Conference :-
Heat Rate
Efficiency Summit 2023

Topic :
Approaches to Enhance Energy Effiency

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3RD HEAT RATE EFFICIENCY SUMMIT 2023

3rd Heat Rate Efficiency in Thermal Power Plants Approaches to Enhance Energy Efficiency

BEE Accredited & Certified Energy

Climate change : Change in the average surface temperature on Earth. The average temp. on our planet has been 15˚C, but the past few years have seen drastic variations in the same, both up and down

REASON: Overexploitation of fossil fuels by humans and deforestation

RESULT: Release of carbon dioxide & other greenhouse gases, such as methane and nitrous oxide, into the atmosphere

IMPACT

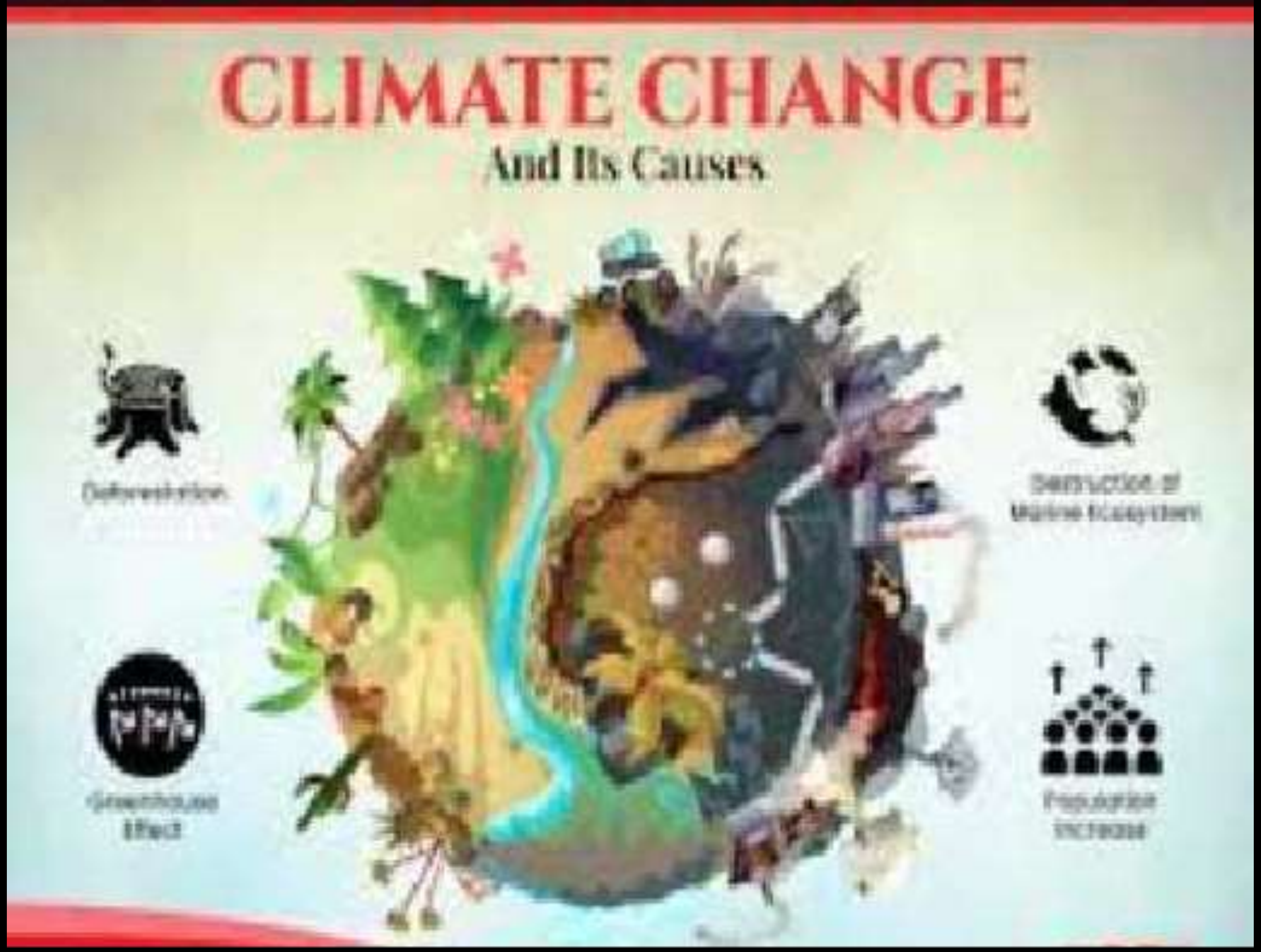
:

1.Rise in the sea level 2.Extreme weather conditions

3.Meltingpolar ice

4. Floods

5.Droughts causing wildfires



What is Heat Rate?

The heat rate is defined as the total amount of energy required to produce one kilowatt-hour (kWh) of electricity by an electric generator or power plant

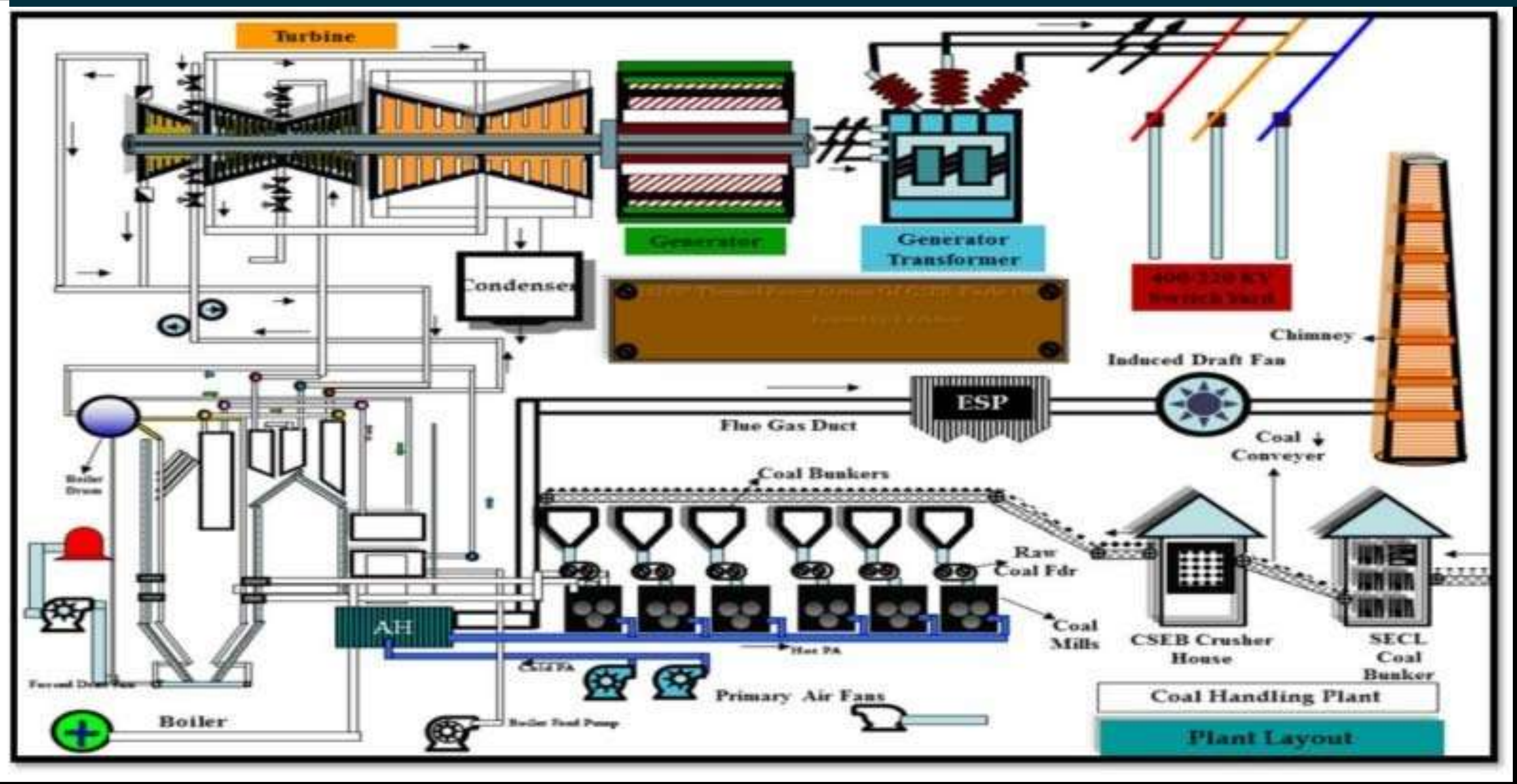
$$\text{Heat Rate} = \frac{\text{Thermal Energy Input}}{\text{Electric Energy Output}}$$

Relation between efficiency and heat rate

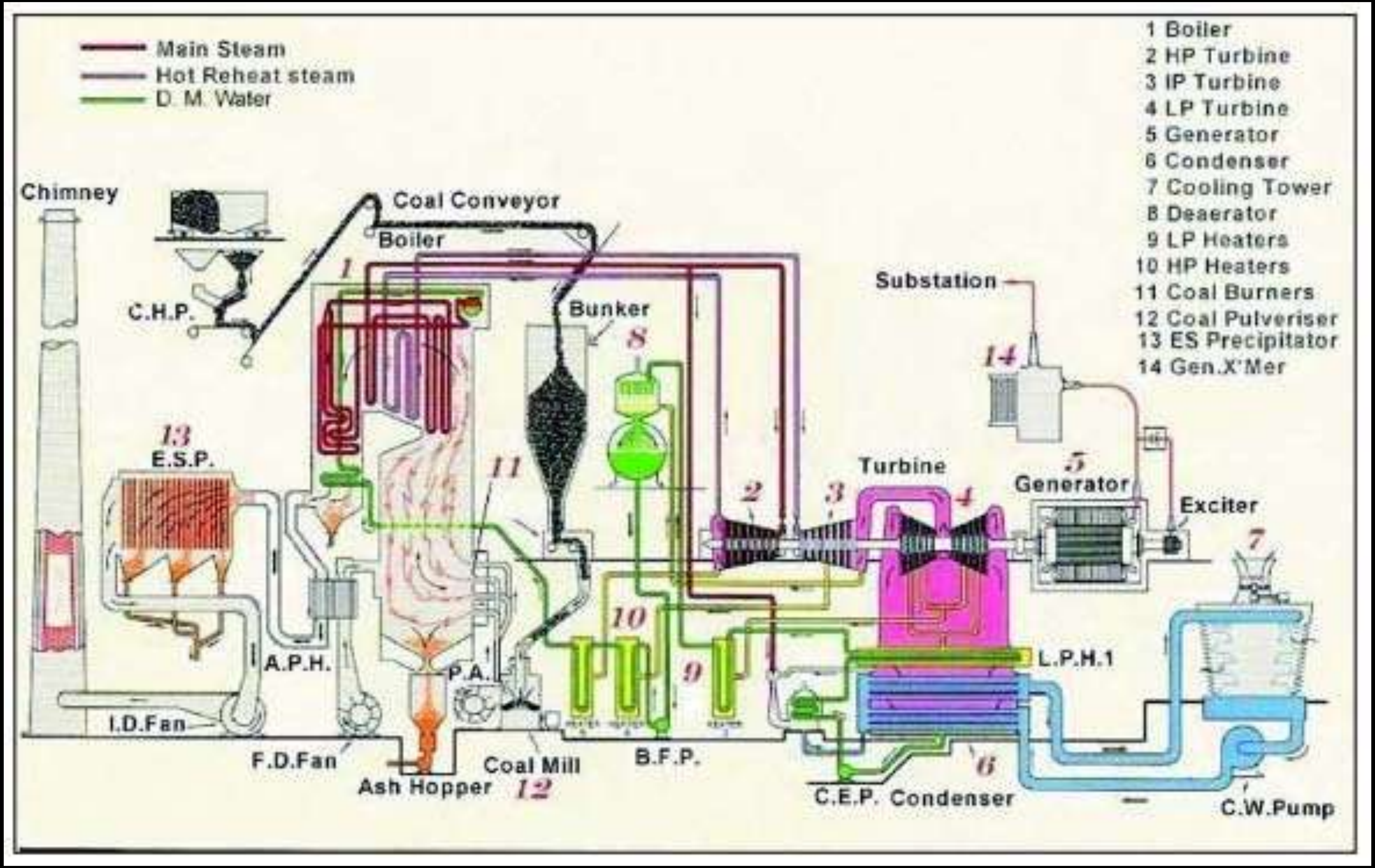
$$\textbf{Efficiency} \propto \textbf{1/ Heat Rate}$$

If a power plant converted 100% of the chemical energy in the fuel into electricity, the plant would have a heat rate of 860 kcal/kWh.

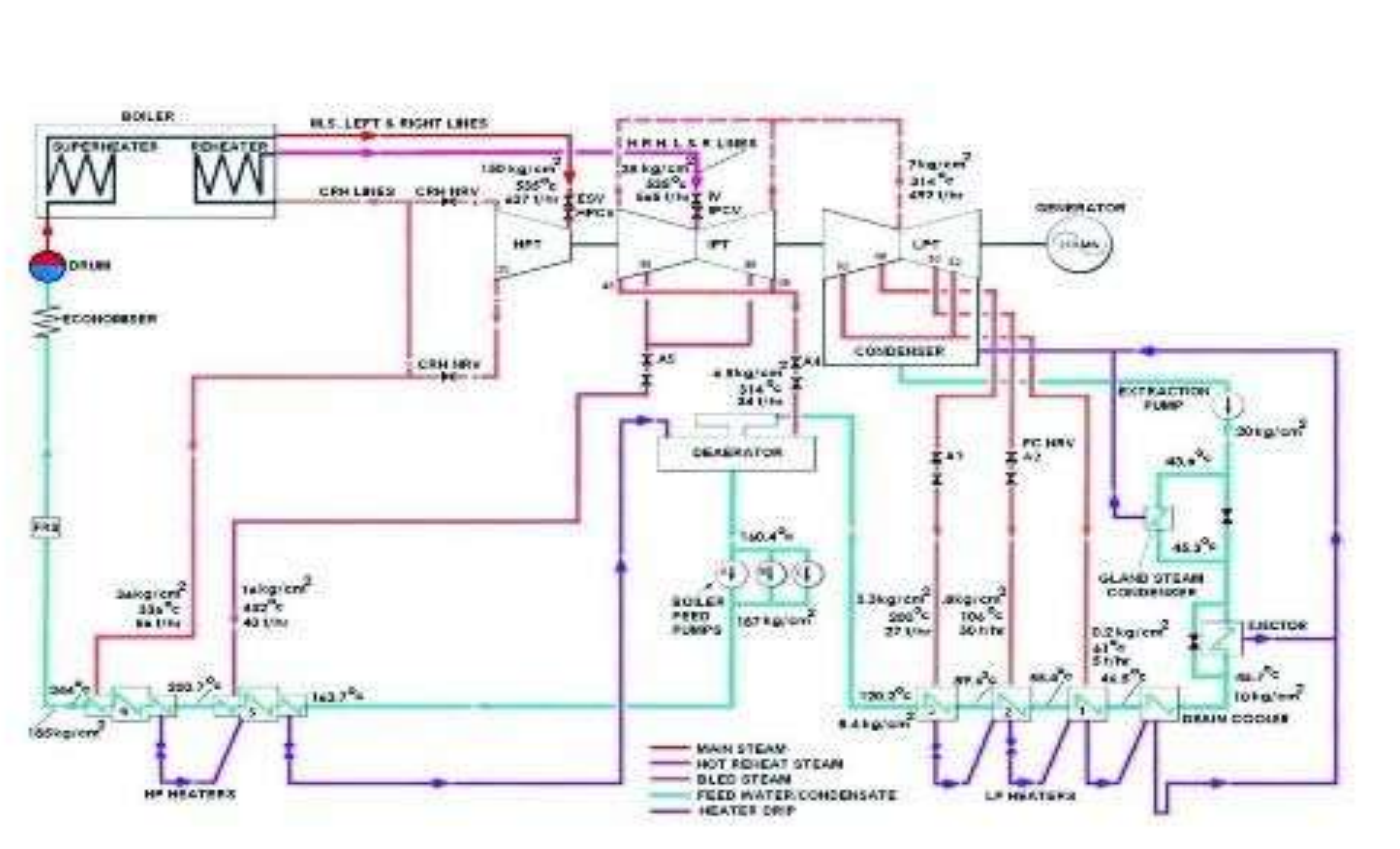
Coal Based Thermal Power Plant Schematic Diagram



Important Components of Typical Coal Based Thermal Power Plant



Heat & Mass Balance Diagram
Turbine Cycle Heat Rate

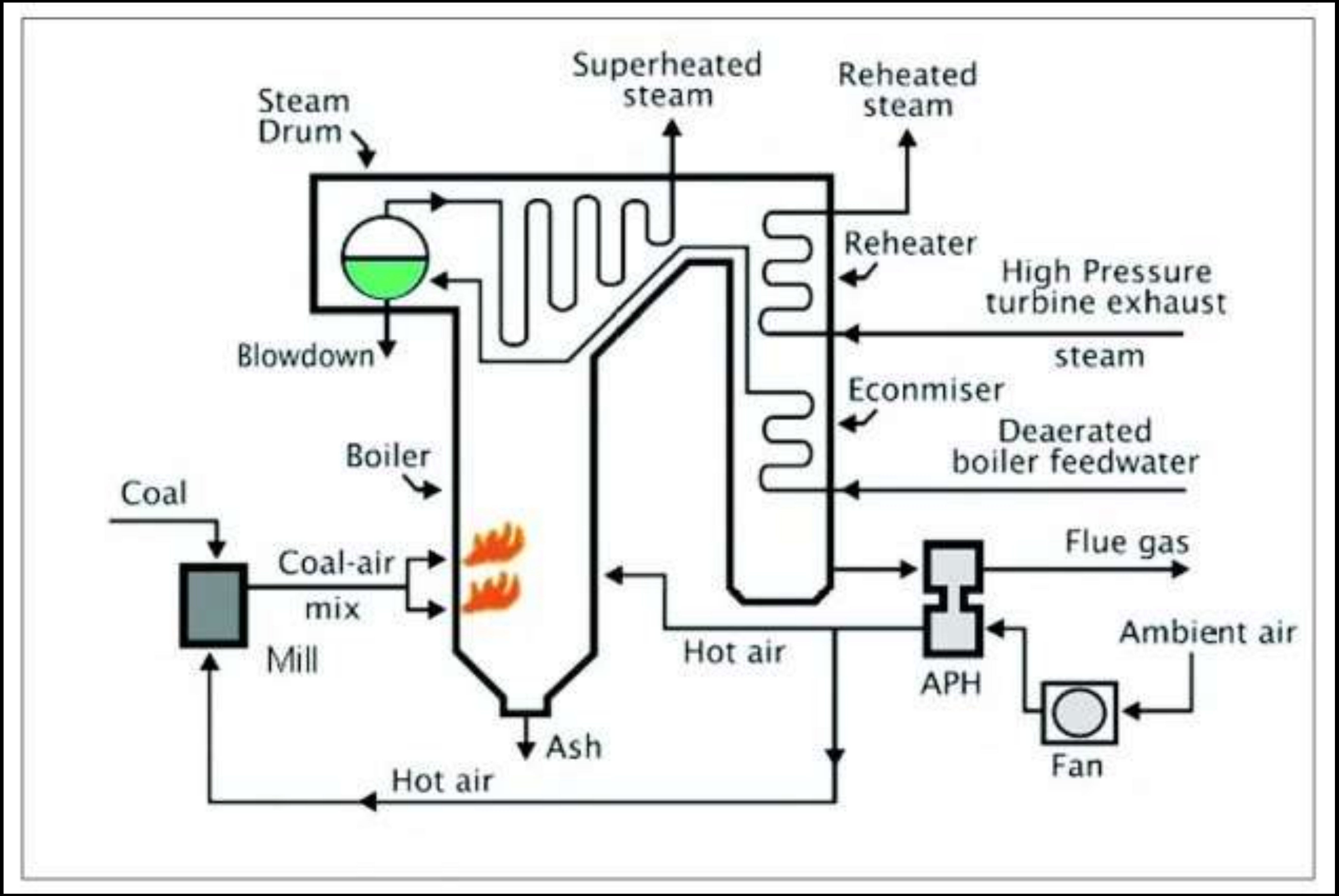


Typical Auxiliary Power consumption in Thermal Power Plant

Equipment Ref.	500 MW		210 MW		110 MW	
	% Gen	% APC	% Gen	% APC	% Gen	% APC
BFP	0.00*	0.00*	2.70	33.60	2.94	24.50
CEP	0.40	5.70	0.27	3.34	0.36	3.00
CWP	1.00	14.20	0.66	8.31	1.26	10.50
IDF	1.30	18.70	1.26	15.80	1.71	14.23
PAF	0.60	8.50	0.68	6.50	1.78	14.46
FDF	0.30	4.10	0.40	5.00	0.26	2.13
Mills	0.60	8.20	0.58	7.23	0.83	6.92
CT fans	0.23	3.20	0.32	3.54	0.48	4.00
Air Comp.	0.08	1.20	0.12	1.56	0.24	2.00
A/C Plant	0.04	0.50	0.08	0.94	0.11	0.92
CHP	0.12	1.70	0.14	1.70	0.29	2.41
AHP	0.09	1.20	0.13	1.66	0.31	2.54
Lighting	0.06	0.80	0.08	1.00	0.08	0.68
others	2.23	31.90	0.60	7.44	1.36	11.32
APC	**7.00**	**100.00**	**8.00**	**100.00**	**12.00**	**100.00**

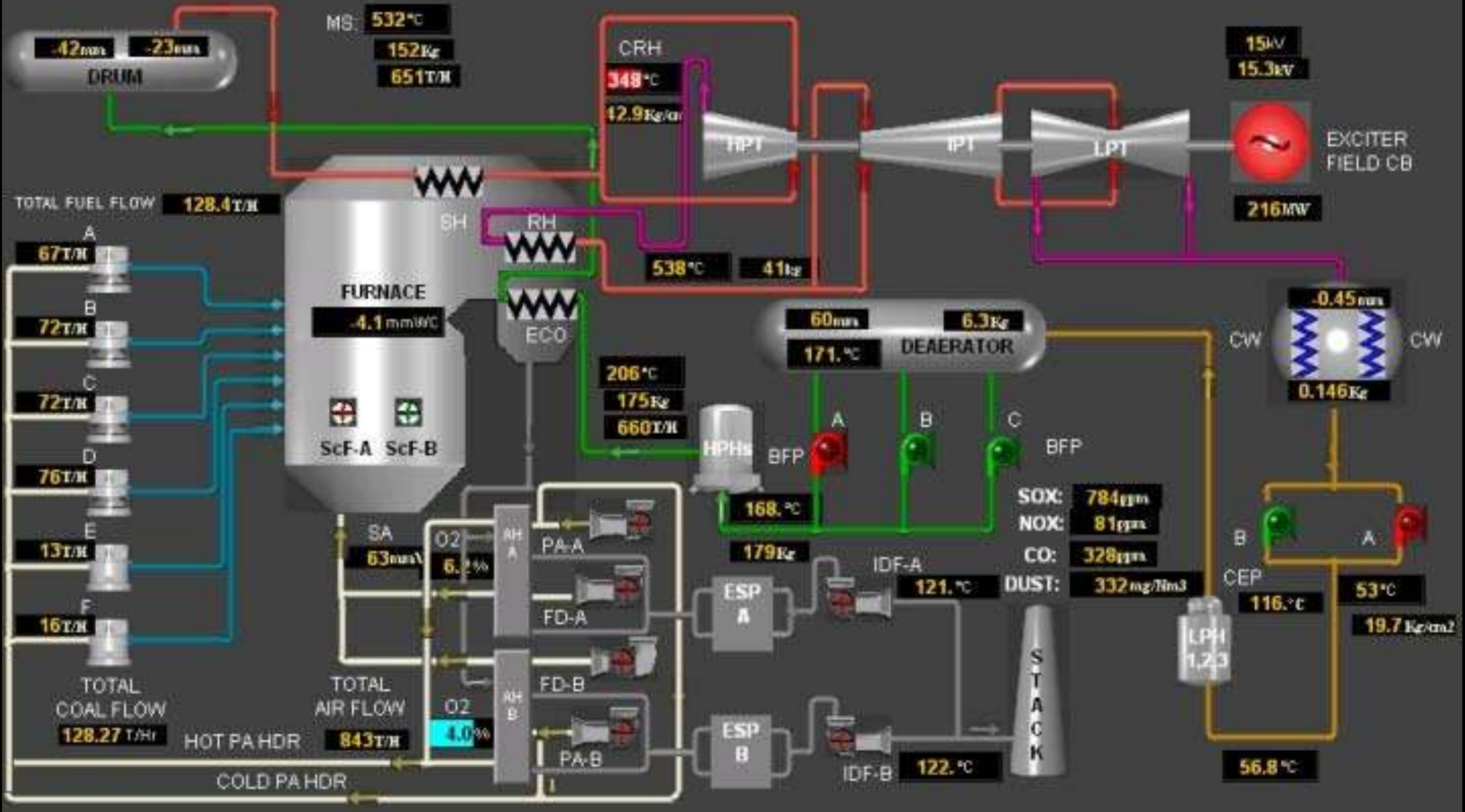
BFP – Boiler feed pump, CEP – Condensate extraction pump, CWP - Cooling water pump, IDF – Induced draft fan, PAF – Primary air fan, FDF – Forced draft fan, CT fans – Cooling tower fans, CHP – Coal handling plant, AHP – Ash handling plant, APC – Auxiliary power consumption and % Gen - % Generation.

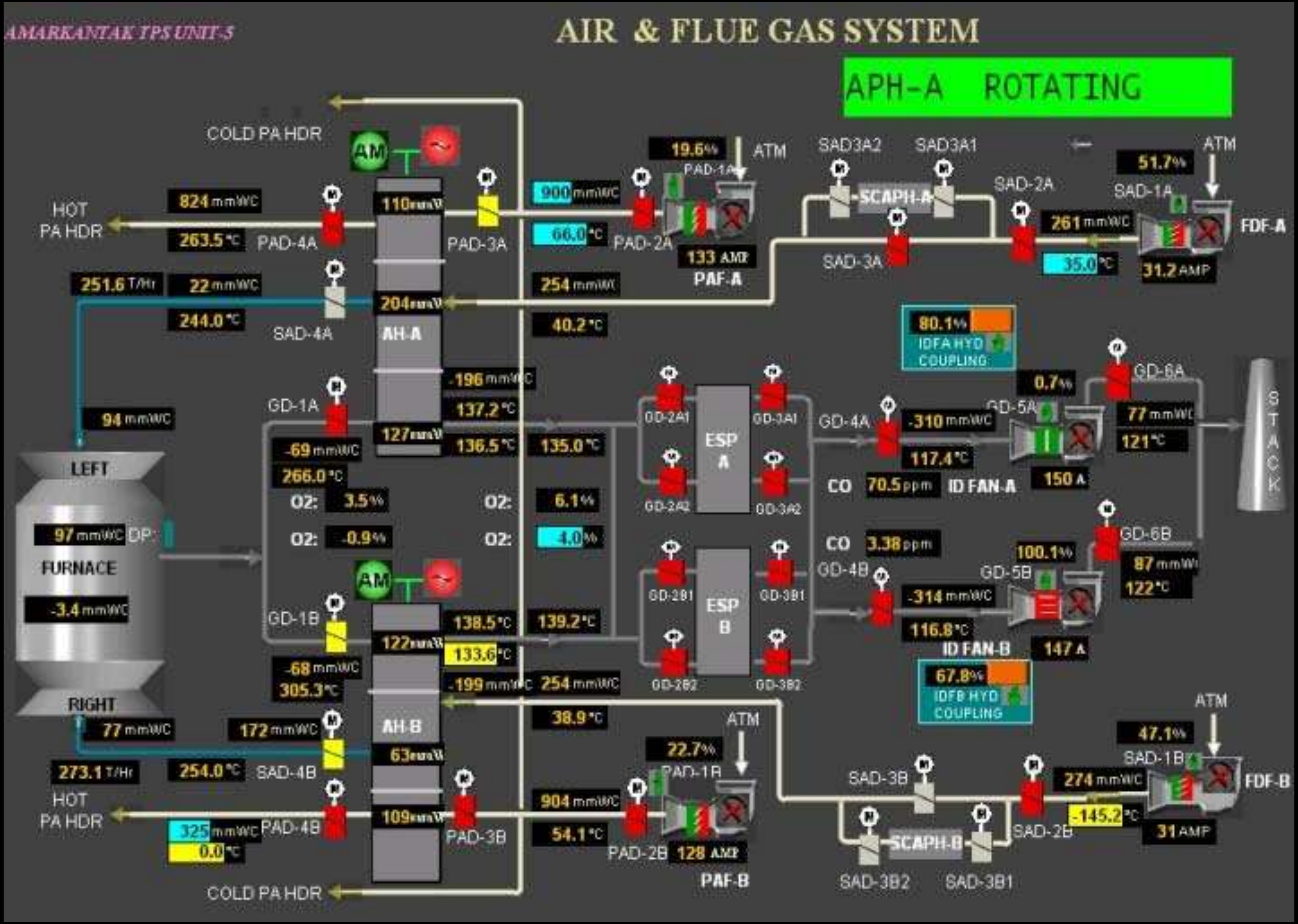
Coal Fired Power Plant Boiler

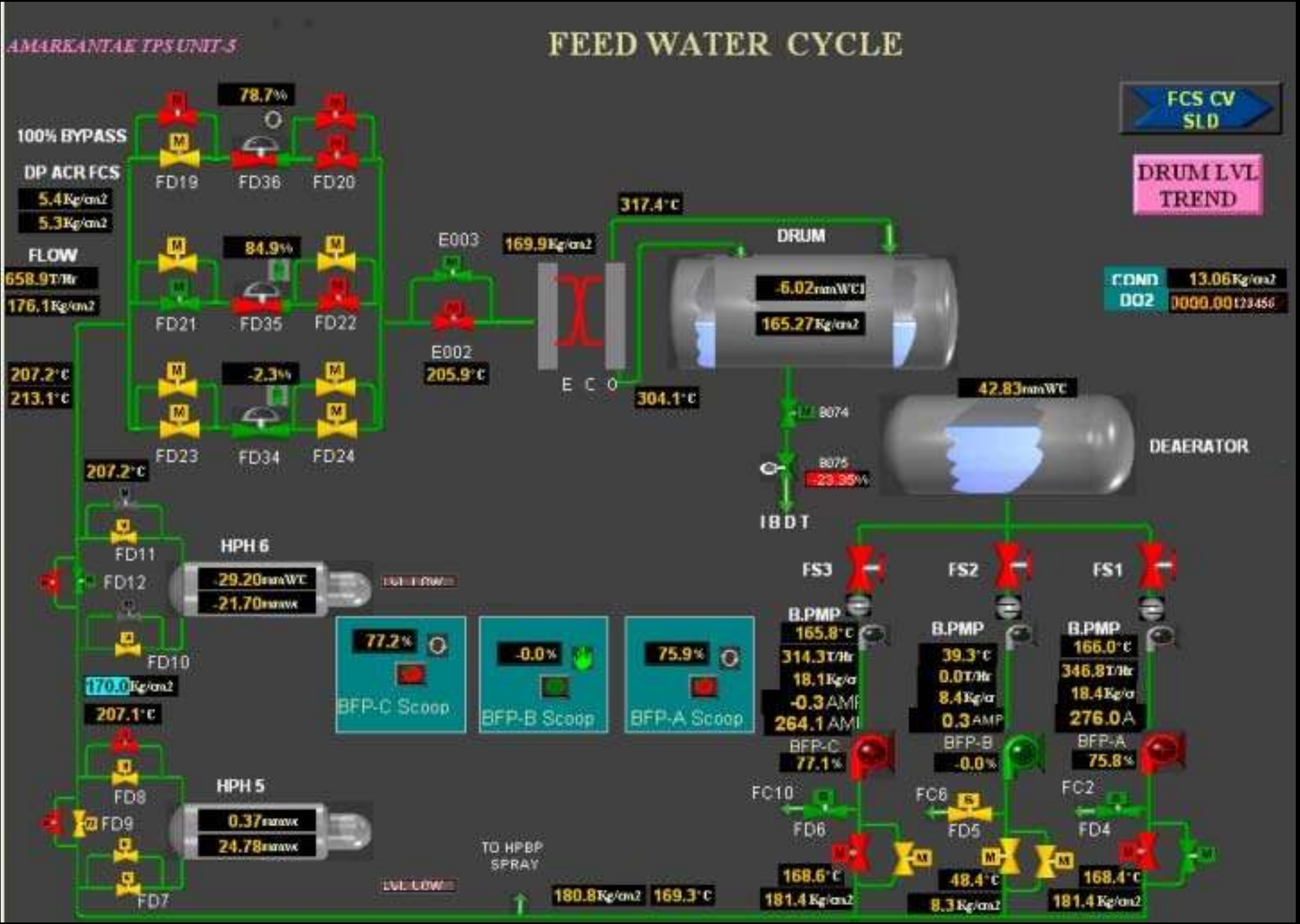


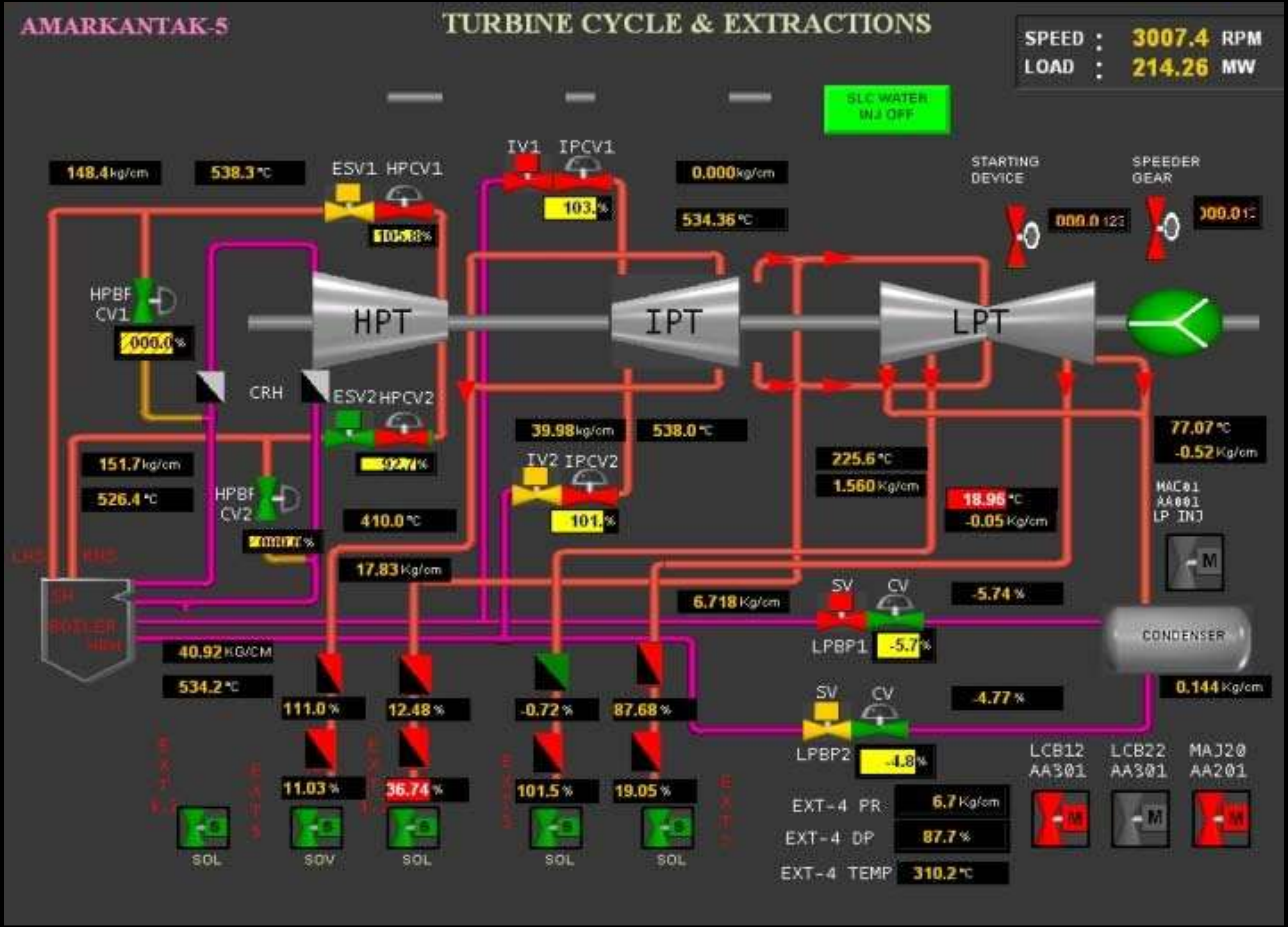
AMARKANTAK TPS UNIT-3

UNIT OVERVIEW




AMARKANTAK TPS UNIT-5
AIR & FLUE GAS SYSTEM
APH-A ROTATING
COLD PA HDR
HOT PA HDR
824 mmWC
263.5 °C
PAD-4A
110 mmW
PAD-3A
900 mmWC
66.0 °C
PAD-2A
19.6%
PAD-1A
ATM
133 AMP
PAF-A
SAD3A2
SAD3A1
SCAPH-A
SAD-3A
SAD-2A
SAD-1A
51.7%
261 mmWC
35.0 °C
31.2 AMP
FDF-A
251.6 T/Hr
22 mmWC
244.0 °C
SAD-4A
204 mmW
AH-A
254 mmWC
40.2 °C
80.1%
IDFA HYD COUPLING
94 mmWC
GD-1A
-196 mmWC
137.2 °C
127 mmW
136.5 °C
135.0 °C
-69 mmWC
266.0 °C
O2: 3.5%
O2: 6.1%
O2: -0.9%
O2: 4.0%
GD-2A1
GD-3A1
GD-2A2
GD-3A2
ESP A
GD-4A
-310 mmWC
117.4 °C
CO 70.5 ppm
ID FAN-A
GD-5A
0.7%
150 A
GD-6A
77 mmWC
121 °C
STACK
LEFT
97 mmWC DP:
FURNACE
-3.4 mmWC
RIGHT
77 mmWC
CO 3.38 ppm
GD-4B
GD-2B1
GD-3B1
ESP B
GD-2B2
GD-3B2
-314 mmWC
116.8 °C
ID FAN-B
GD-5B
100.1%
147 A
GD-6B
87 mmWC
122 °C
67.8%
IDFB HYD COUPLING
GD-1B
138.5 °C
139.2 °C
122 mmW
133.6 °C
-68 mmWC
305.3 °C
-199 mmWC
254 mmWC
38.9 °C
AH-B
172 mmWC
63 mmW
273.1 T/Hr
254.0 °C
SAD-4B
325 mmWC
0.0 °C
PAD-4B
109 mmW
PAD-3B
904 mmWC
54.1 °C
PAD-2B
22.7%
PAD-1B
ATM
128 AMP
PAF-B
SAD-3B
SCAPH-B
SAD-3B2
SAD-3B1
SAD-2B
SAD-1B
47.1%
274 mmWC
-145.2 °C
31 AMP
FDF-B
ATM


AMARKANTAK TPS UNIT-5
FEED WATER CYCLE
FCS CV SLD
DRUM LVL TREND
100% BYPASS
DP ACR FCS
5.4Kg/cm2
5.3Kg/cm2
FLOW
658.9T/Hr
176.1Kg/cm2
78.7%
84.9%
-2.3%
FD19
FD36
FD20
FD21
FD35
FD22
FD23
FD34
FD24
E003
E002
205.9°C
169.9Kg/cm2
317.4°C
E C O
304.1°C
DRUM
-6.02mmWC
165.27Kg/cm2
COND
DO2
13.06Kg/cm2
42.83mmWC
DEAERATOR
8074
8075
-23.35%
IBDT
207.2°C
213.1°C
207.2°C
FD11
FD12
HPH 6
-29.20mmWC
-21.70mmwc
FD10
170.0Kg/cm2
207.1°C
FD8
FD9
HPH 5
0.37mmwc
24.78mmwc
FD7
TO HPBP SPRAY
180.8Kg/cm2
169.3°C
77.2%
BFP-C Scoop
-0.0%
BFP-B Scoop
75.9%
BFP-A Scoop
FS3
FS2
FS1
B.PMP
165.8°C
314.3T/Hr
18.1Kg/cm
-0.3AMP
264.1AMP
BFP-C
77.1%
B.PMP
39.3°C
0.0T/Hr
8.4Kg/cm
0.3AMP
BFP-B
-0.0%
B.PMP
166.0°C
346.8T/Hr
18.4Kg/cm
276.0A
BFP-A
75.8%
FC10
FD6
FC6
FD5
FC2
FD4
168.6°C
181.4Kg/cm2
48.4°C
8.3Kg/cm2
168.4°C
181.4Kg/cm2


AMARKANTAK-5
TURBINE CYCLE & EXTRACTIONS
SPEED : 3007.4 RPM
LOAD : 214.26 MW
SLC WATER INJ OFF
148.4 kg/cm
538.3 °C
ESV1 HPCV1
IV1 IPCV1
103.%
0.000 kg/cm
534.36 °C
STARTING DEVICE
SPEEDER GEAR
HPBF CV1
000.0 %
HPT
IPT
LPT
CRH
ESV2 HPCV2
39.98 kg/cm
538.0 °C
151.7 kg/cm
526.4 °C
HPBF CV2
IV2 IPCV2
101.%
410.0 °C
225.6 °C
1.560 Kg/cm
18.96 °C
-0.05 Kg/cm
77.07 °C
-0.52 Kg/cm
MAC01 AA001 LP INJ
17.83 Kg/cm
6.718 Kg/cm
SV CV
LPBP1
-5.7 %
-5.74 %
CONDENSER
40.92 KG/CM
534.2 °C
111.0 %
12.48 %
-0.72 %
87.68 %
0.144 Kg/cm
SV CV
LPBP2
-4.8 %
-4.77 %
11.03 %
36.74 %
101.5 %
19.05 %
LCB12 AA301
LCB22 AA301
MAJ20 AA201
EXT-4 PR 6.7 Kg/cm
EXT-4 DP 87.7 %
EXT-4 TEMP 310.2 °C
SOL
SOV
SOL
SOL
SOL

ENERGY EFFICIENCY Energy Audit : Methodology

- Audit Step 1 : Data Collection
- Audit Step 2 : Observation, measurement & trials
- Audit Step 3 : Data Analysis & Findings
- Audit Step 4 : Implementing some of the measures and evaluation by trials
  (Online at equipment)
- Audit Step 5 : Recommendations & Techno-economic evaluation
- Audit Step 6 : Presentation to Top management & Detailed report preparation
- Audit Step 7 : Implementation Action plan preparation & Periodic Review

Electrical

Collecting the information on inventory of the electrical equipment installed and its operating parameters (like hours, actual load in kW etc.)

Equipment / Sections
- Electrical Systems-Transformer
- Electric Motor & Drives
- Pump , Fan & Blower
- Chiller compressor
- Compressed Air System

(Generation, Distribution & Utilization)

- Lighting System
- Harmonic analysis

Review of Loading parameters / reasons for deviations analyzed.

Thermal

Collecting the information on inventory of the thermal installed and its operating parameters (like hours, Capacity, etc.)

Equipment / Sections
- Boilers & Steam System
- Steam Turbine
- Deareator
- Condenser
- LP Heaters
- HP Heaters
- Refrigeration & Air-conditioning
- Cooling Tower

Energy & Mass balances carried out and user end requirements matched with installed capacities.

ENERGY EFFICIENCY

OnlineMeasuring Instruments

- Load Manager and Harmonic Analyzer
- Anemometer
- Ultrasonic Flow meter
- Digital Thermometer
- Infrared Thermometer
- Flue Gas Analyzer
- Pressure gauge
- Digital manometer
- Ultrasonic leak detector
- Lux Meter, etc.

Case Study –1 Energy Efficiency
Installationof VFD for Condensate Extraction Pump

Condensate Extraction Pump			
Parameters	**Unit**	**Design**	**Operating**
Motor Operating Power	kW	826	813
Water Flow-rate	m3/hr	870	646
Total Head	m	285	258
Pumping System Efficiency	%	82%	56%
Energy Saving due to low	kWh		585360
load Annual Monetary	INR Lakh		20.5
Benefit Investment for MV	INR Lakh		50
VFD Payback period	Year		2.4

Case Study –2 Energy Efficiency

Reduction of Air Ingressinto Flue gas by arresting APH Leaka ges

Reduction of Air Ingressinto Flue gas by arresting APH Leaka ges

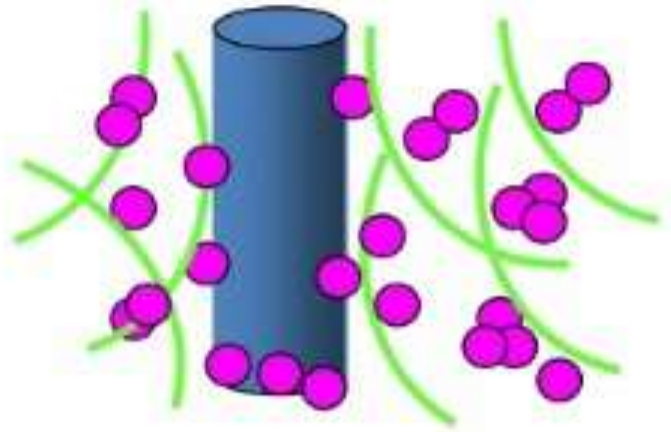
Case Study –3 Energy Efficiency

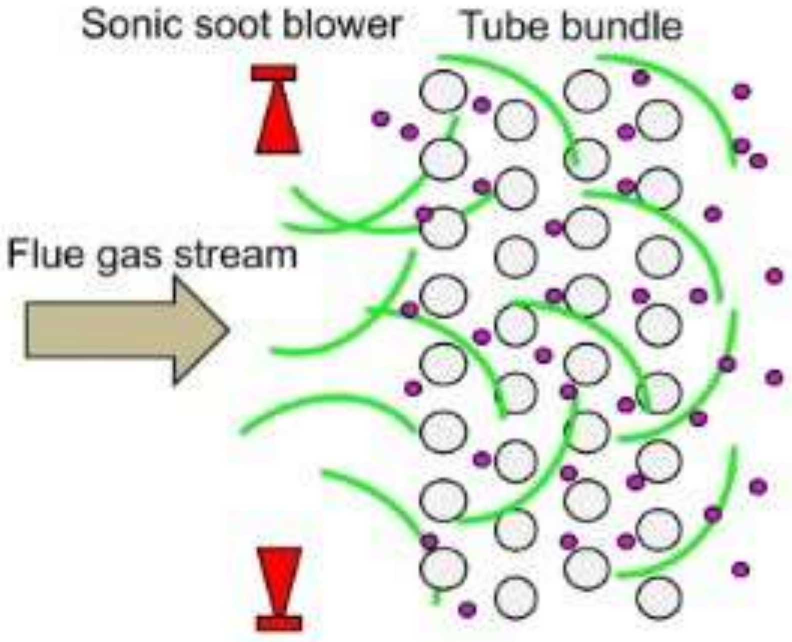
Installation of Sonic soot blowers in place of Steam soot blowers

Sonic soot blowing is cleaning of fouled surfaces by compressed air operated sonic soot blowers.

Sound waves sent inside boiler propagate in all directions and impart energy to ash particulates which fluidize and jump up from fouled surfaces to be carried away by the flue gas stream.

Cleaning is effective even deep into tube bundles leaving no dead corners unclean.





Parameters	Unit	Operating
Steam consumption in APH Soot Blowing	TPD	17
Steam enthalpy	kCal/kg	766
Annual energy saving	kCal	3904306
Coal GCV	kCal/kg	3400
Annual Coal saving	Tonne	1148
Annual Monetary saving	Rs Lakh	24.1
Additional power consumption with compressor	kW	60
Annual Energy consumption due to compressor	kWh	150000
Annual Monetary for consumption due to compressor	Rs Lakh	1.5
Annual Net Monetary Saving	Rs Lakh	22.6
Investment for Sonic Soot Blowers	Rs Lakh	15
Payback period	months	8.0

Case Study –4 Energy Efficiency

Stoppage of one Vacuum pump in Unit Normal operation by arresting Air leakages in Condenser system

Type of Condenser	Surface Condenser
No. of Condenser	1
Water Quality	Sea Water
Cooling ater Flow-rate	70000 TPH
Condense Back pressure	76 mmHg-a

Paramete	Unit	Design	Operating
Condenser Duty	kCal/hr	680461505	703212324
Condenser Pressure	mmHg	75.98	92.68
Terminal Temperature Difference	0C	4.06	2.61
Energy Saving Potential			
Power consumption by Vacuum pump	kW	210	210 X2
Annual Energy consumption	kWh	315000	630000
Annual Monetary saving	Rs. Lakh		6.93
Investment for Air arresting	Rs. Lakh		10.0
Payback period	months		11

Case Study –5 Energy Efficiency

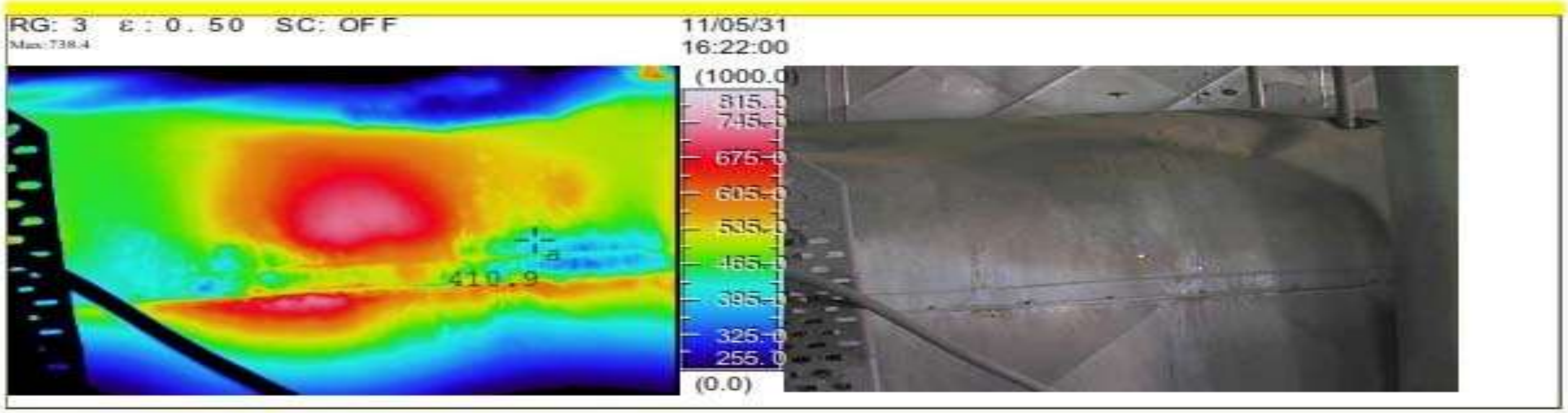
Proper insulation of Boiler, APH, Economiser& Steam Distribution network,LP Heaters, HP Heaters, Deaerator

Hot Insulation Survey by Thermography Camera based on Infrared Radiation Principle To Estimate Heat loss

Case Study –5 Energy Efficiency

Heat Loss Estimation of uninsulated or weak insulated area of Boiler& Turbine area

Parameter	Unit	Value
Annual Insulation Heat Loss	Lakh kCal	29200
Coal GCV	kCal/kg	5400
Annual Coal saving	Tonne	54100
Annual Monetary saving	Rs. Lakh	27.0
Investment for proper insulation	Rs. Lakh	25.0
Payback period	months	11



Location: –Superheater outlet

THANK YOU


Thanking You
on Behalf of!
Council of Enviro Excellence