NATURAL RESOURCES CONSERVATION SERVICE - ILLINOIS

CONSERVATION PRACTICE GUIDANCE

372 – COMBUSTION SYSTEM IMPROVEMENT

I. SCOPE

Real emission reductions are achieved when removing and permanently destroying old, high-polluting internal combustion engines and replacing with new, cleaner technologies. Retiring high-polluting engines earlier than through normal attrition assists agricultural producers with reducing oxides of nitrogen (NOx), volatile organic compounds (VOC) [ozone precursors] and particulate matter [PM = respirable (PM10) and fine (PM2.5) particulate] emissions from the engines they operate.

Combustion system improvement may also be used to improve energy efficiency of existing equipment.

II. CRITERIA

The existing engine is to be fully functional, in operational condition and have the ability to start-up.

Practice Code 372 does not apply to engines or electric motors installed at pumping plants, which are instead covered under Practice Code 533, Pumping Plant.

Where the combustion system improvement is to be accomplished by replacing the existing engine with a new engine, the fuel consumed by the new engine (whether petroleum-based, renewable, or a blend of petroleum-based and renewable fuel) must conform to the new engine warranty and meet any applicable air quality standards.

When installing a replacement combustion system for air quality improvement, the new replacement engine must emit less oxides of nitrogen and/or fine particulate matter than the replaced combustion system.

When installing a replacement combustion system for energy efficiency improvement, the new replacement engine shall be certified to be at least 20% more energy efficient than the system being replaced.

III. EMISSION CALCULATIONS

Document air pollutant emissions of the existing system and the proposed replacement.

Determine emission reductions by calculating the emissions from the existing engine to establish a baseline. Calculate and subtract the emissions of the new engine from the baseline, to report the estimated emission reductions. An emissions inventory will report the estimated annual emissions and track the emission reductions as a result of implementing this conservation practice.

At a minimum, emission calculations require the following data:

- Engine Model Year
- Engine Rated Brake Horsepower
- Type of equipment the engine powers (to determine the load factor)
- Annual hours the engine operates
- Applicable emission factors. If emissions data from an approved source test is not available for the specific engine, use the emission factors in the tables below.

IV. DESTRUCTION AND DISPOSAL OF THE REPLACED ENGINE

After being replaced, the existing engine must be destroyed. Destruction removes the existing high-emitting engine from service and ensures that the emission reductions and/or energy savings are real and permanent. It also prevents the old engine from being rebuilt or moved into another locale to continue emitting high levels of pollutants and/or expending energy inefficiently.

Engine and equipment destruction must be performed in a safe manner that avoids any personal injury risks.

Destruction of the engine may be accomplished by one of the following methods:

1. Disposal by a scrap metal recycling operation or dismantler; or

2. Permanently disabling the old engine block by puncturing with at least a six inch diameter hole to include a portion of the oil pan rail (sealing surface) or by cutting the engine block into multiple pieces. The disabled engine or a copy of the written certification must be kept on-farm for inspection.

The producer must provide the NRCS with a written and signed certification that the engine and associated equipment has been permanently destroyed. If destruction was performed by an approved dismantler or scrap metal recycler, the dismantler will provide the producer with the written certification for submittal to the NRCS. The certification should describe the following:

- The existing engine and equipment type,
- The existing engine serial number,
- The date the existing engine and equipment were decommissioned ,
- How the existing engine and equipment were destroyed
- Specify that no parts or components were or will be parted-out, used or sold as parts, or used to rebuild and engine or equipment intended for destruction.

V. PERFORMANCE AND MAINTENANCE REPORTS

NRCS recommends that producers maintain records of new engine usage for at least five years of operation. Recommended records include the annual hours of operation and gallons of fuel used or kilowatts consumed (if electric) over a calendar year. Records should also record routine maintenance performed on the engine and equipment. The objective is to determine engine usage and the resulting emissions.

REFERENCES

USDA-NRCS California, Conservation Practice Specification 372, September 2010.

United States Environmental Protection Agency, Non-road Diesel Equipment, www.epa.gov/nonroad-diesel/index.htm
Santa Barbara County Air Pollution Control District, http://www.sbcapcd.org/eng/atcm/dice/epatiers1-4.pdf

Emissions Calculations

$$\text{Emissions}_{\text{Tons/year}} = \frac{[(\text{EF } g/bhp\text{-}hr) \times (\text{engine max rated bhp}) \times (\text{annual hours}) \times (\text{load factor})]}{(907{,}200\ g/ton)}$$

Where: Emissions = emissions of NO_x, VOC, or PM
EF = Emission Factor (from Table 1, 2 or 4)

Table 1
Uncontrolled Off-Road Compression-Ignition (Diesel) Engines
Emission Factors (g/bhp-hr)

Horsepower	Model Year	NOx	VOC*	PM10
50 – 119	Pre 1988	12.09	1.73	0.547
	1988 – 1995	8.14	1.19	0.497
120 +	Pre 1970	13.02	1.59	0.554
	1970 – 1979	11.19	1.20	0.396
	1980 – 1987	10.23	1.06	0.396
	1988 – 1995	7.60	0.82	0.274

Source: NRCS-CA Specification 372

**For purposes of determining average annual air emissions, Reactive Organic Gases (ROG) are considered equivalent to Volatile Organic Compounds (VOC).*

Table 2
Controlled Off-Road Compression-Ignition (Diesel) Engines
Emission Factors (g/bhp-hr) *(see also Figure 1)*

Tier	Horsepower	NOx	VOC	PM10
1	50 - 119	6.54	1.19	0.552
	120 - 174	6.54	0.82	0.274
	175 +	5.93	0.38	0.108
2	50 - 119	4.75	0.23	0.192
	120 - 174	4.17	0.19	0.128
	175 - 250	4.15	0.12	0.088
	251 +	3.79	0.12	0.088
3	50 - 120	2.74	0.12	0.160
	121 - 750	2.32	0.12	0.112
4 Interim (4i)	50 - 120	2.40	0.11	0.056
	121 - 174	2.15	0.11	0.008
	175 - 750	1.29	0.08	0.008
	>750	2.24	0.12	0.048
4 Final	50 - 120	1.33	0.08	0.008
	121 – 750	0.26	0.06	0.008
	>750	2.24	0.06	0.016

Source: NRCS-CA Specification 372

Table 3
Diesel Agricultural Equipment Default Load Factors

Hydro Power Units	0.48	Other Agricultural	0.51

Source: NRCS-CA Specification 372

Table 4
Off-Road Large Spark-Ignited Engines
Emission Factors (g/bhp-hr)

Horsepower	Fuel	Model Year	NOx	VOC	PM10
50-120	Gasoline	Uncontrolled – Pre 2004	11.84	2.66	0.060
		Controlled 2001-2006	1.78	0.26	0.060
		Controlled 2007-2009	1.19	0.18	0.060
		Controlled 2010+	0.36	0.05	0.060
	Alt Fuel	Uncontrolled – Pre 2004	10.51	1.02	0.060
		Controlled 2001-2006	1.58	0.11	0.060
		Controlled 2007-2009	1.05	0.07	0.060
		Controlled 2010+	0.32	0.02	0.060
>120	Gasoline	Uncontrolled – Pre 2004	12.94	1.63	0.060
		Controlled 2001-2006	1.94	0.16	0.060
		Controlled 2007-2009	1.29	0.11	0.060
		Controlled 2010+	0.39	0.03	0.060
	Alt Fuel	Uncontrolled – Pre 2004	10.51	0.90	0.060
		Controlled 2001-2006	1.58	0.09	0.060
		Controlled 2007-2009	1.05	0.06	0.060
		Controlled 2010+	0.32	0.02	0.060

Source: NRCS-CA Specification 372

Table 5
Off-Road Large Spark-Ignited Equipment Default Load Factor

Other Agricultural	0.55

Source: NRCS-CA Specification 372

Figure 1
Summary of EPA Emission Standards for Nonroad Compression Ignition Engines
(Tier by model year)

Horsepower	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
<25	1	1	2	2	2	4	4	4	4	4	4	4	4
25-74	1	2	2	2	2	4i	4i	4i	4i	4i	4	4	4
75-99	1	2	2	2	2	3	3	3	3	4i	4i	4	4
100-174	2	2	2	2	3	3	3	3	3	4i	4i	4	4
175-750	2	2	2	3	3	3	3	3	4i	4i	4i	4	4
>750	1	1	1	2	2	2	2	2	4i	4i	4i	4i	4