

TECHNICAL NOTES

U.S. Department of Agriculture

Natural Resources Conservation Service

TN – Air Quality – CA – 01

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Glossary for California Off-Road Agricultural Engines CPS 372 – Combustion System Improvement

After Treatment Devices: also referred to as *exhaust stream control devices*, remove pollutants from exhaust gases after the gases exit the combustion chamber (e.g., catalytic converters, diesel particulate filters).

Air Quality Authority: includes the US Environmental Protection Agency (EPA), California Air Resources Board (ARB), and any state agency or a local Air Pollution Control District (APCD) or Air Quality Management District (AQMD) within California with designated or delegated Clean Air Act authority.

Airborne Toxic Control Measure (ATCM) for Compression-Ignition Engines: ARB establishes emission limits that apply to stationary and portable diesel engines rated at greater than 50 brake-horsepower, including those used in agriculture. Stationary engines are codified in Section 93115 and portable engines in Section 93116 of Title 17, California Code of Regulations. The compliance deadlines specified in the ATCMs or in any applicable air district rule essentially phases-out the continued use of older stationary and portable engines. ATCMs for stationary and portable engines are posted at:

Stationary Diesel Engines:

ATCM: <https://www.arb.ca.gov/diesel/documents/FinalReg2011.pdf>

ARB Stationary Diesel Engines: <https://www.arb.ca.gov/diesel/statporthome.htm>

Portable Diesel Engines:

ATCM: <https://www.arb.ca.gov/portable/perp/perpatcm.pdf>

ARB Portable Equipment: <https://www.arb.ca.gov/portable/portable.htm>

Ambient Air Quality Standards: the National Ambient Air Quality Standards (NAAQS) and California Ambient Air Quality Standards (CAAQS) are health- and welfare-based ambient standards for outdoor air, which identify the maximum acceptable average concentrations of air pollutants during a specified period of time.

ARB has a chart listing the NAAQS and CAAQS standards for ambient pollutants, available at: www.arb.ca.gov/research/aaqs/aaqs2.pdf.

ARB: the State of California Air Resources Board. Website: <http://www.arb.ca.gov>

Baseline Engine: see *In-Use Engine*

Biodiesel: an alternative diesel fuel for used in a compression-ignition engine that is derived from vegetable oils or animal fats. Biodiesel is not a petroleum-based fuel, but produced through a process called “transesterification” that converts these oils and fats into long-chain mono alkyl esters. Biodiesel that is 100 percent pure is referred to as B100, which meets the specifications set forth by [ASTM D6751](#), *Standard Specification for Biodiesel Fuel Blend Stock (B100) for Middle Distillate Fuels*. B100 is used primarily as a blend-stock with petroleum-based diesel fuel than used for powering an engine, of which the most common blends on the market today are B5 (up to five percent biodiesel blended with 95 percent petroleum-based diesel fuel) and B20 (six to 20 percent biodiesel blended with petroleum-based diesel fuel). See *Diesel Fuel*.

According to the US Department of Energy, B20 provides a good balance of cost, emissions, cold-weather performance, materials compatibility, and ability to act as a solvent. However, biodiesel blends above 20 percent will have a lower energy content on a per gallon basis, may impact engine manufacturer warranties, might gel in cold temperatures, and could present unique storage issues. Though air toxic contaminants from engine exhaust are greatly reduced, an increase in oxides of nitrogen (NOx) emissions can be expected from using the higher biodiesel blends.

The US Department of Energy summarizes the biodiesel specifications at:
http://www.afdc.energy.gov/fuels/biodiesel_specifications.html

Biogas: also referred to as *renewable natural gas*, consists primarily of methane and carbon dioxide and is derived through the aerobic decomposition of organic matter or the thermochemical gasification of biomass materials. Gases collected by a biogas control system, such as a digester, can also contain hydrogen sulfide gas. Biogas as a fuel may be used to power a genset for producing electricity, compressed and used as a transportation fuel, or upgraded to natural gas utility standards for pipeline injection. Engines fueled by biogas are typically spark-ignition engines.

The US Department of Energy has more information on renewable natural gas at:
http://www.afdc.energy.gov/fuels/natural_gas_renewable.html

EPA’s AgSTAR program maintains a database of livestock anaerobic digesters at:
<https://www.epa.gov/agstar/livestock-anaerobic-digester-database>

California Code of Regulations (CCR): Website: <http://www.oal.ca.gov/ccr.htm>

Carl Moyer Memorial Air Quality Standards Attainment Program: a California incentive-based voluntary emission reduction program administered by the ARB and local air districts that provides payments for installing cleaner emissions than required technologies, including new off-road agricultural engines.

The Carl Moyer Program Guidelines are available at:
<http://www.arb.ca.gov/msprog/moyer/guidelines/current.htm>

Certification Value (CERT): the product of the measured emissions of the prototype engine at zero hours that includes a calculated or assigned deterioration factor.

Certified Compression-Ignition Engine: a Tier 1, Tier 2, Tier 3, Tier 4-Interim, and Tier 4-Final compression-ignited engine certified by the EPA and/or the ARB.

EPA Engine Databases for Nonroad CI Engines are available on-line at:
<https://www3.epa.gov/otaq/certdata.htm#largeng>

ARB Executive Orders are posted on-line at: www.arb.ca.gov/msprog/offroad/cert/cert.php.

Certified Spark-Ignition Engine: is an ARB-certified spark-ignited engine as specified in Section 2433 of Title 13, California Code of Regulations.

ARB Executive Orders are posted on-line at: www.arb.ca.gov/msprog/offroad/cert/cert.php.

Code of Federal Regulations (CFR): Website: <http://www.ecfr.gov>

Compression-Ignition Internal Combustion Engine: an engine that uses the heat of compression to initiate combustion. These engines generally operate on diesel fuel, biodiesel, or biodiesel blends.

Conservation Practice Standard (CPS): a specific treatment used to meet a specific need in carrying out landowner objectives for which standards have been developed. Standards set forth the minimum acceptable level of quality that is required to plan, design, install, operate, and maintain conservation practices. Specifications are site specific guides that establish the technical details and workmanship required to install the conservation practice in accordance with the requirements of the Conservation Practice Standard. Standards and specifications are found in Section IV of the Field Office Technical Guide.

Criteria Air Pollutant: derived from EPA, an air pollutant for which acceptable levels of exposure can be determined and an ambient air quality standard has been established, based on the pollutant's characteristics and potential health and welfare effects. These pollutants include ozone (O₃), carbon monoxide (CO), nitrogen dioxide (NO₂), sulfur dioxide (SO₂), particulate matter (PM₁₀ and PM_{2.5}), and lead (Pb).

Destruction: in-use engines and associated equipment replaced with new engines and equipment are permanently removed from service by being scrapped at approved salvage yards. Destruction ensures the emission reductions are real and prevents the replaced equipment and parts from being moved to another locale to continue emitting high levels of pollutants.

Diesel Engine: a compression-ignited two- or four-stroke reciprocating internal combustion engine in which liquid fuel (i.e. diesel fuel) is injected into the combustion chamber and ignites when the air charge is compressed to a temperature sufficiency high for auto-ignition.

Diesel Exhaust Fluid (DEF): a liquid solution of urea and deionized water that is injected directly into the diesel exhaust upstream of the Selective Catalytic Reduction (SCR) device, a diesel exhaust after treatment device designed to reduce NO_x emissions. The DEF is mixed with the diesel exhaust in the presence of the catalyst and converts NO_x into nitrogen and water vapor.

Diesel Exhaust Particulate Matter: the ARB designates diesel exhaust particulate matter as a toxic air contaminant (TAC) based on its potential to cause cancer, premature death, and other health problems. As a result, ARB established several Airborne Toxic Control Measures (ATCM's) codified in the California Code of Regulations. The ATCM's establish emission standards to reduce diesel exhaust particulate matter and health risks.

Diesel-exhaust particulate matter ATCM's and others are posted on-line at:
www.arb.ca.gov/toxics/atcm/atcm.htm.

Diesel Fuel: any liquid fuel supplied and represented by the supplier as diesel fuel, No 1-D, or No 2-D fuel oil according to specifications described in [ASTM D975](#) "*Standard Specification for Diesel Fuel Oils*" and suitable for use in a compression-ignition engine. For California, diesel fuel may include "ARB Diesel Fuel" that meets the specifications defined in Sections 2281 and 2282 of Title 13, California Code of Regulations, or "Alternative Diesel Fuels" (ADF) per ARB guidance on biodiesel and biodiesel blends. See *Biodiesel*.

Diesel Particulate Filter: an after treatment device that physically captures diesel particulate and prevents their discharge from the tailpipe. Collected particulates require removal from the filter, usually by continuous or periodic oxidation in a process called *regeneration*.

Dual-Fueled Diesel Engine: any compression-ignition engine that is engineered and designed to operate on a combination of alternative fuels, such as compressed natural gas (CNG) or liquefied petroleum gas (LPG) with diesel fuel. These engines have two separate fuel systems, which inject both fuels simultaneously into the engine combustion chamber.

EPA Integrity Criteria: the EPA applies four criteria for voluntary emission reductions to be creditable under a State Implementation Plan (SIP):

- **Enforceable:** the emission reductions are verifiable by inspections, monitoring, record keeping, or other measures.
- **Permanent:** the emission reductions are permanent, generally through actions that permanently disable and physically destroy in-use baseline engines and their associated components, equipment or vehicles. New electric motors and new engines along with and the accompanying components or equipment are maintained and operated according to manufacturer recommendations for the duration of the project lifespan.
- **Quantifiable:** the emission reductions are determined through the use of emissions source test data or publically available emission factors and calculation methodologies.
- **Surplus:** the emission reductions are not otherwise required by any federal, state, or local air quality authority regulation, or legal mandate, and are in excess of any baseline emission levels stipulated in a State Implementation Plan.

Emergency Stand-by Engine: a stationary or portable internal combustion engine where the primary purpose is to provide temporary electrical or mechanical power during an unscheduled outage caused by a sudden and reasonably unforeseen natural disaster or events beyond the control of the operator. Such engines may operate for a limited number of hours per year (such as 100 hours or less in a calendar year) for periodic or routine maintenance to verify its readiness for emergency standby use. Examples include an engine powering an electric generator to provide electric power or powering a water pump for firefighting or flood control. Engines not considered emergency standby engines are used: for reducing electrical power demand when normal electrical power line service has not failed; to produce power for the utility electrical distribution system; in conjunction with a voluntary utility demand reduction program or interruptible power contract; or to pump water for irrigation.

Emission Control System: any device or system employed with engines or piece of equipment intended to reduce emissions. Examples of emission control systems include, but are not limited to: closed-loop fuel control systems, three-way catalysts, fuel injection systems, and combinations of the above.

Emission Standards for Off-Road Diesel Engines: a new, replacement off-road diesel engine meeting the most recent California emission standards, or the most recent EPA emission standards if the engine is federally preempted. The Tier designation for the new diesel engine is determined from ARB Executive Order (or EPA Certification of Conformity for federally preempted engines), which also identifies the emission standards as “STD” in the ARB Executive Order. Certification is granted annually to individual engine families and valid for one model year.

ARB Executive Orders are posted on-line at: www.arb.ca.gov/msprog/offroad/cert/cert.php.

Engine Family Name: certifies a group of engines with similar emissions characteristics. In California, certified emission standards determinations are by ARB Executive Order (or EPA Certificate of Conformity for federally preempted engines if ARB Executive Order is not available) based on the engine family designation. An engine model listed under the engine family will identify the engine manufacturer's description of the engine displacement, number of cylinders, fuel system, emission control systems, and other engine and emission control system characteristics.

ARB Executive Orders are posted on-line at: www.arb.ca.gov/msprog/offroad/cert/cert.php.

EPA posts spreadsheet files of the certified nonroad compression-ignition engines on-line at: <http://www.epa.gov/otaq/certdata.htm#nrci>

EPA: the United States Environmental Protection Agency. California, Nevada, Arizona, Hawaii, the Pacific Islands, and 148 tribes are administered under EPA Region 9. Website: <http://www.epa.gov/region09/air/>

Existing Engine: see *In-Use Engine*.

Exhaust Gas Recirculation (ERG): where engine exhaust is recycled back through the engine intake, which dilutes the oxygen in the combustion chamber and reduces NOx emissions.

Family Emission Limit (FEL): an emission level declared by the manufacturer for use in any averaging, banking and trading program and in lieu of an emission standard for certification. It serves as the applicable emission standard for determining compliance of any engine within an engine family. National FEL emission standards and requirements begin in Section 1039.101 of 40 CFR, Chapter 1, Subpart U, and California standards in Sections 2423 and 2327 of Title 13, California Code of Regulations.

Fuel Additive: any product approved by the ARB that is designed to be added to fuel or to fuel or engine-related systems to enhance combustion by decreasing emissions, improving fuel economy, increasing engine performance, or improving fuel economy.

Flexibility Provision: provisions that allow equipment manufacturers the flexibility to produce a limited amount of off-road equipment with nonroad engines that are subject to less stringent emission standards after the Tier 4 emission standards begin to apply. The purpose is to provide equipment manufacturers with additional lead time for redesigning their equipment.

The National flexibility provisions are codified in Sections 1039.625, 1039.626, and 1068.265 of 40 CFR, Chapter 1, Subchapter U. For purposes of Section 1068.265, the family name cited on the label will not include its initial model-year prefix letter.

The California flexibility provisions are similar and codified in Section 2423(d) of Title 13, CCR. An ARB Executive Order for the current model-year will list the earlier model-year prefix letter in the engine family name certified under the California's flexibility provisions.

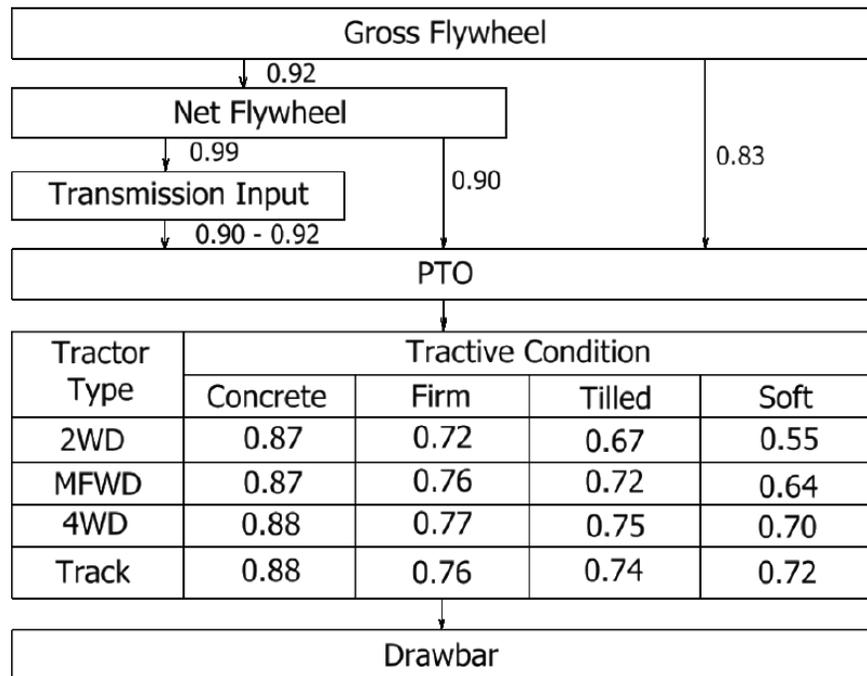
Gasoline: any fuel commonly or commercially known or sold by a supplier as gasoline, or is a mixture of any fuel commonly known or sold as gasoline and alcohol.

Gen-Set: a generator set, which is a generating system comprising of an engine driving an electrical generator. Examples include electric generation operations associated with biogas collection systems (e.g. dairy digesters) or with emergency standby engines.

Gaseous Fuels: fuel that is a gas under standard conditions, including natural gas, methane, propane, butane, biogas, and liquefied petroleum gas.

Horsepower (hp): a unit measure of power. Many different types and standards define horsepower. To help address this, the Society of Automotive Engineers International (SAE) develops industry standards and protocols that manufacturers use for measuring engine horsepower. These standards account for the different horsepower relationships of the engine and the components it powers. The American Society of Agricultural and Biological Engineers (ASABE) illustrates these maximum power relationships in Figure 1 by describing what would be expected from a two-wheeled drive tractor.

Figure 1: Power Relationship for Agricultural Tractors



American Society of Agricultural and Biological Engineers (ASABE)
 Agricultural Machinery Management Data, ASAE D497.7
 March 2011, Reaffirmed December 2015

Only the following are defined for CPS 372 purposes:

- **Brake Horsepower (bhp):** is the rated horsepower capacity specified for the engine by the manufacturer or defined by the engine nameplate under standard conditions without regard to any de-rating or modification. It is the measure of an engine's horsepower without the loss in power caused by the gearbox, generator, differential, water pump, and other auxiliary components that may slow down the actual speed of the engine. May also be referred to as the *SAE Gross Horsepower*, for CPS 372 purposes the engine horsepower determination is based on the manufacturer's advertised brake-horsepower rating under normal operating conditions.
- **Drawbar Horsepower:** is the power an agricultural tractor needs to pull an implement. Tractor performance is measured by coupling a special dynamometer car behind a tractor that continuously records the speed and pull exerted to measure the generated power. For CPS 372 purposes, drawbar horsepower is not used for determining engine rated horsepower due to variations vehicle design and load characteristics, type of hitch and implements, and soil surface condition. More information on drawbar horsepower is available in the referenced ASABE publications.
- **Gross Horsepower:** also referred to as *SAE gross horsepower*, is measured in accordance with Society of Automotive Engineers protocols, generally operating without its belt-driven accessories. For CPS 372 purposes, gross horsepower may be used as the engine horsepower determination provided that brake-horsepower information is not available.
- **Kilowatts:** the metric system unit measure of power. Kilowatts may be converted into horsepower and vice versa by applying the following calculations:

$$\text{Horsepower} = \text{Kilowatts} \times 1.3410$$

$$\text{Kilowatts} = \text{Horsepower} \times 0.7457$$

- **Net Horsepower:** also referred to as *SAE net horsepower*, is measured in accordance with Society of Automotive Engineering protocols. These protocols call for the engine to operate with power-consuming standard accessories, which result in ratings within closer alignment to the engine power as configured and sold in a vehicle or equipment. For CPS 372 purposes, situations where the engine brake- or gross- horsepower rating cannot be determined from an engine label, manual, records or specifications, engine gross horsepower rating can be estimated by multiplying the advertised net-horsepower value by 1.087.

$$\text{Estimated Rated Gross Horsepower} = \text{Net Horsepower} \times 1.087$$

- **Power Take-Off (PTO) Horsepower:** is the usable horsepower measurement at the power take-off (PTO) shaft's output and is the power available for tractor attachments and implements. For CPS 372 purposes, situations where the horsepower rating of an in-use engine cannot be determined from an engine label, manual or records, the in-use engine gross-horsepower rating can be estimated by multiplying the advertised PTO horsepower

value by 1.20. In addition, the PTO horsepower rating can also be a means for verifying equipment similarity (“like-for-like”) by comparing the baseline PTO horsepower with the new PTO horsepower.

$$\textit{Estimated Rated Gross Horsepower} = \textit{PTO Horsepower} \times 1.20$$

In-Use Engine: also referred to as an *existing engine, old engine, or baseline engine*, is the engine used to establish baseline emissions parameters. This engine and its associated components are fully functional, in operational condition, able to start-up, and power the component or equipment it is intended to operate.

Independent Source Test Contractor: a program administered by the ARB that approves private independent source testing contractors to conduct required compliance emissions verification testing. Though ARB does not require testing contractors to be approved prior to testing in California, approval is required if the contractor wishes to conduct source testing for compliance verification purposes.

ARB’s list of approved independent contractors: www.arb.ca.gov/ba/icp/current.pdf.

Internal Combustion Engine: an *IC engine* is any spark- or compression-ignited reciprocating engine.

Hour Meter: future annual hours of equipment operations for calculating emission reductions are determined from an installed, non-resettable hour meter, which is fully functional over the project lifespan and used by the operator to record annual usage. The operator must correct any malfunctions by repairing or replacing the hour meter as soon as possible.

Lean-burn Engine: a spark-ignition internal combustion engine that operates with an exhaust stream oxygen concentration of four percent by volume or greater prior to any exhaust stream control device.

Lifespan: CPS 372 project lifespan is 10 years. Engine manufacturers provide EPA and ARB with *useful life* data for the engines and associated emissions control technologies under an Engine Family Name, which is reported on an ARB Executive Order. The emission standards include durability requirements to ensure compliance with the emission standards throughout the useful engine life. Unless otherwise indicated, the majority of off-road compression-ignition engine families will specify the useful life as 8,000 hours.

Like-for-Like: the new engine powers equipment and components that serves the same function and performs equivalent work to the equipment and components being replaced. Examples include replacing a tractor for a tractor, an irrigation engine for an irrigation engine, a loader for a loader, a combine for a combine, etc.

Mobile Engine: an engine used to self-propel a vehicle or equipment, or to serve a dual purpose by propelling itself and performing another function.

Nonattainment Area: a geographic area identified by the EPA as not meeting the NAAQS pursuant to the Clean Air Act. In addition to the NAAQS, the ARB establishes California specific ambient standards that may be similar or more stringent than the six criteria NAAQS air pollutants, or apply to additional air pollutants that are not included in the NAAQS. These geographic areas that exceed the state ambient standards are deemed by ARB as nonattainment of the California Ambient Air Quality Standards for a given pollutant pursuant to the California Clean Air Act.

Nationally designated non-attainment areas for criteria air pollutants are on-line at:
<https://www3.epa.gov/airquality/greenbook/>

California-state designated non-attainment areas are on-line at:
<http://www.arb.ca.gov/desig/statedesig.htm>

Non-Methane Hydrocarbon (NMHC): the sum of all hydrocarbon air pollutants, except for methane. See *Reactive Organic Gases (ROG)* and *Volatile Organic Gases (VOC)*.

Nonroad Compression-Ignition Engines: the federal definition is found in 40 CFR Part 89. See *Off-Road Compression-Ignition Engines*.

NO_x: a general designation pertaining to compounds of nitric oxide (NO), nitrogen dioxide (NO₂) and other oxides of nitrogen. The largest source of NO_x is from the combustion processes and is a major contributor to ozone formation and acid deposition. NO₂ causes adverse health effects, is a criteria air pollutant and a major component in smog formation. NO_x does not include nitrous oxide (N₂O), a greenhouse gas.

Old Engine: see *In-Use Engine*

Off-Road Compression-Ignition Engines: a category of compression-ignition engines found in a wide variety of nonroad or off-road applications, including farming, construction, and industrial (EPA defines as “nonroad” and ARB defines as “off-road”). Whether nonroad or off-road, these engines are used to power stationary, auxiliary, portable and mobile components and equipment that include tractors, loaders, electric generators, irrigation pumps, and compressors. These engines are not certified to operate as on-road engines to self-propel motor vehicles that function on a road or highway. New equipment and vehicles are powered by engines certified to the off-road compression-ignition engine standards established by the EPA and ARB.

Off-Road Mobile Agricultural Equipment: is any non-stationary agricultural vehicle or equipment powered by an off-road (or nonroad) engine that self-propels the vehicle or equipment, is not designed or intended to be driven on a road or highway, and is used in agricultural production.

Ozone: a form of molecular oxygen that consists of three oxygen atoms linked together (O₃). Ozone in the upper atmosphere occurs naturally and protects life on earth by filtering out ultraviolet radiation from the sun. Ozone at ground level is a noxious pollutant that causes numerous adverse health effects, is a criteria pollutant, and the major component of smog. Ozone is not emitted directly, but is formed in the atmosphere through a complex chemical reaction involving hydrocarbons (VOC), oxides of nitrogen (NO_x), heat, and sunlight. Problematic ozone levels occur most frequently on hot summer afternoons.

Ozone Precursors: compounds that include oxides of nitrogen (NO_x) and reactive hydrocarbons (VOC) occurring naturally or as a result of human activities.

See NRCS Ozone Air Quality Resource Concern Fact Sheet at:
http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1080890.pdf

Particulate Matter (PM): a general designation pertaining to particulate matter emissions. PM_{2.5} has an aerodynamic diameter equal to or less than 2.5 microns and PM₁₀ has an aerodynamic diameter equal to or less than 10 microns as measured by the applicable Federal Reference Methods (FRM). Their small size allows them to make their way to the air sacs deep within the lungs where they may be deposited, resulting in adverse health effects. PM also causes visibility reduction and contributes to regional haze.

See NRCS Particulate Matter Air Quality Resource Concern Fact Sheet at:
http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1080891.pdf

Portable Agricultural Engine: an internal combustion engine designed and capable of being carried or moved from one location to another, does not propel a vehicle, and is used in agricultural operations. These engines will reside at a single location only for a short duration, typically less than a single season or year. Portable engines provide power to stationary components that include irrigation pumps, electric generators, or towable equipment such as sprayers, chippers or shredders. Indicators of portability include wheels, skids or carrying handles, or a dolly, trailer or platform. Engines that self-propel vehicles or equipment are defined as mobile engines.

Reactive Organic Gas (ROG): a photo-chemically reactive chemical gas, excluding exempt VOC, which may contribute to ozone formation. See *Non-Methane Hydrocarbons (NMHC)* and *Volatile Organic Compounds (VOC)*.

Rebuilt or remanufactured: engines offered by the original engine manufacturer (OEM) or by a non-OEM rebuilder where the engine and parts are functionally equivalent from an emissions and durability standpoint to the OEM engine and the components being replaced.

Reciprocating Internal Combustion Engine: an engine in which air and fuel are introduced into cylinders, compressed by pistons and ignited by a spark plug or by compression. Combustion in the cylinders pushes the pistons sequentially, transferring energy to the crankshaft, causing it to rotate.

Replacement: replacement of in-use mobile off-road agricultural equipment or vehicles with new mobile off-road agricultural equipment or vehicles powered by an engine meeting the most recent California emission standards. An example includes replacing an in-use agricultural tractor with a new agricultural tractor. New, replacement equipment will serve the same function and perform the same work equivalent as the in-use equipment it's replacing.

Repower: the replacement of an in-use engine with a new, cleaner emissions-certified engine or new electric motor instead of rebuilding the in-use engine to its original specification and without making major modifications to the in-use components or equipment. Examples include replacing an in-use irrigation pump engine at an operational well site, or replacing an engine on a vehicle or equipment with a new, cleaner emissions engine.

Retrofit: the installation of an ARB-verified emission control system on an in-use engine. Examples include diesel particulate filters on compression-ignited engines and catalyst systems on spark-ignited engines.

Listed ARB-verified retrofit technologies for diesel engines:

<http://www.arb.ca.gov/diesel/verdev/vt/cvt.htm>

Rich-burn Engine: a spark-ignition internal combustion engine that operates with an exhaust stream oxygen concentration of less than four percent by volume prior to any exhaust stream control device.

Rough Terrain Agricultural Forklifts: Class VII forklifts as defined by the Industrial Truck Association and the Occupational Safety and Health Administration. These forklifts are used in agricultural operations, powered by an IC engine, and equipped with at least four pneumatic tires that handle uneven surfaces.

Selective Catalytic Reduction (SCR) System: an emission control system that reduces NO_x emissions by injecting nitrogen-containing compounds into the exhaust stream, such as ammonia or urea. See *Diesel Exhaust Fluid*.

SIP-Creditable Emission Reductions: emission reductions that meet the four EPA integrity criteria of being surplus, quantifiable, enforceable, and permanent.

Spark-Ignition Internal Combustion Engine: a liquid- or gaseous-fueled engine designed to ignite its air to fuel mixture by a spark across a spark plug. These engines may operate on gasoline, natural gas, propane, bio-gas, or bio-fuel.

State Implementation Plan (SIP): comprehensive plans describing how an area will attain the NAAQS. The 1990 Clean Air Act amendments establish attainment deadlines based on the severity of an area's air pollution problem. In California, SIPs are multiple documents where the ARB is the lead agency for all purposes related to California's SIP. The ARB forwards SIP revisions to the EPA for approval and publication in the Federal Register. All SIP elements are referenced in Section 52.220 of 40 CFR, Chapter 1, Part 52, Subpart F.

Approved SIPs within EPA Region 9 states and territories are posted on-line at:
<https://www.epa.gov/approved-sips/approved-sips-region-9>

California SIPs are available at: <http://www.arb.ca.gov/planning/sip/sip.htm>

Stationary Agricultural IC Engine: an internal combustion engine attached to a foundation, designed to remain and operate at a single location, and used in the production of crops or the raising of fowl or animals. These include engines residing at a same location for specified periods of time (generally longer than a single season or a year) or used as backup to replace another engine at a location that is intended to perform the same or similar function.

Tier 1, Tier 2, Tier 3, and Tier 4 Certified Compression-Ignition Engines:

(1): an EPA-certified compression-ignited engine that meets the Tier 1, Tier 2, or Tier 3 emission standards of Table 1 on page 56970 of the Final Rule (October 23, 1998) or the Tier 4 emission standards of Table II.A.2 (Tier 4 NO_x and NMHC Standards and Schedule) on page 38971 of the Final Rule (June 29, 2004) or Table II.A.4 (Tier 4 Standards for Engines Over 750 HP (g/bhp-hr)) on page 38980 of the Final Rule (June 29, 2004), respectively.

(2): an ARB-certified compression-ignited engine that meets the standards according to CCR Title 13, Section 2423(b)(1)(A) and/or CFR Title 40, Part 89.112(a). Tier 4 engines are subject to the interim or final after-treatment based Tier 4 emission standards in CCR Title 13, Section 2423(b)(1)(B) and/or CFR Title 40, Part 1039.101. This also includes engines certified under the averaging, banking, and trading program with respect to the Tier 1, 2, and 3 Family Emission Limits (FEL) listed in CCR Title 13, Section 2423(b)(2)(A) and/or CFR Title 40, Part 89.112(d) and to the Tier 4 FEL listed in CCR Title 13, Section 2423(b)(2)(B) and/or CFR Title 40, Part 1039.101.

Two-for-One Replacement: the replacement of two "like" equipment with one new "like" equipment. The new engine powers equipment that serves the same function and performs equivalent work as each of the two engines and equipment being replaced.

Uncontrolled Compression-Ignition Engines: also referred to as *Tier 0* or *non-Tier* is any diesel engine not meeting any established Tier emission standard. Generally, these are engines manufactured in the following years:

Figure 2: Uncontrolled CI Engine Model Years

Horsepower	Engine Model Year
Greater than 750 hp	1999 and earlier
25-49 hp	1998 and earlier
50-99 hp	1997 and earlier
100-174 hp	1996 and earlier
175-750 hp	1995 and earlier

Useful Life: see *Lifespan*.

Volatile Organic Compounds (VOC): Several definitions describe VOC, but generally they are organic, carbon-containing compounds having high enough vapor pressure under normal conditions to vaporize into the atmosphere. See *Non-Methane Hydrocarbons (NMHC)* and *Reactive Organic Gases (ROG)*.

Because VOC include a variety of organic chemicals, the health effects can vary greatly from compounds that are highly toxic to those with little or no known impact to human health. Toxic or hazardous VOC are known to cause cancer and seriously impact human health. To address this, both EPA and ARB developed standards and regulations for controlling air toxic emissions based on their individual health risks for protecting public health and the environment.

VOC is a major contributor to ozone formation. VOC defined in a legal or regulatory concept for outdoor air pollutants are carbon compounds that contribute in atmospheric photochemical reactions. The EPA definition is in 40 CFR, Part 51, Section 51.100, and lists the VOC that are exempt due to negligible photochemical reactivity for forming ozone.

Methane is a potent greenhouse gases and a VOC. On an equal basis, the comparative impact of methane on climate change is more than 25 times greater than that of carbon dioxide over a 100-year period. However, methane as an ozone precursor is an EPA-exempt VOC.

Information from EPA on hazardous air pollutants:

<https://www.epa.gov/haps>

Information on exempt VOCs in California:

<https://www.arb.ca.gov/research/reactivity/exemption.htm>

Information on methane as a greenhouse gas:

<https://www.epa.gov/ghgemissions/overview-greenhouse-gases#methane>

References:

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