

Conference :- Heat Rate Efficiency Summit 2023

Topic :
Retrofitting and Modernization
Practices

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Council of Enviro Excellence

**3RD HEAT RATE
EFFICIENCY
SUMMIT 2023**

3rd Heat Rate Efficiency Conference

Retrofitting and Modernization Practices

By Pradeep Kumar Sharma & Vikas Kukreja
System & Control Engineering
BHEL PEM Noida



About BHEL

India's Flagship Engineering and Manufacturing Company

 Making in India since 1964; supplying products & services globally

 India's largest engineering and manufacturing enterprise in energy and infrastructure sectors

 Maharatna PSU; Government of India holding of ~63%

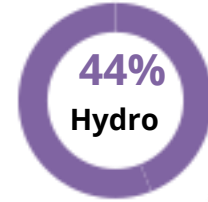
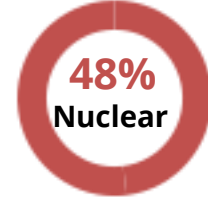
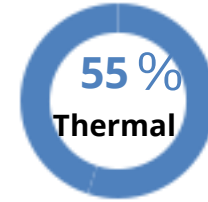
 Only company associated with all 3 stages of

 Indian Nuclear Power Program

Sole Indian supplier of Li-ion batteries of next

Chandrayaan 3 spacecraft with BHEL manufactured Batteries for Lander Module & Propulsion Module and Titanium

BHEL's Share in Nation's Total Installed Power Generation Capacity



PROJECT ENGINEERING MANAGEMENT
HRDI&ESI COMPLEX, NOIDA

PAN India Presence

Manufacturing Units



Regional Marketing Centers



Regional Offices



Service Centers

Projects Sites in India & abroad

Repair Units

BHEL –At a Glance

Providing Light & Life... to a billion people



Power



Transmission



Transportation



Defense & Aerospace



Oil & Gas



Energy Storage

197+ GW power generating capacity installed in India & abroad

89 countries Global Footprints

11 GW+ power generating capacity built

5400+

Total Patents and Copyrights

29000+ Human Capital Base
8300+ Engineers

R&D spend -over 2.5% of the annual revenue

180+ Product Offerings



Majority of satellites launched by ISRO are equipped with BHEL -supplied space grade solar panels and space grade lithium-ion batteries



PEM's Journey

The Road Travelled ...



PROJECT ENGINEERING MANAGEMENT
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500 MW set engineered

Engineering of 500 MW BTG and system engineering for 500 MW EPC



First Export project engineered

Engineering of Tripoli, Libya



Engineering of Thermal Plant with Supercritical Parameters

First project with supercritical parameters engineered, Barh



Engineering of Advance class GT based CCP

First project, 353 MW Hazira engineered



Engineering with Ultra Supercritical Parameters

First thermal plant with Ultra supercritical parameters & ACC engineered -North Karanpura



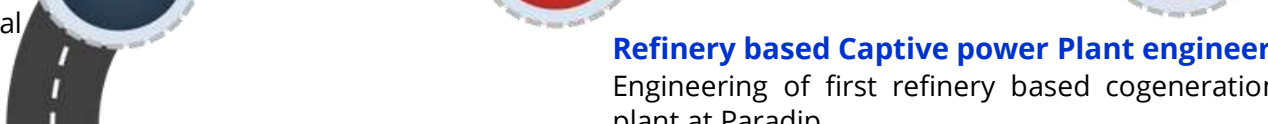
Refinery based Captive power Plant engineered

Engineering of first refinery based cogeneration plant at Paradip



2008 First PFBR based nuclear

Engineering of Bhavini, Kalapakkam project commenced



Engineering for Largest export order

Engineering of largest export order - Maitree Bangladesh commenced

FGD Engineering

Engineering of first FGD project NTPC Dadri commenced



First Nuclear power plant with Civil

Engineering of first nuclear project with Civil, 2X700 MweGHAVP commenced



And Miles to go...



Project Engineering & Execution



Providing Complete Engineering Solutions for

...Enabling BHEL to provide complete EPC solutions...

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Thermal

- Subcritical Set -67MW to 600MW
- Supercritical Set -660MW & 800MW
- Flue Gas Desulfurization (FGD) system

~142 GW Executed

Nuclear

- 500MWe PFBR (TG island)
- 700MWe PHWR (TG island with Civil)
- 300MWe AHWR (Conceptual Design)

~22 GW Under execution

CCPP, Hydro, R&M

- Combined Cycle Power Plants 350MW to 800MW
- R&M & Hydro



Concept Stage
Feasibility Studies

Proposal Engineering
Techno-commercial offer
Technical guarantees

Project Engineering
Basic/System Engineering
Construction Deliverables
Front-end engineering for units
Design improvements

Project Execution
Commercial Management

Support to site
Procurement of BoP/BoPs
E&C Support
Troubleshooting

HISTORY OF R&M OF THERMAL POWER PLANT

At the time of Independence, power generating capacity in the country was 1362 MW only. Many new units were installed after Independence. Up to 1980, the total installed capacity of thermal power stations was 14,250 MW which comprised many imported units of sizes from 30 MW to 120 MW. The average Plant Load Factor (PLF) of thermal power stations during 1976-77 was 56%. Due to deteriorating PLF, thermal generation fell short of the targets, leading to a power shortage of about 11%, as compared to the requirement at that time.

Roving teams of the Central Electricity Authority (CEA) consisting of experts from CEA, BHEL and ILK:

- to improve the operation of the units.
- to identify the defects/reasons for poor performance and
- to prepare action plans to address the problems.

PLF
Based on the reports of Roving Teams, many State Electricity Boards (SEBs) prepared schemes for attending to the problems identified and included them in their annual plans. However, lack of adequate funds with some of the States led

to lower priority being given to such programmes though there was an urgent 1977-78 51.4%

Year deteriorating

HISTORY OF R&M OF THERMAL POWER PLANT

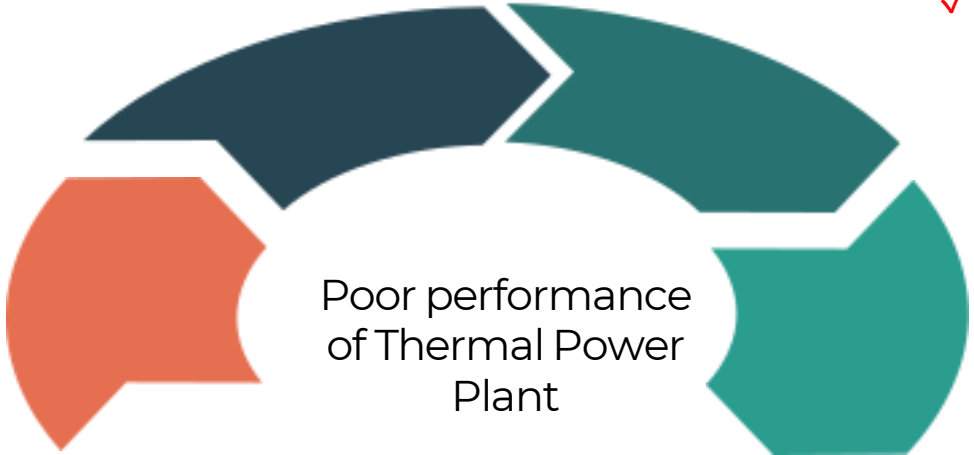
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✓ Inadequate and non timely availability of spare parts especially for imported equipment.

✓ Lack of resources with SEBs even for making payments against supplies , services and fuel (coal supplies)

✓ Operation and Maintenance (O&M) deficiencies causing prolonged and repetitive forced outages.

✓ Design deficiencies, manufacturing and generic defects.



✓ Deteriorated coal quality being supplied as compared to the deigned quality. (high ash content and contained stones, boulders, shale and sand)

✓ Inadequate trained manpower for the plant O&M.

Stabilization of 200/210 MW Units

Early 1970s, Plan to install bigger units of size 200/210 MW and BHEL started the manufacture of these units. During 1979-82 ,Many such units were installed (about 5,000 MW) . Installed units faced a lot of problems since the beginning and the PLF of these units was as low as 40%. To overcome, Stabilization Teams comprising engineers from CEA, BHEL, ILK and the concerned power utilities were formed to visit all 200/210 MW units and identified the problem areas. BHEL and other original equipment manufacturers carried out the required modifications.

Most of the modifications were carried out free of cost by the manufacturers on all the existing units irrespective of occurrence of the failure. The modifications were also incorporated for future units. As a result, the performance of these units substantially improved and got stabilized. Because of that efforts, 200/210 MW units are now operating at a level comparable to the best in the world. **At present, there are about 160 units of 200/210 MW comprising about 44% of the total India's thermal installed capacity**

WHY R&M OF THERMAL POWER PLANT

The objective of R&M of Thermal plant is to equip the running units with latest modified and augmented technology equipment/system to improve their performance in terms of the following;

- Output
- Reliability
- Efficiency & Availability
- Reduction in maintenance requirement
- Ease of maintenance and minimizing inefficiencies

| SL | Five Year Plan | No of Units Identified | Capacity (MW) | SOURCE |
|----|------------------|------------------------|---------------|---|
| 1 | 7 th | 163 | 13,570 | CEA Review of R&M Implementation in Thermal Power Sets (March 2017) |
| 2 | 8 th | 194 | 20,869 | |
| 3 | 9 th | 127 | 18,991 | |
| 4 | 10 th | 14 | 3,445 | |
| 5 | 11 th | 59 | 16,146 | |
| 6 | 12 th | 65 | 17,301 | |
| 7 | 13 th | 29 | 4,800 | |

WHY R&M OF THERMAL POWER PLANT

- ✓ 73% of total generation comes from coal/ lignite based power plants.
- ✓ First 200 MW unit was installed at Obra in 1977.
- ✓ First 500 MW unit was commissioned way back in 1984 in Trombay.

Renovation and Modernization (R&M) and Life Extension (LE) have been recognized as cost effective options to achieve additional generation from existing units at low cost and in shorter period. However, new environmental norms which have come into existence post 2015 and increase in penetration of renewables, the R&M cannot be limited to the improvement of performance only. There needs to be all-inclusive approach for R&M of TPPs.

- ✓ R&M was launched in 1984 as Phase-I programme during 7th Plan.
- ✓ 100 units of 500 MW operational for 20+ years need R&M in future.

- ✓ Replacement of the existing obsolete items of equipment in operation with those with more efficient and of latest designs incorporating the state-of-the-art technologies and improved metallurgy.
- ✓ Improve plant efficiency at base load and part load operation as well to integrate with Renewable energy.

Objective of R&M is shifted from 'generation maximization' to 'efficient flexible operation with lower emissions'.

- ✓ Substantial increase in capacity addition.
- ✓ Reduced gap between demand and availability of power.
- ✓ Reduction in the power plant emissions.
- ✓ Integration of RE power to make the plants flexible.
- ✓ Alternative to high capital cost new TPP installations.

R&M domain has to expand to make the plants flexible in an efficient manner with lower emission.

BETTER UTILIZATION OF EXISTING POWER PLANTS : R&M

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Renovation and Modernisation, Uprating & Upgradation of Existing Power Plants:

- Reduced emissions
- Increased efficiency
- Extended lifespan

Upgrading old and inefficient equipment with more efficient technologies

Less fuel for generating the same amount of electricity Reducing need for immediate replacement

- Various R&M and Uprating & Upgradation works by BHEL:
- 1X228 MW Koradi EE R&M (Earlier 1X210 MW)
 - 3X210 MW Wanakbori 4,5 & 6 ESP Retrofit
 - 1x200 MW + 1X210MW GSECL Ukai TG R&M
 - 250 MW RVUNL ChhabraU#4 ESP Restoration
 - 3X500 MW NTPC Ramagundam Stage II ESP R&M
 - 1X70 MW TANGEDCO KodayarHEP RMU (Earlier 1X60 MW)
 - 3X27.5 MW KSEBL KuttiyadiHydro RMU (Earlier 3X25 MW)

| R&M JOBS | Project |
|--------------------|-----------|
| BTG | 5 |
| C&I | 1 |
| DeNOx | 3 |
| Duct | 6 |
| Replacement ESP | 1 |
| Flexible Operation | 11 |
| HMI Upgradation | 7 |
| Turbine | 1 |
| Grand Total | 33 |

Increasing the power output by 18 MW (heat rate improvement by 7.8 %) at the Koradi TPS results in reduction in CO2 emissions by ~ 0.14 million metric tons per year.

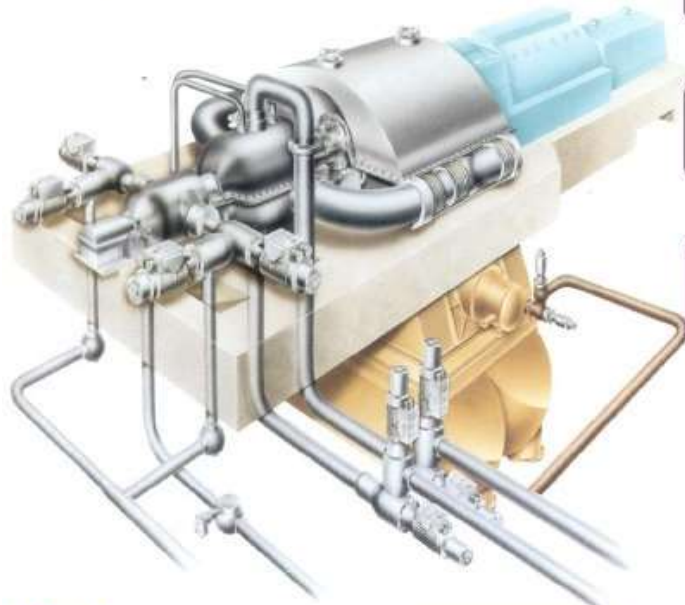


R&M PACKAGES IN THERMAL POWER PLANT

- ❑ Now a days packaging system is being adopted by many of the utilities wherein the comprehensive BTG package is divided into small small packages for better delivery and easy overall monitoring of the jobs by respective utilities.
- ❑ That is the reason that tenders for comprehensive R&M packages are minimal in the market.
- ❑ Following are the package wise categorization of the R&M Packages



STG R&M IN THERMAL POWER PLANT



❖ *M/s Leningrad Metal Works, Russia*
(from 1962 -1976 upto 210 MW power output range)

❖ *M/s Siemens A.G., Germany*
(Ongoing since 1976 upto 1000 MW power output range)

1969

First 100MW Steam turbine (LMW Design);
MS Parameter : 90 ata / 535 °C

1973

First 210MW Steam turbine (LMW Design);
Parameter : 130 ata / 535 °C / 535 °C

1982

First 210MW Steam turbine (KWU Design);
Parameter : 150 ata / 535 °C / 535 °C

1983

First 500MW Steam turbine (KWU Design) ;
Parameter : 170 ata / 537 °C / 537 °C

1994

First In-house design 250MW Steam Turbine
Parameter : 150 ata / 537 °C / 537 °C

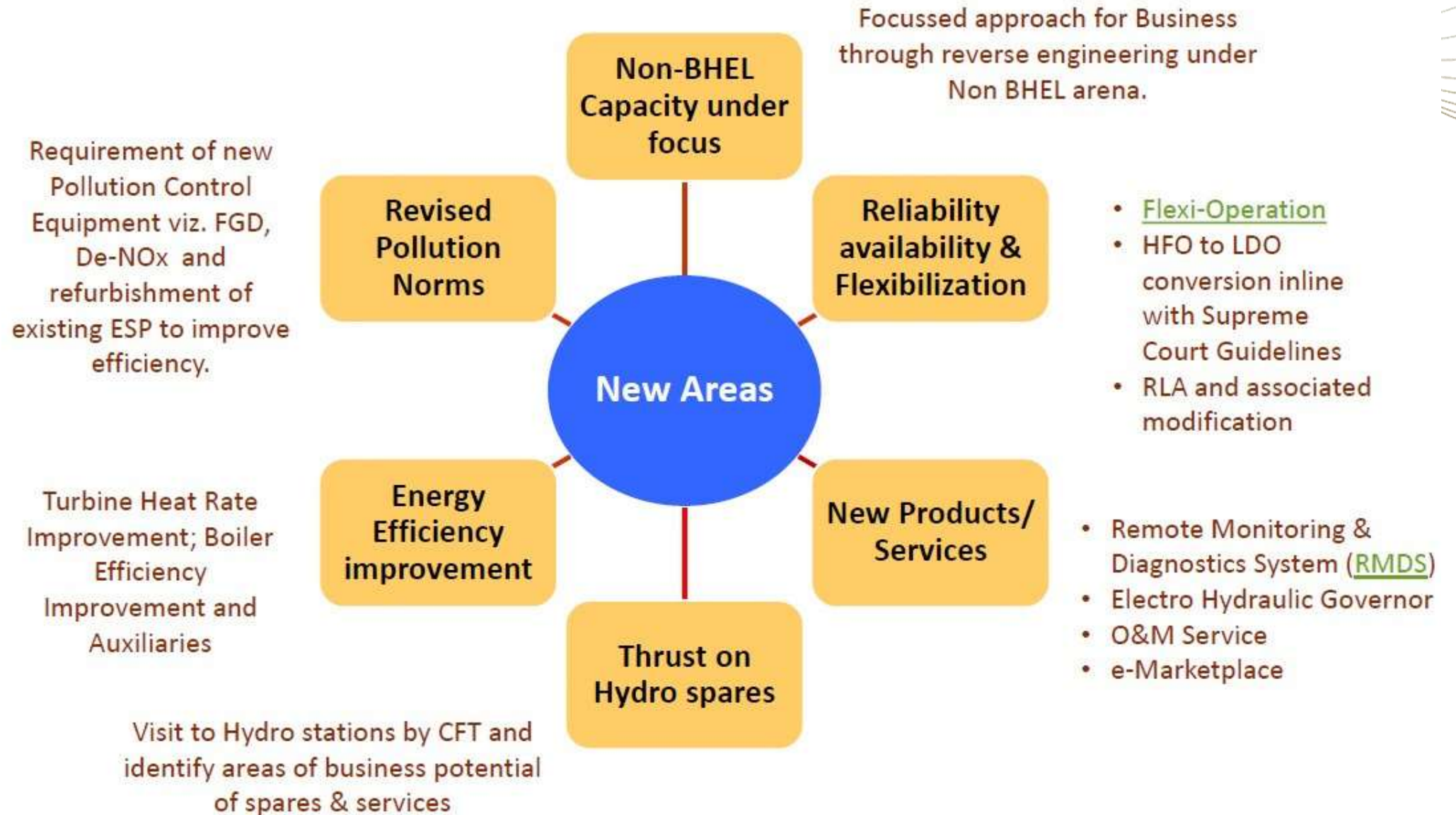
2001

First 500MW Steam turbine with Advance blading
Parameter : 170 ata / 537 °C / 537 °C

2003

First 540MW Steam turbine for Nuclear Power Plant
Parameter : 40 ata / 254 °C / 234 °C

NEW AREA OF FOCUS IN R&M OF THERMAL POWER PLANT



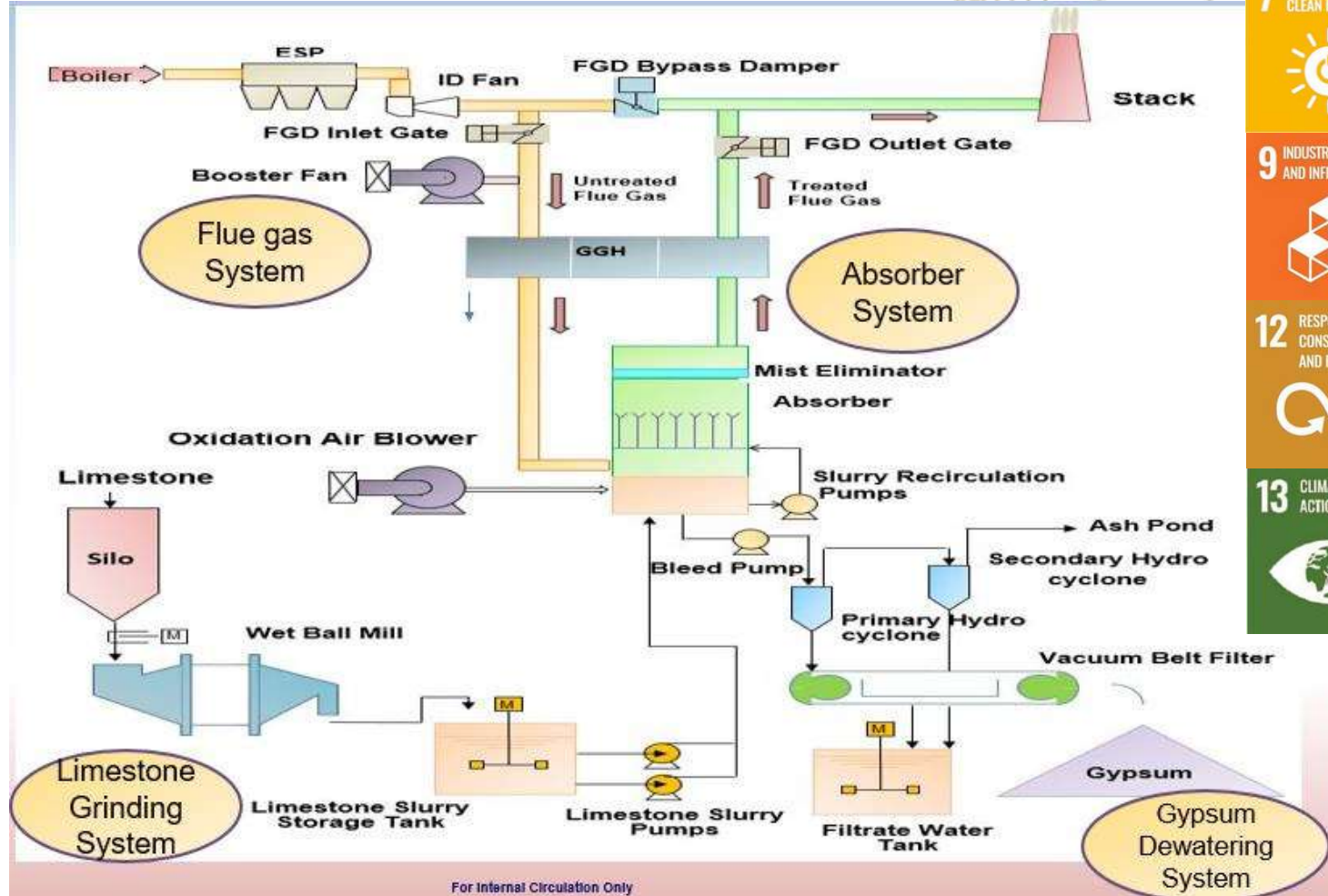
EMISSION NORMS IN THERMAL POWER PLANT

| | |
|--|---|
| <p>Sulphur Di-oxide</p> <p>Technology options</p> | <ul style="list-style-type: none"> : 600 mg/Nm³ (upto 31.12.2016 for rating < 500 MW) : 200 mg/Nm³ (upto 31.12.2016 for rating ≥ 500 MW) : 100 mg/Nm³ (01.01.2017 onwards for all ratings) <p>BHEL offers Wet limestone based FGD Package for Sox abatement</p> |
| <p>Nox</p> <p>Technology options</p> | <ul style="list-style-type: none"> : 600 mg/Nm³ (before 31.12.2003) : 300 mg/Nm³ (01.01.2004 – 31.12.2016)* : 100 mg/Nm³ (01.01.2017 onwards)** <p>* Modification of Firing System ** Separate De NOx Plant (SCR/SNCR)</p> |
| <p>Water Requirement (with cooling tower)</p> <p>Technology Options</p> | <ul style="list-style-type: none"> : 3.5 m³/MWh (max.) (upto 31.12.2016) : 2.5 m³/MWh (01.01.2017 onwards) <p>Air-cooled condenser (North Karanpura 660 MW)</p> |
| <p>Particulate matter</p> <p>Technology options</p> | <ul style="list-style-type: none"> : 100 mg/Nm³ (before 31.12.2003) : 50 mg/Nm³ (01.01.2004 – 31.12.2016) : 30 mg/Nm³ (01.01.2017 onwards) <p>BHEL in-house technology (ESP Retrofitting)</p> |

FGD RETROFIT IN THERMAL POWER PLANT

Flue Gas Desulphurization (FGD)

- India is contributing ~15% of global SO_x emissions.
- Minimizing SO_x emission limit to 100 mg/Nm³ (earlier 600 for < 500 MW & 200 for > 500 MW) in existing thermal power plant.
- BHEL is currently executing orders aggregating more than 34 GW for 65 Absorbers sets of various power utilities including 1320 MW project overseas



7 AFFORDABLE AND CLEAN ENERGY

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

13 CLIMATE ACTION

Reduction in SO_x emission of 0.1 million metric tons per year

RMDS IN THERMAL POWER PLANT

Remote Monitoring and Diagnostic solution (RMDS) having Predictive Analysis with Prescriptive solutions resulting in:

- Conversion of forced outage to planned outage
- Increase in operational efficiency & reduction in operational cost
- Prediction of spares & service requirement

Phase-I : BHEL has developed and established technology driven Remote Monitoring & Diagnostic System (RMDS) for data monitoring without predictive analysis.

Phase-II : BHEL is in the process of developing Predictive Analysis with Prescriptive solutions through Analytical software.

Based on initial advisories, the spares business is likely to increase in order to stabilize the machine. Once the system gets stabilized, there will be dip in spares demand owing to predictive & prescriptive maintenance. However, the services business will grow.

RMDS implemented in 500 MW Vijayawada & 250 MW Trombay

Flexible operation of TPP to support Renewable Energy (RE) integration for increasing green energy utilization

Flexible operation allows power plants to operate at part load operation. Plant can fast ramp up and down as per the load demand in the grid thereby reducing heat and energy losses associated with constant full-load operation.

- BHEL, Raigarh & 1X500MW Sagardih developed Flexible Operation solution at Adani REGL 1X600 MW, Raigarh & 1X500MW Sagardih
- Achieved a ramp rate of 3% per minute keeping all major parameters within stable and deviation limits.
- Other Projects:
 - WBPDCL : 1X210MW Bakreswar & 1X250MW Santaldih
 - TATA: Trombay U#8 (1X250 MW)
 - ADANI: Mahan Energen Limited Singrauli (U#2) (1X600 MW)

Enabling power stations to facilitate RE integration and ensuring energy security



Unit # 6 of Koradi Thermal Power Station is a 210 MW unit commissioned in 1982. The Boiler is BHEL design and turbine is LMZ design manufactured by BHEL.

OBJECTIVES

- a) Up rating capacity to level of 215 MW with the same steam input of existing design
- b) Improve Unit heat rate.
- c) Modernize Turbine control system with state of art technology.
- d) Extending unit life by 15-20 years of reliable operation.
- e) Reduce auxiliary power consumption.

TG performance improvement by

:

- a) Improved blade profile
- b) Optimized flow path
- c) Improvement in TG Shaft sealing
- d) Introduction of Electrohydraulic governing
- e) Removal of Bauman stage in LP turbine
- f) Introduction of Individual heater bypass instead of group bypass.

Koradi R&M Project was included as BEST PRACTICES MANUAL for Thermal power plant in Conference of Indian Industries (CII) in 2020



Thank you

Thanking You
on Behalf of!



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