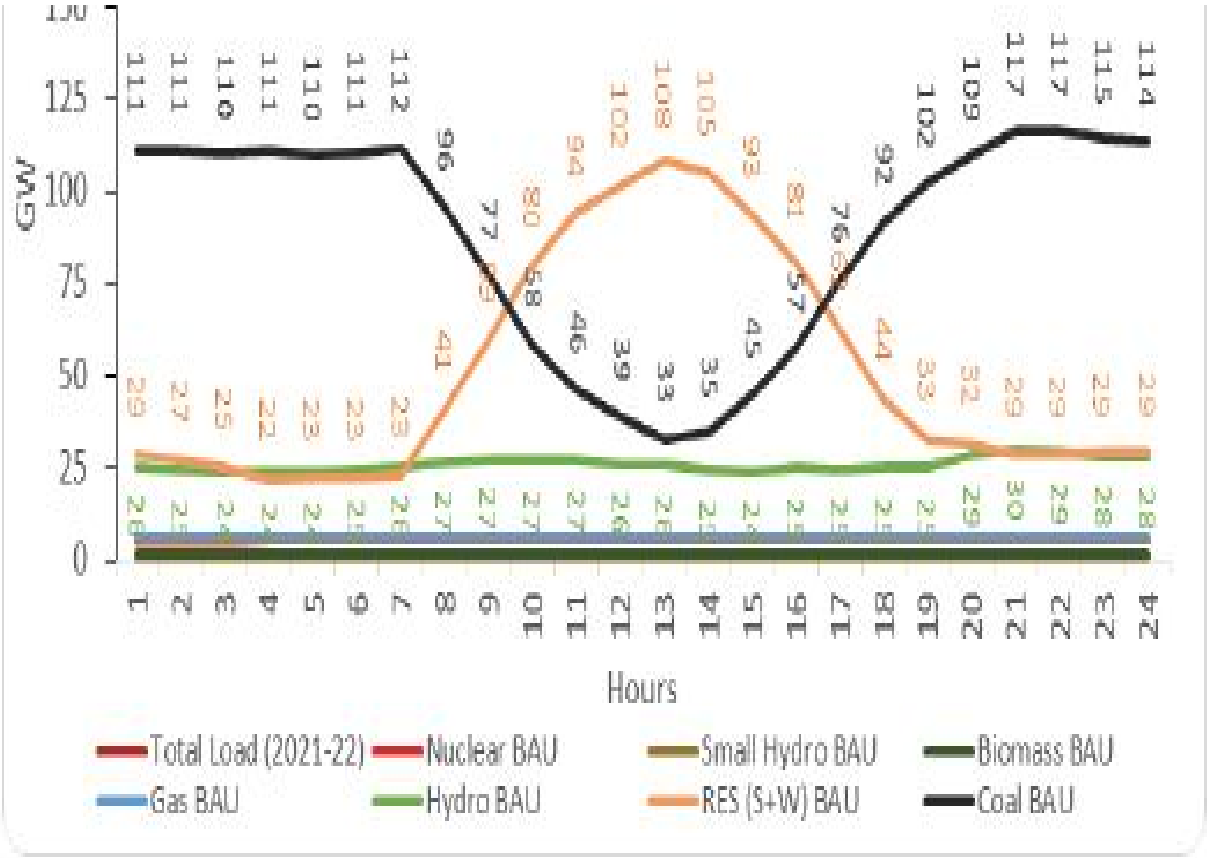
It is unlikely that any indicator will read the true theoretical expansion movement, due to a number of factors such as:

- The Scatter band in theoretical expansion coefficient data (Refer Table)
- Operator error e.g. reading out of parallax.
- Relative casing to tube movements.
- Time lag of heat flow.
- “Shake down’ (jerky movement) of boiler during firing.
- Expansion of Main Building Steelwork.

THERMAL EXPANSION DATA FOR CARBON STEEL AND ALLOY STEEL CONTAINING UP TO 3% CHROMIUM

Temperature (Degree C)	Avg Thermal Expansion Coeff.t ($X10^{-6}$ per ^{o}C)	Tolerance %
20-100	12.07	±5.6
200	12.05	±4.0
300	13.10	±3.1
400	13.55	±3.3
500	14.00	±3.6

NEED OF ONLINE MEASUREMENT

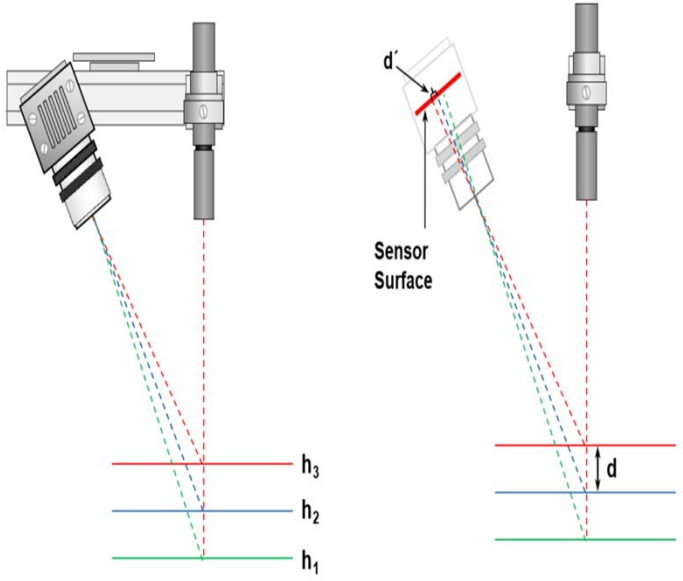


- **Increased rate of wear on high-temperature components.**
- **Thermal fatigue, Thermal expansion, Corrosion & its Related Issues, Fireside Corrosion and many others.**
- Decreased thermal efficiency at low load (high turndown).
- Increased fuel costs due to more frequent unit starts.

- **Generation from one 660MW Unit: 14.85 Billion Units** (Considering 6.25% APC)
- Revenue Loss Per day: **3.09 Crore**

MEASUREMENT TECHNIQUES

ELEVATION	CORNER-1	CORNER-2	CORNER-3	CORNER-4
84.5	2	2	2	2
64.5	2	2	2	2
45.7	2	2	2	2
22.68	2	2	2	2



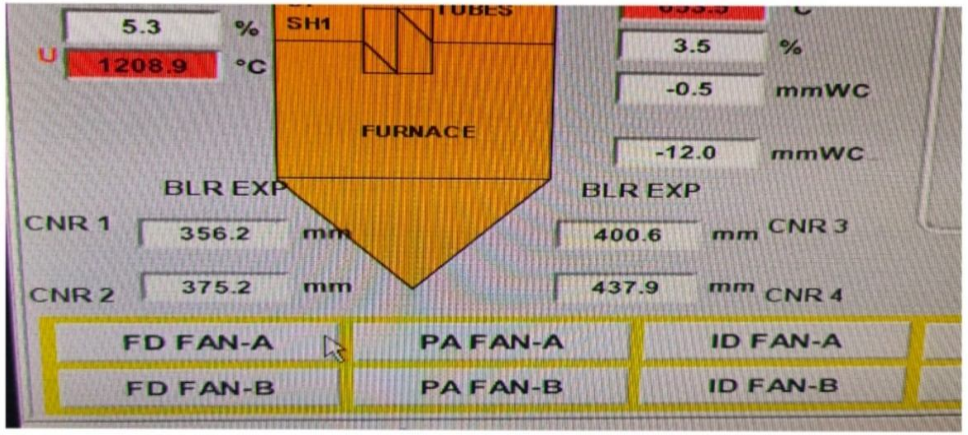
- optoNCDT1420-Smart Laser Triangulation Displacement Sensor" is the best available sensor for this application. This sensor had a repeatability of 0.5micrometer (as high accuracy sensor required for Boiler Expansion)

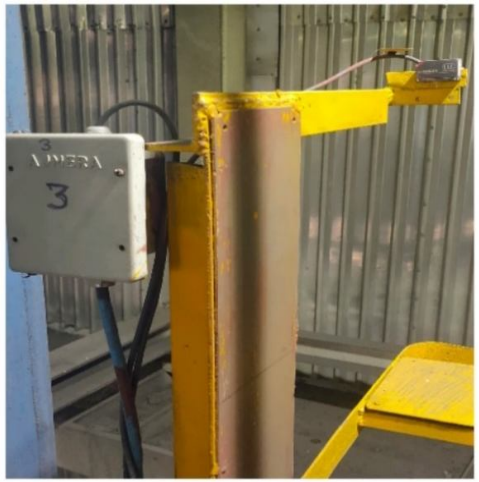
Total Number of Sensor: 32 Nos

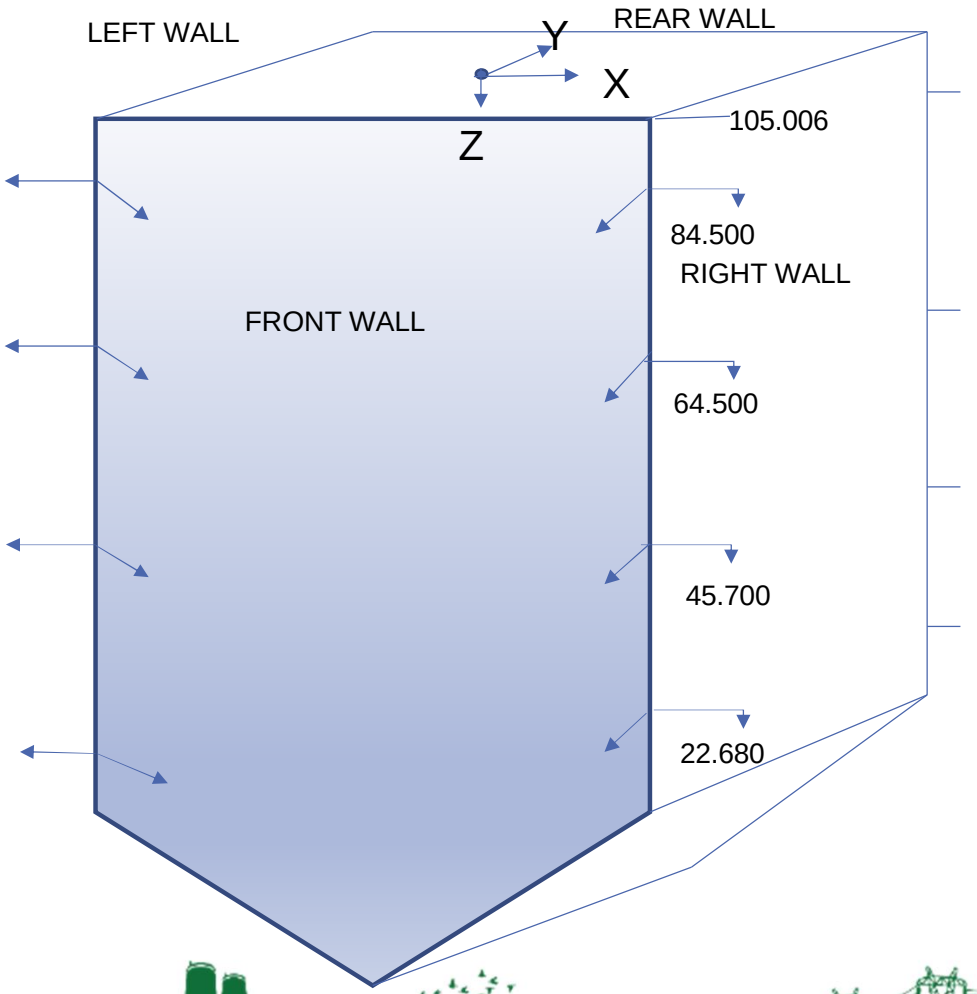
Cost of Sensor: 157,246.00

Total Cost: 50,31,872.00 Rs.

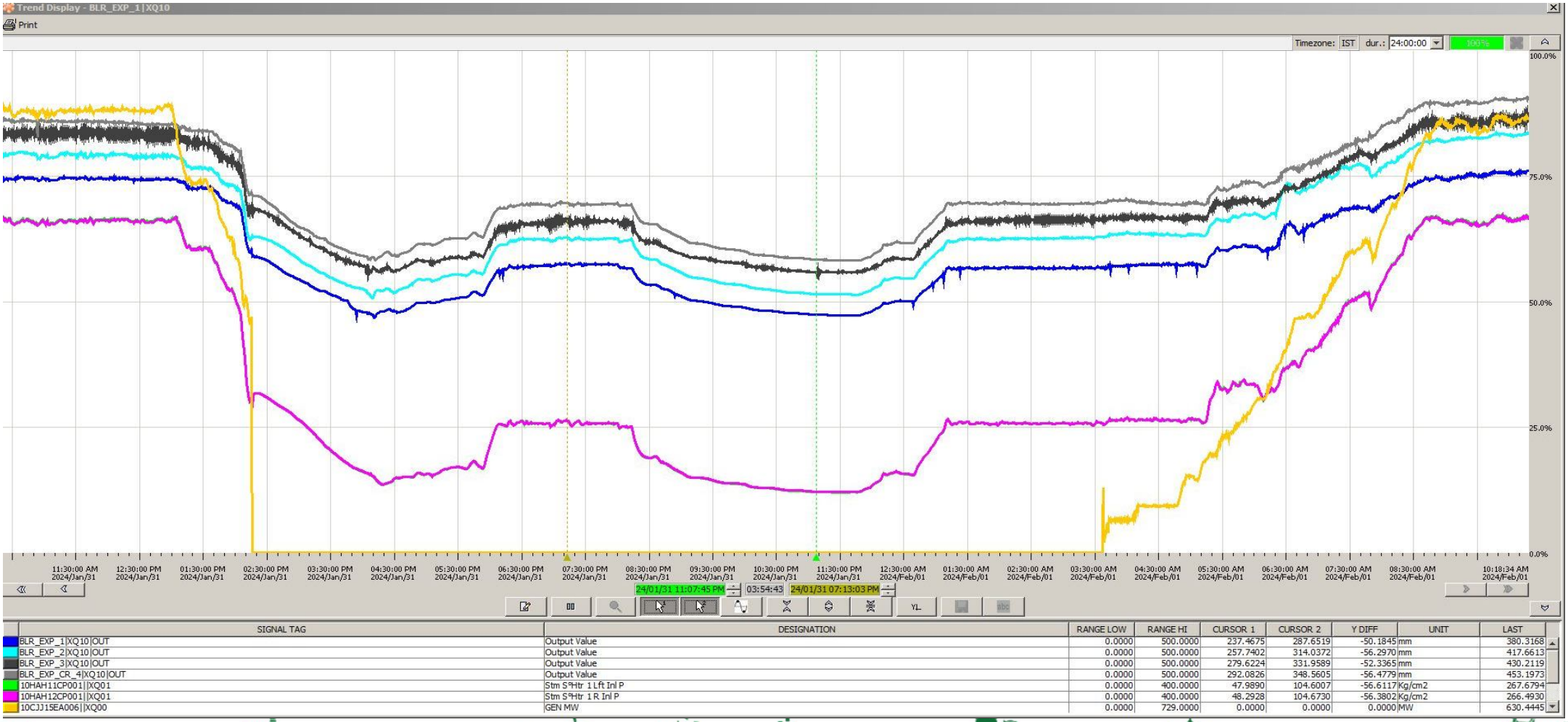
MEASUREMENT TECHNIQUES





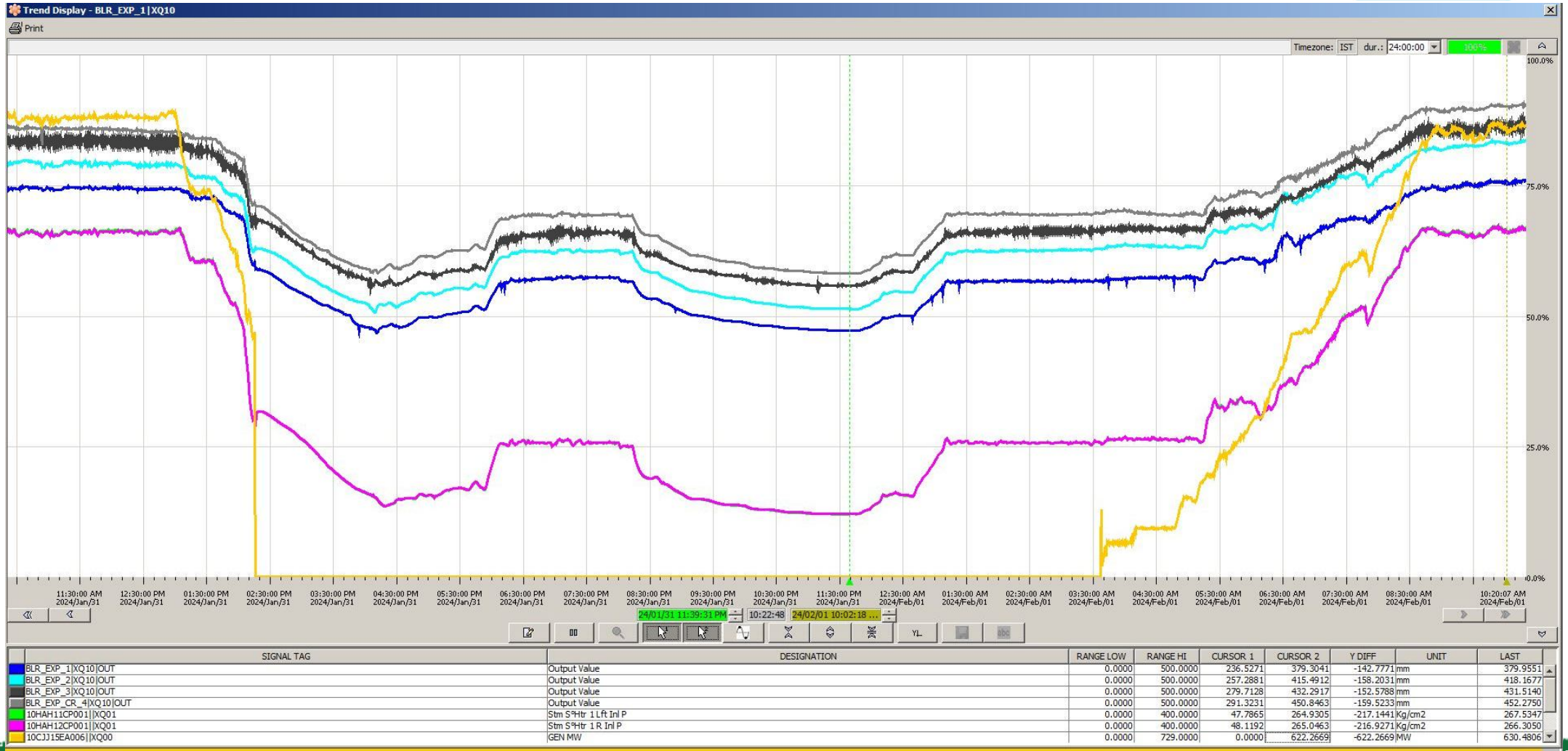


TREND OF BOILER EXPANSION WITH LOAD



SIGNAL TAG	DESIGNATION	RANGE LOW	RANGE HI	CURSOR 1	CURSOR 2	Y DIFF	UNIT	LAST
BLR_EXP_1|XQ10|OUT	Output Value	0.0000	500.0000	237.4675	287.6519	-50.1845	mm	380.3168
BLR_EXP_2|XQ10|OUT	Output Value	0.0000	500.0000	257.7402	314.0372	-56.2970	mm	417.6613
BLR_EXP_3|XQ10|OUT	Output Value	0.0000	500.0000	279.6224	331.9589	-52.3365	mm	430.2119
BLR_EXP_CR_4|XQ10|OUT	Output Value	0.0000	500.0000	292.0826	348.5605	-56.4779	mm	453.1973
10HAH11CP001||XQ01	Stm S°Htr 1 Lft Inl P	0.0000	400.0000	47.9890	104.6007	-56.6117	Kg/cm2	267.6794
10HAH12CP001||XQ01	Stm S°Htr 1 R Inl P	0.0000	400.0000	48.2928	104.6730	-56.3802	Kg/cm2	266.4930
10CJJ15EA006|XQ00	GEN MW	0.0000	729.0000	0.0000	0.0000	0.0000	MW	630.4445

TREND OF BOILER EXPANSION WITH LOAD



SIGNAL TAG	DESIGNATION	RANGE LOW	RANGE HI	CURSOR 1	CURSOR 2	Y DIFF	UNIT	LAST
BLR_EXP_1|XQ10|OUT	Output Value	0.0000	500.0000	236.5271	379.3041	-142.7771	mm	379.9551
BLR_EXP_2|XQ10|OUT	Output Value	0.0000	500.0000	257.2881	415.4912	-158.2031	mm	418.1677
BLR_EXP_3|XQ10|OUT	Output Value	0.0000	500.0000	279.7128	432.2917	-152.5788	mm	431.5140
BLR_EXP_CR_4|XQ10|OUT	Output Value	0.0000	500.0000	291.3231	450.8463	-159.5233	mm	452.2750
10HAH11CP001||XQ01	Stm S°Htr 1 Lft Inl P	0.0000	400.0000	47.7865	264.9305	-217.1441	Kg/cm2	267.5347
10HAH12CP001||XQ01	Stm S°Htr 1 R Inl P	0.0000	400.0000	48.1192	265.0463	-216.9271	Kg/cm2	266.3050
10CJJ15EA006||XQ00	GEN MW	0.0000	729.0000	0.0000	622.2669	-622.2669	MW	630.4806

BOILER EXPANION MODEL

SEP O/L PRESSURE

MTM TEMPERATURE

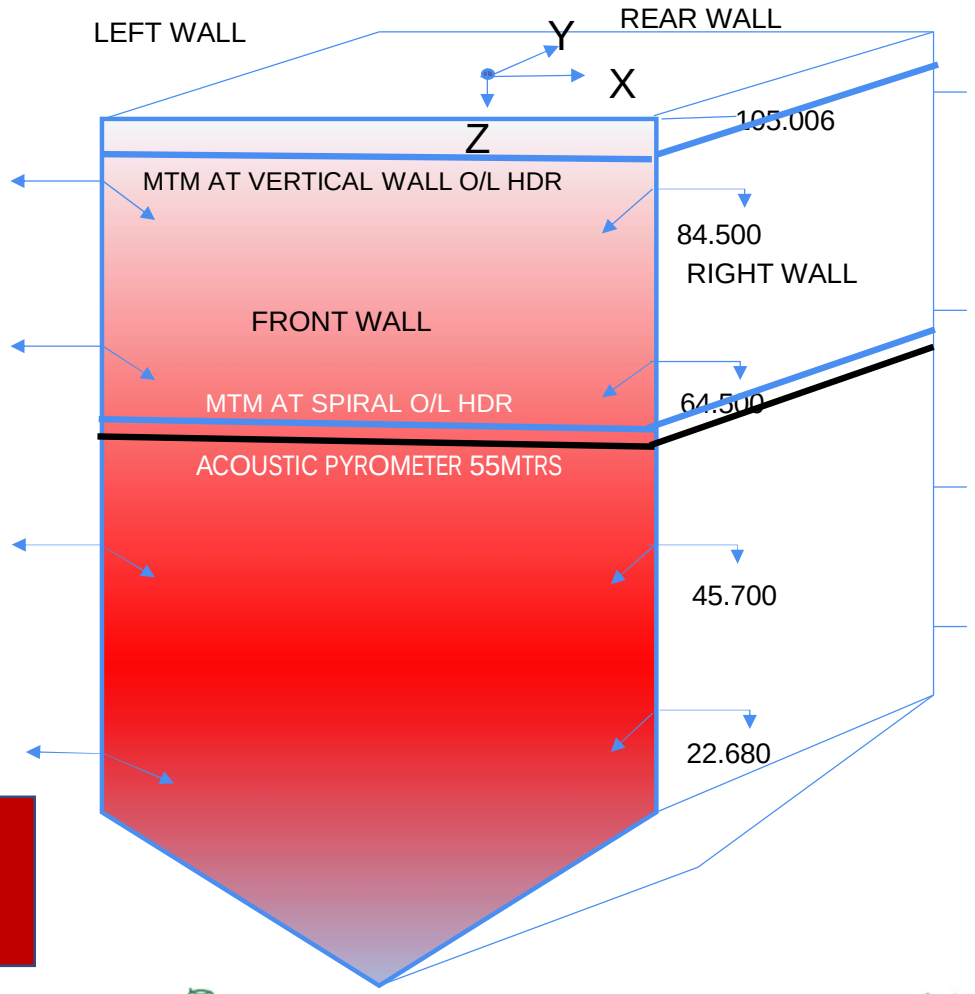
ACOUSTIC PYROMETER TEMP TEMPERATURE

PREDICTED EXPANSION AS PER OEM

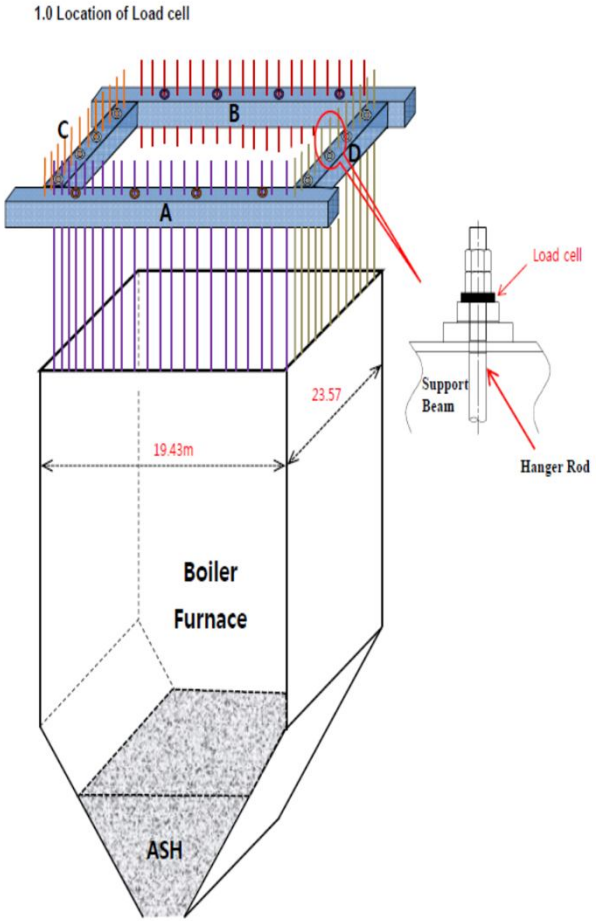
BOILER EXPANSION READING AT EACH ELEVATION

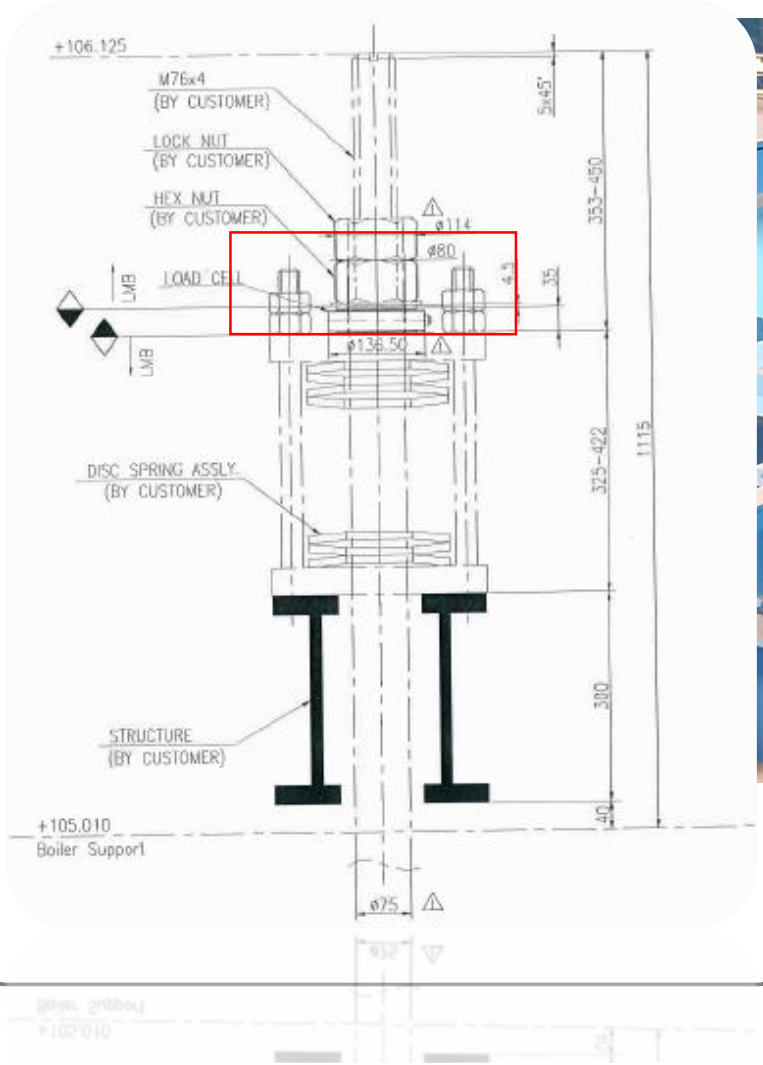
LOGIC /MODEL

ALARM ON DEVIATION BEYOND LIMIT



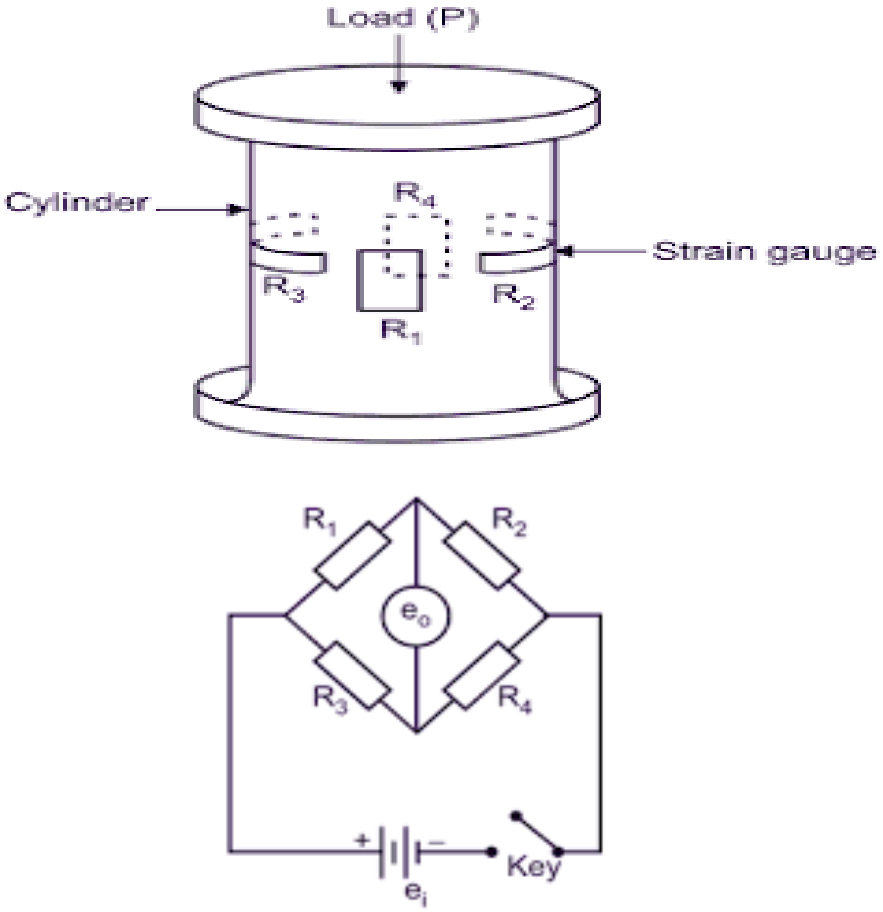
BOILER LOAD CELL- INSTALLATION





Load Cell -Principle

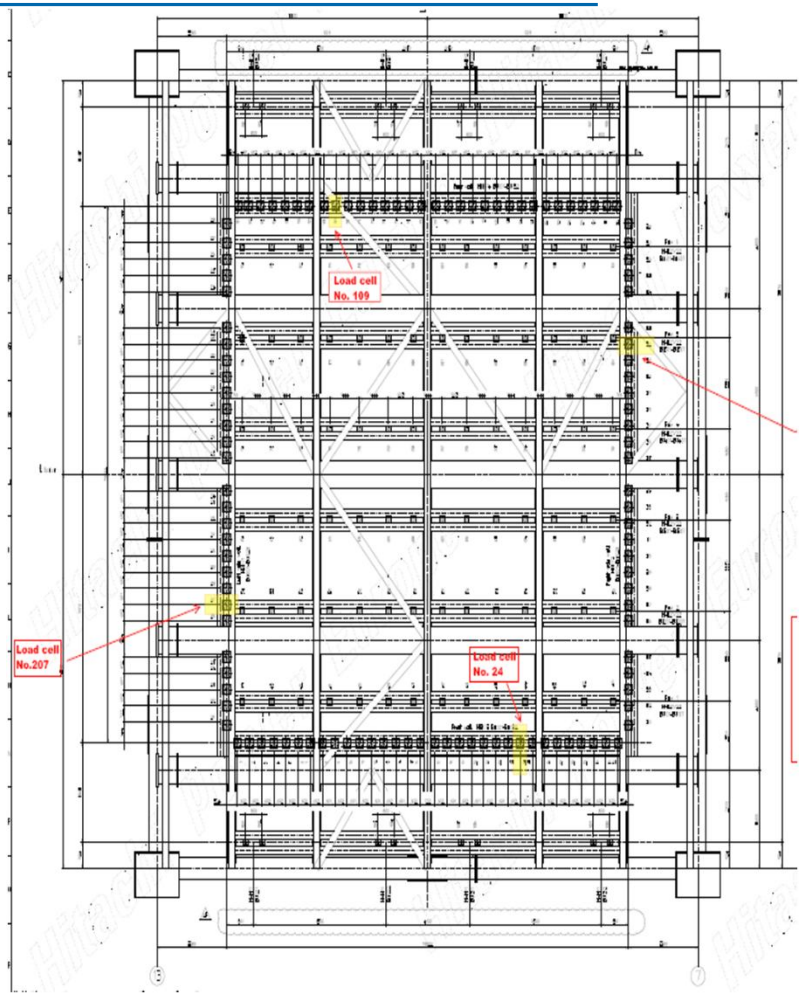
- A load cell is a transducer that measures force, and outputs this force as an electrical signal.
- Strain gauge load cells usually feature four strain gauges in a Wheatstone bridge configuration, which is an electrical circuit that balances two legs of a bridge circuit. The force being measured deforms the strain gauge in this type of load cell, and the deformation is measured as change in electrical signal.



Boiler Ash Load Cell

- Boiler Load cells are provided for monitoring the ash accumulation in furnace hopper.
- Load cells are installed on each wall of the boiler at the specified load points
- The load cell signals are wired to the SG-DDCMIS to alert the operator in case of any ash accumulation in furnace beyond the permissible limit.
- There are two alarm set points configured for each load cell in case of High and High High levels of Ash accumulation through alarms

Location	KKS Code
Front Wall No. 24	10HBK73CW024
Rear Wall No. 109	10HBK74CW009
Left Wall No. 207	10HBK71CW007
Right Wall No. 322	10HBK72CW022



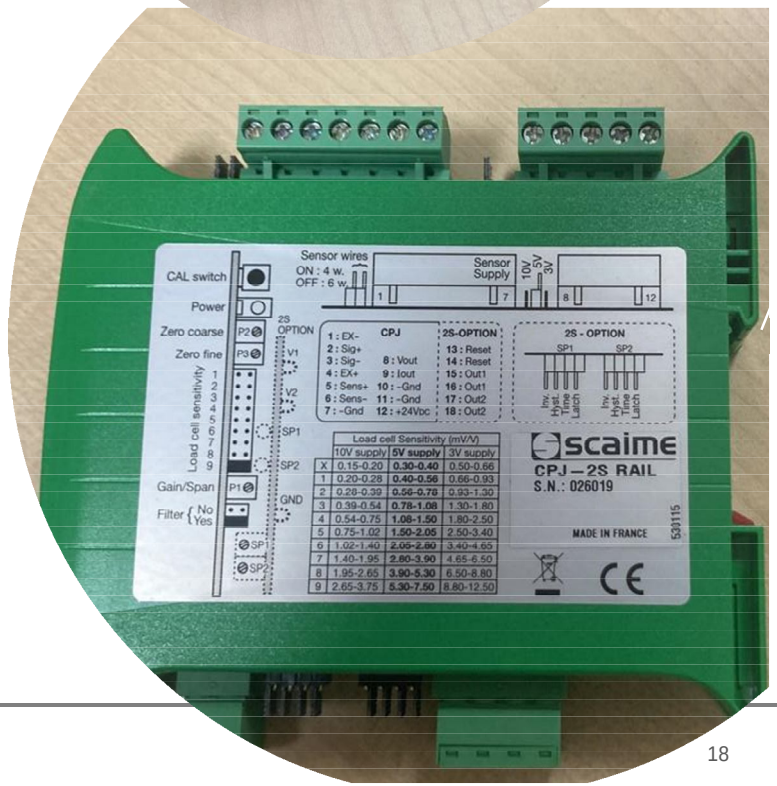
NTPC Installation

PLANT	NO. OF LOAD CELLS	MAKE OF BOILER
Darlipalli & Gadarwara (800MW)	12 Front & 14 Rear (26 Nos)	BHEL/GE/ALSTOM
Solapur & Meja (660MW)	1 in Each wall (4 Nos)	HITACHI (HPE)
Tanda & Khargone (660MW)	6 each in Front & Rear and 2 each in left & Right (16 Nos)	MHI-JAPAN / L&T
Kudgi & Lara (800MW)	4 on each wall (16 Nos)	Doosan
Mouda-II, Barh-II (660MW)	11 Front & 13 Rear (24 Nos)	BHEL/GE/ALSTOM

Total =446 Load Cell (260000*446= 11,59,60,000 /-)

Challenges in Commissioning

- Load cell cannot be taken out in Boiler Running condition.
- Healthiness of the Load cell cannot be checked, it can only be taken out during long shut down only.
- No procedure was provided by OEM/OES how to calibrate the load cell and transmitter.
- The values at different condition for all the four boiler load cells were not coming in DCS.
- There was no information regarding range of Load cell output and corresponding mA output range of transmitter.

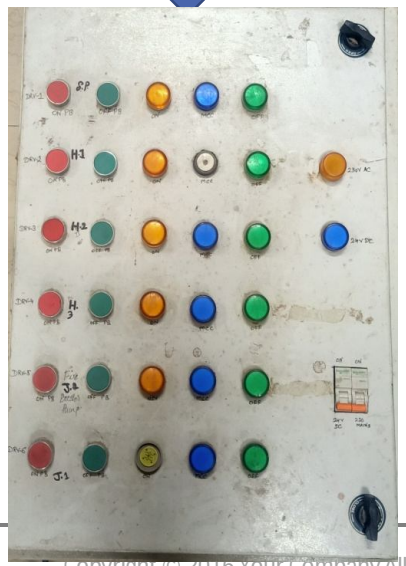


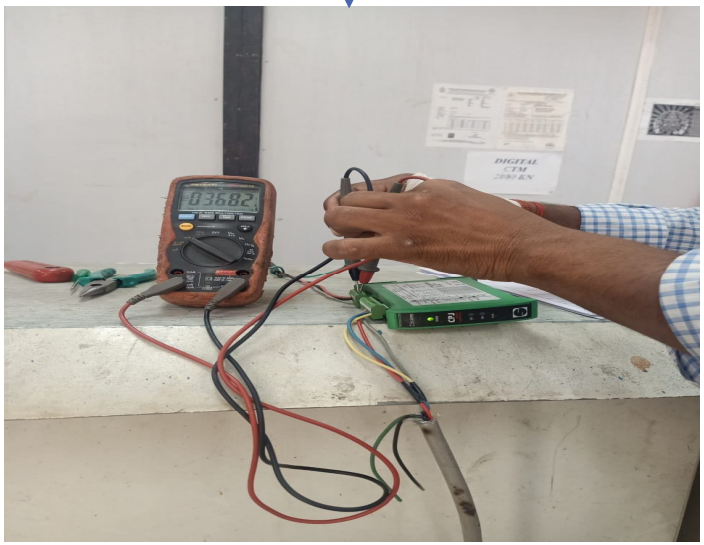
Analysis & Resolution

- From the Model of Load Cell and Load Cell the Range of Load Cell is 100T or 1000KN approx.
- Transmitter to has be calibrated in the range of 0-1000KN +/-10%
- For testing of Load Cell, compression has to be applied on the Load Cell so, CTM machine was selected for compression
- 24VDC supply was generated from 230VAC through, 230VAC to 24VD convertor.

Calibration Setup

24 VDC Power Supply





Outcome- Values & Trends-UNIT2

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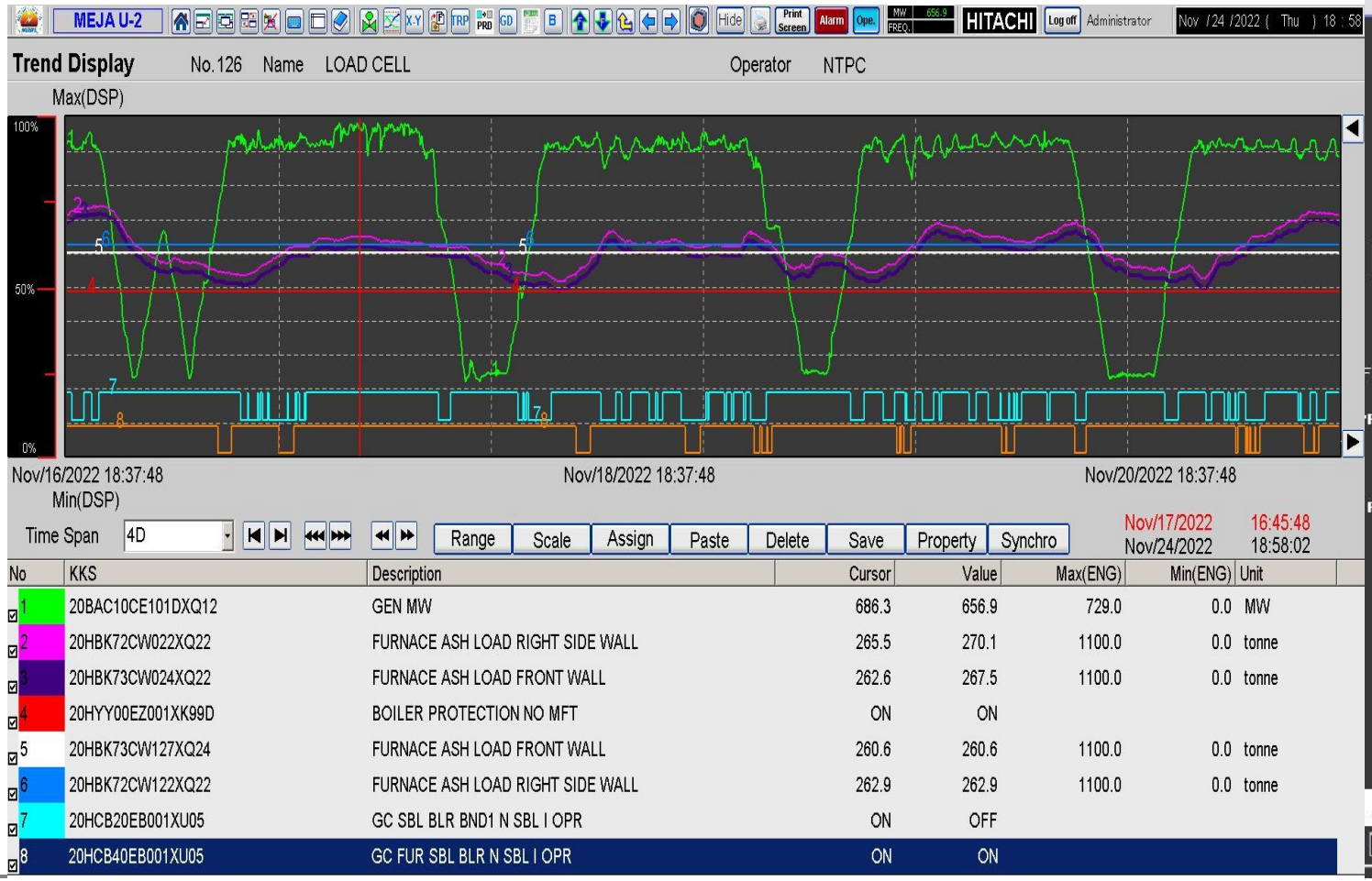
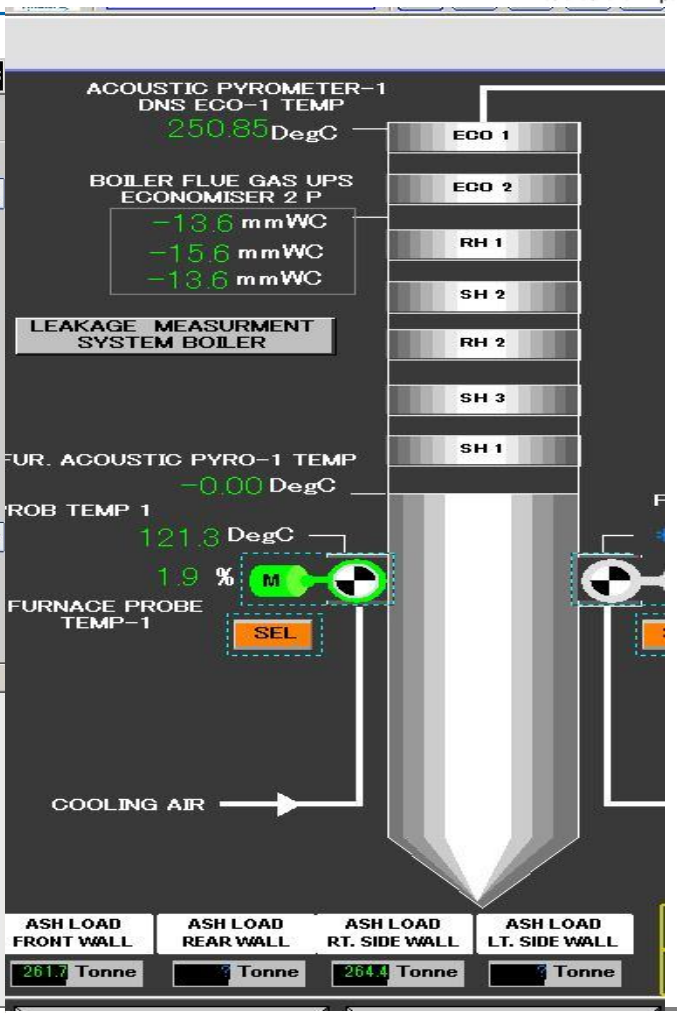
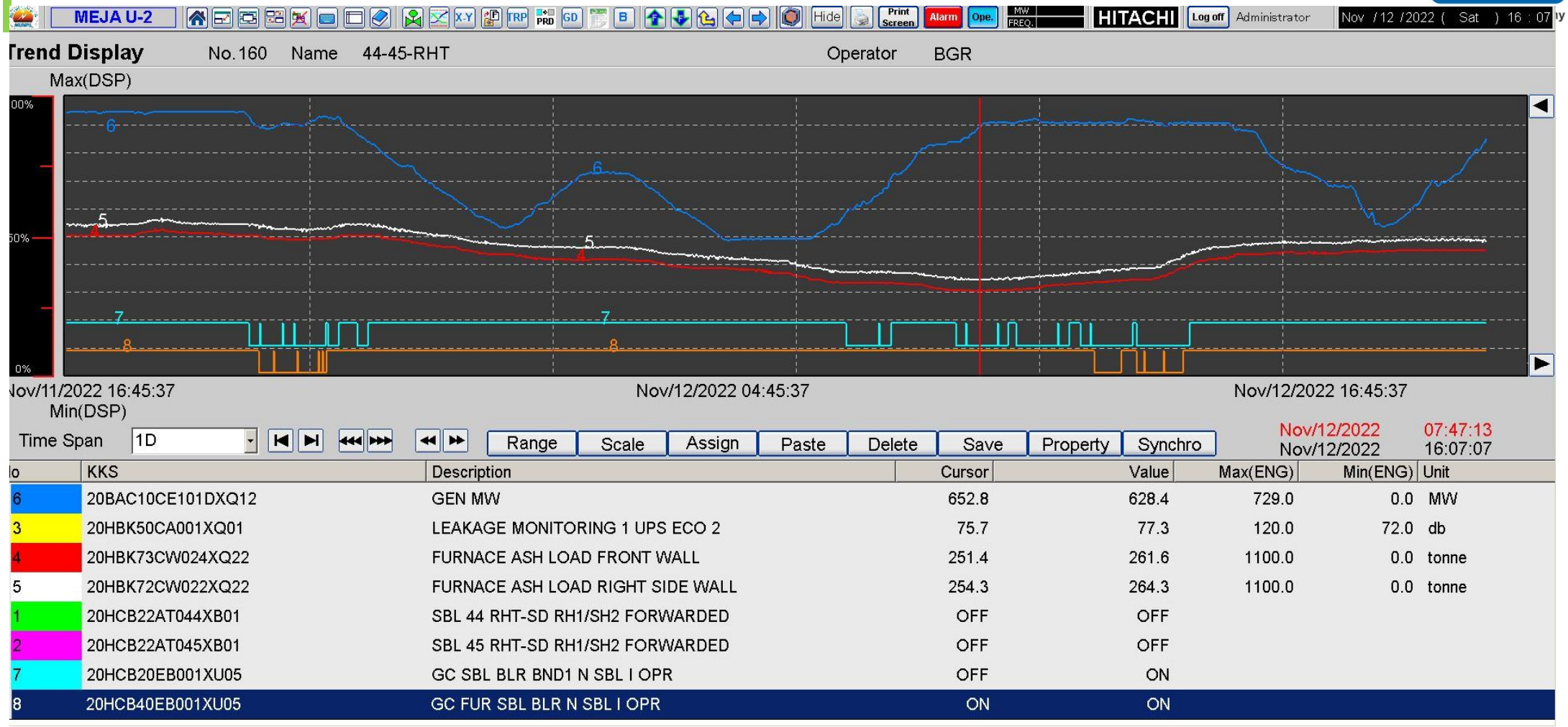


No	KKS	Description	Cursor	Value	Max(ENG)	Min(ENG)	Unit
1	20BAC10CE101DXQ12	GEN MW	686.3	656.9	729.0	0.0	MW
2	20HBK72CW022XQ22	FURNACE ASH LOAD RIGHT SIDE WALL	265.5	270.1	1100.0	0.0	tonne
3	20HBK73CW024XQ22	FURNACE ASH LOAD FRONT WALL	262.6	267.5	1100.0	0.0	tonne
4	20HYY00EZ001XK99D	BOILER PROTECTION NO MFT	ON	ON			
5	20HBK73CW127XQ24	FURNACE ASH LOAD FRONT WALL	260.6	260.6	1100.0	0.0	tonne
6	20HBK72CW122XQ22	FURNACE ASH LOAD RIGHT SIDE WALL	262.9	262.9	1100.0	0.0	tonne
7	20HCB20EB001XU05	GC SBL BLR BND1 N SBL I OPR	ON	OFF			
8	20HCB40EB001XU05	GC FUR SBL BLR N SBL I OPR	ON	ON			

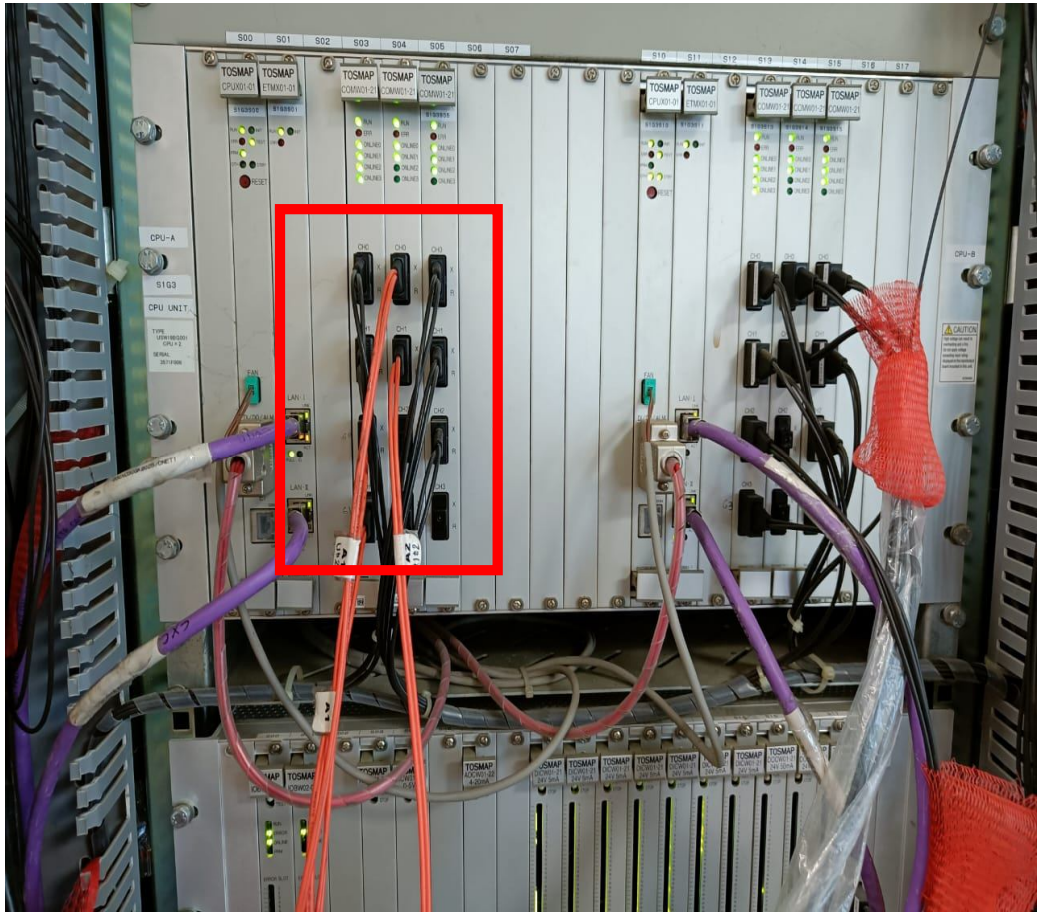


Outcome- Values & Trends-UNIT2

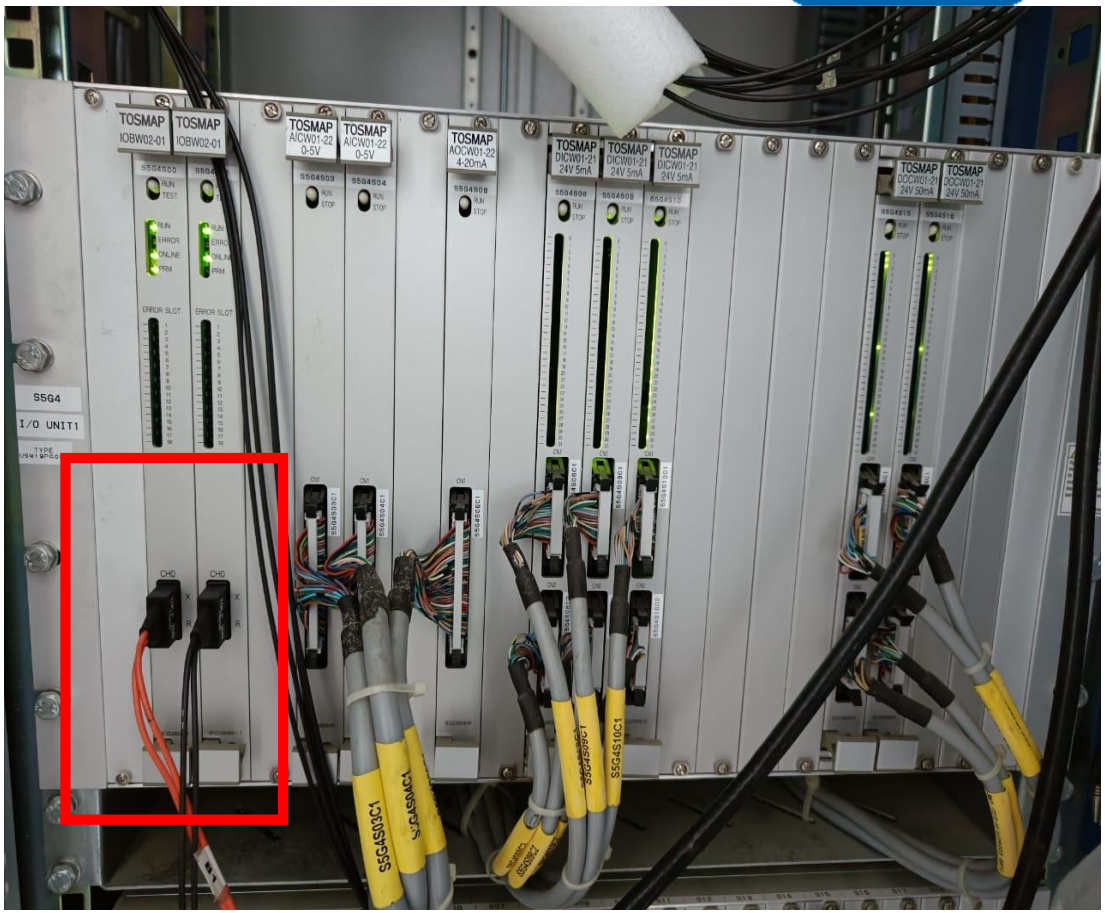


No	KKS	Description	Cursor	Value	Max(ENG)	Min(ENG)	Unit
6	20BAC10CE101DXQ12	GEN MW	652.8	628.4	729.0	0.0	MW
3	20HBK50CA001XQ01	LEAKAGE MONITORING 1 UPS ECO 2	75.7	77.3	120.0	72.0	db
4	20HBK73CW024XQ22	FURNACE ASH LOAD FRONT WALL	251.4	261.6	1100.0	0.0	tonne
5	20HBK72CW022XQ22	FURNACE ASH LOAD RIGHT SIDE WALL	254.3	264.3	1100.0	0.0	tonne
1	20HCB22AT044XB01	SBL 44 RHT-SD RH1/SH2 FORWARDED	OFF	OFF			
2	20HCB22AT045XB01	SBL 45 RHT-SD RH1/SH2 FORWARDED	OFF	OFF			
7	20HCB20EB001XU05	GC SBL BLR BND1 N SBL I OPR	OFF	ON			
8	20HCB40EB001XU05	GC FUR SBL BLR N SBL I OPR	ON	ON			

CHALLENGE FOR CONDENSATE POLISHING UNIT (CPU)



CPP CONTROLLER AT CPU CCR



CPP RIO PANEL UNIT-1/UNIT-2

CHALLENGE FOR CONDENSATE POLISHING UNIT (CPU)

Table.3.2.8-3 Specification of Optical Fiber Cable (COMW card – IOBW/MIFW card)

Make/Type		ACTRONICS Co., Ltd. / TOCP200
Core		2
Storage Temperature		-40 to 70 degrees
Operating Temperature		-20 to 70 degrees
Tension	Between Fiber and Connector	19.6N
	Optical Fiber	98N
Bending Radius		Min 40mm
Transmission Loss		Typical: 220dB/km Max: 240dB/km (Conditions: λp = 650nm, Measured by fiber length 50m)

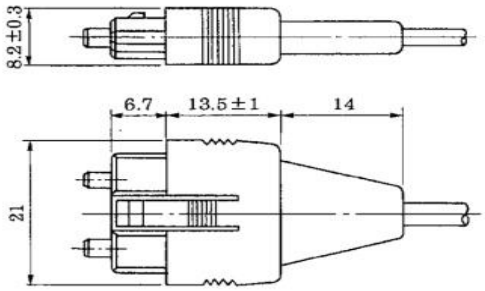


Fig. 3.2.8-2 Fiber Optic Connector

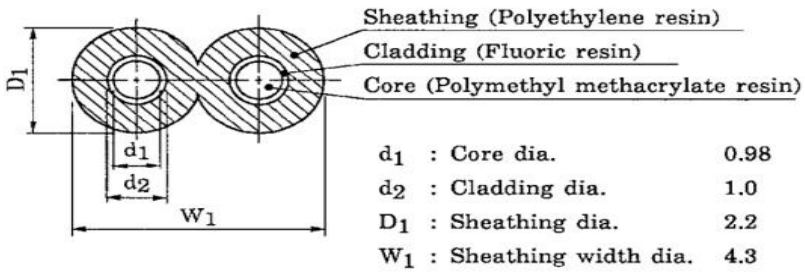
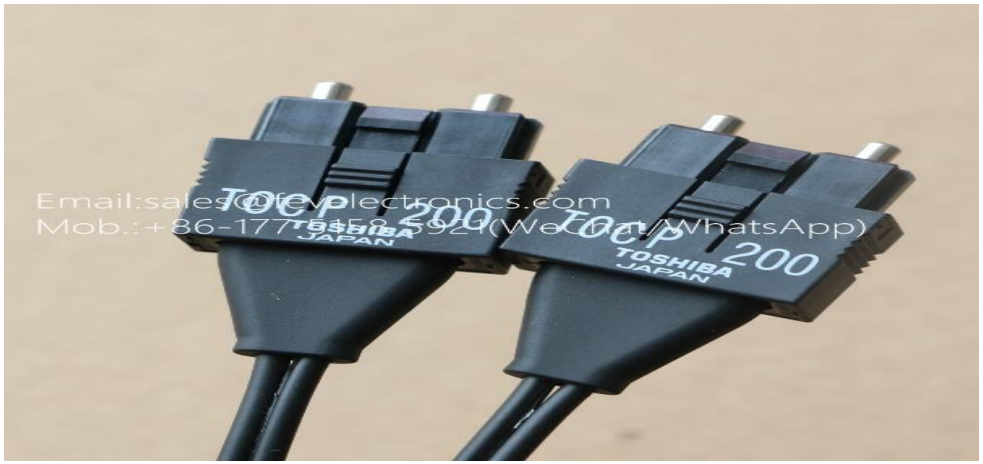


Fig. 3.2.8-3 Optical Fiber



Special Type of OFC:
Core Diameter: 200 micron
Cladding Diameter: 230micron
Total loss < (-4Log L + 7)dB :L being length in Km.

MITIGATION OF CHALLENGE FOR CPU

1. Following options were suggested for mitigation of the challenge:
   a. Upgradation of TOSMAP controllers with communication card having generic fibre Interface/ connectors (Approx. cost 23.3 million Rupees).
   b. Replacement of Toshiba supplied TOSMAP DCS based CPP system with other make DDCMIS (Approx. cost 21.3 million Rupees).
   c. Replacement of standalone CPP system with PLC system (9.1 million Rupees)
   d. Replacement of OFC 4.6 Million Rupees for One Pair of Cable.
2. Local vendor were searched for supply of similar type of OFC with TOCP-200 Connector. After successful trial order was place for two set of cable with cost of 0.59 million rupees only, which is 1.3% of OEM price quoted for replacement of cable.
3. Provision of OWS in Common Control Room & PI data:
   - Provision of OWS in the CPU was provided to enable the CCR operator to monitor the condensate parameters.

CONCLUSION

- Installation of Boiler expansion sensor enabled the operator round the clock monitoring of the Boiler expansion.
- This enabled the operator to ensure free movement of the boiler from no-load to full load condition.
- Alarm at Low and High level of Boiler Expansion can be provided.
- 3-D expansion monitoring can be done after installation of sensor at various locations.
- Load cell data give live information of ash accumulation in Bottom Ash Hopper.
- Optimization of soot blowing can be done with the Load cell data.
- Provision of CPU connectivity through Remote desktop enable operator to take immediate action for any fault in CPU/CPP.
- Use of Indigenous OFC provided cost saving and ensured trouble free operation of CPU.

Flora & Fauna at MUNPL, MEJA

Thank You

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