Packaging Turbomachines for Offshore Applications

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Gas Electric Partnership 2013
Scope

• Turbomachinery in Offshore Applications
• Certification
• Movement and Deflection
• Air
• Fuel
• Weight
Offshore Applications

Mechanical Drive

Generator Set

Multi Body Compressor Set
Gas Turbine Installation on an FPSO

- Power Generation
- Mechanical Drive
Certification
Hazardous Locations

Risk

Duration of time Gas is Present

Zone 0

Division 2
Zone 2

Division 1
Zone 1

1 Hr./Yr.
10 Hrs./Yr.
1000 Hrs./Yr.

Not Classified

Risk

Zone 0

Duration of time Gas is Present

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Movements and Deflection
Movements
Fluid Management

- Bearing Scavenge Systems
- Package Scavenging
- Separate Lube Oil Tank
- Lube Oil Tank Baffles

Evaluate L/O Tanks for Pitch & Roll using CFD
Moderate Package Scavenge System

PACKAGE SCAVENGE OIL TANK

- Lube Oil Tank and Drain
- Vent System
- Lube Oil Supply System

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Installation Orientation

Perpendicular Orientation

Parallel Orientation

Roll Angle

Oil Can’t Drain to Tank

Oil Can Drain to Tank
Deck Deflections

Hogging

Sagging

Twisting

Top View

End View
Anti-Vibration Mount (AVM) Method

Gimbal Mount Method

Stainless Steel Vibration Isolators

Package Mounting Surface

Deck Mounting Surface

Spherical Bearing
3-Point Mount Base Plates

Single-Piece Base Plate

Two-Piece Base Plate

Two-Piece Base Plate with Sub-Base
Air Filtration
Environment: The issues

- Environmental conditions can lead to fouling and corrosion
  - Viscous hydrocarbons from flares, exhausts
  - cement dust, shot blast, iron oxides
  - salt crystals
  - cyclic wet/dry conditions etc.
Air Filters Trade-Off

Effectiveness

Cost, Size
Pressure Loss
GT Maintenance
Behavior of Airborne Salt with Changes in Relative Humidity

Filter has to deal with salt dissolved in water and salt particulates both in the airstream and in its surface!
Fractional efficiency for filter elements

Figure 1. Low-velocity filter system for offshore application [9].

Figure 2. High-velocity filter system for offshore application [9].
Offshore Air Inlet Systems

HIGH VELOCITY INLET SYSTEM

MEDIUM VELOCITY INLET SYSTEM
Fuel
Hot Corrosion

- A form of accelerated oxidation
- 1100 to 1750F temperature range: two types
  - Type I, High Temperature (1350 – 1750F)
  - Type II, Low Temperature (1020 – 1350F)
- \( \text{Na}_2\text{SO}_4 \) commonly responsible
- Sodium intake is critical
- Potassium, vanadium, and lead also contribute to hot corrosion
Dealing with Contaminants in Gas Fuels

- Scale, Rust, Slag, Dirt
  - Clean and Passivate Piping
  - Use Proper Filtration

- Condensibles, Oils, Water
  - Use Coalescing Filtration
  - Fuel Heating
  - Fuel Analysis (up to C14!)

Fuel Filters and Coalescers
Weight
Installed Weights and Footprints
Driver Systems for 10 MW Compressors

<table>
<thead>
<tr>
<th>System Option¹</th>
<th>All Gas Turbine</th>
<th>Electric Drive – Variable Frequency</th>
<th>Electric Drive – Variable-Speed Gear</th>
<th>Electric Drive – Constant Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Driver System Weight</strong></td>
<td>55,000 kg</td>
<td>60,000 kg</td>
<td>60,000 kg</td>
<td>40,000 kg</td>
</tr>
<tr>
<td><strong>Driver System Footprint</strong></td>
<td>30 m²</td>
<td>41 m²</td>
<td>32 m²</td>
<td>26 m²</td>
</tr>
</tbody>
</table>

- **Driver System Weight and Footprint Impact Cost**
- **Gas Turbine and Variable Frequency Electric Drive Systems Comparable**
  - Provided Full Electrical Equipment Scope Included in Analysis
- **Constant Speed Option Compact, But Limits Operability, Increases Size of Power Generation**

¹Driven compressors not included (same for all scenarios). Weight for Generators (EMD Solutions) not included.
Questions?