WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

SUITABILITY OF SPARK IGNITION, GASEOUS FOSSIL FUEL-POWERED EMERGENCY GENERATORS FOR AIR QUALITY GENERAL ORDER OF APPROVAL: EVALUATION OF CONTROL TECHNOLOGY, AMBIENT IMPACTS, AND POTENTIAL APPROVAL CRITERIA

Date

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EXECUTIVE SUMMARY

Ecology's Air Quality Program revised its Notice of construction rules (contained in Chapter 173-400 Washington Administrative Code) in early 2005 to allow for the Establishment of General Orders of Approval

Ecology determined that establishment of a General Order of Approval is appropriate for diesel-powered emergency generators meeting the criteria in Table 1.

Table 1: Diesel-powered Emergency Generator Applicability Criteria for General Order of Approval

Criterion	Limitation
Fuel	Gaseous fossil fuels, such as natural gas and propane.
Generator set size	Not greater than 850 brake horsepower (BHP) engine.
Engine qualifications	Spark ignition. Rich burn design: Equipped with 3-way catalytic muffler.
Location	Located in counties or at industrial facilities under jurisdiction of the Department of Ecology
Minimum distances to property line and publicly-accessible buildings vary with engine size.	If the exhaust stack extends at least ten feet above the roof line, there are no location restrictions. Engines 100 BHP or less may use a shorter stack with location restrictions shown in Table 9.
Minimum stack height criteria Minimum stack height varies with engine size and location.	Engines over 100 BHP, exhaust stack must extend at least ten feet above the roof line. Engines 100 BHP or less may use a shorter stack with location restrictions shown in Table 9.
Hours of operation	Not more than 30 hours in any calendar year for required testing, and not more than 500 hours total operation in any calendar year.

Contents

1. INTRODUCTION

PURPOSE

The purpose of the analysis described in this document is to determine emission unit criteria and approval conditions within which a General Order of Approval is appropriate for spark ignition, gaseous fossil fuel-powered emergency generators (gas-powered emergency generators). In addition, a list of minimum requirements or applicability criteria will be developed to identify gas-powered emergency generators that would qualify for coverage under the General Order of Approval.

BACKGROUND

Since 1972, Ecology has required a preconstruction review and permitting program for new sources that will emit pollutants to the air in the State of Washington. This review and permitting process is referred to as "New Source Review" by the state or the relevant local air quality control agency. Based on that review, the relevant agency issues an approval-to-construct and operates the new source. This "Notice of Construction Approval" contains pollutant emission limitations and operating requirements for the new source.

The typical process to obtain a site-specific, individual Notice of Construction air quality permit is described in "How to Apply for a Notice of Construction Air Quality Permit." HTTP://WWW.ECY.WA.GOV/BIBLIO/ECY070121.HTML

Effective, February 10, 2005, Ecology revised its regulations to include the General Order of Approval as an alternative to the individual Notice of Construction permit. General Orders of Approval are intended to be a method for owners of commonly permitted, small emission sources to know, prior to committing to purchase and submitting an application to Ecology, what is necessary to comply with Washington's new source review requirement. A significant goal of issuing General Orders of Approval is to simplify the permitting process by reducing the regulatory and administrative burden on the applicant and Ecology. Use of General Orders should reduce the permit processing cost to both the applicant and Ecology.

2. EVALUATION BASES

GENERAL CRITERIA

The Ecology Air Quality Program established the following criteria for the General Order of Approval determination. The criteria are intended to facilitate completing the development of each categorical general order with a reasonable amount of time and effort. The criteria are:

1. Best Available Control Technology (BACT) and Toxic Air Pollutant-BACT is the same as for a site specific approval issued during the time the engineering evaluation is developed.
2. The emissions will not delay the attainment date for any area not in attainment nor will the emissions cause or contribute to the exceedance of any ambient air quality standard.
3. An emission unit size or type can not receive a General Order of Approval if the ambient air quality analysis indicates that a Tier 2 review (WAC 173-460-090) would be required at any potential location.
4. The General Order will assure a covered unit will comply with all applicable new source performance standards, national emissions standards for hazardous air pollutants, national emission standards for hazardous air pollutants for source categories, and emission standards adopted under the Washington State Clean Air Act.
5. The individual emission unit cannot cause the facility it is installed in to become subject to the Air Operating Permit program or be subject to Prevention of Significant Deterioration permitting.
6. Information content of and analyses described in the technical analysis will be similar to that required in a permit application for this type of emission unit.

Assumptions 1, 2, 4, and 5, reflect the requirements of WAC 173-400-110, 112, 113, and 560 and are requirements for all new source review actions in Washington. Assumption 5 reflects specific requirements for General Orders of Approval found in WAC 173-400-560. Assumption 6 reflects the actuality that this analysis needs to evaluate a number of control options and generic emissions modeling prospectively rather than a permit application review's retrospective analysis.

Assumption 3 reflects the criteria of the Tier 2 toxic air pollutant review process (WAC 173-460-090). A Tier 2 review is a site specific analysis of the impacts of toxic air pollutants from a known, existing facility on the surrounding community. A General Order of Approval is developed without a specific site in mind. A General Order of Approval is unable to incorporate the site specific considerations of the Tier 2 process. In order to reflect this limitation, Ecology is including criteria related to the distance from the described units to property lines and buildings, hills, or other structures that affect ambient air quality concentrations.

EMERGENCY GENERATORS

Definition

An emergency stationary internal combustion engine (ICE) is defined[1] as any stationary internal combustion engine whose operation is limited to emergency situations and required testing. Examples of when emergency ICEs are used:

- produce power for critical networks or equipment when electric power from the local utility is interrupted,
- pump water in the case of fire or flood, etc.,
- federal or state declared disasters and emergencies, and
- simulations of emergencies by Federal, State, or local governments.

Emergency stationary ICE are allowed to be operated for the purpose of maintenance checks and readiness testing, provided that the tests are recommended by the manufacturer, the vendor, or the insurance company associated with the engine. Ecology limits operation of an emergency generator to not more than 500 hours in any calendar year, consistent with Ecology's routine permitting policy.

Emissions

Gaseous fuel-powered ICEs (gas-powered engines) for emergency generators will emit a variety of air pollutants. Some of these are air pollutants subject to regulation under the National Ambient Air Quality Standards (NAAQS). These are primarily nitrogen oxides (NO_X), sulfur oxides (SO_X), carbon monoxide (CO), particulate matter (PM and PM_{10}[2]), and volatile organic compounds[3] (VOCs, also called nonmethane hydrocarbons, NMHC). Gas-powered engines also emit the toxic air pollutants[4] (TAPs) listed in Table 2.

Table 2: Toxic Air Pollutants from Generators Powered by Natural Gas-fired Engines

Toxic Air Pollutants	Class	Acceptable Source Impact Level (ASIL)*	Small Quantity Emissions Rate (SQER) Limit**

[1] Federal Register: July 11, 2005 (Volume 70, Number 131)], Proposed Rules, Page 39869-39904
[2] Particulate matter less than 10 microns in aerodynamic diameter.
[3] Volatile organic compounds are the surrogate family of air pollutants used to determine an emission unit's impact on ambient ozone concentrations.
[4] Chapter 173-460 TAPs as listed in Tables 3.2-1, 2, and 3 in the EPA's "Compilation of Air Pollutant Emission Factors, AP-42," Office of Air Quality Planning and Standards, Research Triangle Park, NC

		micrograms per cubic meter ($\mu g/m^3$)	Pounds per hour (lb/hr)	Pounds per year (lb/yr)
Acetaldehyde	A	0.45	N/A	50
Acrolein	B	0.02	0.02	175
Benzanthracene	A	Not established (N/E)	N/E	N/E
Benzene	A	0.12	N/A	20
Biphenyl	B	4.3	0.02	175
Butadiene	A	0.0036	N/A	0.5
Butane	B	6300	5	43748
Carbon Tetrachloride	A	0.067	N/A	20
Chlorobenzene	B	150	2.6	22750
Chloroform	A	0.043	N/A	10
Cyclohexane	B	3400	5	43748
Cyclopentane	B	5700	5	43748
1,1 Dichloroethane	B	2700	5	43748
1,2 Dichloroethane	A	0.038	N/A	10
Dichloropropane	B	4	0.02	175
Dichloropropene	B	20	0.2	1750
Ethylbenzene	B	1000	5	43748
Ethylene dibromide	A	0.0045	N/A	0.5
Formaldehyde	A	0.077	N/A	20
Formaldehyde	A	0.077	N/A	20
Hexane	B	200	2.6	11750
Methanol	B	870	5	43748
Methylcyclohexane	B	5400	5	43748
Methylene chloride	A	0.56	N/A	50
Naphthalene	B	170	2.6	22,750
Nitric oxide	B	100	2	17,500
Nonane	B	3500	5	43,748
Octane	B	4700	5	43,748
Pentane	B	6000	5	43,748
Phenol	B	63	1.2	10,500
Styrene	B	1000	5	43,748
Toluene	B	400	5	43,748
Tetrachloroethane	B	23	0.2	1,750

Toxic Air Pollutants		Class	Acceptable Source Impact Level (ASIL)* micrograms per cubic meter ($\mu g/m^3$)	Small Quantity Emissions Rate (SQER) Limit** Pounds per hour (lb/hr)	Pounds per year (lb/yr)
Trichloroethane		B	180	2.6	22,750
Trimethylbenzene		B	420	5	43,748
Trimethylpentane		B	N/E	N/E	N/E
Vinyl chloride		A	0.012	N/A	10
Xylene		B	1,500	2	43,748
Total poly-cyclic aromatic hydrocarbons (PAH)***		A	4.80E-04	N/A	N/A
	Benzo(a)pyrene	A	4.80E-04	N/A	N/A
	Benz-anthracene	A	N/E	N/E	N/E
	Benzofluoro-anthenes	A	N/E	N/E	N/E
	Chrysene	A	N/E	N/E	N/E
	Dibenz-anthracene	A	N/E	N/E	N/E
	Indeno(1,2,3-c,d)pyrene	A	N/E	N/E	N/E

* WAC 173-460-150 and -160
** WAC 173-460-080(2)(e)
*** Quantified according to WAC 173-460-050(4)(d) as the sum of the emissions of benzo(a)anthracene, benzo(b and k)fluoroanthene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, and indol(1,2,3-c,d)pyrene.

Formaldehyde emissions are established at the reciprocating internal combustion engine standard 40 CFR Part 63 Subpart ZZZZ. The remaining anticipated TAPs emission factors are taken from EPA's AP-42 (October, 1996). Formaldehyde and the other significant TAPs emissions factors are shown in Table 2,

Broadly speaking, there are three designs of gas-powered engines: Four stroke rich-burn, 2-stroke lean-burn, and 4-stroke lean-burn. For the sake of brevity, Ecology will assume that the reader knows the difference between two- and four-stroke engines[5]. A rich-burn engine takes in just slightly more air than needed to maintain stable combustion without a smoky exhaust. A lean-burn engine is one designed to operate with an air intake much higher than needed to just maintain combustion. Lean-burn design has at least three benefits over rich-burn engines: First, It increases the efficiency of the engine. Second, it allows a cooler combustion, and lowers the NO_X emissions. Third, it gives more complete combustion, and lower CO emissions. However, it appears to increase VOC emissions. While a lean-burn engine is more efficient, it is also more

[5] For the interested, but uninformed reader, consult "How Stuff Works," http://science.howstuffworks.com/two-stroke.htm

expensive than a rich-burn engine because of design characteristics needed to assure stable combustion.

Uncontrolled criteria pollutant emissions from these three types of gas-powered engines are shown in Table 3.

Table 3: Uncontrolled Criteria Pollutant Emissions from Generators Powered by Natural Gas-fired Engines*

Engine Design		Rich-burn	2-stroke, lean-burn	4-stroke, lean-burn
NO_X	lb/MMBtu	2.27	g/BHP-hr directly from vendor literature	
	g/BHP-hr	9.07	2.5	2.5
CO	lb/MMBtu	3.72	.387	.317
	g/BHP-hr	14.9	1.21	0.993
SO_2	lb/MMBtu	.00059	.00059	.00059
	g/BHP-hr	.00236	.00185	.00185
VOCs	lb/MMBtu	.0296	0.12	0.118
	g/BHP-hr	0.118	0.376	0.37
PM_{10}	lb/MMBtu	.0194	.0483	.01
	g/BHP-hr	.0775	0.151	.0313

* Pounds per million British thermal units (lb/MMBtu) are from Tables 3.2-1, 2, and 3 in the EPA's "Compilation of Air Pollutant Emission Factors, AP-42," Office of Air Quality Planning and Standards, Research Triangle Park, NC. These were converted to grams per brake horsepower-hour (g/BHP-hr) using typical fuel efficiencies in gas-powered engine vendor literature (primarily Caterpillar and Waukesha). Consequently, the later may differ between various engines and manufacturers. However, they are satisfactory for the illustrative purpose of this technical document.

WAC 173-400-110(5), Washington exempts emissions sources from new source review under WAC 173-400-110 if potential NAAQS pollutant emission increases are below those shown in Table 4.

Table 4: Exemption Levels, New Source Review under WAC 173-400-110

Pollutant	Level (tons per year)
Nitrogen Oxides (NO_X)	2.0
Carbon Monoxide (CO)	5.0
Sulfur Oxides (SO_2 and SO_3)	2.0
Volatile Organic Compounds (VOCs, NMHCs)	2.0
Total Suspended Particulates	1.25
PM_{10}	0.75
Lead	0.005

By examining Table 3 with Table 4 in mind, it should be obvious that the determining factor for gas-powered engines is their level of NO_X emissions relative to the WAC 173-400-110 new source review exemption. This leads to the conclusion that rich-burn engines with <u>uncontrolled</u> NO_X emissions used to drive an emergency generator not more than 500 hours per year would be exempt up to 400 BHP. Similarly, a lean-burn engine would be exempt up to 1,451 BHP. For the sake of illustration, if CO were the determining pollutant, the maximum-exempted engine powers would be 609 BHP and (at least) 7,500 BHP, respectively. Any controls that reduced NO_X and (if necessary) CO emissions would increase the exempted engine power level.

Notwithstanding any exemption from new source review under WAC 173-400-110, gas-powered engines also emit TAPs listed in Chapter 173-460 WAC. Chapter 173-460 WAC has its own new source review requirements. There are no diminis levels for these TAPs. Consequently, this general order will be required of any emergency generator up to the specified maximum unless the applicant chooses to use the standard notice of construction approval process. Any applicant proposing any size emergency generator set may opt to use the standard notice of construction approval process to acquire appropriate permitting.

4. Best Available Control Technology

State law and rule[6] defines BACT as "an emission limitation based on the maximum degree of reduction for each air pollutant subject to regulation under the Washington Clean Air Act emitted from or which results from any new or modified stationary source, which the permitting authority, on a case-by-case basis, taking into account energy, environmental and economic impacts and other costs, determines is achievable for such source or modification through application of production processes and available methods, systems, and techniques, including fuel cleaning, clean fuels, or treatment or innovative fuel combustion techniques for control of each pollutant."

Ecology has chosen to implement the "top-down" process to determine what BACT is for notice of construction reviews. In the 'top-down" analysis process, the applicant lists and ranks all potential pollutant control options from highest level of control (lowest emission rate) to the lowest (highest emission rate). Next those emission control options that are technically infeasible are removed from the list of available controls. The highest level of control remaining is considered technically feasible to implement on the emission unit. When that level of control is either proposed by an applicant, it is accepted as BACT with no further analysis involved. An applicant may choose to demonstrate that the highest level of emissions control is not financially feasible (not cost effective) to implement or has adverse environmental or energy impacts. In this case the applicant evaluates the economic, environmental and energy impacts of the next most stringent level of control until a level of control is demonstrated to be economically feasible.

In the case of this General Order of Approval Technical analysis document, there is no identified applicant. Thus, Ecology is responsible for providing this BACT technology analysis comparing the economic feasibility of available emission control options as add-on emission control technologies as part of our process to determine what BACT should be.

BACT for NO_X, CO, VOCs, and PM/PM_{10}

Over recent years, and expected into the future, manufacturers of stationary internal combustion engines and their suppliers have been working diligently to reduce criteria pollutant emissions by a combination of engine design and add-on controls. Most of the add-on technologies under development were reviewed in Ecology's technical supplement document for the general order

[6] RCW 70.94.030(7) and WAC 173-400-030(12)

for diesel-powered emergency generators[7]. That analysis and review concluded that there are only a few options available at this time. This is supported by analyses reported by other sources[8, 9, 10, 11, 12, 13]. Based on these reviews, Ecology concludes that the commercially-available criteria pollutant reduction technologies for gas-powered engines are

Rich-burn: Three-way (muffler) catalyst.

The three-way catalyst system (TWC) is the basic automotive catalytic converter that reduces NO_X, CO, and VOCs. TWC is also called "non-selective catalytic reduction." NO_X can be reduced to less than 1.5 g/BHP-hr, CO by 90%, and VOCs by 80%. A rich-burn gas-powered engine with a TWC would be exempt from WAC 173-400-110 new source review up to 2,421 BHP.

Lean-burn:

Engine and engine-control design: Standard lean-burn engine design is capable of reducing NO_X to less than 2.5 g/BHP-hr. Low-emission design can reduce NO_X emissions to below 1.0 g/BHP-hr. Advanced low-emission designs are in development that may reduce NO_X emissions to less than 0.1 g/BHP-hr. Low-emission designed engines require advanced control systems to maintain combustion stability. Reductions in CO are marginal for low-emission design. Reductions in VOC of about 35% are likely due to cooler engine operation.

TWC cannot be used on an oxygen-rich exhaust. Consequently, TWC is not feasible for use on lean-burn engines.

Selective Catalytic Reduction (SCR) passes the exhaust through a catalyst bed along with an ammonia source (either ammonia or urea) to reduce the NO_X to nitrogen. Some excess ammonia is necessarily emitted. SCR has only been required under permitting when the gas-powered engine is to be located in an area suffering non-attainment with the National Ambient Air Quality Standards for ozone, and never for engines intended for emergency service.

Catalytic Oxidation uses a noble metal catalyst to reduce both CO and VOCs by as much as 98% to 99%. As with SCR, catalytic oxidation has only been required under permitting when the gas-powered engine is to be located in an area suffering non-attainment with the National Ambient Air Quality Standards, in this case, for CO. Fewer than 15% of 2-stroke lean-burn

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[7] "Suitability of Diesel-Powered Emergency Generators for Air Quality General Order of Approval: Evaluation of Control Technology, Ambient Impacts, and Potential Approval Criteria," Washington Department of Ecology Air Quality Program (May, 2006)

[8] "Technology Characterization" Reciprocating Engines," prepared for the EPA Climate Protection Partnership by Energy Nexus Group, Arlington, VA (February, 2002)

[9] "Stationary Reciprocating Internal Combustion Engines - Updated Information on NO_X Control Techniques - Revised Final Report," EPA Contract No. 68-D98-026 prepared by Edgerton, Lee-Greco, and Walsh, EC/R, Inc., Chapel Hill, NC (September, 2001)

[10] "Guidance for the Permitting of Electrical Generation Technologies," California Environmental Protection Agency (November, 2001)

[11] "State of the Art (SOTA) Manual for Reciprocating Internal Combustion Engines," State of New Jersey Department of Environmental Protection (2003)

[12] "What's Up With Lean-Burn Natural-Gas Gensets," Distributed Energy, The Journal for Onsite Power Solutions, HTTP://WWW.FORESTER.NET/DE_0403_WHAT.HTML (March, 2006)

[13] Chapter 3.2 "Natural Gas-fired Reciprocating Engines," EPA's "Compilation of Air Pollutant Emission Factors, AP-42," Office of Air Quality Planning and Standards, Research Triangle Park, NC (July, 2000)

engines and 3% of 4-stroke lean-burn engines have been equipped with catalytic oxidation systems[14].

Both SCR and catalytic oxidation are relatively expensive. Economic justification for imposing their use under permitting depends on the size of the engine and the frequency of use. For 500 hours per year use of an 8,000 BHP engine, application of these technologies would cost over $8,000 per ton of pollutant reduction. The cost goes up exponentially as the engine size is reduced[15]. Ecology concludes this is unjustifiable.

SO_2 and PM_{10} emissions are almost negligible for either rich- or lean-burn gas-powered engines. Ecology is aware of no case in which add-on technology was imposed under permitting to reduce emissions of these pollutants from gas-powered engines.

Ecology concludes that BACT for minimization of NO_X, CO, and VOC emissions from gas-powered engines is three-way catalysis for rich-burn engines and low-emission engine design for lean-burn engines. BACT for minimization of SO_2 and PM_{10} emissions is inherent in fuel restriction to natural gas or propane.

BACT for Toxic Air Pollutants

The TAPs known to be emitted from gas-powered engines are listed in Table 2. All are organic chemicals except nitric oxide. There are no add-on technologies technically feasible or demonstrated or commercially available for reduction of organic TAPs emissions other than those designed generally for VOC reduction. Control technologies that reduce NO_X reduce nitric oxide proportionately. No emission control technologies specifically reduce nitric oxide beyond those designed for NO_X control.

Table 5 shows Ecology's estimate of the TAPs emissions from the various gas-powered IC engine designs after impositions of the above BACT determination. TWC's effectiveness on VOCs have not been determined on a chemical-by-chemical basis. From a chemical theory point-of-view, the TWC system should be most efficient on lower molecular weight chemicals. To be conservative, Ecology assumed 80% destruction efficiency on organic chemicals with five or fewer carbon units, 50% destruction efficiency for six or more carbon units, and no destruction on halogenated organic chemicals.

[14] "Regulatory Impact Analysis for the Stationary Internal Combustion Engine (RICE) NESHAP - Regulatory Impact Analysis," Environmental Protection Agency 2060-AG63 (February, 2004)

[15] Op. cit., "Stationary Reciprocating Internal Combustion Engines - Updated Information on NO_X Control Techniques - Revised Final Report,"

Table 5: Emission Factors for Toxic Air Pollutant Emissions from Gas-Powered IC Engines and Maximum Engine Sizes up to SQER Dispersion Modeling Exemption

TAP	TAP Emission Factor*: Rich-burn w/ 3-way cat.: 80% red'n of ≤C5, 50% rd'n ≥ C6. No red'n of halogenated HC Lean-burn Lo-E compared to Std LB: 35 % VOC reduction all VOCs No red'n of halogenated HC Grams per BHP-hr				Max. Allow. Engine BHP Allowable Up to SQER Exemption from Dispersion Modeling			
	RB N/A or T/A	LB Std	LB Lo-Emission	LB 2-st	RB N/A or T/A	LB Std	LB Lo-Emission	LB 2-st
Acetaldehyde	2.23E-03	2.62E-02	1.70E-02	2.43E-02	> 10,000	1,734	2,667	1,868
Acrolein	2.10E-03	1.61E-02	1.05E-02	2.44E-02	4,321	564	868	373
Benzanthracene				1.05E-06	Not limited by this TAP			No SQER exemption. Modeling required
Benzene	3.16E-03	1.38E-03	8.96E-04	6.08E-03	5,754	> 10,000	> 10,000	2,988
Biphenyl				1.24E-05	Not limited by this TAP			> 10,000
Butadiene	5.30E-04	8.36E-04	5.44E-04	2.57E-03	857	543	835	177
Butane		1.69E-03	1.10E-03	1.97E+04	Not limited by this TAP	> 10,000	> 10,000	> 10,000
Carbon Tetrachloride	7.07E-05	1.15E-04	1.15E-04	1.90E-04	> 10,000	> 10,000	> 10,000	> 10,000
Chlorobenzene	5.15E-05	9.52E-05	9.52E-05	1.39E-04	> 10,000	> 10,000	> 10,000	> 10,000
Chloroform	5.47E-05	8.93E-05	8.93E-05	1.48E-04	> 10,000	> 10,000	> 10,000	> 10,000
Cyclohexane				9.65E-04	Not limited by this TAP			> 10,000
Cyclopentane		7.11E-04	4.62E-04	2.97E-04	Not limited by this TAP	> 10,000	> 10,000	> 10,000
1,1 Dichloroethane	4.51E-05	7.39E-05	7.39E-05	1.22E-04	> 10,000	> 10,000	> 10,000	> 10,000
1,2 Dichloroethane	4.51E-05	7.39E-05	7.39E-05	1.32E-04	> 10,000	> 10,000	> 10,000	> 10,000
Dichloropropane	5.19E-05	8.43E-05	8.43E-05	1.40E-04	> 10,000	> 10,000	> 10,000	> 10,000
Dichloropropene	5.07E-05	8.27E-05	8.27E-05	1.37E-04	> 10,000	> 10,000	> 10,000	> 10,000
Ethylbenzene	4.95E-05	1.24E-04	8.08E-05	3.38E-04	> 10,000	> 10,000	> 10,000	> 10,000
Ethylene dibromide	8.51E-05	1.39E-04	1.39E-04	2.30E-04	5,335	3,272	3,272	1,974

TAP	TAP Emission Factor*: Rich-burn w/ 3-way cat.: 80% red'n of ≤C5, 50% rd'n ≥ C6. No red'n of halogenated HC Lean-burn Lo-E compared to Std LB: 35 % VOC reduction all VOCs No red'n of halogenated HC Grams per BHP-hr				Max. Allow. Engine BHP Allowable Up to SQER Exemption from Dispersion Modeling			
	RB N/A or T/A	LB Std	LB Lo-Emission	LB 2-st	RB N/A or T/A	LB Std	LB Lo-Emission	LB 2-st
Formaldehyde	1.64E-02	1.65E-01	1.08E-01	1.73E-01	1,109	110	169	105
Formaldehyde: Over 500 BHP, 40 CFR 63 Part ZZZZ. 350 ppb formaldehyde limit.	2.24E-03				8,107			
Hexane		3.48E-03	2.26E-03	1.39E-03	Not limited by this TAP	> 10,000	> 10,000	> 10,000
Methanol	2.45E-03	7.83E-03	5.09E-03	7.77E-03	> 10,000	> 10,000	> 10,000	> 10,000
Methyl-cyclohexane		3.85E-03	2.50E-03	1.06E-03	Not limited by this TAP	> 10,000	> 10,000	> 10,000
Methylene chloride	1.65E-04	6.27E-05	6.27E-05	4.60E-04	> 10,000	> 10,000	> 10,000	> 10,000
Naphthalene	1.94E-04	2.33E-04	1.51E-04	3.02E-04	> 10,000	> 10,000	> 10,000	> 10,000
Nitric oxide**	0.98	1.63	0.65	1.63	927	557	1397	557
Nonane		3.45E-04	2.24E-04	9.65E-05	Not limited by this TAP	> 10,000	> 10,000	> 10,000
Octane		1.10E-03	7.15E-04	2.33E-04	Not limited by this TAP	> 10,000	> 10,000	> 10,000
Pentane		8.14E-03	5.29E-03	4.79E-03	Not limited by this TAP	> 10,000	> 10,000	> 10,000
Phenol		7.52E-05	4.89E-05	1.32E-04	Not limited by this TAP	> 10,000	> 10,000	> 10,000
Styrene	2.38E-05	7.39E-05	4.81E-05	1.72E-04	> 10,000	> 10,000	> 10,000	> 10,000
Toluene	1.11E-03	1.28E-03	8.31E-04	3.02E-03	> 10,000	> 10,000	> 10,000	> 10,000
Tetrachloroethane	1.01E-04	1.25E-04	1.25E-04		> 10,000	> 10,000	> 10,000	Not limited by this TAP
Trichloroethane	6.11E-	9.96E-	9.96E-05	1.65E-04	> 10,000	> 10,000	> 10,000	> 10,000

TAP	TAP Emission Factor*: Rich-burn w/ 3-way cat.: 80% red'n of ≤C5, 50% rd'n ≥ C6. No red'n of halogenated HC; Lean-burn: Lo-E compared to Std LB: 35 % VOC reduction all VOCs; No red'n of halogenated HC. Grams per BHP-hr				Max. Allow. Engine BHP Allowable Up to SQER Exemption from Dispersion Modeling			
	RB N/A or T/A	LB Std	LB Lo-Emission	LB 2-st	RB N/A or T/A	LB Std	LB Lo-Emission	LB 2-st
	05	05						
Trimethylbenzene		2.29E-04	1.49E-04	5.14E-04	Not limited by this TAP	> 10,000	> 10,000	> 10,000
Trimethylpentane		7.83E-04	5.09E-04	2.65E-03	Not limited by this TAP	No SQER exemption. Modeling required		
Vinyl chloride	2.87E-05	4.67E-05	4.67E-05	7.74E-05	> 10,000	> 10,000	> 10,000	> 10,000
Xylene	3.90E-04	5.76E-04	3.75E-04	8.40E-04	> 10,000	> 10,000	> 10,000	> 10,000
Total poly-cyclic aromatic hydrocarbons (PAH)***	0	3.99E-06	2.59E-06	2.19E-06	Not limited by this TAP.	No SQER exemption. Modeling required		

* Except for nitric oxide (see next footnote), grams per brake horsepower-hour (g/BHP-hr) are derived from pounds per million British thermal units (lb/MMBtu) taken from Tables 3.2-1, 2, and 3 in the EPA's "Compilation of Air Pollutant Emission Factors, AP-42," Office of Air Quality Planning and Standards, Research Triangle Park, NC. The lb/MMBtu were converted to g/BHP-hr using typical fuel efficiencies in gas-powered engine vendor literature (primarily Caterpillar and Waukesha), and adjusted for individual chemical destruction using the factors shown in the table header.

** Nitric oxide: All NO_X assumed to be NO. Rich-burn using TWC. Lean-burn from vendor literature.

*** WAC 173-460-50(4)(c): PAHs shall be quantified as the sum of benzo(a)anthracene, benzo(b and k)fluoranthene, chrysene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, and benzopyrene. No emission factor is reported in EPA's AP-42 for these chemicals for rich-burn gas-powered IC engines.

Table 6: NAAQS Pollutant Emissions from Natural Gas-Fired IC Engines

Emissions of Pollutants Subject to National Ambient Air Quality Standards from Emergency, Natural Gas-Fired IC Engines: 500 hour per year maximum operation					
Engine Type	**Sulfur Dioxide** **Pounds per BHP-hr**	**Carbon Monoxide▲** **Pounds per BHP-hr**	**Nitrogen Oxides (NO_X)♦** **Pounds per BHP-hr**	**Particulate Matter▲** **Pounds per BHP-hr**	**Volatile Organic Compounds▲** **Pounds per BHP-hr**
Rich burn with 3-way catalytic muffler	5E-06	.00294	.00330	1.53E-04	4.68E-05
Lean burn, 2 stroke	4E-06	.00252	.00551	3.22E-04	7.83E-04
Standard lean burn, 4-stroke	4E-06	.00297	.00551	9.36E-05	.00111
Lean burn, 4-stroke, lo-emission	3.5E-06	.00258	.00220	8.13E-05	6.27E-04

▲ EPA AP-42 emission factors, Chapter 3.2, "Natural Gas-Fired Reciprocating engines (July, 2000)
Rich-burn: 90% CO and 80% VOC reduction assumed from use of three-way-catalytic muffler.
Low-emissions lean burn: 35% VOC reduction assumed due to cooler engine operation.

♦ Rich-burn: Use of three-way-catalytic muffler.
Lean-burn: Vendor literature.

5. Ambient Impact analysis

All notice of construction applications are required to be evaluated for their ambient air quality impacts. "Ambient air" means the surrounding outside air, the air outside of buildings to which the public has access. In other words this is the air we all breathe.

The federal government has established National Ambient Air Quality Standards (NAAQS) for six common air pollutants. Ecology has adopted these standards with minor changes and also has one additional ambient air quality standard that applies in Washington. All new and modified sources of air pollution in Washington are required to demonstrate that the project will not cause or contribute to an exceedance of one or more of these ambient air quality standards.

Proposed sources that are exempt from new source review under WAC 173-400-110[16] satisfy this requirement by default. As noted previously under the "Emissions" and "BACT" discussions, a standard lean-burn gas-powered engine or a TWC-equipped rich-burn engine would be exempted from new source review under WAC 173-400-110 up to at least 1,450 BHP. Ecology believes this is sufficiently large to include the majority of gas-powered emergency generator sets. It is also much larger than a logical ceiling based on TAPs emissions

[16] In other words, proposed sources with potential emissions of the NAAQS-related pollutants below the new source review permitting thresholds shown in Table 4 have the collateral default presumption of passing the NAAQS-protection requirement.

considerations as explained below. Consequently, Ecology recommends an engine power ceiling that will exempt emergency generators permitted under this general order from new source review under WAC 173-400-110. Collaterally, this restriction will exempt emergency generators permitted under this general order from the requirement to demonstrate NAAQS protection by dispersion modeling.

Chapter 173-460 WAC provides that a source of TAP emissions must be located such that resulting increases in ambient concentrations of the TAPs "are sufficiently low to protect human health and safety from potential carcinogenic and/or other toxic effects."[17] WAC 173-460-080 provides that this may be demonstrated in either of two ways:

- Ambient impact analysis (dispersion modeling): The source must show that each TAP's ambient concentration increase is less than the corresponding acceptable source impact level (ASIL)[18], or perform higher level, case-specific risk analyses showing adequate public protection.
- Small quantity emission rates (SQER): Instead of using dispersion modeling, a source may use the SQER tables (reproduced in Table 7 below) for TAPs with ASILs equal to or greater than 0.001 $\mu g/m^3$.[19] In other words, a proposed emission source is not required to demonstrate that air quality impacts are below the ASIL for any TAP for which mass emissions per unit time are below the corresponding thresholds in the SQER tables.

Table 7: Small Quantity Emission Rate Tables

Small Quantity Emission Rates Class A Toxic Air Pollutants (Tables 1, 2, and 3, WAC 173-460-150)	
ASIL ($\mu g/m^3$)	**TAP emissions Pounds per year (10 meter stack and downwash)**
0.001 to 0.0099	0.5
0.01 to 0.06	10
0.07 to 0.12	20
0.13 to 0.99	50
1.0 to 10	500

[17] WAC 173-460-070, first paragraph.

[18] A TAP concentration increase below the ASIL should not cause a significant increase in air pollution impact. A TAP above the ASIL triggers a second tier risk analysis. By definition, a second tier risk analysis case-by-case, not "general."

[19] WAC 173-460-080(2)(e)

Small Quantity Emission Rates Class B Toxic Air Pollutants (WAC 173-460-160)		
ASIL ($\mu g/m^3$)	**TAP emissions (10 meter stack and downwash)**	
	Pounds per year	**Pounds per hour**
< 1	175	0.02
1 to 9.9	175	0.02
10 to 29.9	1750	0.2
30 to 59.9	5250	0.6
60 to 99.9	10,500	1.2
100 to 129.9	17,500	2.0
130 to 250	22,750	2.6
> 250	43,748	5.0

If the source is expected to emit a TAP at rates for which the SQER variance does not apply, dispersion modeling must show that the ASIL is not exceeded at ground level or at any vertical location where ambient air may be breathed by humans for several hours each day[20]. This is an important consideration because emergency generators are often placed very near publicly accessible buildings that might have open windows or air intake vents exposed to the diesel engine's emissions.

For rich-burn, gas-powered engines, all the TAPs expected to be emitted from diesel-powered emergency generators (Table 5) qualify for application of the SQER tables. A rich-burn, gas-powered engine may be as large as 857 BHP and avoid dispersion modeling under Chapter 173-460 WAC if

- It is equipped with a TWC.
- It has an exhaust stack height that is functionally equivalent to the generic "ten meter stack," and
- It is used not more than 500 hours per year.

Lean-burn engines present a more complicated scenario. First, several of the expected TAPs do not qualify for application of the SQER tables. Either the ASIL is too low, as in the case of PAHs, or the ASIL is not established, as with benzanthracene and trimethylpentane. In either case, dispersion modeling is mandatory. In the latter case, there is the additional complication of having to determine an acceptable default ASIL. Second, the 40 CFR Part 63 Subpart ZZZZ formaldehyde emission limitation applies only to engines larger than 500 BHP. Standard lean-burn engines between about 100 and 500 BHP will emit too much formaldehyde to qualify for application of the SQER tables. Third, above 500 BHP, standard lean-burn engines meet a ceiling for SQER table applicability at around 550 BHP due to nitric oxide and acrolein emissions. Practically speaking, these considerations limit SQER table applicability of standard lean-burn engines to those smaller than 100 BHP. However, due to their being more expensive,

[20] Strictly speaking, the ASIL cannot be exceeded at any location where ambient air is likely to be breathed by members of the general public. Protection of employees and indoor air generally is under the jurisdiction of the Department of Labor and Industries and the Department of Health, respectively, in the state of Washington.

lean-burn engines under about 350 BHP are rarely (maybe never) installed. Consequently, Ecology concludes this general order is not practical for lean-burn engines, and they will not be further considered.

Emergency Generator Size Limit

For rich-burn, gas-powered engines, the analysis could continue beyond 857 BHP. The analysis would attempt to determine appropriate distancing of the gas-powered engine from publicly-accessible locations. However, several considerations suggest this may not be necessary or advisable:

- As noted in the "Background" section, the purpose of a general permit is applicability to "commonly permitted, small emission sources."
    - The most common emergency generators are likely to be below 857 BHP. This is about enough power to generate electricity for over twenty homes or a typical commercial building having over 225,000 square feet.
    - In other words, 857 BHP should be sufficiently large to cover the field of "small" gas-powered emergency generators.
- General permits are intended "to simplify the permitting process by reducing the regulatory and administrative burden on the applicant and Ecology."
    - An analysis extended to emergency generators driven by gas-powered engines larger than 857 BHP will result in a matrix of requirements and recommendations that may be difficult or impossible to enforce:
        - Requirements for distancing the generator from publicly-accessible locations will vary with
            - Height variations of off-site buildings (emission receptor heights).
            - Building downwash variations from nearby buildings, on-site or off-site.
            - Exhaust stack diameters that differ between engine manufacturers.
            - Uncertainties about stack exhaust temperature variations between engine sizes and designs.

Because of these considerations, Ecology will limit this general order to rich-burn gas-powered emergency generators that are 857 BHP or smaller. Gas-powered engines used for emergency electricity generation less than 500 hours per year that are 857 BHP or smaller may be permitted under both WAC 173-400-110 and Chapter 173-460 WAC without dispersion modeling as long as they are equipped with a stack not less than ten feet taller than the roofline.

Stack Heights for Smaller Engines

For engines smaller than 100 BHP, it will often be impractical to mandate stack heights ten feet above the building. Notwithstanding the above discussion of the complexity of analysis outside the qualifiers of the SQER tables, Ecology determined additional requirements that will allow emergency generators up to 100 BHP to install small stacks.

Dispersion Model

Ecology uses an air quality plume dispersion model to determine whether the ambient impacts from a proposed project will be acceptable. The dispersion model predicts the ambient air concentrations of the various air pollutants caused by the project. For this general order, Ecology used the results of the model to determine minimum stack heights and setbacks for rich-burn engines of 100 BHP or smaller. The minimum stack heights and setbacks assure that no ASIL is exceeded at ground level or at any vertical location where ambient air may be breathed by humans.

There are a number of dispersion models available for use. All of them use mathematical formulas and meteorological information to predict where the exhaust emissions will travel and the ambient concentrations at specific locations. Models generally come in 2 forms, screening models and complex models. In most cases, the models use the same formulae. The differences occur in the level of detail of the emission source(s) and meteorological information required by the model. Screening models use a set of default meteorological characteristics and reports which characteristics give the highest pollutant concentration, and the resulting concentration. More complex models require actual weather conditions for the site or the region around the site. Due to their simpler meteorological input characteristics, screening models are typically conservative, in other words, screening models will usually over-predict the ambient concentrations compared to what would be actually measured (and compared to what would be predicted by a more complex model).

Ecology chose the SCREEN3 model for predicting ambient concentrations. This is a common screening model that has been recognized by EPA as suitable for this purpose and has been in common use for the past 15 + years. There are other models that Ecology could choose, but this one is both the simplest to use and the one most often used by small facilities and Ecology in determining ambient air quality impacts from a given facility.

The general SCREEN3 input variables are shown in Table 8.

Table 8: SCREEN3 Input Variables for Emergency Generator General Order Analysis

Variable	Model Input
Source type	Point
Emission rate	Rich burn, natural gas-powered engine equipped with a three-way catalyst (nonselective catalytic reduction of NO_X, CO, and VOCs): See Table 5.
Stack Height	25 BHP: 7.5, 8, 8.5, and 10 meters 50 BHP: 7.5, 8.5, and 10 meters 100 BHP: 7.5, 8.5, and 10 meters
Stack diameter	Sufficient to have the stack velocity at 50 meters per second for all engine sizes.
Stack velocity	50 meters per second
Stack temperature	850 ^oK
Ambient temperature	293 ^oK
Receptor height	5 meter (single story), and 20 meter (2 to 3 story)
Urban/rural option	Both
Building downwash	6.5 meter high, 8.5 meter × 11 meter horizontal
Terrain	Not considered

Meteorology	Full (All stabilities and wind speeds)

Dispersion Modeling Results

Table 5 shows that the SQER applicability limitation for TWC-equipped rich-burn gas-powered engines is dictated by both butadiene and nitric oxide. Under Chapter 173-460 WAC, butadiene is a Class A TAP, and nitric oxide is a Class B TAP. As a Class A TAP, butadiene's annual impact is averaged over only the 500 hour per year operating limit. As a Class B TAP, nitric oxide's impact is a 24-hour average. This minimizes the modeled butadiene impact relative to that of nitric oxide sufficiently that the nitric oxide impact dominates in determining minimum stack heights and engine setback[21].

Nitric Oxide (NO)

NO is a member of the family of nitrogen oxides (NO_X) formed during combustion processes. In the presence of sufficient oxygen and high temperature, NO will convert rapidly to nitrogen dioxide (NO_2). However, ICI exhaust is at high temperatures for only a fraction of a second. For all practical purposes, all the nitrogen oxide leaving the exhaust stack is in the form of NO. Since the exhaust cools very rapidly on exposure to ambient air, the NO is effectively "frozen." The NO will react with ambient oxygen (O_2) relatively slowly. If there is no ozone (O_3) in the ambient air, it will take a day or two for half the NO from the diesel exhaust to convert to NO_2. However, ambient air always has some ozone.

Ozone and NO react very rapidly at ambient temperatures. Although the ambient ozone concentration varies with location, time of day, and time of year, ozone monitors in Washington indicate that 40 parts per billion (ppb) is a typical background level. In the presence of 40 ppb ozone at ambient temperatures, it takes about 40 seconds to convert half the NO from the diesel exhaust to NO_2[22]. In addition to the effect of this NO-ozone reaction, the NO concentration in the exhaust plume decreases by dispersion to below the ASIL in 2 to 30 seconds for engines up to 2000 BHP. Because the NO-ozone reaction time and the dispersion time are of similar magnitude, both must be considered in estimating the NO air quality impact.

Assuming the exhaust plume drifts from the stack at 10 miles per hour, Figure 1 shows the extinction of NO by conversion to NO_2 due to reaction with ambient ozone.

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[21] In the worst case in this analysis, the butadiene impact does not exceed about 60% of the ASIL. Whereas, the stack heights and engine setbacks in Table 9 are all based on the point at which NO concentrations hit the ASIL.

[22] Ratio of the concentration of NO at times 1 and 2)

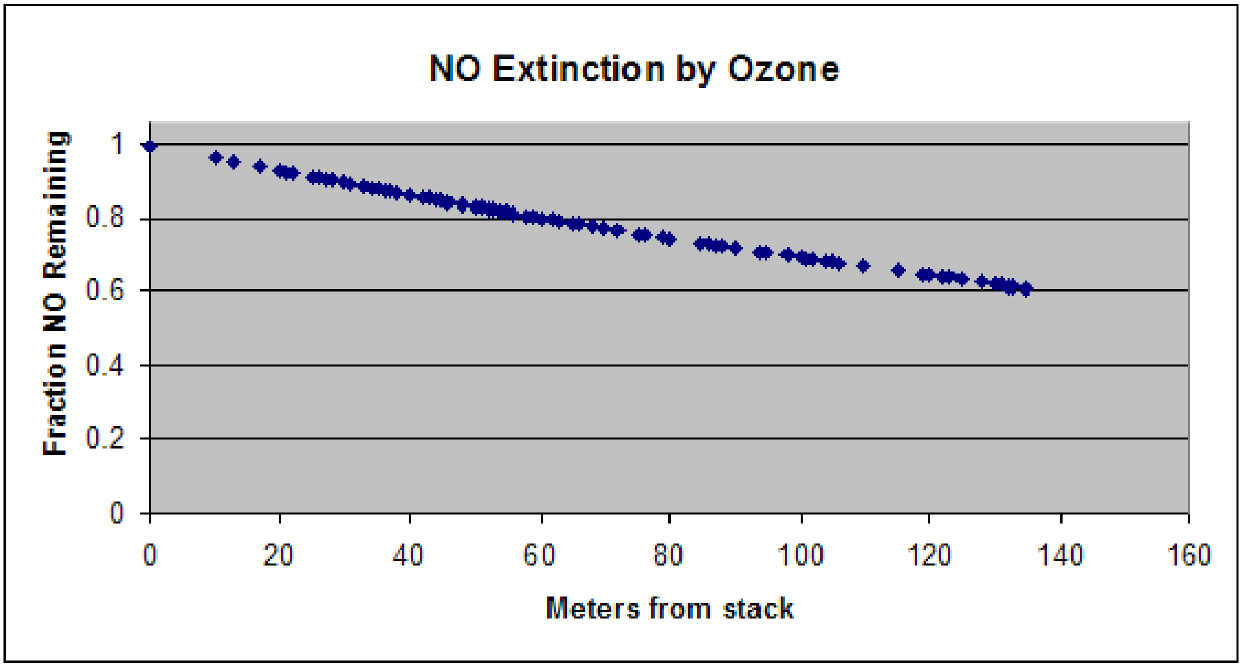
$= \exp[-9.64\times 10^{9} \times (\text{ambient ozone concentration}) \times (\text{time 2 - time 1})]$

Time in seconds, ozone concentration in gram-moles per cubic centimeter

(40 ppb ozone = 1.7×10^{-12} gram-moles per cubic centimeter)

"Kinetics of the Reaction Between NO and O_2," Descriptive Chemistry of Nitrogen in an Environmental Context, Bruner, et al., Department of Chemistry and Biology, University of California at San Diego (1997)

Figure 1



Using SCREEN3 and the NO extinction rate from Figure 1, Ecology estimated NO concentrations at one story, two story, and higher levels for rich-burn, TWC-equipped, gas-powered engines up to 100 BHP. The general SCREEN3 input variables are shown in Table 8. The results relative to stack height minima and engine distances from public-access are shown in Table 9.

Table 9: Emergency Rich-burn, Natural Gas-fired Generator Placement, Small Engines with Stack Height Less Than 10 Feet Above Roofline

Engine BHP	Exhaust stack height above housing or adjacent building roofline	Minimum from property line (feet)	Minimum distance from nearest single story building (feet)	Minimum distance from nearest building two stories or greater in height (feet)
Rural Environment				
≤ 25	3 feet	Zero	Zero	Zero
	4.5 feet	Zero	Zero	Zero
	6 feet	Zero	Zero	Zero
	10 feet	Zero	Zero	Zero
> 25 to 50	3 feet	Zero	75	75
	6 feet	Zero	Zero	Zero
	10 feet	Zero	Zero	Zero
> 50 to	3 feet	Zero	95	280

Engine BHP	Exhaust stack height above housing or adjacent building roofline	Minimum from property line (feet)	Minimum distance from nearest single story building (feet)	Minimum distance from nearest building two stories or greater in height (feet)
100	6 feet	Zero	Zero	184
	10 feet	Zero	Zero	Zero
Urban Environment				
≤ 25	3 feet	Zero	Zero	Zero
	4.5 feet	Zero	Zero	Zero
	6 feet	Zero	Zero	Zero
	10 feet	Zero	Zero	Zero
> 25 to 50	3 feet	Zero	Zero	Zero
	6 feet	Zero	Zero	Zero
	10 feet	Zero	Zero	Zero
> 50 to 100	6 feet	Zero	Zero	145
	10 feet	Zero	Zero	Zero

6. REGULATORY REQUIREMENTS

There are a number of regulations that apply to the installation and operation of the emergency generators proposed for coverage under this General Order of Approval. The following is a listing of those requirements. Some of these requirements result in notification, monitoring, and reporting requirements. There are also requirements related to periodic payment of fees and reporting of emissions. Ecology recommends that these requirements be included in the text of the General Order of Approval so the applicant understands what is expected once coverage is granted.

Washington State Law

Title 70 RCW, Chapter 70.94, "Washington Clean Air Act"

- 70.94.152 (3) requires that any order that is adopted under this chapter shall be in accord with this chapter, or the applicable ordinances, resolutions, rules, and regulations adopted under this chapter.
- 70.94.152 (7) requires that any features, machines, or devices that are the subject of an order shall be maintained and operated in good working order.
- 70.94.152 (10) requires that any notice of construction approval issued under (3) above shall include a determination that the source will achieve best available control technology (BACT).

Washington State Regulations

- WAC 173-400-99 through 104, these sections deal with the source registration program. Section 100 defines which facilities are subject to the registration program and payment of periodic registration fees.
- WAC 173-400-105, Subsection (1) relates to submittal of annual emission inventory information. Subsection (2) relates to the ability of Ecology to request emissions testing. Subsection (3) relates to site access by agency personnel at reasonable times to ascertain compliance or investigate complaints.
- Under WAC 173-400-110, Subsection (5) (d) Exemption threshold table for criteria pollutants (See Table 4).
- Chapter 173-460 WAC "New Sources of Toxic Air Pollutants" does not allow facilities discharging toxics listed under WAC 173-460-150 and WAC 173-460-160 to be exempt from new source review.
  WAC 173-460-080(2)(e): Small Quantity Emission Rate (SQER) Tables: This rule allows an applicant for a proposed TAP emissions source to avoid a second tier risk analysis without first doing a modeling dispersion analysis if all TAPs emission rates are less than those shown under WAC 173-460-080(2)(e).

Federal Regulations

- 40 CFR 63.6645(d), Initial notification requirements for Reciprocating Internal Combustion Engines: Diesel-driven emergency generator sets greater than or equal to 500 BHP that are installed in or would cause the stationary source to become a major source of hazardous air pollutants must provide initial notification of installation to the permitting agency.

7. Conclusions

Generator set placement and size

1. Lean-burn, gas-powered engines will have to be permitted via the normal new source review process. This is because several TAP emission levels preclude exemption from dispersion modeling except for a narrow range of engine sizes that may not even be available.

2. Rich-burn, gas-powered engines equipped with three-way catalytic (TWC) mufflers and used not more than 500 hours per year may be permitted under the general order associated with this technical document up to 857 BHP. However, they must have exhaust stacks not less than ten feet higher than the roof line of the adjacent or enclosure building.

3. Rich burn, gas-powered engines up to 100 BHP and equipped with TWC mufflers may be permitted under this general order with shorter stacks. Some sizes will have to be set back from the nearest publicly-accessible building. See Table 9.

Other Approval Conditions

- Opacity from the exhaust stack shall not exceed 10% when averaged over 6-minutes. This shall be measured using Method 9 and a correspondingly certified opacity reader when required by Ecology. Ecology expects this will occur as a result of complaints, visibility observations, or compliance questions.

- The permittee is to follow all recommended operation and equipment maintenance provisions supplied by the manufacturer of the generator set.
- Periodic emissions inventory information and other information may be requested by the Ecology. Information requested by Ecology shall be submitted within 30 days of receiving the request unless otherwise specified in the request. Ecology will supply the necessary forms to use for the periodic emission inventory.
- The applicant will pay the required annual/periodic registration or air operating permit fees within 30 days of receipt of the invoice from Ecology.
- Access to the source for the purpose of determining compliance with the terms of this General Order of Approval by Ecology staff shall be permitted during normal business hours. Failure to allow such access is grounds for an enforcement action under the Washington State Clean Air Act.
- The generator set shall be installed and operated shall be the same as described in the application.
- The provisions of this General Order of Approval are severable and, if any provision of this authorization, or application of any provisions of this authorization to any circumstance, is held invalid, the application of such provision to their circumstances, and the remainder of this authorization, shall not be affected thereby.
- The applicant is required to comply with applicable rules and regulations pertaining to air quality, and conditions of operation imposed upon issuance of this order. Any violation of applicable state and/or federal air quality rules and regulations or of the terms of this approval shall be subject to the sanctions provided in Chapter 70.94 RCW. Authorization under this Order may be modified, suspended, or revoked in whole or part for cause including, but not limited to, the following:
    - Violation of any terms or conditions of this authorization;
    - Obtaining this authorization by misrepresentation or failure to disclose fully all relevant facts.

8. ABBREVIATIONS AND ACRONYMS

AAQS	Ambient Air Quality Standards
Ar	Arsenic
ASIL	acceptable source impact level
BACT	Best Available Control Technology
BHP	brake horsepower
BHP-hr	brake horsepower-hour
CFR	Code of Federal Regulations
CI	compression ignition
CO	carbon monoxide
Cr VI	hexavalent chromium
Ecology	Washington State Department of Ecology
EPA	United States Environmental Protection Agency
ºF	degrees Fahrenheit
ft	feet
g	grams

HHV	higher heat value
hr/yr	hours per year
ICE	internal combustion engine
^oK	degrees Kelvin
kw	kilowatt
lb/MMBtu	pounds per million British thermal units
m	meter(s)
MW	megawatt
NA	Naturally aspirated
NAAQS	National Ambient Air Quality Standards
NMHC	non-methane hydrocarbon(s)
NO	nitric oxide
NOC	Notice of Construction
NO_X	oxides of nitrogen
NSPS	New Source Performance Standard
O_3	ozone
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 micrometers or less
PSD	Prevention of Significant Deterioration
psig	pounds per square inch gage (above ambient pressure)
SCR	Selective Catalytic Reduction
SO_2	sulfur dioxide
SO_X	sulfur oxides (SO_2, SO_3, and H_2SO_4)
SQER	small quantity emission rate
SI	Spark ignition
TA	Turbocharger aspirated
TAP(s)	toxic air pollutants as defined in Chapter 173-460 WAC
VOC	volatile organic compound
WAC	Washington Administrative Code
%	percent
ppb	parts per billion
ppmdv	parts per million, dry volume
ppmw	parts per million by weight
sec	second
µg (pollutant)/m^3	micrograms (pollutant) per cubic meter