

Area Source Emission Inventory Methodology Diesel Agricultural IC Engines (Revised October 2017)

EMISSION INVENTORY SOURCE CATEGORIES:

SIC = 3519 Internal Combustion Engines, Not Elsewhere Classified
NAICS = 333618 Other Engine Equipment Manufacturing

EMISSION INVENTORY CODES AND DESCRIPTION:

| EIC | CES | DESCRIPTION |
|-------------------|-------|--|
| 052-042-1200-0010 | 92171 | Agricultural Irrigation I.C. Engines – Diesel – Stationary |
| 052-042-1200-0011 | 92189 | Agricultural Irrigation I.C. Engines – Diesel – Portable |

METHODOLOGY DESCRIPTION:

This category is used to inventory emissions from diesel agricultural internal combustion (IC) engines. In response to the State’s Stationary Diesel Engine ATCM, the Santa Barbara County APCD requires all diesel agricultural engines rated at 50 brake horsepower (bhp) or greater to be registered with the District.

Information for each diesel agricultural engine registered with the district is updated as necessary and provided on the engine’s registration form and includes its horsepower rating, model year and engine tier.

Estimated average operating hours are provided on the registration application form for each diesel agricultural engine and are used to calculate annual fuel usage. Fuel usage is calculated using the following equation:

$$\text{kgal burned} = \text{Annual Hours} * \text{bhp rating} * (7,500 \text{ BTU/bhp-hr}) * [1/(138,500 \text{ BTU/gal})] * (1/1000)$$

EMISSION FACTORS:

There are multiple sets of emissions factors used for diesel agricultural IC engines based on the engine tier, maximum rated horsepower, and model year. For diesel engines that are Tier 0, the District has developed the following set of default emission factors (g/bhp-hr):

| Tier | Model Year | ROC | NOx | SOx | CO | PM |
|------|------------|------|-------|-------|------|------|
| 0 | Pre-1996 | 1.12 | 14.06 | 0.224 | 3.03 | 0.98 |

The District default emission factors can be converted to lb/kgal using the following equation:

$$\text{lb/kgal} = (\text{g/bhp-hr}) / (7,500 \text{ Btu/bhp-hr}) / (453.6 \text{ g/lb}) * (138,500 \text{ Btu/gal}) * (1000 \text{ gal/kgal})$$

The District uses the U.S. EPA’s emission standards for Tier 1-4 engines, which can be found on our website.¹

ASSUMPTIONS:

- Engines use 7,500 Btu of energy per brake horsepower-hour (bhp-hr) that they operate.
- The energy content of the diesel fuel is 138,500 Btu per gallon.
- Agricultural engines with unknown annual operating hours are assumed to operate 1,000 hours per year.
- Stationary agricultural engines represent 65% of total emissions and portable agricultural engines represent 35% of total emissions.²
- Emissions from agricultural engines rated at less than 50 bhp in Santa Barbara County are assumed to be insignificant and are not estimated.
- The fraction of reactive organic gases (FROG) in the engine exhaust is 0.8785

TEMPORAL ACTIVITY:

The current monthly temporal profile for diesel agricultural IC engines is based on the San Joaquin Valley APCD’s area source methodology and assumes that approximately 67% of the emissions occur in the summer months (May-October) and 33% in the winter months (November-April)³

| | | | | | | | | | | | |
|------|------|------|-------|-------|-------|-------|-------|-------|------|------|------|
| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 4.4% | 4.4% | 4.4% | 11.5% | 11.5% | 11.5% | 13.4% | 13.4% | 13.4% | 4.0% | 4.0% | 4.0% |

EMISSIONS EXAMPLE:

2016 Diesel Ag IC Engines Process Rates (lb/kgal) and Emissions (ton/yr)

| Engine Type | kgal Burned | ROC (ton/yr) | NOx (ton/yr) | CO (ton/yr) | PM (ton/yr) | SOx (ton/yr) |
|---------------|-------------|--------------|--------------|-------------|-------------|--------------|
| Stationary Ag | 1006.49 | 7.05 | 80.89 | 67.27 | 4.41 | 0.11 |
| Portable Ag | 572.97 | 4.02 | 46.05 | 38.30 | 2.51 | 0.06 |

2016 Diesel Ag I.C. Engines Average Emission Factors (lb/kgal)

| Engine Type | TOG EF | ROC EF | NOx EF | CO EF | PM EF | SOx EF |
|--------------------------|--------|--------|---------|--------|-------|--------|
| Stationary & Portable Ag | 15.954 | 14.015 | 160.744 | 133.68 | 8.773 | 0.224 |

¹ <https://www.ourair.org/dice/emission-factors/>

² CARB’s Ag. Irrigation I.C. Engines – Diesel (April 2003) Area Source Methodology

³ SJVAPCD’s Agricultural Irrigation Pumps (May 2003) Area Source Methodology