MEMORANDUM

DATE: January 21, 2002

SUBJECT: Stationary Combustion Turbines Emissions Database Version 5

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TO: Sims Roy EPA OAQPS ESD Combustion Group

The purpose of this memorandum is to document the activities conducted to develop and maintain the Stationary Combustion Turbines Emissions Database Version 5. This database will be used to support rulemaking decisions for the stationary combustion turbines NESHAP and NSPS efforts. The database development and refinements and the format of the database are described in this memorandum.

Database Development and Refinements

The first version of the database, in Access 2.0, was released to the public (via the EPA ICCR TTN site) in June 1997. This release contained reports for hazardous air pollutants (HAP) only. Version 2 of the database was released during January 1998, in both Access 2.0 and Access '97 formats. This version contained more HAP data than in version 1 and also contained criteria pollutant data. Version 3 of the database was released in September 1998 in Access 2.0 and contained additional test reports for HAP and criteria pollutants received from the Gas Technology Institute and a facility in California. Version 4 of the database was released in March 1999 in Access '97. This version did not contain new HAP data, but refinements and clarifications were made to the database. The current version of the database is included with this memorandum (version 5, in Access '97). An additional six test reports (31 tests) for HAP and criteria pollutants have been added since version 4. Test report 243 (four tests) was removed from the database since the unit tested was not a stationary combustion turbine. In addition, it was discovered that test reports 19 and 223 were duplicates. Therefore, test report 223 was removed from the database.

The current version of the database contains 264 tests, representing applications in industrial, pipeline, and utility sectors. The test dates of the source tests in the database range from 1988 to 1999. Some test reports contain HAP or criteria pollutant data only while other test reports contain data on both sets of pollutants. Seventy-nine tests contain HAP data; the number with criteria pollutant data is 222. Many of the tests involved replicate sampling and analysis runs.

A list of references for the test reports included in the database is given in Appendix A. Test reports included in the database were numbered as follows: numbers from 1 to 99 were assigned to tests containing only HAP, and numbers greater than 100 were allocated for tests with only criteria pollutants or with both HAP and criteria pollutants. Exceptions are the reports numbered 10, 15, and 19. These test reports contain both HAP and criteria pollutant test results. They are numbered as HAP-only type reports because criteria pollutant data were identified in these reports after the first version of the database was posted on the TTN. Test reports containing more than one turbine, multiple load conditions, different fuels, control device inlet and outlet samples, or more than three sampling runs were assigned the same initial number followed by an extension (for example, 1.1 or 1.1.1).

The test reports comprising the database include emissions data for turbines firing natural gas, distillate oil, digester gas, landfill gas, refinery gas, and field gas. The turbines tested ranged in size from 0.8 megawatts (MW) to 165 MW. Emissions were measured for various loads, ranging from 25 percent to 100 percent of full load. Some of the tested turbines were equipped with pollution control devices, including water or steam injection, lean pre-mix combustion design, and SCONOx.

Database format

The Stationary Combustion Turbines Emissions Database consists of tables, queries, modules, and reports. Data extracted from the source test reports are entered into tables. Queries are used to collect selected data from the tables and to perform calculations using the data. This is done by calling specific functions within database modules. The result of the calculation is returned to the query. The reports draw on the queries and display raw data fields and calculated values. A brief description of each component of the database structure follows.

Tables

The database contains two master tables, a “Facilities” table and a “Test Data” table. The common field which links the two tables is the ID field which contains the Source Test Identification Number (these numbers correspond to those provided in Appendix A, Source Test References). The “Test Data” table was divided into three tables: “Test Data - HAPs,” containing all HAP data in the Test Data table, including the HAP data from reports with both HAP and criteria pollutant data; “Test Data - Criteria Pollutants,” containing all criteria pollutant data in the Test Data table, including criteria pollutant data from reports with both HAP and criteria pollutant data, and “Test Data - HAPs + Criteria,” containing only the data from tests with data for both HAP and criteria pollutants. A list of data definitions identifying the various data fields in these tables is included as Appendix B. The data presented in the Facility and Test Data tables are “as reported” information. All calculations (corrected concentrations, emission rates, and

emission factors) are performed within the database through the developed queries and modules and are displayed in the reports.

Queries

The queries in the database serve to organize and group data and to call functions to perform calculations on the data. There are two sets of queries. The first set contains the queries “qry_Emissions - Criteria Pollutants”, “qry_Emissions - HAPs”, and “qry_Emissions - HAPs + Criteria.” These queries contain the calls to functions within database modules which calculate the average reported run concentration, the average of the average reported run concentrations, the “corrected” run concentrations, and the calculated emission factors per individual test run and overall test average in lb/MMBtu, lb/MW, and lb/hr. The second set of queries includes the queries “Summary - Criteria Pollutants”, “Summary - HAPs”, and “Summary - HAPs + Criteria.” In these queries, the reported individual test run concentrations are corrected to 15 percent O_2 and the average of the corrected concentrations is computed.

Modules

Using raw test data (i.e., lab-reported pollutant concentrations and stack test parameters), calculations are performed to correct reported concentrations to 15 percent O_2 and to estimate emissions in lb/hr, lb/MW-hr and lb/MMBtu. Modules are small programs written in Visual Basic code that were built to perform the calculations. Each module contains functions. Calculations are performed within the module using parameters sent from the query when the function is called. The results of the calculation are returned to the query that called the module.

There are various modules in the emissions database that perform different tasks. A brief description of each of the modules used in the database follows:

Module AConc:	Computes the average concentration for the reported individual test run concentrations.
Module Convert:	Corrects the reported run concentrations to 15 percent O_2, inserts flags for non-detected concentrations, and calculates emission factors.
Module Correction:	Assigns ½ the detection limit for a given run to run concentrations that are reported as non-detects.
Module NonDetect:	Handles the criteria for the use of detection limits.
Module SigDig:	Performs the reduction of a calculated result to a given number of significant digits.

Reports

The report section contains several summaries of the calculated emissions data. Reports are included for individual test run concentrations as well as for average concentrations over all runs in the test. In the report section, a set of six different reports was built for each of the test data tables discussed above. These reports provide information about pollutant concentrations (corrected to 15 percent O_2) and emissions in units of lb/hr, lb/MMBtu, and lb/MW-hr. Individual sets of reports were also developed for test summaries and pollutant summaries. A listing of the reports included in the database is in Appendix C. In order to obtain the calculated emissions data, the appropriate report must be opened (when opening a report, all related queries and modules are run).

Many pollutants were not detected in some or all of the sampling runs conducted during a test. Individual run concentrations preceded by "<" in the reports indicate a non-detect concentration. In these cases, ½ the detection limit (DL) was substituted as the concentration for that run for calculation purposes. Detection limit values were not always provided and review of the lab report and additional calculations were necessary to determine the DL value. If the DL could not be calculated and the pollutant was not detected in all sampling runs, the pollutant was not entered into the database for that test. If more than one DL was determined for the same pollutant in a test, the highest DL value was used. A "<" appearing before an average concentration value indicates that at least one (but not all) of the individual run concentrations was a non-detect and the detection limit was averaged in as the concentration for that run. A "<<" preceding the average concentration denotes that *all* of the individual run concentrations were non-detects and that ½ the detection limit was used as the concentration.

A more complete description of the treatment of non-detects and detection limits is provided in the memorandum attached as Appendix D. This memorandum also provides information on the calculations performed on the raw data and the default assumptions used in the calculations.

Enclosure: Stationary Combustion Turbines Emissions Database, version 5 (ttestsv5_01.mdb)

Appendix A
Source Test References

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2. Source Emission Test Report Regarding Formaldehyde Emissions from the Agnews Cogeneration Facility, San Jose, California. Prepared by Best Environmental, Inc., San Leandro, California for Calpine, San Jose, California. October 2, 1992.

3. Bell, A.C. Emissions Inventory Testing at Long Beach Combustion Turbine No. 3 for Inclusion in Air Toxics Hot Spots Inventory Required Under AB2588. Prepared by Carnot, Tustin, California for Southern California Edison Company, Rosemead, California. May, 1989.

4. McDannel, M. D. Air Toxics Emissions Inventory Testing at Coolwater Generating Station Combustion Turbine No. 42 for Inclusion in Air Toxics Hot Spots Inventory Required Under AB2588. Prepared by Carnot, Tustin, California for Southern California Edison Company, Rosemead, California. May, 1990.

5. AB2588 Pooled Source Emission test Program. Prepared by Almega Corporation (Project # I6551) for Western States Petroleum Association, Glendale, California. July 9, 1990.

6. Source Test Report AB2588 for Turbine #1 at Choachella Power Plant. Prepared by South Coast Environmental Company, La Verne, California for Imperial Irrigation District, Imperial, California. February 25, 1991.

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8. Emission Measurements for Speciated PAH's and BTXE Compounds on Gas Fired Turbine and Steam Generator. Prepared by The Almega Corporation (Project # C6823) for Shell Western E & P, Bakersfield, California. August 1, 1991.

9. Source Test Report for the Texaco Heater Treater, the Mobil Steam Generator, and the SWEPI Gas Turbine in the San Joaquin Valley Unified Air Pollution District,

California. Prepared by Radian Corporation for Western States Petroleum Association, Bakersfield, California. September, 1992.

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13. Reel, T. Test Report: AB2588 Testing for South Bay Unit 2 and Kearny GT-1. Prepared by Carnot, Tustin, California for San Diego Gas & Electric Company, San Diego, California. October, 1991.

14. Report of Air Pollution Source Testing For California AB 2588 at the Kern River Cogen Company, Bakersfield, California. Prepared by Engineering-Science, Inc., Pasadena, California for Kern River Cogen Company, Bakersfield, California. March 28, 1990.

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Bakersfield, California. June 30, 1992.

19. Gas Turbine Emission Testing for McClure Generating Station. Prepared by Acurex Corporation, Mountain View, California for Modesto Irrigation District, Modesto, California. December 18, 1989.

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22. Schnitt, M.L. AB2588 Emission Test Report, Procter & Gamble, Sacramento Cogeneration Facility. Prepared by Carnot, Tustin, California for Procter and Gamble Manufacturing Company, Sacramento, California. April, 1991.

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203. Engineering Testing at PGT Compressor Station 6, Unit A. Prepared by Carnot, Concord, California for Pacific Gas Transmission Company, San Francisco, California. November 14, 1994.

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Louisiana. June 28, 1988.

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323. Source Emission Evaluation for Coyote Springs Power Generation Project, November 16-20, 1996. Prepared by AmTest-Air Quality, LLC., Preston,

Washington, for Raytheon Constructors, Inc., Boardman, Oregon. January 15, 1996.

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Appendix B
Definitions of Database Fields

The "Facility" table contains the following fields:

ID	-	The Test Identification Number. The ID corresponds to the test reference number in Appendix A, Source Test References.
Facility Name	-	The name of the facility.
Location	-	The location of the test site.
Testing Company	-	The name of the company that conducted the test.
Date	-	The date the test was performed.
Tester	-	The name of the person that conducted the test.
Manufacturer	-	The name of the turbine manufacturer.
Model	-	The turbine model designation.
Load	-	The load at which the turbine is operated at during the test.
Rating	-	The rating of the turbine.
Unit	-	The rating units.
Test Rating	-	The rate at which the test was conducted.
Units Test R	-	The test rating units.
Fuel Type	-	The fuel used for charging.
Application	-	Any supplemental information, comments on turbine use, and any underlying assumptions.
Control Device	-	The type of device used to control emissions.
Comments	-	Any comments.
Flag Control Device	-	Control Device.

The "Test Data" table consists of the following fields:

ID	-	Test Identification Number.
Pollutant	-	The name of the hazardous air pollutant.
Method	-	The method used for sampling and quantification of pollutant.
Run 1 Conc R	-	The reported concentration for Run 1.
Run 2 Conc R	-	The reported concentration for Run 2.
Run 3 Conc R	-	The reported concentration for Run 3.
SD	-	The number of significant digits.
DL	-	The detection limit reported for the pollutant.
Avg Conc R	-	The average of the reported concentration for all runs.
C Unit	-	The units used for reported concentration.
Run 1 O_2	-	The percent oxygen in exhaust measured in Run 1.
Run 2 O_2	-	The percent oxygen in exhaust measured in Run 2.
Run 3 O_2	-	The percent oxygen in exhaust measured in Run 3.
Blank Conc1	-	The blank concentration for Run 1, when available.
Blank Conc2	-	The blank concentration for Run 2, when available.
Blank Conc3	-	The blank concentration for Run 3, when available.

Run 1 Rate - The pollutant emission rate reported for Run 1.
Run 2 Rate - The pollutant emission rate reported for Run 2.
Run 3 Rate - The pollutant emission rate reported for Run 3.
Avg Rate - The average pollutant emission rate for all runs.
Runit - The units for the pollutant emission rate.
Run 1 Factor - The pollutant emission factor reported during Run 1.
Run 2 Factor - The pollutant emission factor reported during Run 2.
Run 3 Factor - The pollutant emission factor reported during Run 3.
Avg Factor - The average pollutant emission factor for all runs.
FUnit - The units for the pollutant emission factor.
Run 1 Fuel Factor - The F-factor for the fuel used for firing (dscf/MMBtu).
Run 1 Gas Flowrate - The exhaust gas flowrate for Run 1.
Run 2 Gas Flowrate - The exhaust gas flowrate for Run 2.
Run 3 Gas Flowrate - The exhaust gas flowrate for Run 3.
Gas Flowrate Unit - The units for the gas flowrate.
Fuel Heating Value - The heating value of the fuel.
Fuel Heating Value Unit - The units for the fuel heating value.
Standard Temperature - The standard temperature used for the emission calculations.
Standard Temperature Unit - The units for the standard temperature.
Run 1 Fuel Flowrate - The fuel firing rate in Run 1.
Run 2 Fuel Flowrate - The fuel firing rate in Run 2.
Run 3 Fuel Flowrate - The fuel firing rate in Run 3.
Avg Fuel Flowrate - The average fuel firing rate for all runs.
Fuel Flowrate Unit - The units for the fuel flowrate.
Run 1 % Moist - The amount of moisture detected in the exhaust for Run 1.
Run 2 % Moist - The amount of moisture detected in the exhaust for Run 2.
Run 3 % Moist - The amount of moisture detected in the exhaust for Run 3.
Avg % Moist - The average amount of moisture detected for all runs.
MW - The molecular weight of the pollutant.
Stack Temperature - The temperature of the stack.
Stack Temperature Units - The units of the stack temperature.
Comm - Any comments.

The following tables contain the same fields as the “Test Data” table:

- Test Data - Criteria Pollutants

- Test Data - HAPs
- Test Data - HAPs + Criteria

Appendix C
Reports Included in the Stationary Combustion Turbines Emissions Database

Report Title	Data Reported
"Criteria Pollutant Summary (lb/MW-hr)" "HAPs Pollutant Summary (lb/MW-hr)" "HAPs + Criteria Pollutant Summary (lb/MW-hr)	Pollutant, Fuel Type, ID, Turbine Description, individual test runs and average lb/MW-hr
"Criteria Pollutant Summary (lb/MMBtu)" "HAPs Pollutant Summary (lb/MMBtu)" "HAPs + Criteria Pollutant Summary (lb/MMBtu)"	Pollutant, Fuel Type, ID, Turbine Description, individual runs and average lb/MMBtu
"Criteria Pollutant Summary (lb/hr)" "HAPs Pollutant Summary (lb/hr)" "HAPs + Criteria Pollutant Summary (lb/hr)"	Pollutant, Fuel Type, ID, Turbine Description, individual runs and average lb/hr
"Criteria Pollutant Summary - Average conc @ 15% O_2" "HAPs Pollutant Summary - Average conc @ 15% O_2" "HAPs + Criteria Pollutant Summary - Average conc @ 15% O_2"	Fuel Type, Pollutant, ID, Method, DL, Concentration (at 15% O_2), Rating, Load
"Criteria Pollutant Summary/run - Concentrations @ 15% O_2" "HAPs Pollutant Summary/run - Concentrations @ 15% O_2" "HAPs + Criteria Pollutant Summary/run - Concentrations @ 15% O_2"	Fuel Type, Pollutant, ID, Method, DL, Corrected Concentration at 15% O_2 for each run, Concentration Units
"Facility Criteria Pollutants Summary (lb/MMBtu)" "Facility HAPs Pollutants Summary (lb/MMBtu)" "Facility HAPs + Criteria Pollutants Summary (lb/MMBtu)"	ID, Description, Manufacturer, Model, Testing Company, Date, Pollutant, Method, lb/MMBtu for each run and average
"HAPs Averages Max Avg"	Fuel, Pollutant, ID, Method, Uncorrected Concentration and Unit, maximum and average for lb/hr, lb/MMBtu, and lb/MW-hr

Appendix D

MEMORANDUM

DATE : March 6, 1998
SUBJECT : Documentation on the Combustion Turbines Emissions Database
TO : Combustion Turbines Project File
FROM : Ana Rosa Alvarez and Dan Herndon

This memorandum provides a short description of the development of the emissions database for turbines, including assumptions used in the underlying calculations.

Development of the Emissions Database

The emission test reports were first carefully reviewed and summarized. Facility name, location, testing company, date of testing, make and model of turbine, manufacturer rating (and units), load, fuel type, application and control device (for emissions) were entered in a table named "Facilities." Pollutant name, sampling method, concentrations and units, detection limits and units, percent oxygen, fuel factors, exhaust gas flow rates, stack temperature, fuel heating value and flow rate, percent humidity, standard temperature, and pollutant molecular weight were entered in a table named "Test Data." Emission rates (lb/hr) and emission factors (lb/MMBtu) were also entered in that table for comparison with the emissions calculated in the database using the pollutant concentrations for each test run.

Test reports included in the database were identified using the following scheme: numbers from 1 to 99 were assigned to tests containing only HAP, and numbers greater than 100 were allocated for tests with only criteria pollutants or with both HAP and criteria pollutants. Exceptions are the reports numbered 10 and 15. These test reports contain both HAP and criteria pollutant test results. They are numbered as HAP-only type reports because criteria pollutant data were identified in these reports after the first version of the database was posted on the TTN. Test reports containing more than one turbine, multiple load conditions, different fuels, control device inlet and outlet samples (criteria pollutant data only), or more than three sampling runs were assigned the same initial number followed by an extension (for example, 1.1 or 1.1.1).

Some of the test reports in the database include an "x" symbol at the end of the test report number (e.g., test report 8x). The "x" symbol indicates that the test report does not meet the acceptance criteria developed by the CTWG. The data from these test reports are included in the database for informational purposes only.

Construction of database reports (i.e., summaries of relevant data) required the complete separation of tests with HAP-only data from tests with only criteria pollutant data and tests with both HAP and criteria pollutant data. The "Test Data" table was consequently divided into three tables: "Test Data - HAPs," containing all HAP data in the Test Data table; "Test Data - Criteria Pollutants," containing all criteria pollutant data in the Test Data table, and "Test Data - HAPs + Criteria," containing the tests that include data for both HAP and criteria pollutants.

In the report section, a set of 6 different reports was built for each of the test data tables discussed above. These reports provide information about pollutant concentrations (corrected to 15 percent O_2) and emissions in units of lb/hr, lb/MMBtu, and lb/MW-hr. Individual sets of reports were also developed for test summaries and pollutant summaries.

Treatment of non-detected or non-reported concentrations

Many pollutants, especially HAP, were not detected in some or all of the sampling runs collected during a test. In these cases, concentrations were entered in the database as "ND." Although the test reports identified those pollutants not detected for a given testing run, the detection limit (DL) values were not always provided (i.e., ND was reported rather than a detection limit concentration). Often, review of the lab report and some additional calculations were necessary to determine the DL concentration. For example, in the case of formaldehyde, detection limits were usually given in micrograms or micrograms per milliliter in the lab report. Estimation of the DL in the same units as the test data (e.g., ppb) involved the use of the sample volume collected during the test and additional unit conversions (for example, micrograms/cubic meter to ppb).

Unfortunately, the DL could not always be found or calculated based on the laboratory report. Whenever a pollutant was not detected in all three runs and the DL could not be determined, the pollutant was removed from the database. This procedure was used for report ID #1 for benzene and chromium (VI). Also, due to the calculations discussed above, two or three different DLs (one per testing run) were determined for the same pollutant in some tests. The protocol followed in these cases was to take the highest DL value.

In some tests, only one or two runs were conducted, or runs were eliminated during test report preparation due to sampling problems encountered during the test. Missing runs were entered as NR (not reported) in the database. Other parameters missing from the test reports, such as exhaust gas flow rates, were also entered in the database as NR.

The acronym NA sometimes appears in the DL field. This acronym is used in those cases when a pollutant was measured above the detection limit in all of the testing runs but a detection limit value was not reported in the test report.

Equations

Using raw test data (i.e., lab-reported pollutant concentrations and stack test parameters), calculations were performed to estimate emissions in lb/hr, lb/MW-hr and lb/MMBtu. Modules, small programs written in Visual Basic code, were built to perform the calculations. There are various modules in the emissions database that perform different tasks, but only the main modules are described in this memorandum.

The equations used in the modules were taken from EPA sampling methods 19 and 20 in 40 CFR Part 60, Appendix A. For example, for the correction of the dry pollutant concentration to 15 percent O_2, Equation 20-4 from EPA method 20 is used:

$$C_{adj} = C_d * \frac{20.9 - 15}{20.9 - \%O_2}$$

where $\%O_2$ refers to the reported oxygen level during the testing and C_d to the pollutant dry concentration in ppb.

For the calculation of emission rates in lb/hr, lb/MW-hr, and lb/MMBtu, the following equations were used :

1. Pounds per hour:

When the concentration of pollutant is given in ppb :

$$M(lb/hr) = C_{ppb} * Q * 60 * \frac{MW}{T_{std} + 460} * 1.369x10^{-9}$$

where C_{ppb} is the dry concentration of pollutant in ppb; Q is the exhaust gas flow rate in dry standard cubic feet per minute; 60 is the conversion factor from minutes to hours; MW is the pollutant molecular weight (in lb/lb-mol); T_{std} is the standard temperature in degrees Fahrenheit used in the test report; 460 is the conversion factor from degrees Fahrenheit to degrees Rankine; and $1.369x10^{-9}$ is the conversion factor from ppb to pounds per cubic feet. The conversion factor from ppb to pounds per cubic feet was derived from 40 CFR, App. A, Meth. 20, page 1026.

When the concentration of a pollutant is given in units other than ppb or ppm, the equation is :

$$M(lb/hr) = C_p * Q * 60 * A$$

where C_p is the concentration of pollutant in micrograms per dry cubic feet (:g/dscf), micrograms per dry cubic meter (:g/dscm), grams per dry cubic feet (g/dscf) or grams per dry cubic meter (g/dscm). For particulate matter, concentrations are in grains per dry cubic feet (gr/dscf), grains per dry cubic meter (gr/dscm), micrograins per dry cubic feet (:gr/dscf) and micrograins per dry cubic meter (:gr/dscm). Q is the exhaust gas flow rate in dry standard cubic feet per minute; 60 is the conversion factor from minutes to hours; and A is a conversion factor from the given units to lb/dscf.

The values for A for the different units are:

1.1 For :g/dscf, A = 2.205×10^{-8}
1.2 For :g/dscm, A = 6.24×10^{-10}
1.3 For g/dscf and g/dscm, multiplying the values given for A in 1.1 and 1.2 by 1×10^{-6}, respectively
1.4 For :gr/dscf, A = 1.43×10^{-10}.
1.5 For :gr/dscm, A = 4.043×10^{-12}.
1.6 For gr/dscf and gr/dscm, multiplying 1.4 and 1.5 by 1×10^{-6}

2. Pounds per megawatt-hour:

The emission factor is calculated by dividing the emissions rate in lb/hr by the turbine rating during the test. The manufacturer rating and the test load are necessary data for this calculation. When load was not available, it was assumed to be 100 percent. The equation is :

$$M(lb/MW-hr) = \frac{M(lb/hr)}{\frac{R * L}{100}}$$

where M(lb/hr) is the emission rate in lb/hr; R is the manufacturer rating for the turbine in MW; and L is the turbine testing load in percent.

3. Pounds per million Btu:

The equation is :

$$M(lb/MMBtu) = C_p * F * \frac{20.9}{20.9 - \%O_2} + B * \left(\frac{MW}{T_{std} + 460} \right)$$

where C_p is the dry concentration of pollutant in any of the units already described for the calculation of emission factors (1.1 - 1.6); F is the fuel factor in dry standard cubic feet per minute per million Btu; the fraction $20.9/(20.9-\%O_2)$ is an oxygen correction factor; and B is the conversion factor corresponding to the units in which the pollutant concentration is reported (see the units described in 1.1 - 1.6). The fraction $MW/(T_{std}+460)$ is a conversion factor used only when the pollutant concentration was provided in ppb.

When the fuel factor or standard temperature was not available, defaults were used. These defaults are discussed in next section.

A sample of the modules used for the calculations is provided in Attachment F-1.

Defaults and Assumptions

For the estimation of emission factors from the concentrations given in ppb, gaseous pollutants were assumed to have ideal gas behavior, so that the volume occupied by an ideal gas (22.4 liters/mol) could be used for calculation of a conversion factor.

Not all of the reports contained the necessary information required for the calculation of emission factors. Important parameters are concentrations, units, detection limits, oxygen levels, exhaust gas flow rates, fuel factors, standard temperatures and molecular weights. In most cases, fuel factors and standard temperatures were missing. In some cases, exhaust gas flow rates were not provided in the report. Lack of gas flow rates still allows for the calculation of emission factors in pounds per million Btu. Consequently, tests lacking exhaust gas flow rates were kept in the database, but the emissions in pound per hour are shown as NR.

For non-methane hydrocarbons (NMHC) and total hydrocarbons (THC), a molecular weight of 16 (as methane) was assumed. Test reports in the database indicated a molecular weight of 16 for THC and, in most cases, for NMHC. However, in some test reports, the molecular weight chosen to report emission factors for NMHC was the molecular weight of hexane.

Fields with NR for fuel factors and standard temperatures were filled with default values based on Table 19-1 in 40 CFR Part 60, Appendix A. A default standard temperature of 68°F was used. This standard temperature was selected because EPA sampling methods rely on this value.

As discussed earlier, some pollutants were not detected in one or more of the sampling runs conducted during a test. In these cases, the detection limit was used in the emission calculations. Reports generated in the emissions database use a “<” sign in front of the sampling run concentration, as well as the average concentration calculated for the three runs, to indicate when a pollutant was not detected in one or more of the runs. When a

pollutant was not detected in all three runs, a “<<” sign is shown in front of the average concentration presented in the database reports. The DL value was used in calculating the average concentration when a pollutant was not detected in one or more of the runs.

Attachment D-1
Sample of modules used in the database

The modules shown here are the modules for the calculation of emission factors in pounds per million Btu (Module Convert) and the module that handles the criteria for the use of detection limits (Module NonDetect).

1. Module for the calculation of emission factors in pounds per million Btu

1.1 Declaring the function that will perform the calculations and return the result to the query. The parameters r, s, t, u, v, w, z refer to concentration units (r), fuel factor (s), molecular weight (t), standard temperature (u), percent oxygen (v), concentration (w), and a parameter (z, set to three in the database) used to limit the number of significant digits (utilizing another module) in the result.

Function lbMMBtu (r, s, t, u, v, w, x, y, z)

1.2 Estimating the emission factor to return to the query that is calling this module. First the module identifies the units (r=ppb), then it makes sure that there are values in all necessary fields and finally performs the calculation. SigDig_ is calling another module that will perform the reduction of the result to a given number (z) of significant digits. Val calls for the numerical value of the field being processed.

```
If ((r = "ppb") And Not (s = "NR" Or t = "NR" Or v = "NR" Or w = "NR")) Then
    lbMMBtu = CStr(SigDig_((Val(s) * Val(t) * (.00000000137 / (Val(u) + 460)) *
                    (20.9 / (20.9 - Val(v))) * Val(w)), z))

ElseIf ((r = "ug/dscm") And Not (s = "NR" Or v = "NR" Or w = "NR")) Then
    lbMMBtu = CStr(SigDig_((Val(s) * Val(w) * .0283 * .000000002204 *
    (20.9 / (20.9 - Val(v)))), z))

ElseIf ((r = "ug/dscf") And Not (s = "NR" Or v = "NR" Or w = "NR")) Then
    lbMMBtu = CStr(SigDig_((Val(s) * Val(w) * .000000002204 *
    (20.9 / (20.9 - Val(v)))), z))

ElseIf ((r = "gr/dscf") And Not (s = "NR" Or v = "NR" Or w = "NR")) Then
    lbMMBtu = CStr(SigDig_((Val(s) * Val(w) * (20.9 / (20.9 - Val(v))) / 7000), z))

ElseIf ((r = "ugr/dscm") And Not (s = "NR" Or v = "NR" Or w = "NR")) Then
    lbMMBtu = CStr(SigDig_((Val(s) * Val(w) * .0283 * (20.9 / (20.9 - Val(v))) *
                    0.000001 / 7000), z))
```

ElseIf ((r = "gr/dscm") And Not (s = "NR" Or v = "NR" Or w = "NR")) Then
*lbMMBtu = CStr(SigDig_((Val(s) * Val(w) * .0283 * (20.9 / (20.9 - Val(v))) / 7000), z))*

1.3 In any other case (units not recognized or necessary parameters were not reported) the function is returned with the value “NR”

Else
lbMMBtu = "NR"
End If
End Function

2. Module Handling the use of non-detected values

2.1 Declaring the function that will return the values to the query. The parameters x and y refer respectively to concentration and detection limit.

Function Correction (x, y)

2.2 Identifying the concentration. If it is not reported, return the value “NR;” if it is not detected, take the value of the detection limit as the value for the concentration to be returned. Otherwise leave the value as it is.

If (x = "NR") Then
Correction = "NR"
ElseIf
If (x = "ND") Then
Correction = y
Else
Correction = x
End If

End Function