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Emissions Requirements for Compression Ignition Engines in EPA Non-Emergency Operation

October 31, 2017 11:00 PDT / 13:00 CDT

(1PDH issued by Cummins)

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Disclaimer

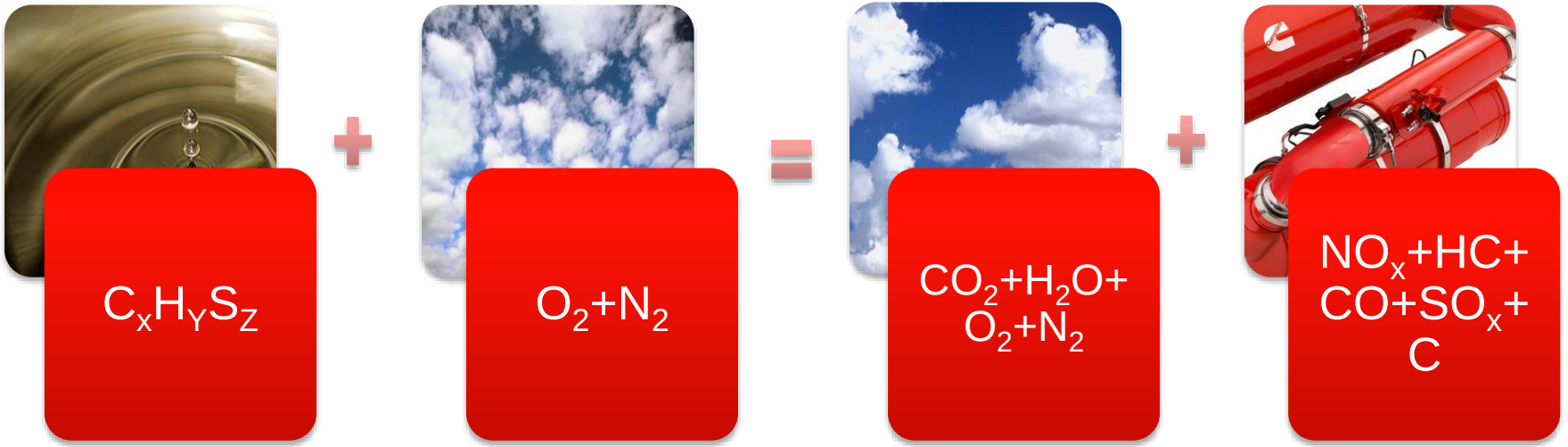
The views and opinions expressed in this course shall not be considered the official position of the EPA and shall not be considered to be, nor be relied upon as, a Formal Interpretation.

Participants are encouraged to refer to the entire text of all referenced documents available at ecfr.gov. In addition, when it doubt, reach out to the Authority Having Jurisdiction.

Course Objectives

- Review US EPA New Source Performance Standards (NSPS) and emission regulations related to emergency and non-emergency engines.
- Identify appropriate usage of certified and compliant engines.
- Recognize applications requiring EPA non-emergency emissions certification in order to specify products that best fit project requirements.
- Recognize the potential impact of product misapplication as related to federal and local guidelines.

Hydrocarbon Fuel Combustion Reaction



Fuel | Air | Major Exhaust Constituents | Trace Exhaust Components

Stationary Emergency

- Unlimited use during emergencies.
- 50 hours per year allowed for:
  - Maintenance and testing
  - Non-Emergency operation:
    - storm avoidance, local reliability (avoiding potential voltage collapse, line overload)
- Emergency Demand Response (EDR) programs eliminated in May 2015[1]
- Peak shaving **eliminated** in January 2013; special allowance expired May 3, 2014

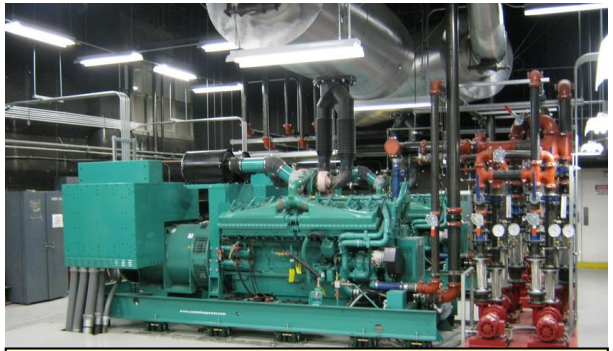
1) Ruling in Delaware Department of Natural Resources v EPA eliminated EDR allowance for emergency engines

Stationary Emergency Engine Operation

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

Application: Standby power system including seven C2000 D6 (2000 kWe) generator sets provided by Cummins.

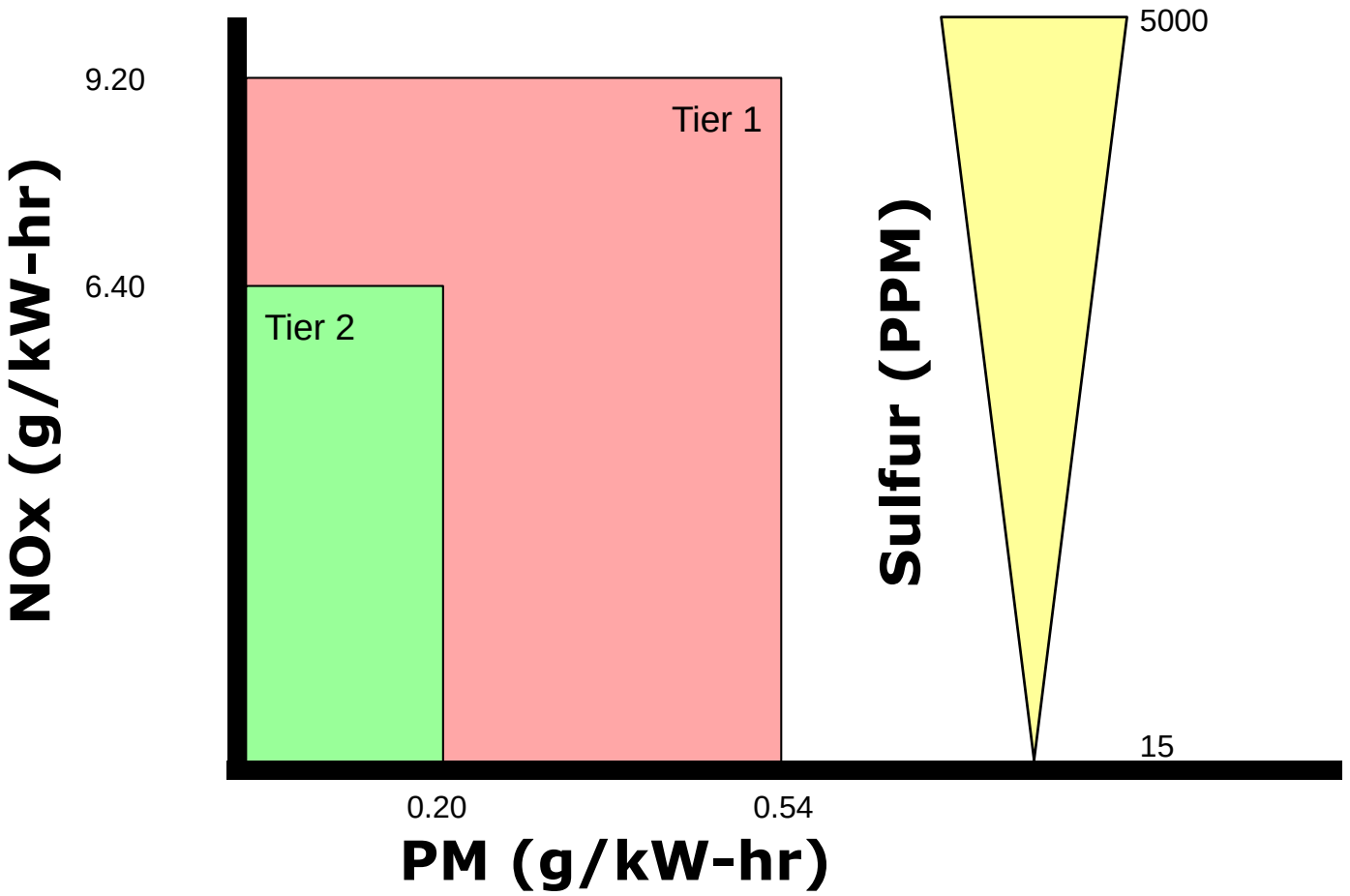
Location: Samsung SDS Institute in Suwon, South Korea



Application: Emergency standby system including two DQGAA (1250 kWe) and one DQGAB (1500 kWe) provided by Cummins.

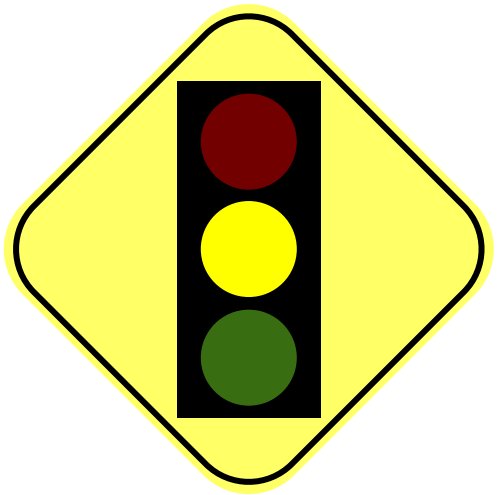
Location: Intermountain Healthcare Facility in Salt Lake City, UT

Evolution of Off-Highway Standards (>751HP)



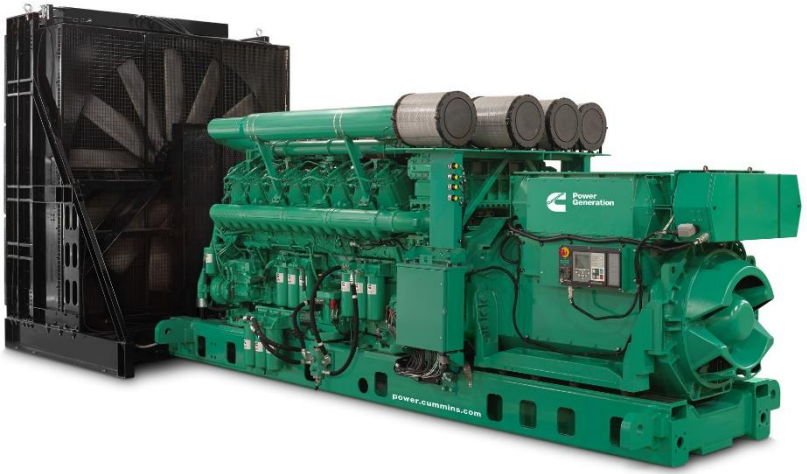
Industry Standard for Generator Set Ratings

- ISO 8528: Standard for reciprocating internal combustion engine driven alternating current generator sets.
- Defines application, ratings and performance of generator sets.
- Sect. 13 defines these ratings:
  - Emergency Standby Power (ESP)
  - Limited Time Prime Power (LTP)
  - Prime Rated Power (PRP)
  - Continuous Operating Power (COP)



Why do clients ask for “Tier 4”?

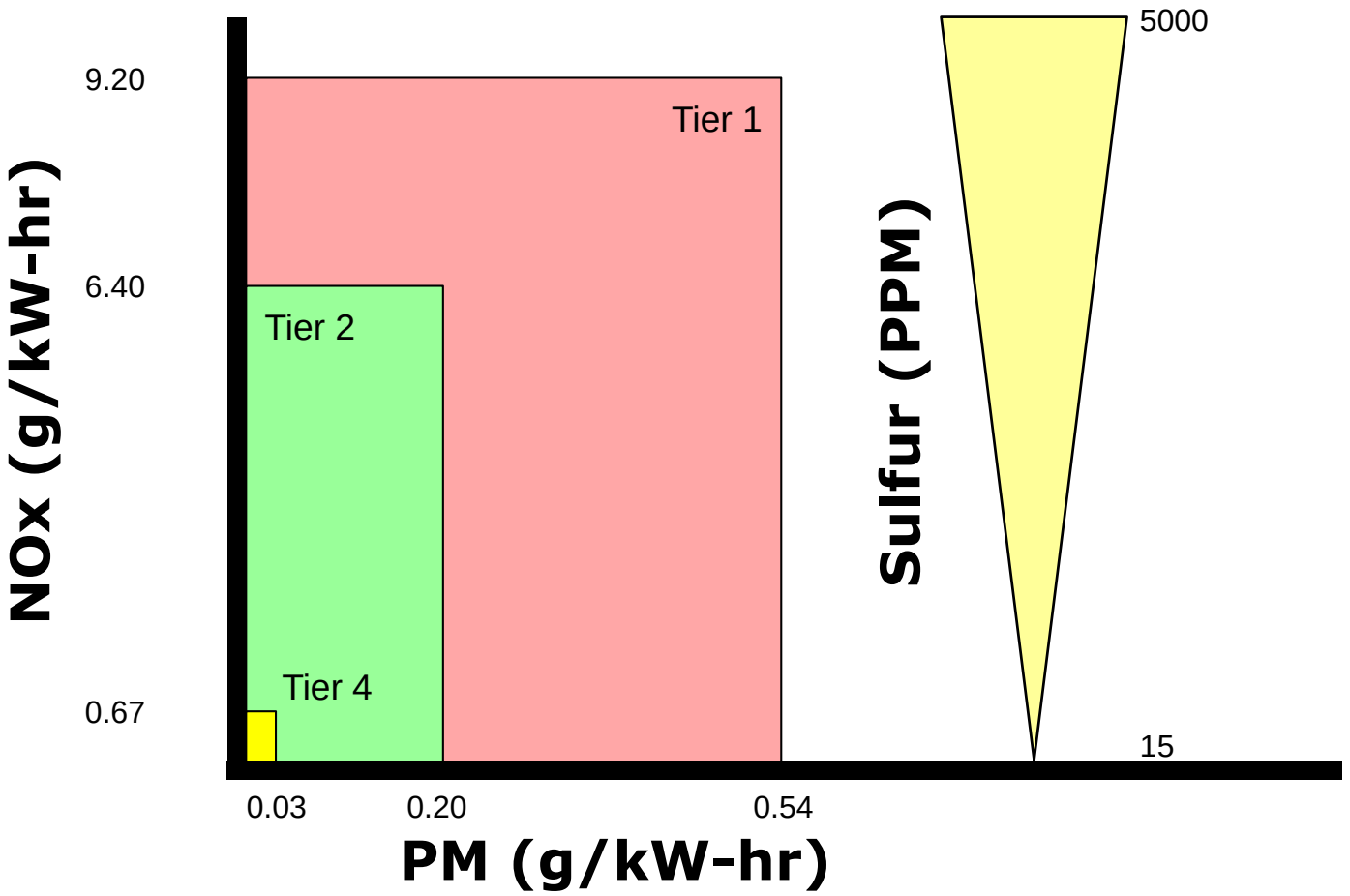
… to legally operate an engine in a non-emergency application.



Nonroad / Stationary Non-Emergency

- 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)
- Combined heat and power (capture and use waste heat)
- Prime power generator set (to be used as a primary source of power)

Evolution of Off-Highway Standards (>751HP)



EPA CI NSPS for Stationary Emergency and Nonroad Engines

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

kW	(hp)	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
0-7	0-10	(7.5) / 8.0 / 0.40									
8-18	11-24	(7.5) / 6.6 / 0.40									
19-36	25-48	(7.5) / 5.5 / 0.30			(4.7) / 5.5 / 0.03 **Emergency: Previous tier**						
37-55	49-74	*Optional T4i 0.30 PM*			(4.7) / 5.0 / 0.03 **Emergency: Previous tier**						
56-74	75-99	(4.7) / 5.0 / 0.40		3.4 / 0.19 / 5.0 / 0.02 **Tier 3**			0.40 / 0.19 / 5.0 / 0.02 **Tier 3**				
75-129	100-173	(4.7) / 5.0 / 0.30		3.4 / 0.19 / 5.0 / 0.02 **Tier 3**			0.40 / 0.19 / 5.0 / 0.02 **Tier 3**				
130-560	174-751	(4.0) / 3.5 / 0.20	2.0 / 0.19 / 3.5 / 0.02 **Tier 3**			0.40 / 0.19 / 3.5 / 0.02 **Tier 3**					
> 560	> 751	(6.4) /3.5 / 0.20	3.5 / 0.40 / 3.5 / 0.10 **Tier 2** *0.67 / 0.40 / 3.5 / 0.10 (a)*				3.5 / 0.19 / 3.5 / 0.04 **Tier 2** *0.67 / 0.19 / 3.5 / 0.03 (b)*				

T2	T3	Tier 4 Interim	Tier 4

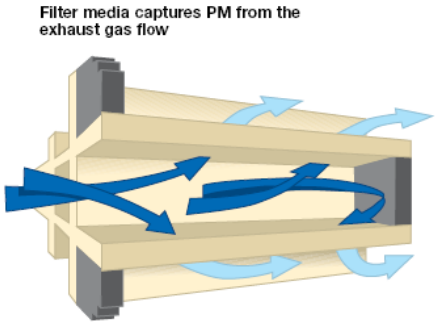
(a) Applies to non-emergency power gen engines > 900kW (> 1207hp).
(b) Applies to non-emergency power gen engines > 560kW (> 751hp).
Emergency engine tier levels shown in **RED**

Text in *red italics* indicates projected standards

Requirements for Nonroad Certified Engines

- Engines are certified, not generator sets.
- Engines are required to meet emissions levels based on their date of manufacture, usage and brake horsepower rating.
- Emissions levels are evaluated on a 5-mode, weighted test cycle following a specific test method in a test-cell environment.
- 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).

… to achieve emissions levels beyond EPA requirements.



“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

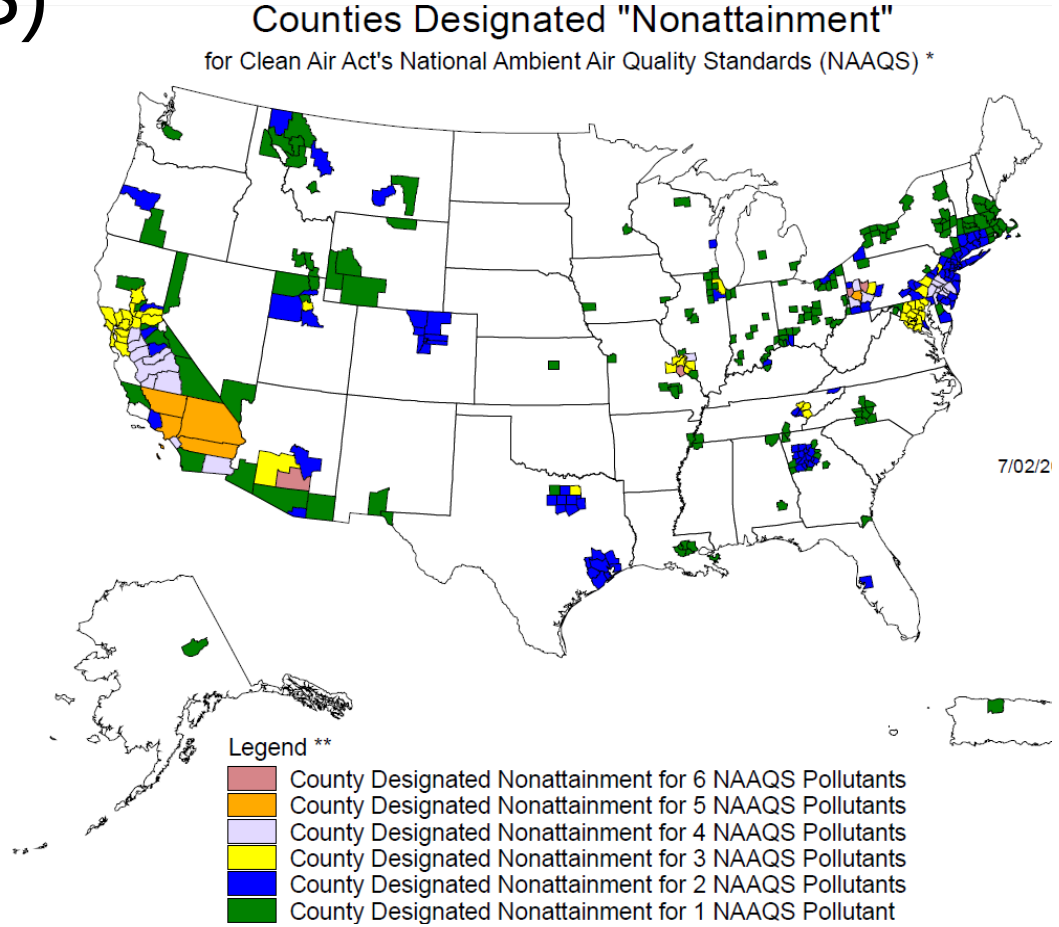
State / City / County Requirements

[redacted]

a. 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.

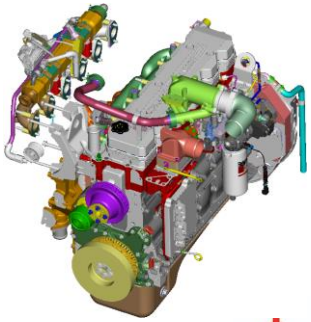
National Ambient Air Quality Standards (NAAQS)

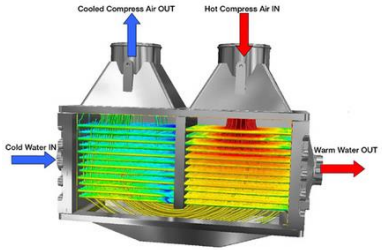


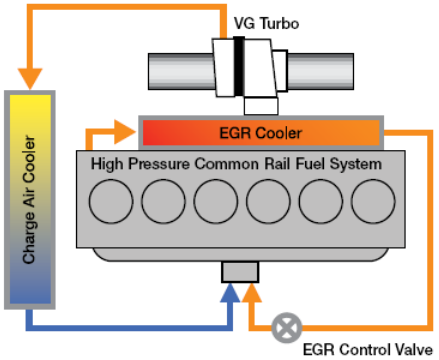
Why Tier 4?

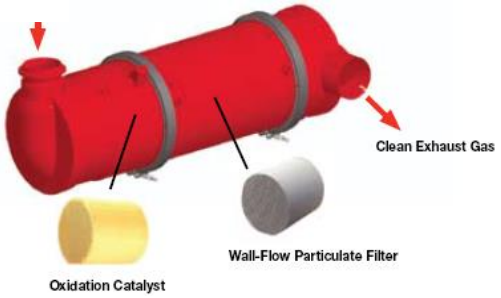
- To legally operate engines in non-emergency applications (peak shaving, base load, combined heat and power, etc.).
- To achieve emissions levels exceeding EPA requirements:
  - “Go Green”
  - Meet local / state requirements

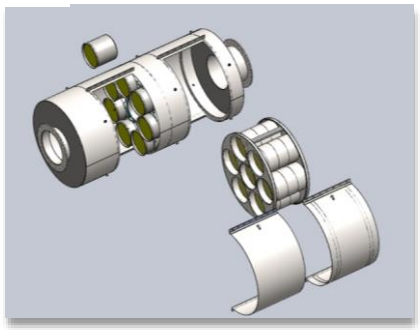
How do engine manufacturers meet these requirements?



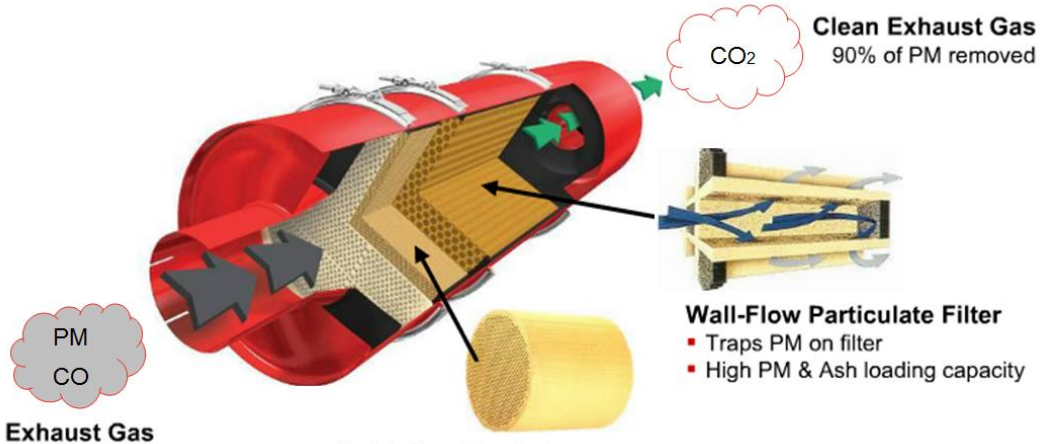








Diesel Oxidation Catalyst (DOC) and Diesel Particulate Filter (DPF)



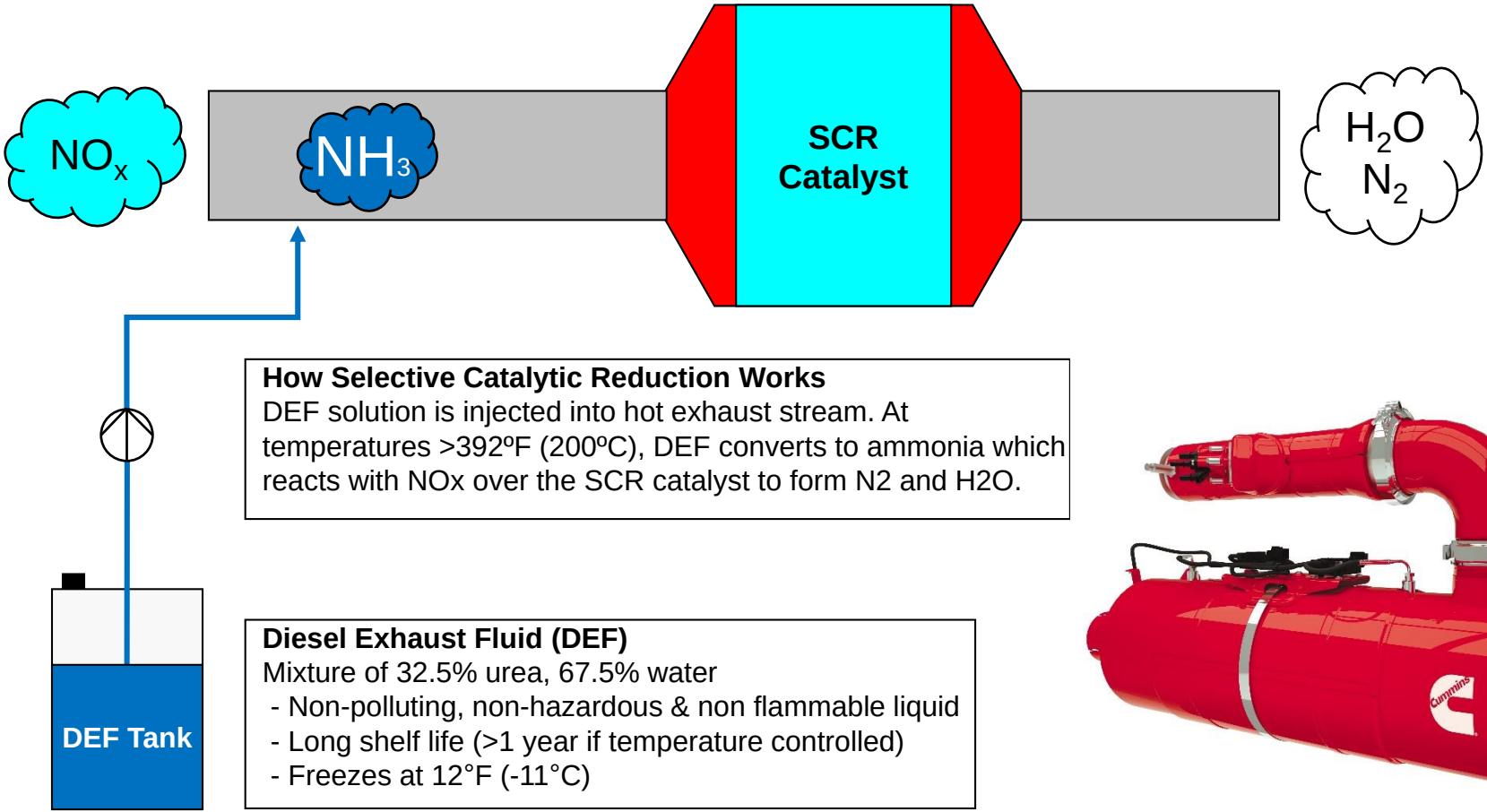
Diesel Oxidation Catalyst

DOC catalytic material reacts above 572ºF (300ºC) in passive regeneration mode to generate Nitrogen Dioxide (NO2) which oxidizes the carbon soot.

Active Regeneration

When soot accumulation in the DPF exceeds soot oxidation a periodic active regeneration mode is performed to prevent filter plugging. This is actuated by small quantities of fuel from a dosing injector or HPCR injection pulse during exhaust blow down. The heat released (no flame or burning) at 1022ºF (550ºC) ensures sufficient oxidation to remove soot

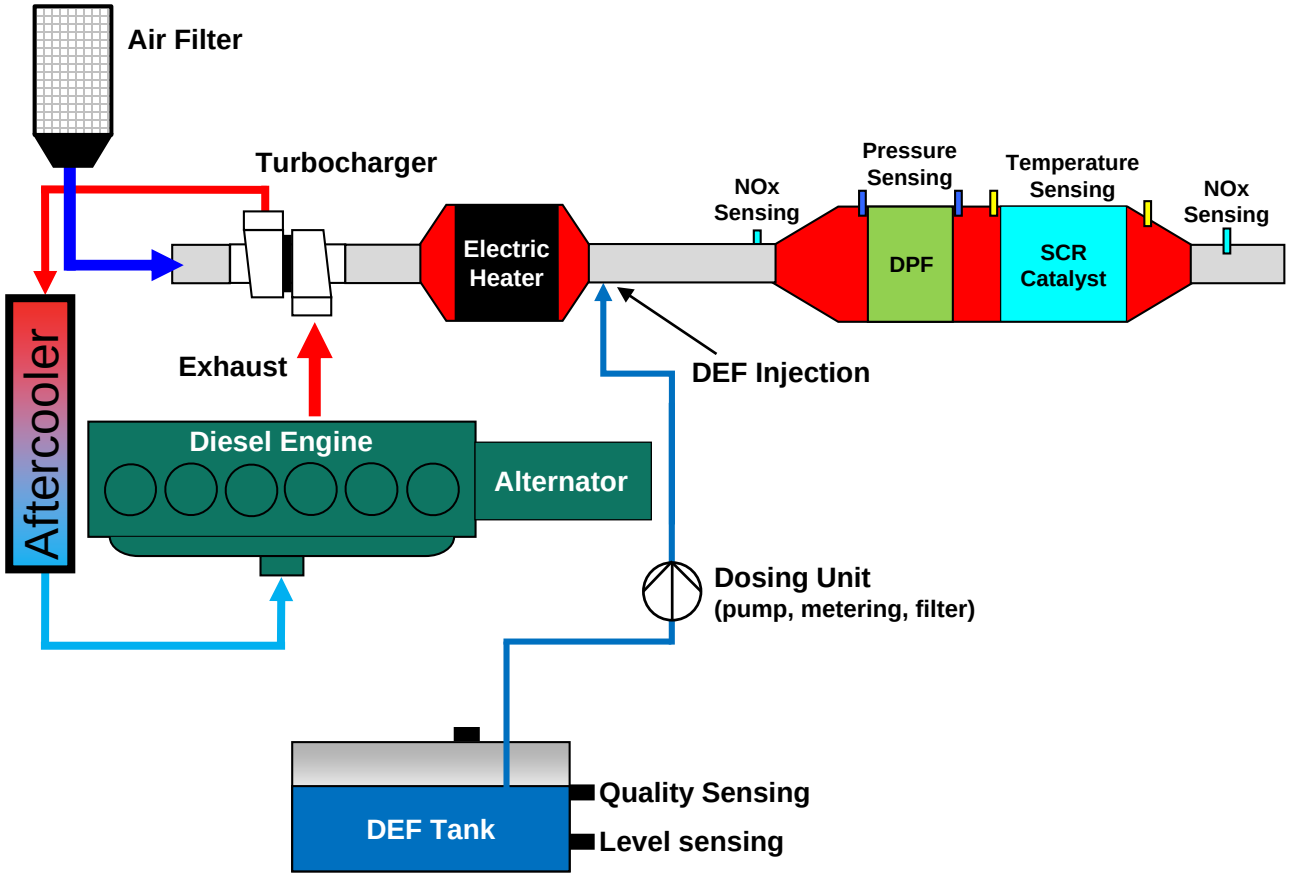
Selective Catalytic Reduction (SCR)



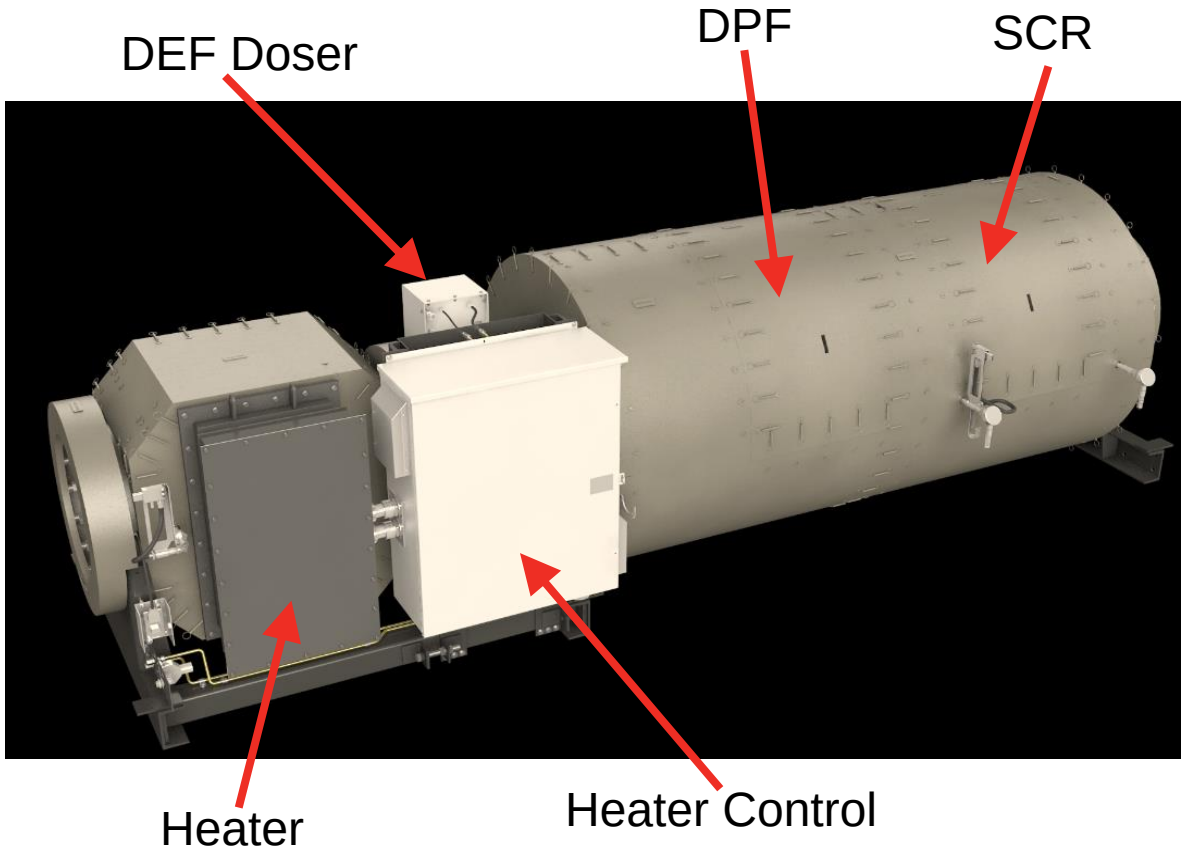
How Selective Catalytic Reduction Works
DEF solution is injected into hot exhaust stream. At temperatures >392ºF (200ºC), DEF converts to ammonia which reacts with NOx over the SCR catalyst to form N2 and H2O.

Diesel Exhaust Fluid (DEF)
Mixture of 32.5% urea, 67.5% water
- Non-polluting, non-hazardous & non flammable liquid
- Long shelf life (>1 year if temperature controlled)
- Freezes at 12°F (-11°C)

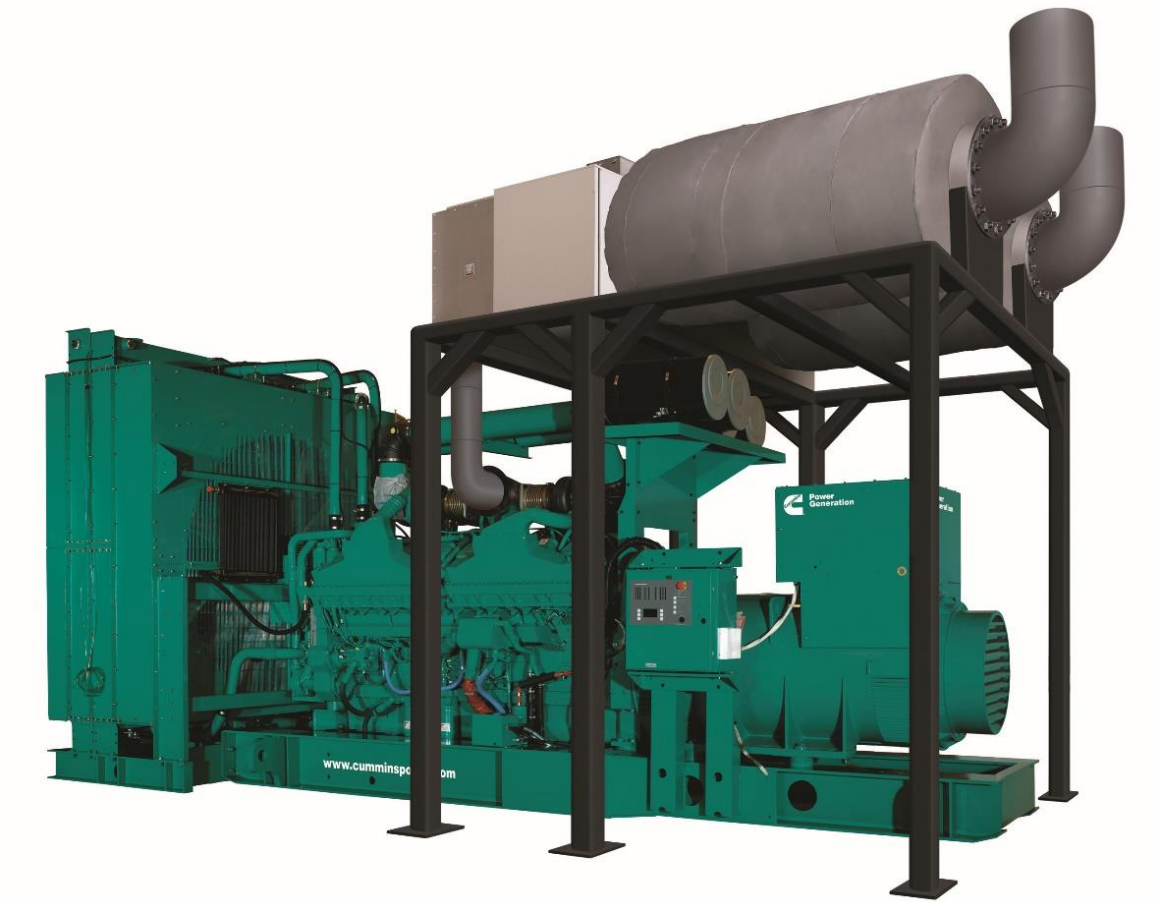
Meeting Tier 4



Nonroad Certified Product Example

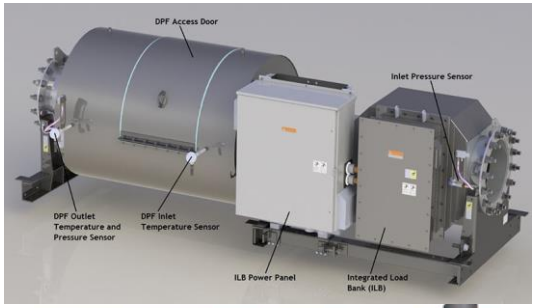


Nonroad Certified Product Example



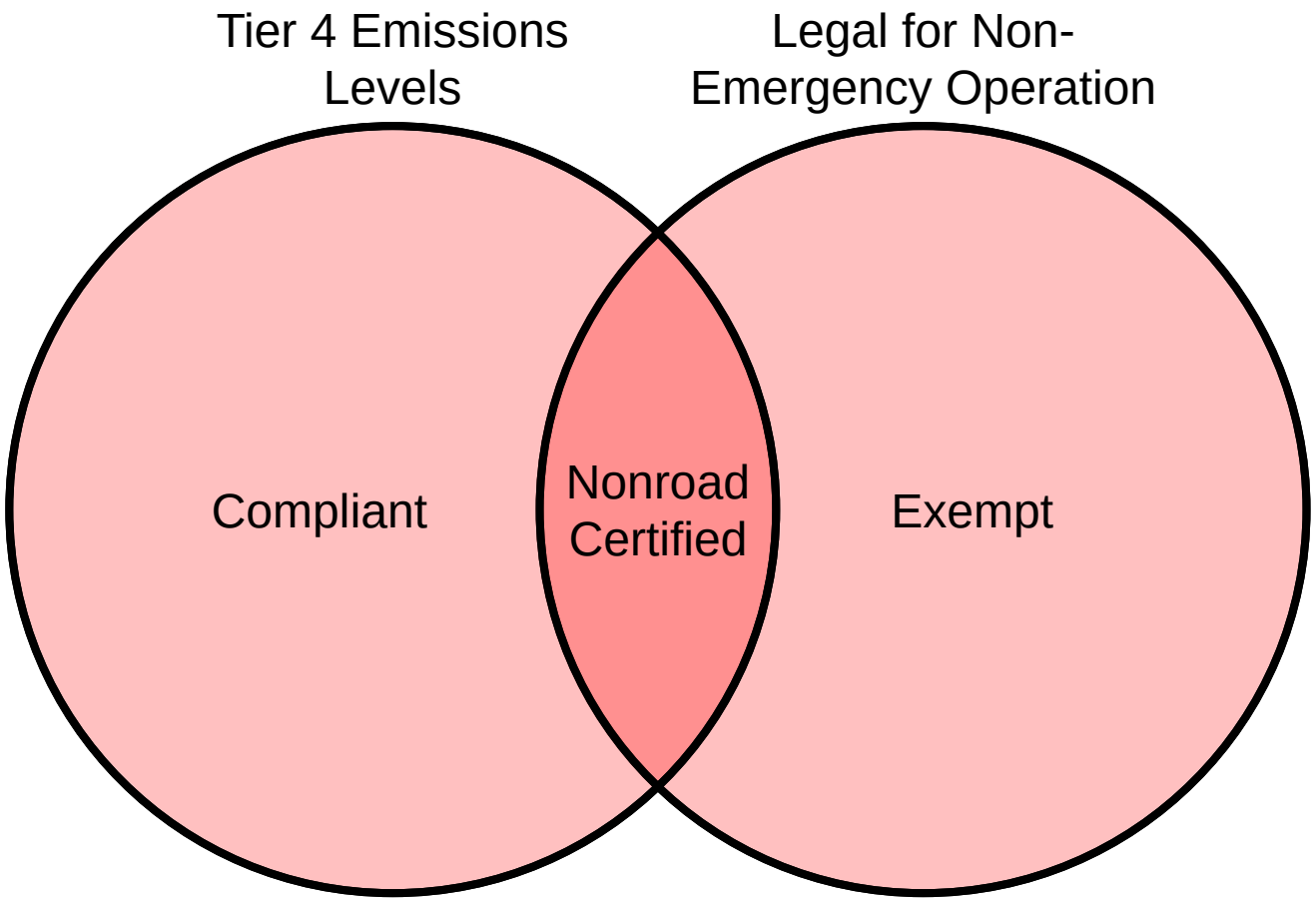
Aftertreatment Considerations

- Expensive (initial investment, maintenance, and operation)
- Handling, storing, and refilling chemicals (i.e. DEF)
- Space and power requirements
  - Compressors, control panels, and heaters
- Increased system air flow requirements
- Sensitive to packaging and mounting location constraints
- Can increase back pressure
- Accurate system operation logs required
- Engine loading will affect after-treatment



Exemptions (Credits)

- Allows engine manufacturers to sell a percentage of their annual certified engine volume as exempt as long as the exempt engines meet the previously required emissions level standard.
- Current emissions level for Nonroad certification is Tier 4, exempt engines must meet still meet defined emissions constituent concentration targets.
- Engines **may not** have hardware needed to meet current emissions levels.
- Engines are **legal** for non-emergency operation.


Tier 4 Emissions Levels
Legal for Non-Emergency Operation
Compliant
Nonroad Certified
Exempt

Recommendations

Specification Recommendations

- If the intended usage is emergency only (only operates when the utility has failed), specify EPA Stationary Emergency certification.
- If the intended usage is non-emergency, specify nonroad certification.
- If specific emissions levels are a concern (client request, air permit, etc.), specify the required emissions constituent concentrations and associated test methods.

Specification Language

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)
6. ISO 8528 (International Standards Organization Standard for Engine Generators and Generator Control Switchgear)
7. ISO 3046 (International Standards Organization Standard for Reciprocating Internal Combustion Engines Performance)
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.

Summary

- Review US EPA New Source Performance Standards (NSPS) and emission regulations related to emergency and non-emergency engines.
- Identify appropriate usage of certified and compliant engines.
- Recognize applications requiring EPA non-emergency emissions certification in order to specify products that best fit project requirements.
- Recognize the potential impact of product misapplication as related to federal and local guidelines.

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

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