INSIGHTS

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INSIGHTS is published on an as-needed basis to inform our clients and friends in the industrial community about environmental topics of high current interest.

General Permits for Emergency Engines

This issue of *Insights* deals with emergency engines, and requirements to register them with the Department of Environmental Protection (DEP) under a new general permit.

An emergency engine is simply one that drives:

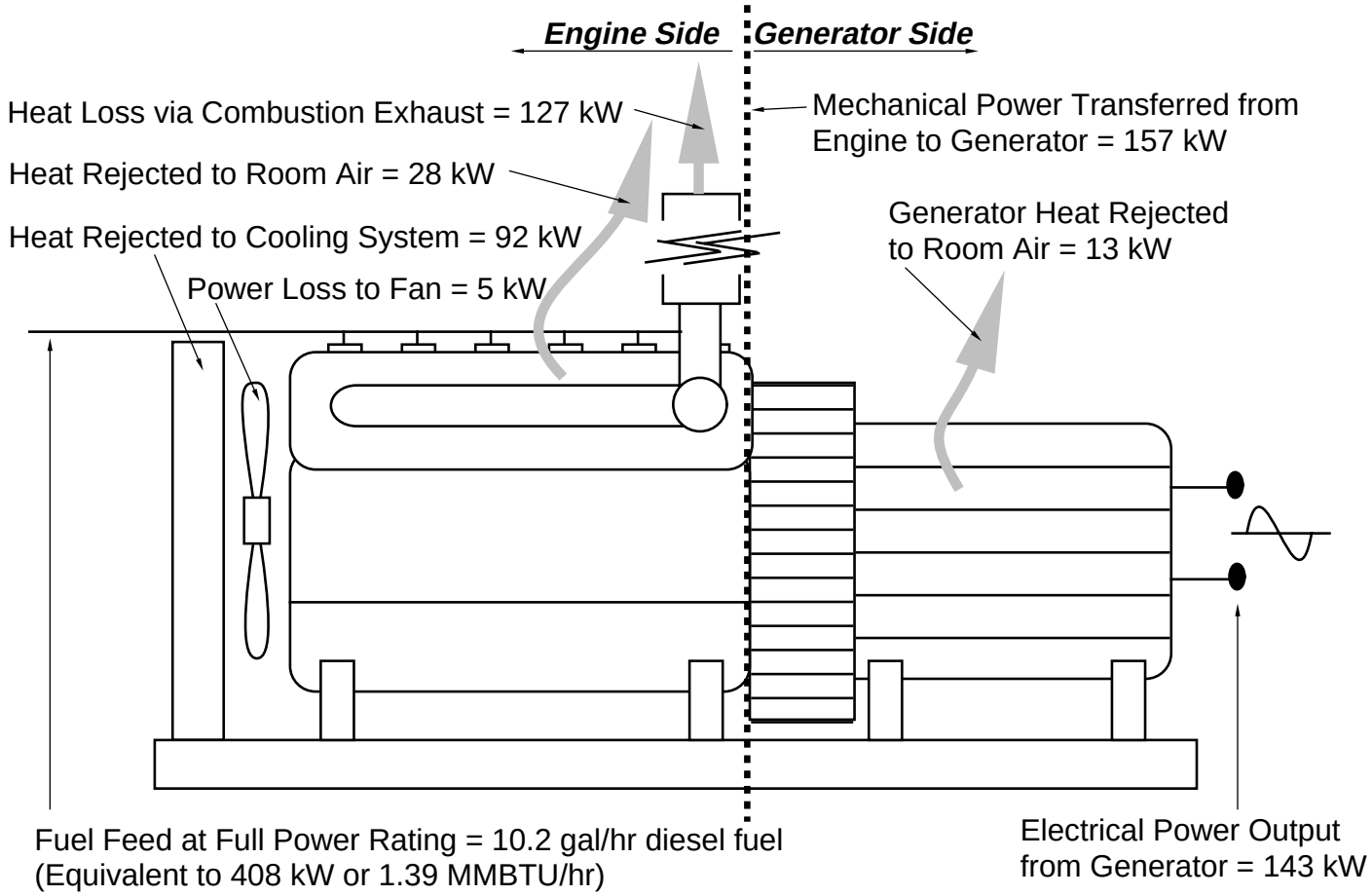
- an emergency electrical power generator; or
- an emergency pump for a fire protection or water supply system; or
- an emergency compressor or any other engine-driven device that is designed to operate only in an emergency, not routinely.

A typical engine is about the same size as found in a moving van. A typical electrical output is that sufficient to power a medium-size apartment building. Last year, DEP published a general permit (called the GPEE permit) requiring registration of any existing or planned emergency engines above a minimum size threshold. There is a significant number of such engines in Connecticut. Hospitals, schools and municipal buildings, as well as certain industrial and commercial facilities, require emergency electrical or mechanical power in the event of a power outage by the electric utility service.

DEP is not interested in limiting the use of engines for emergency power purposes. The general permit carries a simple restriction on the number of hours per year that the generator is allowed to operate. The operating hours allowed are generally far greater than your need for emergency power or periodic system testing. The permit does not impose any emission control requirements on existing systems, except for burning low sulfur fuel. (Also, please note that the information in this *Insights* applies only to reciprocating engines, not to jet engines (such as used by electric utilities for backup power).

This material describes emergency engines and provides some useful calculation tools and reference information to clarify the registration process under the GPEE permit. The tables and diagrams are intended to help facility managers who want to do the registration, but don't know much about engines or air emissions. The information offered below is for background and reference; it stops short of explaining in detail how to register an engine. That is covered very well in the DEP GPEE instruction package. Registration is not difficult, but if you don't want to try it, please give us a call.

Figure 1: An example of a small emergency electrical power generator, showing the power balance, for you to use as reference and comparison to your own situation.



Efficiencies for This Example
Engine: (157 kW / 408 kW) = 38%
Generator: (143 kW / 157 kW) = 91%
System: (143 kW / 408 kW) = 35%

Useful Conversion Factors
1 kW = 3410 BTU/hr
1 kW = 1.34 hp (brake)
1 kW-hr = 0.00341 MMBTU
1 hp-hr = 0.00254 MMBTU

Table 1: Some sources of useful information about emergency engines and generators.

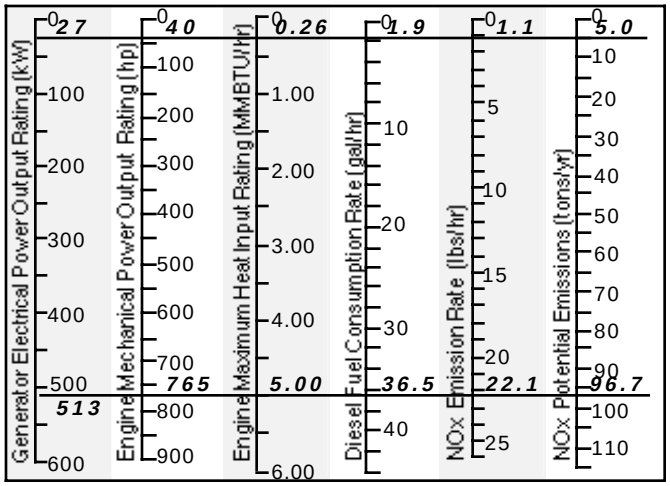
Mfr	Phone	E-Mail	Internet
Caterpillar	(309) 675-1000	cat_power@cat.com	http://www.cat.com
Cummins	1-800-343-7357	powermaster@cummins.com	http://www.cummins.com
Kohler	(920) 544-2444	generfb@excel.net	http://www.kohlerco.com
Onan	(804) 589-2415	wg4t@genset.com	http://www.genset.com/onan.htm
Waukesha	(414) 547-3311	dan_hesse@wed.dress.com	http://www.waukeshaengine.com

Table 2: A process for estimating fuel consumption, heat input, and NOx potential emissions based on engine or generator nameplate information. You need these parameters to fill out the GPEE registration form. See Figure 2 on the next page for quick estimation.

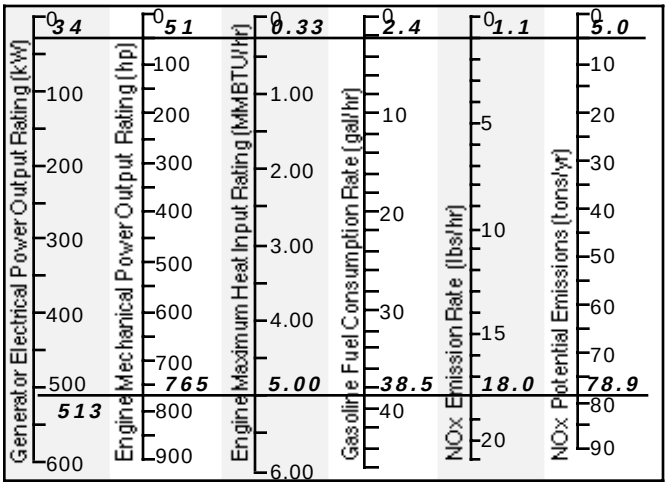
Step	Action	Comment
1.	Find the engine mechanical power rating. *(Example from Figure 1 , opposite page: 211 hp)*	This is expressed as horsepower (hp) or sometimes as brake horsepower (bhp) on the engine nameplate or in the operations manual specs.
2.	Find the electrical power output rating on the generator side of the equipment. *(Example: 143 kW)*	This is expressed as kilowatts (kW) or sometimes as kilovolt-amps (kVA) on the generator nameplate or in the operations manual specs. If kVA, multiply by the stated power factor (typically 0.8) to get kW.
3.	Use the manufacturer's specs for fuel consumption if available. If not, multiply the mechanical power rating (hp) from Step 1, or the electrical rating (kW) from Step 2, by one of the following conversion factors to get fuel consumption, as follows: multiply hp by: / multiply kW by / to get consumption of 0.0476 / 0.0711 / diesel fuel (gal/hr) 0.0502 / 0.0749 / gasoline (gal/hr) 0.0720 / 0.107 / propane liquid (gal/hr) 2.61 / 3.90 / propane gas (cf/hr) 6.53 / 9.75 / natural gas (cf/hr) *(Example: 143 kW x 0.0711 = 10.2 gal/hr)*	If you use the specification given in the operations manual, make sure it is not the max pumping capacity of the fuel pump, which may be a lot higher than the engine actually can consume. The conversion factors at left give maximum fuel consumption at the rated engine power or generator electrical output (based on typical engine efficiency of 38%, generator efficiency of 91% and system (engine + generator) efficiency of 35%). gal = gallon cf = cubic foot hr = hour
4.	Multiply the result in Step 3 by the appropriate conversion factor to get maximum heat input (in mmBTU/hr), as follows: gal/hr diesel fuel x 0.137 = mmBTU/hr gal/hr gasoline x 0.130 = mmBTU/hr gal/hr propane liquid x 0.091 = mmBTU/hr cf/hr propane gas x 0.0025 = mmBTU/hr cf/hr natural gas x 0.001 = mmBTU/hr (If the engine burns #2 heating oil or kerosene, use the factor for diesel fuel.) *(Example: 10.2 gal/hr x 0.137 = 1.39 mmBTU/hr)*	mmBTU/hr is a million British Thermal Units (a measure of energy) per hour. The conversion factors are based on average energy content values and fuel densities as follows: Fuel / Energy Content / Density diesel fuel / 137,000 BTU/gal / 7.05 lb/gal gasoline / 130,000 BTU/gal / 6.17 lb/gal propane liquid / 91,000 BTU/gal / 4.24 lb/gal propane gas / 2500 BTU/cf / 0.105 lb/cf natural gas / 1025 BTU/cf / 0.042 lb/cf
5.	Compare the number calculated above to the regulatory threshold criterion for maximum heat input of 5.0 mmBTU/hr. *(Example: 1.39 < 5.0 ; no other requirements)*	If greater than 5.0 mmBTU/hr, check with DEP, since other permitting requirements possibly may apply to this emergency engine.
6.	Multiply the result in Step 3 by one of the following conversion factors to get maximum potential NOx emissions (in tons/yr): gal/hr diesel fuel x 2.65 = NOx (tons/yr) gal/hr gasoline x 2.05 = NOx (tons/yr) gal/hr propane liquid x 1.37 = NOx (tons/yr) cf/hr propane gas x 0.0378 = NOx (tons/yr) cf/hr natural gas x 0.0127 = NOx (tons/yr) *(Example: 10.2 gal/hr x 2.65 = 27.0 tons/yr of NOx)*	Based on the current EPA AIRS, FIRE and AP-42 emission factors, as listed in the GPEE instruction package, multiplied by 8760 hrs/yr and divided by 2000 lbs/ton. If you have a different, verifiable NOx emission factor specified by the manufacturer, use that instead. (These are frequently found in tables of test data of the engine at different power levels in the engine operations manual; make sure you pick the factor for the full rated power level.)
7.	Compare the number calculated above to the permit threshold criterion for potential NOx emissions of 5.0 tons/yr. *(Example: 27.0 > 5.0; need to register this engine)*	If greater than 5.0 tons/yr potential NOx emissions, a GPEE registration is required for new or existing units. *Engines smaller than 40 hp, or generators smaller than 27 kW, are not regulated under current DEP rules.*

Figure 2: Relationship estimator between power, fuel consumption and NOx emissions for different fuels.

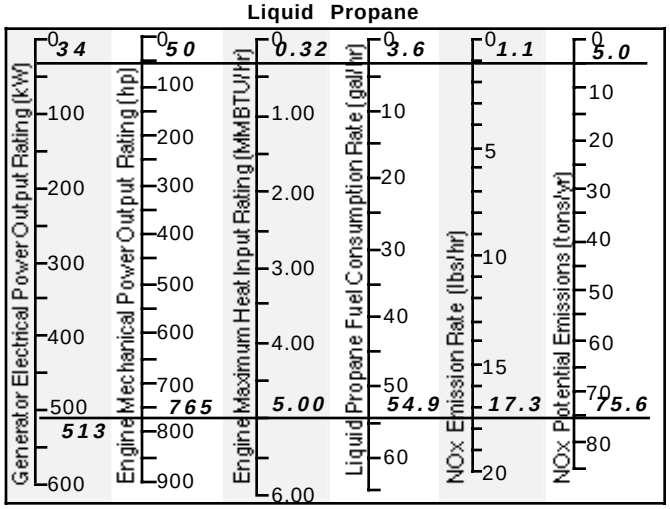
Diesel Fuel



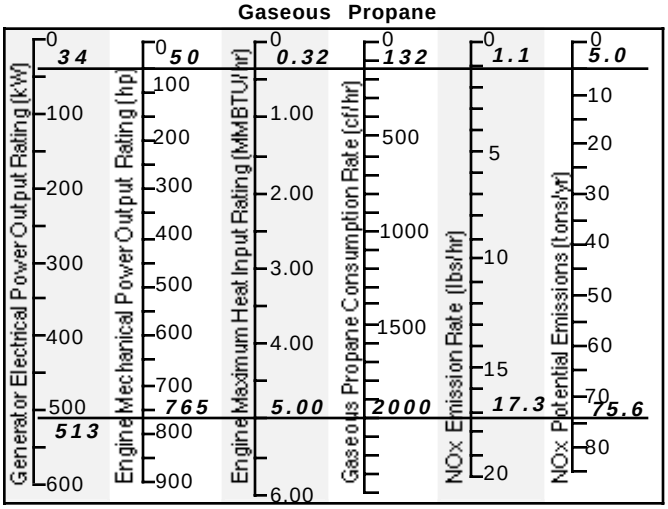
Gasoline



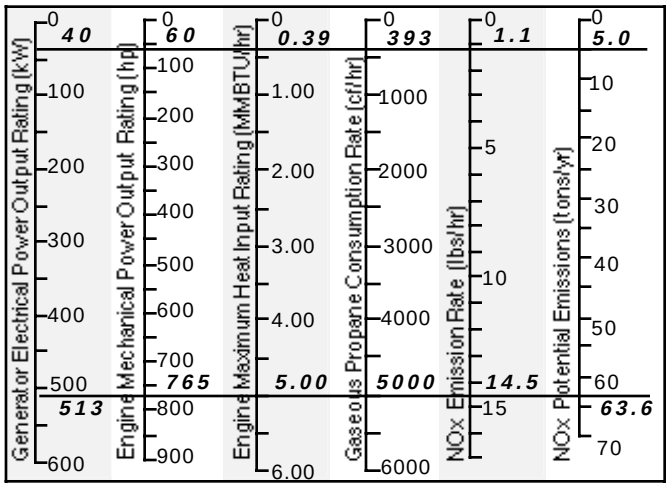
Liquid Propane



Gaseous Propane



Natural Gas



By setting a straight edge across any of these figures, you can estimate the relationship between power, fuel consumption and NOx emissions, within about 5%.

Power is energy per unit time and may be expressed as electrical (kW), mechanical (hp), or heat rate (mmBTU/hr). The above estimators assume that an engine is 38% efficient and that an engine-generator combination is 35% efficient. See Figure 1 for the power balance around a typical engine and generator.

The emission factors that are the basis for the NOx emission rates were taken from the DEP GPEE instruction package. NOx emission rate (lbs/hr) assumes full rated engine power. NOx potential emissions (tons/yr) assumes the engine runs continuously at its full rated power all year (8760 hours).

The top dotted line with numbers in italics represents 5 tons/yr of potential NOx emissions. If the hp or kW ratings are less than these numbers, there is no need to register the engine. The bottom dotted line with numbers in italics represents 5 mmBTU/hr heat input. If the hp or kW ratings are greater than those numbers, other requirements may apply; check with DEP or call us.