

Appendix F: Cost Methodology

This appendix explains the cost methodology used to estimate the costs of the proposed amendments to the off-road regulation. Section A below explains why the compliance costs for the current off-road regulation are different than those presented in the original staff report (ARB, 2007a). Section B outlines the cost methodology, and Section C lists references used.

A. Updated Current Regulatory Costs

The current regulation costs presented (in Chapter VII of this document) are different than those estimated in the original staff report (ARB, 2007a) for several reasons, including:

- The current regulation costs presented in Chapter VII are in 2010 dollars; the original staff report cost estimates were presented in 2006 dollars.
- The current regulation costs are the costs associated with vehicle turnover and retrofitting only; the original staff report estimates included additional costs for reporting, labeling, and retrofit operational and maintenance costs. It is reasonable to leave out the reporting and labeling costs because all fleets must report and label their vehicles, even under the proposed amended regulation; hence, it was not necessary to recalculate these costs for the purposes of comparing the current regulatory costs with the proposed amended regulation costs or for comparing regulation amendment proposals. Staff did not include retrofit operational and maintenance costs because these costs, when calculated, were insignificant compared to the overall compliance costs for the statewide fleet.
- The current regulation costs in Chapter VII take into account the amendments made to the regulation since its initial approval in 2007. These amendments include the Assembly Bill (AB) 8 2X amendments, and the delay of enforcement of the March 1, 2010, compliance date which have resulted in a cost savings for many fleets. Because the regulation has already been amended to give economic relief to affected fleets, staff believed it was appropriate to recalculate the costs of the regulation, as it currently exists, and not how it was originally adopted.
- The cost estimates for both the current regulation and the proposed amended regulation in this staff report were calculated using the most recent inventory of off-road vehicles, which includes fewer vehicles than previously estimated. The original staff report costs were calculated using an estimated statewide vehicle inventory. However, because more accurate reported data from the Diesel Off-road On-line Reporting System (DOORS) now exists, staff believes it is more appropriate to estimate statewide costs based on this updated inventory data.

For the many reasons stated above, it was more appropriate to recalculate the statewide costs of the regulation, as it currently exists, than to compare the proposed amended regulatory costs to the original costs presented in the 2007 staff report.

B. Updated Cost Methodology

As stated in Chapter VII, the methodology used to calculate the costs in this staff report were similar to the methodology used when originally estimating the costs for the off-road regulation. For a full description of the original cost methodology, please see Chapter XI of the original Technical Support Document (TSD) for the off-road regulation (ARB, 2007b). The subsections below provide a summary of the updated cost methodology, as well as the retrofit and vehicle costs used in the modeling.

1. Statewide Costs

The original methodology relied on the compliance modeling for 200 sample fleets, and required these costs to be scaled to reflect statewide costs. However, the updated methodology used to calculate costs for this report used the Off-road Simulation Model (OSM) to model the compliance paths of approximately 8,800 real fleets reported to DOORS (DOORS, 2010). For each fleet in DOORS, OSM calculated the costs the fleet would normally spend without the regulation in place. These costs are referred to as a fleet's baseline costs, and depend upon a fleet's average age and natural turnover rate. Once the baseline cost for a fleet was determined, a compliance cost was then calculated, based on a fleet's anticipated compliance path. The difference between a fleet's baseline cost, and a fleet's compliance cost is the cost attributed to the off-road regulation. For more information on OSM, please see Appendix D.

Once these costs were calculated for each fleet, they were summed to provide staff with the overall compliance costs for each year over the life of the regulation (for those fleets in DOORS). To determine the cost in 2010 dollars, the cost for each year was multiplied by the net present value (NPV)¹ factor.

Although the fleets in DOORS represent a majority of the fleets affected by the regulation, there are still some fleets that have not reported to DOORS (and are therefore not in compliance with the off-road regulation). To account for these noncompliant fleets (estimated to be 10 percent of the statewide fleet), the costs for each year were multiplied by a 1.1 noncompliance factor.

2. Compliance Costs

The compliance path for each real fleet included the option of retrofitting or accelerated turnover (to new or used vehicles). Although repowering a vehicle with a new engine is a viable compliance option, it is not applicable to all vehicle types and horsepower categories and is expected to be a relatively rare compliance choice. Therefore, to simplify the analysis, staff did not include repowers as a compliance option in OSM.

¹ NPV = $1/(1+r)^n$, where r = the annual interest rate, and n = the number of years in the future. An annual five percent real interest rate is the basis of all economic impacts, assuming seven percent nominal interest rate and two percent inflation rate.

a) Vehicle costs

The new and used vehicle costs were determined from for-sale prices of vehicles of various types. Prices were plotted by vehicle age and curve fit on a dollar per horsepower (\$/hp) basis to represent the typical price for each vehicle type. For a majority of the vehicle types in the off-road inventory, this analysis had already been performed; these numbers are available in Appendix J of the original TSD of the off-road regulation (ARB, 2007b), and were used in this analysis. However, for various types of GSE vehicles, prices were compiled from used vehicles for sale on several websites, including Machinerytrader.com and Tradequip.com. The \$/hp values used for GSE vehicles is included in Attachment 1.

b) Retrofit costs

Staff contacted several retrofit manufactures to collect current retrofit costs. These costs were used in OSM, and are shown below in Table F-1 (Aleixo, 2010, Halloran, 2010, Machado, 2010, Swenson, 2010).

Table F-1: Retrofit Costs

Horsepower Range	Retrofit Cost
Less than 50 hp	\$16,750
50 hp – 125 hp	\$17,588
125 hp – 175 hp	\$19,733
175 hp – 300 hp	\$24,796
300 hp – 400 hp	\$28,763
400 hp and Greater	\$52,333

c) Additional costs

When the costs for the original regulation were calculated, staff included a 'transportation cost' of \$10/hp to account for the potential price impact on changes in demand for clean and dirty vehicles (ARB, 2007b). This cost was also included in OSM, and was added to the price of every vehicle (new or used) purchased for compliance.

An additional cost that was also included in the original regulation costs was the Tier 4 premium. This cost was to account for the increase in cost for Tier 4 vehicles because of the exhaust aftertreatment technology expected to be used in those engines. The Tier 4 premium costs were estimated to be similar to the cost of a retrofit device, and are shown below in Table F-2.

Table F-2: Tier 4 Premium Costs

Horsepower Range	Retrofit Cost
Less than 50 hp	\$8,000
50 hp – 175 hp	\$12,000
175 hp – 400 hp	\$18,000
400 hp and Greater	\$30,000

C. References

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Attachment 1 – GSE Vehicle Costs

New Vehicle Types Added

The table below identifies the new² vehicle types for which the costs were included in OSM. If not enough cost data could be found, the costs for a similar vehicle type were used, and are noted in Table F1-1 below.

Table F1-1: Vehicle Types with Updated Costs

Vehicle Type
Aerial Lifts
Forklifts
Other General Industrial Equipment (used "Other Construction" costs)
Other Material Handling Equipment (used "Other Construction" costs)
Sweepers/Scrubbers
Drill Rig (Mobile)
Workover Rig (Mobile)
A/C Tug Narrow Body
A/C Tug Wide Body
Baggage Tug
Belt Loader
Bobtail (used "Skid Steer Loader" costs)
Cargo Loader
Cargo Tractor (used "Tractor/Loader/Backhoe" costs)
Forklift (GSE) (used "Forklift" costs)
Lift (GSE) (used "Aerial Lift" costs)
Other GSE (used "Other Construction" costs)
Passenger Stand (used "Aerial Lift" costs)

Estimated Vehicle Costs

The costs used for estimating new and used vehicle prices are shown in the Table F1-2 below (Aeroservicios, 2010; AeroTech, 2010; EEA, 1995; MachineryTrader, 2010; Mercury, 2010; SunMachinery, 2010; Sunnda, 2010; Tradequip, 2010).

² Not included in the cost estimates for the original regulation (ARB, 2007b).

Table F1-2: Vehicle \$/hp Cost by Vehicle Type (Ages 0 to 85)

Vehicle Type	Vehicle Age (Years)												
	0	1	2	3	4	5	6	7	8	9	10	11	12
Aerial Lifts	2368	1951	1608	1325	1092	900	741	611	504	415	342	282	232
Forklifts	641	599	559	522	487	455	425	397	370	346	323	301	281
Sweepers/Scrubbers	442	413	386	361	337	315	294	275	257	240	224	209	196
Drill Rig (Mobile)	1766	1568	1392	1236	1098	975	865	768	682	606	538	478	424
Workover Rig (Mobile)	1035	950	872	800	734	674	618	567	521	478	438	402	369
A/C Tug Narrow Body	975	914	857	803	753	705	661	620	581	545	510	479	449
A/C Tug Wide Body	975	914	857	803	753	705	661	620	581	545	510	479	449
Baggage Tug	1016	904	804	716	637	566	504	448	399	355	316	281	250
Belt Loader	551	516	483	452	423	397	371	348	326	305	286	267	250
Cargo Loader	1051	1007	966	926	888	851	816	782	750	719	689	661	633

Vehicle Type	Vehicle Age (Years)												
	13	14	15	16	17	18	19	20	21	22	23	24	25
Aerial Lifts	191	158	130	107	88	73	60	49	41	34	28	23	19
Forklifts	263	245	229	214	200	186	174	163	152	142	132	124	115
Sweepers/Scrubbers	183	171	160	149	139	130	122	114	106	99	93	87	81
Drill Rig (Mobile)	377	334	297	264	234	208	184	164	145	129	115	102	90
Workover Rig (Mobile)	339	311	285	262	240	220	202	186	170	156	144	132	121
A/C Tug Narrow Body	420	394	369	346	325	304	285	267	251	235	220	206	193
A/C Tug Wide Body	420	394	369	346	325	304	285	267	251	235	220	206	193
Baggage Tug	222	198	176	157	139	124	110	98	87	78	69	61	55
Belt Loader	234	220	206	193	180	169	158	148	139	130	122	114	107
Cargo Loader	607	582	558	535	513	492	471	452	433	415	398	382	366

Vehicle Type	Vehicle Age (Years)												
	26	27	28	29	30	31	32	33	34	35	36	37	38
Aerial Lifts	15	13	11	9	7	6	5	4	3	3	2	2	2
Forklifts	108	101	94	88	82	76	71	67	62	58	54	51	47
Sweepers/Scrubbers	76	71	66	62	58	54	50	47	44	41	38	36	33
Drill Rig (Mobile)	80	71	63	56	50	44	39	35	31	28	24	22	19
Workover Rig (Mobile)	111	102	93	86	79	72	66	61	56	51	47	43	40
A/C Tug Narrow Body	181	170	159	149	140	131	123	115	108	101	95	89	83
A/C Tug Wide Body	181	170	159	149	140	131	123	115	108	101	95	89	83
Baggage Tug	49	43	39	34	30	27	24	21	19	17	15	13	12
Belt Loader	100	93	88	82	77	72	67	63	59	55	52	48	45
Cargo Loader	351	336	322	309	296	284	272	261	250	240	230	220	211

Vehicle Type	Vehicle Age (Years)												
	39	40	41	42	43	44	45	46	47	48	49	50	51
Aerial Lifts	1	1	1	1	1	1	1	1	1	1	1	1	1
Forklifts	44	41	38	36	34	31	29	27	26	24	22	21	19
Sweepers/Scrubbers	31	29	27	26	24	22	21	19	18	17	16	15	14
Drill Rig (Mobile)	17	15	13	12	11	9	8	7	7	6	5	5	4
Workover Rig (Mobile)	36	33	31	28	26	24	22	20	18	17	15	14	13
A/C Tug Narrow Body	78	73	69	64	60	57	53	50	47	44	41	38	36
A/C Tug Wide Body	78	73	69	64	60	57	53	50	47	44	41	38	36
Baggage Tug	11	9	8	7	7	6	5	5	4	4	3	3	3
Belt Loader	42	40	37	35	33	31	29	27	25	24	22	21	19
Cargo Loader	203	194	186	179	171	164	157	151	145	139	133	127	122

Vehicle Type	Vehicle Age (Years)												
	52	53	54	55	56	57	58	59	60	61	62	63	64
Aerial Lifts	1	1	1	1	1	1	1	1	1	1	1	1	1
Forklifts	18	17	16	15	14	13	12	11	10	10	9	9	8
Sweepers/Scrubbers	13	12	11	11	10	9	9	8	8	7	7	6	6
Drill Rig (Mobile)	4	3	3	3	2	2	2	2	1	1	1	1	1
Workover Rig (Mobile)	12	11	10	9	8	8	7	7	6	5	5	5	4
A/C Tug Narrow Body	34	32	30	28	26	24	23	21	20	19	18	17	16
A/C Tug Wide Body	34	32	30	28	26	24	23	21	20	19	18	17	16
Baggage Tug	2	2	2	2	1	1	1	1	1	1	1	1	1
Belt Loader	18	17	16	15	14	13	12	11	11	10	9	9	8
Cargo Loader	117	112	108	103	99	95	91	87	84	80	77	74	71

Vehicle Type	Vehicle Age (Years)												
	65	66	67	68	69	70	71	72	73	74	75	76	77
Aerial Lifts	1	1	1	1	1	1	1	1	1	1	1	1	1
Forklifts	7	7	6	6	6	5	5	5	4	4	4	3	3
Sweepers/Scrubbers	5	5	5	4	4	4	4	3	3	3	3	3	2
Drill Rig (Mobile)	1	1	1	1	1	1	1	1	1	1	1	1	1
Workover Rig (Mobile)	4	4	3	3	3	3	2	2	2	2	2	2	1
A/C Tug Narrow Body	15	14	13	12	11	11	10	9	9	8	8	7	7
A/C Tug Wide Body	15	14	13	12	11	11	10	9	9	8	8	7	7
Baggage Tug	1	1	1	1	1	1	1	1	1	1	1	1	1
Belt Loader	8	7	7	6	6	6	5	5	5	4	4	4	3
Cargo Loader	68	65	62	60	57	55	53	50	48	46	44	43	41

Vehicle Type	Vehicle Age (Years)							
	78	79	80	81	82	83	84	85
Aerial Lifts	1	1	1	1	1	1	1	1
Forklifts	3	3	3	2	2	2	2	2
Sweepers/Scrubbers	2	2	2	2	2	2	1	1
Drill Rig (Mobile)	1	1	1	1	1	1	1	1
Workover Rig (Mobile)	1	1	1	1	1	1	1	1
A/C Tug Narrow Body	6	6	6	5	5	5	4	4
A/C Tug Wide Body	6	6	6	5	5	5	4	4
Baggage Tug	1	1	1	1	1	1	1	1
Belt Loader	3	3	3	3	3	2	2	2
Cargo Loader	39	37	36	34	33	32	30	29