



OVERVIEW - OFF-ROAD ENGINES MITIGATION MEASURE TABLES

Summary

This document provides an overview of the off-road engines tables (Tables I, II, and III), the purpose of each table, and, as appropriate, how to use the information provided. Additionally, a hyperlink to company contact information for specific projects that have been achieved in practice has been included.

Table I - Mitigation Measure Examples: Repowered Off-Road Engines

Table I provides examples of specific off-road equipment repowered with Tier 2 or 3 engines that operate within the AQMD's jurisdiction. In particular, Table I provides the following details organized by equipment horsepower (hp) in California Air Resources Board (CARB) defined engine power categories:

- Project where the engine repower has been achieved in practice, equipment type and equipment horsepower (all listed examples are uncontrolled baseline engines repowered through the AQMD's Carl Moyer Memorial Air Quality Standards Attainment Program and funded in 2004/2005)
- Baseline engine model year
- Repowered engine:
 - Model year
 - CARB/EPA Certification Level (e.g., Tier 2 or Tier 3)
 - Cost
- Achieved emission reductions (reduction from baseline to repowered emission rate)

Knowing the hp range and baseline engine model year of a given off-road engine, the CEQA practitioner can calculate emission reductions achieved by repowering the given uncontrolled engine using the data listed in Table I. To do so, apply the emission reduction to the applicable uncontrolled pollutant emission rate.

As an example, a 90 hp, 1980 model year baseline engine repowered with a Tier 2 engine yields the following emission reductions: 56% NO_x; 84% VOC; and 50% PM. (Refer to the 75 – 99 hp category under Table I.) Assuming the baseline engine emits 100 pounds per hour (lb/hr) NO_x, the quantity mitigated is 56 lb/hr NO_x, while the repowered emission rate is 44 lb/hr NO_x.

Note that the data in Table I may be used only for the specific listed repower scenarios. Refer to Table II for a broader range of repower scenarios and their respective emission reductions. Table I can be downloaded directly from the following location:

<http://www.aqmd.gov/ceqa/handbook/mitigation/offroad/TableI.doc>

Table II - Off-Road Engine Emission Rates and Comparison of Uncontrolled-to-Tiered Rates and Tiered-to-Tiered Rates

Table II lists off-road engine emission factors and standards, as well as tier-to-tier percentage reductions. The purpose of Table II is twofold: 1) to provide the background data used to determine emission reductions listed in Table I; and, 2) to provide a basis upon which emission reductions of other repower scenarios can be evaluated.



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Table II is divided into six sub-tables: Tables II-A, II-B, II-C, II-D, II-E and II-F. Table II-A lists uncontrolled off-road engine emission factors by engine model year and size. Uncontrolled emission factors follow those prescribed under CARB Table B-12¹. Table II-B lists Tier 1, 2, 3 and 4 emission standards prescribed under CARB Table 1². Model year ranges and power categories follow the CARB standard. Note the following regarding Tables II-A and II-B:

- Data shaded in orange are from CARB Table B-12 and data shaded in green are from CARB Table 1.
- Tier 4 rates reflect the interim and final standards for NO_x and the final standards for ROG and PM.
- For cases in CARB Table 1 where NO_x and VOC standards are not separately listed (e.g., the standard is given as “NMHC+NO_x”), NO_x = 95% and VOC = 5% of the “NMHC+NO_x” value³.

Tables II-C through II-F compare emission reductions from uncontrolled-to-tiered rates (e.g., uncontrolled-to-Tier 1, uncontrolled-to-Tier 2, etc.) and tiered-to-tiered rates (e.g., Tier 1-to-Tier 2, Tier 1-to-Tier 3, etc.). As with Table I, knowing the hp range and baseline engine model year of a given off-road engine, the CEQA practitioner can use the data in Tables II-C through II-F to calculate emission reductions achieved by repowering the given uncontrolled engine. The difference between Tables I and II is that Table I shows control efficiencies for specific repowered projects (based on the data in Table II), whereas Table II shows control efficiencies for broad categories of horsepower ratings and engine model years

Table II can be downloaded directly from the following location:
<http://www.aqmd.gov/ceqa/handbook/mitigation/offroad/TableII.xls>

Table III - Mitigation Measures: Level 1, 2 & 3 Retrofits for Off-Road Engines

Table III lists current CARB verified⁴ off-road engine emission control technologies and corresponding emission reductions for specific achieved in practice projects. Table III provides the following information organized by PM reduction level:

- Control technology
- Manufacturer & model number
- Emission source

¹ CARB uncontrolled off-road engine emission factors are listed in CARB Table B-12 (*Emission Factors for Off-Road Diesel Engines*) of the 2005 Carl Moyer Program Guidelines. The table is included in Part IV (Appendices) and can be downloaded from the following location: <http://www.arb.ca.gov/msprog/moyer/guidelines/current.htm>.

² CARB and EPA off-road diesel engine standards are listed in CARB Table 1 (*CARB and USEPA Off-Road Compression-Ignition (Diesel) Engine Standards*) of the CARB's Off-Road Equipment Documents and Fact Sheets page (<http://arb.ca.gov/msprog/ordiesel/documents.htm>). CARB Table 1 can be downloaded from the following location: http://www.arb.ca.gov/msprog/ordiesel/documents/Off-Road_Diesel_Std.xls.

³ CARB NO_x/NMHC fractions are listed in Table B-22 (*NO_x and NMHC Fraction Default Values for All Engines except TRUs*) of the 2005 Carl Moyer Program Guidelines. The table is included in Part IV (Appendices) and can be downloaded from the following location: <http://www.arb.ca.gov/msprog/moyer/guidelines/current.htm>.

⁴ CARB periodically verifies additional retrofit technologies as part of its ongoing Diesel Emission Control Strategies Verification program. The most updated information is available at the following location: <http://www.arb.ca.gov/diesel/verdev/vt/cvt.htm>.



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- Level specific emission reductions
- CARB verification links
- Project/equipment type where engine retrofits have been achieved in practice.

Table III can be used to determine emission reductions for the listed control technologies used on the approved off-road engine families. In much the same way as the example shown for Table I above, the CEQA practitioner can calculate emission reductions by applying the identified percentage reduction to the applicable uncontrolled pollutant emission rate. Table III can be downloaded directly from the following location:

<http://www.aqmd.gov/ceqa/handbook/mitigation/offroad/TableIII.doc>

Company Contact Information

For additional information on the control measures achieved in practice, company contact information can be downloaded directly from the following location:

<http://www.aqmd.gov/ceqa/handbook/mitigation/AIPContact.pdf>