BHEL Welcomes You

Combustion of Washery Rejects in BFBC, CFBC Systems

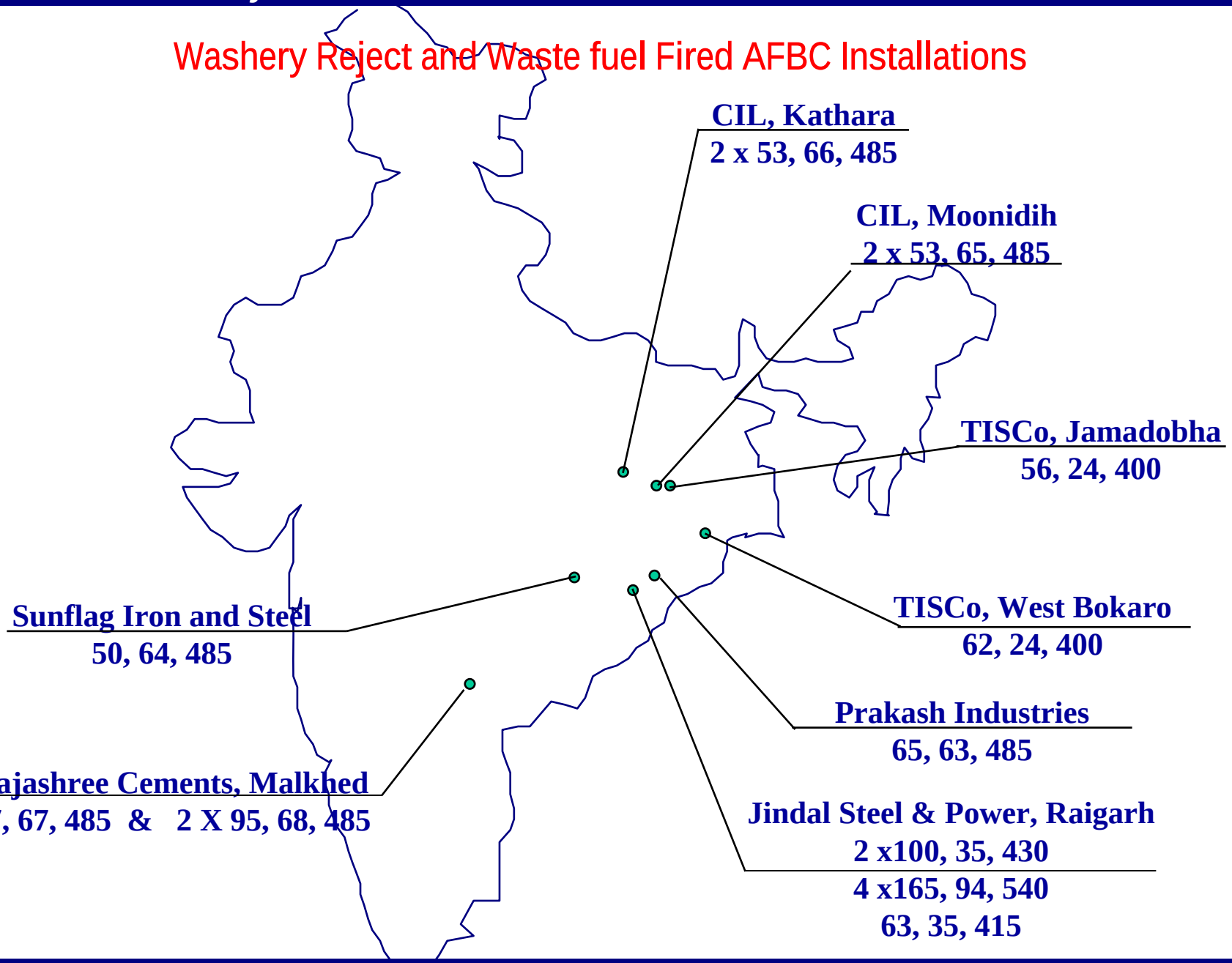
Indian Experience Waste Coal Utilisation

- **Bubbling Bed**
  - Technology developed in – house by BHEL,
  - 65 boilers contracted
  - Operating maximum capacity - 165 t/h at Jindal Steel
  - Contracted maximum capacity – 1 x 53MW(2x210t/h) Ind Synergy limited , Raigarh, Chattisgarh
  - Fuels used - Coal, Lignite, Washery rejects, Coal fines Char, ESP dust, Biomass (rice straw, rice husk) , Petcoke

BFBC Development Journey

- Prototype Boiler installed - 1977
- First Commercial boiler installed - 1981
- First Rejects Fired boiler - 1987
- First Straw Fired boiler - 1991
- Largest Boiler in operation (165 t/h) - 2001
- First Export order to PT-IBR, Indonesia - 2002
- Largest Boiler (345 t/h) offered – 2002
- 60 MW Design ready - 2003
- 120 MW Reheat Design on the board

Washery Reject and Waste fuel Fired AFBC Installations



AFBC Boilers Status

- 65 boilers (19 for Washery rejects) contracted so far
- Maximum capacity in Operation 165 tph
- Offer made for 345 t/h to Bhushan
- Design ready for 60 MW and 120 MW (Reheat)

FBC test facilities at BHEL

Facility	in operation since
Prototype FBC boiler (10 T/H, 10 kg/cm^2(g), Sat)	1977
0.5 M X 0.5 M test rig (4,00,000 Kcal/h)	1979
Prototype FBC shell boiler (7.5 T/H, Sat)	1982
BHEL/ USAID BFBC (90 T/H Hot water)	1986
Indo / Canadian CFBC (90 T/H Hot water)	1991

FBC Prototype Boilers

10 t/h Prototype Boiler - 1977

7.5 t/h Prototype Shell Boiler-1982

FBC Test Rigs

Combustion Test Rig-1979

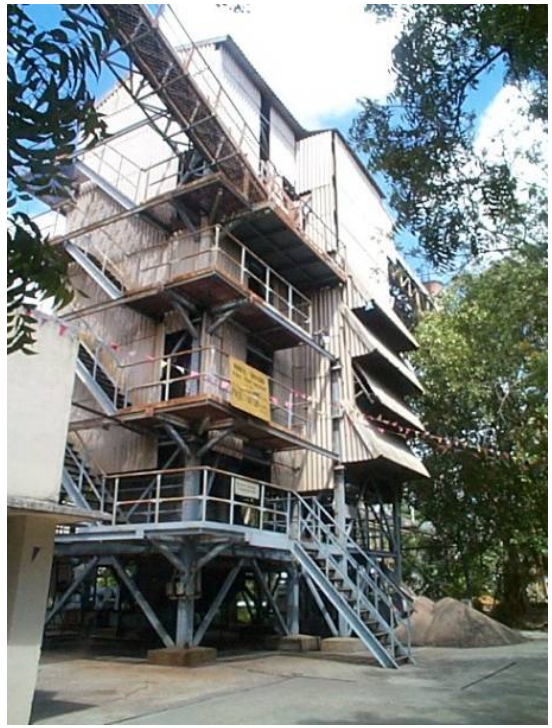
0.5 M X 0.5 m
(4,00,000 kcal/h)

CFBC Test Facility - 1991

(90 t/h Hot water)

USAID Test Facility-1986

(90 t/h Hot water)



Fuels Tested

Fuels Tested

Biomass Fuels Tested

Biomass Fuels Tested

Petcoke


Petcoke Pile
RIL, Jamnagar


Petcoke Lumps
Before Crushing


Petcoke
After Crushing

Gujarat Lignite

Neyveli Lignite

Rejects / Middlings Tested

Fuel	Moisture %	Ash %	HHV kcal/kg
Middlings / Rejects :			
Bhojudih	1.0	55.0	3100
Kathara*	1.0	73.0	1900
Jamadoba*	1.0	65.0	2100
Mill rejects	1.5	57.3	3300
West Bokaro*	8.0	67.6	1550

*** Units Contracted for burning these Rejects**

Low Volatile - Steel plant wastes

Fuel	DRI ash	Kiln ESP dust
Proximate anlysis %		
Moisture	5 - 12	4 - 8
Ash	50 – 70	70 - 80
Volatile	0.5 - 1	2 - 28
Fixed Carbon	20 - 25	22 – 28
HHV	2400 – 2600	2600 - 2800

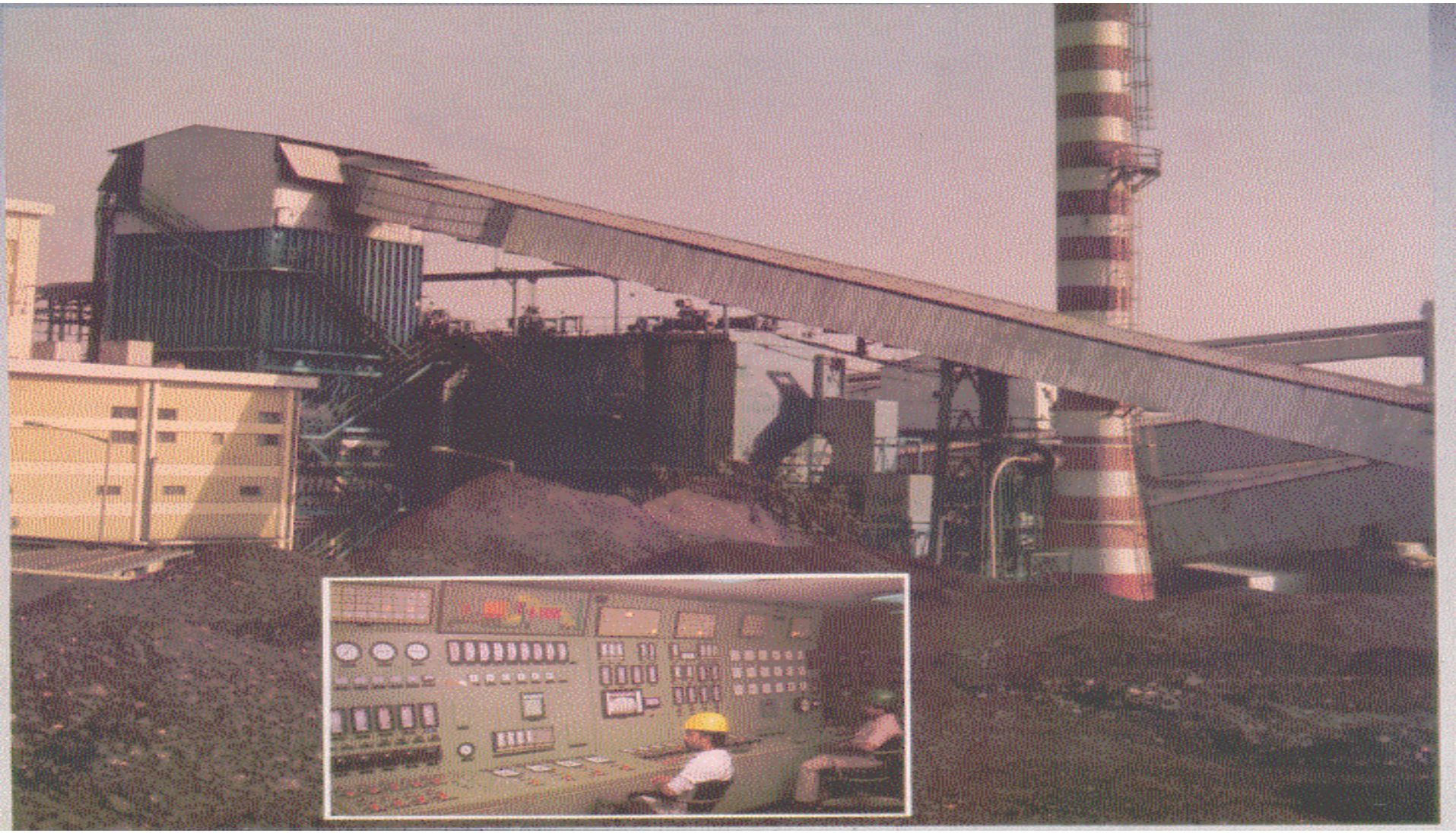
AFBC Boilers firing Washery Rejects

Sl.No	Customer	Parameter (t/h,kg/cm^2,^{0}C)	Syncronising Date
1.	TISCo. Jamadobha	56, 24, 400	03/87
2.	CIL, Kathara	2x53, 65, 485	02,03/93
3.	CIL, Moonidih	2x53, 65, 485	01,02/93
4.	TISCo. West Bokaro	2 x62,24,400	03/94, 02/95
5.	Jindal Strips Ltd.	2 x 100,35,430	01,06/96
6.	Jindal Steel & PowerLtd.*	2 x 165,94,540	9/2001
7.	Jindal Steel & Power Ltd.*	63, 35, 415	6/2003
8.	Jindal Steel & PowerLtd.*	2 x 165,94,540	6/2004
9.	Bhushan Steel & Strips Ltd*	1 x 120,94,540 2 x 75,67,485 2 x 180,94,540	

* Rejects,Char, Coal

AFBC Boilers firing Low Rank Fuels

Sl.No	Customer	Parameter (t/h,kg/cm^2,^{0}C)	Syncronising Date	Remarks
1.	Sunflag Iron & Steel	50, 65, 485	2/97	CF,DRI ash,ESP dust
2.	Prakash Industries	65,63,485	03/99	CF,Kiln Waste,ESP dust
3.	Rajashree Cements	77, 67, 485	08/92	Coal, Wash. Rejects
4.	Rajashree Cements	2x95, 68, 485	09/95, 03/96	Coal, Wash. Rejects



56 t / h boiler at TISCo, Jamadoba

Experience in TISCO

- Jamodoba 56 tph
  - syncronised in March 1987
  - In operation for over 1,20,000 hours.
- West Bokaro 2 x 62 tph
  - first unit commissioned in April 1994,
  - the second in Feb. 1995.
  - The units have cumulatively logged about 70,000 hours
  - one of the units is generally standby.

77 t/h AFBC Boiler at Rajashree Cements

Experience in Rajashree Cements

- **77 tph**
  - **syncronised in 1992**
  - **In operation for over 70,000 hours.**

- **2 x 95 tph**
  - **first unit commissioned in Sep 1995,**
  - **the second in March 1996.**
  - **The units have cumulatively logged about 70,000 hours**
  - **Although the units were not designed for firing Washery Rejects, the Customer fires a mixture of Coal and Rejects**
  - **After 1996, one of the units is standby.**

Experience in Coal India Ltd.

2 x 10 MW (50 t/h) at Kathara

- commissioned in 1993

2 x 10MW (50 t/h) at Moonidih

- commissioned in 1993

Experience in Jindal Steel & Power

2 x 100 t/h

- commissioned in 1996
- in operation for over 1,00,000 hours cumulatively with an availability of over 95%.

2 x 165 t/h

- commissioned in September 2001
- The customer placed a repeat order for another 2 x 165 t/h & commissioned in 2003

63 t/h for BFG, Washery Rejects, Coal and Char

- Ordered in 2002
- commissioned in 2004

Overview of 165 t/h AFBC Boiler at Jindal Steel & Power

Experience in SISCo.

- Sponge Iron Based Steel Plants have waste fuels like:
  - Char from the Kiln which has no volatiles
  - ESP Dust which is very fine (25 to 50 microns)

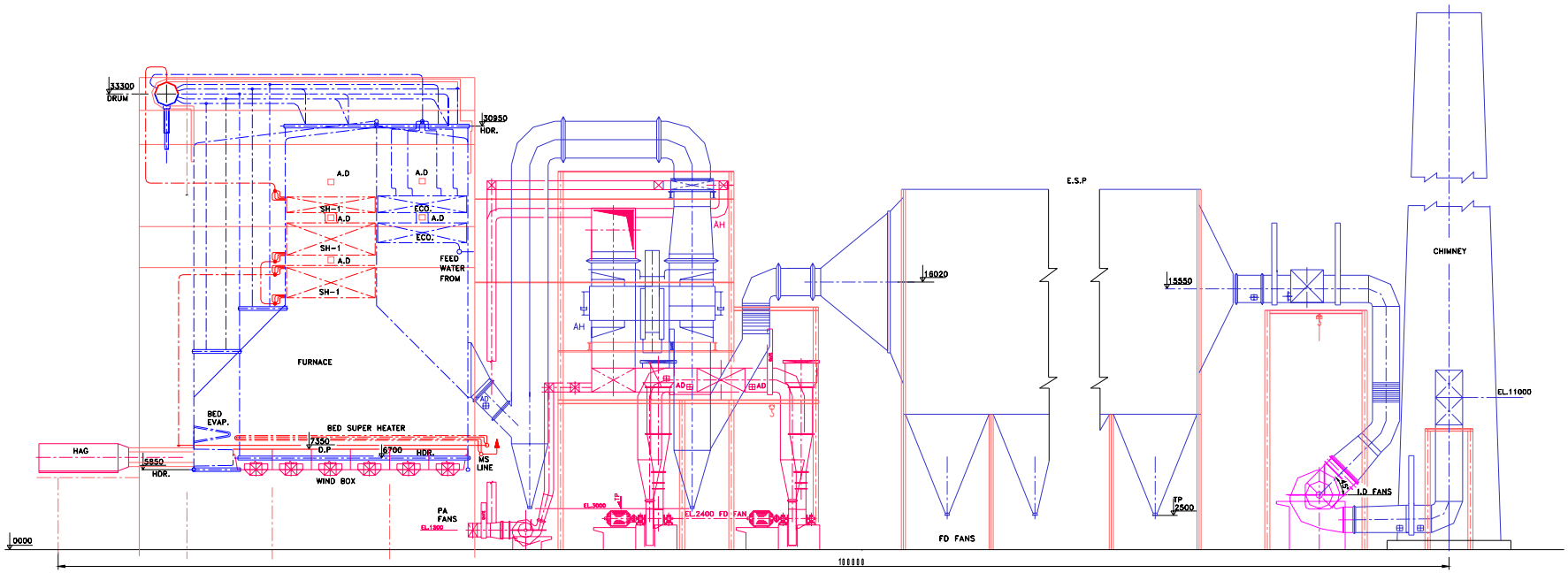
- These fuels were test fired, and FBC Boiler of 50t/h capacity was offered with a unique fuel mixing and feeding system.

- Commissioned in October 1997 and is in Operation for over 60,000 hours with availability of over 90%.

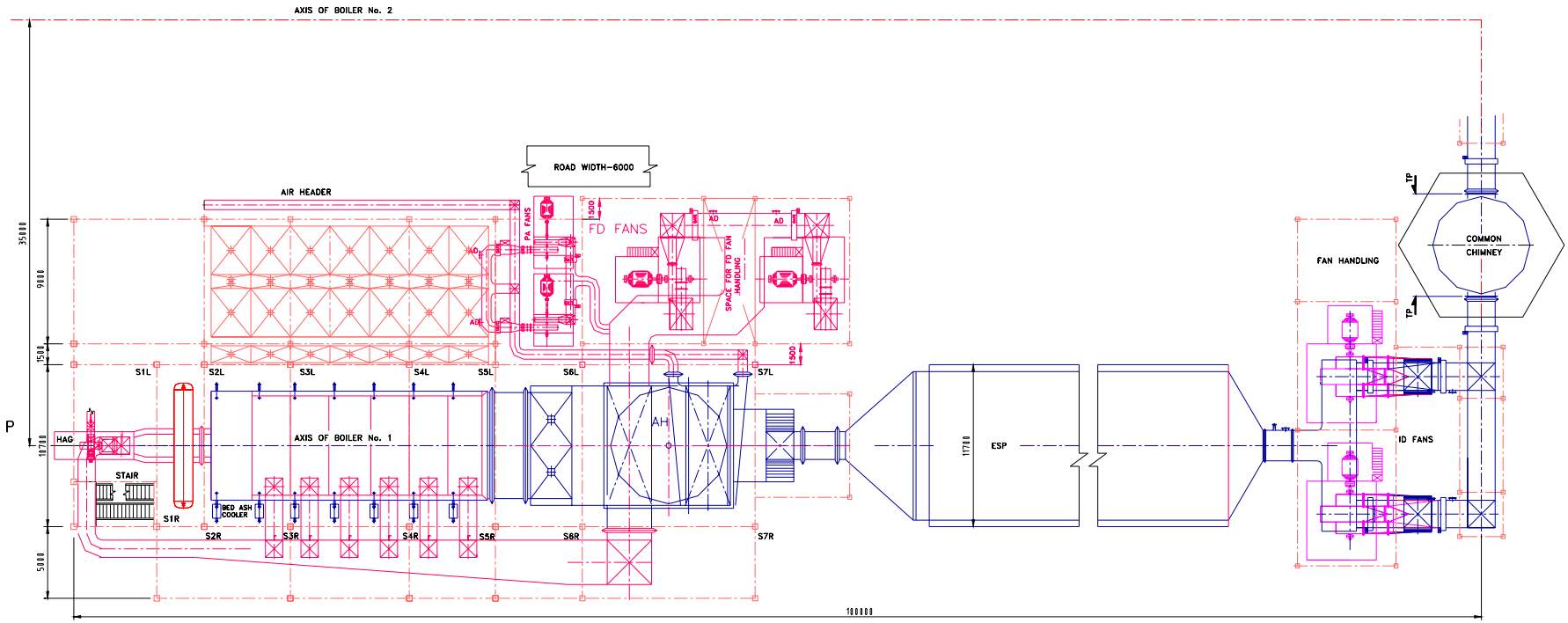
Experience in Prakash Industries Limited

- a 65 t/h unit to burn similar fuels as SISCo.
- unit commissioned in March 1999
- in operation for over 50,000 hours.

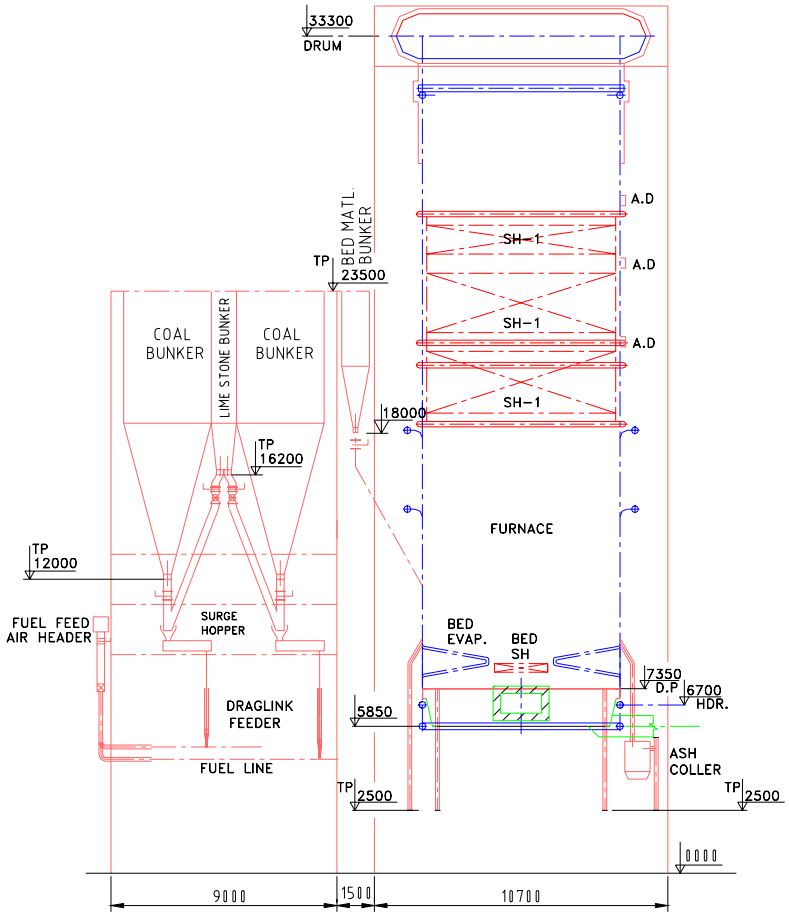
Arrangement (Elevation)-60MW BFBC boilers



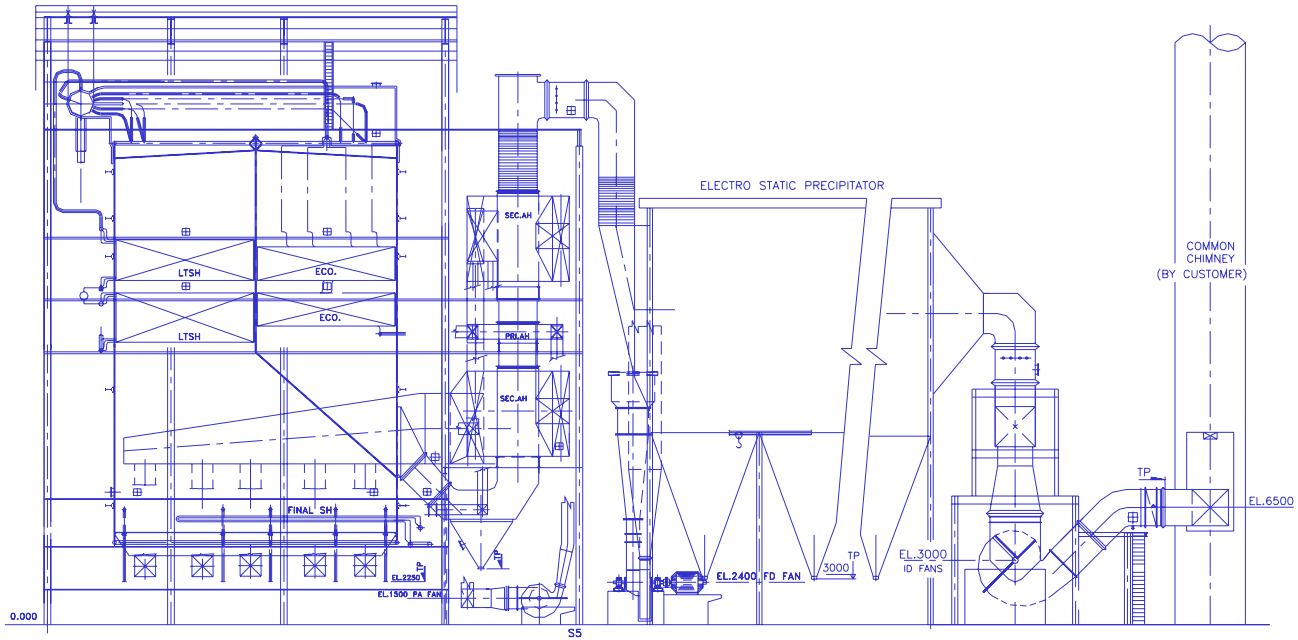
Arrangement (Plan) 60MW BFBC boilers



Arrangement (Side View) 60MW BFBC boilers



Arrangement (Elevation) of 180 t/h BFBC Boiler firing Washery Rejects & Char(Bhushan steel)



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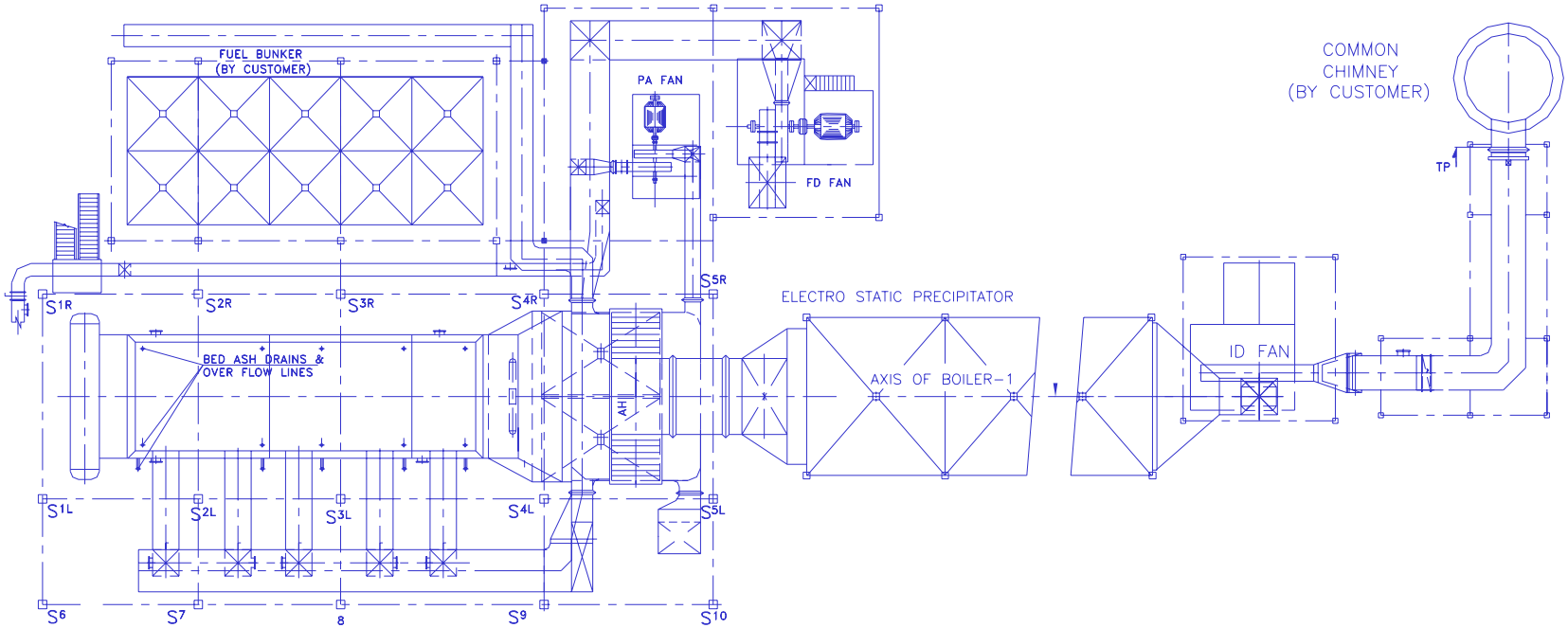


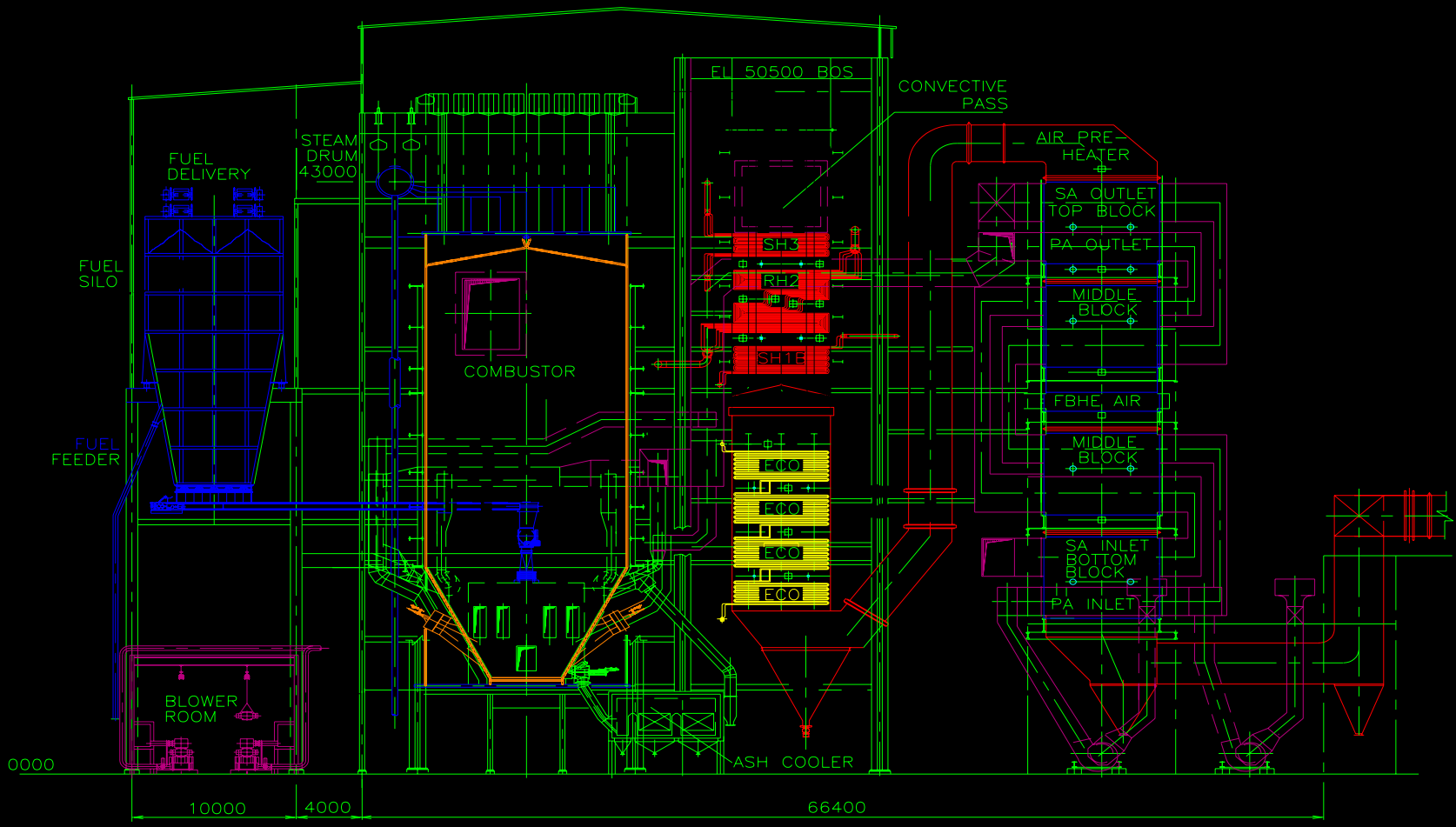
Indian Experience -CFBC

- Circulating Bed
- Technology – Based on LLAG- Germany
- 18 boilers contracted
- Operating maximum capacity – 125 MW
- Contracted maximum capacity – 250 MW firing Neyveli Lignite for M/s Neyveli Lignite Corpn
- Fuels used - Gujarat Lignite, Neyveli Lignite, Rajasthan Lignite , Kutch Lignite , Petcoke, Coal , Washery Rejects, Char

CFBC Development Journey

- Test Facility installed – 1991
- Collaboration with LLB (LEE) – 1993
- Technology transfer/Training of Engineers - 1996
- First non –reheat boiler (175 t/h) installed - 1998
- First Utility reheat boiler (125 Mw) installed - 1999
- 250 MW offer made - 1998

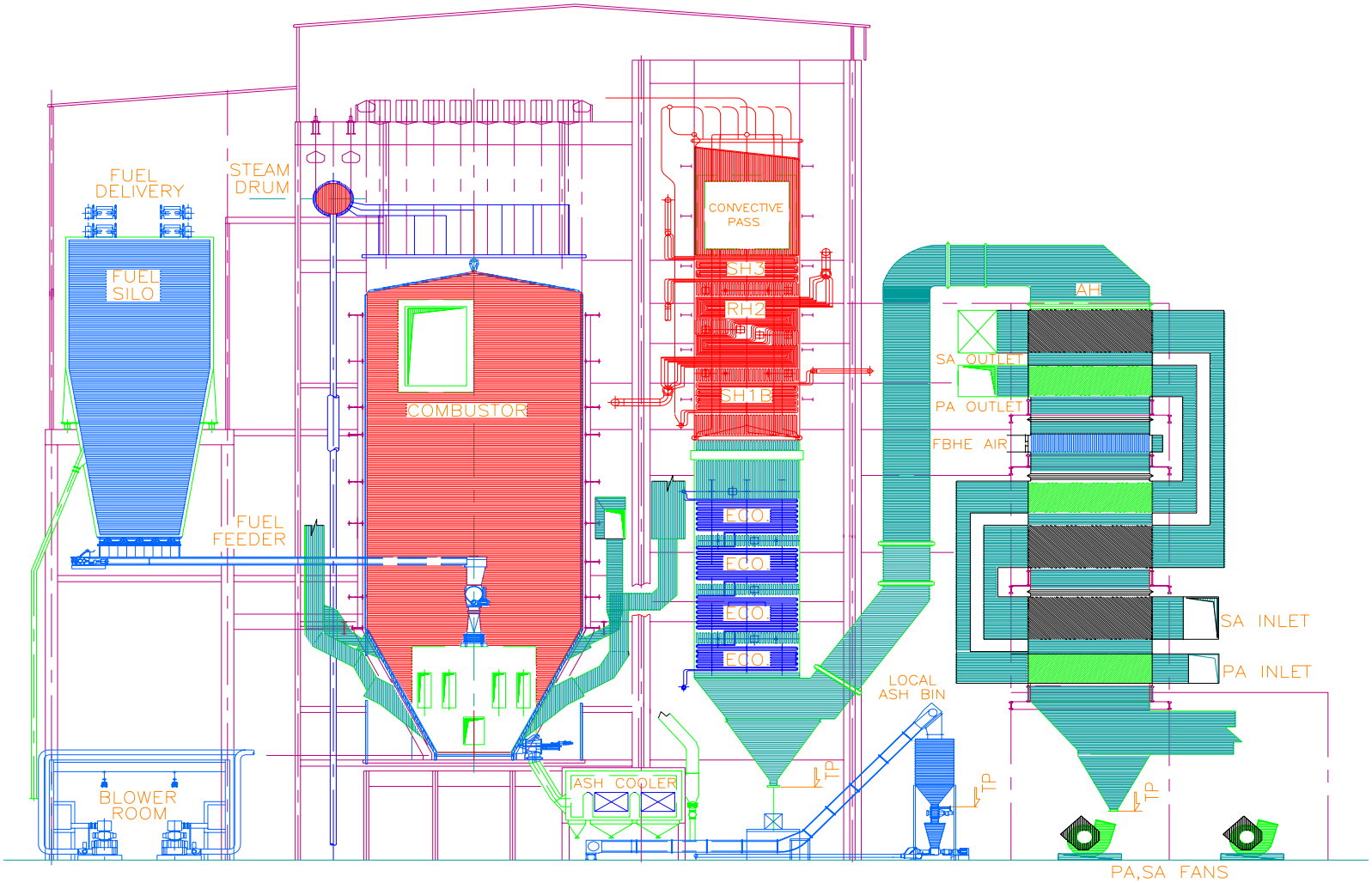
View of 2 x 125 MWe SLPP



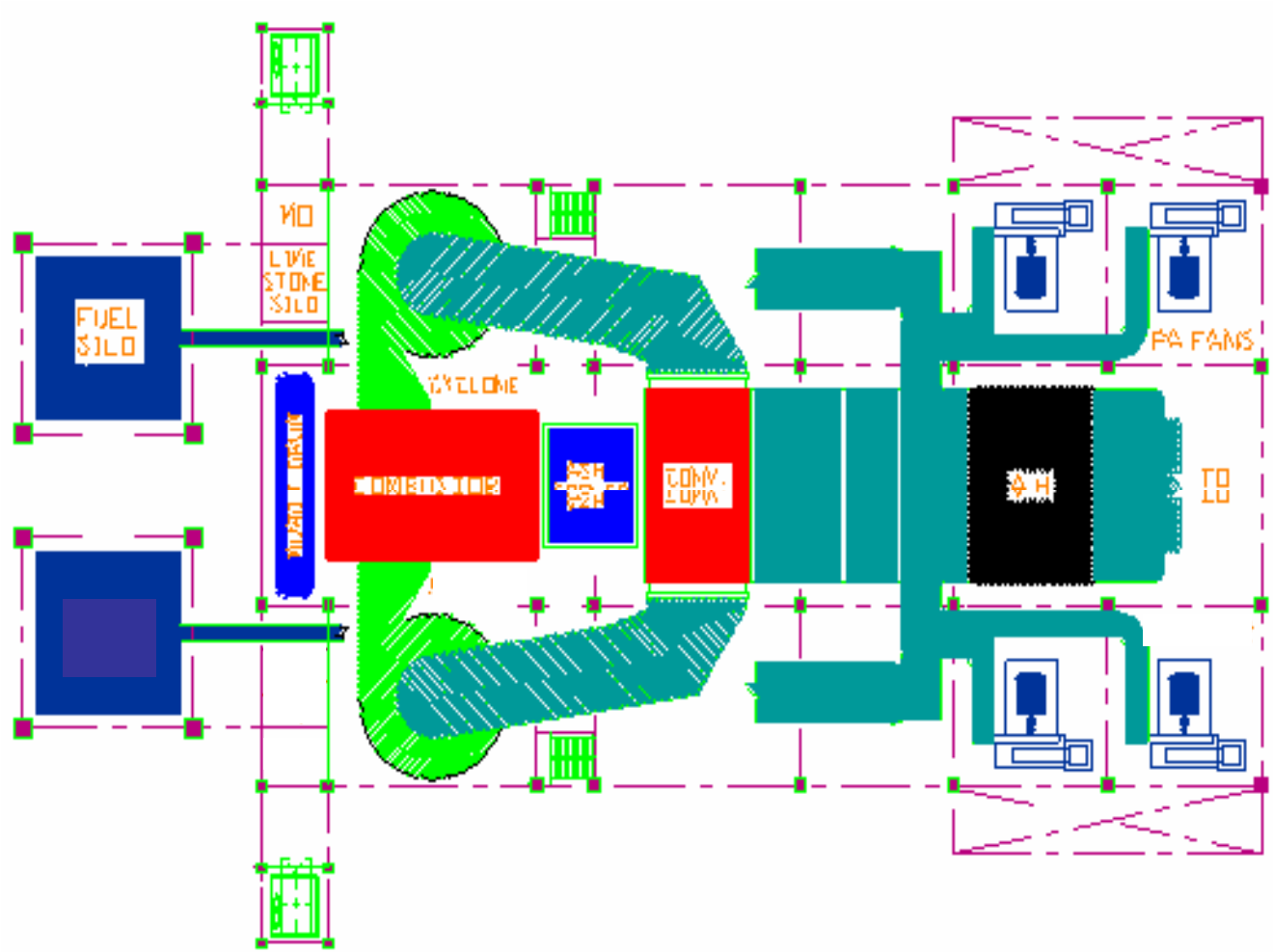
ELEVATION

GIPCL 2 x 125 MWe CFBC BOILER

Arrangement (Elevation) of SLPP CFBC125MW Boiler

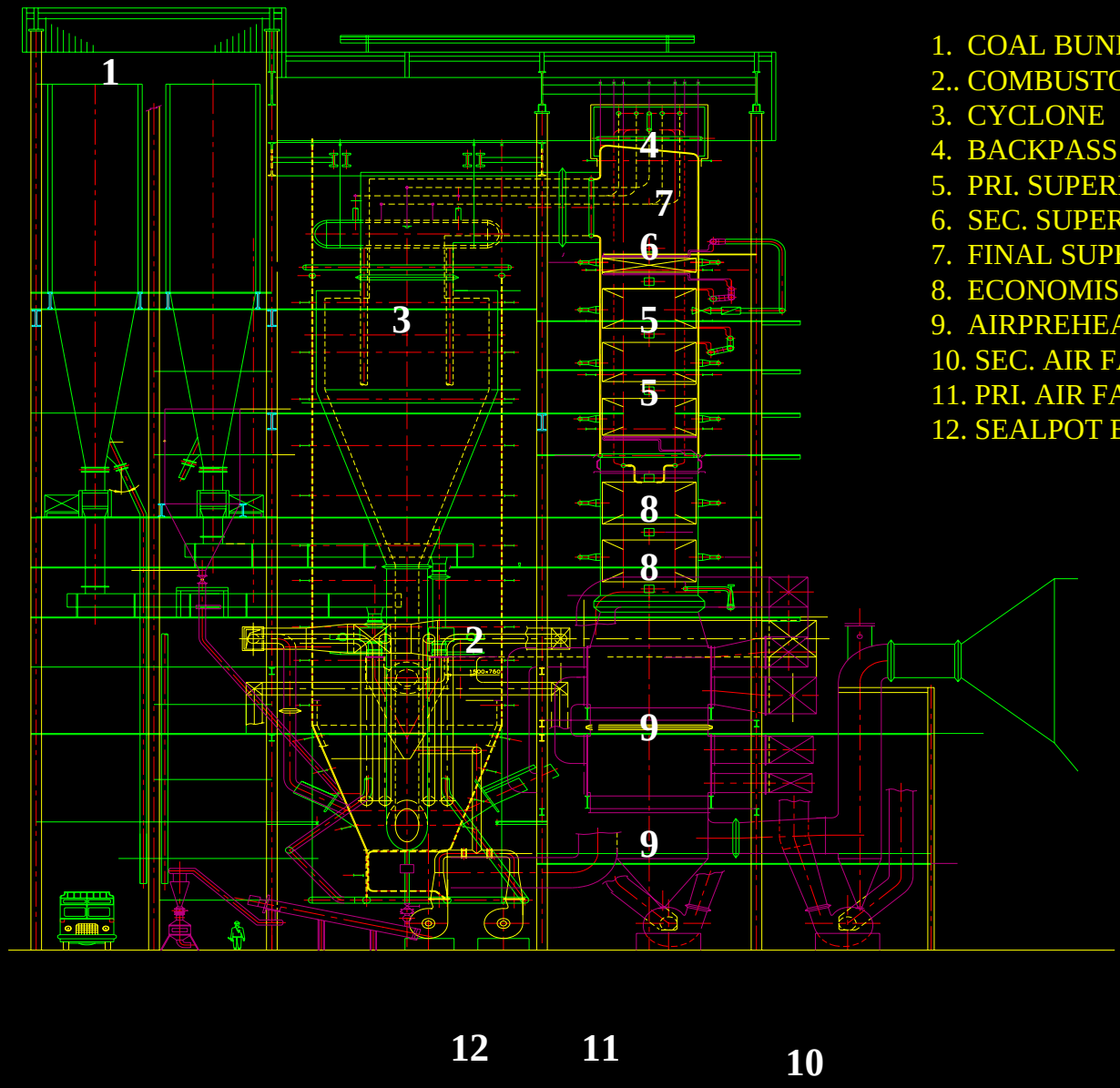


Arrangement (Plan) of SLPP CFBC Boiler



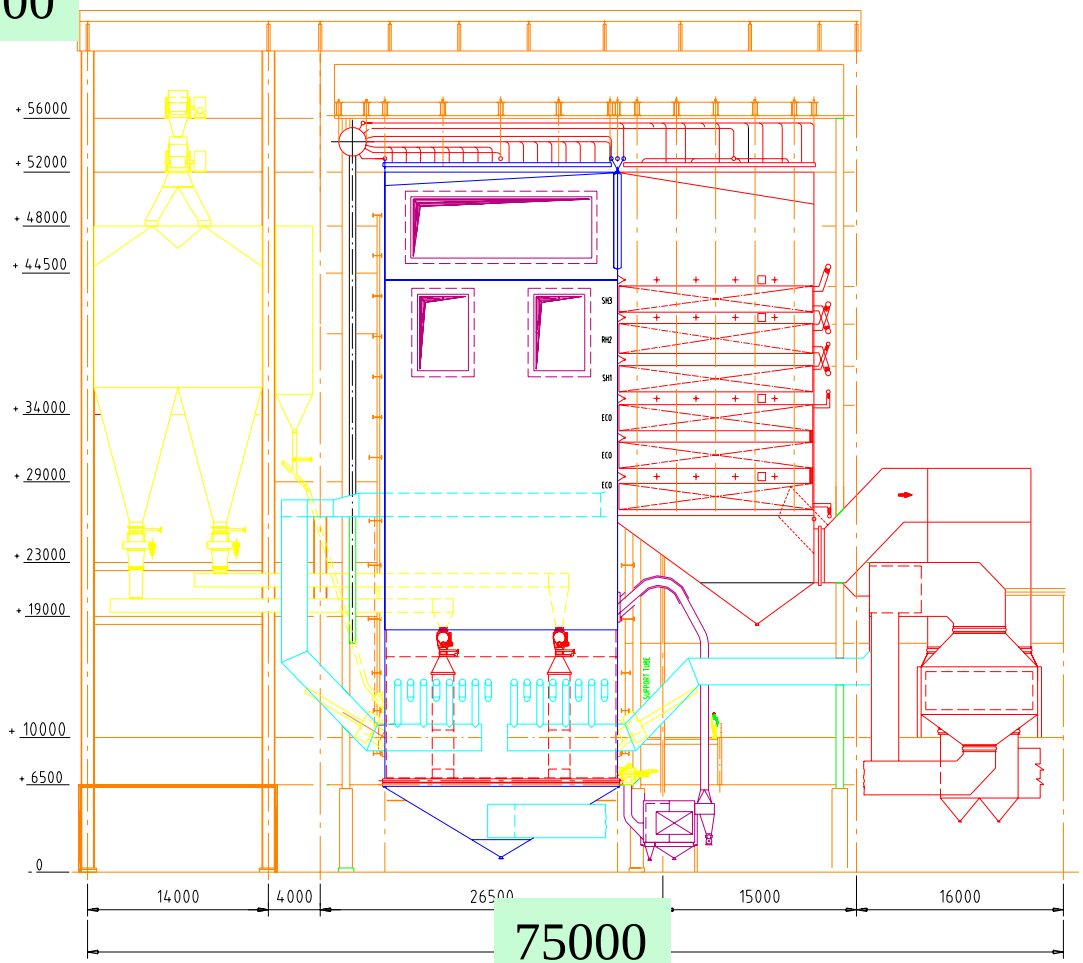
View of 175 t/h CFBC Boiler at Bilt Graphics

SINARMAS
175 T/H
CFBC
BOILER



1. COAL BUNKER
2.. COMBUSTOR
3. CYCLONE
4. BACKPASS
5. PRI. SUPERHEATER
6. SEC. SUPERHEATER
7. FINAL SUPERHEATER
8. ECONOMISER
9. AIRPREHEATER
10. SEC. AIR FAN
11. PRI. AIR FAN
12. SEALPOT BLOWER

64000



75000

Arrangement of 250 MW CFBC Boiler

Economics of using Washed coal /Rejects for Electricity Generation

- Typical -500 MW boiler coal firing coal quantity - 334-t/h coal of 3400kcal/kg ROM coal
- Discard on coal washing will be 66 t/h and after removing 10ton/hr stones & unburnable material (Yield 75 to 80%)
- MW generable in BFBC = 50t/h x 0.31 efficiency 1600kcal/kg //860 = 28 MW
- A 25 MW BFBC boiler can be selected

Typical parameters for BFBC boiler utilising rejects

- Coal washery rejects fired Bfbc boilers can be designed to suit varying customer requirements of steam parameters.
- Typical parameters of a 25 MW BFBC boiler : Main steam flow: 115 tph MS pressure: 67 kg/cm2g MS temp: 485 Deg C FW temp: 200 Deg C Rejects consumption approx: 35 to 55 tons /hr
- Range of washery rejects Proximate analysis could be M-8-15 % ASH 55-72 % VM- 12 -18 % FC- 10-18 % HHV - 1700 -2500 kcal/kg
- A 500 MW unit needs ROM coal of about 2.6 million tons per year maximum. With 80 % yield in a washery rejects qty will be around 20 %. Rejects will be able to generate 25 to 30 MW. For a 2x500 MW station a 60 MW BFBC boiler is recommended by BHEL

Typical parameters for BFBC boiler utilising rejects (contd..)

- The para meters of a 60 MW-- BFBC station
- Main steam flow: 275 tph MS pressure: 95 kg/cm2g MS temp: 540 Deg C FW temp: 235 Deg C Rejects coal consumption approx: 100 tons /hr - with CV of 2200 kcal/kg

Electricity Costs with ROM coal vs. Washed Coal study Parameters

-Plant configuration selected 2 x 500 MW sub critical unit along with both 2x 60 MW BFBC or 125 MW CFBC for burning rejects

-Unit heat rate 2400 for 500 MW, 2500 for 125 MW CFBC and 2800 for BFBC (kcal / kw hr)

-PLF for 500 MW units pegged at 85% and increase in PLF due to washed coal not taken

-For CFBC 125 MW 85% PLF used, Incase of BFBC units 90% PLF taken due to the fact these units in the country operate very near 100% PLF

-Coal consumption – t/hr for worst coal of lower range calculated based on HHV.

-Benefits due to Coal handling plant capacities not considered, even though this will be a major benefit when considered for the entire power plant.

Electricity Costs with ROM coal vs. Washed Coal study Parameters (contd..)

-Range of practical yields as given by International / National Coal Preparation Industry as 80, 75, 70 percent used for 44 to 34 and 44 to 30 and 30 to 24 percentage ash levels.

- Cost of coal as on date is taken as supplied by CIL, and washing charges and example calculation for arriving at cost per ton of washed coal is indicated

-Aux.Power consumption 7 % to 4%

Cost of installation- Rs .3.5Cr/MW to 3.18 Cr/MW

Savings in Boiler cost--% 3 to 20% as per projections

Cost of installation of power plant to Boiler Investment cost ratio - 75: 25

Specific oil consumption reduction as per CEA norms in ml/kwhr

Electricity Costs with ROM coal vs. Washed Coal study Parameters (contd..)

From the Units sent out with FBC rejects power generated / utilization Million kw-hr Variable cost of Electricity with CFBC generation in Paisa worked out.

As per CEA /GOI norms for Power project investment

O &M charges 2.5 % to 2.2 % -- Debt -@ 70%

Interest on Debt @ 9.5% - Equity @ 30%

Return on Equity @ 14% -Depreciation @ 5% of 90% of capital cost

-O&M @ 2.5 to 2.2%--Interest on working capital provision -Total fixed charges

Units sent out million kw-hr

Fixed expenditure paisa / kW hr

Total charges Electricity costs / kW hr paisa

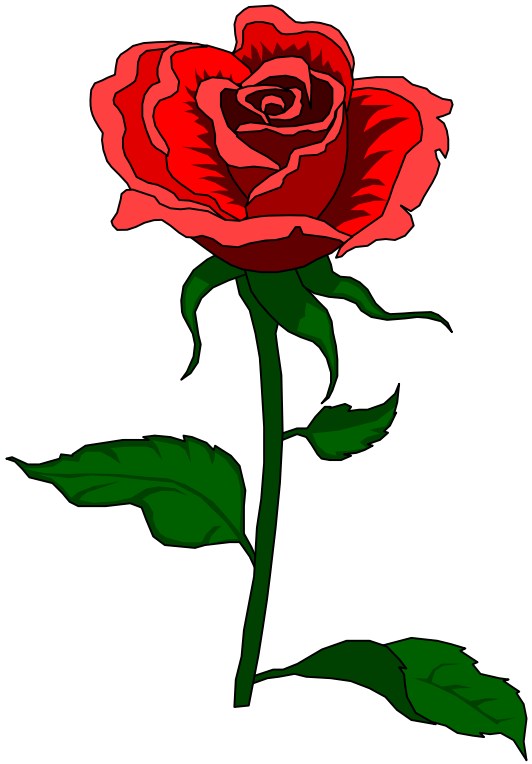
Return on Investment 14%

Electricity Costs with ROM coal vs. Washed Coal

Results of Electricity cost study

Total charges- Electricity costs / paisa per kw-hr comes down from approx 138 paisa to 119 paisa

For unwashed ROM coals to Washed coals in favor of washed coal. It shall be noted that this is an illustration to demonstrate the cost savings that would accrue in Electricity generation if washed coal is used, without considering Transportation costs and in actual projects variations are likely in the parameters considered.



Thank You