COMBUSTION – DIESEL FIRED ENGINES

Date Initiated:

March 10, 2010

Dates Modified / Updated:

PROCESS DESCRIPTION:

Combustion of diesel fuel in engines results in the release of several criteria pollutants and toxic air contaminants to the atmosphere. Emissions typically include NOx, SOx, ROG, PM, CO, hydrogen chloride, naphthalene, PAHs, propylene, toluene, and xylene, and some metals such as lead, manganese, nickel, and zinc, as well as other trace pollutants. Testing may include the speciation of non-methane organic compounds in the stack gas exhaust. Factors can also be derived by applying average destruction efficiency to combustible components of the fuel. Stack testing for metals is considered less reliable for emission estimation purposes than mass balance techniques based on fuel analyses.

Current District default factors have been compiled from the following sources;

- Sections 3.3, and 3.4 of AP-42 (10/96) from EPA,

- Section 2281 of Title 13, California Code of Regulations (8/2004) and,

- Ventura County Air Pollution Control District AB 2588 Combustion Emission Factors (5/2001).

All emission factors have been converted into units of lbs pollutant/1000 gallons fuel burned. This conversion is necessary to allow comparisons of like emission factors for different types of equipment and fuels. Emission factors for diesel-fired engines represent "controlled releases." Therefore, any reported control efficiencies should not be used in emissions calculations. The following equations are used to calculate releases of each compound:

Ea = Ua x EF

Eh = Uh x EF

Where:

Ea = Annual emissions of each listed substance per device, (lbs/year)

Eh = Maximum hourly emissions of each listed substance per device, (lbs/hour)

Ua = Annual fuel consumption per device, (1000 gallons burned)

Uh = Maximum hourly fuel usage per device, (1000 gallons burned)

EF = Emission factor, (lbs pollutant/1000 gallons burned)

EMISSIONS INFORMATION:

Emission factors from the above documents are used as default values for total organic gases (TOG), reactive organic gases (ROG), oxides of sulfur (SOx), oxides of nitrogen (NOx), particulate matter 10 microns or less (PM10), particulate matter 2.5 microns or less (PM2.5), carbon monoxide (CO), and trace toxics unless more accurate emission factors are entered into the database for the given device. Default factors can be "overwritten" by inserting site-specific values into the emission factor section of the data entry form.

ARB certifies diesel engines meeting different tiered emission standards for hydrocarbon (HC), oxides of nitrogen (NOx), non-methane hydrocarbons plus oxides of nitrogen (NMHC+NOx), carbon monoxide (CO), and particulate matter (PM) in grams/kilowatt-hour (g/kw-hr) and categorizes them in engine family numbers. It is assumed that HC and NMHC are the same as ROG for emissions estimation purposes. Specific engine emission factors for diesel particulate, CO, NOx, ROG+NOx, ROG, and TOG in grams/brake horsepower-hour (g/bhp-hr) are converted to lbs/1000 gallons assuming brake-specific fuel consumption of 7,000 BTU/hp-hr, diesel BTU content of 19,300 BTU/lb, and density of 7.1 lb/gal (137,000 BTU/gal) per AP-42 Table 3.3-1. Likely sources of other acceptable engine-specific emission factors that upon District review and approval could be used in lieu of District default factors are District source test results, manufacturing engine data, ARB engine certification with family number or EPA engine certification with supporting documentation.

Fuel usage and hours of operation are broken down into non-emergency and emergency usage. Emissions are evaluated for non-emergency use per ARB Emission Inventory Criteria and Guidelines for the Air Toxics “Hot Spots” Program, Section XI Diesel Engine Reporting Requirements. Emergency fuel usage and hours of operation are collected to obtain a complete understanding of diesel engine operations.

ASSUMPTIONS / LIMITATIONS:

- Equipment types, designs, burner configurations, operating temperatures, control devices, and other variables may significantly affect emissions from any given type of device or fuel. In some cases, the existing database default factors may not adequately assess emissions from a particular type of equipment. New sets of default factors should be developed and entered into the database when available. The addition of more "default choices" improves the flexibility of the database and is the key ingredient to "continuous improvement" of the system.

- Emissions of diesel particulate include, but are not limited to non-VOC toxic emissions quantified such as lead, manganese, mercury, nickel, and zinc. PM10 and diesel particulate matter are considered interchangeable. Hence, default diesel particulate emission factors are equivalent to AP-42 PM10 emission factors for diesel engines.

- Due to the ARB Airborne Toxic Control Measure for Stationary Compression Ignition Engine, emission factors for NMHC+NOx may be documented to show that it is meeting emissions standards. ROG and NOx emission factors are estimated using AP-42 individual pollutant emission factor ratios and engine rating.

- In some instances, EPA documents contain multiple conflicting values for ROG emissions or missing ROG values. A combination of the EPA TOC emission factor and the EPA VOC Speciation were usually used to derive ROG factors when a conflict or omission in reported values existed.

- Default emission factors should be developed for each type of fuel used in each type of equipment. In many cases, trace toxic data is extremely limited and criteria pollutant data is somewhat variable. General assumptions regarding fuel composition and destruction efficiency may have been used to develop default factors until more accurate information becomes available. Often, pooled testing of similar equipment is more accurate for average annual estimation purposes than a single test of the actual device.

- Biodiesel is not typically used in engines as an alternative fuel to diesel. Biodiesel emission factors are currently still under development for various blends noted as Bnumber, where number is the percent biofuel. For example, B20 is 20% biofuel and 80% diesel. Until approved biodiesel emission factors are available, diesel emission factors are used as defaults.

FORMS:

The Combustion - Diesel Fired Engines form should be used to obtain information for internal combustion engines burning diesel fuel. Internal combustion engines burning gasoline, propane, jet fuel, or residual oil should be reported on Combustion - Liquid Fuel form. Engines burning natural gas, landfill gas, or digester gas should be reported on Combustion - Gaseous Fuel form.