Understanding Gas Engine Emissions in Standby Power Applications

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ABSTRACT

Air-quality regulations have a major impact on the choice of engine-generator sets for standby electric power. Federal, state and local rules can dictate the level of emission control required and can make gas engines a more advantageous choice than the traditional diesel technology.

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INTRODUCTION

Increasingly strict air emissions rules have brought natural gas engines into the forefront for standby power applications.

While offering lower emission profiles, the latest gas engines designed for standby duty offer rapid startup and load acceptance capability similar to diesel engines, at competitive installed cost per kW, and with lower long-term costs for fuel and maintenance.

Choosing gas engines for standby duty is more complex than simply selecting and installing a diesel generator set sized for the expected standby loads. It requires an understanding the gas quality and composition along with applicable treatments services. Similarly, to diesel, the optimum. The optimum choice of gas equipment requires an understanding of emissions control technologies and of federal, state, regional, and local emission standards.

Before selecting a gas-fueled standby power system, engineers and facility managers need to consider options carefully in light of operating objectives and site-specific emission standards.

KNOWING THE RULES

To a large extent, the expected use of gas standby equipment determines the emission standards at the site. For pure standby/emergency use only – engines expected to run only for brief spells during routine exercising and emergencies – emission standards are usually not a major issue. In this case the engine is allowed to run during the duration of the outage.

This changes for engines installed for other purposes but also offering standby capability. For example, in load management (demand response) applications, gas engine-generators deliver a financial benefit by lowering electric utility rates, and have the added benefit of availability for standby duty. The same can be true of engine-generators in combined heat and power (CHP) installations. In these cases, the expected hours of operation are much longer than for pure standby, and emission standards are therefore more restrictive.

Apart from those considerations, emission standards can vary greatly from one region to another. Emission standards are a primary driver of gaseous-fueled engines as alternatives to diesels for standby power. In general, federal regulations allow Environmental Protection Agency (EPA) Stationary Emergency rated engine generator sets to operate for only 100 hours per year or less during non-emergency situations such as testing and maintenance. Applications other than providing power during a utility outage is classified as non-emergency and for diesel engines require EPA Tier 4 emission standards (Table 1).

Stationary Emission Standards (g/bhp-hr)		NOx	CO	NMHC	NOx + NMHC	PM	VOC
Diesel (CI) >560 bkW	EPA Stationary Emergency	–	3.5	–	6.4	0.2	–
	EPA Non-Emergency (Tier 4 Final)	0.67	3.5	0.19	–	0.03	–
Natural Gas (SI) >75 bkW	EPA Stationary Emergency	2	4	–	–	–	1
	EPA Non-Emergency	1	2	–	–-	–	0.7

Table 1: Allowable emissions for diesel- and natural-gas-fueled engines based on application (U.S. EPA)

Stricter rules apply in areas classified by the U.S. EPA as non-attainment with federal air-quality standards. Threshold values for sites to become a major source vary based on non-attainment severity; for example, 50 tons/year in Chicago and New York City and 10 tons/year in Los Angeles. Major sources are subject to rigorous and expensive emission standards. As a result, major facilities with large standby diesel capacity requirements may exceed the site annual tonnage limits and become a major source when running only during federally allowed testing and maintenance.

The federal stationary emission standards must be met but the state and local government bodies requirements have the authority to make emission standards stricter. For example, the California Air Resources Board (CARB) sets its state's emission standards for a range of pollution sources, and 35 local air pollution control districts may further regulate emissions from various businesses and facilities based upon their local situation. All this favors natural-gas-fueled standby power equipment.

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GAS ENGINE EMISSIONS

Like diesels, gas engines have their emissions ratings certified at the manufacturing factory (for example, 1-gram NOx per brake horsepower-hour for prime power, non-emergency units as seen in Figure 1). However, unlike diesels, they can be fitted with field-deployed exhaust aftertreatment devices for further emissions control, in some cases subject to on-site emissions performance testing.

Today's lean-burn standby gas engines have substantial advantages over older rich-burn technology in fuel economy, power output, service life, reliability and, most significant, in emissions profile. Lean-burn engines, operating on a lean air-fuel mixture, inherently operate with low cylinder temperatures that limit formation of NOx and other emissions. They typically can meet any site NOx limit. Particulates, unburnt hydrocarbons (THC) and CO are also extremely low, and exhaust aftertreatment typically is not needed.

However, there are cases, particularly at higher altitudes, where these emissions may be out of compliance locally. For example, a 1 MW gas generator set rated at 2 g/bhp-hr NOx would produce about 6.3 percent more THC and 2.8 percent more CO at 8,000 feet elevation than the same unit at 500 feet. In those cases, an inexpensive oxidation catalyst can be added to control the specific emissions constituents that are out of compliance (Figure 1). To meet extremely low NOx limits, selective catalytic reduction (SCR) also can be deployed. For non-emergency engines an oxidation catalyst is likely required to meet National Emission Standards for Hazardous Air Polutants (NESHAP).

Figure 1: Oxidation catalyst integrated with muffler to control CO on a 2 MW gas generator set

ACHIEVING BEST VALUE

There is no one right answer to the question of which generating technology is best for standby power. A best-value proposition should become clear based on a fair evaluation of the level of standby support the application requires, the potential cost of lost power, the all-inclusive installed system cost, and operation and maintenance costs.

In choosing a standby power solution it is helpful to consult with a dealer or engine-generator manufacturer representative with a track record in the standby market. These professionals have access to engine-generators in a broad range of power ratings and configurations. Knowing the needs of different commercial, industrial and institutional facilities, they can help select the most appropriate standby system at the optimum installation, operating, and maintenance cost. They are also familiar with standby power code requirements and the preferences of local authorities having jurisdiction (AHJ).

Dealerships can manage whole-project engineering, procurement, and construction; and supply all engines, generators, transformers, switchgear, and other ancillaries required. They also have access to the manufacturer's financing programs to help complete the project in a budget- and cash-flow-friendly manner. A methodical approach can enable a sound selection of standby generator sets to meet operating goals and site-specific requirements.

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