National Workshop on DISSEMINATION of BEST PRACTICES in THERMAL POWER PLANTS FOR GHG EMISSION REDUCTION

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Prudent O&M Practices and Energy Conservation Technologies

LANCO KONDAPALLI COMBINED CYCLE POWER PLANT

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Senior Manager (Operations)
LANCO Kondapalli Power Limited
Contents

• Company profile
• Indian Electricity Scenario
• Combined cycle power plant thermodynamic cycles & overview
• Importance of O&M
• Outline of plant improvement initiatives undertaken
• Prudent Operations and Maintenance practices
• Energy Conservation Technologies adopted
3,460 MW Under operation and 4,636 MW under construction
## Lanco Kondapalli Power Plant

### A Snapshot of LKPL

<table>
<thead>
<tr>
<th>Installed Capacity</th>
<th>1476 MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phases</td>
<td>Phase-1</td>
</tr>
<tr>
<td></td>
<td>368 MW</td>
</tr>
<tr>
<td>Configuration</td>
<td>2 9E GT+ 1 ST</td>
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<tr>
<td>Fuel</td>
<td>Gas/Naphtha</td>
</tr>
<tr>
<td>Fuel source</td>
<td>ONGC/RIL/HPCL</td>
</tr>
<tr>
<td>Water Source</td>
<td>Krishna River</td>
</tr>
<tr>
<td>Transmission Lines</td>
<td>2X 220 KV</td>
</tr>
<tr>
<td>Beneficiaries</td>
<td>Andhra Pradesh</td>
</tr>
</tbody>
</table>
### All India Installed Capacity (in MW) of Power Stations

(As on 31.10.2016)

<table>
<thead>
<tr>
<th>Ownership/Sector</th>
<th>Region</th>
<th>Thermal</th>
<th>Nuclear</th>
<th>Hydro</th>
<th>RES* (MNRE)</th>
<th>Grand Total</th>
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<tbody>
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<td>Coal</td>
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<td>25057.13</td>
<td>918.89</td>
<td>212468.90</td>
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</table>
Per capita consumption

India: 1025 Kwhr
USA: 13000 kwhr
China: 3000 kwhr

Deficit

Deficit energy (MWHR): 0.7%
Deficit Peak MW: 1.6%

-Peak Demand Met ~ 160 GW
-Daily Consumption-3318MU
COMBINED CYCLE

Combined gas–steam power plant.
Importance of O&M

Role of O&M

- Optimum Plant availability
- Highest Reliability
- Safety of the plant and personal
- Meeting the statutory and legal requirements
- Energy management
- Minimization of Maintenance Costs
- Optimization of Inventory
- Retrofits
- Upgrades
- Reduced Downtime and Surprise Breakdowns
- Managing OEMs
- Managing third parties
- Preservation of equipment
Challenges to O&M

- Training and retaining the O&M professionals
  - Early detection of defects helps to take preventive action and equipment tripping and failures can be avoided
- Technology obsolesce
- Stringent environment emissions
- Skilled man power availability for turn around
- Preservation activates
  - Short term
  - Long term
- Equipment aging
  - O&M requirement also increases due to higher requirement of maintenance and higher price of spares than spares supplied with main equipment
- Statutory compliance - PAT under Energy conservation Act
- Cyclic operation as per dispatch instructions
- Liquid fuel operation
  - More maintenance (Maintenance factor is 1.5)
- Managing BOP spares
  - Most of the vendors do not extend support and force for upgrades/replacement
Plant Modifications

Number of modifications proposed: 239

Number of modifications executed: 181

Number of modifications in process: 20

Number of modifications under review: 38
Plant Improvements

Safety & Reliability Improvements

- 2\textsuperscript{nd} VG fan installation for Gas turbines for load compartment cooling
- Over head LO tank installed for STG
- 2\textsuperscript{nd} DC LOP from Switchyard battery bank for Steam turbine
- Additional pressure switch installed in LO circuit to start the stand by pump early in case of running pump trips
- UPS extended to STG main lube oil pumps control supply
- UPS extended to GT TCC 240 V emergency supply
- 2\textsuperscript{nd} water injection pump (Indigenous) for Gas turbines NO\textsubscript{X} control.
- Lift oil and DC LOP start sequence modification for Gas Turbines
- GT Generator winding temp inputs shifted to main processors from \textless C\textgreater core in Mark V controls
- DM water transfer pumps remote start from DCS
- Fire water line shifted from under ground to above ground
- STG PLC up gradation
- DM plant PLC up gradation
- VFD installation for HPBFPs to reduce the feed water header pressure to avoid boiler tube failures
- Instrument air compressors control supply segregation to avoid tripping of all compressors.
- Dehumidifier provided in STG EHC fluid tank to control the moisture content in EHC fluid
- Provided back up supply for STG AOP and JOP from AC Emergency Board.
- Provided separate suction lines for STG JOPs to avoid pumps failure
- GT Lift oil pumps relocated to outside the Generator Compartment
Plant Improvements

Performance & Capacity Improvements

- Evaporative cooler installation for Gas Turbines
- Gas turbine up rates
- Gas Turbine bypass stack temp measurement for identifying the diverter damper seals passing
- Water injection optimization for gas turbine
- Gas Check metering (Ultrasonic flow meter and Gas chromatograph)
- Excellance performance tool for offline performance monitoring
- Cooling tower PVC fills replacement
- Gas heaters air damper adjusted to reduce the stack losses
- Auxiliary cooling water given to vacuum pump seal water cooler to improve the vacuum pump efficiency
- Ultrasonic leak detector for passing valves identification
- Thermal imager purchased for scanning Boiler duct and switch yard hot spots
- LR grade phosphate application for boiler water treatment to reduce the boiler blow down losses.
- HRSG HP out let steam temperature increased from 511 to 514°C for STG output improvement.
- 9FA GTs with DLN and technology adopted for phase-2&3
9FA GTs with DLN Technology

**Natural resources saving**

<table>
<thead>
<tr>
<th>Water</th>
<th>1,27,750 M3</th>
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<tbody>
<tr>
<td>Natural gas</td>
<td>5,97,08,160 SM3/Anuum</td>
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<tr>
<td>Reduction in GHG emission</td>
<td>1,35,823 Tons/Anuum</td>
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<tr>
<td>Standard Operating procedures</td>
<td></td>
</tr>
<tr>
<td>-------------------------------</td>
<td></td>
</tr>
<tr>
<td>LOTO PTW system</td>
<td></td>
</tr>
<tr>
<td>Weekly/Monthly equipment changeover and availability checks</td>
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</tr>
<tr>
<td>Station Performance Monitoring (PLF, Heat Rate, APC) using ExcelANCE performance tool.</td>
<td></td>
</tr>
<tr>
<td>Check metering for natural gas</td>
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</tr>
<tr>
<td>Optimum loading of the Gas turbines with the available gas and Load scheduling</td>
<td></td>
</tr>
<tr>
<td>Periodic (alternate days) GT compressor Online wash.</td>
<td></td>
</tr>
<tr>
<td>Offline compressor wash quarterly (or based on compressor fouling)</td>
<td></td>
</tr>
<tr>
<td>Optimum water Injection to maintain the Nox below statutory limits.</td>
<td></td>
</tr>
<tr>
<td>Daily Water Consumption Monitoring.</td>
<td></td>
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<tr>
<td>Bypass stack and Main stack temperature Monitoring.</td>
<td></td>
</tr>
<tr>
<td>Jumper register and review</td>
<td></td>
</tr>
<tr>
<td>Near miss reporting, analysis and preventive action</td>
<td></td>
</tr>
<tr>
<td>Incident Reporting and Analysis to identify the root cause and implementing corrective and preventive measures.</td>
<td></td>
</tr>
<tr>
<td>Plant modifications for plant safety, reliability and performance improvements</td>
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<tr>
<td>In house technical trainings</td>
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</table>
Prudent Maintenance Practices

Preventive Maintenance.

**MCDT (Machine conditioning diagnostic Tests)**
- Vibrations monitoring (critical equipment fortnightly and non critical equipment monthly).
- Valve passing test with Ultrasonic detector in water and steam circuits (Quarterly).
- Lube Oil and Transformer oil Analysis (Half yearly).
- Thermography for HRSG duct, GT compartments, Switch yard (Half yearly).
- Pipe line thickness measurement (Half yearly)

Corrective Maintenance

Break down maintenance

Root cause Analysis

Equipment History

Scheduled Inspections
- GT – OEM under LTSA
- STG-OEM under LTSA
- GTG & STG Auxiliaries (In-house)
- BOP-In house
ENERGY SAVING MEASURES

- VFDs 2 Nos. installed for HP boiler feed water pumps
- HRSGs cleaning done by Dry Ice Blasting
- Energy efficient fan blades provided for CT fans and GT fin fan
- Corro coating done for condenser cooling water pump internals
- VFDs installed for DM feed pump and DM water transfer pump
- ACW provided for Vacuum pump seal water cooler
- HRSG blow down water diverted to cooling tower fore bay (water and energy saving project)
ENERGY SAVING MEASURES

- Raw water chlorination ejector water modified and booster pump stopped.
- Energy savers installed for plant lighting
- Service water pump replaced with new energy efficient and less capacity pump
- Jockey pump replaced with less capacity pump
- Power saver installed for AC units
- 40 watts Fluorescent Tubes replaced with 20 watts LED tubes in control room
- Turbo ventilators installed for power block building
- Solar fencing provided for plant boundary wall
ENERGY SAVING MEASURES
(LOGIC MODIFICATION)

- During the period of single GT operation (due to short supply of gas), Single HPBFP at 43 Hz frequency and single LPBFP operated by modifying the existing logic.

- Single condenser cooling water pump operated during single GT operation after doing the required logic modification in DCS.

- Instrument air header pressure reduced from 7.8 to 6.8 bar by changing the compressor Load/Unload set points.

- Clarified water pump auto start/stop logic based on Filter water storage tank level implemented. Pump operation reduced by 10 hours a day.
ENERGY SAVINGS AND CO₂ EMISSIONS REDUCTION

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<th>Year</th>
<th>MWHR</th>
<th>T CO₂</th>
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<td>1465</td>
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<tr>
<td>2012-13</td>
<td>3845</td>
<td>3153</td>
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<td>2013-14</td>
<td>4188</td>
<td>3434</td>
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<td>2014-15</td>
<td>1970</td>
<td>1615</td>
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<td>2015-16</td>
<td>3145</td>
<td>2579</td>
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<tr>
<td>2016-17</td>
<td>3154</td>
<td>2586</td>
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VFDs For Boiler Feed Pumps

Approach:
- SULZER make 3x 50% HPBFPs Feed to both HRSGs HP and IP sections
- CGL make 1.5MW motor (motor speed 2975rpm at 50Hz) transmits power to the BFP through a Gearbox (2960/3600)
- HP Drum level Control valve is provided at the outlet of the economizer
- At Full load, HPFW header pressure maintains at 144kg/Cm², whereas Drum pressure maintains at 95bar.
- Pressure drop across the economizer is about 13kg/Cm² at full load, which means that the pressure drop across the Feed Control Valve is 36kg/Cm². Energy saving is possible by reducing the throttling loss.

Various Options:
1. VFD
2. Fluid coupling
3. Impeller trimming
4. Gear box replacing
5. Stage blanketing

VFD is chosen for its flexibility feature

Affinity Laws
\[
\frac{q_1}{q_2} = \frac{n_1}{n_2} \left(\frac{d_1}{d_2}\right)
\]
\[
\frac{\Delta p_1}{\Delta p_2} = \left(\frac{n_1}{n_2}\right)^2 \left(\frac{d_1}{d_2}\right)^2
\]
\[
\frac{P_1}{P_2} = \left(\frac{n_1}{n_2}\right)^3 \left(\frac{d_1}{d_2}\right)^3
\]

Where
Q is flow
\(\Delta p\) is head or pressure
P is power
VFDs For Boiler Feed Pumps

DEAERATOR

△P = 36 kg/cm²

HP Boiler Feed Pumps

Pr: 144 kg/cm²

HP Economizer

Pr: 131 kg/cm²

HP Feed Water CV

Pr: 95 kg/cm²

HP Steam Drum

Steam Drum
**VFDs For Boiler Feed Pumps**

**Data Before & After Installing VFD**

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<tr>
<th>Function</th>
<th>Before</th>
<th>After</th>
<th>Units</th>
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<tbody>
<tr>
<td>Motor Current</td>
<td>120</td>
<td>95</td>
<td>Amps</td>
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<tr>
<td>Control Valve Opening</td>
<td>65</td>
<td>90</td>
<td>%</td>
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<tr>
<td>Feed Water Flow / HRSG</td>
<td>195</td>
<td>195</td>
<td>M³/hr</td>
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<tr>
<td>Discharge Header Pr</td>
<td>144</td>
<td>120</td>
<td>Kg/cm²</td>
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<tr>
<td>Power Consumption</td>
<td>1160</td>
<td>960</td>
<td>kW</td>
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**VFD details**

Model HARVEST-A06.6/180. Rating 1600KW/6.6 KV.180 Amp with cell bypass facility and rated for 45°C. Harvest make MV Drive bypass panel.

**Energy Savings**

<table>
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<th>Station Load</th>
<th>Reduction In Speed</th>
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<td>Base Load</td>
<td>8 %</td>
<td>200 kW</td>
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<td>75% Load</td>
<td>10 %</td>
<td>250 kW</td>
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<td>60% Load</td>
<td>12 %</td>
<td>300 kW</td>
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<tr>
<td>50% Load</td>
<td>14 %</td>
<td>325 kW</td>
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**Pay Back Period**

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<td>Investment in Rs million</td>
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<td>Annual savings in million Units</td>
<td>3.618</td>
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<tr>
<td>Annual savings in Rs Million</td>
<td>12.663</td>
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<tr>
<td>Payback period in Months</td>
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</table>
HRSG inlet pressure Before and after DIB are 370 and 340 mmwc respectively. Improvement is 30 mmwc

STG load improved by 0.2MW

HR improvement due to DIB(Kcal/kwh): 1.12 Kcal
LKPL is having 13 nos. cooling tower ID fans. Hot water from condenser is circulated through the cooling tower where the water gets cooled on evaporation principle. 10 nos. fans blades were replaced with FRP ENCON blades. Total weight of the fan blades assembly got reduced by 25% and blades shape also changed to airfoil to improve the air discharge air flow.

Performance test was carried out after replacement to measure the discharge air flow and energy consumption. Resulted energy savings for each fans: 15 KWh
LKPL is having 16 nos. fin fans in closed cooling water circuit. One fan blades were replaced with FRP ENCON blades. Energy savings: 2.24 kwhr (29%) Investment: INR 55000
Fluglide coating (Corrocoating) done for 2 CW pumps internals to improve pump efficiency through reduction in Hydraulic frictional losses, which results in reduction in power consumption & protection against corrosion & erosion. Resulted Energy savings: 43KWH.

**Various steps in corrocoat**
- Grit blasting
- Coat applied for inner of discharge header, Bowl, Bell moth, inner and outer for the two column pipes and impeller
- Dynamic balancing
- DFT and spark test
VFD for DM water transfer pump

DM transfer pump (18.5kW / 86m³/hr / 4 bar) supplies water for hot well make up and Gas turbine water injection. One pump used to operate on continuous basis with recirculation open.

VFD installed and pump speed reduced by 18% and recirculation got closed.

Energy savings: 6 kwhr (32%)
Lanco Kondapalli Power Limited

**Vacuum Pump Seal Water**

Return water from Vacuum pumps is cooled in Plate Heat Exchanger and pumped to vacuum pumps for sealing purpose through recirculation pump.

Circulating cooling water is used in the PHE for cooling the seal water.

The CCW temperature is usually more than 38°C.

**ACW (Auxiliary cooling water) is provided in place of CCW to improve the vacuum pump efficiency. ACW water temp is in the order of 32 to 35°C**

Condenser vacuum has improved by 3 milli bar and Steam turbine output improved by 200kW.
Chlorination Booster pump

- **Before**
  Chlorination booster pumps suction is from service water header (2 bar).

- **After**
  Clarified water (4 bar) given to Booster pumps suction in place of service water

- Booster pumps stopped during part load operation as low chlorine flow is required

- Savings: 7.5kwhr
Clarified water pump feeds water to HPSF bed. HPSF discharge goes to Filter water storage tank. Filter water application is DM plant feed, service water and potable water. One pump used to operate continuous basis.

FWST level control logic introduced and there by pump operation hours reduced by 10 hours a day. Energy savings: 14.5 kwhr
Energy saver for Plant lighting

- 4 nos. Energy savers installed on Plant lighting MLDBs
- Voltage reduced from 425 to 380 Volts on HV side
- Energy savings: 132kwh per day
Service water pump replaced with less capacity and energy efficient pump. 16kwh savings achieved
Fire water jokey pump replaced with less capacity. 23 kwh savings achieved
POWER SAVER FOR AC UNITS

2 nos. Power savers are installed for AC units. 15% savings achieved
Major equipment like 2 nos. Gas Turbines and one Steam Turbine are located in power block. Originally 4 nos. Air washer units contains blower and circulation pump are installed for cooling and ventilation of power block. 13 Number Eco ventilators were installed on the power block roof to create natural ventilation. Power block temperatures were measured after eco ventilators installation and found normal. By stopping the air washer units, the resulted savings are 65kw per hour. CO2 reduction by 125 T/year.
Solar Fencing

Fence height: 1.2M, Length: 5KM
Battery 12 V, 65AH
Investment: 18.5 lakh rupees
Annual savings: 157.68kw
CO2 emissions avoided: 73.37 Ton per year
CII Excellent Energy Efficient Unit Award 2013

National Energy Conservation Award 2013

NREDCAP Award 2013

NREDCAP Award 2013
THANKS