Considerations for Specifying Generator Set Fuel Sources

PowerHour webinar series for consulting engineers
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January 28, 2020 11:00 PDT / 13:00 CDT
(1PDH issued by Cummins)
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Technical Marketing Specialist
Cummins Inc.

Cummins Facilitator: Mark Taylor
Technical Marketing Specialist
Cummins Inc.

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The views and opinions expressed in this course shall not be considered the official position of any regulatory organization and shall not be considered to be, nor be relied upon as, a Formal Interpretation.

Participants are encouraged to refer to the entire text of all referenced documents. In addition, when in doubt, reach out to the Authority Having Jurisdiction.
Considerations for Specifying Generator Set Fuel Sources

The installation of gaseous generator sets in a wide variety of applications continues to rise in North America while facility performance requirements, codes and standards are often most closely linked to their traditional diesel counterpart. As natural gas and propane fueled generator sets reach the market with “diesel-like” performance, it’s critical to understand how best to apply these products in order to maximize the value they provide. This course will provide an overview of gaseous generator set capabilities in various applications and will empower participants to recognize how to best apply gaseous generator sets to meet common performance and code requirements.

After completing this course, participants will be able to:

• Recognize performance requirements applicable to both diesel and gaseous generator sets.
• Describe key features and capabilities of gaseous generator sets.
• List key considerations unique to gaseous generator set installation.
When compared to a diesel generator set, what are some of the differentiators unique to a natural gas (or propane) fueled generator set?
Generator Set Fuel Sources

Diesel and Gaseous Fuels

Diesel Fuel
  Power dense, high energy content
  ULSD Diesel #2 ASTM D975
Generator Set Fuel Sources

Diesel and Gaseous Fuels

Diesel Fuel
  Power dense, high energy content
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Gaseous Fuel
  Variable energy content
  “Pipeline natural gas”
Generator Set Fuel Sources

Diesel and Gaseous Fuels

- **Diesel Fuel**
  - Power dense, high energy content
  - ULSD Diesel #2 ASTM D975

- **Gaseous Fuel**
  - Variable energy content
  - "Pipeline natural gas"

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<th>Diesel Fuel</th>
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<tr>
<td>Gasoline</td>
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## Generator Set Fuel Sources

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**Spec Note** Conduct a fuel sample analysis, include the results in the specification and require manufacturers to provide documentation demonstrating capability with the on-site fuel.
Generator Set Fuel Sources

Gaseous Fuels - Methane Number

Methane Index Number (MN)
- Defines likelihood of a fuel to auto-ignite
- Scale of 0-100
Generator Set Fuel Sources

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**Spec Note** Specify project requirements critical to the generator set such as transient performance, motor starting capability or emissions limits. Avoid specifying “Rich Burn” or “Lean Burn” as it may drive unnecessary product requirements.
Concept Check

When describing gaseous fuels, which of the following attributes are often used to describe fuel composition? Choose all that apply.

a) Methane Number (MN)
b) Energy Density (BTU/ft³ or MMBTU)
c) ASTM D975
d) Air/Fuel Ratio
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Compliance to Codes and Standards

Fuel Source for Emergency Systems

NFPA 110-2019

5.1.1 The following energy sources shall be permitted to be used for the emergency power supply (EPS):

(1) Liquid petroleum products…
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(3) Natural or synthetic gas
Compliance to Codes and Standards

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Exception: For Level 1 installations in locations where the probability of interruption of off-site fuel supplies is high, on-site storage of an alternate energy source sufficient to allow full output of the EPSS to be delivered for the class specified shall be required, with the provision for automatic transfer from the primary energy source to the alternate energy source.
Compliance to Codes and Standards

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Natural Gas Council

Natural gas is a secure, reliable and resilient choice for customers

- Operational reliability
  - 2017 survey of 51 interstate pipelines – 99.97% of contractual commitments
  - Geographic dispersion of production reduces vulnerability to local weather
  - Transportation network interconnected, offering multiple pathways for rerouting

- Contractual continuity of service
  - Firm or interruptible contracts

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Compliance to Codes and Standards

Fuel Source for Emergency Systems

Map of U.S. interstate and intrastate natural gas pipelines

Source: U.S. Energy Information Administration, About U.S. Natural Gas Pipelines
**Compliance to Codes and Standards**

**Fuel Source for Emergency Systems**

Specify natural-gas fueled generator sets for emergency power systems where permitted by the local Authority Having Jurisdiction.

Map of U.S. interstate and intrastate natural gas pipelines

Source: U.S. Energy Information Administration, *About U.S. Natural Gas Pipelines*
Compliance to Codes and Standards

Generator Set Ratings

ISO 8528: Defines application, ratings and performance of generator sets.

- Emergency Standby Power (ESP)
- Prime Rated Power (PRP)
- Limited Time Prime Power (LTP)
- Continuous Operating Power (COP)
- Data Center Power (DCP)

Any manufacturer can go above and beyond the ISO ratings definitions.
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ISO 8528 is a reference standard that only describes duty cycle, NOT fuel type.

Spec Note: Include ISO 8528 in specification codes and standards reference.
Compliance to Codes and Standards

Generator Set Ratings

Emergency Standby Power (ESP)

- “Maximum power available during a variable electrical power sequence…for up to 200 h of operation per year”
- “The permissible average power output over 24 h of operation shall not exceed 70% of the ESP unless otherwise agreed by the RIC engine manufacturer”
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Spec Note Specify ISO 8528 generator set power rating based on application requirements.
Compliance to Codes and Standards

NFPA 110 Type Requirements

4.3 Type. The type defines the maximum time, in seconds, that the EPSS will permit the load terminals of the transfer switch to be without acceptable electrical power.
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Spec Note Specify NFPA 110 Type requirement for Emergency Power Supply System based on application requirements and loads served.
Compliance to Codes and Standards

Emissions Requirements

US EPA New Source Performance Standards (NSPS)
Compliance to Codes and Standards

Emissions Requirements

US EPA New Source Performance Standards (NSPS)

Fuel Type

- Compression Ignition (Diesel) and Spark-Ignited (Gaseous)
Compliance to Codes and Standards

Emissions Requirements

US EPA New Source Performance Standards (NSPS)

Fuel Type
- Compression Ignition (Diesel) and Spark-Ignited (Gaseous)

Usage
- Stationary Emergency – operation when utility power is not available
- Stationary Non-Emergency – operation when utility power is available
- Non-road – mobile, non-propulsion without operational limitation (trailerized)
Compliance to Codes and Standards

Emissions Requirements

US EPA New Source Performance Standards (NSPS)

Fuel Type
- Compression Ignition (Diesel) and Spark-Ignited (Gaseous)

Usage
- Stationary Emergency – operation when utility power is not available
- Stationary Non-Emergency – operation when utility power is available
- Non-road – mobile, non-propulsion without operational limitation (trailerized)

Spec Note Require generator set vendors to provide documentation demonstrating compliance with applicable limits of U.S. EPA New Source Performance Standards for stationary emergency or non-emergency engines as appropriate.
## Compliance to Codes and Standards

### Emissions Requirements

<table>
<thead>
<tr>
<th></th>
<th>Definition</th>
<th>Diesel Engine</th>
<th>Gaseous Engine</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO\textsubscript{x}</td>
<td>Oxides of nitrogen</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>HC</td>
<td>Over 100 different types of hydrocarbons</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>PM</td>
<td>Anything that is trapped on or condenses onto a filter</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>CO</td>
<td>Carbon Monoxide</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>SO\textsubscript{x}</td>
<td>Oxides of Sulfur</td>
<td>✓</td>
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</tbody>
</table>
**Compliance to Codes and Standards**

**Emissions Requirements**

- Mandatory factory certification of rich burn propane engines
- Optional factory certification of all natural gas engines and lean burn propane engines
- If not factory certified, the owner/operator may be responsible for demonstrating compliance:

<table>
<thead>
<tr>
<th>Engine Power</th>
<th>Maintenance plan and records, maintain/operate engine in a way to minimize emissions</th>
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<tr>
<td>&lt; 100 hp</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100-500 hp</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>&gt; 500 hp</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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Reference: 40 CFR 60 Subpart JJJJ §60.4243 (a)(2)(i-iii)
Compliance to Codes and Standards

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<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

Reference: 40 CFR 60 Subpart JJJJ §60.4243 (a)(2)(i-iii)

Spec Note Require generator set vendor to provide documentation demonstrating compliance with specific emissions levels or engine certification.
Compliance to Codes and Standards

Emissions Requirements

US EPA New Source Performance Standards (NSPS)

Fuel Type
- Compression Ignition (Diesel) and Spark-Ignited (Gaseous)

Usage
- Stationary Emergency – operation when utility power is not available
- Stationary Non-Emergency – operation when utility power is available
- Non-road – mobile, non-propulsion without operational limitation (trailerized)

Local Air Quality Management Board
- May mandate stringent emissions limits requiring exhaust aftertreatment
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Spec Note: Require generator set vendor to provide documentation demonstrating compliance with specific emissions level requirement and applicable test methodology.
Concept Check

When specifying a generator set solution for an emergency power system, make sure to include… (choose all that apply)

a) US EPA and other applicable emissions requirements
b) ISO 8528 Power rating
c) Fuel type
d) NFPA 110 Type requirement for system
e) Engine air/fuel ratio
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Installation Considerations

Gaseous and Diesel Generator Sets

- Foundation, mounting and vibration isolation
- Exhaust systems
- Cooling and ventilation
- Starting system
- Sound considerations
- Service and maintenance access
- Remote monitoring solutions
- Housing and enclosure requirements
Installation Considerations

Gaseous and Diesel Generator Sets

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- Exhaust systems
- Cooling and ventilation
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Consult Cummins Application Engineering T-030: Liquid-Cooled Generator Set Application Manual for more information.
Installation Considerations

Fuel Source and Maintenance

Maintenance of Diesel Fuel

Diesel fuel quality critical to equipment operation.

- Typical stable lifespan of diesel is 12 – 16 months in ideal conditions.
- Diesel sulfur content reduction (ULSD) limits fuel's anti-microbial properties.
- Bio-diesel blending may reduce fuel stability (up to 6 months), promotes water absorption and biomass growth.
Installation Considerations

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Spec Note Require vendors to provide service and maintenance contracts that include fuel testing at least annually.
Installation Considerations

Fuel Source and Maintenance

Maintenance of Gaseous Fuel
- Natural gas available through extensive pipeline network
- Avoid fuel transportation, handling, and storage issues
- No fuel tank cleaning required
- No fuel degradation over time
- Various fuels can be used
Installation Considerations

Fuel System Requirements

- Volume and pressure must be available at RATED load, not static pressure
- Be aware of fuel system pressure drop
- Accumulator or compressor to boost pressure, if necessary
- Consult generator set manufacturer for specific fuel system requirements.

<table>
<thead>
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<th></th>
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<tr>
<td>Gas supply pressure to engine inlet, bar (psi)</td>
<td>0.2 (2.9)</td>
</tr>
<tr>
<td>Minimum methane index</td>
<td>62</td>
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**Fuel system**

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**Spec Note** Require generator set vendors to provide documentation indicating engine minimum fuel pressure at rated load.
Operational Considerations

Operating Costs of NG-Fueled Generator Sets

Natural Gas Operating Costs

- Natural gas generator set may be associated with greater capital costs (when compared to diesel) due to power density.
- Long term total cost of ownership indicates for diesel and natural gas products to be comparable in similar applications.
- Non-emergency operation (demand response, peaking, etc.) mandates Tier 4 levels for CI engines minimizing capital investment difference when compared to natural gas.

www.eia.gov/naturalgas
Concept Check

When considering natural gas generator sets, what are some of the key installation and operational differentiators when compared to diesel generator sets? (choose all that apply)

a) Sound attenuation and mufflers
b) Fuel system design requirements
c) Fuel quality management
d) Foundation, mounting and vibration
e) Cost of operation
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When considering natural gas generator sets, what are some of the key installation and operational differentiators when compared to diesel generator sets? (choose all that apply)

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c) Fuel quality management
d) Foundation, mounting and vibration
e) Cost of operation
Gaseous Generator Set Applications

Myths and Misconceptions

MYTH: “Gaseous generator sets may not be suitable for emergency or life safety applications.”

✓ Generator set manufacturers may be able to offer gaseous-fueled products that meet a wide range of applications.

✓ Natural gas may be acceptable to local authority having jurisdiction for life safety applications.

✓ Gaseous products may provide advantages over diesel products in applications due to fuel quality and logistics.
Gaseous Generator Set Applications

Myths and Misconceptions

**MYTH:** “Because gaseous generator sets are cleaner than their diesel counterparts, they NEVER need exhaust aftertreatment.”

- Emissions limits may be based on a combination of Federal (US EPA), state (local air board) or customer-driven requirements.
- Application type (standby vs. nonroad, emergency vs. non-emergency) drive emissions limits.
- Engine manufacturers offer a wide range of products capable of meeting the most stringent requirements.
- In some cases, exhaust aftertreatment may be needed to achieve targeted emissions levels.
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**Spec Note** Require generator set vendor to provide documentation demonstrating compliance with specific emissions level requirement and applicable test methodology.
Gaseous Generator Set Applications

Myths and Misconceptions

**MYTH:** “Gaseous generator set transient performance and load acceptance is always worse than their diesel counterparts.”

✓ Rated load acceptance may not be suitable as a benchmark for product performance – transient performance limits must be based on application.

✓ Generator set sizing software may help to determine right-size generator set for a given application.

✓ Engine control and fueling strategies continue to evolve.
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60 Hz, 0.8 Power Factor
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</table>

60 Hz, 0.8 Power Factor

*Spec Note* Require generator set vendors to provide documentation from sizing software indicating compliance with transient and other project limits.
Gaseous Generator Sets

Key Takeaways

Natural gas fueled generator sets can provide…

... reliable power generation in emergency and non-emergency applications

... emissions solutions that fit application requirements

... high efficiency options for prime and continuous operation

... compliance with appropriate codes and standards

... low or comparable cost of ownership

... strong performance capability comparable to diesel counterparts.
Course Summary

Considerations for Specifying Generator Set Fuel Sources
• Recognize performance requirements applicable to both diesel and gaseous generator sets.
• Describe key features and capabilities of gaseous generator sets.
• List key considerations unique to gaseous generator set installation.

Key Takeaways
• Write specifications based on performance and application requirements such loads, transient limits, emissions, start-time and other code-driven requirements.
• Consider gaseous-fueled generator sets in applications where appropriate.
Additional Resources

Cummins White Papers
- Understanding EPA NSPS Emissions Regulations for Stationary Spark-ignited Engines
- The Latest Evolution Of Distributed Energy Resources: Opportunity For Business Within The PJM
- Utilizing Flare Gas To Generate Power For The Oil And Gas Sector
- Palm Oil Mill Effluent in Lean Burn Natural Gas Generator Sets

Cummins On-Demand Webinars
- Lean Burn Natural Gas Generator Sets in Standby-Peak Shaving Applications
- Specifying Gaseous Generator Sets
- Introduction to Generator Set Sizing Software
- EPA Emissions and Air Permitting
Q&A

Type your questions, comments, feedback in the WebEx Q&A box. We will get to as many questions as we can.

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- CA, HI: Brian E Pumphrey (brian.pumphrey@cummins.com), Pacific Region
- WA, OR, AK: Tom Tomlinson (tom.tomlinson@cummins.com), Pacific Region
- For other states and territories, email powergenchannel@cummins.com or visit http://power.cummins.com/sales-service-locator
Closing

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• A PDH Certificate

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• Other Cummins Continuing Education programs
• Sizing and specification development tools

Upcoming PowerHour Webinars:

• February – Understanding and Applying UL 1008 Transfer Switch Withstand and Closing Rating
• March – Advanced Generator Sizing: Transient Performance and Motor Loads

Please contact Mohammed Gulam if you have any questions related to the PowerHour webinar (mohammed.gulam@cummins.com)