RB211-H63 Advancements and Meeting Future Demand of Oil & Gas Requirements for Midstream Applications

by

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RB211- Through the Years

- **1974**  1st Unit into service – TCPL Canada @ Burstall
- **1980**  24B variant introduced
- **1983**  24C variant introduced
- **1987**  1st Dual Fuel Onshore Water Injected Unit
- **1987**  100th Sale Achieved
- **1989**  First Big Order – 24 units in Middle East.
- **1990**  1st GG to surpass 100,000 hours.
- **1991**  200th Sale Achieved
  - 1 million Hours
- **1992**  24G variant introduced at TCPL in October
- **1994**  Dry low emission variant launched – PGT Starbuck, USA
- **1995**  5 Million Hours
  - 2 million Hours Offshore
- **2000**  24GT variant introduced
- **2005**  30th anniversary of industrial RB211
  - 500th RB211 delivered
  - First Run of Dual Fuel DLE
- **2008**  Next generation gas generator – Aero Trent technology in development
- **2010**  Introduction of the RB211-H63
- **2011**  Introduction of the RB211-Gzero
RB211 Fleet Statistics (Sep 2011)

Total engines sold 696
Total running hours 28.2 million
Fleet leader running hours – 24C 193,000 (TCPL)
Fleet Leader – DLE 109,000 (TCPL)
Fleet Leader – RB211-GT61 50,000 (Port of Liverpool)
Mechanical Drive running hours 22.5 Million (>500 Engines)
Power Generation hours 5.7 Million (>160 Engines)
DLE units sold 162
Total DLE running hours 4.1 Million

Product distribution:

<table>
<thead>
<tr>
<th>Mark</th>
<th>Number</th>
<th>Experience (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>18</td>
<td>866,000</td>
</tr>
<tr>
<td>24A</td>
<td>17</td>
<td>1,718,000</td>
</tr>
<tr>
<td>24B</td>
<td>10</td>
<td>926,000</td>
</tr>
<tr>
<td>24C</td>
<td>117</td>
<td>8,571,000</td>
</tr>
<tr>
<td>RB211-G</td>
<td>338</td>
<td>11,662,000</td>
</tr>
<tr>
<td>DLE</td>
<td>99</td>
<td>3,458,000</td>
</tr>
<tr>
<td>RB211-G DLE DF</td>
<td>3</td>
<td>1,700</td>
</tr>
<tr>
<td>RB211-GT DLE</td>
<td>60</td>
<td>640,000</td>
</tr>
<tr>
<td>RB211-GT PhII</td>
<td>34</td>
<td>348,000</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>692</strong></td>
<td><strong>28.2 Million hours</strong></td>
</tr>
</tbody>
</table>

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Utilisation of components & technology from aero for industrial product development

RB211/Trent Engine Family

Aero thrust

Output Power (MW)


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RB211-H63: Product Placement

- GT shaft power (MW)
- GT shaft efficiency (%)
Designed for both peak lopping duty thereby giving Operators greater availability to provide generation capacity at times of peak loading and also continuous duty thereby delivering an economically friendly product across a wide dispatch range.

All shipped Packages will be Equipment Health Monitoring (EHM) enabled, which will further enhanced operational flexibility and lower the cost of ownership through faster fault diagnostics and prediction of engine component failures before they occur.
The RB211-H63 is the most powerful RB211 gas turbine model produced by Rolls-Royce Energy Systems, with a current ISO rating of:
- 44MW - WLE (Wet Low Emissions)
- 38MW - without WLE water injection.

The unit will deliver **5MW** more power and **2%** more efficiency than the current RB211-GT61 unit without any increase in firing temperature. (38MW Rating). This will enable our customers to meet their power demands with few units leading to a smaller footprint, lower weight, lower initial cost and lower maintenance cost.

Robust RB211 architecture and design experience combined with proven technology advancements of the Trent to provide the most powerful and efficient RB211 gas turbine on the market.

The modular GG construction and the package have been designed for reliable operation, easy maintenance and quick installation.
RB211-H63 Product Overview

Industrial RB211

Design experience &
commonality

+

Technology
advancements

+

RB211 - GT61 footprint

Industrial Trent

The RB211 - H63
The RB211-H63 – Design and Heritage

- Lube Oil System
- Gas Fuel Manifold
- HP3 BOV System
- Junction Boxes, Harnesses, Thermocouples
- Air Battery Plate
- Diesel Fuel Manifold
- Electric Starter
- Electrical Battery Plate
- IP8 BOV System
- VIGV/VSV System
- Turbine Case Cooling manifold

View looking Port

View looking Starboard

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The RB211-H63 – Design and Heritage

- 8 stage axial IP compressor
- IP compressor casing
- 6 stage HP compressor
- Air inlet casing – 29 pre-swirl vanes and VIGV actuation system
- WLE Dual Fuel Combustor
- Single Stage HP Turbine
- Single Stage IP turbine
- 2 independent shafts
- RB211 Style Intercase - materials changes
- Direct, permanently driven electric starter motor

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The RB211-H63 – Common running experience

**Trent Intermediate Pressure Compressor**
Industrial > 450,000 hours
Aero > 17 million hours

**Trent High Pressure Compressor**
Industrial > 450,000 hours
Aero > 17 million hours

**Trent combustor**
Industrial > 35,000 hours
Aero > 17 million hours

**Trent High Pressure Turbine**
Industrial > 450,000 hours
Aero > 17 million hours

**Re-profiled RB211-GT**
Intermediate pressure turbine
Industrial > 750,000 hours
The RT63 Free Power Turbine – Design and Heritage

• RT63 is a 2 staged free power turbine with a rated speed of 6000 rpm and an aerothermal isentropic efficiency 93.4% providing 38 MW to 44 MW Shaft Power.

• The very latest aero engine performance technology has been employed in the design of the power turbine blade path, while traditional, rugged industrial design concepts have been retained in the mechanical design.

- Rotor support via seven forged struts to the exhaust frame casing for improved rotor-stator concentricity.
- Short low loss diffusing inter-turbine duct between gas generator and power turbine working blades.
- Two moderately loaded reaction stages with orthogonally-shaped airfoil cascades to produce the very highest blading efficiencies.
- Reinforced exhaust diffuser support for improved support stiffness and deflection control.
- Modular Design for easy assembly, disassembly, transportation and replacement of the modules in field.
- Forward pullout of the entire Duct and Turbine module reduces overhaul time to less than 10 days from 21 days for current RT61s.
The RB211-H63 Package

Estimated Weights (kg & Wet)

- Filter house and ventilation: 28500 kg
- Driver Skid (BP, GG & PT, LOC, Encl etc): 53500 kg
- Exhaust System (comb & Vent): 21200 kg
- Driven (BP + Reservoir, AC Gen, GB): 147900 kg
- Aux equipment (F&G, GGLOC, VFD): 3800 kg

Total: 254,900 kg Wet
       235,900 kg Dry
The RB211-H63 Package

- AC Generator
- Power Turbine
- Bleed Air Ducting
- GG Lube Oil
- Gas Generator
- Gearbox & Coupling Guard
- Turbine Base
- (Lube Oil Skid)
- Fire & Gas System
- Driven Equipment Lube Oil
- Generator Base

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# RB211 – Simple Cycle Performance

<table>
<thead>
<tr>
<th></th>
<th>G62 PhII</th>
<th>G62 DLE</th>
<th>GT62 DLE</th>
<th>GT61 DLE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power, kWs</strong></td>
<td>29136</td>
<td>27934</td>
<td>29901</td>
<td>32987</td>
</tr>
<tr>
<td><strong>Heat Rate, kJ/kW.hr</strong></td>
<td>9538</td>
<td>9645</td>
<td>9335</td>
<td>8903</td>
</tr>
<tr>
<td><strong>PT Exit Temp, °C</strong></td>
<td>488</td>
<td>502</td>
<td>491</td>
<td>504</td>
</tr>
<tr>
<td><strong>Thermal Efficiency, %</strong></td>
<td>37.74</td>
<td>37.33</td>
<td>38.5</td>
<td>40.43</td>
</tr>
<tr>
<td><strong>PT Exit Flow, kg/s</strong></td>
<td>93.9</td>
<td>91.9</td>
<td>95.1</td>
<td>94.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Gzero PhII</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power, kWs</strong></td>
<td>32054</td>
</tr>
<tr>
<td><strong>Heat Rate, kJ/kW.hr</strong></td>
<td>9479</td>
</tr>
<tr>
<td><strong>PT Exit Temp, °C</strong></td>
<td>497</td>
</tr>
<tr>
<td><strong>PT Exit Flow, kg/s</strong></td>
<td>102.4</td>
</tr>
<tr>
<td><strong>Thermal Efficiency, %</strong></td>
<td>38.01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>H63 GD</th>
<th>H63 GW</th>
<th>H63 LD</th>
<th>H63 LW</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power, kWs</strong></td>
<td>38000</td>
<td>44000</td>
<td>35683</td>
<td>41610</td>
</tr>
<tr>
<td><strong>Heat Rate, kJ/kW.hr</strong></td>
<td>8679</td>
<td>8839</td>
<td>8874</td>
<td>9027</td>
</tr>
<tr>
<td><strong>PT Exit Temp, °C</strong></td>
<td>486</td>
<td>482</td>
<td>495</td>
<td>491</td>
</tr>
<tr>
<td><strong>PT Exit Flow kg/s</strong></td>
<td>106.5</td>
<td>115.5</td>
<td>103.4</td>
<td>112.3</td>
</tr>
<tr>
<td><strong>Thermal Efficiency, %</strong></td>
<td>41.5</td>
<td>40.72</td>
<td>40.56</td>
<td>39.87</td>
</tr>
</tbody>
</table>

*Simple Cycle –15°C(59°F), 60% RH, 0 MASL, zero installation losses, 50/60 Hz, gas fuel, 25 vppm NOx (dry 15% O2)*
**RB211 – Combined Cycle Performance**

<table>
<thead>
<tr>
<th>Model</th>
<th>G62 DLE</th>
<th>GT62 DLE</th>
<th>GT61 DLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>– Net Plant Output, kWe</td>
<td>37,725</td>
<td>39,760</td>
<td>42,640</td>
</tr>
<tr>
<td>– Net Plant Heat Rate kJ/kWe.hr (BTU/kWe.hr)</td>
<td>7,175 (6,801)</td>
<td>7,005 (6,639)</td>
<td>6,820 (6,464)</td>
</tr>
<tr>
<td>– Thermal Efficiency, %</td>
<td>50.2</td>
<td>51.4</td>
<td>52.8</td>
</tr>
<tr>
<td>– Gas Turbine Output, kWe</td>
<td>26,716</td>
<td>28,626</td>
<td>31,171</td>
</tr>
<tr>
<td>– Steam Turbine Output, kWe</td>
<td>12,045 #</td>
<td>12,205 #</td>
<td>12,593 #</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model</th>
<th>H63 WLE</th>
<th>H63 WLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>– Net Plant Output, kWe</td>
<td>54,019</td>
<td>68,232</td>
</tr>
<tr>
<td>– Net Plant Heat Rate kJ/kWe.hr (BTU/kWe.hr)</td>
<td>7,085 (6,715)</td>
<td>7,428 (7,040)</td>
</tr>
<tr>
<td>– Thermal Efficiency, %</td>
<td>50.8</td>
<td>48.5</td>
</tr>
<tr>
<td>– Gas Turbine Output, kWe</td>
<td>40,935</td>
<td>40,935</td>
</tr>
<tr>
<td>– Steam Turbine Output, kWe</td>
<td>14,189 #</td>
<td>29,125 +</td>
</tr>
</tbody>
</table>

# Combined Cycle –15 °C (59 °F), 60% RH, 50/60 Hz, gas fuel, 25 vppm NOx (dry 15% O2), Dual pressure steam Cycle
+ Combined Cycle –15 °C (59 °F), 60% RH, 50/60 Hz, gas fuel, 25 vppm NOx (dry 15% O2), Single pressure steam cycle, Supplementary fired to 750 °C (1382 °F)
ISO Conditions, Zero Installation Losses, Natural Gas LCV = 49,111kJ/kg, Non-DLE (Dry)
Non-guarantee, for information purposes only
RB211-H63  Product Summary

- Modular construction as per today’s RB211
  - Quick and easy maintenance
  - Six modules

- Load acceptance capability over large degree of power range.
  - Full load rejection capability

- Fast start to full power within 10 minutes.
  - Proven on Trent 60

- Dual fuel capability
  - Proven technology and reliability.

- Fuel change-over with no noticeable change in power level (up to an including baseload levels) within 45 seconds.
  - Proven capability and reliability on Trent60.

- DLE capability to be available after WLE introduction

- All Units will come pre-equipped with Equipment Health Monitoring
THANK YOU!