Minnesota Pollution Control Agency
520 Lafayette Road North
St. Paul, MN 55155-4194

EC-03

Internal Combustion Engine (Single Fuel) Calculations

Air Quality Permit Program

Doc Type: Permit Application

Instructions on page 4

1a) AQ Facility ID No.: _____ **1b)** AQ File No.: _____

2) Facility Name: _____

Fill out Part 1 of this form for each fuel burned in each engine, or attach sheets with equivalent information. Also complete and attach Form EC-13C for Hazardous Air Pollutants (HAP), and Form EC-17 for Greenhouse Gas (GHG) emissions.

Fill out Part 2 of this form only if you are installing a generator to be used for other than emergencies.

Part 1

3) Emission Unit Identification Number: _____

4) Stack/Vent Designation Number: _____

5) Control Equipment Identification Number: _____

6) Engine type: ☐ Reciprocating ☐ Turbine ☐ Other: _____

7) Engine is used for: ☐ Non-Emergency use ☐ Emergency use only
(If you check this box, you must complete Part 2)

8) Rated heat input: _____ MMBtu/hr (million British thermal units/hour)

9) Rated mechanical output: _____ HP @ _____ RPM

10) Fuel type: _____ @ _____ % Sulfur

11) Fuel consumption rate: _____ (gallons/hour or cubic feet/hour)

12) Calculations summary:

12a) Pollutant	12b) Emission factor (lbs/unit)	Emission factor units and source	12c) Emission rate (lbs/hr)	12d) Maximum uncontrolled emissions (tons/yr)	12e) Pollution control efficiency (%)	12f) Maximum controlled emissions (tons/yr)	12g) Limited controlled emissions (tons/yr)	12h) Actual emissions (tons/yr)
PM								
PM_{10}								
$PM_{2.5}$								
SO_2								
NO_X								
VOC								
CO								
Lead								

13) Operating limitations, if applicable:

Part 2

Complete Part 2 (Screen Model for Ambient Air Impacts) for each non-emergency engine to be installed, and/or each non-emergency engine that was installed in its current location after January 1, 2000, and has not been modeled in its current location. Complete Part 2 for each fuel burned in each such engine

Running the Screen Model

14) Run SCREEN3, enter name for this run

15) Source type: P

16) Emission rate: 1.0 gram/second

17) Stack height: _____ meters

18) Stack inside diameter: _____ meters

19) Stack velocity:

- ☐ Option 1: the velocity directly in meters/second as a number only (default) _____
- ☐ Option 2: the flowrate in cubic meters/second _____
- ☐ Option 3: the flowrate in cubic feet/minute _____

20) Stack temperature:

- ☐ Option 1 (default) 700
- ☐ Option 2: the manufacturer's estimated typical operating temp (K) _____

21) Ambient air temperature (K): 293

22) Receptor height: 0.0

23) Urban or rural? _____

24) Consider building downwash? Yes

25) Building height: (meters) _____

26) Building horizontal dimensions (meters): Minimum: _____ Maximum: _____

27) Complex terrain option No

28) Simple terrain option No

29) Select full meteorology, option 1

30) Select automated distance array YES

31) Enter distances ,

32) Record highest ambient air impact: _____

33) Select discrete distances: ☐ 10 ☐ 20 ☐ 30 ☐ 40 ☐ 50 ☐ 60 ☐ 70 ☐ 80 ☐ 90

34) Highest predicted 1-hour ambient air impact _____

35) Ambient Air Impact Table

	35a)	35b)	35c)	35d)	35e)	35f)	35g)
Pollutant and averaging time	**Maximum uncontrolled emissions**	**Pollution control efficiency**	**Maximum controlled emissions**	**Maximum controlled emissions**	**1-hour Ambient air impact at 1 gram/sec**	**Averaging time scaling factor**	**Ambient air impact for stated averaging time**
	lb/hour	**%**	**lb/hr**	**grams/sec**	**µg/m^3**		**µg/m^3**
PM_{10} 24-hr						0.4	
$PM_{2.5}$ 24-hr						0.4	
SO_2 1-hr						1.0	
NO_2 1-hr						1.0	
CO 1-hr						1.0	
CO 8-hr						0.7	

PM_{10} = Particulate Matter less than 10 µm in size
$PM_{2.5}$ = Particulate Matter less than 2.5 µm in size
SO_2 = Sulfur Dioxide
NO_2 = Nitrogen Dioxide
CO = carbon monoxide
µg/m^3 = microgram per cubic meter

36) Compare ambient air impacts for the appropriate averaging time to the following target levels in micrograms/cubic meter:

PM_{10} 24-hour target:	150	NO_2 1-hour target:	188
$PM_{2.5}$ 24-hour target:	35	CO 1-hour target:	35,000
SO_2 1-hour target:	196	CO 8-hour target:	10,000

37) If any target level is exceeded, rerun SCREEN3 using a different stack height, until no exceedance is predicted. That is the stack height that must be used with the engine.

Instructions for Form EC-03

1a) **AQ Facility ID No. --** Fill in your Air Quality (AQ) Facility identification (ID) Number (No.). This is the first eight digits of the permit number for all permits issued under the operating permit program. If your facility has never been issued a permit under this program, leave this line blank.

1b) **AQ File No. --** Fill in your AQ File Number. This number can be found in the "cc" section of correspondence from the Minnesota Pollution Control Agency (MPCA).

2) **Facility Name --** Enter your facility name.

Part 1

3) **Emission Unit Identification Number --** Fill in the identification number of the emission unit. Obtain this number from Form GI-05B, unless you are using this form for Registration Permit Option D. In that case, just provide a description of the emission unit.

4) **Stack/Vent Designation Number --** ***[Skip this item if using this form for Registration Permit Option D.]*** Fill in the designation number of the stack(s) or vent(s) through which the engine will exhaust into the atmosphere. Obtain these numbers from Form GI-05B.

5) **Control Equipment Identification Number --** Fill in the identification number of the control equipment. Obtain this number from Form GI-05B, unless you are using this form for Registration Permit Option D. In that case, enter the description from Form RP-D2.

6) **Engine Type --** Indicate the appropriate engine type.

7) **Engine is Used For --** Indicate if the engine is used for routine operation or for emergency use.

8) **Rated Heat Input --** Enter the rated heat input of the engine, in units of million British thermal units (mmBtu) per hour.

9) **Rated Mechanical Output** -- Fill in the rated output of the engine in horsepower at a specified rpm.

10) **Fuel Type --**Fill in the fuel type (e.g., natural gas, diesel). **Fill out this form for each fuel burned.** Fill in the weight percent sulfur content, if applicable.

11) **Rated Fuel Consumption --** Fill in the manufacturer's rated fuel consumption for the engine. This information can be obtained from the manufacturer. If the engine has been derated, attach the supporting documentation. Circle the appropriate units.

12) **Calculations Summary:**

12a) **Pollutant --** For each pollutant listed in the table, calculate the engine's emissions. Note that for PM_{10} and $PM_{2.5}$, the emissions must include organic and inorganic condensable particulate matter.

12b) **Emission Factor --** Fill in the uncontrolled emission factor for each pollutant, including the units and the source of the emission factor (where or how you obtained the number). See. Minn. R. 7005.0100, subp. 10a, for information on finding and using emission factors. If the emission factor is from AP-42, cite the exact section or table used. If emission factor is from some other source, attach a photocopy of the information used, or provide an exact internet address, so the information can be verified. For PM_{10} and $PM_{2.5}$, be sure your chosen emission factor includes organic and inorganic condensable particulate matter.

12c) **Emission Rate --** Fill in the Emission Rate in lb/hr. Calculate the emission rate by using one of the following methods:

- If the emission factor is in units of pounds per quantity of fuel (gallons or cubic feet):

  Emission Rate [lb/hr]
  = Fuel Consumption Rate [qty/hr] x Emission Factor [lb/qty]
  = (item 11) x (item 12b)

- If the emission factor is in units of pounds per hp-hr power output:

  Emission Rate [lb/hr]
  = Rated Mechanical Output [hp] x Emission Factor [lb/hp-hr]
  = (item 9) x (item 12b)

- If the emission factor is in units of pounds per MMBtu heat input:

  Emission Rate [lb/hr]
  = Rated Heat Input [MMBtu/hr] x Emission Factor [lb/MMBtu]
  = (item 8) x (item 12b)

12d) Maximum Uncontrolled Emissions -- ***[Skip this item if using this form for Registration Permit Option D.]*** Fill in the maximum uncontrolled emissions in tons per year. If the engine is an "emergency generator" (a generator whose sole function is to provide back-up power when power from the local utility is interrupted), the U.S. Environmental Protection Agency (EPA) has stated in a memorandum dated September 6, 1995, that maximum uncontrolled emissions may be based on operating the generator 500 hours per year. Use the following equation:

Maximum Uncontrolled Emissions [tons/year]:

= Emission Rate [lb/hr] x 0.25 [hr/year x ton/lb]

= (item 12c) x 0.25

The September 6, 1995 EPA memo applies only to emergency generators as defined above. It does not apply to peaking units at electric utilities (peak shaving units); generators at industrial facilities that typically operate at low rates but are not confined to emergency use; or any standby generator that is also used during times when power is available from the utility. If your engine is not an emergency generator, you must base maximum uncontrolled emissions on operating the engine 8,760 hours per year. Use the following equation:

Maximum Uncontrolled Emissions [tons/year]:

= Emission Rate [lb/hour] x 4.38 [(hrs/year) x (tons/lb)]

= (item 12c) x 4.38

12e) Pollution Control Efficiency -- The pollution control efficiency is the product of the capture efficiency and the destruction/collection efficiency indicated on Form GI-05A, or, if you are using this form for Registration Permit Option D, the control efficiency is indicated on Form RP-D2. Enter the number here and remember to include on Form CD-01 a plan to demonstrate and maintain the destruction/collection efficiency. [If you are using this form for Registration Permit Option D, you do not need to fill out Form CD-01.] The efficiency should be expressed for each pollutant. If there is no control equipment for the particular pollutant, then indicate zero.

12f) Maximum Controlled Emissions -- ***[Skip this item if you are using this form for Registration Permit Option D.]*** Fill in the maximum controlled emissions (i.e., after taking into consideration the pollution control efficiency [PCE]) of the process/unit in tons per year. Calculate the maximum controlled emissions (in tons per year) by using the following formula:

Maximum Controlled Emissions [tons/year]:

= Maximum Uncontrolled Emissions [tons/year] x ((100 – PCE)/100)

= (item 12d) x ((100 – (item 12e))/100)

12g) Limited Controlled Emissions -- ***[Skip this item if using this form for Registration Permit Option D.]*** The Limited Controlled Emissions are calculated by taking into account all proposed limitations on operation of the source. These limitations include limits on hours of operation, on the amount of material mined, handled, crushed, screened, etc. The proposed limit should be described in item 13 and on Form CD-01. You start the calculation of Limited Controlled Emissions by repeating the calculation of Emission Rate (item 12c) but taking into account the limits you propose.

If an emission unit is subject to an emission limitation specified in 40 CFR pt. 60, 40 CFR pt. 61, 40 CFR pt. 63 or Minn. R. ch. 7011, you must show this requirement in the calculation of Limited Controlled Emissions and take this into account in calculating the Limited Controlled Emissions. If you choose to propose to comply with more a stringent limit, you should state this clearly and show the resulting allowed emissions in this calculation.

12h) Actual Emissions -- If this is an existing unit and historical records exist, calculate actual emissions using the average of the previous two calendar years of equipment or fuel usage data (last 12 months if using this form for Registration Permit Option D], or average the previous two emission inventory reports if an inventory was submitted. Report actual emissions in tons/year.

Calculate actual emissions using the following method:

§ If the emission factor is in units of pounds per quantity of fuel (gallons or cubic feet):

Actual Emissions [tons/year]:

= Fuel Consumption Rate [quantity/year] x Emission Factor [lb/quantity] x 0.0005 [ton/lb] x ((100 – PCE)/100)

= Fuel Consumption Rate x (item 12b) x 0.0005 x ((100 – (item 12e))/100)

§ If the emission factor is in units of pounds per hp-hr power output or pounds per MMBtu heat input:

Actual Emissions [tons/year]:

= Emission Rate [lb/hr] x Actual Operating Hours [hr] x 0.005 [ton/lb] x ((100 – PCE)/100)

= (item 12c) x Actual Operating Hours x 0.0005 x ((100 – (item 12e))/100)

If this is a new unit or no records exist, use a reasonable estimate of how many hours the unit will be operated, how much fountain solution will be used, how much cleaning solution, etc.

13) **Operating Limitations --** Describe any permit limits you plan to take to restrict your PTE (fuel type and/or usage, hours of operation, etc.). Attach additional sheets, if necessary. Describe the limiting factors and cite any rules that apply (e.g. Minn. Rules, Best Available Control Technology (BACT)). The associated limits must be used to calculate your PTE. If you used vendor certification or stack test data to limit your PTE, that factor will become a permit limit. Include all proposed limits on Form CD-01.

Part 2

Running the Screen Model: You can obtain the SCREEN3 model from U.S. EPA at the following webpage: http://www.epa.gov/ttn/scram/dispersion_screening.htm. Instructions are provided here.

14) **Start SCREEN:** enter a name for this run.

15) **For "Source Type":** choose "P" for Point Source.

16) **Emission Rate**: Enter 1.0 gram/second. At the end of this form, you will adjust the results from the SCREEN3 model for the calculated maximum grams/second for each pollutant.

17) **Stack Height**: Enter the stack height above grade level in meters (3.28 feet = 1 meter).

18) **Stack Inside Diameter**: Enter the stack inside diameter in meters.

19) **Stack Velocity**: SCREEN3 provides three ways to enter this data. The default (Option 1) is to enter the exhaust gas velocity directly in meters/second as a number only. As an alternative, you can enter the flowrate in cubic meters/second (Option 2) or cubic feet/minute (Option 3) but you must include the appropriate notation so the program will know which data you are giving it. The diesel engine manufacturer will be able to provide this data for the engine.

20) **Stack Temperature**: The exhaust gas temperature must be entered in degrees Kelvin (K). Enter the manufacturer's estimated typical operating temperature, converted to K, or use 700 as default.

As an example, a typical temperature might be 800 degrees F. First convert to Celsius (C) using the following equation:

Degrees C = (5 / 9) x (degrees F – 32)

427 degrees C = (5 / 9) x (800 degrees F – 32)

Next convert to Kelvin (K) by adding 273:

Degrees K = degrees C + 273

700 degrees K = 427 degrees C + 273

21) **Ambient Air Temperature**: Enter 293

22) **Receptor Height**: Enter 0.0

23) **Urban or Rural option**: Choose "Urban" unless the generator is in a truly rural area. If there are several buildings in the vicinity of the generator, the urban option should be selected.

24) **Consider Building Downwash**: Enter Yes. **Note:** For a generator located far from any buildings, the generator enclosure itself acts as a building and can cause downwash. For buildings that are short in height compared to the length and width, and the generator is located more than 5 building heights from the closest wall, use the generator enclosure dimensions for building downwash. For tall buildings, use 5 times the projected width, which is the diagonal length across the roof of the building. In general, use 5 times the LESSER of the building height or projected width to determine if a building is close enough to cause downwash.

25) **Building Height**: Enter the roofline height of the nearby building that dictates the most severe building downwash effect. This may be difficult to predict, and you may need to run SCREEN3 more than once, using different nearby buildings and the generator enclosure, to determine which one produces the highest ambient air impact.

26) **Building Minimum and Maximum Horizontal Dimensions**: Enter the horizontal dimensions of the building used in item 25.

27) **Complex Terrain Option:** Enter No.

28) **Simple Terrain Option:** Enter No.

29) **Meteorology:** Select the full meteorology option, Option 1.

30) **Automated Distance Array**: Select by entering Yes.

31) **Enter Distances:** Enter 2 numbers here, separated by a comma. The first number is the distance to the nearest property line, in meters, from the stack you are modeling. The 2nd number is 1000, or 500 meters more than the distance to the nearest property line, whichever is higher. For example, if the nearest property line is 50 meters from the source, enter "50,1000" and SCREEN3 will automatically calculate and display the ambient air impact from 50 to 1000 meters in increments of 100 meters. If the nearest property line is 1500 meters from the source, enter "1500,2000" and SCREEN3 will automatically calculate and display the ambient air impact from 1500 to 2000 meters in increments of 100 meters.

32) Record highest ambient air impact: Record the highest ambient air impact for 100 to 1000 meters.

33) Select Discrete Distances: Enter distances of 10, 20, 30, 40, 50, 60, 70, 80, and 90. As you enter each one, SCREEN3 will compute the ambient air impact at that distance and display it.

34) Record the highest predicted 1-hour ambient air impact. Also enter this number in all rows under column 35e in the Ambient Air Impact table on page 9.

35) Ambient Air Impact Table.

35a) Emission Rate in lb/hr: For all pollutants other than NO_2, use the same hourly emission rate as calculated for Section 1. For NO_2, the default is to use the NO_X hourly emission rate calculated in Section 1, multiplied by 0.6. If you want to use source-specific test data or manufacturer's data that shows that NO_2 is a smaller fraction (less than 0.6) of NO_X at the ambient boundary, contact the MPCA at 651-296-6300 or 800-657-3864 to discuss options, including the possibility of a more refined modeling analysis.

35b) Pollution Control Efficiency: Enter the pollution control efficiency from Part 1, item 12e, for each pollutant. Use the same SO_2 efficiency for both SO_2 lines, and the same NO_X efficiency for both NO_2 lines.

35c) Maximum Controlled Emissions in lb/hour: For each line, calculate the maximum controlled emissions in lb/hour using the following equation:

Maximum Controlled Emissions [lb/hr] = Emission Rate [lb/hr] x ((100 – PCE)/100)

(item 35c) = (item 35a) x ((100 – (item 35b))/100)

35d) Maximum Controlled Emissions in grams/second: For each line, calculate the maximum controlled emissions in grams/second by dividing the maximum controlled emissions in lb/hour by 7.94:

Maximum Controlled Emissions [grams/second] = Maximum Controlled Emissions [lb/hr] ÷ 7.94

(item 35d) = (item 35c) ÷ 7.94

35e) 1-hour Ambient Air Impact at 1 gm/second: This is the number identified in item 34. This should be the same number in each line of the table.

35f) Averaging Time Scaling Factor: This has been provided for you.

35g) Ambient Air Impact for Stated Averaging Time: This is the number you will compare to the standards shown in item 36. Calculate this number by multiplying the maximum controlled emissions in grams/second by the 1-hour ambient impact at 1 gram/second and then by the averaging time scaling factor, to obtain the ambient air impact in micrograms per cubic meter ($\mu g/m^3$) as follows:

Ambient Air impact [$\mu g/m^3$] = Max. Controlled Emissions [gram/second] x 1-hour Ambient Impact [$\mu g/m^3$] x scaling factor

(item 35g) = (item 35d) x (item 35e) x (item 35f)

36) Compare ambient air impact for each pollutant and for the appropriate averaging time to the following target levels:

PM_{10} 24-hour ambient air standard	=	150 micrograms/cubic meter[1]
$PM_{2.5}$ 24-hour ambient air standard	=	35 micrograms/cubic meter[1]
SO_2 1-hour ambient air standard	=	196 micrograms/cubic meter[1,2]
NO_2 1-hour ambient air standard	=	188 micrograms/cubic meter[1,2]
CO 1 hour ambient air standard	=	35,000 micrograms/cubic meter[1]
CO 8 hour ambient air standard	=	10,000 micrograms/cubic meter[1]

37) If any target level is exceeded, rerun SCREEN3 using a different stack height, until no exceedance is predicted. That is the stack height that must be installed.

[1] National Ambient Air Quality Standard (NAAQS)
[2] NAAQS, converted from standard's units of parts per billion (ppb)