Introduction of 50 Hz SC 660/800MW Steam Turbine
Contents

I  General Introduction

III  Steam Turbine Technologies
History of Doosan STG Technology and business

- Established (1962)
- Turbine & Generator Manufacturing license with GE (1976)
- 500MW Subcritical (1988)
- 1000MW Nuclear STG (1988)
- 800MW Supercritical STG (1998)
- 500MW Supercritical / 1455MW Nuclear STG (2002)
- Fossil, Nuclear, CCPP STG, Total 55 units (2003~2012)
- Acquisition of Skoda (2009)
- GE license termination (2010)
TG Business Line

**Steam Turbine**
- Steam Turbine for Fossil, Nuclear and Combined Cycle
- Steam Turbine Upgrading (Retrofit)

**Generator**
- Generator for Fossil, Nuclear and Combined Cycle
- Generator Upgrading (Retrofit)

**Gas Turbine**
- Gas Turbine for Simple & Combined Cycle
- Licensed with Mitsubishi Heavy Industries

**Control & Excitation**
- Turbine Generator Control System
- Generator Excitation System
- Electrical Equipment
Shops and Facilities in Korea

Manufacturing facilities covering from material to the assembled product

Quality control program certified by ISO 9001 for entire manufacturing process

Manufacturing Capacity

- 2,600MW / Year
- 5,500MW / Year
- 9,500MW / Year
Steam Turbine Experience – Major Projects

Experience for Steam Turbine & Generator

- **Thailand**
  - GHECO-one (700MW x 1)

- **Indonesia**
  - Cirebon (698MW x 1)

- **India**
  - Raipur (685MW x 2)

- **Saudi Arabia**
  - Yanbu #2 (276MW x 3unit)
  - Rabiigh #7~10 (700MW x 4unit)

- **Czech Republic**
  - Ledvice (660MW x 1)

- **UAE**
  - BNPP #1~4 (1390MW x 4unit)

- **Korea**
  - *Coal*
    - Younghung #1/2 (814MW x 2)
    - Hadong #7/8 (518MW x 2)
    - Tangjin #5~8 (518MW x 4)
    - Poryong #7/8 (550MW x 2)
    - Taean #7/8 (550MW x 2)
    - Samchungpo #1~6 (577MW x 4unit, 541MW x 2unit)
  - *Nuclear*
    - Wolson #2~4 (714MW x 3unit)
    - Yonggwang #3~6 (1050MW x 4unit)
    - Ulchin #3~6 (1050MW x 4unit)
    - Shin Kong #1/2 (1050MW x 2unit)
    - Shinwon #1/2 (1050MW x 2unit)
    - Shin Kong #3/4 (1450MW x 2unit)
    - Shinulchin #1/2 (1450MW x 2unit)

- **Vietnam**
  - Mong Duong I (540MW x 2unit)
  - Mong Duong II (900MW x 2unit)

- **Australia**
  - Eraring #1~4 (750MW x 4unit)

- **UAE**
  - Yoonwol (845MW x 3~1 x 1unit)
  - Pocheon (600MW x 2~1 x 2unit)
  - Yangju (540MW x 2~1 x 1unit)
  - Haengbok (540MW x 2~1 x 1unit)

- **CCPP/CHP**
  - Yeongwol (845MW x 3~1 x 1unit)

**Total Unit (MW)**
- Subcritical: 74Unit (47,565 MW)
- Supercritical: 16Unit (9,368 MW)
- Total Fossil Fired: 90Unit (55,933 MW)

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# Steam Turbine Product Line-Up (1/2)

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Specification</th>
<th>Capacity Range</th>
</tr>
</thead>
</table>
| TC1F, 1 Casing | • 1HP + 1LP  
• 50Hz / 60Hz Application  
• Fossil / CCPP Unit | Up To 180MW |
| TC1F, 2 Casing | • 1HP + 1ILP  
• 50Hz / 60Hz Application  
• Fossil / CCPP Unit | Up To 210MW |
| TC2F, 2 Casing | • 1HIP + 1LP  
• 50Hz / 60Hz Application  
• Fossil / CCPP Unit | 160MW~450MW |

![Diagram](image-url)
### Steam Turbine Product Line-Up (2/2)

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Specification</th>
<th>Capacity Range</th>
</tr>
</thead>
</table>
| TC2F, 3 Casing | • 1HP + 1IP + 1LP  
• 50Hz / 60Hz Application  
• Fossil Unit | 200MW ~ 700MW |
| TC4F, 3 Casing | • 1HIP + 2LP  
• 50Hz / 60Hz Application  
• Fossil Unit | 400MW ~ 800MW |
| TC4F, 4 Casing | • 1HP + 1IP + 2LP  
• 50Hz / 60Hz Application  
• Fossil Unit | 600MW ~ 1,100MW |

(MW)

300  600  900
Contents

I General Introduction

III Steam Turbine Technologies
Steam Turbine Test Facility
- Verification of New Steam Turbine Technology
- Verification of Last Stage Bucket

Generator Test Facility
- Efficiency Evaluation
- Electrical Characteristics & Mechanical Reliability
- Capacity: 100MW to 1,800MW
DHI steam turbine was designed based on DHI’s own material test data base.

- Critical Fatigue Life ($N_{cr}$)
  - Stress
    - 1) 40% of Average $10^5$hr Rupture Stress
    - 2) 50% of Minimum $10^5$hr Rupture Stress
    - 3) 100% of the Smallest $10^5$hr Rupture Stress

- Allowable of Casing
  - Stress
    - 20% of TS_spec, min. @ Temp.
    - 50% of YS_spec, min. @ Temp.
    - 100% of the Creep Strength which produces 1% Plastic Strain in $10^5$hr

- Temperature
50 Hz SC 660 MW/ 800 MW Turbine

## Layout and Steam Conditions

<table>
<thead>
<tr>
<th></th>
<th>SC 660</th>
<th>SC 800</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Steam Pressure</td>
<td>242 bar</td>
<td>242 bar</td>
</tr>
<tr>
<td>Main Steam Temperature</td>
<td>566°C</td>
<td>566°C</td>
</tr>
<tr>
<td>Reheat Steam Temperature</td>
<td>593 °C</td>
<td>593 °C</td>
</tr>
</tbody>
</table>
50 Hz SC 660 MW/ 800 MW Turbine

- HP Turbine

- Honeycomb seal
- Assembled diaphragm
- 3D blade Design Technology

HP Valves
CV
MSV
OLV*

Doosan Heavy Industries & Construction
50 Hz SC 660 MW/ 800 MW Turbine

- **IP Turbine**

  - Honeycomb seal
  - Assembled diaphragm
  - 3D blade Design Technology
50 Hz SC 660 MW/ 800 MW Turbine

- LP Turbine

LP 1 to LP 3 Shroud

LP 4 Shroud

Hollow Diaphragm

33.5” LSB

48” LSB

Doosan Heavy Industries & Construction
Advanced Technologies (1/5)

Advanced Steam Path Technology

- Flow path optimize with compound lean blade
- High end blade design technology
- Compound lean technology
- Optimized radial reaction to decrease loss

Increased stage efficiency

Blade shape

3D Optimization of Turbine Blade
Bucket & Tip Seal Technology

- Reducing the tip leakage flow
- Reducing vibration

- Minimize installation clearance
- Minimize friction and maintain tooth profile

Reduces tip losses
Increased Reliability

Continuous Coupled Blade

Honeycomb Seal
Advanced Technologies (3/5)

Nozzle & Diaphragm Construction

- Moisture removing
- Water drain slot in suction & pressure side

- High geometrical accuracy
- High blade surface quality
- Easy maintenance

**Hollow type nozzle**

**Assembled diaphragm**
Overload Valve Application

- Smooth control response at overload secured by aerodynamically linearized characteristic

**Schematic Valve Arrangement**

**Configuration of Overload valve Chamber**
**Overload Valve Application**

- Smooth control response at overload secured by aerodynamically linearized characteristic
- All control valves operate at the same time (Full arc admission)
- OLV is starting to open getting over 100% TMCR
Advanced Technologies (5/5)

- 48” Steel LSB for 50 Hz SC 660MW

- **Design Basic**
  - Tie-boss
  - Shroud
  - Fir tree dovetail

- **CFD Verification** (full scale)

- **Fatigue test**

- **Dynamic Testing**

- **Vacuum Spin-pin Test**

- **Wind Tunnel Test**

- **Campbell diagram**

- 3D full aero design/Integral blade tip cover
- High structural reliability and stability
- Verify structural reliability with full scale dynamic test
- Curved axial entry dovetail
Current development for 50 Hz SC 660 MW/ 800 MW Turbine

• HIP1F-LP2F
• Wheel Stage
• 48” LSB
• 2HP & 2IP Valve

• HP1F-IP1F-LP4F
• Wheel Stage
• 33.5” LSB
• 2HP & 2IP Valve
Thank you
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