Emissions and Air Permitting Requirements for Standby Generator Sets

PowerHour webinar series for consulting engineers
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June 25, 2019 11:00 PDT / 13:00 CDT
(1PDH issued by Cummins)
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Disclaimer

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.
Course Objectives

Emissions and Air Permitting Requirements for Standby Generator Sets

Air permitting for standby generator sets can vary wildly from site to site and when misunderstood can have a major impact on project success. Although EPA regulations have stabilized and are thought to be well understood, ever-increasing local requirements are changing the criticality of air permitting for engine-driven generator sets.

This course will provide a brief overview of regulated emissions constituents and their formation in order to provide a foundational understanding of engine emissions. Next, the EPA's New Source Performance Standards (NSPS) will be reviewed as it relates to both compression ignited (diesel) and spark ignited (natural gas or propane) engine equipped generator sets. Participants will gain an awareness of common pitfalls related to emissions permitting and will be introduced to various strategies employed to meet local emissions regulations.

After completing this course, participants will be able to:

• Recognize commonly regulated exhaust emissions constituents.
• Describe EPA emissions requirements for diesel and gaseous standby generator sets.
• Identify common requirements for permitting engine-driven generator sets.
What are some of the commonly regulated exhaust constituents?
Exhaust Emissions Formation

\[ C_xH_yS_z + O_2 + N_2 \]
Exhaust Emissions Formation

$$C_xH_yS_z + O_2+N_2 = CO_2+H_2O+O_2+N_2$$

Fuel + Air = Major Exhaust Constituents
Exhaust Emissions Formation

\[ C_xH_yS_z + O_2+N_2 = CO_2+H_2O+O_2+N_2 + NO_x+HC+CO+SO_x+C \]

Fuel + Air = Major Exhaust Constituents + Trace Exhaust Components
# Exhaust Emissions Formation

<table>
<thead>
<tr>
<th>What is it?</th>
<th>How is it formed?</th>
<th>CI</th>
<th>SI</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOₙ</td>
<td>Oxides of nitrogen (NO and NO₂)</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Formed at high in-cylinder temperatures, most prominent during high engine load.</td>
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<tr>
<td>HC</td>
<td>Over 100 different types of hydrocarbons</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Product of incomplete combustion, most prominent during low engine load.</td>
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<tr>
<td>NMHC</td>
<td>Non-methane hydrocarbons, subset of total hydrocarbons</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Product of incomplete combustion, dependent on fuel composition.</td>
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<td></td>
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<tr>
<td>VOC</td>
<td>Volatile organic compounds</td>
<td>✓</td>
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</tr>
<tr>
<td>Primarily hydrocarbons but may include other compounds.</td>
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<tr>
<td>PM</td>
<td>Anything that is trapped on or condenses onto a filter</td>
<td>✓</td>
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<tr>
<td>Most prominent during low load operation.</td>
<td></td>
<td></td>
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<tr>
<td>CO</td>
<td>Carbon monoxide</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Product of imperfect combustion, most prominent during low engine load.</td>
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<td></td>
<td></td>
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<tr>
<td>SOₓ</td>
<td>Oxides of sulfur (SO and SO₂)</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Product of combustion process when sulfur is present. Increases linearly with fuel consumption.</td>
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</table>
New Source Performance Standards (NSPS) for Compression-Ignited and Spark-Ignited engines
What is NSPS?

New Source Performance Standards
What is NSPS?

New Source Performance Standards
What is NSPS?

**New Source Performance Standards**

Source of emissions, when manufactured or installed
What is NSPS?

New Source Performance Standards
What is NSPS?

New Source Performance Standards

Emissions limits, operational guidelines and test methodologies
What is NSPS?

New Source Performance Standards

Emissions limits, operational guidelines and test methodologies

Source of emissions, when manufactured or installed
Requirements for EPA Certified Engines

- Engines are certified, not generator sets.
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<td>0-7</td>
<td>0-10</td>
<td>(7.5) / 8.0 / 0.40</td>
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<td>19-36</td>
<td>25-48</td>
<td>(7.5) / 5.5 / 0.30</td>
<td>(4.7) / 5.5 / 0.03</td>
<td>Emergency: Stay at previous tier</td>
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<tr>
<td>37-55</td>
<td>49-74</td>
<td>Optional Tier 0.30 PM</td>
<td>(4.7) / 5.0 / 0.03</td>
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<tr>
<td>56-129</td>
<td>75-173</td>
<td>Tier 3</td>
<td>3.4 / 0.19 / 5.0 / 0.02 Tier 3</td>
<td>0.40 / 0.19 / 5.0 / 0.02 Tier 3</td>
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<td>174-751</td>
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<tr>
<td>&gt; 560</td>
<td>&gt; 751</td>
<td>Tier 2</td>
<td>3.5 / 0.40 / 3.5 / 0.10 Tier 2</td>
<td>3.5 / 0.19 / 3.5 / 0.04 Tier 2</td>
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<td>0.67 / 0.40 / 3.5 / 0.10 (a)</td>
<td>0.67 / 0.19 / 3.5 / 0.03 (b)</td>
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<td>T2 T3</td>
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<td>Tier 4 Interim</td>
<td>Tier 4 Final</td>
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- Emissions levels are evaluated on a standardized test cycle including engine load and pollutant weighting following a specific test method in a test-cell environment.
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• Engines and emissions control devices must be certified as a complete solution by the engine manufacture (field upfit or third-party installations cannot meet certification requirements).
EPA Engine Usage Designations

- Stationary
  - Emergency
  - Non-Emergency
- Nonroad

Least Stringent → Most Stringent
Stationary and Nonroad Engines

Stationary
• On site for at least 12 consecutive months.
• Unable to be mounted on a trailer or be mobilized.

Nonroad
• No movement or operation restrictions.
• Must comply with most stringent emissions requirements.
Stationary Emergency Operation

- Emergency standby (safe evacuation, life support)
- Legally required standby (fire–fighting operations)
- Optional standby (could cause an economic loss)

Standby power system including seven C2000 D6 (2000 kWe) generator sets.

Standby system including two DQGAA (1250 kWe) and one DQGAB (1500 kWe).
Stationary Emergency Operation

- Unlimited use during emergencies.
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- Up to 100 hours per year allowed for:
  - Maintenance and testing
Stationary Emergency Operation

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- Up to 100 hours per year allowed for:
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  - Up to 50 hours per year for non-emergency operation (restrictions apply)
Stationary Emergency Operation

• Unlimited use during emergencies.
• Up to 100 hours per year allowed for:
  • Maintenance and testing
  • Up to 50 hours per year for non-emergency operation (restrictions apply)
  • Emergency Demand Response (EDR) allowance vacated in May 2015

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 engines.
Stationary Non-Emergency Operation

Remote mining site including two DQGAS (1500 kWe) generator sets.

Combined heat and power project producing steam with one C2000 N5C (2000 kWe) generator set.
Stationary Non-Emergency Operation

- Demand Response
- Peak shaving (reduce or flatten peak electricity use)
- Rate curtailment (favorable energy rates)
- Interruptible rate programs (favorable energy rates)
- Continuous base load (constant power to utility grid)
- Co-generation (capture and use waste heat)
- Prime power generator set (to be used as a primary source of power)

Spec Note: Require generator set vendors to provide documentation demonstrating compliance with applicable limits of U.S. EPA New Source Performance Standards for stationary non-emergency engines.
Other Industry Standards

NEC (NFPA 70): Practical safeguarding of persons and property from hazards arising from the use of electricity. Contains provisions that are considered necessary for safety.

- Emergency Systems (700)
- Legally Required Standby Systems (701)
- Optional Standby Systems (702)
- Critical Operations Power Systems (708)

ISO 8528: Standard for reciprocating internal combustion engine driven alternating current generator sets.

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

**Spec Note** Specify EPA certification requirements, ISO power ratings and NEC load types served independently.
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Cummins Power Topic #6240: Understanding ISO 8528-1 Generator Set Ratings
Concept Check

The EPA designates certification requirements for __________ based on __________ and __________.

a) Generator Sets, Electrical Output, NEC Load Type  
b) Engines, Brake Power, Usage  
c) Power production equipment, Alternator rating, ISO 8528 rating
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New Source Performance Standards (NSPS) for Stationary CI engines

Title 40, Part 60: Subpart IIII
Evolution of NSPS CI Engine Regulations

EPA Non-Road / Stationary Non-Emergency Engines >751 HP

Tier 1 (2000)

<table>
<thead>
<tr>
<th>NOx (g/kW-hr)</th>
<th>PM (g/kW-hr)</th>
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<tbody>
<tr>
<td>9.20</td>
<td>0.54</td>
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9.20  | 0.20
6.40  | 0.54
Evolution of NSPS CI Engine Regulations

EPA Non-Road / Stationary Non-Emergency Engines >751 HP

Tier 1 (2000)
- NOx: 9.20 g/kW-hr
- PM: 0.67 g/kW-hr

Tier 2 (2006)
- NOx: 6.40 g/kW-hr
- PM: 0.20 g/kW-hr

Tier 4i (2011)
- NOx: 0.54 g/kW-hr
Evolution of NSPS CI Engine Regulations

EPA Non-Road / Stationary Non-Emergency Engines >751 HP

<table>
<thead>
<tr>
<th>Tier</th>
<th>Year</th>
<th>NOx (g/kW-hr)</th>
<th>PM (g/kW-hr)</th>
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<tbody>
<tr>
<td>Tier 1</td>
<td>2000</td>
<td>9.20</td>
<td>0.10</td>
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<tr>
<td>Tier 2</td>
<td>2006</td>
<td>6.40</td>
<td>0.20</td>
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<tr>
<td>Tier 4</td>
<td>2015</td>
<td>0.67</td>
<td>0.54</td>
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<tr>
<td>Tier 4i</td>
<td>2011</td>
<td>0.10</td>
<td>0.30</td>
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# EPA NSPS for CI Engines

## Regulated Emissions Levels

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(a) Applies to non-emergency power gen engines > 900kW (> 1207hp).

(b) Applies to non-emergency power gen engines > 560kW (> 751hp).

Emergency engine tier levels shown in **RED**

NOx / NMHC / CO / PM (g/kW-hr)

(NOx+NMHC) / CO / PM (g/kW-hr)

Certified product follows ISO 8178 D2 - 5 Mode Test Cycle for constant speed engines
EPA NSPS for CI Engines

Pollutant and Engine Load Weighting

Engine Load

10% 25% 50% 75% 100%

Weighting

0.10 0.30 0.30 0.25 0.05
EPA NSPS for CI Engines
Mandatory Manufacturer Certification

CI Engines including exhaust aftertreatment must be certified as a complete solution by engine manufacturer.

• Stationary Emergency (e.g. Tier 2)
EPA NSPS for CI Engines

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CI Engines including exhaust aftertreatment must be certified as a complete solution by engine manufacturer.

- Stationary Emergency (e.g. Tier 2)

CI Engines certified Stationary Emergency may be upfit with aftertreatment provided by the engine manufacturer or third-party to meet targeted emissions levels.

- Stationary Emergency certified with third-party provided aftertreatment meeting Stationary Non-Emergency limits (e.g. Tier 4)
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Spec Note Require generator set vendors to provide documentation demonstrating compliance with applicable limits of U.S. EPA New Source Performance Standards for stationary non-emergency engines.
New Source Performance Standards (NSPS) for Stationary SI engines
Title 40, Part 60: Subpart JJJJ
# EPA NSPS for SI Engines

## Regulated Emissions Levels

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<tr>
<td>NG / LPG: Non-emergency</td>
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<tr>
<td>NG RB</td>
<td>NG RB</td>
<td>26-99</td>
<td>1048 or for on-site ver. use 1048.101(c) for in-field test</td>
<td>1.0 / 2.0 / 0.7</td>
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<td>&gt;100</td>
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<td>1.0 / 2.0 / 0.7</td>
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<td>&gt;100</td>
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<tr>
<td>M</td>
<td>M</td>
<td>LPG RB</td>
<td>&gt;25</td>
<td>1048 cert: (2.7)/4.4</td>
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<tr>
<td>Natural Gas / LPG: Emergency</td>
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<td>V</td>
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</tr>
<tr>
<td>NG &amp; LB LPG</td>
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<td>26-129</td>
<td>90.103 phase 1 class II cert: (10) / 387</td>
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<td>V</td>
<td>All LB &amp; RB</td>
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<td>2.0 / 5.0 / 1.0</td>
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**Notes:**
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3. Engines < 40 hp that are < 1000 cc may instead comply with Part 90.
4. Emergency engines limited to 100 hours per year for maintenance and testing.
5. O/O of new non-emergency LB SI engines ≥250hp at a major source complying with 40 CFR 63 ZZZZ Table 2a do not have to comply with CO emissions of above table.
# EPA NSPS for SI Engines

## Regulated Emissions Levels

<table>
<thead>
<tr>
<th>Mandatory or Voluntary</th>
<th>NOx/CO/VOC (g/bhp-hr)</th>
<th>HP</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NG / LPG: Non-emergency</strong></td>
<td>(NOx + HC) / CO (g/bhp-hr)</td>
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EPA NSPS for SI Engines

Certification Summary

- 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 must perform certain tasks:

<table>
<thead>
<tr>
<th>Engine Power</th>
<th>Maintenance plan and records, maintain/operate engine in a way to minimize emissions</th>
<th>Initial performance testing within 1 year of engine startup</th>
<th>Subsequent performance testing every 8,760 hours or 3 years, whichever comes first</th>
</tr>
</thead>
<tbody>
<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>
</tr>
<tr>
<td>&gt; 500 hp</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
Specifying Emissions Requirements Beyond EPA Stationary Emergency
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• To legally operate engines in non-emergency applications (demand response, base load, prime power, etc.).
Specifying Emissions Requirements Beyond EPA Stationary Emergency

• To legally operate engines in non-emergency applications (demand response, base load, prime power, etc.).
• To achieve emissions levels exceeding EPA requirements:
  • Voluntarily reduce emissions footprint (e.g. LEED)
  • Meet local / state requirements

Spec Note Require generator set vendor to provide documentation demonstrating compliance with specific emissions level requirement.
National Ambient Air Quality Standards (NAAQS)

- Identifies pollutants that are harmful to human health.
- Establishes criteria pollutant limits for geographical areas:
  - CO, Pb, NO₂, O₃, PM and SO₂
“State and local agencies are not prevented from providing additional regulations beyond these regulations and such agencies may institute additional testing requirements independent of EPA related actions.”

Response to Public Comments on Proposed Standards of Performance for Stationary Compression Ignition Internal Combustion Engines
Emissions testing for each selected emergency engine-generator set shall consist of three one-hour test runs under load. The average of the three runs shall be reported as the short-term emission rate for that emergency engine-generator set.

b. Testing shall be conducted while operating at greater than ninety percent of the engine-generator set’s standby rated capacity, unless multiple load band testing is approved by DEQ.
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State / City / County Requirements

Spec Note Require generator set vendor to provide documentation demonstrating compliance with specific emissions level requirement and applicable test methodology.

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On-Site Testing

- Non-standard equipment may be needed to secure air-permit / conduct on-site testing:
  - Fuel flow meter(s)
  - Pollutant monitor(s)
  - Exhaust sample port(s)
  - Load banks
- Test methodology and permit data must be verified by equipment manufacturer.
- Applicable environmental correction factors allowable by AHJ must be identified.
- Costs and time associated with on-site testing requirements must be considered.
- Review air permit requirements early in the project in order to accommodate lead times.
- Leverage experience of third-party testing companies and engine manufacturers.
- Review implications of failing on-site test including penalties and project delays.
- Permitted emissions values may need to be “guaranteed” by the engine manufacturer.
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Facility owners with stationary engines installed on-site are obligated to meet which of the following:

a) EPA guidelines for engine operation, as applicable
b) State guidelines for engine operation, as applicable
c) Local air permitting requirements, as applicable
d) All of the above
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d) All of the above
Compliance Documentation

### EPA Compliance Statement

Manufacturer statement certifying the generator set’s engine compliance with EPA regulations for a specific model year

<table>
<thead>
<tr>
<th>Compliance Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine Model: Cummins QSK60-G3</td>
</tr>
<tr>
<td>Engine Identification: 96768265</td>
</tr>
<tr>
<td>Engine Configuration: 4.2L, 8-cylinder, Diesel, Direct Injection, Charge Air Cooler (CAC), Turbocharged and Aftertreatment System (ATS)</td>
</tr>
<tr>
<td>Engine Power Rating: 90 HP (67 kW) at 1500 rpm</td>
</tr>
<tr>
<td>Engine Horsepower: 90 HP (67 kW)</td>
</tr>
<tr>
<td>Engine Torque: 722 lb-ft (980 Nm)</td>
</tr>
<tr>
<td>Engine Efficiency: 42.9% (at 1500 rpm)</td>
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</table>

<table>
<thead>
<tr>
<th>Engine Operation Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power (kW)</td>
</tr>
<tr>
<td>Torque (lb-ft)</td>
</tr>
<tr>
<td>Efficiency</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Emissions Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOx (g/kWh)</td>
</tr>
<tr>
<td>CO (g/kWh)</td>
</tr>
<tr>
<td>Particulate Matter (g/kWh)</td>
</tr>
</tbody>
</table>

*Note: Emissions data is based on full-load operation and meets applicable emission standards.*
Compliance Documentation

EPA Compliance Statement
Manufacturer statement certifying the generator set’s engine compliance with EPA regulations for a specific model year.

Exhaust Emission Data Sheet
Factory data sheet with recorded emissions and performance values at different load levels.
Compliance Documentation

**EPA Compliance Statement**
Manufacturer statement certifying the generator set's engine compliance with EPA regulations for a specific model year.

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**EPA Certificate of Conformity**
EPA statement certifying conformity of the engine with EPA regulations for a specific model year.

**Spec Note**
Require generator set vendor to provide documentation of engine EPA certification including EPA Family name and generator set model.
1.06 APPLICABLE CODES, STANDARDS AND APPROVALS

A. The design, equipment, installation, and testing shall be in accordance with the applicable requirements set forth in the following standards:

1. NFPA 70 (National Electrical Code)
2. NFPA 110 (National Fire Protection Association Standard for Emergency and Standby Power Systems)
3. NFPA 37 (National Fire Protection Association Standard for Installation and Use of Stationary Combustion Engines and Gas Turbines)
4. ANSI/NEMA MG-1 (National Electrical Manufacturer’s Association Standard for Motors and Generators)
5. ANSI/NEMA MG-2 (National Electrical Manufacturer’s Association Safety Standard for Construction and Guide for Selection, Installation and Use of Motors and Generators)
8. Applicable portions of 40 CFR Part 60 (Standards of Performance for New Stationary Sources) as indicated herein.
9. Applicable portions of 40 CFR Part 89 (Control of Emissions From New and In-Use Nonroad Compression-Ignition Engines) as indicated herein.

B. Compliance with requirements of the authority having jurisdiction (A.H.J.) shall also be included, if A.H.J. requirements affect the manufacturing of the equipment.
Course Summary

Emissions and Air Permitting Requirements for Standby Generator Sets

• Recognize commonly regulated exhaust emissions constituents.
• Describe EPA emissions requirements for diesel and gaseous standby generator sets.
• Identify common requirements for permitting engine-driven generator sets.

Specify:
• Generator set shall include engine which complies with U.S. EPA New Source Performance Standards (NSPS) for **Stationary Emergency** engines under the provisions of [40 CFR Part 60 Subpart IIII or 40 CFR Part 60 Subpart JJJJ] when tested per ISO 8178 D2.
• Engine shall meet emissions limits as defined for **Stationary Emergency** engines in [40 CFR Part 60 Subpart IIII or 40 CFR Part 60 Subpart JJJJ] when tested per ISO 8178 D2.

Avoid specifying:
• Generator set shall be Tier 2 certified.
• Engine generator set shall meet emissions requirements as determined by AHJ.
Q&A

Type your questions, comments, feedback in the WebEx Q&A box. We will get to as many questions as we can. We will publish consolidated FAQ along with presentation and webinar recording on powersuite.cummins.com

Your local Cummins contacts:

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- Eastern Canada: Gianluca Ianiro (gianluca.ianiro@cummins.com), Eastern Canada Region
- AZ, ID, NV, NM: Carl Knapp (carl.knapp@cummins.com), Rocky Mountain Region
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- NY, NJ, CT, PA, MD: Charles Attisani (charles.attisani@cummins.com), East Region
- 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
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- A PDH Certificate

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