



How the Tier 4 Rule Affects Generator Specification

The more stringent Tier 4 emissions standards for non-road diesel engines adopted by the U.S. Environmental Protection Agency in May 2004 are intended to significantly reduce (by about 90 percent) the emissions of non-road construction, agricultural, mining and industrial equipment that at the time accounted for nearly half of all diesel particulate matter and a quarter of all nitrogen oxide (NO_x) emissions nationwide.

[Clarion Energy Content Directors](#) 11.1.2011

Share this article

By Mark Sweeney, Power Solutions Manager, Generac Power Systems

The more stringent Tier 4 emissions standards for non-road diesel engines adopted by the U.S. Environmental Protection Agency in May 2004 are intended to significantly reduce (by about 90 percent) the emissions of non-road construction, agricultural, mining and industrial equipment that at the time accounted for nearly half of all diesel particulate matter and a quarter of all nitrogen oxide (NO_x) emissions nationwide. The standards were slated to be applied across all engines covered in the scope of the rule—and thus the equipment using those engines—beginning in 2008 and continuing through 2015.

Diesel-fueled generator sets above 120 to 125kW became subject to Tier 4 at the beginning of 2011. As a result, generator manufacturers have begun incorporating Tier 4 compliant engines into many new products of this size. However, it's important to note that the rule does not impact all generator sets uniformly. For example, it affects “emergency” and “non-emergency” generators differently. Additionally, Tier 4 compliance for these generators is being regulated by the EPA in phases that require different levels of compliance at different times.

TABLE 1 EPA STATIONARY DIESEL EMERGENCY GENSET EMISSIONS STANDARDS										
kW	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
<8	10.5 8.0 1.0	7.5 8.0 0.80	7.5 8.0 0.40		7.5 8.0 0.80					
8<19	9.5 6.6 0.80	7.5 8.0 0.80	7.5 6.6 0.40							
19<37	9.2	7.5 5.5 0.60	7.5 5.5 0.30							
37<56 Option 1	9.2	7.5 5.0 0.40	4.7 5.0 0.30				4.7 5.0 0.40			
37<56 Option 2	9.2	7.5 5.0 0.40	4.7 5.0 0.40							
56<75	9.2	7.5 5.0 0.40	4.7 5.0 0.40							
75<130	9.2	4.0 5.0 0.30								
130<225	9.2 1.3 11.4 0.54	4.0 3.5 0.20								
225<450	9.2 1.3 11.4 0.54	4.0 3.5 0.20								
450<560	9.2 1.3 11.4 0.54	4.0 3.5 0.20								
560<900	9.2 1.3 11.4 0.54	6.4 3.5 0.20								
900<2237	9.2 1.3 11.4 0.54	6.4 3.5 0.20								
>2237	9.2 1.3 11.4 0.54					6.4 3.5 0.20				

Legend

NO_x, HC, CO, PM
NO_x + HC, CO, PM
g/kW-hr

Tier 1 Tier 2 Tier 3 Tier 4 Interim Tier 4 Final

Power in kWm
kWm=0.9 kWm

For these reasons, most generator manufacturers offer products with engines that are configurable to either support Tier 4 or an earlier standard, depending upon the application in which the generator will be used. Engineers, facility managers and others responsible for purchasing generators need to be aware of how the Tier 4 standards affect the generators they are specifying and on what timeline those generators need to comply with the standards.

“Emergency” vs. “Non-Emergency” Generator Sets

The EPA differentiates between generators used for emergency power and those used in non-emergency applications because the running times—and therefore emissions—in each application tend to be vastly different. Emergency generators are assumed by the EPA to run only a certain number of hours per year in response to power outages and for routine maintenance, and because that number of hours can be effectively estimated, the EPA acknowledges the potential emissions of an emergency power generator is significantly less than the unit’s theoretical maximum emissions.

TABLE 2 EPA STATIONARY DIESEL NON-EMERGENCY GENSET EMISSIONS STANDARDS										
kW	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
<8	10.5 8.0 1.0	7.5 8.0 0.80	7.5 8.0 0.40		7.5 8.0 0.60					
8<19	9.5 6.6 0.80	7.5 8.0 0.80	7.5 6.6 0.40							
19<37	9.2	7.5 5.5 0.60	7.5 5.5 0.30					4.7 5.5 0.03		
37<56 Option 1	9.2	7.5 5.0 0.40	4.7 5.0 0.30					4.7 5.0 0.03		
37<56 Option 2	9.2	7.5 5.0 0.40	4.7 5.0 0.40				4.7 0.5 0.33			
56<75	9.2	7.5 5.0 0.40	4.7 5.0 0.40				3.4 0.19 5.0 0.02			0.40 0.19 5.0 0.02
75<130	9.2	4.0 5.0 0.30					3.4 0.19 5.0 0.02			0.40 0.19 5.0 0.02
130<225	9.2 1.3 11.4 0.54	4.0 3.5 0.20				2.0 0.19 3.5 0.02			0.40 0.19 3.5 0.02	
225<450	9.2 1.3 11.4 0.54	4.0 3.5 0.20				2.0 0.19 3.5 0.02			0.40 0.19 3.5 0.02	
450<560	9.2 1.3 11.4 0.54	4.0 3.5 0.20				2.0 0.19 3.5 0.02			0.40 0.19 3.5 0.02	
560<900	9.2 1.3 11.4 0.54	6.4 3.5 0.20				3.5 0.40 3.5 0.10				0.67 0.19 3.5 0.03
900<2237	9.2 1.3 11.4 0.54	6.4 3.5 0.20				0.67 0.40 3.5 0.10				0.67 0.19 3.5 0.03
>2237	9.2 1.3 11.4 0.54					0.67 0.40 3.5 0.10				0.67 0.19 3.5 0.03

Legend

NOx, HC, CO, PM
NOx + HC, CO, PM
g/kW-hr

Tier 1 Tier 2 Tier 3 Tier 4 Interim Tier 4 Final

Power in kW
kW = 0.9 kW

For regulatory purposes, the EPA defines an emergency power generator as “a generator whose sole function is to provide back-up power when electric power from the local utility is interrupted”. Its typical operating scenario is as follows:

- Utility power is lost
- The emergency generator set starts up and supplies power to the electrical loads
- Utility power returns
- The emergency generator set shuts down and returns to standby mode.

Using this definition as a reference, a non-emergency generator is—simply put—one that is not being used exclusively for emergency power. It covers a number of diesel generator applications:

- Non-emergency standby power
- Prime power
- Load management/peak shaving
- Electric power rental and other mobile uses
- Storm avoidance.

In the future, emergency-use diesel engines will be made more identifiable. Those built after the effective date of the Tier 4 regulation for their power class will display a permanent label indicating that they are for emergency use only, making it easier for all those involved to identify the engine—and the generator it drives—as being for emergency use only.

Tier 4 Implementation

To make it easier for manufacturers to comply with Tier 4, it is being regulated in two phases, each of which defines emission caps based upon engine power. The first phase is called Tier 4 interim (Tier4i), and will primarily focus on the reduction of hydrocarbons (HC), carbon monoxide (CO), and particulate matter (PM). The second phase, called Tier 4 final (Tier4f), will focus on the reduction of NO_x.

Tier 4i is effective from 2011 to 2012, while Tier 4f begins in 2013 and continues through 2015.

Because of their lower emissions potential, EPA is allowing the emergency generators defined above to continue operating at pre-Tier 4 standards for the foreseeable future. Emergency power generators rated 56 to 560 kW can maintain their existing Tier 3 rating until 2017, while those rated above 560 kW can maintain their existing Tier 2 rating until 2017. The only exceptions would be in California and other non-attainment areas that have adopted stricter air-quality standards.

Additionally, while the EPA does not limit the hours of operation for emergency generators under emergency conditions, they do limit non-emergency operation of such generators to keep emissions potential low. For example, maintenance and exercise hours must be limited to 100 hours a year. Of these, up to 50 hours a year can be used for general non-emergency operation, but not for peak shaving or for earning income by selling power to another party. The exception to this is 15 hours a year of generator operation allowed as part of a demand response program intended to mitigate a potential utility failure, performed in cooperation with the regional transmission organization (RTO) or equivalent authority. Demand response operation is further limited to 30 minutes prior to the expected emergency condition until immediately after notification by the RTO or equivalent that there is no longer an emergency condition.

For all applications, the generator operator will be required to document maintenance, service, exercise and other non-emergency operation time, and be able to cross-reference this to a non-resettable hour meter on the generator set.



Diesel oxidation catalyst (see sidebar for details). Photo courtesy Engine Control Systems.

By comparison, non-emergency generators are subject to Tier 4. Those that are used in non-emergency standby applications or for rental/mobile use are required to comply with Tier 4f regulations immediately.

Keep in mind, state and local regulatory authorities can dictate stricter regulated limits. Additionally, the EPA continues to modify the rule and related definitions. As it is the generator operator's responsibility to ensure compliance with all codes and regulations, it is always recommended to consult state or local code authority for verification of emergency generator set emission requirements.

Engineers, facilities managers and all those involved in the specification and purchase of diesel-fueled generators must be familiar with the Tier 4 regulation governing emissions for these units. Application of the regulation depends upon the generator's application and the timetable for compliance as defined by the EPA. As a result, most generator manufacturers build systems that can comply with Tier 4 if necessary, or pre-Tier 4 regulations as applicable. For example, emergency generators, which are defined as those used exclusively to provide emergency power during a power outage,

are exempt from Tier 4 for the foreseeable future, and will be allowed to maintain their current Tier 2 or Tier 3 compliance. Non-emergency generators, by contrast, will be required to comply with the rollout of Tier 4 according to EPA-defined phases. You should work closely with your generator manufacturer when determining regulatory compliance, and also consult your local code authorities to ensure that emissions requirements in your municipality are not more stringent than those defined by the EPA.

References:

Seitz, John S. Calculating Potential to Emit (PTE) for Emergency Generators. Memorandum, United States Environmental Protection Agency, 1995.

United States Environmental Protection Agency. Clean Air Nonroad Diesel Rule Summary. May 2004. <http://www.epa.gov/nonroad-diesel/2004fr/420f04029.htm> (accessed June 22, 2011).

Author: As a power solutions manager for Generac Power Systems, Mark Sweeney provides clients with design support for large emergency power projects. He brings over 30 years of experience in the power generation industry—including both factory and dealer level expertise—to his role. In addition to diesel-fueled standby generator projects, Mark is experienced in prime and continuous duty natural gas power generation as well as large paralleling digester and biogas applications.

The Technology Behind Tier 4 Compliance

Meeting Tier 4 emissions levels—thereby simultaneously reducing hydrocarbon, carbon monoxide, particulate matter and NO_x emissions—requires diesel engine manufacturers to use a variety of after-treatment technologies.

Reducing hydrocarbons and carbon monoxide typically requires the use of a diesel oxidation catalyst (DOC). The DOC typically utilizes palladium and platinum as catalysts within the system to remove these emissions.

The DOC does remove a small percentage of particulate, but only approximately 20 percent. The main source for particulate matter (PM) removal is typically the PM trap. The most effective PM traps are made of a continuously regenerating technology (CRT). For the CRT to be effective on a generator set, it must be loaded between 30 percent and 50 percent and maintain a minimum temperature above 500 F. This burns out soot and keeps the filter clean.

NO_x is often reduced using exhaust gas recirculation (EGR). This technology diverts a percentage of the exhaust gas back in to the cylinders, lowering combustion temperatures and reducing the amount of NO_x in the exhaust gases.

To achieve the required Tier 4f levels of NO_x reduction, however, selective catalytic reduction (SCR) systems will be employed. An SCR system uses a consumable catalyst (typically urea) to convert NO_x to nitrogen and water vapor.–MS

[More Power Engineering Issue Articles](#)

[Power Engineering Issue Archives](#)

[View Power Generation Articles on PennEnergy.com](#)

Share this article

Tags [PE Volume 115 Issue 11](#)