

Off-road Equipment Rule - Inventory Updates

Based on the 2005 ARB survey data, 2003 TIAX public fleet survey data, the MacKay construction equipment universe study (2003), Yengst equipment analysis reports (~2005), U.S Environmental Protection Agency's NONROAD model, and additional fleet data gathered from stakeholders during Spring of 2006, ARB staff is updating a number of assumptions in the OFFROAD model for our off-road equipment rule analysis. We are changing the model's annual use, equipment populations, and useful life for construction/mining, industrial, and ground support equipment, as described further below.

Annual Use

Table 1 shows the updated average annual use and old OFFROAD model average annual use for each construction/ mining equipment type. The source of the new average annual use is noted in Table 1 and was either combined data from both the 2003 TIAX (TIAX, 2003) survey of public fleets and the 2005 ARB off-road equipment survey, or the 2003 MacKay study. We used survey data to update the annual use when there was a sufficient response rate (i.e., when survey data included annual use estimates for over 10% of the total population of an equipment type). When there was not a sufficient response rate, we relied on the 2003 MacKay study.

**Table 1–Average Annual Use Updates–Construction/Mining Equipment
[hours/year]**

Construction/ Mining Equipment Type	Old ARB OFFROAD Average Annual Use	New Average Annual Use	Source of New Annual Use ^{1,2}
Bore/Drill Rigs	726	811	MacKay
Cranes	1464	1,252	MacKay
Crawler Tractors	936	1,013	Surveys
Excavators	1162	1,396	Surveys
Graders	965	929	MacKay
Off-Highway Tractors	855	1,091	Surveys
Off-Highway Trucks	1641	1,958	MacKay
Other Construction Equipment	606	690	Surveys
Pavers	828	821	MacKay
Paving Equipment	622	829	MacKay
Rollers	748	695	MacKay
Rough Terrain	1198	1,123	MacKay

Construction/ Mining Equipment Type	Old ARB OFFROAD Average Annual Use	New Average Annual Use	Source of New Annual Use ^{1,2}
Forklifts			
Rubber Tired Dozers	899	1,589	Surveys
Rubber Tired Loaders	1346	957	Surveys
Scrapers	1090	1,092	Surveys
Skid Steer Loaders	811	834	MacKay
Surfacing Equipment	561	446	Surveys
Tractors/Loaders/ Backhoes	1135	942	Surveys
Trenchers	620	618	MacKay

¹ – “Surveys” means average annual use is from combined data from both the 2003 TIAX (TIAX, 2003) survey of public fleets and the 2005 ARB off-road equipment survey.

² – “MacKay” means average annual use is average annual hours of operation reported in 2003 MacKay and Company Construction Equipment Universe of Construction Equipment and Machinery study (MacKay, 2003)

ARB’s old OFFROAD model used a constant average annual use for every year of an equipment’s life. Anecdotal information as well as survey results in the 2003 MacKay study indicates that equipment is actually used less as it ages. ARB staff have updated the OFFROAD model for construction and mining equipment to reflect this trend. For each equipment type, we gathered from the 2003 MacKay study the percent decline in annual use for each equipment type from when new to when at median useful life (See Table 2). We set the annual use at the average age (one half the useful life) to the average annual use, and then used the MacKay percent decline to determine the slope of a line passing through this average annual use for the period from age 0 to median useful life. After the median useful life, we assumed that the annual use remained constant. The shape of the annual use trend can be seen in Chart 1.

Table 2–Usage Percent Declines–Construction/Mining Equipment [%]

Construction/Mining Equipment Type	Percent Decline in Annual Use from When Equipment New to When at Median Useful Life¹
Bore/Drill Rig	86%
Crane	30%
Crawler Tractor	80%
Excavator	65%

Construction/Mining Equipment Type	Percent Decline in Annual Use from When Equipment New to When at Median Useful Life¹
Grader	79%
Off-Hwy Tractor	59%
Off-Hwy Truck	57%
Other Const Equip	59%
Paver	53%
Paving Equip	38%
Roller	41%
Rough Terrain Forklift	34%
Rubber Tired Dozer	59%
Rubber Tired Loader	69%
Scraper	61%
Skid Steer Loader	67%
Surfacing Equip	59%
Tractor/Loader/Backhoe	81%
Trencher	61%

¹ - Usage Percent Declines are from MacKay, 2003. Note that for Off-Hwy Tractor, Other Const Equip, Rubber Tired Dozer, and Surfacing Equipment, the average usage percent decline was used, because those equipment types are not included in MacKay, 2003.

Chart 1–New Average Annual Use Trend for Equipment with 29 Year Median Useful Life

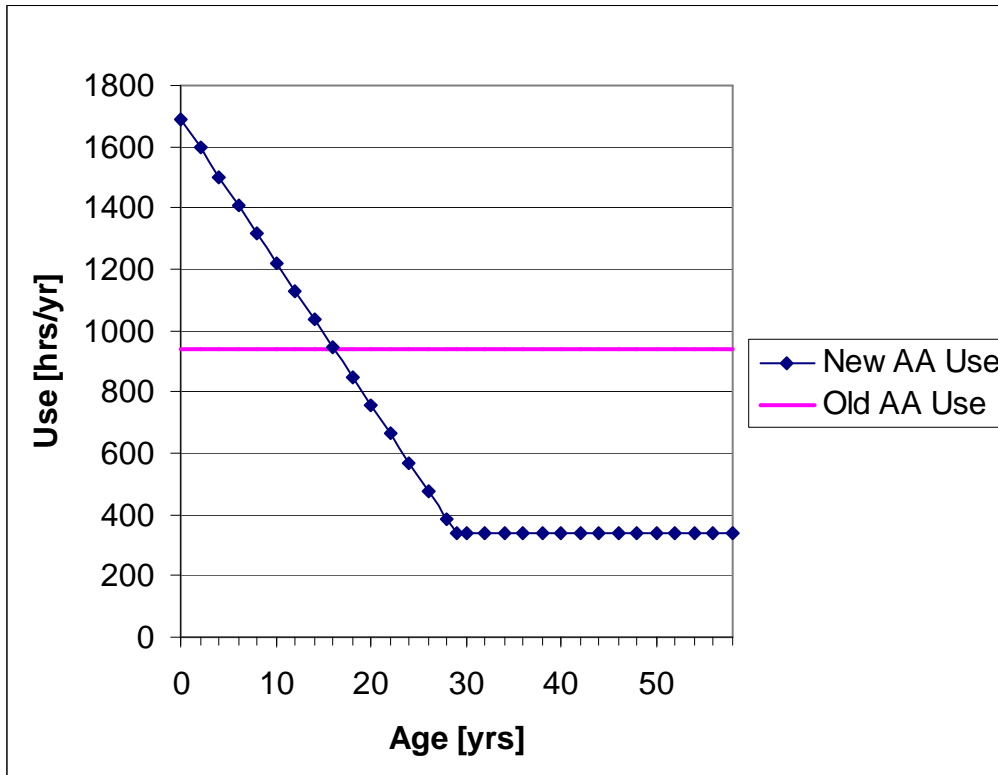


Table 3 shows the updated average annual use and old OFFROAD model average annual use for airport ground support equipment. We updated the annual use based on the 2005 ARB off-road equipment survey for all airport ground support equipment (GSE) types except wide body aircraft tugs and lav trucks, for which no data was reported. For all other GSE types, the survey annual use response rate was over 10%.

Table 3–Average Annual Use Updates–Airport Ground Support Equipment [hours/year]

Equipment Type	Old ARB OFFROAD Average Annual Use	New Average Annual Use
A/C Tug Narrow Body	606	625
A/C Tug Wide Body	759	NA
Baggage Tug	1624	1392
Belt Loader	1038	974
Bobtail	1867	683
Cargo Loader	902	906

Equipment Type	Old ARB OFFROAD Average Annual Use	New Average Annual Use
Cargo Tractor	101	1309
Catering Truck	1600	370
Forklift	732	743
Fuel Truck	3489	625
Hydrant Truck	224	623
Lav Truck	1307	NA
Lift	917	791
Other	1646	922
Service Truck	1931	505
Sweeper	12	289

Table 4 shows the updated average annual use and old OFFROAD model average annual use for each industrial equipment type. We updated the annual use based on the 2005 ARB off-road equipment survey when the survey had a sufficient response rate (i.e., when survey data included annual use estimates for over 10% of the total population of an equipment type).

Table 4–Average Annual Use Updates–Industrial Equipment [hours/year]

Industrial Equipment Type	Old ARB OFFROAD Average Annual Use	New Average Annual Use	Source of New Annual Use ¹
Aerial Lifts	384	384	Unchanged
Forklifts	1800	1800	Unchanged
Other General Industrial Equipment	878	1,425	Survey
Other Material Handling Equipment	421	1,318	Survey

¹ - "Survey" means average annual use is from the 2005 ARB off-road equipment survey.

Equipment Populations

Table 5 shows the updated equipment populations for construction/mining equipment. Equipment populations were updated to match those in MacKay (2003) for

equipment types for which MacKay provides an estimate, except for paving equipment. The MacKay estimate for paving equipment was much lower than both the ARB and U.S. EPA estimates. Therefore, we updated the paving equipment estimate to match U.S. EPA's estimate, which is based on estimates of sales of off-road equipment from Power Systems Research through the year 2000. Equipment populations for off-highway tractors, other construction equipment, rubber tired dozers, and surfacing equipment were left unchanged. We back cast the MacKay 2003 data to get revised equipment populations for the year 2000. Finally, for categories such as excavators that contained port cargo handling equipment, port cargo handling equipment was removed because it will not be included in the off-road equipment rule. It is instead included in its own inventory category. The old and new year 2000 populations are shown in Table 5. The new estimated total population of construction/mining equipment in year 2000 is about 156,000.

Table 5—Equipment Population Updates—Construction/Mining Equipment [Total California Population, year 2000]

Construction/ Mining Equipment Type	Old ARB OFF- ROAD Population	New Population
Bore/Drill Rigs	1138	1173
Cement and Mortar Mixers	557	557
Concrete/Industrial Saws	102	102
Cranes	2406	2208
Crawler Tractors	25486	14698
Crushing/Proc. Equipment	937	937
Dumpers/Tenders	24	24
Excavators	13621	17667
Graders	6510	6178
Off-Highway Tractors	2936	2936
Off-Highway Trucks	2147	2147
Other Construction Equipment	1266	1266
Pavers	2616	2710
Paving Equipment	3858	556
Plate Compactors	328	328
Rollers	7980	7980
Rough Terrain Forklifts	5779	6170
Rubber Tired	775	775

Construction/ Mining Equipment Type	Old ARB OFF- ROAD Population	New Population
Dozers		
Rubber Tired Loaders	17,667	17,853
Scrapers	1,859	1,859
Signal Boards	3,231	3,231
Skid Steer Loaders	26,012	28,460
Surfacing Equipment	114	114
Tractors/Loaders/B ackhoes	33,990	28,213
Trenchers	7,235	7,777
TOTAL	168,571	155,917

Table 6 shows the updated equipment populations for airport ground support equipment; equipment types for which changes were made are highlighted. The equipment populations were updated to match the survey results when the population reported in the survey exceeded that in the OFFROAD model for the entire state. For aircraft tractors, many airlines reported all their aircraft tractors as narrow body, rather than distinguishing between narrow- and wide-body. The total population of narrow- and wide-body aircraft tractors reported in the survey was greater than the total population in the OFFROAD model. Therefore, we maintained the previous split between narrow- and wide-body tractors, but updated the population of narrow- and wide-body tractors such that the total matches the total reported in the survey for narrow- plus wide-body tractors.

Table 6—Equipment Population Updates—Mobile Airport Ground Support Equipment [Total California Population, year 2000]

Equipment	Old ARB OFFROAD Population	New Population
A/C Tug Narrow Body	226	238
A/C Tug Wide Body	56	59
Baggage Tug	479	479
Belt Loader	231	231
Bobtail	17	17
Cargo Loader	282	282
Cargo Tractor	5	44
Catering Truck	8	8
Forklift	26	39
Fuel Truck	21	21
Hydrant Truck	11	16
Lav Truck	5	5

Equipment	Old ARB OFFROAD Population	New Population
Lift	19	52
Other GSE	48	93
Service Truck	33	33
Sweeper	3	23
TOTAL	1,470	1,640

Table 7 shows the updated equipment populations for industrial equipment. Industrial equipment populations were updated to incorporate U.S. EPA NONROAD model populations. The NONROAD model populations were derived based on Power Systems Research (PSR) sales data through the year 2000, combined with U.S. EPA estimates of load factor, activity, median life, scrappage, growth, and state manufacturing employment. Cargo handling equipment was also removed from these categories, as it is being covered by a separate rulemaking and is now included in its own category in the emissions inventory model.

Table 7 - Equipment Population Updates–Industrial Equipment [Total California Population, year 2000]

	ARB OFFROAD	USEPA NONROAD
Aerial Lifts	1375	6167
Forklifts	5006	4869
Other Material Handling Equipment	267	227
Other General Industrial Equipment	1511	4882

Useful Life

In the OFFROAD mode, the useful life, is the age at which the survival curve shows a point of inflection and is equivalent to when half of the units of a certain model year will have been scrapped. At the age of twice the useful life, all equipment will have been scrapped. Based on the 2005 survey data on average age when scrapped or sold and discussions with our stakeholders at the March 2006 workgroup meetings, we concluded that the OFFROAD model was underestimating the useful life of construction/mining equipment and airport GSE.

To come up with revised estimates for useful life, we reviewed the following data sources:

- 2003 MacKay study
- 2003 survey data on “average age when scrapped or sold”

- On-line auction data on equipment available, their ages and prices
- 2003 TIAX public fleet survey data on equipment age

In March to April 2006, we also did a “mini-survey” of fleet owners who had participated in the off-road equipment rule workgroup. We solicited data from these fleet owners on the average age of equipment by equipment type and were able to quickly gather age data on 13 fleets. This, combined with age data from the 2003 TIAX survey gave us age data on over 5,000 pieces of equipment.

Based on the normal distribution of ages of equipment in the OFFROAD model, there is a set relationship between average age of equipment and its useful life. Equipment with a long useful life has a high average age; conversely, equipment with a short useful life turns over quickly and thus has a low average age. The average age of equipment is equal to approximately one half the useful life. Thus, the useful life should be equal to approximately twice the average age of equipment present in the field.

After reviewing all the data sources, we concluded that the 2003 MacKay study data on average age scrapped was the best overall source of useful life data. We updated the useful life to the MacKay average age when scrapped unless:

- There was no MacKay data for the equipment type, or
- The April 2006 mini-survey and 2005 off-road equipment survey indicated California equipment was very different from the national equipment represented in MacKay (i.e., if the MacKay average age scrapped was less than the survey average age retired or sold, and the MacKay average age was much less than the mini-survey average age).

In that case, we updated useful life to twice the mini-survey average age. Table 8 summarizes the useful life updates. On average, the useful life of construction/mining equipment doubled.

Table 8–Useful Life Updates–Construction/Mining Equipment [years until half of equipment has been scrapped]

Construction/Mining Equipment Type	Old ARB OFFROAD Useful Life	New Useful Life	Source
Bore/Drill Rigs	3	10	MacKay (2003)
Skid Steer Loaders	5	13	MacKay (2003)
Rough Terrain Forklifts	8	16	MacKay (2003)
Other Construction Equipment	16	16	April '06 survey
Excavators	7	17	MacKay (2003)
Off-Highway Trucks	10	17	MacKay (2003)
Tractors/Loaders/Backhoes	16	18	MacKay (2003)

Construction/Mining Equipment Type	Old ARB OFFROAD Useful Life	New Useful Life	Source
Cranes	9 if <=750 hp, 16 if > 750 hp	19	MacKay (2003)
Rollers	8	20	MacKay (2003)
Rubber Tired Loaders	8	21	MacKay (2003)
Surfacing Equipment	16	22	April '06 survey
Graders	10	23	MacKay (2003)
Paving Equipment	16	24	April '06 survey
Pavers	8	26	April '06 survey
Scrapers	12	26	MacKay (2003)
Trenchers	7	28	April '06 survey
Crawler Tractors	16	29	April '06 survey
Off-Highway Tractors	16	31	April '06 survey
Rubber Tired Dozers	6 if <=175 hp, 16 if >175 hp	32	April '06 survey

For airport GSE, useful life was updated based on the 2004 Air Transport Association (ATA) survey, which included data on average age of equipment by equipment type. Useful life was updated to twice the average age reported in the ATA survey if the 2004 ATA survey included average age data for over 25% of the state population. For hydrant trucks, there was no 2004 ATA survey data, so the useful life was updated to the average age when scrapped or sold from the 2005 ARB survey. If there was inadequate 2004 ATA and 2005 ARB survey data, the useful life was left unchanged. Table 9 summarizes the airport GSE useful life changes.

Table 9–Useful Life Updates–Airport Ground Support Equipment [years until half of equipment has been scrapped]

Equipment Type	ARB OFFR OAD Useful Life (years)	New Useful Life	Source
A/C Tug Narrow Body	11	30	2 x avg age in '04 ATA survey
A/C Tug Wide Body	15	30	2 x avg age in '04 ATA survey
Baggage Tug	14	25	2 x avg age in '04 ATA survey
Belt Loader	12	22	2 x avg age in '04 ATA survey
Bobtail	16	22	2 x avg age in '97 ATA survey
Cargo Loader	13	18	2 x avg age in '04 ATA survey

Equipment Type	ARB OFFR OAD Useful Life (years)	New Useful Life	Source
Cargo Tractor	16	17	2 x avg age in '04 ATA survey
Catering Truck	11	12	2 x avg age in '97 ATA survey
Forklift	16	16	Unchanged
Fuel Truck	16	16	Unchanged
Hydrant Truck	16	17	2005 offroad survey avg age scrapped or sold
Lav Truck	16	16	Unchanged
Lift	6	16	2 x avg age in '04 ATA survey
Other	16	22	2 x avg age in '04 ATA survey
Service Truck	16	16	Unchanged
Sweeper	12	12	Unchanged

Industrial equipment useful lives were left unchanged.

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