Coal-Fired Power Plant Upgrade and Capacity Increase Solutions for Eraring Unit 1-4

February 2013
Doosan Heavy Industries & Construction Co.
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Improving the thermal efficiency of existing fossil fuel fired power plant represents one of the most promising, low-cost solutions for reducing near-term carbon emissions.

Doosan has delivered a number of major power plant retrofit and modernisation projects.

The project objectives have included:-

- Regaining design operating conditions and efficiencies
- Increasing operational and fuel flexibility
- Increased base load and peak capacity
- Improved low load operation
- Reductions in start-up times, and generating costs

Implementation was programmed to minimise the cost impact, and loss of income.

The Doosan approach to delivering a project of this type is described using the named reference below,

- Eraring Power Plant in NSW, Australia; a Boiler, Turbine upgrade and capacity increase.
Eraring Power Station

Power Plant Upgrade & Capacity Increase

- **Project Name**: Eraring Unit 1~4 Upgrade
- **OEM Manufacturer**: Toshiba
- **Plant Type**: Conventional Subcritical Coal Fired
- **Plant Site**: Australia, New South Wales
- **Owner**: Eraring Energy

- Project Overview
- Stage 1 – Turbine Upgrade
- Stage 2 – Boiler Upgrade
- Project Execution
In 2007 Eraring Energy, a NSW State owned facility, commissioned studies by the Original Equipment Manufacturers to evaluate the potential to improve the Eraring Power Station generation capacity. The main driver for the study was to increase short term peaking capacity, provide Station mid life Turbine efficiency improvements and reduce the carbon footprint of the station whilst maintaining the New South Wales State base load energy supply.

The study was carried out in two stages:

- The evaluation of the Toshiba 660MWe turbine generator
- The evaluation of the IHI-Foster-Wheeler boiler

The study indicated that the turbine efficiency could be increased to 89% and, that by upgrading the steam supply conditions from the boiler to the turbine, the generating capacity could be increased to 750MWe.

### Technical Data

<table>
<thead>
<tr>
<th>Description</th>
<th>OEM</th>
<th>Retrofit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer</td>
<td>Toshiba</td>
<td>Doosan</td>
</tr>
<tr>
<td>Rating</td>
<td>660 MWe x 4</td>
<td>750 MWe x 4</td>
</tr>
<tr>
<td>Steam Condition</td>
<td>167bar/540°C/540°C</td>
<td>167bar/540°C/540°C</td>
</tr>
<tr>
<td>Steam Turbine</td>
<td>TC4F</td>
<td></td>
</tr>
<tr>
<td></td>
<td>33.5”LSB (4 Casing)</td>
<td></td>
</tr>
<tr>
<td>Generator</td>
<td>Hydrogen Water Cooled</td>
<td></td>
</tr>
</tbody>
</table>
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4. Boiler Upgrade Overview

5. Summary
Project Milestone

Unit #4

- '07.08.01 Proposal Due Date
- '07.09 Preferred Bidder Selection
- '07.11 Contract
- 24 Months
- Design: 6 Months
- Manufacturing *
- 16.5 Months
- 08.2.28
- 09.6.30
- Packaging & Delivery: 2 Mon.
- Outage Period: 13 Weeks
- Test: '09.12.22
- Synch: '09.11.12
- Comm: '10.1.4
- 1st Unit Completion

FOB Schedule

- Commercial Proposal
  - 1st Unit: '09.06.30
  - 2nd Unit: '09.12.30
  - 3rd Unit: '10.06.30
  - 4th Unit: '10.12.30

- To Be Expected
  - Plant outage will be done at 6 months interval as specified on ITB.
  - Customer request that plant outage will be done at 1 year interval.
  - Above project milestone will be revised.

* Based on Rotor Manufacturing
HP Turbine Retrofit Range

1. Rotor & Bucket
2. Nozzle Plate (From Nozzle Box)
3. Diaphragm
4. Inner Shell
5. Packing Head & Packing Rings
6. Interstage Packing Seals
7. Seal Rings and Snout Pipe for Inner Shell
8. #1, 2 Journal Bearing (if required)
Replacement Scope (2/2)

IP Turbine Retrofit Range

1. Rotor & Bucket
2. Diaphragm
3. Inner Shell
4. Packing Head & Packing Rings
5. Interstage Packing Seals
6. Thrust Bearing
7. #3, 4 Journal Bearing (if required)

LP Turbine Retrofit Range

- Interstage Packing Seals
- Packing Head and Packing Rings

7 stages ➔ 9 stages

IP Steam Path Modification
Achievement (Eraring #2)

Achieve MGR 750MW (2010 October)
Operating data recorded very successfully at PF 0.91 for Generator capacity test (Temp saturation 20min, Holding 20 min)
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The following modifications were made to improve turbine efficiency to 89% and increase output to 720MWe with over-run peaking capacity at 750MWe.

- HP / IP increased stage count and bucket active lengths, smaller root diameter (ART* Design)
- HP / IP introduction of advanced bucket, diaphragm and tip seals
- HP / IP advanced bucket root geometries
- HP / IP inner casings, packings and rotors renewed to accommodate changes
- Generators re-wound to permit higher power outputs

* ART; Advanced Reaction Technology Blade
Design Review : Existing LP Capacity

• Doosan’s Reference Model
  - TC4F 33.5” LSB, 50Hz(3000 RPM), 627MW, G3 Type, 16.5MPa/538℃/538℃
  - Total 46 Stages: HP 8 Stages, IP 14 Stages (7 Stages X 2 Flows), LP 24 Stages (6 Stages X 4 Flows)

• Review of LP Turbine Capacity

<table>
<thead>
<tr>
<th>Descriptions</th>
<th>Eraring LP Turbine at VWO</th>
<th>Up-rate Eraring LP Turbine at VWO (A)</th>
<th>Max. Capacity of DOOSAN’s LP Turbine (B)</th>
<th>A/B(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LP Total Flow (ton/hr)</td>
<td>1,727</td>
<td>1,789</td>
<td>2,614</td>
<td>68.4%</td>
</tr>
</tbody>
</table>

• Existing Eraring LP turbine would cover up to 750MW uprating
  - Doosan’s LP turbine is similar to Eraring LP turbine
  - Uprating Eraring LP turbine flow at VWO: 68.4% of max. capacity of Doosan’s LP turbine
Review of Torsional Vibration Effect (1/2)

- **Torsional Natural Frequencies of a Steam TBN/GEN (General Result)**
  - In Case of 50Hz
    - HP/IP TBN: Above 140Hz
    - LP TBN/GEN: 80~120Hz
  - In Case of 60Hz
    - HP/IP TBN: Above 160Hz
    - LP TBN/GEN: 100~140Hz

  **Torsional natural frequencies of HIP TBN are much higher than those of LP TBN/GEN**
  - Rotor Stiffness: HP/IP TBN >> LP TBN/GEN
  - Rotor Mass: HP/IP TBN << LP TBN/GEN

- **Assumption of Torsional Natural Frequencies (HP/IP TBN)**
  - Nearly does not change compared with the original HP/IP TBN
    - Rotor masses of HP/IP TBN nearly do not change: Same Bearing Span
  - In case of +20% rotor mass (Doosan experience)
    - Change of torsional natural frequency: About 1.5Hz

- **Conclusion**
  - There are no possibilities to occur torsional resonances with the changes of HP/IP TBN configuration
  - To perform the torsional vibration analysis, the geometric data of LP TBN are required
Review of Torsional Vibration Effect (2/2)

• **Torsional Natural Frequencies of a Steam TBN/GEN (General Result)**
  - In Doosan experiences & technical backgrounds, we have confidence that the TNF of the new TBN/GEN(750MW) nearly does not change compared with the original TBN/GEN (660MW)

• **Technical Backgrounds**
  - Rotor masses of the new HP/IP TBN would be slightly increased (3 ~ 5%) compared with the original HP/IP TBN
  - Retrofit of generator (+12% rotor mass, nuclear unit, 1000MW, Korea)
    ▪ The change of TNF : about 1.5Hz
  - 50Hz, 700MW (fossil unit, Brazil) • 60Hz, 800MW (Korea)
    ▪ The change of TNF : almost same

• **Conclusion**
  - There are no possibilities to occur a kind of design problems with the changes of HP/IP TBN Configurations
Review of Differential Expansion & Clearance

• Differential Expansion Review

<table>
<thead>
<tr>
<th>Descriptions</th>
<th>Doosan Model</th>
<th>Eraring Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspect of thermal expansion</td>
<td>Similar</td>
<td>Base</td>
</tr>
<tr>
<td>Steam condition and turbine span to affect to thermal expansion</td>
<td>Similar</td>
<td>Base</td>
</tr>
<tr>
<td>Location of foundation anchor key to affect differential expansion</td>
<td>LPA, LPB</td>
<td>IP, LPA, LPB</td>
</tr>
</tbody>
</table>

An effect by IP anchor is small because of low LP hood temperature

• Conclusion  Not affect LP clearance by new HIP turbine
Review of Thrust Force

**Thrust Force Review**
- Thrust force is axial force by steam pressure difference built up across rotating parts
- Thrust force of reaction turbine is larger than that of impulse turbine
- Because of ART technology applied to Doosan turbine, the increase of HP&IP thrust force is predicted. However, it can be decreased by below methods during design process

**The Method to decrease a Excessive Thrust Bearing Load**
- To adjust rotor packing diamete
- To adjust steam balance hole
- To add thrust balance piston
- To adjust thrust bearing size

Steam Balance Hole

Balance Piston

Upstream Pressure

Downstream Pressure

Pressure distributions around bucket and wheel
Replacement of Valve Actuator

• Hydraulic System Replacement

Existing Hydraulic System
- Throttle Valves with Cam Shaft
- 217psi Toshiba Actuator
- Mechanical Trip System

New 2400psi Hydraulic System
- Throttle Valves with Separate Direct Actuator
- Compatible with 2 out of 3 Logic Electronic Trip System

• Replacement Items

- Power actuators for all valves
- Hydraulic power system
- Replace mechanical trip system with electrical trip system
- Turbine control system modification & adjustment for EHC valve actuator:
  Customer’s scope

• Advantages

- Variable Operation Mode
- Lower Maintenance Cost
- Removal of Complicated Mechanical Trip System
- Increase of Actuator Life Time
- Improved Reliability
**Turbine Control System**

- **Model**: MARK VI
- **Type**: TMR (Triple Modular Redundancy)
- **Application**: Yonghung (800MW X 2), Tangjin (500MW X 4), Taean (500MW X 2)
**Excitation System**

- **Model**: DEX2100
- **Type**: TMR (Triple Modular Redundancy)
- **Application**: Yonghung (800MW x 2), Tangjin (500MW x 4), Taean (500MW x 2)

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**TMR Processor Boards and Communication Paths**

<table>
<thead>
<tr>
<th>Board</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>Control Module Master 1</td>
</tr>
<tr>
<td>M2</td>
<td>Control Module Master 2</td>
</tr>
<tr>
<td>C</td>
<td>Control Module Protection</td>
</tr>
<tr>
<td>DPM</td>
<td>Dual-Ported Memory</td>
</tr>
<tr>
<td>EGD</td>
<td>Ethernet Global Data</td>
</tr>
<tr>
<td>ACLA</td>
<td>Communication Card</td>
</tr>
<tr>
<td>DSPX</td>
<td>Digital Signal Processor</td>
</tr>
</tbody>
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## Generator Uprating Concept

<table>
<thead>
<tr>
<th>Component</th>
<th>750MW at 0.85PF</th>
<th>750MW at 0.9PF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stator core &amp; frame</td>
<td>maybe re-used</td>
<td>Re-used</td>
</tr>
<tr>
<td>Stator winding</td>
<td><strong>Rewinding</strong></td>
<td><strong>Rewinding</strong></td>
</tr>
<tr>
<td>Rotor body &amp; shaft</td>
<td>Re-used</td>
<td>Re-used</td>
</tr>
<tr>
<td>Rotor coil &amp; component</td>
<td><strong>Maybe re-used or re-insulation (further review required)</strong></td>
<td><strong>Maybe re-used or re-insulation (further review required)</strong></td>
</tr>
<tr>
<td>Excitation system</td>
<td><strong>Maybe re-used (further review required)</strong></td>
<td>Maybe re-used</td>
</tr>
<tr>
<td>Stator water cooling system</td>
<td><strong>Replacement (if required)</strong></td>
<td><strong>Replacement (if required)</strong></td>
</tr>
<tr>
<td>H2 control system</td>
<td>Re-used</td>
<td>Re-used</td>
</tr>
<tr>
<td>Seal oil system</td>
<td>Re-used</td>
<td>Re-used</td>
</tr>
<tr>
<td>Lub oil system</td>
<td>Re-used</td>
<td>Re-used</td>
</tr>
<tr>
<td>Retaining ring</td>
<td><strong>Replacement (if 18Mn5Cr)</strong></td>
<td><strong>Replacement (if 18Mn5Cr)</strong></td>
</tr>
<tr>
<td>Rotor amortisseur</td>
<td><strong>Replacement (if required)</strong></td>
<td><strong>Replacement (if required)</strong></td>
</tr>
<tr>
<td>Rotor wedge</td>
<td><strong>Re-wedging (If required)</strong></td>
<td><strong>Re-wedging (If required)</strong></td>
</tr>
</tbody>
</table>

- Further study should be followed to decide design change exactly
- Further inspection & diagnostic test should be followed to decide reusing exactly
STG Upgrade Summary

• 2,241 ton/hr Steam flow would be required to produce 750MW generator output at VWO

• Rotor with bucket, diaphragm, inner shell for HP section and rotor with bucket, diaphragm for IP section would be replaced with new one as a minimum

• Advanced technologies such as high efficiency reaction blade, integral covered bucket and brush seal were applied for uprating

• Number of stages of HP turbine were increased form 7 to 9

• Existing ERARING LP turbine would cover up to 750MW rating

• Use all existing valves and replace all valve actuators & main steam lead pipe

• Proven design and advanced technology were adopted
1. Introduction
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5. Summary
Eraring Power Station Upgrade – Boiler Upgrade Overview

The design of the existing boiler plant resulted in a shortfall in final and reheat steam temperature of 3 to 8 degrees Celsius which in turn limited the potential for the turbine to generate in excess of 660MWe.

The way forward then was to determine how to recover this shortfall in steam temperature with the installation of additional heat recovery surface area in the boiler to correct the imbalance between evaporation and superheat heating surfaces.

The improvement in steam temperature would then enable the turbine to generate 660MWe at the original steam inlet design conditions.

Coupled with the turbine efficiency enhancements, the actual power output could then be raised to 720MWe, peaking at 750MWe.

- Doosan was commissioned to carry out optioneering studies to determine the best technical and commercial solution for locating and increasing the heat recovery capability of the boiler plant.
- The studies that followed involved extensive boiler performance modelling to confirm the boiler performance parameters which were subsequently guaranteed.
- Doosan was then also awarded the contract to design, supply and oversee the installation of the boiler plant modifications with design, fabrication and installation support based in Renfrew, Scotland, UK.
Eraring Power Station – Boiler Upgrade

Required Boiler Upgrade Duty

<table>
<thead>
<tr>
<th>% CMR</th>
<th>Load MWe Gross</th>
<th>Steam flowrate kg/s</th>
<th>Δ Flow %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing Turbine</td>
<td>95% CMR</td>
<td>660 MWe</td>
<td>560</td>
</tr>
<tr>
<td></td>
<td>100% CMR</td>
<td></td>
<td>590</td>
</tr>
<tr>
<td>Turbine Upgrade</td>
<td>88% CMR</td>
<td>660 MWe</td>
<td>537</td>
</tr>
<tr>
<td></td>
<td>96% CMR</td>
<td>720 MWe</td>
<td>595</td>
</tr>
<tr>
<td></td>
<td>100% CMR</td>
<td>750 MWe</td>
<td>625</td>
</tr>
</tbody>
</table>

Boiler Upgrade Objectives

- A Boiler upgrade to deliver final steam parameters at the original design intended rated conditions to enable the upgraded turbine to deliver 720MWe (750MWe peak) output.
- Maximise boiler thermal efficiency with reduced dry gas loss.

Key target design basis parameters:

- Ambient Temperature: 0°C / 20°C / 32°C
- Fuel Specification: Typical / Best / Worst
- Final Steam: Recovery of 3 to 5°C shortfall in Final Steam Temperature
- Reheat Steam: Recovery of 5 to 20°C shortfall in Reheat Steam Temperature
- Achieve rated steam temperature 540°C (with bottom mills) at boiler MCR & load range
- Achieve 105% original boiler design peaking capacity
- Minimise Heat Recovery Area rear gas pass erosion with Gas Velocity limit <16m/s
- Airheater exit gas temperature max: <135°C (due to Fabric Filters)
- Assessment of circulation checks and design implications on drum internals & furnace
- Air and flue gas path assessment
**Eraring Boiler Layout.**

**Existing Boiler Layout with Turbine Upgrade.**

Based on Typical Coal
6 bottom Mills & Primary Zone Stoichiometry = 0.98, O<sub>2</sub> = 3.2%v/v dry

**Boiler Layout After Upgrade.**

Prim SH Horiz: 5.5 loops : 44 tubes deep; 4 TPG.
R/H inlet: 3.0 loops : 48 tubes deep; 8 TPG.
Economiser: Replacement plain / finned tubes.

**Upgraded Boiler with Full Achievement of Performance Targets.**

<table>
<thead>
<tr>
<th>Unit 2 Results</th>
<th>Base Simulation 96% TMCR (730 MWe)</th>
<th>Before 660 MWe Dec 2009</th>
<th>After 660 MWe Dec 2010</th>
<th>After 720 MWe Dec 2010</th>
<th>After 750 MWe Oct 2010</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>MST</td>
<td>°C</td>
<td>517</td>
<td>537</td>
<td>540</td>
<td>540</td>
<td>540</td>
</tr>
<tr>
<td>RST</td>
<td>°C</td>
<td>540</td>
<td>530</td>
<td>540</td>
<td>540</td>
<td>540</td>
</tr>
<tr>
<td>Main Steam Flow</td>
<td>kg/s</td>
<td>561.4</td>
<td>543.4</td>
<td>600.6</td>
<td>625.0</td>
<td>&lt; 16.0</td>
</tr>
<tr>
<td>RH Gas Velocity</td>
<td>m/s</td>
<td>18.0</td>
<td>18.0</td>
<td>14.2</td>
<td>15.0</td>
<td>15.8</td>
</tr>
<tr>
<td>SH Spray</td>
<td>%</td>
<td>1.0</td>
<td>1.9%</td>
<td>5.8%</td>
<td>3.3%</td>
<td>7.7%</td>
</tr>
<tr>
<td>Expected Control Load</td>
<td>%</td>
<td>Not Met</td>
<td>Not Met</td>
<td>Exceeded Expectations</td>
<td>Exceeded Expectations</td>
<td>Exceeded Expectations</td>
</tr>
<tr>
<td>GAH EXIT @ Test Amb T</td>
<td>°C</td>
<td>136</td>
<td>136</td>
<td>116</td>
<td>117</td>
<td>128</td>
</tr>
<tr>
<td>GAH EXIT @ 32°C Amb T</td>
<td>°C</td>
<td>146</td>
<td>144</td>
<td>120</td>
<td>126</td>
<td>134</td>
</tr>
</tbody>
</table>
Achievement - Eraring Unit 2

Performance

- Unit 2 achieved 720MWe in August 2010 and demonstrated safe achievement of peaking capacity of 750MWe in October 2010.
- Unit 2 Boiler Performance Guarantees successfully demonstrated in December 2010.

Achieved **MGR 750MWe** October, 2010.
Eraring Boiler Capacity Upgrade

Before : Unit 2 (Mar 2009).

Gross Capacity: 660 MWe
Boiler Type:
Coal-fired, natural circulation, twin steam drum, two-pass of TPH design, 3-stage desuperheat, OWF, PBE arrangement, single reheat.
Coal Quality:
Locally mined: low S, high ash coal 22 – 26%. 660 MWe.
95% CMR: 560 kg/s @ 165 bara / 537°C / 530°C.
A/H Exit Gas Temperature : 136°C @ 23° Ambient.
Boiler Gross Thermal Efficiency 87.9 %.
CO₂ Emissions (based on gross output) 865 g/kWh.

Environmental.
1st Generation LNBs with OFA and UFA .
Fabric Filter – 50% PAN / PPS bag shaker type (with attempering air).

After : Unit 2 (Oct 2010).

Gross Capacity: 720 MWe.
Boiler Type:
Coal-fired, natural circulation, twin steam drum, two-pass of TPH design, 3-stage desuperheat, OWF, PBE arrangement, single reheat.
Coal Quality:
Locally mined: low S, high ash coal 22 – 26%. 660 MWe.
88% CMR: 540 kg/s @ 150 bara / 540°C / 540°C.
A/H Exit Gas Temperature : 120°C @ 25° Ambient.
Boiler Gross Thermal Efficiency 88.7 %.
CO₂ Emissions (based on gross output) 835 g/kWh. 720 MWe.
96% CMR: 595 kg/s @ 164 bara / 540°C / 540°C. 750 MWe.
100% CMR: 629 kg/s @ 160 bara / 540°C / 540°C.
Boiler Circulation and Steam Purity within limits.
Pressure Part Metal Temperatures within limits.
Environmental.
Retrofit Siemens ABT LNBs with OFA and UFA.
Fabric Filter 50% PAN / PPS bag shaker type (with attempering air).
Eraring Project Timeline.

**Doosan Contract**
The upgrade of 4 x 660MW Toshiba Turbines and IHI Boilers to 720MW through the use of Doosan Turbine and Boiler Technologies.

1982

2006

2008

2009

2010

**PROJECT MANAGER**

BHC

**BOILER**
Doosan Babcock

Feasibility studies
Performance Modelling
Process Engineering
Design Engineering
Pressure Part Manufacturing
Site Support

**TURBINE**
Doosan Heavy

Architect Engineering Design Engineering Manufacturing Installation Plan Procedure Commissioning (EPC)
Performance Test

**CONSTRUCTION**

PFI

Installation Agent

Unit 1

Unit 2

Unit 3

Unit 2 - RTS Commissioning
Unit 2 - 720MW/We output achieved

Unit 2 - 750MW/We peak output achieved

Boiler capacity upgrade contract award Dec 2008

Accreditation from AGR & Eraring QC for Doosan process and manufacturing capabilities

16.5 Months

24 Months

Packing & Delivery 2 Min.

Outage Period 13 Weeks

Test 2 Min.

Synch. Comm.

'07.06.01 Proposal Due Date

'07.9 Preferred Bidder Selection

'07.11 Contract

'08.2.28

'09.6.30 Installation

'09.2.22

'09.12.22

'10.1.4

1st Unit Completion

* Based on Rotor Manufacturing

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Extensive boiler thermal performance modelling was commissioned in order to confirm boiler upgrade performance parameters and subsequent guarantees. The results of the boiler modelling and overall upgrade objectives determined the need for the addition of increased heat recovery surface in the following areas:

**Primary Superheater**
- 5.5 loops 44 tubes deep with 4 tubes / group.

**Reheater Inlet**
- 3.0 loops 48 tubes deep with 8 tubes / group.

**Economiser**
- Replacement of plain tube section with both plain and finned tube sections.

On award of the Contract the components were designed, material procured and components were then manufactured by Doosan Power Systems at their facility in Renfrew, Scotland.
Eraring Boiler Upgrade – Implementation Activities

Boiler Side Casing Removal

- Removal of sootblowers
- Removal of service pipes
- Removal of access platforms
- Removal of cladding and insulation

Backpass – loading with new elements

- Boiler 22m wide
- Back pass 10.8m deep (5.3m SH & 5.5m RH)
- New Additional Primary Superheater Elements
- New Additional Re-heater Elements
- New Finned Economizer
- New Plain Economizer
Eraring Boiler Upgrade – Implementation Activities

**Boiler Reheater Element Loading**
- Reheater elements centrally loaded – mono rails for efficiency
- Working around internal distribution header pipework

**New and Relocated Headers**
- New Primary Economiser Outlet Header
- New Header Supports
- Relocated Header Supports
- Inlet Reheat Header to be lowered 3m
- New rear wall seal boxes
Primary Superheater Elements

- Primary Superheater Elements being loaded
- Bracket extensions for variation in pass width
- Gravitational Hazards captured by false floors
- 100% NDT of all tube welds ~ 9,460
- 100% NDT of attachment weld ~ 7,500
Eraring Boiler Upgrade – Implementation Activities

**Phased Array Ultra sonic Testing (PAUT)**
- Non intrusive to adjacent work
- Allows instant results and re-work if needed
- Results electronically recorded

Hardware and Display Unit

Track Mounted Sensor with angle indexing

NDT by Austpower
Boiler Upgrade Summary

- **Innovation**
  - Integration of boiler and turbine technologies to maximise plant efficiency.
  - Optimised upgrade offering the best techno-economic solution within the constraints of the Plant Upgrade project.

- **Key Performance Achievements**
  - Commercial boiler performance guarantees between 67% - 96%TMCR.
  - Enhanced control load and hence improved cycle efficiencies across wider load range.
  - Eraring Energy reduced coal consumption, increased the station capacity in the most environmentally friendly and economic way whilst securing base load supply for the NSW State.
  - Improved future operational flexibility in a carbon constrained business scenario achieved by CO₂ savings in the order of 450,00 tonnes per annum; double the upgrade business case’s minimum requirement.

- **Achievements Earned Through Attention to Detail, Co-operation and Teamwork**
  - Extensive site surveys in particular on the Boiler Plant proved crucial in identifying and resolving potential construction challenges.
  - Close and regular communication across design, manufacturing and construction teams proved invaluable throughout the project.
  - Single point accountability and defined division of responsibility facilitated project delivery.

All of the above actions played their part in ensuring the boiler pressure part design, manufacturing, and subsequent installation went according to plan within the scheduled outages.
1. Introduction
2. Project Milestone/Replacement
3. Review of Technical Update (STG)
4. Boiler Upgrade Overview
5. Summary
SUCCESSFUL ERARING RETROFITTING PROJECT

RELIABILITY IMPROVEMENT

Performance Improvement

Advanced Technology

Proven Experience

Confidence
Enabling energy to realise opportunities for our customers and the world we live in.
Appendix

1. Introduction
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5. Summary
6. Doosan Experience
STG Experiences

Since Seohae unit in 1984, **42 units of 22.3GW** have been supplied for fossil fired power plant.

**Subcritical Units**
- **Steam Condition**: 170kg/cm² / 538°C / 538°C
- **Experiences**: Total 8 Units / 3.1GW
- **Progress**: All units are under commercial operation

**Supercritical Units**
- **Steam Condition**: 247kg/cm² / 538°C / 538°C
- **Experiences**: Total 20 Units / 10.8GW
- **Progress**: All units are under commercial operation

**Ultra Supercritical Units**
- **Steam Condition**: 247kg/cm² / 566°C / 593°C
- **Experiences**: Total 10 Units / 5.3GW
- **Progress**: 6 Units are under commercial operation
  - 4 Units are under construction

2 Units are under commercial operation
2 Units are under design and eng’g
## STG Experience List

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