WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

SUITABILITY OF DIESEL-POWERED EMERGENCY GENERATORS FOR AIR QUALITY GENERAL ORDER OF APPROVAL: EVALUATION OF CONTROL TECHNOLOGY, AMBIENT IMPACTS, AND POTENTIAL APPROVAL CRITERIA

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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	Low-sulfur content, off-road quality fuel: Not greater than 500 parts sulfur per million by weight (ppmw).
Generator set size	Not greater than 530 brake horsepower (BHP) engine
Diesel engine qualifications	Certified by manufacturer to meet the Tier II standards of 40 CFR Part 60 Subpart IIII (as proposed July, 2005)
Location 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 under 100 BHP may use a shorter stack with location restrictions shown in Table 13.
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.

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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 diesel-powered emergency generators. In addition, a list of minimum requirements or applicability criteria will be developed to identify diesel-powered emergency generators that would qualify for coverage under the General Order of Approval.

This General Order of Approval will be required of any diesel-driven 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.

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 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 a facility to become subject to the Air Operating Permit program or be subject to Prevention of Significant Deterioration (PSD) permitting. However, the facility may be an existing Title V or PSD source.
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. Under the proposed federal New Source

[1] Federal Register: July 11, 2005 (Volume 70, Number 131)], Proposed Rules, Page 39869-39904

Performance Standard, 40 CFR Part 60, Subpart IIII, required testing of such units is limited to 30 hours per year, and owners and operators are required to keep records of this information. In routine permitting, Ecology generally limits operation of an emergency generator to not more than 500 hours in any calendar year.

Emissions

Diesel-fired compression-ignition ICE will emit a variety of air pollutants. The primary criteria pollutants[2] are nitrogen oxides (NO_X), sulfur dioxide (SO_2), carbon monoxide (CO), particulate matter (PM and PM_{10}[3]), and volatile organic compounds[4] (VOCs, also called nonmethane hydrocarbons, NMHC). Diesel-fired engines also emit various toxic air pollutants (TAPs). In addition to nitric oxide, the primary TAPs emitted by diesel engines are listed in Table 10.

At the time of writing of this document, the EPA is finalizing the new source performance standard (NSPS) for diesel-fired compression-ignition ICEs. When finalized, the new rule (40 CFR Part 60 Subpart IIII) will specify the maximum allowable emissions of CO, NO_X plus NMHC, and PM (which includes PM_{10}) for diesel-fired compression-ignition ICEs. Over several years, the rule progressively reduces allowable emissions of these air pollutants from new engines in stages called "Tiers." The standards are engine-based pollution emission controls. Depending on engine size, the emission standards are applied as

- Tier I: Engines built between 1996 and 2005.
- Tier II: Engines built between 2003 and 2006.
- Tier III: Engines built between 2006 and 2008.

Tier II requirements for all engine sizes and Tier III requirements for engines greater than or equal to 175 BHP up to less than 750 BHP take effect not later than this year. In addition, Subpart IIII will require use of non-road specification fuel, that is, fuel containing not more than 500 parts per million sulfur by weight (0.05 weight percent sulfur content)[5]. Because the Tier II and some Tier III NSPS will go into effect this year, Ecology considers this to be the "base case" for establishing emission factors of the primary criteria pollutants.

The criteria pollutant emission factors are shown in Table 4. TAP emission factors are shown in Table 10. Nitric oxide was assumed to be 100 molar percent of the nitrogen oxides at the stack. For engines over 500 BHP, formaldehyde emissions are established at the reciprocating internal combustion engine standard 40 CFR Part 63 Subpart ZZZZ (350 parts per billion, dry basis). The remaining TAPs emission factors are taken from EPA's AP-42[6].

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[2] Several other so-called criteria pollutants are listed under the National Ambient Air Quality Standards. However, none of these are known to be emitted by diesel-powered engines in measurable quantities for the engine sizes subject to consideration for this general order.

[3] Particulate matter less than 10 microns in aerodynamic diameter.

[4] Volatile organic compounds are the surrogate family of air pollutants used to determine an emission unit's impact on ambient ozone concentrations.

[5] 40 CFR 80.510(a)(1)

[6] EPA AP-42, "Stationary Internal Combustion Sources," Chapter 3.3 (Gasoline and Diesel Industrial Engines), Table 3.3-2 for engines up to 600 BHP, Chapter 3.4 (Large Stationary Diesel and All Stationary Dual-fuel Engines) Tables 3.4-3 and 3.4-4 for engines over 600 BHP (October, 1996)

Basis for Requiring Permit

Under 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 2.

Table 2: Exemption Levels, New Source Review (WAC 173-400-110)

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

If the NAAQS pollutants were the only ones emitted by diesel-powered engines, emergency generator sets operating less than 500 hours per year would be exempted[7] from Washington's new source review process unless they exceeded 875 BHP (See Table 4). However, as noted previously, diesel-fired ICEs also emit TAPs listed in Chapter 173-460 WAC. Proposed sources of TAPs listed in Chapter 173-460 WAC are required to undergo new source review. There are no diminis levels for these TAPs. Consequently, a Notice of Construction approval is required for installation of diesel-powered generators.

4. Best Available Control Technology

State law and rule[8] 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

[7] Because the exemption is based a limitation on annual hours of operation, diesel-driven emergency generator sets above about 875 BHP would have to request and receive a voluntary regulatory order to limit emissions issued under WAC 173-400-091.

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

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 several of the available emission control options available as add-on emission control technologies as part of our process to determine what BACT should be.

BACT for NO_X, CO, VOCs, and $PM/PM_{10}/PM_{2.5}$

EPA expects the final 40 CFR 60 Subpart IIII NSPS to go into effect in 2006. Ecology considers this to be the "base case" for the Best Available Control Technology (BACT) analysis for NO_X, CO, VOCs, and PM/PM_{10}. The South Coast Air Quality Management District came to the same conclusion after their extensive analysis performed in 2002[9].

Beyond the "base case" emission limits of the proposed NSPS, there are several existing and anticipated emission control systems for diesel-fired CI-ICEs. Several of these are promising, and even expected to be mechanisms by which engine manufacturers can comply with Tier IV emission control requirements under the NSPS. However, all of them fail the test for selection as BACT because they are either not sufficiently demonstrated in practice, not commercially available, or are unjustifiably costly for an emergency generator.

- Not yet commercially available or adequately demonstrated in practice: EPA reasonably concludes that control technologies that are specifically designed for stationary ICEs will not be commercialized until related emissions levels are required under regulation. EPA also realizes that it will take several years advance notice to manufacturers to allow time to design and implement engine modifications to accommodate advanced emission controls. EPA anticipates that several of the following emission control technologies will become commercially available as a result of implementation of Tier IV requirements under Subpart IIII[10]. Because most of these are multi-pollutant reduction systems, the following discussion will not itemize them by targeted pollutant. The potential pollutant reduction levels described are based on pre-Tier I emissions.
    - Catalyzed Diesel Particulate Filter: Requires fuel with less than 30 ppm sulfur content and an electronic fuel control system. Traps and catalytically burns emission particulate at an operating temperature above 482 °F. Ninety percent reduction of PM, CO, and NMHC.
    - Lubrizol Purifilter: Requires fuel with less than 15 ppm sulfur content (ultra-low sulfur). Traps and catalytically burns emission particulate at an operating

[9] Preliminary Draft Staff Report for Proposed Amended Best Available Control Technology (BACT) Guidelines, Part D- Non-Major Polluting Facilities, Regarding Emergency Compression Ignition (Diesel) Engines, South Coast Air Quality Management District, Los Angeles, California (July, 2002)

[10] Documents associated with development and comment collection for 40 CFR Part 60 Subpart IIII, Docket ID No. OAR-2005-0029.

temperature above 536 ^{o}F. Requires periodic shutdown and cleaning of filter. Ninety percent reduction of CO, and NMHC. Eighty-five percent reduction of PM. Five to 10 percent increase in NO_X emissions.

  - <u>NO_X adsorber</u>: Precious metal catalyst on a ceramic matrix converts NO_X to nitrates. The nitrates are adsorbed on the ceramic, and periodically reduced to nitrogen by a momentary switch to a fuel-rich environment. Ninety percent reduction of NO_X, NMHC, and CO. Ten to 30 percent reduction of PM.
  - <u>EM_X</u>^{TM} (formerly $SCONO_X$^{TM}): Potassium carbonate and noble metal catalyst are coated on a ceramic matrix. NO_X reacts with the potassium carbonate in situ to form potassium nitrate. CO and NHMC are catalytically oxidized by the noble metal catalyst. When all the potassium carbonate is converted, exhaust gas flow is switched to an active module while the potassium nitrate in the "spent" module is converted back to potassium carbonate by contact with hydrogen. The nitrate is reduced and released to atmosphere as nitrogen. Operates between 300 and 700 ^{o}F. Relatively mechanized system compared to other control technologies. NO_X, CO, and NMHC reduction expected to be up to 95%. In various cost comparisons, has been much more expensive than competing technologies. Advertised as commercially available for diesel-fired ICEs, but no units yet in commercial operation.
  - <u>Ozone injection</u>: Ozone oxidizes NO_X to water soluble nitrous pentoxide which is removed via a scrubber. Must operate below 350 ^{o}F. Eighty to 85 percent NO_X reduction.
  - Systems that might be adaptable from mobile engine emission control technology:
    - <u>Donaldson diesel particulate muffler systems</u>: Requires ultra-low sulfur fuel. Up to 34% PM reduction. Up to 50% CO and NMHC reduction.
    - <u>Cleaire Flash and Catch</u>: Recalibrated fuel injection with a diesel particulate filter. Eighty-five percent reduction of PM. Ninety percent reduction of CO and NMHC. Twenty percent reduction of NO_X.
    - <u>Fuel Borne and Diesel Oxidation Catalyst</u>: Requires ultra-low sulfur fuel. Fifty percent reduction of PM (compared to using low-sulfur fuel). Sixty percent reduction of CO and NMHC. Seven percent reduction of NO_X.
    - <u>Platinum Plus Purifier</u>: Requires ultra-low sulfur fuel, fuel reformulation, and platimum-based catalytic muffler. Fifty percent reduction of PM, CO and NMHC. Twenty-five percent reduction of NO_X.
    - <u>Catalyzed Converter/Muffler</u>: Oxidation catalyst muffler. Twenty percent reduction of PM and CO. Forty percent reduction of NMHC.

  Application of these systems would require various design modifications to the stationary engine that are not currently commercial available.

- <u>Ecology concludes that the following are unjustifiably costly for an emergency generator set</u>:
  - <u>Noble metal coated, honeycomb ceramic oxidation catalyst/filter</u>: Ultra-low sulfur fuel recommended. Eighty-five percent reduction of PM. Ninety-five percent reduction of CO. Ninety percent reduction of NMHC. Ten to 20 percent increase in NO_X. Overall BACT cost $25,000 per ton pollutant reduction to $8,000/ton for engine sizes ranging from 100 BHP to 2000 BHP diesel-driven emergency generator sets, respectively.

- Selective Catalytic Reduction (SCR): Low-sulfur fuel required. Urea or ammonia injected into exhaust prior to contact with non-noble metal catalyst (ususlly vanadium-based). NO_X is reduced to nitrogen. Must use stoichiometrically excess ammonia (i.e., excess ammonia is expelled in exhaust). Four percent fuel penalty. Fifty to 90 percent NO_X reduction. Overall BACT cost $47,000 per ton pollutant reduction to $16,000/ton for engine sizes ranging from 100 BHP to 2000 BHP diesel-driven emergency generator sets, respectively.
- Combustion catalyst: Ultra-low sulfur fuel required. CO and NMHC oxidized over noble metal catalyst on a ceramic matrix. Ninety percent CO and NMHC reduction. Overall BACT cost $25,000 per ton pollutant reduction to $7,500/ton for engine sizes ranging from 100 BHP to 2000 BHP diesel-driven emergency generator sets, respectively.

Ecology concludes that BACT for diesel-driven emergency generators for NO_X, CO, VOCs, and $PM/PM_{10}/PM_{2.5}$ emissions is compliance with the NSPS standards in 40 CFR Part 60 Subpart IIII (as proposed July, 2005).

Table 3: BACT for Diesel-Driven Emergency Generators for NO_X, CO, Vocs, and $PM/PM_{10}/PM_{2.5}$ Emissions

Engine Power		Tier	Engine model year effective	Carbon monoxide grams per BHP per hr	Non-methane hydro-carbons plus nitrogen oxides grams per BHP per hr	Particulate matter grams per BHP per hr
Brake horsepower (BHP)	Kilowatts					
Less than 11	Less than 8	Tier 2	2005 and after	6.0	5.6	0.6
25 to less than 25	8 to less than 19	Tier 2	2005 and after	4.9	5.6	0.6
25 to less than 50	19 to less than 37	Tier 2	2004 and after	4.1	5.6	0.45
50 to less than 100	37 to less than 75	Tier 2	2004 through 2007	3.7	5.6	0.3
		Tier 3	2008 and after	3.7	3.5	0.3
100 to less than 175	75 to less than 130	Tier 2	2003 through 2006	3.7	4.9	0.22
		Tier 3	2007 and after	3.7	3.0	0.22
175 to less than 300	130 to less than 225	Tier 2	2003 through 2005	2.6	4.9	0.15
		Tier 3	2006 and	2.6	3.0	0.15

			after			
300 to less than 600	225 to less than 450	Tier 3	2006 and after	2.6	3.0	0.15

BACT for Sulfur Oxides (SO_2, SO_3 and H_2SO_4 mist)

Sulfur in diesel fuel oxidizes during combustion to sulfur dioxide (SO_2) and sulfur trioxide (SO_3). In the presence of water vapor, these will hydrolyze to sulfuric acid mist (H_2SO_4). Beginning in 2006, ultra-low sulfur diesel will be widely available in the United States. Whereas low-sulfur diesel has a maximum sulfur content of 500 ppmw, ultra-low sulfur diesel is limited to 15 ppmw. The anticipated price premium for the reduction in sulfur content is five to ten cents per gallon[11]. This translates to an annualized cost of $15,000 to $30,000 per ton sulfur reduced. Ecology believes this is unjustifiably costly. Ecology knows of no other technically feasibly and economically justifiable sulfur oxide reduction methods for diesel-powered IC engines. **Ecology concludes that use of diesel fuel with not greater than a 500 ppmw sulfur content is BACT for diesel-powered emergency generators.** If finalized in its present form, this limit will be imposed on all new diesel-powered ICEs by 40 CFR Part 60 Subpart IIII through September 30, 2010. Beginning on October 1, 2010, 40 CFR Part 60 Subpart IIII will require that all new diesel-powered ICEs use ultra-low sulfur fuel.

Based on Subpart IIII standards, using low sulfur fuel, and 500 hour per year limit, the potential-to-emit of the air pollutants subject to regulation under the NAAQS is shown in Table 4 for diesel-driven generator sets from 11 BHP to 6,900 BHP capacity.

[11] Ibid., 40 CFR Part 60 Subpart IIII, Docket ID No. OAR-2005-0029

Table 4: NAAQS Pollutant Emissions from Diesel Engines

Emissions of Pollutants Subject to National Ambient Air Quality Standards from Emergency, Diesel-powered Generators: Tier II Compliant, 500 hour per year maximum operation									
Generator set Capacity: Electrical output capacity and diesel engine power capacity	**Sulfur Dioxide (low sulfur fuel) tons per year @ top of range**	**Carbon Monoxide**		**Nitrogen Oxides (NO_X) plus Non-methane Hydrocarbons (NMHC)**		**NO_X (tons per year)**	**NMHC (tons per year)**	**Particulate Matter**	
		Year 2006 40 CFR 60 Sub-part IIII (grams per BHP-hr)	**tons per year @ top of range**	**Year 2006 40 CFR 60 Sub-part IIII (grams per BHP-hr)**	**tons per year @ top of range**	**Estimated based on assumed 6.9:1 NO_X to NMHC ratio (Tier I)**		**Year 2006 40 CFR 60 Sub-part IIII (grams per BHP-hr)**	**tons per year @ top of range**
<8 kw <11 BHP	.0014	6.0	.036	5.6	.034	.03	.004	0.6	.0036
8 to <19 kw 11 to <25 BHP	.0031	4.9	.067	5.6	.077	.067	.01	0.6	.008
19 to <37 kw 25 to <50 BHP	.0057	4.1	.112	5.6	.154	.135	.019	0.45	.012
37 to <75 kw 50 to <100	.0094	3.7	.203	5.6	.308	.27	.038	0.3	.017
112.5 kw 150 BHP	.0138	3.7	.305	4.9	.404	.354	.06	0.22	.018
130 kw 175 BHP	.01645	2.6	.250	3.0	.289	.253	.036	0.15	.014
150 kw 200 BHP	.018	2.6	.286	3.0	.330	.288	.042	0.15	.017
225 kw 300 BHP	.026	2.6	.43	3.0	.495	.432	.063	0.15	.025
375 kw 500 BHP	.044	2.6	.716	3.0	.825	.720	.105	0.15	.041
559 kw	.067	2.6	1.085	3.0	1.236	1.078	.158	0.15	.062

Emissions of Pollutants Subject to National Ambient Air Quality Standards from Emergency, Diesel-powered Generators: Tier II Compliant, 500 hour per year maximum operation									
Generator set Capacity: **Electrical output capacity and diesel engine power capacity**	**Sulfur Dioxide** **(low sulfur fuel)** **tons per year @ top of range**	**Carbon Monoxide**		**Nitrogen Oxides (NO_X) plus Non-methane Hydrocarbons (NMHC)**		**NO_X** **(tons per year)**	**NMHC** **(tons per year)**	**Particulate Matter**	
		Year 2006 40 CFR 60 Sub-part IIII (grams per BHP-hr)	**tons per year @ top of range**	**Year 2006 40 CFR 60 Sub-part IIII (grams per BHP-hr)**	**tons per year @ top of range**	**Estimated based on assumed 6.9:1 NO_X to NMHC ratio (Tier I)**		**Year 2006 40 CFR 60 Sub-part IIII (grams per BHP-hr)**	**tons per year @ top of range**
749 BHP									
656 kw 875 BHP	.077	2.6	1.25	4.8	2.31	2.0	0.31	0.15	.072
750 kw 1000 BHP	.088	2.6	1.432	4.8	2.64	2.31	.33	0.15	.083
1.5 MW 2000 BHP	.176	2.6	2.86	4.8	5.29	4.62	.67	0.15	.165
5.2 MW 6,900 BHP	0.61	2.6	9.98	4.8	18.25	16.0	2.25	0.15	.637

BACT for Toxic Air Pollutants

Nitric oxide is a component of NO_X. 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.

There are no add-on technologies technically feasible or demonstrated or commercially available for reduction of organic TAPs emissions from diesel-powered generators. Technologies that will be required under 40 CFR Subpart IIII, Tier IV that are intended to reduce particulate emissions are likely to collaterally reduce some of the TAPs. However, there is no documentation to quantify this expectation. Currently available add-on technology for CO emissions reduction might reduce some of the organic TAPs, especially the ones having relatively lower molecular weights, such as formaldehyde and acetaldehyde. However, even if all the organic TAPs could be 100% reduced (15 pounds per year, see Table 10), the effectiveness cost would be about $2.9 million per ton. Ecology considers this to be economically unjustifiable.

40 CFR Part 63 Subpart ZZZZ is already in effect. Subpart ZZZZ requires stationary internal combustion engines larger than 500 BHPO to emit formaldehyde at not greater than 350 parts per billion (dry basis). Ecology concludes that BACT for non-nitric oxide TAPs (T-BACT) is no control except for formaldehyde emissions from engines over 500 BHP. For engines over 500 BHP, T-BACT for formaldehyde is compliance with 40 CFR Part 63 Subpart ZZZZ. T-BACT for nitric oxide is compliance with NO_X emission standards in 40 CFR 60 Subpart IIII, as-proposed in 2005 (Table 3).

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.

The federal government has established National Ambient Air Quality Standards 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.

Dispersion Model

Ecology used 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. Ecology compared the results of the model with the ambient standards to see if the project will cause or contribute to an exceedance of the standard.

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 National Ambient Air Quality Standards (NAAQS) and Washington State Ambient Air Quality Standards (AAQS) for Class II Areas are shown in Table 5.

Table 5: National Ambient Air Quality Standards

Pollutant	Averaging Time	National		Washington State AAQS
		Primary	Secondary	
Particulate	Annual	50 μg/m^3	50 μg/m^3	50 μg/m^3
	24-hr	150 μg/m^3	150 μg/m^3	150 μg/m^3
Sulfur Dioxide	Annual	0.03 ppm	----	0.02 ppm
	24-hr	0.14 ppm	----	0.10 ppm
	3-hr	----	0.50 ppm	----
	1-hr	----	----	0.40 ppm[12]
Carbon Monoxide	8-hr	9 ppm	9 ppm	9 ppm
	1-hr	35 ppm	35 ppm	35 ppm
Nitrogen Dioxide	Annual	0.05 ppm	0.05 ppm	0.05 ppm

The general SCREEN3 input variables are shown in Table 6 and Table 7.

Table 6: SCREEN3 Input Variables for Emergency Generator General Order Analysis

Variable	**Model Input**
Source type	Point
Emission rate	40 CFR part 60, Subpart IIII compliant: See Table 7.
Stack Height	25 BHP: 7.5, 8, 8.5, and 10 meters 50 BHP: 7.5, 8.5, and 10 meters 100 BHP: 8.5, and 10 meters > 100 BHP: 10 meters
Stack diameter	Sufficient to have the stack velocity at 44.6 meters per second for all engine sizes based on volumetric flow of 0.284 cubic meters per second per 100 BHP.
Stack velocity	44.6 meters per second
Stack temperature	See Table 7
Ambient temperature	293 ^{o}K
Receptor height	All pollutants: 1.7 meters (nose height) TAPs: 5 meter (single story), and 20 meter (2 to 3 story)
Urban/rural option	Rural
Building downwash	6.5 meter high, 8.5 meter × 11 meter horizontal
Terrain	Neither complex nor simple terrain considered
Meteorology	Full (All stabilities and wind speeds)

[12] 0.25 ppm not to be exceeded more than two times in any 7 consecutive days

Table 7: Engine Size-Dependent SCREEN3 Input Variables for Emergency Generator General Order Analysis

BHP	Subpart IIII g-NO_X per BHP-hr	Emission rate g-NO_X /sec	Stack height (m)	Stack diam. (m)	T_{stk} (°K)[13]
25	4.9	0.0340	7.5	0.045	528
25	4.9	0.0340	8	0.045	526
25	4.9	0.0340	8.5	0.045	524
25	4.9	0.0340	10	0.045	519
50	4.9	0.0681	7.5	0.064	568
50	4.9	0.0681	8.5	0.064	563
50	4.9	0.0681	10	0.064	556
100	4.3	0.1277	8.5	0.090	674
100	4.3	0.1277	10	0.090	670
150	4.3	0.1916	10	0.110	702
200	2.6	0.1444	10	0.127	734
300	2.6	0.217	10	0.156	799
500	2.6	0.361	10	0.201	897
6900	4.20	8.05	10	0.285	1100

Dispersion Modeling Results

NAAQS Pollutants

Under the Tier II standards proposed in Subpart IIII and using low sulfur fuel, PM_{10} is the first pollutant emission from diesel-driven generators to encroach on a NAAQS-related ambient impact limit as one considers progressively larger machines. It would take a diesel-fired, compression ignition (CI) emergency generator having as large as a 6,900 BHP engine, to emit enough PM_{10} to exhaust the 24-hour average allowable increment. This would be an unusually large emergency generator. Up to and including this size generator set, no pollutant will contribute to an exceedance of the NAAQS even when coupled with background concentrations. In other words, criteria pollutant emissions will not be the limiting factor in establishing qualifying terms for a general order for emergency generators, at least up to about 6,900 BHP. This agrees with the conclusion reached on emergency generator placement at the State Penitentiary in Walla Walla, Washington[14].

[13] Based on data from Caterpillar Detroit engines.
[14] Order No. 05AQ-E154, First Amendment; August 25, 2005

Table 8: Modeled Air Quality Impact 6,900 BHP Diesel-fired CI engine[15]

Pollutant		Air Quality Impact µg/m³	Significance Level* µg/m³	Allowable Increment Consumption µg/m³	Estimated Background Level** µg/m³	A/Q Impact plus Background µg/m³	NAAQS µg/m³
SO_2	3-hr avg.	19.5	25	512	11.25	31	1300
	24-hr avg.	8.7	5	91	5	13.7	365
	ann. avg.	0.1	1	20	1	1.1	80
PM_{10}	24-hr avg.	8	5	8	60	68	150
	ann. avg.	0.094	1	4	12	12.1	50
NO_X	ann. avg.	3.5	1	25	78	81.5	100

***** The EPA does not require a full air quality impact analysis for a particular pollutant when the emissions of that pollutant from a proposed source or modification would not increase ambient concentrations by more than the significant levels shown in this column.
** Background levels are estimated from Washington air quality monitorin data.

Toxic Air Pollutants

Diesel-fired emergency generators emit a variety of TAPs as products of partial combustion. In order to qualify for this general permit, emergency generators must be located such that their emissions do not cause an ambient TAP concentration increase in excess of any acceptable source impact level (ASIL)[16]. WAC 173-460-080 provides that this may be demonstrated in either of two ways:

- Ambient impact analysis (dispersion modeling).
- Small quantity emission rates (SQER): Instead of using dispersion modeling, a source may use the SQER tables (reproduced in Table 9, below) for TAPs with ASILs equal to or greater than 0.001 µg/m³.[17] 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.

[15] Stack height ten feet above the roof; adequate stack diameter to avoid excessive back pressure on the engine; rural conditions; building downwash included, 1.7 meter detector height; 500 hour per year operation limit, Tier II compliant, low-sulfur content (<500 ppm) fuel.
[16] 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."
[17] WAC 173-460-080(2)(e)

Table 9: Small Quantity Emission Rate Tables

Small Quantity Emission Rates Class A Toxic Air Pollutants (Tables 1, 2, and 3, WAC 173-460-150)		
ASIL (µg/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	
Small Quantity Emission Rates Class B Toxic Air Pollutants (WAC 173-460-160)		
ASIL (µg/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[18]. 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.

All the TAPs expected to be emitted from diesel-powered emergency generators (Table 10) qualify for application of the SQER tables except "polycyclic aromatic hydrocarbons (PAH)." PAHs have an ASIL that is too low to qualify for consideration under the SQER dispersion modeling exemption. All the other TAPs expected to be emitted from diesel-powered emergency generators are exempted from dispersion modeling by the SQER consideration up to 530 BHP engine size (Table 10). Above 530 BHP, nitric oxide emissions exceed the 2.0 pounds per hour SQER threshold.

[18] 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.

Table 10: TAPS, Diesel-powered emergency generator

TAP	Class	ASIL (µg/m³)	Emission Factor (Pounds per million British thermal units)†	Engine BHP⊥	Pounds per hour	SQER limit Pounds per hour	Pounds per year, 500 hour per year operating limit	SQER limit Pounds per year
Acetaldehyde	A	0.45	7.67E-04	600	.0035	N/A	1.8	50
			2.52E-05	2000	0.0004		0.2	
Acrolein	B	0.02	9.25E-05	600	0.0004	0.02	0.2	175
			7.88E-06	2000	0.0012		0.6	
Benzene	A	0.12	9.33E-04	600	0.004	0.02	2.1	175
			7.76E-04	2000	0.0118		5.9	
Butadiene	A	0.0036	<3.9E-05	2000	<.0006	N/A	<0.3	0.5
Formaldehyde	A	0.077	1.18E-03	500	0.0045	N/A	2.25	20
Formaldehyde	A	0.077	6.07E-04	2000	0.0092	N/A	4.6	20
Naphthalene	B	170	8.48E-05	600	0.0004	2.6	0.19	22,750
			1.6E-04	2000	0.0024		1.21	
Nitric oxide	B	100	0.926	100-	0.65	2.0	325	17,500
			0.810	175-	1.075		538	
			0.496	531	2.00		1000	
			0.496	750-	2.82		1,410	
			0.792	2000	12.0		6,000	
Toluene	B	400	4.09E-04	600	0.0019	5.0	0.9	43,748
			2.81E-04	2000	0.0043		0.7	
Xylene	B	1,500	2.85E-04	600	0.0013	2.0	2.2	43,748
			1.93E-04	2000	0.0029		1.5	
Total poly-cyclic aromatic hydrocarbons (PAH)▲	A	4.8E-04	3.4E-06	600	1.5E-05	N/A	0.008	N/A
			4.5E-06	2000	6.8E-05		0.033	
Benzo-pyrene	A	4.8E-04	<1.9 E-07	600	<8.4 E-07	N/A	<0.0004	N/A
			<2.6E-07	2000	<3.8 E-06		<0.0014	
Benz-anthracene	A	Not estab-lished (N/E)	1.68E-06	600	8.3E-06	N/E	0.0026	N/E
			6.22E-07	2000	9.2E-06		0.003	
Benzofluoro-anthenes	A	N/E	<2.5 E-07	600	<1.11 E-06	N/E	<0.0004	N/E
			1.33E-06	2000	2.0E-05		0.0069	

TAP	Class	ASIL ($\mu g/m^3$)	Emission Factor (Pounds per million British thermal units)┼	Engine BHP⊥	Pounds per hour	SQER limit	Pounds per year, 500 hour per year operating limit	SQER limit
						Pounds per hour		Pounds per year
Chrysene	A	N/E	<3.5 E-07	600	<5.2 E-06	N/E	<0.002	N/E
			1.53E-06	2000	2.3E-05		0.0087	
Dibenz-anthracene	A	N/E	<5.8E-07	600	<2.5 E-06	N/E	<0.0009	N/E
			<3.5E-07	2000	<5.1 E-06		<0.0018	
Indeno-pyrene	A	N/E	<3.8E-07	600	<1.7 E-06	N/E	<0.0006	N/E
			<4.1E-07	2000	<6.0 E-06		<0.0021	

⊥ 7,585 British thermal units per BHP-hr

┼ Emission factors for organic TAPs are from EPA's AP-42, Tables 3.3-2, 3.4-3, and 3.4-4 (October, 1996) except for formaldehyde from engines 500 BHP or greater. Stationary combustion engines over 500 BHP must follow the formaldehyde emission limit in 40 CFR 63 Subpart ZZZZ. The emission factor for nitric oxide is based on Tier II NO_X emission limits in 40 CFR 60 Subpart IIII assuming the NO_X to be 100 molar % nitric oxide at the stack exit.

▲ Subject to quantification under WAC 173-460-050(4)(c)

Because of the SQER exemption, air quality impact dispersion modeling for TAP impacts relative to preconstruction review and permitting can be limited to

- Engines greater than 530 BHP for nitric oxide air quality impacts.
- PAH air quality impacts.
- All TAPs for cases using less than 10 meter exhaust stack height.

Emergency Generator Size Limit

The analysis could continue beyond this 530 BHP, SQER exemption point to larger engine sizes. The analysis would attempt to determine appropriate distancing of the diesel 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 530 BHP. This is about enough power to generate electricity for over twenty homes or a typical commercial building having over 150,000 square feet.
    - In other words, 530 BHP should be sufficiently large to cover the field of "small" 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 diesel engines larger than 530 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 diesel-powered emergency generators that are 530 BHP or smaller.

Because PAHs are not exempted under the SQER consideration, dispersion modeling to determine the PAH air quality impact is mandatory. However, dispersion modeling of any sort for the other TAPs could be eliminated from consideration by simply mandating a 10 meter stack for all emergency generator sizes. Ecology believes that for the smallest emergency generators, this may be impractical, and against the interests of potential general permit applicants. 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.

Polycyclic Aromatic Hydrocarbons

Ecology ran SCREEN3 dispersion analyses for a variety of configurations to determine the air quality impact of PAH emissions from emergency generators. As noted earlier in Section 5, the base case parameters are shown in Table 6 and Table 7. In reality, any given engine may have a stack diameter, exhaust temperature, and downwash building height that differ from the base case. However, it appears that the only one of these variables that may cause modeled impacts to vary significantly form the base case is the downwash building height (at least up to 530 BHP).

Stack diameter and exhaust temperature are not likely to vary greatly from the base case. Engines must be designed with a sufficiently large exhaust port diameter to prevent significant back pressure. At the same time, an unnecessarily large exhaust port only adds cost to the engine's manufacture. Ecology found that exhaust port diameter was comparable from one manufacturer to another for the same engine sizes. Exhaust temperature will depend primarily on fuel consumption. Similar size engines use similar amounts of fuel, and will have similar exhaust temperatures. Ecology varied stack diameter ± 25% and stack temperature ± 50 ^{o}K and found less than a 25% change in modeled impact. The results of a variety of analyses over a range of downwash and receptor combinations are shown in Table 11. They show that modeled impacts do not exceed about 30% of the ASIL. So, the likely variations in stack diameter and temperature should not be sufficient to elevate impacts above the ASIL if superimposed on these results.

Table 11: Air Quality Impact for PAHs from a 530 BHP Diesel Engine

Environment	Receptor height	Downwash building height; except where indicated, stack is on and 10 feet above the downwash building.	Maximum PAH impact $\mu g/m^3$, ann. avg.
Urban	10 stories (46 meters)	10 stories (46 meters)	2E-05
	8 stories (36 m.)	10 stories	5.3E-07
	6 stories (27 m.)	10 stories	1.7E-07
	10 stories	8 stories (36 m.)	4.6E-05
	10 stories	6 stories (27 m.)	8.9E-05
	10 stories	4 stories (20 m.)	5.4 E-05
	6 stories (27 m.)	6 stories (27 m.)	2E-05
	4 stories (20 m.)	6 stories	8.5E-07
	6 stories (27 m.)	4 stories (20 m.)	5.6E-05
	6 stories (27 m.)	3 stories (15 m.)	4.8E-05
	6 stories (27 m.)	2 stories (10 m.)	1.3E-04
	6 stories (27 m.)	1 story (5 m.)	1.4E-04
	5 stories (23.5 m)	10 stories (46 m.)	<1E-06
	4 stories (20 m.)	4 stories	1.7E-05
	4 stories	2 stories	1.2E-04
	4 stories	**1 story**	**0.0026 max; 1.3E-04 @ 10 meters**
		4 stories; stack is on and 10 feet above the 1 story generator building	**6.6E-05**
	3 story (14 m.)	**1 story**	**0.0034 max; 1.45E-04 @ 27 meters**
		3 stories; stack is on and 10 feet above the 1 story generator building	**4.6E-05**
	2 stories (10 m.)	2 stories (10 m.)	2.6E-05
	2 stories	1 story	4.7E-05
	1 story (5 m.)	2 stories	6.9E-06
	1 story	1 story	8.2E-06
Rural	3 story (14 m.)	3 story (14 m.)	5.3E-05
	3 story	**2 stories (10 m.)**	**0.0015 max. 1.2E-04 @ 31 meters**
		3 stories; stack is on and 10 feet above the 2 story generator building	**9.1E-05**

Environment	Receptor height	Downwash building height; except where indicated, stack is on and 10 feet above the downwash building.	Maximum PAH impact µg/m^3, ann. avg.
	3 story	1 story (5 m.)	7.8E-05
	2 stories (10 m.)	3 story	2.4E-05
	2 story	2 stories (10 m.)	6.2E-05
	2 story	1 story (5 m.)	6.2E-05
	1 story (5 m.)	1 story (5 m.)	9.2E-06

Several of the entries (hi-lighted) in Table 11 deserve explanation. Whether a building near the emission source is to be considered as a downwash source is determined in SCREEN3 by the "area of influence (AOI)" rule. A nearby building will have a downwash effect if the emission source is within that building's AOI. The AOI is 5 times the lesser of height or the maximum width of the building. To illustrate, consider the example in the table where the receptor is 4 stories high and the generator building is one story high. SCREEN 3 predicts an ASIL exceedance at a 4 story receptor height. However, the impact is below the ASIL if the 4 story receptor is 10 meters horizontally away from the generator. Assuming the foot print of the receptor building is similar to the base-case generator building (11 meters), the AOI of the receptor building is 55 meters. Because the AOI of the receptor is greater than the "<ASIL" distance, the receptor building downwash will reduce the PAH impact. SCREEN3 does not have the capability of considering multiple downwash sources. However, the calculations procedures in SCREEN3 suggest that the tallest building with a relevant AOI will dominate the downwash effect[19]. Where this is meaningful, the results are shown in the hi-lighted entries in the table. The results in the table also show that whenever the downwash building is greater than or equal in height to the receptor, the impact at all levels is below the ASIL. Ecology concludes that PAH impacts will not exceed the ASIL in any configuration of receptor building and generator building heights.

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. Using SCREEN3 modeling, Ecology determined NO air quality impacts for various stack heights for smaller engines. The base case model input variables are shown in Table 12. NO extinction by reaction with ambient ozone following the discussion outlined in the Appendix was considered in these calculations. The results are shown in Table 13.

Table 12: Input Variables for Small Engine Stack Height Analysis

BHP	Subpart IIII g-NO_X per BHP-hr	Emission rate g-NO/sec	Stack height (m)	Stack diam. (m)	T_{stk} (^oK)[20]
25	4.9	0.0222	7.5	0.045	528
25	4.9	0.0222	8	0.045	526

[19] SCREEN3 Model User's Guide, EPA-454/B-95-004, Section 3.6 "Downwash Effect," page 48, Equation (9)
[20] Based on data from Caterpillar Detroit engines.

BHP	Subpart IIII g-NO_X per BHP-hr	Emission rate g-NO/sec	Stack height (m)	Stack diam. (m)	T_{stk} (^oK)[20]
25	4.9	0.0222	8.5	0.045	524
25	4.9	0.0222	10	0.045	519
50	4.9	0.0443	7.5	0.064	568
50	4.9	0.0443	8.5	0.064	563
50	4.9	0.0443	10	0.064	556
100	4.3	0.0778	8.5	0.090	674
100	4.3	0.0778	10	0.090	670

Table 13: Emergency 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	109	109
	4.5 feet	Zero	94	94
	6 feet	Zero	69	69
	10 feet	Zero	Zero	Zero
> 25 to 50	3 feet	Zero	148	352
	6 feet	Zero	110	401
	10 feet	Zero	Zero	Zero
> 50 to 100	6 feet	Zero	132	395
	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	79	79
	6 feet	Zero	Zero	Zero
	10 feet	Zero	Zero	Zero
> 50 to 100	6 feet	Zero	Zero	188
	10 feet	Zero	Zero	Zero

As can be seen in Table 13, when one cannot invoke the SQER exemption, one must consider the location of the generator relative to publicly-accessible locations.

The modeling procedure used to estimate the allowable relative generator and public-access locations (SCREEN3) gives different results depending upon whether the area is "urban" or "rural." These are somewhat qualitative distinctions. EPA guidance recommends assessing the urban vs. rural character of a location on either the basis of land-use or population density[21]. The land-use approach is the more complicated and more accurate. It involves an assessment of the degree and combination of industrial (heavy and light), commercial, and compact residential land-use. The population density approach requires knowledge of the average number of persons living within about 2 miles of the generator. If 24,000 persons or more live within 2 miles of the proposed generator, the location is urban. Otherwise, it is rural. Because the Ecology regional offices for which this general order is intended are not heavily industrial, and simplicity is at a premium, Ecology believes that the population density approach will adequately determine the urban-rural characterization.

Figure 1 shows the results of dispersion modeling for PAH air quality impacts from small diesel -powered engines at distances from the emergency generator where the nitric oxide impact is 100 $\mu g/m^3$ or less. In other words, as long as a small emergency generator is located far enough from a publicly-accessible location so that the nitric oxide air quality impact is below the ASIL, the PAH air quality impact will also be substantially below the ASIL.

Figure 1

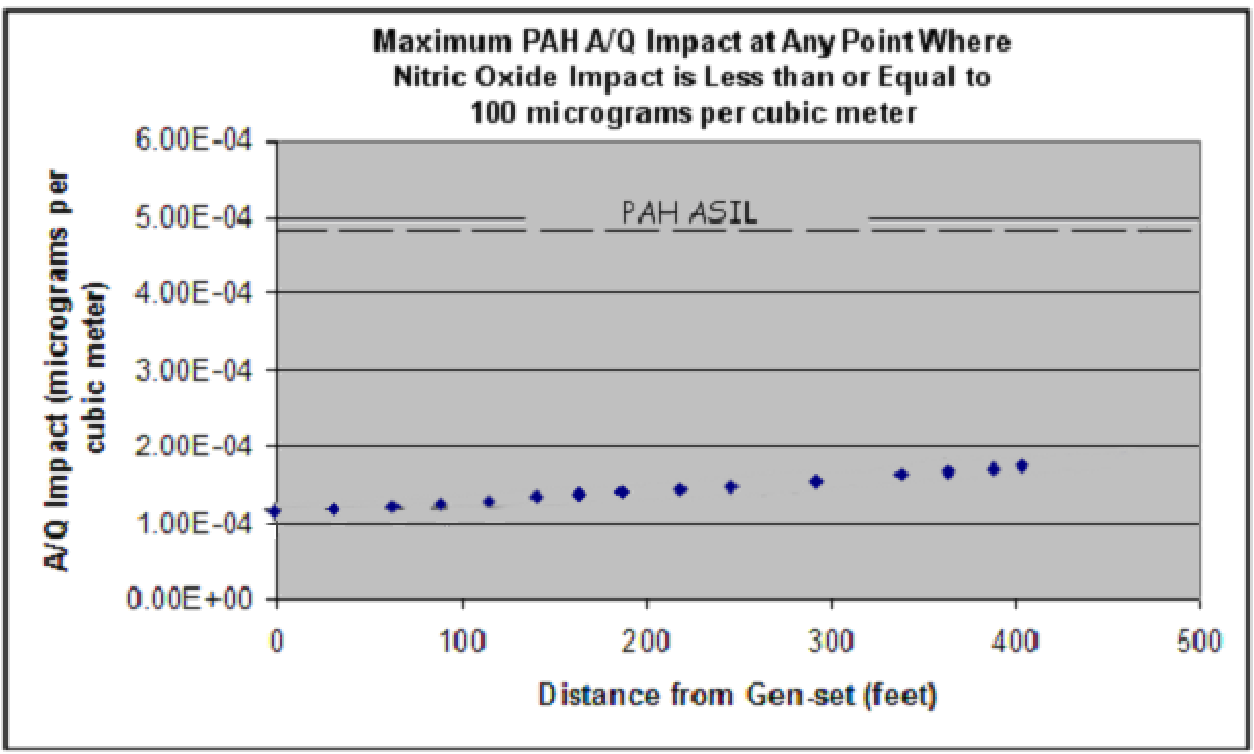

Figure 1 and Table 13 show that the highest non-nitric oxide impact for the small engines having less than a "standard" stack height will occur at 401 feet from the generator (50 BHP engine,

[21] 40 CFR Part 50, Appendix W, Section 8.2.3.

stack 6 feet above roofline, receptor at two story or higher building). At that point, the air quality impacts of the other diesel engine TAPS (PAH already having been considered in Figure 1) are shown in Table 14. None exceeds its ASIL.

Table 14: Non-PAH TAP Maximum Impacts for Non-Standard Stack Heights for Small Diesel-Powered Engines

TAP	ASIL ($\mu g/m^3$)	Maximum Impact ($\mu g/m^3$)	Ratio of Impact to ASIL
Acetaldehyde	0.45	0.025	5.6%
Acrolein	0.02	0.0155	77.5%
Benzene	0.12	0.031	25.8%
Butadiene	0.0036	0.0013	36.1%
Formaldehyde	0.077	0.039	60.6%
Naphthalene	170	0.0143	<1%
Toluene	400	0.0682	<1%
Xylene	1,500	0.0471	<1%

Because none of the TAPs exceed its ASIL at any point where the NO air quality impact is less than or equal to 100 $\mu g/m^3$, NO is the determining TAP relative to the generator placement. The generator placement requirements relative to publicly accessible locations are as shown in Table 13. The most dramatic restrictions are for rural locations. However, in practice there are likely to be many applications for generator installation in rural locations, such as farms and food storage locations that are sufficiently distant from publicly-accessible buildings. In urban locations, generators having a diesel engine smaller than 25 BHP may be installed with as little as a three foot stack above the roof. Applicants intending to install larger engines will have to comply with the indicated stack heights relative to the neighboring buildings or process their notice of construction applications through the non-general procedure.

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 2).
- 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.
- 40 CFR Part 60, Subpart IIII, Standards of Performance for Stationary Compression Ignition Internal Combustion Engines: Finalization of this federal rule appears to be imminent. Emissions standards, notification, monitoring, reporting and recording requirements in this general order will be consistent with this federal rule.

7. Conclusions

Generator set placement and size

As long as the diesel engine is equipped with a stack that extends ten feet above the roofline[22], emergency generators up to 530 BHP may be installed without consideration of location. If the notice of construction approval applicant wants to install a shorter stack for a smaller engine, he/she will have to comply with the location requirements in Table 13.

[22] Taken as functionally equivalent to a 10 meter stack for the SQER exemption.

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 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
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
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
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
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

APPENDIX: EMERGENCY GENERATORS LARGER THAN 530 BHP

The following analysis determines how far the engine must be from publicly-accessible locations for nitric oxide concentrations caused by the engine to decline below the ASIL.

NO is a member of the family of nitrogen oxides (NO_X) formed during combustion processes. Up to 530 BHP, all TAPs from a Subpart IIII compliant diesel-powered emergency generator are exempted from dispersion modeling except PAHs. The analysis described in the body of this technical document demonstrated that PAH air quality impact from the Subpart IIII compliant emergency generator will not exceed the ASIL anywhere for any reasonably expected receptor height at least up to 530 BHP. Above 530 BHP, however, NO air quality impacts can exceed the ASIL at reasonably expected receptor heights.

In the presence of sufficient oxygen and high temperature, NO will convert rapidly to nitrogen dioxide (NO_2). However, diesel exhaust is at high temperatures for only a fraction of a second. For all practical purposes, all the nitrogen oxides leaving the exhaust stack are 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[23]. In addition to the effect of this NO-ozone reaction, the NO concentration in the exhaust plume decreases by dispersion into the ambient atmosphere. In the range of wind speeds used in the SCREEN3 model, NO is diluted 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.

Using the recommended "full meteorology" option, SCREEN3 calculates the air quality impacts concurrent with a variety of wind speeds. The worst case result is reported for each distance from the stack, and the wind speed used may differ point-to-point. The wind speeds in analysis most frequently fell in the 7.5 to 11 mile per hour range. While SCREEN3 reports the magnitude and location of the pollutant air quality impact, it does not report the time it took the pollutant to get from the stack to that location. For the sake of simplicity in extending this analysis to include the extinction of NO by ambient ozone, Ecology assumed the exhaust plume drifts from the stack at 10 miles per hour[24]. Figure 2 shows the extinction of NO by conversion to NO_2 due to reaction with ambient ozone.

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

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

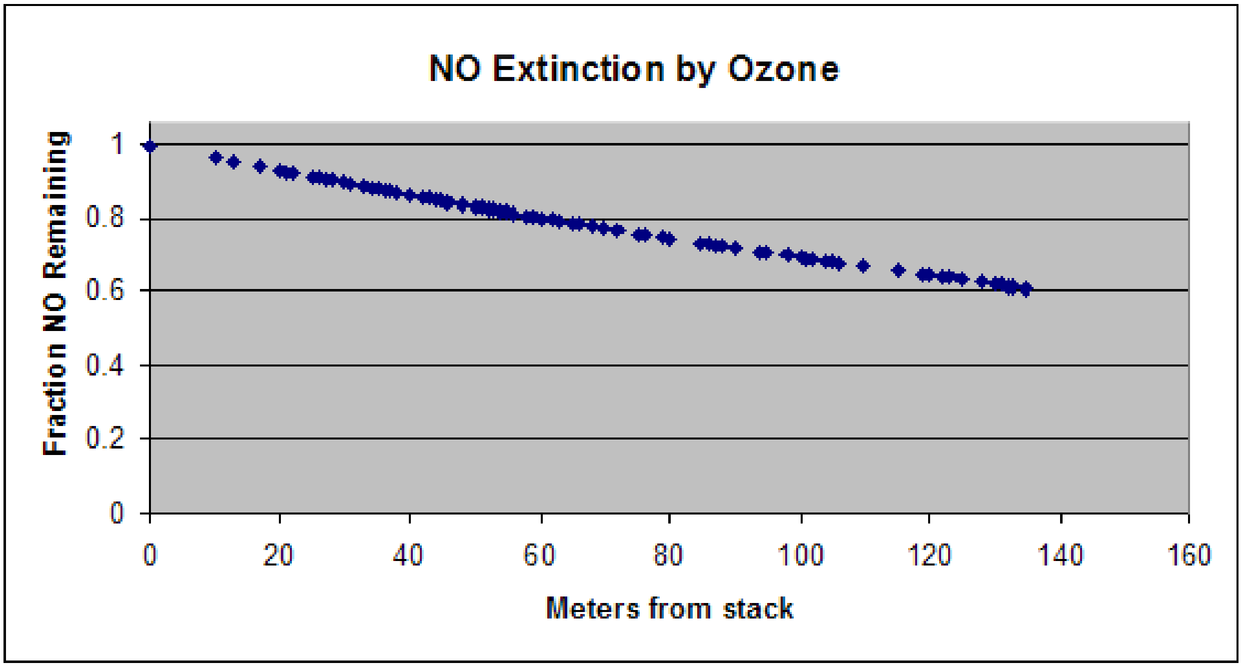
Time in seconds, ozone concentration in gram-moles per cubic centimeter

(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)

[24] The slower the assumed wind speed, the greater effect the NO extinction rate will have in mitigating the air quality impact. However, SCREEN3 is generally-recognized as conservative relative to reality. Ecology believes that choosing a higher wind speed for the sake of analysis serves no realistic purpose.

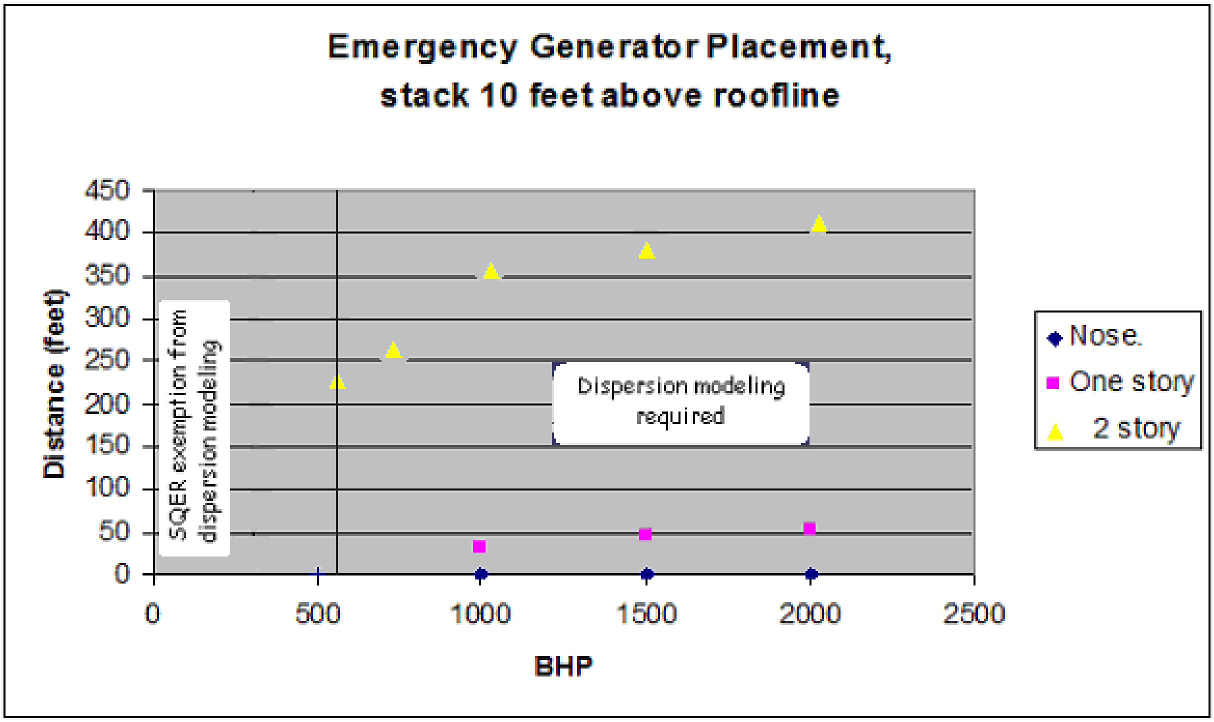
Figure 2



Using SCREEN3 and the NO extinction rate from Figure 2, Ecology estimated NO concentrations at nose height, one story, two story, and higher levels. The general SCREEN3 input variables are shown in Table 6 and Table 7.

The results are shown in Figure 3, and for stack height variations for small engines in Table 13. For the sake of visualization, the term "single story" has been substituted for a 5 meter receptor height, and "two stories or greater" has been substituted for a receptor height of 20 meters.

Figure 3



Emergency Generator Placement,
stack 10 feet above roofline
Distance (feet)
450
400
350
300
250
200
150
100
50
0
0
500
1000
1500
2000
2500
BHP
SQER exemption from dispersion modeling
Dispersion modeling required
Nose
One story
2 story