Best O&M Practices – Energy Efficiency
Dahanu Thermal Power Station
Bureau of Energy Efficiency
Knowledge Exchange Platform – 2015

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Energy Auditor
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- Approach
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  - Efficiency based maintenance practice
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Company Profile

- Infrastructure
- Generation
- EPC
- Transmission
- Distribution
- Trading

RINFRA WINS D&B AWARD
- Rinfra bagged the Top Indian company award under the ‘Construction - Infrastructure Development’ category at the prestigious Dun & Bradstreet Corporate Awards 2012.

RINFRA: LIFE IN THE FAST LANE
- Rinfra ranked amongst India’s top 5 fastest growing companies by Businessworld ahead of Reliance Industries, L&T, Wipro, Infosys, NTPC and many other industry bigwigs.
Dahanu Thermal Power Station
DTPS Geographical location

Well connected by Western Railway & National Highway No. 8

At a distance of 128 Kms from Mumbai

Surrounded by two natural Creeks - Savata and Dandi

Surya Dam nearby – 32 kms
About DTPS

The setting up of the Plant was approved in 1989 for 2 x 250 MW capacity.

First Synchronization
Unit – I - January 1995
Unit – II - March 1995

Station Commercial operation
- July 1995/Jan 1996

Till date Running Hours
Unit – I - 1.57 lacs
Unit – II - 1.54 lacs
DTPS Journey towards Excellence

1998 ISO 9001

1999 ISO 14001
1999 QIP/SIP/EMP
2000 RAMCO ERP Package implementation

2001 ISO Upgradation
2003 SAP & ESS implementation
2004 British Safety Council Audit

2005 Benchmarking CII
2005 Six Sigma drive I
2005 Mercer HR study
2006 OHSAS 18001

2007 SA 8000
2008 Integrated Management System

2008 ISO 27001
2009 SAP in place of RAMCO
2010 BS EN 16001
Continual improvement is ensured through improvement plans for IMS, ISMS, SA and EnMS
Process

- Safe
- Reliable
- Sustainable
- Efficient
- Economical
- Clean

- Communication: Log-books
- Team Work: Environment
- Standardisation: Systems

- NEW TECHNOLOGY
- INNOVATION
- MONITOR
- OPTIMISE
- CONTROL
- REVIEW
Selection of process for Improvement

- Stretch targets
- Benchmarking
- Resource optimisation
- Energy conservation
- Efficiency improvement
- Legal requirement
Approach for Improvement

Data Collection  Validation & conversion in reportable format  GAP Analysis  Probable solutions  Pilot testing  Monitor

Brainstorming  D-logbooks  Event analysis  MIS reports  Technical Validation

OEM data  Benchmarking  Other plant visit  Other site inputs

Once the optimisation process reached the desired results solutions are finalized through ISO systems and controls are placed
Energy Conservation - Techniques

- R & M
  - Online Energy monitoring System

- Fuel Switch
  - HFO to LDO

- New technology introduction
  - Modular Scaffolding
  - APH Brush Seals
  - Thermo-vision applications

- Optimisation
  - Innovative approach
  - Equipment running hours
  - VFD applications
  - Soot blowers
  - Standardization
  - “PROMT” maintenance
  - Coal Blending
Online Energy Monitoring System

- **FGD Process parameter**
  - 4-20 mA
  - 16 channel
  - SCANNER

- **PCR-1 Process parameter**
  - 4-20 mA
  - 24+16 channel
  - SCANNER
  - RS485

- **PCR-2 Process parameter**
  - 4-20 mA
  - 24+16 channel
  - SCANNER
  - RS485

- **Compressor Room Process parameter**
  - 16 channel
  - 4-20 mA
  - SCANNER
  - RS485

- **ELAN SERVER**
  - LAN
  - RS485

- **ELAN VIEW**
  - Single Login

- **6.6 KV Swgr U-1**
  - 24+16 channel

- **6.6 KV Swgr U-2**
  - 16 channel

**Continual Improvement**

*Total 219 New Energy Meters Installed (HT&LT)*
Daily Energy Deviation Report

<table>
<thead>
<tr>
<th>HT Auxiliaries</th>
<th>Average as on Date (2011-12)</th>
<th>Base Value</th>
<th>Operational Value</th>
<th>Maintenance Value</th>
<th>Run Value</th>
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<tbody>
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<td>&gt;7350</td>
<td>&gt;7450</td>
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<td>7450</td>
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<td>CEP-1A</td>
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<td>CEP-2A</td>
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<td>CEP-2B</td>
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<tr>
<td>ECW - 1A</td>
<td>298</td>
<td>&gt;305</td>
<td>&gt;330</td>
<td>&gt;355</td>
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<tr>
<td>ECW - 1B</td>
<td>308</td>
<td>305</td>
<td>330</td>
<td>355</td>
<td></td>
</tr>
<tr>
<td>ECW - 1C</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ECW - 2A</td>
<td>318</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ECW - 2B</td>
<td>307</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ECW - 2C</td>
<td>304</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TURBINE TOTAL(Kw)</td>
<td>16420</td>
<td>3.13</td>
<td>16942</td>
<td>-88</td>
<td>36.40</td>
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</tbody>
</table>

Average Power Consumption Rate As On Date

**Maintenance Control:**
- This control includes
  - Detail Analysis Of Problems
  - Solution In Terms Of New Alternative Technology
  - Repair or Replacement.
## Monthly Building Energy Deviation Report

### Format No: 10.1.3B

<table>
<thead>
<tr>
<th>Plant Buildings</th>
<th>Average as on Date (2011-12) kWh</th>
<th>Base Value kWh</th>
<th>Operating value &gt; kWh</th>
<th>Operational Control kWh</th>
<th>Maintenance Control kWh</th>
<th>Actual Value kWh</th>
<th>Deviation w.r. to Base Value kWh</th>
</tr>
</thead>
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<tr>
<td>Fire station</td>
<td>1726</td>
<td>1990</td>
<td>&gt;1990 - 2110</td>
<td>&gt;2110 - 2216</td>
<td>&gt;2216</td>
<td>1732</td>
<td>-258</td>
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<tr>
<td>OH centre</td>
<td>654</td>
<td>782</td>
<td>&gt;782 - 1049</td>
<td>&gt;1049 - 1102</td>
<td>&gt;1102</td>
<td>451</td>
<td>-331</td>
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<tr>
<td>Security Office</td>
<td>2534</td>
<td>2325</td>
<td>&gt;2325 - 2888</td>
<td>&gt;2888 - 3032</td>
<td>&gt;3032</td>
<td>2160</td>
<td>-165</td>
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<tr>
<td>ADM</td>
<td>14994</td>
<td>14088</td>
<td>&gt;14088 - 18280</td>
<td>&gt;18280 - 19194</td>
<td>&gt;19194</td>
<td>13061</td>
<td>-1027</td>
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<tr>
<td>Main store</td>
<td>5645</td>
<td>6463</td>
<td>&gt;6463 - 7760</td>
<td>&gt;7760 - 8148</td>
<td>&gt;8148</td>
<td>4642</td>
<td>-1821</td>
</tr>
<tr>
<td>Canteen</td>
<td>8678</td>
<td>8224</td>
<td>&gt;8224 - 13040</td>
<td>&gt;13040 - 13692</td>
<td>&gt;13692</td>
<td>6560</td>
<td>-1664</td>
</tr>
<tr>
<td>DM Plant</td>
<td>1778</td>
<td>2320</td>
<td>&gt;2320 - 2688</td>
<td>&gt;2588 - 2822</td>
<td>&gt;2822</td>
<td>1804</td>
<td>-516</td>
</tr>
</tbody>
</table>

*All Buildings Of Plant Are Covered Under Monitoring*
Innovative Maintenance Approach

- Modular Maintenance concept
- “PROMT” Priority on Managing Performance Trends maintenance
- Innovative Maintenance Approach
- Efficiency Based Maintenance Concept
- Energy Monitoring System
Modular Maintenance Concept

- A maintenance procedure that allows the replacement of major assemblies in a minimum amount of time and expenditure is called “module” (e.g. HP turbine module, CW debris filter, Primary & Secondary fans rotor, Boiler feed pump cartridge, vacuum pump, CW pump)

BFP Cartridge

HP Turbine Module
BFP Cartridge Replacement

<table>
<thead>
<tr>
<th>Boiler Feed Pump</th>
<th>Saving Achieved</th>
</tr>
</thead>
</table>
| Performance Based BFP cartridge Replacement (serviced cartridge) | BFP-1A = 461 kw  
BFP-2A = 656 Kw  
BFP-1B = 347 Kw |
Air pre heater basket cleaning

- During overhaul APH baskets of cold end are removed and water jet cleaning at 40 ksc pressure is carried & chocking is removed.
Modular Scaffolding
Overhaul Best Practices

- Generator decoupling within 17 Hrs of unit De-synchronization saving 5 days in Generator activities.
- Modular concept – maintain HP module, which has reduced overhaul time by 6 days
- Use of SAP PM and PS module for effective overhaul management
- Round the clock working.
- Zero idle time in & between succeeding /preceding activities
- Cross-functional teams for Safety and Quality.
PROMT Maintenance Concept

- “PROMT” - Priority On Managing Performance Trends maintenance (e.g. wise Flue gas duct leakages, HP heaters performance)

Flue Gas duct leakages

HP Heaters parting plate leakages
Identification of Air Ingress in Boiler & Flue gas Duct – Unit Running Condition

- **Visual Inspection**: Daily routine rounds
- **Sound/Temperature observations**: Offline 02% measurement & analysis
- **Offline flow measurement (Pitot Tube)**: Third Party
- **Air ingress checklist**: Scheduled
Defects Management process

1. Notification raised in SAP
2. Discussed in Daily plant meeting
3. Categorized Aux power / Heat rate

Running Defect:
- Yes: Planning done to attend
- No:
  - Equipment Shutdown
  - Short Shutdown
  - Major Overhaul
Arresting Of Duct Leakages in Every Opportunity

Air Ducts

Flue Gas Duct
Efficiency based O&M

- Along with preventive and predictive maintenance, scheduled equipment changeovers focus is shifted to Efficiency based O&M

- Equipments where standby are available, less power consuming or more efficient kept in service most of the time.

- Reasons for lower efficiency are find out and maintenance is planned accordingly.

- Coal mill O&M is based on the output and quality of the pulverised coal.
Innovative Operation Approach

Intelligent Soot blower operations

Efficiency Based operations

Innovative Operation Approach

Coal Blending Mechanism

SOG, SOP & Checklists, Digital Logbooks

Optimization

Benchmarking
Process Optimisation

- Process optimization is the discipline of adjusting a process so as
  - to optimize specified set of parameters
  - without violating system constraint.

- Process optimization is a continuous process it's a “Journey not Destination”

- “The savings are recurring”

- Investment - NIL
Soot blowers conventional schedule

- DTPS is provided by 56 Water wall soot blowers and 18 Long retractable soot blowers in convective zone of super heaters, re-heaters & economizer tubes

- Effects of conventional approach
  - Timed based approach typically results in over cleaning.
  - Excessive use of steam is an economic penalty for this type of operation.
  - Results in the around 80% variation in the main-steam & re-heat temperatures.
  - High furnace exit flue gas temperature.
  - Lower efficiency.
  - Erosion of tubes.
Intelligent approach

- “Intelligent soot blower operation” is an innovative strategy to achieve optimum steam generator operation & performance by controlling the cleanliness and fouling of heat transfer surfaces.

Development

The Soot blowers are operated in a pair left and right side of each bank. The data is collected and logged.

Typical data includes:
- Fluid temperatures at inlets and outlets of each convection pass including the temperature before and after attemperators.
- Operating pressures (drum, super heater, re-heater)
- Boiler exit gas temperatures before and after Soot blowing
- Flue gas excess Oxygen (O2) – at the boiler exit
- Fluid flow (main steam, reheat steam, feed water)
- Fuel and total air flow
- Boiler tubes metal temperature before and after Soot blowing
- Flue gas temperature at different zones before and after Soot blowing
- Coal Elevations in service.
Intelligent approach

- After Analysis of the data collected for 3 months for each LRSB a schedule is prepared for operation of long retractable soot blowers in group as per the locations.

<table>
<thead>
<tr>
<th>Day</th>
<th>LRSB numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>65, 57, 58, 69</td>
</tr>
<tr>
<td>3</td>
<td>66, 59, 60, 70</td>
</tr>
<tr>
<td>5</td>
<td>63, 68, 71</td>
</tr>
<tr>
<td>7</td>
<td>64, 67, 72</td>
</tr>
<tr>
<td>9</td>
<td>61, 62, 73, 74</td>
</tr>
</tbody>
</table>

- Group operation of water wall soot blower like 1, 4, 8, 12 (in gap of 3) or 1, 6, 11 (in gap of 4) gives better results than simply whole set (1-14, 15-28, 29-42) sequential operation previously carried out.

- The scheduled of WWSB operations kept the same but the sequence of operation is changed.
Flow Chart for Scheduler Software

Start

Enter:
1. Reheater Temp
2. BT
3. Mill Combination
4. Last LRSB operated
5. Last LRSB operated Date

Is (present date - last operated LRSB date) > 3?

Is (present date - last operated LRSB date) ≥ 2?

Is RH temp ≤ 535°C?

Is BT ≥ 25°?

Display "DON'T OPERATE LRSB"

Display "OPERATE LRSB"

Is mill combination = "ABCD"?

Is last operated LRSB include LRSB 64?

Date = Last operated LRSB date + 3

Generate DATE schedule

Date = Last operated LRSB date + 2

Generate DATE schedule

Generate LRSB schedule

Generate LRSB schedule

Display LRSB schedule
## Development of Soot blower Scheduler

### Please Enter

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVG Re-heater Temp</td>
<td>532</td>
</tr>
<tr>
<td>AVG Burner Tilt Position</td>
<td>22</td>
</tr>
<tr>
<td>Coal Mill Combination Eg. abcd/cdef/abef</td>
<td>abcd</td>
</tr>
<tr>
<td>Last operated LRSB Among 62,63,64,65,66,68</td>
<td>63</td>
</tr>
<tr>
<td>Last operated LRSB Date</td>
<td>14/07/2011</td>
</tr>
</tbody>
</table>

### Schedule

<table>
<thead>
<tr>
<th>Date</th>
<th>LRSB Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>16/07/2011</td>
<td>64, APH-A,61,60,APH-B</td>
</tr>
<tr>
<td>18/07/2011</td>
<td>65, APH-A,62,59,APH-B</td>
</tr>
<tr>
<td>20/07/2011</td>
<td>66, APH-A,73,74,APH-B</td>
</tr>
<tr>
<td>22/07/2011</td>
<td>63,58, APH-A,68,57,APH-B</td>
</tr>
<tr>
<td>24/07/2011</td>
<td>63, APH-A,71,72,APH-B</td>
</tr>
<tr>
<td>26/07/2011</td>
<td>64, APH-A,61,60,APH-B</td>
</tr>
</tbody>
</table>
# Development of Soot blower Scheduler

<table>
<thead>
<tr>
<th>Conventional Approach</th>
<th>Intelligent approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time based fix interval approach.</td>
<td>Need and condition based approach.</td>
</tr>
<tr>
<td>Over cleaning or under cleaning of tubes.</td>
<td>Optimum cleaning of tubes.</td>
</tr>
<tr>
<td>Excessive use of steam.</td>
<td>Optimum use of steam.</td>
</tr>
<tr>
<td>Variations in Main steam and Reheat steam temperatures than the design.</td>
<td>Main steam and Reheat temperature are maintained in a narrow band nearer to design</td>
</tr>
<tr>
<td>Probability of erosion of tubes high due to over cleaning.</td>
<td>value.</td>
</tr>
<tr>
<td>Attemperation spray required in on higher side.</td>
<td>Probability of erosion of tubes is very less.</td>
</tr>
<tr>
<td>High boiler exit flue gas temperature.</td>
<td>Attemperation spray required in very low or nil.</td>
</tr>
<tr>
<td>Lower efficiency.</td>
<td>Low boiler exit flue gas temperature.</td>
</tr>
<tr>
<td>No logical explanation.</td>
<td>Higher efficiency.</td>
</tr>
<tr>
<td>High TPM.</td>
<td>Manual decision is replaced by logical software.</td>
</tr>
<tr>
<td></td>
<td>Low TPM.</td>
</tr>
</tbody>
</table>
Development of Soot blower Scheduler

MS Heat rate loss kcal/kwh
- Average Loss 2005-2009: 2.74
- Average Loss 2009-2014: 0.7

RH Heat rate loss kcal/kwh
- Average Loss 2005-2009: 1.45
- Average Loss 2009-2014: 0.92
Optimization of Cooling water Pumps operations

Running of 4th CW pump is optimized as per:
- Tide Level
- Sea water temperature,
- Condenser Vacuum,
- Generator Current,
- MS Flow

0.1% reduction in APC is achieved
Phase wise evolution of optimisation

**Phase-I**
- Pump continuous running
- Pump start stop as per operator experience no logical explanation
- 3.5 – 3.0 mtr

**Phase-II**
- Standardized with logical explanations
- 1.8 – 1.5 mtr

**Phase-III**
- Low load operations
- 1.0 – 0.8 mtr
Enhancement of Energy Efficient Equipment Operation

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Auxiliary</th>
<th>Running + Stand By</th>
<th>Average Power consumption (kw)</th>
<th>Energy Efficient Rating</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>BFP-1A</td>
<td>1+1</td>
<td>7010</td>
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<td>2</td>
<td>BFP-1B</td>
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<td>7200</td>
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<td>3</td>
<td>CEP-1A</td>
<td>1+1</td>
<td>555</td>
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<td>4</td>
<td>CEP-1B</td>
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<td>440</td>
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<tr>
<td>5</td>
<td>ECW-1A</td>
<td>2+1</td>
<td>299</td>
<td>1</td>
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<td>6</td>
<td>ECW-1B</td>
<td></td>
<td>310</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>ECW-1C</td>
<td></td>
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</tr>
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<td>8</td>
<td>COAL MILL-1AB</td>
<td>2+1</td>
<td>1149</td>
<td>1</td>
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<td>9</td>
<td>COAL MILL-1CD</td>
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<td>COAL MILL-1EF</td>
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<td>1252</td>
<td>3</td>
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</table>

APC can Reduced by 0.19 %

Increased Running Hour of EE Equipment
## Applications of Variable frequency drives

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<tbody>
<tr>
<td></td>
<td></td>
<td>Nos</td>
<td>Nos</td>
<td>kwh</td>
<td>kwh</td>
<td>kwh</td>
<td>Rs in Lakhs</td>
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<td>1</td>
<td>Coal Mill Seal Air Fan</td>
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<td>473</td>
<td>222</td>
<td>251</td>
<td>30.55</td>
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<td>2</td>
<td>CEP-1B</td>
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<td>1</td>
<td>583</td>
<td>435</td>
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<td>3</td>
<td>CEP-2A</td>
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<td>1</td>
<td>583</td>
<td>435</td>
<td>148</td>
<td>90.50</td>
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<td>ACW Pump</td>
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<td>75</td>
<td>44</td>
<td>31</td>
<td>4.50</td>
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<tr>
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<td>Ash SILO</td>
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<td>1</td>
<td>68</td>
<td>42</td>
<td>26</td>
<td>6.50</td>
</tr>
<tr>
<td>6</td>
<td>LDO Pump</td>
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<td>1</td>
<td>10</td>
<td>8</td>
<td>2</td>
<td>2.00</td>
</tr>
<tr>
<td>7</td>
<td>Drinking Water Pump</td>
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<td>1</td>
<td>40</td>
<td>24</td>
<td>16</td>
<td>5.00</td>
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<tr>
<td>8</td>
<td>Service Water Pump</td>
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<td>1</td>
<td>16</td>
<td>10</td>
<td>6</td>
<td>2.00</td>
</tr>
<tr>
<td></td>
<td><strong>0.11% reduction in APC</strong></td>
<td></td>
<td></td>
<td><strong>1847</strong></td>
<td><strong>1219</strong></td>
<td><strong>622</strong></td>
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</table>
Blending Mechanism

Two different grades of coal are mixed uniformly in predetermined proportion for achieving desired calorific value. Blending of coal is done on conveyor and as per requirement.

Two / three different grades of Coal are lifted from separate locations. Lifting rates / flow is predetermined and is monitored through Belt Scale by the operator as well as from Control room.

These different grades of coal are fed on a single conveyor (three locations). There are minimum two transfer points where these three grades of coal get mixed uniformly (due to free fall of about 8-10 meter) before being fed to bunker. During bunkering, there is another free fall of coal. The process itself ensures proper blending of two/three coal.
Adoption of Imported Coal in DTPS

1995-96

1st Phase 1999

2nd Phase 2001

3rd Phase 2006

- Coal quantity reduced
- Unit Load increased
- Emission level reduced
- Aux power reduced
- Flame stability improved
- formation of clinker & soot is minimum
- Overall performance improved

1. Loading factor improved & PLF achieved more than 100% consistently
2. Failure of equipments in CHP & AHP reduced
3. Plant Reliability and availability improved by reduction in tube leakages, equipment break down
4. Environmental parameters improved
5. Aux. power reduced

Commercial operations
F-grade Coal

Indian raw coal + Imported coal

Wash coal + Various grades of imported coal

LCV coal is generally used as a partial substitute of Indian wash coal due to acute shortage of washed coal. The same level of performance is maintained.

P E R F O R M A N C E
Use of Thermography

- Portable thermo-vision camera is used for
- Insulation surveys
- Coal pipe chocking
- Monitoring bearing temperatures
- Monitoring Valve passing (reducing DM make-up)
- Finding cold spot (air ingress)
- Finding hotspot
  - Bunkers
  - Coal yards
  - Motor terminals
  - Motor winding
  - DDC panel
1] Boiler Insulation Survey

Insulations to all manholes done
Boiler Insulation Survey

Before Insulation

After Insulation
Piping Survey

Main Steam (MS), Cold Reheat (CRH) & Hot Reheat steam piping (HRH) insulation survey
Reducing Steam and water leakages

Check list for checking DM WATER Leakages at
BOILER & TURBINE SIDE

Unit - ___

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At boiler side all the drains are connected to IBD tank and if there is steam from vent or water draining through the IBD tank drain then we should check as below. (Prior to checking ensure soot blowing valve S-135 is in closed condition).

- All Low Point Drain Header Valves should be closed.
  - Boiler drain from Bottom ring Header valve close
  - Economizer inlet Drain valve close
  - Economizer outlet valve close
  - Low Point Header drain to IBD tank Valve close

- MS-101 & 102 drain valve close
- SH Header drains valves close
- EBD drain valves B-60 & 61 close
- CBD Drain B-66 & 67 valve close
Thank you