Renovation & Modernization of the Eraring Power Plant

In 2007, Eraring signed a contract and Doosan to upgrade its HP and LP turbines, and also the rewind stator of the generator. In 2009, the company signed another contract to upgrade its conventional boiler. Doosan successfully finished installation and performance testing for the last of four units in 2013, and all the units are now operating with enhanced performance. This contract was the largest overseas power plant modernization project undertaken by Doosan.

<table>
<thead>
<tr>
<th>Division</th>
<th>Original</th>
<th>Retrofit</th>
</tr>
</thead>
<tbody>
<tr>
<td>OEM</td>
<td>BLR</td>
<td>IHI</td>
</tr>
<tr>
<td>TBN</td>
<td>Toshiba</td>
<td>Doosan</td>
</tr>
<tr>
<td>Rating (MGR)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>660MW x 4</td>
<td>750MW x 4</td>
</tr>
<tr>
<td>COD</td>
<td>Unit #1</td>
<td>1981</td>
</tr>
<tr>
<td></td>
<td>Unit #2</td>
<td>1982</td>
</tr>
<tr>
<td></td>
<td>Unit #3</td>
<td>1983</td>
</tr>
<tr>
<td></td>
<td>Unit #4</td>
<td>1984</td>
</tr>
<tr>
<td></td>
<td>Nov. 2011</td>
<td>Aug. 2010</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Apr. 2011</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dec. 2012</td>
</tr>
<tr>
<td>Boiler</td>
<td>Coal-fired, Natural circulation, Twin steam drum, Two-pass</td>
<td></td>
</tr>
<tr>
<td>Steam Turbine</td>
<td>TC4F (4 Casing)</td>
<td></td>
</tr>
<tr>
<td>Generator</td>
<td>Hydrogen/Water cooled type</td>
<td></td>
</tr>
</tbody>
</table>
Key Features

**HP Section**
- Reuse of the outer casing, packing casing and oil deflector
- Change of most parts of HP turbine including:
  - Rotor, Bucket, Diaphragm
  - Inner shell, No. 1/2 journal bearing pad
  - All of packing rings including inter-stage and gland packing, packing head and snout pipe
- Increase in the number of stages
- Increase in the active length of bucket

**LP Section**
- Change of most parts of LP turbine including:
  - Rotor, Bucket, Diaphragm
  - Inner shell, No. 3/4 journal bearing liner, Thrust bearing
  - All of packing rings including inter-stage and gland packing, packing head and snout pipe
- All of packing rings including inter-stage and gland packing, packing head and snout pipe
- Change of the packing ring of 1-3 stages and gland part in LP section with new one
- Increase in the number of stages
- Increase in the active length of bucket

**Generator**
- Stator was fully rewound to increase capacity, and some of items were replaced including:
  - Stator bar
  - Teflon hose
  - End winding support
  - Slot wedge & RTD, TC
  - Packing gland
  - Flexible lead conn
  - High voltage bushing
  - Current transformer
  - Vent tube
Key Features

**Boiler**

Doosan undertook boiler assessments and modeling before project execution began, and optimized results from the assessments and modeling established the need for the addition of increased heat recovery surfaces in the following areas:

- Primary superheater tube
- Reheater inlet tube
- Economiser tube with finned tube

Implemented activities are as follows:

- Removal of boiler side casing
- Loading reheater elements centrally
- Loading primary superheater elements
- Loading economizer tube elements
- Replacement of economizer outlet header, header supports and rear wall seal boxes
- Relocation of header supports and inlet reheat header

It was the first collaboration for the power plant upgrade business with Doosan Babcock – a subsidiary of Doosan Heavy Industries & Construction

Customer Benefits

The upgrades have contributed to achieving enhanced output and environmental objectives including:

- Enhanced output up to 750MW power generation
- Increased efficiency
- Reduced maintenance costs and coal consumption
- Reduction in startup time
- Improved low load operation
- Turbine lifetime expansion
- Upgrades help reduce environmental impacts of the Eraring Power Plant
Renovation & Modernization of the Bandel Thermal Power Station

On February 29, 2012, WBPDCL, a power company in West Bengal, India, signed a contract with Doosan to enhance the performance of its ageing Bandel Thermal Power Station, which had been in operation for 30 years since its completion in 1982. Doosan was required to uprate the output of the existing turbine, increase the efficiency of the boiler, and install the latest surveillance and control systems. This project has enabled Doosan to enter the market for improving performance at 210MW-class power plants, the main power service market in India.

PROJECT OUTLINE

Owner
West Bengal Power Development Corporation Ltd.

Location
Hooghly Dist City, West Bengal, India

Unit
Bandel Thermal Power Station #5

Contract
Feb. 2012

Scope of Work
- Replacement of the HP, IP & IP turbine with new one
- Replacement of the generator with new one
- Replacement of boiler pressure parts (S/H, R/H, Eco. and Tube)
- Adoption of the latest design of low NOx burner
- Enhancement of pulverizer capacity, Retrofit of ESP
- Upgrade plant control & instrumentation system

Capacity
210MW x 1 Unit → 215MW x 1 Unit

OEM
BN (LMZ Design), GEN (BHEL), Boiler (Babcock Power Ltd)

COD
Nov. 2015

Delivery
Manufacturing: 18 months
Installation
6 months (shutdown period)
Key Target

- 215MW x 1 Unit
- 210MW x 1 Unit

R&M Key Target

Flow Diagram

Key Features

Steam Turbine & Generator

- **Target Improvement**
  - Enhance continuous TG output to at least 215MW from 210MW
  - Improve unit heat rate
  - Modernize turbine control system by leveraging state-of-the-art technologies

- **Scope of Work**
  - Replacement of existing HP, IP & LP turbine with the new and efficient HP, IP & LP turbine of modified design
  - Modification of the exhaust hood cooling system
  - New bearings along with bearing pedestals
  - New HP hydraulic system
  - New main oil pump, emergency oil pump, etc.
  - New turbine lube oil cooler
  - Replacement of the tube nest, C&I, V/V of HP/LP heaters
  - Algorithms for new turbine control system & protection system
  - New field instruments for new system requirement
  - Complete replacement of the existing water-cooled generator by a new air-cooled one
Key Features

Boiler

- **Target Improvement**
  - Extension of heating surface areas of boiler tubes to suit the requirement of a retrofitted turbine

- **Scope of Work**
  - Complete replacement including:
    - Superheater, reheater, economizer tubes, drum internals
    - Furnace bottom panel & water wall burner panel, etc.
    - Wind box
    - Coal burner (for high capacity low NOx burners)
    - PF piping (for larger size pipes)
    - Air pre-heater tubes
  - Retrofit of the complete soot blowing system
  - Enhancement of pulverizer capacity

C&I Upgradation

- **Target Improvement**
  - New control & instrumentation (C&I) systems to achieve total automation of the plant

- **Scope of Work**
  - New set of distributed digital control & management information system (DDCMIS)
  - Open & close loop automation to achieve such goals as steam generator control, turbine control, generator control, station C&I (balance of plant) control and electrical auxiliary power distribution system

The upgrades have contributed to enhancing the efficiency of power generation including:

- **Enhanced output up to 215MW from 210MW**
- **Extension of plant lifetime by at least 15 years**
- **Performance improvement**
- **Availability and reliability increase**
- **Optimal trouble-shooting**
- **Incorporation of modernized technologies**

Customer Benefits

- **Extend Lifetime**
- **Increase Power Output**
- **Increase Reliability**

---

Doosan Heavy Industries & Construction

Seoul Office
465 Gangnam-daero, Seocho-Gu, Seoul 06611, Korea
+82-2-513-6991~2

Headquarters & Changwon Plant
22 DoosanVolvo-ro, Seongsan-Gu, Changwon, Gyeongnam 51711, Korea
+82-55-278-6114
Renovation & Modernization of the Sabarmati Thermal Power Station

On July 5, 2011, Doosan became the first Korean company to enter India’s power generation service market when we signed a contract with Torrent Power Limited (TPL), India’s leading private power company, for a project to enhance the performance of its E & F units of the Sabarmati Thermal Power Station. Doosan was required to uprate the output of the plant’s turbine and boiler, improve power generation efficiency, and upgrade the control systems. This project was completed successfully in 2013, demonstrating improved performance and reliability.

PROJECT OUTLINE

Owner
Torrent Power Limited

Location
Ahmedabad Dist City, Gujarat State, India

Unit
Sabarmati Thermal Power Plant E&F

Contract
Jul. 2011

Scope of Work
- Upgrade of the turbine steam path including HP & IP, LP rotor with bucket, inner casing, etc.
- Exciter replacement, Generator overhaul
- Upgrade and modification of boiler reheater tube and headers
- Upgrade of the plant control and instrumentation system

Capacity
110MWe x 2 Units → 121MWe x 2 Units

OEM
BHEL (Turbine: Skoda Design, Boiler: Alstom Design)

COD
#E — 1984, #F — 1988

Delivery for Each Unit
- Manufacturing: 25 months
- Installation: 3 months (shutdown period)
Key Target

**R&M Key Target**

- **121MWe x 2 Units**
- **110MWe x 2 Units**

Flow Diagram

### Key Features

**Steam Turbine & Generator**

- **Target Improvements**
  - Up-rating of the steam turbine
  - Replacement of steam turbine components to enhance lifetime of the power plant
  - Improvement on turbine cycle efficiency
  - New efficient HP heater

- **Scope of Work**
  - Dismantling of existing turbine internal parts and equipment
  - Machining inside of the HP/IP outer casings
  - Incorporation of state-of-the-art and efficient new turbine flow parts
  - New inner casing with integrated nozzle boxes
  - New upgraded diaphragm nozzle 3D profiles for perfect streamline and minimization of aerodynamic losses
  - Generator overhaul
  - New static excitation system
Key Features

**Boiler**

- **Target Improvement**
  - Extension of heating surface areas of reheater along with the replacement of inlet and outlet headers to suit the requirement of a retrofitted turbine

- **Scope of Work**
  - Site assessment for checking space availability and approach for the reheater section
  - Residual life assessment (RLA) of main steam, hot reheater and cold reheater pipes
  - Replacement of the reheater tube including inlet and outlet header
  - Installation of boiler pressure parts
  - Steam blowing of the reheater section

**C&I Upgradation**

- **Target Improvement**
  - Upgrade of the control & instrumentation system to improve reliability and maintainability

- **Scope of Work**
  - State-of-the-art SCADA system for remote control & monitoring of entire 132kV switchyard
  - Upgrade the existing analog controls by installing distributed control system (DCS) based on digital control & instrumentation system
  - Monitoring and control of generator and electrical system for unit e & f through respective plant DCS
  - Integration of the control room for stations D&E

Customer Benefits

The upgrades have contributed to enhancing the efficiency of power generation including:

- Enhanced output up to 121MW from 110MW
- Extension of steam turbine lifetime by at least 15 years
- Performance improvement
- Availability and reliability increase
- Optimal trouble-shooting

---

Doosan Heavy Industries & Construction

Seoul Office
465 Gangnam-daero, Seocho-Gu, Seoul 06611, Korea
+82-2-513-6991~2

Headquarters & Changwon Plant
22 DoosanVolvo-ro, Seongsan-Gu, Changwon, Gyeongnam 51711, Korea
+82-55-278-6114
Renovation & Modernization of the Boryeong Power Plant

Improving the thermal efficiency of existing fossil fuel-fired power plants is one of the most promising low-cost solutions for reducing carbon emissions, and Doosan has delivered a number of major power plant retrofit and modernization projects. In 2007, KOMIPO (Korea Midland Power Co, Ltd.) with us to upgrade the Boryeong Thermal Power Station, the largest power plant modernization project undertaken by Doosan in Korea.

**PROJECT OUTLINE**

**Owner**  
KOMIPO (Korea Midland Power Co., Ltd.)

**Location**  
Boryeong City, Korea

**Unit**  
Boryeong Power Station #1, 2

**Contract**  
Jun. 2007

**Scope of Work**  
Renovation and modernization of the boiler, turbine and generator

**Installation Period**  
3 months for each unit

<table>
<thead>
<tr>
<th>Division</th>
<th>Original</th>
<th>Retrofitted</th>
</tr>
</thead>
<tbody>
<tr>
<td>OEM</td>
<td>BLR</td>
<td>TBN</td>
</tr>
<tr>
<td>B&amp;W</td>
<td>Toshiba</td>
<td>Doosan</td>
</tr>
<tr>
<td>Rating (MGR)</td>
<td>516MW x 2</td>
<td>535MW x 2</td>
</tr>
<tr>
<td>COD</td>
<td>1983-84</td>
<td>May 2009</td>
</tr>
<tr>
<td>Boiler</td>
<td>Coal-fired, Natural circulation, Twin steam drum, Two-pass</td>
<td></td>
</tr>
<tr>
<td>Steam Turbine</td>
<td>TC4F (3 Casings)</td>
<td></td>
</tr>
<tr>
<td>Generator</td>
<td>Hydrogen/Water cooled type</td>
<td></td>
</tr>
</tbody>
</table>

Boryeong Power Plant
Key Features

**HIP Section**
- State-of-the-art technologies were used, and major components of each turbine section were replaced to increase output and enhance section efficiency
- **Replaced parts**
  - Rotor & bucket
  - Diaphragm
  - Packing casing
  - Journal bearing
  - HP/IP inner casing
- **Others**
  - Integral shroud blades (ISB)
  - High efficiency stage design
  - Root sealing & tip sealing

**LP Section**
- **Replaced parts**
  - LSB, L-1 bucket, Nozzle and LP 1st stage nozzle
  - Nozzle spill strips & packing seal for LP interstage
  - Steam guide & No. 3 bearing

**Generator**
- Stator was fully rewound with rotor re-insulation to increase capacity, and some of items were replaced including:
  - Stator bar & slot wedge
  - Phase connection ring
  - End winding support
  - Water head
  - Brush holder
  - H2 cooler
  - High voltage bushing
  - Bushing current transformer
  - Air end terminal
  - Collector ring
  - Retaining ring
  - Coil wedge
Key Features

Boiler

Boiler assessments and modelling were implemented before execution, in order to enhance the performance and steam output, then the results determined the need for replacement and addition of increased heating surface in the following areas:

- **Replaced parts**
  - SH tube with upgraded materials
  - RH tube with upgraded materials
  - Furnace roof wall tubes

- **Newly installed parts**
  - Pri SH inlet tube
  - Duct economizer
  - Low NOx combustion system

- **Others**
  - Change the source of soot blower
  - Field instrument and monitoring system
  - Reinforcement of the civil and architectural structure through safety diagnosis
  - Site installation

Customer Benefits

The upgrades have contributed to achieving enhanced output and environmental objectives, including:

- **Enhanced output up to 535MW power generation**
- **Increased efficiency**
- **Reduced maintenance costs and coal consumption**
- **Reduction in startup time**
- **Improved low load operation**
- **Turbine lifetime expansion**
- **Upgrades help reduce environmental impacts of the Boryeong Power Plant**