



## 1.0 INTRODUCTION (CONTINUED):

By the time that Tier 4 Final regulations are introduced in 2013 and 2014, the NOx and PM levels from diesel exhaust will have been reduced by 99%. These Tier levels were introduced and 'staggered' over this time frame dependent on the generator diesel engine horsepower (or metric mechanical kW equivalent) and NOT the kW output per the generator nameplate.

## 2.0 ACHIEVING TIER 4 INTERIM AND TIER 4 FINAL EMISSIONS REGULATIONS

Diesel engine manufacturers were able to achieve compliance to Tier 2 and 3 by in-engine or internal design changes (e.g. combustion chamber, increased high pressure (up to 20,000 psi) common rail fuel injection, valve timing, cooled exhaust gas recirculation, four-valve cylinder heads, advanced variable geometry or waste-gated turbochargers, compound or staged turbochargers, air-to-air after-cooling, and electronic engine controls).

In order to meet the higher Tier 4 Interim and Tier 4 Final emission regulations, manufacturers will have had to resort to additional devices such as cooled exhaust gas recirculation (ERG) to lower the nitrogen dioxide (NOx) levels and add 'external' aids for the after-treatment of the exhaust - such as exhaust filters to reduce particulate matter (PM). When these systems are added to today's clean diesel engine, the result can achieve NOx and PM emission reduction improvements of more than 99%.

## 3.0 TYPICAL NON – EMERGENCY STANDBY POWER (ESP) APPLICATIONS REQUIRING THE USE OF TIER 4 INTERIM & TIER 4 FINAL DIESEL ENGINES

- Non-emergency diesel standby units – permanently installed or operating at the same location for 12 consecutive months
- Prime Power applications – where the set is the primary source of electrical power
- Load management, operation as part of a financial arrangement (e.g. Interruptible rates) or peak shaving applications – including and set paralleled with the local utility and used for containment programs. These may also be used for emergency standby duty, the secondary use for load management disqualifies them for Tier 4 Interim and Tier 4 Final exemptions
- Rental and other mobile generator sets – including temporary power used on construction sites, any seasonal utility load peak shaving, special events or any other temporary power application.

For any non-emergency diesel applications, Tier 4 regulations are to be introduced in two steps – Tier 4 Interim in 2011 and Tier 4 Final for small non-emergency gensets in 2013, and finally all non-emergency generator sets by 2015.

## 4.0 EXHAUST AFTER-TREATMENT TECHNOLOGIES

For Tier 4 Interim and Tier 4 Final, most diesel engines will further require selective catalytic reduction (SCR) to control NOx and diesel particulate filters (DPF) to capture the remaining PM. Some engine models will be capable of meeting Tier 4 Final regulations for PM without the use of a DPF. Others may use ERG combined with a DPF on certain platforms in order to reduce NOx rather than a SCR.

- **Selective Catalytic Reduction (SCR).** This system works by combining ammonia in the form of urea or diesel emissions fluid (DEF) and passing the mixture over a catalyst. The resultant exhaust contains the harmless element of nitrogen, water vapor and carbon dioxide. Approximately one gallon of DEF is required for every 20 gallons of diesel fuel burnt. The SCR will be introduced to meet ESP Tier 4 Interim regulations in California and certain non-attainment areas, and for all non-emergency generator applications with regard for location. (See drawing 1)
- **Diesel Particulate Filters (DPF).** These devices trap and incinerate soot particles (PM). They will not be required to meet Tier 4 Interim but will be needed in most power nodes to operate in conjunction with SCR to meet Tier 4 Final. The DPF has a mechanical filter to trap these soot particles after the partial oxidization by the catalyst. At certain intervals during operation, these trapped particles are incinerated. Periodically, any inert ash will have to be removed from the DPF. It is expected that a combined DPF and SCR device in 2014 and 2015 to comply with Tier 4 Final regulations for ESP sets in California and certain non-attainment areas, and for all non-emergency applications regardless of location. (See drawing 1 overleaf)
- **Exhaust Gas Recirculation (EGR).** This technology is used by certain manufacturers to reduce the NOx in diesel exhaust. EGR operates by the recirculation of a small amount of the cooled exhaust gas back into the combustion chamber. This will reduce the combustion temperature thus effectively lowering the NOx and EGR equipped models will not need SCR after-treatment. On the other hand, EGR increases the particulate emissions, so a DPF will be required for both Tier 4 Interim and Tier 4 Final regulations. (See drawing 2 overleaf)

The above engineering changes for Tier 6 Interim and Tier 4 Final will mean that the engine will have to cope with a higher heat rejection level and so larger and/or more expensive radiators will be required. This may well increase the physical size of an enclosure or canopy of the generator set - as does the placement of any such after-treatment exhaust devices inside the canopy. This will be particularly noticeable on sound attenuated units.

*Note! Always consultate your local generator distributor/dealer for the latest regulations that will apply to your particular installation.*

## 5.0 USEFUL SITES - [www.epa.gov](http://www.epa.gov)

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