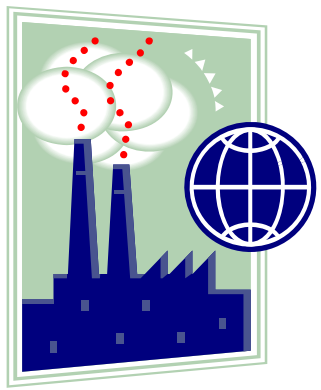
Maintaining/improving thermal efficiency of aged coal-fired thermal power stations



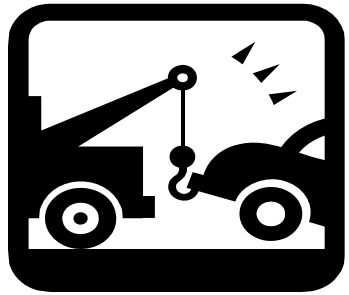
- **NTPC's present installed capacity 24,640 MW.**
- **NTPC's Capacity consists of 13 coal based and 7 Gas based power stations.**
- **This capacity is made of up 104 machines .**
- **Comprising 72 thermal units of 60 / 110 / 200 / 210 / 500 MW rating.**
- **22 Gas Turbine units.**
- **10 Steam Turbines in combined cycle mode.**
- **Presently venturing in to Hydro/Nuclear Energy fields**

Coal has economic advantage but it is challenging from Environment Point

- *Advantages:*
  - **Abundant coal reserves (about 7% of world reserve)**
  - **Comparatively stable prices**
  - **Energy Security due to indigenous availability**
- *Challenges:*
  - **Environmental impact (High CO2, Sox, NOx,Ash etc)**
  - **Efficiency Improvement**
  - **Poor Calorific Value and quality**
  - **Increasing Capital Cost due to environmental mitigation measures**
  - **Competitive Pricing of Power**

WHY MAINTAIN ?

- **Just like a car requires routine servicing & maintenance on a regular basis followed by major overhaul after say, 100,000 Km a power plant has to undergo R&M works after around 20 years or 100,000 hours of operation.**



- **Routine maintenance and overhauls are expected to take care of the general upkeep of the equipment & ensure plant performance over long periods of operation.**

- **However periodically, the equipments have to undergo Renovation & Modernization activities to sustain the High Performance Levels & extend Life.**

WHAT TO MAINTAIN ?

- **Metallic components operating at high temperature and pressure like Boiler pressure parts, Turbine rotors, etc are subject to Creep (permanent elongation in the direction of stress) which, if unchecked, can take the equipment to an unsafe zone of operation & leading to failure of the component & the equipment.**
- **Ageing & natural wear & tear of the Power Plant components.**
- **Changes of inputs & outputs within the battery limits of the Plant that may have taken place over a prolonged period of operation, such as deterioration of coal & water quality & power delivery requirements imposed by the regulatory authorities.**

COMPULSION FOR MATIAINING !

- **To comply with fast changing environmental / statutory standards.**
- **Technological obsolescence especially in the area of Instrumentation, which has a high electronic content.**
- **Lifting the performance of very old fleet vintages to levels achieved by contemporary state-of-the- art units by leveraging technology development in various areas such as Upgrades, Repowering, Improvement in efficiency, use of superior materials, etc.**

Present Emission norms in India

- **Suspended Particulate matter**
  - **Present norm – 150 mg/NM ^{3}**
- **SOx**
  - **No norm to limit Sox emission from power plant**
  - **Control through dispersion by Stack Height**
- **NOx**
  - **At present no norm for NOx**

CPCB NORMS FOR STACK HEIGHT OF THERMAL POWER PLANTS	
Unit Capacity	**Stack Height H (m)**
Less than 200/210 MW	**H = $14(Q)^{0.3}$, where Q is the emission rate of SO_2 in kg/hr.**
200/210 MW or less than 500 MW	**220**
500 MW and above	**275**

With growing environmental concern, norms are likely to be tighter in future

Emission Control Technologies

SPM Control

SPM

- *–Use of large size ESP with advanced controller*
- *–Adoption of Bag Filter to remove particle below 10 micron size*
- *–Adoption of Flue gas conditioning to improve the performance of Old ESP*

SOx Control

- **–Use of Flue gas Desulfurisation (FGD)**
- **–In bed sulfur capture in AFBC/CFBC/PFBC**

NOx Control

- **•Combustion Control**
  - **Low NOx burner**
  - **Overfire Air**
- **•Post Combustion Treatment**
  - **Selective Catalytic Reduction (SCR)**
  - **Selective Non Catalytic Reduction (SNCR)**

Steps for Renovation & Modernisation

- **RLA Studies to be carried out for components more than 20 years life or more than 1 lack operating hours.**
- **Activities resulting into improvement in availability, reliability, generation and safety**
- **Activities to sort out design deficiency, generic problems and obsolescence of equipment**
- **Activity relating to technological upgradation**
- **Activity relate to improvement in environmental conditions**
- **Augmentation of coal milling system arising due to poor quality of coal**

International Best Practices in R&M

- **Internationally, R&M program are focused on leveraging technological developments in various fields to upgrade candidate plants & bring them at par with contemporary machines**
- **The techniques generally used include:**
  - **Modern CDA techniques to assess the condition of the plant accurately.**
  - **Upgradation & modernization packages, which result in improved performance & even increased, plant capacity with lower generation costs.**
  - **Product/equipment design and reverse engineering.**
  - **Adoptio n of reliability based financial risk optimisation techniques.**
  - **Upgradation of Process parameters to enhance efficiencies.**
  - **Adoption of innovative Repowering options.**

Strategy for Renovation

- **Statutory Residual Life Assessment (RLA) of Boiler is mandated after 1,00,000 hours.**
- **R&M is generally carried out when the unit has operated for 1,00,000 hours or after 20 years, and at periodic intervals after that.**
- **To minimize the downtime & consequent loss of generation the implementation of the R&M program is matched with the major overhauls of the units, which occurs only once in 3-4 years.**
- **Consequently, R&M works in NTPC stations extend over a longer period of time compared to construction of new projects, but this strategy is beneficial in commercial terms in the long-run.**

Categorization of activities

1. One to one replacement

2. To comply with fast changing Environmental / statutory standards / guidelines.

3. To cater to technological obsolescence.

4. To cater to changes in the input / output of the plant – coal, water, power evacuation.

5. Mega R&M – Technology Upgrades & High End Solutions in Units which are nearing 200,000 Hrs of Operation to bring the performance in line with contemporary Units.

Age Profile of NTPC Units

Age (hours)	No. of Units			
	Thermal	Gas Turbines	Steam Turbines in Combine Cycle mode	Total
0 to 25,000	8	0	0	8
25000 to 50,000	6	4	2	12
50,000 to 75,000	7	3	0	10
75,000 to 1,00,000	7	8	5	20
100,000 to 1,50,000	25	7	3	35
1,50,000 to 2,00,000	16	0	0	16
More than 2,00,000	3	0	0	3
Total	72	22	10	104

The average age of NTPC units works out to 100,000 operating hours in respect coal fired units & about 80,000 hours for the gas based units.

Issues in improving efficiency

- Coal quality related problems
  - Variations in GCV of coal fired from multiple sources
  - Maintaining consistency in combustion
  - Difficulty in combustion optimization
  - Use of imported coal / blending
  - Higher Dry Flue gas losses

Issues in improving efficiency

- Airpreheater Efficiency
  - Advanced development in rotary Airpreheater technology
  - Leakages from seals deterioration from Overhaul to Overhaul
  - Baskets fouling/reduced heat transfer
  - Effectiveness in online cleaning of baskets

Issues in improving efficiency

- Consistency in mill performance
  - Pulverised coal Fineness deterioration with grinding elements wear and tear causing poor combustion and rise in unburned coal in fly/bottom ash
  - Useful & effective life of grinding elements
  - Availability of proven and reliable online CO monitoring technology for optimising combustion excess air

Issues in improving efficiency

- Optimization of soot blowing operation by increasing blowing effectiveness through intelligent soot blowing systems by assessing heat flux/ slagging
- Water/steam side depositions in aged boilers
- Mismatch in boiler outlet steam temperatures at LHS / RHS and high spray levels

Issues in improving efficiency

- Increased fan loads due to duct leakages calling for need to make design changes in profile, orientation and layout
- Fans designed for high efficiency
- Expansion joint failures- metallic and fabric
- Avenues for ash utilisation
- Sea water usage for ash disposal
- Proven and reliable flame monitoring technology
- Equipment for online coal quality measurement.

Issues in improving efficiency

- State of the art tools for boiler maintenance
  - Robotic Tube thickness scanning/mapping
  - In-situ internal oxide layer thickness measuring devices
  - Probes to detect hydrogen damage/caustic gouging
  - Lightweight boiler scaffolding for quick erection
  - Tube cutting/fin cutting/chamfering tools
  - Mass Welding technologies

FACTORS FOR IMPROVING EFFICIENCY OF AGED POWER PLANTS

- TECHNO ECONOMIC SOLUTIONS AVAILABLE
- LAYOUT CONSTRAINTS FOR REPLACEMENT
- LIFE EXPECTANCY AFTER RENOVATION
- TECHNOLOGIES AVAILABLE &PROVENNESS
- IMPROVEMENT IN EFFICIENCY EXPECTED
- STRINGENT ENVIRONMENTAL REGULATIONS
- FUNDING LIMITATIONS & PAYBACK PERIODS

CONCLUSION

- **NTPC LOOKING FORWARD TO ADOPT NEW TECHNOLOGIES**
- **ANALYSIS/UNDERSTANDING OF NEW TECHNOLOGIES**
- **PROVENNESS OF TECHNOLOGIES**
- **ENVIRONMENTAL ASPECTS GIVEN PRIME CONCERN**

Asia Pacific conference is the ideal platform for utilities to understand and adopt such technologies with specific action plan.

THANK YOU