CHP Design Considerations for Cold Climates

Don’t Stick Your Tongue on That Pipe!

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CHP Design Considerations for Cold Climates – Don’t Stick Your Tongue on That Pipe!
Case Study: K+S Windsor Salt

- One (1) 3.5 MW Gas Turbine (Centaur 40)
- One (1) Rentech Heat Recovery Steam Generator (R&V Burner)
- Emerson Vilter Fuel Gas Booster Compressor
- New 27.6 kV Electrical Switchgear
- Provides electricity and steam to on-site salt evaporation plant
- Electrically islanded operation
Case Study: K+S Windsor Salt
Case Study: TransAlta, Alberta

- Two (2) 15 MW Gas Turbines (Titan 130)
- Two (2) Rentech Heat Recovery Steam Generators (R&V Burner)
- One (1) 9 MW Caterpillar Reciprocating Engine
- New Electrical E-House
- Provides electricity and steam to host gas processing site
- Market participant in Alberta power market
Case Study: TransAlta, Alberta
Case Study: International Wax

- One (1) 3.5 MW Gas Turbine (Centaur 40)
- One (1) Rentech Heat Recovery Steam Generator
- Emerson Vilter Fuel Gas Booster Compressor
- New 5 kV & 27.6 kV Electrical Switchgear
- Provides electricity and steam to on-site wax plant
- Electrically islanded operation
- Installed inside industrial building
Case Study: International Wax
Case Study: Archer Daniels Midland

• Two (2) 3.5 MW Gas Turbine (Centaur 40)
• Two (2) Rentech Heat Recovery Steam Generators
• New Condensing Economizer & Natural Gas Blackstart Generator
• New 15 kV Electrical Switchgear
• Provides electricity and steam to on-site corn processing plant
• Electrically islanded operation
Case Study: Archer Daniels Midland
Cold Weather Package Design Options

Powering the Future

Solar Turbines
A Caterpillar Company
Cold Weather Package Design

- Combustion power generation equipment is installed in many different geographic locations, some of which expose the equipment to temperature extremes.

- -4°F (-20°C) is the minimum temperature guideline for the standard Solar package. The following table lists the temperature limits for standard packages. Generally, packages can operate within these limits without any special modifications.

<table>
<thead>
<tr>
<th>Temperature Range</th>
<th>Lower Limit</th>
<th>Upper Limit</th>
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<tbody>
<tr>
<td>°F</td>
<td>°C</td>
<td>°F</td>
</tr>
<tr>
<td>Packages with Offskid Control Systems</td>
<td>-20</td>
<td>-29</td>
</tr>
<tr>
<td>Packages with Onskid Control Systems*</td>
<td>-4</td>
<td>-20</td>
</tr>
<tr>
<td>Control Console (Offskid and Onskid)</td>
<td>-4</td>
<td>-20</td>
</tr>
</tbody>
</table>
Standard Generator Package
Scope of Supply

- Base Frame
- Driver, Gearbox & Generator
- Auxiliary Systems
- Combustion Air Inlet Filtration
- Control Panel & HMI

Typical Options
- Enclosure & Ventilation
- Fire Suppression
- Exhaust System
# Cold Weather Requirements

<table>
<thead>
<tr>
<th>Component</th>
<th>Standard Package</th>
<th>Modified Package</th>
<th>Extreme Cold Package</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>STANDARD</strong></td>
<td>40°C (104°F) to -20°C (-4°F)</td>
<td>-21°C (6°F) to 30°C (-22°F)</td>
<td>-31°C (-24°F) to -40°C (-40°F) &lt; -40°C (-40°F)</td>
</tr>
<tr>
<td><strong>PACKAGES</strong></td>
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<tr>
<td><strong>ENGINE</strong></td>
<td>STANDARD</td>
<td>MODIFIED TO INCLUDE</td>
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<tr>
<td><strong>BASEPLATE</strong></td>
<td>STANDARD</td>
<td></td>
<td></td>
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<tr>
<td><strong>ODP GENERATOR</strong></td>
<td>STANDARD</td>
<td></td>
<td></td>
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<tr>
<td><strong>CO2 CABINET</strong></td>
<td>LOW AMBIENT ENGINE</td>
<td></td>
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<tr>
<td><strong>ENGINE HANDLING KIT</strong></td>
<td>HANDLING KIT</td>
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<tr>
<td><strong>DUCTING</strong></td>
<td>CARBON STEEL</td>
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<tr>
<td><strong>TURBINE AIR INLET FILTER</strong></td>
<td>STD FILTER WITH SPACE HEATER</td>
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<tr>
<td><strong>ODP LUBE OIL COOLER</strong></td>
<td>STD A387 ALLOY STEEL</td>
<td>LOW AMBIENT SILICON SEALANT</td>
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<tr>
<td><strong>ENCLOSURE</strong></td>
<td>VENTILATION INTERNAL FILTER BULBS</td>
<td>OVERSIZED COLD WEATHER</td>
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<tr>
<td><strong>CONTROL PANEL</strong></td>
<td>STANDAR PANEL</td>
<td>SELF-CLEANING UPDRAFT FILTER</td>
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<td><strong>HEATERS</strong></td>
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<tr>
<td><strong>STANDARD PANEL</strong></td>
<td>BARRIER FILTER</td>
<td>LOW AMBIENT CONTROL PANEL</td>
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<tr>
<td><strong>LOW AMBIENT HEATER</strong></td>
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<tr>
<td><strong>EXTREME COLD WEATHER</strong></td>
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<tr>
<td><strong>STANDARD SPACE HEATER</strong></td>
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<tr>
<td><strong>HEAT TRACING</strong></td>
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<td><strong>INDOOR INSTALLATION</strong></td>
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Standard Cold Weather Logic Below 0°F (-18°C)

- Increased fuel pilot flow required for flame stability to prevent combustor rumble
- For DLE cold ambient emissions, the turbine must be configured with the appropriate combustion hardware and software.

Pilot Active Control Logic

- Uses active oscillations feedback to increase pilot fuel & reduce oscillations
- Offered for DLE emission requirements of 42 ppm NOx on natural gas from below 0°F (-18°C) to -20°F (-29°C)
- Provides reduced emissions below -20°F (-29°C) on natural gas only
Air Flow Design Changes

- Turbine Air Inlet
- Enclosure ventilation
Generator Design Changes

- Proper Generator Selection

![Image of a generator system]

[Graph showing Ambient Temperature Effect on Generator Power]

- Ambient Temperature (°C) vs. Power (kW)

Caterpillar: Confidential Green
Questions?
Thank You!

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