AP42 Section: **3.3** **Gasoline and Diesel Industrial Engines**

Title: **Correpsondence and comments**

1992

Engine Manufacturers Association
401 North Michigan Avenue
Chicago, Illinois 60611-4267
312/644-6610

TO: EMA Non-Road Emissions Group

FROM: Glenn Keller

DATE: April 23, 1992

RE: EMA Member Input to Revise AP-42 Emission Factors

Please give your priority attention to this request for emission factor data to assist EPA's contractor in the update of AP-42 emission factors.

They are requesting data on stationary and portable engine applications for spark ignited engines from 20 to 250 HP and diesel, dual fuel and natural gas engines from 45 HP and up.

The memo is self-explanatory. I thought it best if members submitted their data directly to Acurex Environmental.

Attachment

GK/gj

cc: Michael Chan
Acurex Environmental

Acurex Environmental

CORPORATION

April 22, 1992

Mr. Glenn Keller, Executive Director
Engine Manufacturers Association
401 N. Michigan Avenue
Chicago, Illinois 60611

Dear Mr. Keller,

Acurex Environmental Corporation is currently engaged in an update of Chapters 1 and 3 in the document Compilation of Air Pollutant Emission Factors (AP-42's Volume I: Stationary Point and Area Sources) for the US EPA's Office of Air Quality Planning and Standards (OAQPS). I am responsible for sections 3 and 4 of Chapter 3, entitled "Gasoline and Diesel Industrial Engines" and "Stationary Large Bore Diesel and Dual Fuel Engines" respectively. An emission factor is the quantity (mass) of pollutants emitted divided by a unit of activity (e.g., g/hp-hr of NO_X). The emission factors are used in making estimates of areawide emissions, emission estimates for a specific facility, and evaluation of emissions in relation to ambient air quality.

The primary emissions of interest are uncontrolled criteria pollutant emissions that are already listed in AP-42 (I have enclosed a copy of the current sections 3.3 and 3.4 of AP-42). EPA's OAQPS would also like to include any available data on Speciated VOC's, Air Toxics, Greenhouse Gases, Fugitive Emissions, and Particulate Sizing (PM_{10}) in this current update. As I mentioned, the current emission factors in AP-42 are based on uncontrolled data, but I would like to include a new table of emission factors that would be based on controlled data.

The data needs to include as much detail as possible to enable the rating of the data quality by EPA guidelines (I also enclosed a copy of the page on data quality rating). Preferably, the data would include the actual source tests and data sheets.

Currently, the stationary internal combustion reciprocating engines are divided by fuel used (gasoline, diesel, and dual fuel), rated power (20 to 250 hp for gasoline engines and 45 to 600 hp for diesel engines) in section 3.3, and bore size (greater than 560 cubic inch displacement per cylinder for diesel and dual fuel engines) for in section 3.4. It has been suggested to me that the engines should be sorted by the rated power and fuel used to make AP-42 easier to use. Therefore, I would like to be able to sort the data by fuel and horsepower (I have a preference for data on engines greater than 600 hp due to the scarcity of the data). I am open to any suggestions on improving the sections 3.3 and 3.4 in AP-42.

I am aware of the confidentiality of the data to the individual engine manufacturers, and if requested, I would reference the source of the data as from the Engine Manufacturers Association. The data for each rated power range (maybe grouped by 100 hp increments and fuel) will be averaged and weighted by the estimated market share before being published in the revised AP-42. Therefore, I am also interested in what the estimated existence or market share of stationary internal combustion reciprocating engines by rated power and fuel in the Unites States.

Because this phase of the update needs to be completed and published by June 1, 1992 for compliance with the Clean Air Act, I need to submit a draft of the revisions and supporting calculations by May 15, 1992. This puts a severe time constraint on my efforts, and any data that you can provide would be appreciated. If I can be of any assistance in collecting the information, please call me at (415) 961-5700, extension 3700.

Sincerely,

Michael J. Chan
Project Engineer
Acurex Environmental Corporation

3.3 Gasoline and Diesel Industrial Engines

3.3.1 General – This engine category covers a wide variety of industrial applications of both gasoline and diesel internal combustion power plants, such as fork lift trucks, mobile refrigeration units, generators, pumps, and portable well-drilling equipment. The rated power of these engines covers a rather substantial range--from less than 15 kW to 186 kW (20 to 250 hp) for gasoline engines and from 34 kW to 447 kW (45 to 600 hp) for diesel engines. Understandably, substantial differences in both annual usage (hours per year) and engine duty cycles also exist. It was necessary, therefore, to make reasonable assumptions concerning usage in order to formulate emission factors.[1]

3.3.2 Emissions – Once reasonable usage and duty cycles for this category were ascertained, emission values from each of the test engines [1] were aggregated (on the basis of nationwide engine population statistics) to arrive at the factors presented in Table 3.3-1. Because of their aggregate nature, data contained in this table must be applied to a population of industrial engines rather than to an individual power plant.

The best method for calculating emissions is on the basis of "brake specific" emission factors (g/kWh or lb/hphr). Emissions are calculated by taking the product of the brake specific emission factor, the usage in hours (that is, hours per year or hours per day), the power available (rated power), and the load factor (the power actually used divided by the power available).

Table 3.3-1. EMISSION FACTORS FOR GASOLINE AND DIESEL POWERED INDUSTRIAL EQUIPMENT
EMISSION FACTOR RATING: C

Pollutant[a]	Engine category[b]	
	Gasoline	Diesel
Carbon monoxide		
g/hr	5700.	197.
lb/hr	12.6	0.434
g/kWh	267.	4.08
g/hphr	199.	3.03
kg/10^3 liter	472.	12.2
lb/10^3 gal	3940.	102.
Exhaust hydrocarbons		
g/hr	191.	72.8
lb/hr	0.421	0.160
g/kWh	8.95	1.50
g/hphr	6.68	1.12
kg/10^3 liter	15.8	4.49
lb/10^3 gal	132.	37.5
Evaporative hydrocarbons		
g/hr	62.0	–
lb/hr	0.137	–
Crankcase hydrocarbons		
g/hr	38.3	–
lb/hr	0.084	–

Table 3.3-1 (continued). EMISSION FACTORS FOR GASOLINE AND DIESEL POWERED INDUSTRIAL EQUIPMENT
EMISSION FACTOR RATING: C

Pollutant[a]	Engine category[b]	
	Gasoline	Diesel
Nitrogen oxides		
g/hr	148.	910.
lb/hr	0.326	2.01
g/kWh	6.92	18.8
g/hphr	5.16	14.0
kg/10^3 liter	12.2	56.2
lb/10^3 gal	102.	469.
Aldehydes		
g/hr	6.33	13.7
lb/hr	0.014	0.030
g/kWh	0.30	0.28
g/hphr	0.22	0.21
kg/10^3 liter	0.522	0.84
lb/10^3 gal	4.36	7.04
Sulfur oxides		
g/hr	7.67	60.5
lb/hr	0.017	0.133
g/kWh	0.359	1.25
g/hphr	0.268	0.931
kg/10^3 liter	0.636	3.74
lb/10^3 gal	5.31	31.2
Particulate		
g/hr	9.23	65.0
lb/hr	0.021	0.143
g/kWh	0.439	1.34
g/hphr	0.327	1.00
kg/10^3 liter	0.775	4.01
lb/10^3 gal	6.47	33.5

[a] References 1 and 2.

[b] As discussed in the text, the engines used to determine the results in this table cover a wide range of uses and power. The listed values do not, however, necessarily apply to some very large stationary diesel engines.

References for Section 3.3

1. Hare, C. T. and K. J. Springer. Exhaust Emissions from Uncontrolled Vehicles and Related Equipment Using Internal Combustion Engines. Final Report. Part 5: Heavy-Duty Farm, Construction, and Industrial Engines. Southwest Research Institute. San Antonio, Texas. Prepared for Environmental Protection Agency, Research Triangle Park, N.C., under Contract No. EHS 70-108. October 1973. 105 p.

2. Hare, C. T. Letter to C. C. Masser of the Environmental Protection Agency concerning fuel-based emission rates for farm, construction, and industrial engines. San Antonio, Tex. January 14, 1974.

3.4 STATIONARY LARGE BORE DIESEL AND DUAL FUEL ENGINES

3.4.1 General

The primary domestic use of large bore diesel engines, i.e., those greater than 560 cubic inch displacement per cylinder (CID/CYL), is in oil and gas exploration and production. These engines, in groups of three to five, supply mechanical power to operate drilling (rotary table), mud pumping and hoisting equipment, and may also operate pumps or auxiliary power generators. Another frequent application of large bore diesels is electricity generation for both base and standby service. Smaller uses include irrigation, hoisting and nuclear power plant emergency cooling water pump operation.

Dual fuel engines were developed to obtain compression ignition performance and the economy of natural gas, using a minimum of 5 to 6 percent diesel fuel to ignite the natural gas. Dual fuel large bore engines (greater than 560 CID/CYL) have been used almost exclusively for prime electric power generation.

3.4.2 Emissions and Controls

The primary pollutant of concern from large bore diesel and dual fuel engines is NO_x, which readily forms in the high temperature, pressure and excess air environment found in these engines. Lesser amounts of carbon monoxide and hydrocarbons are also emitted. Sulfur dioxide emissions will usually be quite low because of the negligible sulfur content of diesel fuels and natural gas.

The major variables affecting NO_x emissions from diesel engines are injection timing, manifold air temperature, engine speed, engine load and ambient humidity. In general, NO_x emissions decrease with increasing humidity.

Because NO_x is the primary pollutant from diesel and dual fuel engines, control measures to date have been directed mainly at limiting NO_x emissions. The most effective NO_x control technique for diesel engines is fuel injection retard, achieving reductions (at eight degrees of retard) of up to 40 percent. Additional NO_x reductions are possible with combined retard and air/fuel ratio change. Both retarded fuel injection (8°) and air/fuel ratio change of five percent are also effective in reducing NO_x emissions from dual fuel engines, achieving nominal NO_x reductions of about 40 percent and maximum NO_x reductions of up to 70 percent.

Other NO_x control techniques exist but are not considered feasible because of excessive fuel penalties, capital cost, or maintenance or operational problems. These techniques include exhaust gas recirculation (EGR), combustion chamber modification, water injection and catalytic reduction.

TABLE 3.4-1. EMISSION FACTORS FOR STATIONARY LARGE BORE DIESEL AND DUAL FUEL ENGINES[a]

EMISSION FACTOR RATING: C

Engine type	Particulate[b]	Nitrogen oxides[c]	Carbon monoxide	VOC[d]		Sulfur dioxide[e]
				Methane	Nonmethane	
Diesel						
lb/10^3 hph	2.4	24	6.4	0.07	0.63	2.8
g/hph	1.1	11	2.9	0.03	0.29	1.3
g/kWh	1.5	15	3.9	0.04	0.4	1.7
lb/10^3 gal[f]	50	500	130	1	13	60
g/l	6	60	16	0.2	1.6	7.2
Dual fuel						
lb/10^3 hph	NA	18	5.9	4.7	1.5	0.70
g/hph	NA	8	2.7	2.1	0.7	0.32
g/kWh	NA	11	3.6	2.9	0.9	0.43

[a]Representative uncontrolled levels for each fuel, determined by weighting data from several manufacturers. Weighting based on % of total horsepower sold by each manufacturer during a five year period. NA = not available.

[b]Emission Factor Rating: E. Approximation based on test of a medium bore diesel. Emissions are minimum expected for engine operating at 50 - 100% full rated load. At 0% load, emissions would increase to 30 g/l. Reference 2.

[c]Measured as NO_2. Factors are for engines operated at rated load and speed.

[d]Nonmethane VOC is 90% of total VOC from diesel engines but only 25% of total VOC emissions from dual fuel engines. Individual chemical species within the nonmethane fraction are not identified. Molecular weight of nonmethane gas stream is assumed to be that of methane.

[e]Based on assumed sulfur content of 0.4 weight % for diesel fuel and 0.46 g/scm (0.20 gr/scf) for pipeline quality natural gas. Dual fuel SO_2 emissions based on 5% oil/95% gas mix. Emissions should be adjusted for other fuel ratios.

[f]These factors calculated from the above factors, assuming heating values of 40 MJ/l (145,000 Btu/gal) for oil and 41 MJ/scm (1100 Btu/scf) for natural gas, and an average fuel consumption of 9.8 MJ/kWh (7000 Btu/hph).

References for Section 3.4

1. Standards Support And Environmental Impact Statement, Volume I: Stationary Internal Combustion Engines, EPA-450/2-78-125a, U. S. Environmental Protection Agency, Research Triangle Park, NC, July 1979.

2. Telephone communication between William H. Lamason, Office Of Air Quality Planning And Standards, U. S. Environmental Protection Agency, Research Triangle Park, NC, and John H. Wasser, Office Of Research And Development, U. S. Environmental Protection Agency, Research Triangle Park, NC, July 15, 1983.

Data Quality Rating from the "Technical Procedures for Developing AP-42 Emission Factors and Preparing AP-42 Sections" by the Emission Inventory Branch (Technical Support Division) of U.S. EPA/OAQPS's Office of Air and Radiation (March 6, 1992) as follows:

A - When tests are performed by a sound methodology and are reported in enough detail for adequate validation. These tests are not necessarily EPA reference method tests, although such reference methods are preferred and certainly to be used as a guide.

B - When tests are performed by a generally sound methodology, but they lack enough detail for adequate validation.

C - When tests are based on an untested or new methodology or are lacking a significant amount of background data.

D - When tests are based on a generally unacceptable method but the method may provide an order-of-magnitude value for the source.

The author uses the following criteria to evaluate source test reports for sound methodology and adequate detail:

1. **<u>Source operation</u>. The manner in which the source was operated is well documented in the report. The source was operating within typical parameters during the test.**

2. **<u>Sampling procedures</u>. If actual procedures deviated from standard methods, the deviations are well documented. Procedural alterations are often made in testing an uncommon type of source. When this occurs, an evaluation is made of how such alternative procedures could influence the test results.**

3. **<u>Sampling and process data</u>. Many variations can occur without warning during testing, sometimes without being noticed. Such variations can induce wide deviation in sampling results. If a large spread between test results cannot be explained by information contained in the test report, the data are suspect and are given a lower rating.**

4. **<u>Analysis and calculations</u>. The test reports contain original raw data sheets. The nomenclature and equations used are compared with those specified by EPA, to establish equivalency. The depth of review of the calculations is dictated by the reviewers' confidence in the ability and conscientiousness of the tester, which in turn is based on factors such as consistency of results and completeness of other areas of the test report.**

Acurex Environmental CORPORATION

555 Clyde Avenue
P.O. Box 7044
Mountain View, CA 94039
(415) 961-5700
FAX Numbers: (415) 964-6523, 964-5145

FAX COVER SHEET

TO

Name: Glenn Keller FAX No.: (312) 527-6658

Organization: EMA

Number of Pages Including Cover Sheet: 8

Date: 4/22/92 Time: 2:00 p.m.

FROM

Name: Michael Chan Ext.: 3700

MESSAGE

Glenn,

I forgot to ask you whether or not you have (or know of) any information on the estimated market share of the different sized engines and fuels in the U.S.

Could you also send/~~fax~~ me a list of the manufacturers that you send this information to?

Thanks for your cooperation in this revision of AP-42.

Mike

Acurex Environmental

CORPORATION

April 22, 1992

Mr. Glenn Keller, Executive Director
Engine Manufacturers Association
401 N. Michigan Avenue
Chicago, Illinois 60611

Dear Mr. Keller,

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555 Clyde Avenue, P.O. Box 7044, Mountain View, CA 94039 (415) 961-5700 FAX: (415) 964-6523/5145

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Because this phase of the update needs to be completed and published by June 1, 1992 for compliance with the Clean Air Act, I need to submit a draft of the revisions and supporting calculations by May 15, 1992. This puts a severe time constraint on my efforts, and any data that you can provide would be appreciated. If I can be of any assistance in collecting the information, please call me at (415) 961-5700, extension 3700.

Sincerely,

Michael J. Chan
Project Engineer
Acurex Environmental Corporation

Acurex
Environmental
CORPORATION

555 Clyde Avenue
P.O. Box 7044
Mountain View, CA 94039
(415) 961-5700
FAX Numbers: (415) 964-6523, 964-5145

FAX COVER SHEET

TO
Name: Steve Hill FAX No.: (415) 928-8560
Organization: Bay Area Air Quality Management District
Number of Pages Including Cover Sheet: 3
Date: 4/27/92 Time: 12:45

FROM
Name: Michael Chan Ext.: 3700

MESSAGE

Mr. Hill,

If you have any questions, please call me. I would like to come up with Carolyn as soon as possible.

Thanks,

Mike

FORM 4058 A 3/92

Acurex Environmental
CORPORATION

April 27, 1992

Mr. Steve Hill
Bay Area Air Quality Management District
939 Ellis Street
San Francisco, CA 94109

Dear Mr. Hill,

This is a request for a date and time in which Carolyn Rushforth and myself can come up to Bay Area AQMD to find some emissions data. Acurex Environmental Corporation is currently engaged in an update of Chapters 1 and 3 in the document Compilation of Air Pollutant Emission Factors (AP-42's Volume I: Stationary Point and Area Sources) for the US EPA's Office of Air Quality Planning and Standards (OAQPS). Chapters 1 and 3 of AP-42 deals with stationary external and internal combustion sources.

The primary emissions of interest are uncontrolled criteria pollutant emissions that are currently listed in AP-42. EPA's OAQPS would also like to include any available data on Speciated VOC's, Air Toxics, Greenhouse Gases, Fugitive Emissions, and Particulate Sizing (PM_{10}) in this current update. The current emission factors in AP-42 are based on uncontrolled data, but a new table of emission factors that would be based on controlled data is desirable.

The data needs to include as much detail as possible to enable the rating of the data quality by EPA guidelines. Preferably, the data would also include the actual source test data.

In regard to Chapter 1, any air toxics data for any sized oil, coal, and/or LPG fired boilers is being requested.

555 Clyde Avenue, P.O. Box 7044, Mountain View, CA 94039 (415) 961-5700 FAX: (415) 964-6523/5145

In summary, the data that are being requested for a visit by Carolyn and myself is: (1) any emissions data (Criteria, Speciated VOC's, Air Toxics, Greenhouse Gases, Fugitive Emissions, and Particulate Sizing (PM_{10})) for all stationary internal combustion engines running on gasoline, diesel, or dual fuels; and (2) any air toxics data for any sized oil/coal/LPG fired boilers.

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Sincerely,

Michael J. Chan
Project Engineer
Acurex Environmental Corporation

Acurex
Environmental
CORPORATION

555 Clyde Avenue
P.O. Box 7044
Mountain View, CA 94039
(415) 961-5700
FAX Numbers: (415) 964-6523, 964-5145

FAX COVER SHEET

TO
Name: Bob Nishimura FAX No.: (415) 749-5030
Organization: Bay Area AQMD
Number of Pages Including Cover Sheet: 3
Date: 4/28/92 Time: 9:00 A.M.

FROM
Name: Michael Chan Ext.: 3700

MESSAGE

Bob,

This is a copy of the letter that sent to Steve Hill yesterday.

Mike

Acurex Environmental

CORPORATION

April 27, 1992

Mr. Steve Hill
Bay Area Air Quality Management District
939 Ellis Street
San Francisco, CA 94109

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Michael J. Chan
Project Engineer
Acurex Environmental Corporation

Acurex Environmental

CORPORATION

April 22, 1992

Mr. Clair Fancy
Buerau of Air Regulations
Department of Environmental Regulations
2600 Blairstone Road
Tallahassee, Florida 32399

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Project Engineer
Acurex Environmental Corporation

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g/kWh	267.	4.06
g/hphr	199.	3.03
kg/10^3 liter	472.	12.2
lb/10^3 gal	3940.	102.
Exhaust hydrocarbons		
g/hr	191.	72.8
lb/hr	0.421	0.160
g/kWh	8.95	1.50
g/hphr	6.68	1.12
kg/10^3 liter	15.8	4.49
lb/10^3 gal	132.	37.5
Evaporative hydrocarbons		
g/hr	62.0	–
lb/hr	0.137	–
Crankcase hydrocarbons		
g/hr	38.3	–
lb/hr	0.084	–

Table 3.3-1 (continued). EMISSION FACTORS FOR GASOLINE AND DIESEL POWERED INDUSTRIAL EQUIPMENT
EMISSION FACTOR RATING: C

Pollutant[a]	Engine category[b]	
	Gasoline	Diesel
Nitrogen oxides		
g/hr	148.	910.
lb/hr	0.326	2.01
g/kWh	6.92	18.8
g/hphr	5.16	14.0
kg/10^3 liter	12.2	56.2
lb/10^3 gal	102.	469.
Aldehydes		
g/hr	6.33	13.7
lb/hr	0.014	0.030
g/kWh	0.30	0.28
g/hphr	0.22	0.21
kg/10^3 liter	0.522	0.84
lb/10^3 gal	4.36	7.04
Sulfur oxides		
g/hr	7.67	60.5
lb/hr	0.017	0.133
g/kWh	0.359	1.25
g/hphr	0.268	0.931
kg/10^3 liter	0.636	3.74
lb/10^3 gal	5.31	31.2
Particulate		
g/hr	9.33	65.0
lb/hr	0.021	0.143
g/kWh	0.439	1.34
g/hphr	0.327	1.00
kg/10^3 liter	0.775	4.01
lb/10^3 gal	6.47	33.5

[a]References 1 and 2.

[b]As discussed in the text, the engines used to determine the results in this table cover a wide range of uses and power. The listed values do not, however, necessarily apply to some very large stationary diesel engines.

References for Section 3.3

1. Hare, C. T. and K. J. Springer. Exhaust Emissions from Uncontrolled Vehicles and Related Equipment Using Internal Combustion Engines. Final Report. Part 5: Heavy-Duty Farm, Construction, and Industrial Engines. Southwest Research Institute. San Antonio, Texas. Prepared for Environmental Protection Agency, Research Triangle Park, N.C., under Contract No. EHS 70-108. October 1973. 105 p.

2. Hare, C. T. Letter to C. C. Masser of the Environmental Protection Agency concerning fuel-based emission rates for farm, construction, and industrial engines. San Antonio, Tex. January 14, 1974.

3.4 STATIONARY LARGE BORE DIESEL AND DUAL FUEL ENGINES

3.4.1 General

The primary domestic use of large bore diesel engines, i.e., those greater than 560 cubic inch displacement per cylinder (CID/CYL), is in oil and gas exploration and production. These engines, in groups of three to five, supply mechanical power to operate drilling (rotary table), mud pumping and hoisting equipment, and may also operate pumps or auxiliary power generators. Another frequent application of large bore diesels is electricity generation for both base and standby service. Smaller uses include irrigation, hoisting and nuclear power plant emergency cooling water pump operation.

Dual fuel engines were developed to obtain compression ignition performance and the economy of natural gas, using a minimum of 5 to 6 percent diesel fuel to ignite the natural gas. Dual fuel large bore engines (greater than 560 CID/CYL) have been used almost exclusively for prime electric power generation.

3.4.2 Emissions and Controls

The primary pollutant of concern from large bore diesel and dual fuel engines is NO_x, which readily forms in the high temperature, pressure and excess air environment found in these engines. Lesser amounts of carbon monoxide and hydrocarbons are also emitted. Sulfur dioxide emissions will usually be quite low because of the negligible sulfur content of diesel fuels and natural gas.

The major variables affecting NO_x emissions from diesel engines are injection timing, manifold air temperature, engine speed, engine load and ambient humidity. In general, NO_x emissions decrease with increasing humidity.

Because NO_x is the primary pollutant from diesel and dual fuel engines, control measures to date have been directed mainly at limiting NO_x emissions. The most effective NO_x control technique for diesel engines is fuel injection retard, achieving reductions (at eight degrees of retard) of up to 40 percent. Additional NO_x reductions are possible with combined retard and air/fuel ratio change. Both retarded fuel injection (8°) and air/fuel ratio change of five percent are also effective in reducing NO_x emissions from dual fuel engines, achieving nominal NO_x reductions of about 40 percent and maximum NO_x reductions of up to 70 percent.

Other NO_x control techniques exist but are not considered feasible because of excessive fuel penalties, capital cost, or maintenance or operational problems. These techniques include exhaust gas recirculation (EGR), combustion chamber modification, water injection and catalytic reduction.

TABLE 3.4-1. EMISSION FACTORS FOR STATIONARY LARGE BORE DIESEL AND DUAL FUEL ENGINES[a]

EMISSION FACTOR RATING: C

Engine type	Particulate[b]	Nitrogen oxides[c]	Carbon monoxide	VOC[d]		Sulfur dioxide[e]
				Methane	Nonmethane	
Diesel						
lb/10^3 hph	2.4	24	6.4	0.07	0.63	2.8
g/hph	1.1	11	2.9	0.03	0.29	1.3
g/kWh	1.5	15	3.9	0.04	0.4	1.7
lb/10^3 gal[f]	50	500	130	1	13	60
g/l	6	60	16	0.2	1.6	7.2
Dual fuel						
lb/10^3 hph	NA	18	5.9	4.7	1.5	0.70
g/hph	NA	8	2.7	2.1	0.7	0.32
g/kWh	NA	11	3.6	2.9	0.9	0.43

[a]Representative uncontrolled levels for each fuel, determined by weighting data from several manufacturers. Weighting based on % of total horsepower sold by each manufacturer during a five year period. NA = not available.

[b]Emission Factor Rating: E. Approximation based on test of a medium bore diesel. Emissions are minimum expected for engine operating at 50 - 100% full rated load. At 0% load, emissions would increase to 30 g/l. Reference 2.

[c]Measured as NO_2. Factors are for engines operated at rated load and speed.

[d]Nonmethane VOC is 90% of total VOC from diesel engines but only 25% of total VOC emissions from dual fuel engines. Individual chemical species within the nonmethane fraction are not identified. Molecular weight of nonmethane gas stream is assumed to be that of methane.

[e]Based on assumed sulfur content of 0.4 weight % for diesel fuel and 0.46 g/scm (0.20 gr/scf) for pipeline quality natural gas. Dual fuel SO_2 emissions based on 5% oil/95% gas mix. Emissions should be adjusted for other fuel ratios.

[f]These factors calculated from the above factors, assuming heating values of 40 MJ/l (145,000 Btu/gal) for oil and 41 MJ/scm (1100 Btu/scf) for natural gas, and an average fuel consumption of 9.9 MJ/kWh (7000 Btu/hph).

References for Section 3.4

1. Standards Support And Environmental Impact Statement, Volume I: Stationary Internal Combustion Engines, EPA-450/2-78-125a, U. S. Environmental Protection Agency, Research Triangle Park, NC, July 1979.

2. Telephone communication between William H. Lamason, Office Of Air Quality Planning And Standards, U. S. Environmental Protection Agency, Research Triangle Park, NC, and John H. Wasser, Office Of Research And Development, U. S. Environmental Protection Agency, Research Triangle Park, NC, July 15, 1983.

Data Quality Rating from the "Technical Procedures for Developing AP-42 Emission Factors and Preparing AP-42 sections" by the Emission Inventory Branch (Technical Support Division) of U.S. EPA/OAQPS's Office of Air and Radiation (March 6, 1992)

as follows:

A - When tests are performed by a sound methodology and are reported in enough detail for adequate validation. These tests are not necessarily EPA reference method tests, although such reference methods are preferred and certainly to be used as a guide.

B - When tests are performed by a generally sound methodology, but they lack enough detail for adequate validation.

C - When tests are based on an untested or new methodology or are lacking a significant amount of background data.

D - When tests are based on a generally unacceptable method but the method may provide an order-of-magnitude value for the source.

The author uses the following criteria to evaluate source test reports for sound methodology and adequate detail:

1. **<u>Source operation</u>. The manner in which the source was operated is well documented in the report. The source was operating within typical parameters during the test.**

2. **<u>Sampling procedures</u>. If actual procedures deviated from standard methods, the deviations are well documented. Procedural alterations are often made in testing an uncommon type of source. When this occurs, an evaluation is made of how such alternative procedures could influence the test results.**

3. **<u>Sampling and process data</u>. Many variations can occur without warning during testing, sometimes without being noticed. Such variations can induce wide deviation in sampling results. If a large spread between test results cannot be explained by information contained in the test report, the data are suspect and are given a lower rating.**

4. **<u>Analysis and calculations</u>. The test reports contain original raw data sheets. The nomenclature and equations used are compared with those specified by EPA, to establish equivalency. The depth of review of the calculations is dictated by the reviewers' confidence in the ability and conscientiousness of the tester, which in turn is based on factors such as consistency of results and completeness of other areas of the test report.**