Steam Turbine performance improvement solutions for Indian fleets

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Steam Turbine Thermal Service in India

- Close to customers
  - 7 field offices

- Local footprint:
  - Service workshop in Baroda

- Competent and experienced:
  - ST execution center office in Noida with fully established engineering capabilities
  - Field service and project management organization
  - C.a. 70 dedicated personnel for Steam Turbines

Strong local presence
Steam Turbine retrofit

A steam turbine retrofit is the selective replacement of specific hardware with components of more modern technology in order to:

- Improve efficiency
- Extend the operational life time of selected turbine components
- Eliminate generic design weaknesses
- Adapt turbine design to new operational regimes
- Adjust the STG unit to new grid requirements
Sources of customer value

Key sources of customer value:

- An increase in the cylinder efficiency that will translate into lower fuel consumption or better electrical output
- Increased life time of the replaced components,
- First C-inspection time extension after the retrofit installation – up to 100k EOH
- General turbine reliability improvement that positively affects plant load factor

Typical performance gains

<table>
<thead>
<tr>
<th>Cylinder</th>
<th>Fossil retrofit</th>
<th>Nuclear retrofit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Δη*</td>
<td>ΔMW</td>
</tr>
<tr>
<td>HP</td>
<td>2 - 10%</td>
<td>2 - 4%</td>
</tr>
<tr>
<td>IP</td>
<td>2 - 4%</td>
<td>0.3 - 0.7%</td>
</tr>
<tr>
<td>LP</td>
<td>6 - 10%</td>
<td>3 - 5%</td>
</tr>
<tr>
<td>Shaft-line</td>
<td>-</td>
<td>6 - 10%</td>
</tr>
</tbody>
</table>

*) Cylinder global efficiency, including valve pressure drop and ageing

Performance increase often above as originally design levels
Variety of Steam Turbine performance improvement solutions

LMZ 200MW – HP steam path upgrade
• $\Delta MW \geq +3 MW$

LMZ 200MW – LP steam path upgrade
• $\Delta MW \geq +2 MW$

LMZ 200MW – ST shaft-line retrofit
• $\Delta MW \geq +14 MW$

Modernisation packages to suit customers needs
Solution selection criteria

- Current operational status
- Limitations in nearby equipment
- Techno-commercial optimization

Solution always optimised to customer requirements
Customer Value Analysis

Assumptions:

– Only coal consumption reduction benefit due to efficiency improvement is taken into consideration
– Three product categories has been considered:
  • Overhauls
  • Steam path upgrades
  • Steam turbine retrofits
– Note – very simplistic approach has been adopted – in practice unit specific calculation shall be conducted

Assumed values

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR – as design</td>
<td>2067 kcal/kWh</td>
</tr>
<tr>
<td>HR – as current</td>
<td>2274 kcal/kWh (10% degradation)</td>
</tr>
<tr>
<td>Current output</td>
<td>180MW</td>
</tr>
<tr>
<td>PLF</td>
<td>0.72</td>
</tr>
<tr>
<td>Landed coal price</td>
<td>1’953 INR/kWh</td>
</tr>
<tr>
<td>GCV</td>
<td>3’662 kcal/kg</td>
</tr>
</tbody>
</table>

Comparable analysis
# Customer Value Analysis

<table>
<thead>
<tr>
<th>Activity</th>
<th>Payback Period Approx. Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overhauls</td>
<td>&lt;1</td>
</tr>
<tr>
<td>LP Upgrade</td>
<td>1</td>
</tr>
<tr>
<td>HP Upgrade</td>
<td>1</td>
</tr>
<tr>
<td>LP+HP Upgrade</td>
<td>1-2</td>
</tr>
<tr>
<td>LP retrofit</td>
<td>2-3</td>
</tr>
<tr>
<td>HP Retrofit</td>
<td>2-3</td>
</tr>
<tr>
<td>IP Retrofit</td>
<td>3-4</td>
</tr>
<tr>
<td>HP+IP+LP Retrofit</td>
<td>7-8</td>
</tr>
</tbody>
</table>
Conclusion from the analysis

- Overhauls bring the quickest return on investment;

- Steam path upgrades deliver more profitable option in the longer term; They are recommended to be implemented in turbines where the remaining lifetime of key components such as the rotor shaft / casings is not a driving factor.

- Module wise retrofit / Full shaft line retrofit holistically addresses efficiency improvement and lifetime extension, this is the right option for the machines reaching the end of design life

- ‘Mixing’ the solutions in the shaft line, e.g., LP retrofit and HP upgrade can meet particular performance and budget requirements.

There’s no ‘One fit for all’ option
Alstom solutions for Indian fleet
BHEL/LMZ 200MW

More than 20 years of retrofitting experience
Alstom solutions for Indian fleet
BHEL/Siemens 210 & 500MW

HP retrofit:

- Horizontal sectional plane design enables overhaul without dismantling the whole module
- Significant MW uplift, more than 6MW for 210MW and 20MW for 500MW turbines,
- Proven new equipment modules
- Short retrofit installation time; new modules can be installed during a typical overhaul outage,
- Reliability improvement due to opportunity for modernisation of the existing control system

Note: ST shaft-line retrofit solution is also available
• Alstom is a world leader for retrofitting both Alstom and non-Alstom steam turbines

• By Dec ’12 Alstom had accumulated:
  – C.a. 974 ST cylinders retrofitted worldwide
  – C.a. 395 ST cylinders retrofitted that were manufactured by third parties

• LMZ 200MW – modernisation contracts:
  – 50 LP cylinders
  – 30 HP cylinders
  – 13 IP cylinders

• 2 orders obtained on KWU turbines
Recent references

CUSTOMER: Suez-Tractebel SA
POWER PLANT: Polaniec #2-7
COUNTRY: Poland
ST OEM: Alstom/Zamech 13K215
ST PARAMETERS: 128bar/535°C/535°C/215MW

MAIN DRIVERS FOR RETROFIT:
- Life time extension of HP&IP cylinders (note: LP was retrofitted in 1995)
- Adaptation to the new operation regime due to boiler conversion to biomass firing

RETROFIT SCOPE:
- HP & IP full module
- New Stop and Control valves

RETROFIT YEAR: In execution

Step by step approach
**Recent references**

**HP retrofit on Siemens turbine**

<table>
<thead>
<tr>
<th>CUSTOMER</th>
<th>Evonic Steag</th>
</tr>
</thead>
<tbody>
<tr>
<td>POWER PLANT</td>
<td>Herne #4</td>
</tr>
<tr>
<td>COUNTRY</td>
<td>Germany</td>
</tr>
<tr>
<td>ST OEM</td>
<td>Siemens KWU – H30-63</td>
</tr>
<tr>
<td>ST PARAMETERS</td>
<td>265bar/535°C/535°C/514MW</td>
</tr>
<tr>
<td>MAIN DRIVERS FOR RETROFIT</td>
<td>Efficiency improvement</td>
</tr>
<tr>
<td>RETROFIT SCOPE</td>
<td>• HP full module</td>
</tr>
<tr>
<td></td>
<td>• New Stop and Control valves</td>
</tr>
<tr>
<td>RETROFIT YEAR</td>
<td>In execution</td>
</tr>
</tbody>
</table>
### Recent references

**Full Shaft line option**

<table>
<thead>
<tr>
<th>CUSTOMER</th>
<th>RWE/Essent</th>
</tr>
</thead>
<tbody>
<tr>
<td>POWER PLANT</td>
<td>Claus C</td>
</tr>
<tr>
<td>COUNTRY</td>
<td>Netherlands</td>
</tr>
<tr>
<td>ST OEM</td>
<td>Siemens KWU – H30-63-2/M30-50/N30-4x6.3</td>
</tr>
<tr>
<td>ST PARAMETERS</td>
<td>265bar/535°C/535°C/630MW</td>
</tr>
<tr>
<td>MAIN DRIVERS FOR RETROFIT</td>
<td>• Repowering</td>
</tr>
<tr>
<td>RETROFIT SCOPE</td>
<td>• HP + IP + LP</td>
</tr>
<tr>
<td></td>
<td>• Control system upgrade</td>
</tr>
<tr>
<td>RETROFIT YEAR</td>
<td>2012</td>
</tr>
</tbody>
</table>

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Summary

• Various modernization packages are available

• Decision on which option to be follow should be preceded with detailed techno-commercial analysis

• Steam path upgrades provide moderate efficiency and power output improvements along with quick ROI – implementation limited by remaining life-time in the rotor shaft and casings

• Module wise retrofit using step by step approach provides good efficiency and power output improvements along with life time extension, staggered investment and relatively quick ROI

• Full shaft line retrofit addresses all the issues holistically and is a good option but with relatively longer ROI

• Alstom have retrofit options available for all key fleets installed in India supported by extensive retrofit experience.
Thank You