Appendix C

Cost Analysis – Basis for Calculations

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A. Methodology

The costs or savings for each amendment was evaluated based on the action allowed by the proposed amendment. The majority of the proposed amendments provided additional compliance flexibility and result in a cost savings to affected businesses. Some of these amendments allow a delay in capital expenditure, others allow an avoidance of capital expenditure. In cases where costs are delayed, savings is based on the capital expenditure and the cost of money for that expenditure over the delay time period. The cost of money was based on a real interest rate of 5 percent. All costs and savings were compared in net present value of 2011 dollars. This was calculated using the following equation:

Net Present Value = Future Cost x $1/(1+i)^n$
where i = real interest rate and n = future date – 2011.
A real interest rate of 5 percent was used.

Capital costs for retrofitting or purchasing equipment were based on costs for similar off-road equipment used in the cost analysis for the Off-Road In-Use Equipment Regulation. (ARB, 2010a) The costs for the purchase of RTG cranes were based on costs generated for the original CHE Regulation rulemaking. (ARB, 2005a) The equipment purchase costs include a premium cost for Tier 4 engines, as developed for the Off-Road Equipment Regulation. These costs are provided in Tables C-1, C-2 and C-3.

Table C-1: Retrofit Cost for Various Horsepower Engines

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

(ARB, 2010a) – Table F-1

Table C-2: Replacement Equipment with Tier 3 Engines

Horsepower Range	Replacement Cost
Construction Equipment	$1,000/hp
Container Handling Equipment	$797/hp
Forklift	$875/hp
Other General Industrial Equipment	$1,000/hp
RTG Crane (less than 600 hp)	$800,000/RTG
RTG Crane (600 hp or more)	$1,200,000/RTG

(ARB, 2007b) – Table XI-2

Table C-3: Replacement Tier 4 Engine Incremental Cost

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

(ARB, 2010a) – Table F-2

B. Statewide Costs

1. Additional time for equipment with "No VDECS Available"

This amendment provides for an additional two years of annual compliance extension for equipment for which VDECS is not available. The number of pieces of equipment, equipment type, and horsepower that would be eligible for this extension was predicted by the Cargo Handling Emissions Inventory model and emissions model working files. (ARB, 2011f) (ARB, 2011o) Worksheets with the calculations for the economic analysis are posted on ARB's web site at: http://www.arb.ca.gov/ports/cargo/cheamd2011.htm. (ARB, 2011g) The compliance costs were estimated for this equipment based on Tables C-1 through C-3 above.

For forklifts, it was assumed that 90 percent of the equipment would be replaced and 10 percent would be retrofitted. For all other CHE, it was assumed that half would be replaced and half would be retrofitted. These assumptions are summarized in Table C-4.

Table C-4: Retrofit and Replacement by Each Equipment Type for Proposed 2-Year "No VDECS Available" Compliance Extension

Equipment Type	Fleet Size	Percent Replace	Percent Retrofit	Replace ($million)	Retrofit ($million)	Total Cost ($million)
Construction Equipment	21	50%	50%	4.6	0.4	5.0
Container Handling Equipment	5	50%	50%	3.5	0.4	3.9
Forklift	275	90%	10%	41.6	0.7	42.3
Other General Industrial Equipment	11	50%	50%	1.2	0.2	1.4
Total	312	266.0	46.4	50.9	1.7	52.6

The percentages of the different types of equipment that would be brought into compliance at the end of the additional two-year compliance extension provided by the amendment are shown in Table C-5.

Table C-5: Timing of VDECS Replacement with Proposed "No VDECS Available" Amendment

Year	Construction Equipment	Container Handling Equipment	Forklift	Other General Industrial Equipment
2011	-	-	-	-
2012	-	-	-	-
2013	5.7%	20.5%	3.8%	5.3%
2014	15.4%	6.0%	13.1%	17.7%
2015	25.3%	25.8%	26.5%	26.1%
2016	26.6%	25.1%	28.4%	26.7%
2017	27.0%	22.6%	28.2%	24.2%
2018	-	-	-	-
	100.0%	100.0%	100.0%	100.0%

The costs to bring this equipment into compliance are shown in Table C-6 for the case with the amendment, and two years earlier in Table C-7, without the amendment.

Table C-6: Future and Present Value Costs to Retrofit or Replace Equipment Impacted by the Proposed "No VDECS Available" Amendment

Year	Construction Equipment	Container Handling Equipment	Forklift	General Industrial Equipment	Actual Costs	Present Value Cost in 2011 Dollars (5%)
2011	-	-	-	-	-	
2012	-	-	-	-	-	
2013	$284,732	$788,330	$1,618,655	$76,511	$2,768,228	$2,510,865
2014	$772,478	$232,210	$5,548,902	$256,465	$6,810,055	$5,882,782
2015	$1,265,986	$995,057	$11,219,524	$377,996	$13,858,563	$11,401,474
2016	$1,332,579	$969,207	$12,021,230	$386,136	$14,709,152	$11,525,006
2017	$1,346,281	$870,394	$11,935,825	$350,340	$14,502,840	$10,822,242
2018	-	-	-	-	-	-
Total	$5,002,056	$3,855,198	$42,344,136	$1,447,448	$52,648,838	$42,142,369

Table C-7: Present Value Cost to Retrofit without the Proposed "No VDECS Available" Amendment

Year	Construction Equipment	Container Handling Equipment	Forklift	General Industrial Equipment	Actual Costs	Present Value Cost in 2011 Dollars (5%)
2011	$284,733	$788,330	$1,618,655	$76,511	$2,768,229	$2,768,228
2012	$772,478	$232,210	$5,548,902	$256,465	$6,810,055	$6,485,767
2013	$1,265,986	$995,057	$11,219,524	$377,996	$13,858,563	$12,570,125
2014	$1,332,579	$969,207	$12,021,230	$386,136	$14,709,152	$12,706,319
2015	$1,346,281	$870,394	$11,935,825	$350,340	$14,502,840	$11,931,522
2016	-	-	-	-	-	-
2017	-	-	-	-	-	-
2018	-	-	-	-	-	-
Total	$5,002,057	$3,855,198	$42,344,136	$1,447,448	$52,648,839	$46,461,962

The savings, which are the difference between the net present value cost with the amendment and the net present value cost without the amendment are summarized in Table C-8.

Table C-8: Savings from Delayed Expenditure for Equipment with the Proposed "No VDECS Available" Amendment

Year	Equipment Eligible for No VDECS Available	Future Cost of Retrofit Without Amendment	Future Cost of Retrofit With Amendment	Present Value Cost Without Amendment	Present Value Cost With Amendment	Present Value (Savings)
2011	-	$2,768,229	-	$2,768,228	-	($257,364)
2012	-	$6,810,055	-	$6,485,767	-	($602,985)
2013	13	$13,858,563	$2,768,229	$12,570,125	$2,510,865	($1,168,651)
2014	42	$14,709,152	$6,810,055	$12,706,319	$5,882,782	($1,181,313)
2015	82	$14,502,840	$13,858,563	$11,931,522	$11,401,474	($1,109,280)
2016	88	-	$14,709,152	-	$11,525,006	-
2017	87	-	$14,502,840	-	$10,822,242	-
2018	-	-	-	-	-	-
Total	312	$52,648,839	$52,648,839	$46,461,962	$42,142,369	($4,319,593)

2. Add a safety provision for VDECS

This is a clarification amendment and there are no associated costs or savings.

3. Low-use compliance extension

As with the "No VDECS Available" provision discussed in section 1 above, this amendment allows the owners/operators to delay a capital expenditure for up to two years for equipment that is currently low-use.

Similar to the "No VDECS Available" amendment analysis, the number of pieces of equipment, equipment type, and horsepower were predicted by the emissions inventory model. The cost of bringing the equipment into compliance was estimated at the end of the two year extension and at the original compliance date. The net present value of these future costs was then compared to calculate a cost savings.

As with the previous amendment analysis, forklifts were assumed to be replaced at a rate of 90 percent of equipment and 10 percent would be retrofitted. For all other CHE, it was assumed that half would be replaced and half would be retrofitted. The numbers of equipment and compliance assumptions are summarized in Table C-9.

Table C-9: Savings Calculation for Proposed 2-Year Low-Use Compliance Extension

Equipment Type	Fleet Size	Percent Replace	Percent Retrofit	Replace ($million)	Retrofit ($million)	Total ($million)
Construction Equipment	22	50%	50%	3.9	0.4	4.3
Container Handling Equipment	13	50%	50%	2.3	0.3	2.6
Forklift	98	90%	10%	13.6	0.2	13.8
Other General Industrial Equipment	19	50%	50%	2.1	0.2	2.3
RTG Crane	23	50%	50%	13.3	0.6	13.9
Total	175	127.2	48.2	35.4	1.7	37.1

The percentages of the different types of equipment that would be brought into compliance at the end of the additional two-year compliance extension provided by the amendment are shown in Table C-10.

Table C-10: Distribution of VDECS Replacement Under Proposed Low-Use Amendment

Year	Construction Equipment	Container Handling Equipment	Forklift	Other General Industrial Equipment	RTG Crane
2011	-	-	-	-	-
2012	-	-	-	-	-
2013	44.1%	30.7%	58.2%	41.7%	29.0%
2014	32.7%	31.3%	31.1%	37.2%	35.5%
2015	23.2%	38.0%	10.7%	21.1%	35.5%
2016	-	-	-	-	-
2017	-	-	-	-	-
2018	-	-	-	-	-
	100.0%	100.0%	100.0%	100.0%	100.0%

The costs to bring this equipment into compliance are shown in Table C-11 for the case with the amendment, and two years earlier in Table C-12, without the amendment.

Table C-11: Present Value Cost to Retrofit With the Proposed Low-Use Amendment

Year	Construction Equipment	Container Handling Equipment	Forklift	General Industrial Equipment	RTG Crane	Actual Costs	Present Value Cost in 2011 Dollars (5%)
2011	-	-	-	-	-	-	-
2012	-	-	-	-	-	-	-
2013	$1,897,929	$803,707	$8,062,362	$988,749	$4,038,885	$15,791,632	$14,323,476
2014	$1,408,722	$819,574	$4,315,441	$880,965	$4,927,038	$12,351,740	$10,669,898
2015	$997,093	$997,343	$1,489,352	$499,754	$4,927,123	$8,910,665	$7,330,826
2016	-	-	-	-	-	-	-
2017	-	-	-	-	-	-	-
2018	-	-	-	-	-	-	-
Total	$4,303,744	$2,620,624	$13,867,155	$2,369,468	$13,893,046	$37,054,037	$32,324,200

Table C-12: Present Value Cost to Retrofit without Proposed Low-Use Amendment

Year	Construction Equipment	Container Handling Equipment	Forklift	General Industrial Equipment	RTG Crane	Actual Costs	Present Value Cost in 2011 Dollars (5%)
2011	$1,897,929	$803,707	$8,062,362	$988,749	$4,038,885	$15,791,632	$15,791,632
2012	$1,408,722	$819,574	$4,315,441	$880,965	$4,927,038	$12,351,740	$11,763,562
2013	$997,093	$997,343	$1,489,352	$499,754	$4,927,123	$8,910,665	$8,082,236
2014	-	-	-	-	-	-	-
2015	-	-	-	-	-	-	-
2016	-	-	-	-	-	-	-
2017	-	-	-	-	-	-	-
2018	-	-	-	-	-	-	-
Total	$4,303,744	$2,620,624	$13,867,155	$2,369,468	$13,893,046	$37,054,037	$35,637,431

The savings, which are the difference between the net present value cost with the amendment and the net present value cost without the amendment are summarized in Table C-13.

Table C-13: Savings from Delayed Expenditure Under Proposed Low-Use Amendment

Year	Equipment Required to comply Without Amendment	Cost of Compliance Without Amendment	Cost of Compliance With Amendment	Present Value Cost Without Amendment	Present Value Cost With Amendment	Present Value (Savings)
2011	86	$15,791,633	-	$15,791,633	-	($1,468,157)
2012	57	$12,351,740	-	$11,763,562	-	($1,093,664)
2013	33	$8,910,665	$15,791,633	$8,082,236	$14,323,476	($751,410)
2014	-	-	$12,351,740	-	$10,669,898	-
2015	-	-	$8,910,665	-	$7,330,826	-
2016	-	-	-	-	-	-
2017	-	-	-	-	-	-
2018	-	-	-	-	-	-
Total	176	$37,054,038	$37,054,038	$35,637,431	$32,324,200	($3,313,231)

4. Exempt equipment at low-throughput ports in NO_x-exempt areas not within 75 miles of an urban area

As with the "No VDECS Available" and the low-use provisions discussed in sections 1 and 3, above, this amendment allows the owners/operators at the Port of Humboldt Bay to avoid capital expenditures until 2019 to 2028 under the Off-Road In-Use Equipment Regulation. (ARB,2010a) We assumed that engines newer than 1996 model year would be retrofitted and that equipment with engines 1996 model year and older would be replaced.

Similar to the approach taken with the "No VDECS Available" and the low use provisions, we take a conservative approach to quantifying the savings, savings were estimated by comparing the cost to replace or retrofit equipment at the end of the initial two years extension to the cost at the end of the additional two year extension, all in 2011 dollars. The delayed expenditure for VDECS is based on the current estimated cost to retrofit various CHE and the horsepower of the respective engines as shown in Table C-1.

The alternative of replacing equipment would require a much higher expenditure which is deferred by taking the proposed exemption. The deferred cost for each type of CHE is calculated using current estimated equipment replacement cost shown in Table C-2 plus the additional cost for Tier 4 engines as shown in Table C-3.

The resulting savings are summarized in Table C-14.

Table C-14: Cost Savings for Proposed Low-Throughput Port Equipment Exemption

Fleet	Equipment	Engine Model Year	Max. Horse-power	CHE Compliance			Off-Road Compliance		
				Year	Cost in 2011 Dollars	Present Value**	Year	Cost in 2011 Dollars	Present Value**
A	Loader	1981	200	2011	$177,400	$177,400	2021	$177,400	$108,908
A	Loader	1981	375	2012	$316,875	$301,786	2022	$316,875	$185,270
A	Loader	1982	200	2011	$177,400	$177,400	2025	$177,400	$89,599
A	Loader	1987	215	2012	$189,355	$180,338	2026	$189,355	$91,083
B	Loader	1995	235	2011	$205,295	$205,295	2021	$205,295	$126,033
B	Loader	1987	410	2012	$353,770	$339,781	2022	$353,770	$208,596
B	Loader	2003	180	2011	$24,796	$24,796	N/A***	0	0
B	Loader	1990	250	2013	$217,250	$197,052	2028	$217,250	$94,785
B	Loader	1973	170	2011	$147,490	$147,490	2019	$147,490	$99,827
C	Loader	1981	375	2012	$316,875	$301,786	2019	$316,875	$214,473
C	Loader	2004	260	2011	$24,796	$24,796	N/A***	0	0
C	Log Loader	2005	135	2013	$17,588	$15,953	N/A***	0	0
C	Bulldozer	2003	120	2011	$17,588	$17,588	2028	$152,640	$66,596
C	Bulldozer	1985	300	2012	$369,600	$352,000	2022	$369,600	$216,097
C	Backhoe	2003	85	2011	$17,588	$17,588	2028	$72,605	$31,677
C	Dump Truck*	1996	400	2011	$15,000	$15,000	2012	$15,000	$14,286
C	Fork Lift	1990	120	2011	$83,520	$83,520	2027	$83,520	$51,274
Total Fleet Cost (Present Value**)				$2,579,569			$1,598,504		
Total Savings Under Off-Road vs. CHE Regulation							($981,065)		

* The dump truck has an on-road engine and therefore would be subject to On-Road Truck and Bus Regulation.

** "Present Value" indicates that actual future costs have been discounted to 2011 Present Value dollars, Present value = Cost x $1/(1+i)^n$, where i=5% and n=future date-2011.

*** These pieces of equipment are not required to retrofit because the fleet meets its fleet average target and/or has sufficient BACT carry-over retrofit credit under the Off-Road In-Use Equipment Regulation.

5. Require CHE opacity monitoring and set maximum allowable levels

This amendment would require annual opacity monitoring of the engine-out exhaust for all CHE engines. Tests for equipment retrofitted with VDECS could be scheduled when the VDECS is removed for cleaning and inspection. This amendment would result in incremental costs to owners/operators.

Owners/operators may opt to purchase the test equipment and train their mechanics to test the equipment themselves or to hire consultants to test the equipment. Costs have been estimated for each scenario to conduct opacity tests on every CHE. One scenario is to train and utilize terminal maintenance employees to conduct the testing. The other scenario is to hire a third-party.

The costs for in-house testing would include an initial capital investment of training mechanics to perform the opacity tests and to purchase an opacity test meter. These capital costs are in addition to yearly cost associated with testing each engine.

ARB staff estimated the cost for an opacity meters at approximately $5,500 each based on the experience of the ARB staff performing the opacity correlation study. (ARB, 2011i) It was assumed that each of the 140 terminals and rail yards would purchase a meter for a total industry cost of $770,000.

Training costs include the class tuition plus the labor cost for the mechanics to attend class. Two one-day (eight-hour) classes are required for certification in the test procedure. Labor rates are estimated at $100 per hour. The tuition for the training classes is $175 per one-day class. (CCDET, 2011) The training costs are summarized in Table C-15. The total cost for training is estimated to be $1,950 per mechanic.

Table C-15: Opacity Monitoring Training Costs (Per Mechanic)

Cost Category	Cost	Required	Cost for two 8-hour classes
Class tuition	$175/class	2 classes	$350
Labor rate	$100/hour	16 hours	$1,600
Total costs			$1,950

ARB staff assumed that each terminal would train two mechanics. It was assumed that there would be approximately 140 terminals and rail yards based on the initial number of facilities that reported under the CHE Regulation in 2005. Consequently, the total training costs for industry would be $546,000, as presented in Table C-16.

Table C-16: Opacity Monitoring Training Cost for Two Mechanics at 140 Facilities

Cost for two 8-hour classes	Mechanics Per Terminal	Number of Facilities	Training Cost
$1,950	2	140	$546,000

The total initial cost for training mechanics and purchasing opacity meters for each of approximately 140 terminals and rail yards is $1,316,000 as summarized in Table C-17.

Table C-17: Initial Costs for Mechanic Training and Opacity Meters

Cost Category	Initial Cost
Mechanic Training	$546,000
Opacity Meters	$770,000
Total Initial Cost	$1,316,000
Total Initial Cost, 2011$	$1,253,333

Testing an engine is estimated to take approximately 30 minutes. At a labor rate of $100/hour, this results in a cost of $50 per engine per year. (ARB, 2011j) The total estimated fleet cost is summarized In Table C-18:

Table C-18: Cost for Terminal Mechanics to Conduct Opacity Tests

Calendar Year	Non-Yard Truck Engines	Yard Trucks Engines	Total Engines	Mechanic Testing Cost Per Year	
				Future Cost	2011 $
2012	1,585	2464	4,049	$202,450	$192,810
2013	1606	2502	4,108	$205,400	$186,304
2014	1707	2660	4,367	$218,350	$188,619
2015	1841	2853	4,694	$234,700	$193,088
2016	1979	3042	5,021	$251,050	$196,704
2017	2137	3256	5,393	$269,650	$201,217
2018	2256	3419	5,675	$283,750	$201,656
2019	2383	3590	5,973	$298,650	$202,138
2020	2487	3732	6,219	$310,950	$200,441
Total					$1,762,977

The total estimated costs for terminals or rail yards to perform the opacity testing in-house would be the sum of the initial capital costs of $1.25 million plus the recurring cost of testing of $1.76 million dollars for a total of $3 million in 2011 dollars.

The industry cost for opacity testing was also estimated based on third-party costs for testing. Third-party costs to run opacity tests range from $30 to $60 per engine. (ARB, 2011k) (BNR, 2011) (CCS, 2011) ARB staff used the higher value of $60 per engine to estimate the opacity test costs of about $2 million in 2011 dollars over the 2012 to 2020 period, as summarized in Table C-19.

Table C-19: Cost for Consultants to Conduct Opacity Tests

Calendar Year	Non-Yard Truck Engines	Yard Trucks Engines	Total Engines	Consultant Testing Cost Per Year	
				Future Cost	2011$
2012	1,585	2464	4,049	$242,940	$231,371
2013	1606	2502	4,108	$246,480	$223,565
2014	1707	2660	4,367	$262,020	$226,343
2015	1841	2853	4,694	$281,640	$231,706
2016	1979	3042	5,021	$301,260	$236,045
2017	2137	3256	5,393	$323,580	$241,460
2018	2256	3419	5,675	$340,500	$241,987
2019	2383	3590	5,973	$358,380	$242,566
2020	2487	3732	6,219	$373,140	$240,529
Total					$2,115,572

Opacity testing costs are estimated to range from $2 to $3 million in 2011 dollars, based on the costs for terminals or rail yards to perform the tests themselves or hire a third-party for the testing.

Engines with monitored opacity levels greater than the limit consistent with their certification level would be required to be repaired. However, this repair cost would not result in additional costs as this would be maintenance required to keep the engine well maintained to operate as originally designed.

6. Allow demonstration of emissions equivalency

While this amendment provides for additional compliance flexibility, it is not estimated to provide any significant costs or savings.

7. Non-yard truck equipment transfers

Allowing owners/operators to move their non-yard truck equipment from port-to-port or rail yard-to-rail yard to provide operational flexibility will eliminate the need to purchase redundant equipment. This would result in a savings. The savings to industry would depend upon the number of transfers requested, the cost to purchase the equipment, and transportation costs if the equipment were moved.

The cost savings is estimated to be the difference between the cost to purchase a new piece of equipment and the cost to transport the equipment. ARB staff assumed a purchase cost of approximately $200,000 based on current population of equipment and current replacement costs. The transportation costs would depend on the type and size of equipment and the distance between terminals. The transportation cost could be significant. It is reasonable to assume that an owner/operator would not transfer older equipment if the transfer costs were more than 50 percent of the purchase price.

Therefore, ARB staff assumed that transportation costs were 50 percent of the purchase cost, or $100,000 per piece of equipment transferred.

ARB staff assumed that two pieces of equipment are required to be moved each year, over the period from 2012 to 2020. This would result in a net savings of $200,000 per year as summarized in Table C-20. The total savings, in 2011 dollars, would be $1.4 million.

Table C-20: Savings Due to Proposed Equipment Transfer Amendment

Calendar Year	Annual Transfers	Transfer Cost	Avoided Purchase Cost	Future (Savings)	Present Value Savings 2011 $
2012	2	$200,000	($400,000)	($200,000)	($190,476)
2013	2	$200,000	($400,000)	($200,000)	($181,406)
2014	2	$200,000	($400,000)	($200,000)	($172,768)
2015	2	$200,000	($400,000)	($200,000)	($164,540)
2016	2	$200,000	($400,000)	($200,000)	($156,705)
2017	2	$200,000	($400,000)	($200,000)	($149,243)
2018	2	$200,000	($400,000)	($200,000)	($142,136)
2019	2	$200,000	($400,000)	($200,000)	($135,368)
2020	2	$200,000	($400,000)	($200,000)	($128,922)
Total					($1,421,564)

8. Manufacturer delays for new equipment

While this amendment provides for additional compliance flexibility, it is not estimated to provide any significant costs or savings.

9. Warranty engine replacement

The uncertainty in how often situations utilizing this amendment would arise causes too much of an error band in any analysis of the savings. Consequently, no analysis of the savings was attempted for this amendment.

10. Treat Tier 4 Engines Certified to Alt PM Emissions Standards as Tier 3 Engines

Allowing owners/operators to utilize Family Emissions Limits (FEL) Alternative PM (Alt PM) engines with a requirement to retrofit them with Level 3 VDECS will impose an additional cost. It was estimated that about 224 FEL Alt PM engines would enter the CHE fleet. However, the number is actually dependent on the purchase choices of owners/operators. Owners/operators may be able to specify non-FEL Alt PM engines for their purchases and avoid this cost.

The number of FEL Alt PM engines that were estimated for each type of CHE equipment and estimated cost to retrofit with VDECS are summarized in Table C-21.

Table C-21: Cost of FEL VDECS Retrofit with the Proposed FEL Alt PM Amendment

Equipment Type	Number of Engines	Retrofit Cost ($ millions)
Construction Equipment	17	0.6
Container Handling Equipment	75	2.4
Forklift	70	1.7
Other General Industrial Equipment	14	0.4
RTG Crane	48	1.9
Total	224	7.0

The percentages of the different types of equipment powered by FEL engines that would require retrofit in the different years are shown in Table C-22.

Table C-22: Timing of FEL VDECS Replacement without the Proposed FEL Alt PM Amendment

Year	Construction Equipment	Container Handling Equipment	Forklift	Other General Industrial Equipment	RTG Crane
2011	-	-	-	-	-
2012	13.5%	20.5%	5.4%	14.0%	18.1%
2013	15.5%	19.9%	8.5%	14.9%	17.6%
2014	23.7%	24.2%	25.8%	23.0%	26.1%
2015	23.8%	19.7%	28.3%	24.7%	22.7%
2016	23.5%	15.7%	32.0%	23.4%	15.5%
2017	-	-	-	-	-
2018	-	-	-	-	-
	100.0%	100.0%	100.0%	100.0%	100.0%

The costs to bring this equipment into compliance with the amendment are shown in Table C-23. There is no requirement for compliance in the regulation in its current form. The cost associated with the amendment is simply the net present value of the year to year actual costs as summarized in Table C-23.

Table C-23: Present Value Cost to Retrofit Due to the Proposed FEL Alt PM Amendment

Year	Construction Equipment	Container Handling Equipment	Forklift	General Industrial Equipment	RTG Crane	Future Value cost	PV Cost in 2011 Dollars (5%)
2011	-	-	-	-	-	-	-
2012	$84,968	$493,227	$90,420	$56,533	$344,507	$1,069,656	$1,018,720
2013	$97,851	$479,427	$143,749	$59,933	$334,945	$1,115,905	$1,012,158
2014	$149,854	$582,530	$437,650	$92,813	$497,936	$1,760,783	$1,521,031
2015	$150,159	$474,321	$480,145	$99,765	$433,619	$1,638,008	$1,347,593
2016	$148,490	$376,818	$542,889	$94,272	$294,633	$1,457,101	$1,141,677
2017	-	-	-	-	-	-	-
2018	-	-	-	-	-	-	-
Total	$631,322	$2,406,323	1,694,853	403,315	1,905,639	7,041,340	$6,041,179

Table C-24: Cost for VDECS Retrofits Due to the Proposed FEL Alt PM Amendment

Year	Number of Engines Required to Comply Without Amendment	Future Cost of Retrofit With Amendment	Present Value Cost With Amendment
2011	-	-	-
2012	32	1,069,656	1,018,720
2013	34	1,115,905	1,012,158
2014	56	1,760,783	1,521,031
2015	53	1,638,008	1,347,593
2016	49	1,457,101	1,141,677
2017	-	-	-
2018	-	-	-
Total	224	7,041,452	6,041,179

The emissions benefit from the retrofit of the FEL Alt PM engines is provided in Table C-25. The estimated benefit for this amendment is estimated to be a total of 48 tons over the 2012 to 2020 time period. This benefit results in a cost-effectiveness of $63 per pound of PM with all costs attributed to the PM reduction.

Table C-25: Emission Reductions due to Proposed FEL Alt PM Engine Amendment

Calendar Year	PMAmd - PM Rule (Tons)
2011	
2012	-1.0
2013	-2.2
2014	-3.9
2015	-5.6
2016	-6.9
2017	-7.1
2018	-7.2
2019	-7.2
2020	-6.9
Total	-48.0

Note: Negative numbers indicate emission reduction

11. Add Flexibility to extension for experimental diesel PM emissions control

While this amendment provides additional flexibility for compliance, it is not anticipated to provide significant costs or savings.

12. Allow compliance schedule swapping

While this amendment provides additional flexibility for compliance, it is not anticipated to provide significant costs or savings.

C. Impact on Business

The statewide annual capital costs and savings are shown in Table C-26 for the amendments that would impact small and typical business, with the exception of the opacity monitoring amendment. The costs associated with the opacity monitoring amendment are primarily operating and maintenance (O&M) costs and so will be accounted for separately. The numbers of engines anticipated to be impacted by each of these amendments are also shown in the table. The amendment to exempt equipment at rural low-throughput ports is not included as it would not impact business at other ports.

Table C-26: Summary of Total Capital Costs/(Savings) Resulting from Proposed Amendments

Year	Additional 2 Years for VDECS	Low-Use Extension	Non-Yard Truck Transfers	Allow Tier 4 FEL Engines
Equipment Impacted	312	176	18	224
2011	($257,000)	($1,468,000)		
2012	($603,000)	($1,094,000)	($190,000)	$1,019,000
2013	($1,169,000)	($751,000)	($181,000)	$1,012,000
2014	($1,181,000)		($173,000)	$1,521,000
2015	($1,109,000)		($165,000)	$1,348,000
2016			($157,000)	$1,142,000
2017			($149,000)	
2018			($142,000)	
2019			($135,000)	
2020			($129,000)	
Total	**($4,319,000)**	**($3,313,000)**	**($1,421,000)**	**$6,042,000**

Note: Negative numbers in parenthesis indicate savings.
Note: Costs express in 2011 dollars at present value
Note: Values have been rounded

Impact on Small Business

Staff does not have access to financial records for most of the companies that are impacted by the CHE Regulation. However, in the survey conducted for the original rulemaking, the small business status of the survey respondents was determined by including a query on the ARB Survey for the owner of the equipment to indicate if their business was a small business as defined by California Government Code section 11342.610 (i.e. annual gross receipts of $1,500,000 or less for transportation and warehousing). Approximately 10 percent of the respondents identified themselves as small businesses.

The cost to a typical small business is derived from the type and number of equipment and number owned. Based on the ARB Survey made for the original rulemaking, the average small business owns 11 pieces of equipment. For the cost estimates, this average small business was selected to represent costs for a typical small business.

The statewide costs and equipment numbers in Table C-26 were used to estimate the cost or savings due to the different amendments during the overall time period of 2011

to 2020 and the initial time period, the current year and next two years (2011 through 2013).

For a small business, savings from the proposed amendment allowing non-yard truck equipment transfers are assumed not to be applicable. However savings from the "No VDECS Available" and the low-use equipment extensions as well as costs for retrofitting engines certified to the FEL Alt PM emission standards would impact these businesses.

The numbers of equipment estimated to be affected by these proposed amendments in a typical small fleet during the 2011 through 2020 time periods are shown in Table C-27. For the small business, with 11 pieces of equipment, it was assumed that it would have two pieces of equipment impacted by "No VDECS Available" extension and one piece each impacted by the low-use extension and FEL Alt PM retrofit requirments. Small business may have more need for the extensions due to their more limited resources.

Table C-27: Small Business Numbers of Equipment Affected by Proposed Amendments During 2011 through 2020

Small Business	11 CHE
# No VDECS	2
# Low-Use	1
# Equipment Transfers	0
# FEL engines	1

The 2011 through 2020 costs associated with the amendments are summarized in Table C-28 for a typical small business. These costs or savings were estimated based on prorating the overal costs or savings for the different amendments, provided in Table C-26, on a per engine basis. The opacity costs were estimated at $60 per engine per year for 9 years (2012 through 2020). The net cost over the 2011 through 2020 time period for small business is estimated to be a cost savings of $13,600, as shown in Table C-28.

Table C-28: Small Business Costs On-Going Costs/(Savings) During 2011 through 2020 as a Result of Proposed Amendments

Small Business	11 CHE
No VDECS	($27,700)
Low Use	($18,800)
Equipment Transfers	-
FEL engine	$ 27,000
Opacity	$ 5,940
Total	**($13,600)**

Note: Negative numbers in parenthesis indicate savings.
Costs express in 2011 dollars at present value
Values have been rounded

Initial Costs: The initial cost to small business is evaluated over the current year (2011) and the next two years (2012 and 2013). The initial cost is calculated by combining the costs and savings from the amendments over this time period. The annual on-going costs for opacity monitoring are accounted for separately. These costs and savings are a subset of the 2011 through 2020 costs provided above. The number of engines in the fleet that are estimated to be affected by the different amendments during the initial time period are shown in Table C-29 below. The associated costs or savings were estimated by prorating the costs in Table C-26 on a per engine basis as mentioned above.

Table C-29: Small Business Numbers of Equipment Affected by Proposed Amendments During 2011 through 2013

Small Business	11 CHE
# No VDECS	1
# Low-Use	1
# Equipment Transfers	0
# FEL engines	0

The net initial cost for a typical small business for the 2011 through 2013 time period is estimated to be a cost savings of $32,700, as shown in Table C-30.

Table C-30: Small Business Initial Costs/(Savings)
During 2011 through 2013 As A Result of Porposed Amendments

Small Business	11 CHE
No VDECS	($13,900)
Low Use	($18,800)
Equipment Transfers	$ -
FEL engine	$ -
Total	**($32,700)**
Annual Operating and Maintenance: Opacity	**$660**

Annual Ongoing Costs: The annual on-going O&M costs for a small business are based on the proposed opacity monitoring. Opacity monitoring is assumed to be performed by a third party at a cost $60 per engine per year for small businesses. Based on an average fleet size of 11 CHE, the average small businesses annual ongoing costs are $660 per year.

The small business costs are summarized in Table C-31 below.

Table C-31: Summary Economic Impact on Small Business

Small business	11 CHE
Equipment Population	11
Initial Cost – Current and Next 2 Years	($32,700)
Overall Cost 2011-2020	($13,600)
Ongoing Annual Costs	$660

Note: Negative numbers in parenthesis indicate savings.
Note: Costs express in 2011 dollars at present value
Note: Values have been rounded

Impact on Typical Business

The cost to a typical business is derived using the same methodology as for small business. Based on the economic analysis for the original regulation, the typical port container terminal owns 77 pieces of equipment, a typical port bulk terminal owns 13 pieces of equipment, and a typical intermodal rail yard owns 24 pieces of equipment. The port container terminals operate the greatest number of CHE in California and therefore are being evauluated as a typical business affected by these amendments. Tables C-32 and C-34 summarize the equipment assumptions for the typical terminal for the overall time period of 2011 through 2020 and the initial time period, respectively. These assumptions are discussed in the following paragraphs.

While small businesses would not be expected to benefit from the non-yard truck equipment transfers amendment, a container terminal with 77 pieces of equipment may benefit from this amendment. Additionally, savings from the "No VDECS Available" and the low-use equipment extensions as well as costs for the FEL Alt PM engine retrofit requirement would also impact these businesses.

The opacity costs for this larger business are anticipated to include both intial capital costs, to purchase the opacity measurement device and train employees to perform this function, and annual on-going O&M costs. This results in a higher initial cost, but a slightly lower O&M cost of $50 per engine per year.

The number of low-use engines was limited to no more than two per business based on the option for ARB to limit the use of this extension. The estimated equipment affected by the amendments and associated costs and savings are shown in Tables C-32 and C-34, respectively. The statewide costs and equipment numbers from Table C-26 were used to estimate the cost or savings due to the different amendments during the overall time period of 2011 through 2020 and the initial time period (2011 through 2013), as shown in Tables C-33 and C-35, respectively.

Table C-32: Numbers of Equipment Affected by Proposed Amendments During 2011 through 2020 for a Typical Business

Typical Business	Container (77 CHE)
# No VDECS	4
# Low-Use	2
# Equipment Transfers	1
# FEL engines	4

Table C-33: Costs/(Savings) During 2011 through 2020 as a Result of Proposed Amendments for a Typical Business

Typical Business	Container (77 CHE)
No VDECS	($55,400)
Low-Use	($37,600)
Equipment Transfers	($79,000)
FEL engine	$108,000
Opacity	$44,000
Total	**($20,000)**

Note: Negative numbers in parenthesis indicate savings.
Note: Costs express in 2011 dollars at present value
Note: Values have been rounded

Initial Cost: The initial cost is evaluated over the current year (2011) and the next two years (2012 and 2013). The initial cost is calculated by combining the costs and savings from the amendments over this time period. These costs include the intial opacity monitoring costs to purchase equipment and train employees. However, the annual on-going O&M costs for opacity monitoring are accounted for separately.

As summarized in Table C-35, the initial cost, for the current year and next two years, result in a net cost savings of $28,800 as presented in Table C-37, expressed in 2011 dollars brought to present value.

Annual Ongoing Costs: The annual on-going O&M costs for a typical business are based on the required number of opacity tests. The opacity monitoring estimated cost is based on the assumption that this size of business will purchase the opacity measurement device and train employees, which results in a higher initial cost, included in Table C-35, but a slightly lower opacity test cost of $50 per engine per year. The average typical business annual ongoing O&M cost, based on a fleet inventory of 77 pieces of equipment, is $3,850 per year as shown in Table C-36.

All of the initial costs/savings for a typial business are summarized in Table C-37.

Table C-34: Typical Business Numbers of Equipment Affected by Proposed Amendments During 2011 through 2013

Typical Business	Container (77 CHE)
# No VDECS	2
# Low-Use	2
# Equipment Transfers	0
# FEL engines	1

Table C-35: Typical Business Initial Costs/(Savings) During 2011 through 2013 as Result of Proposed Amendments

Typical Business	Container (77 CHE)
No VDECS	($27,700)
Low-Use	($37,600)
Equipment Transfers	-
FEL engine	$27,000
Opacity Initial Cost	$9,500
Total	**($28,800)**

Note: Negative numbers in parenthesis indicate savings.
Note: Costs express in 2011 dollars at present value
Note: Values have been rounded

Table C-36: Annual Operating and Maintenance – Opacity Monitoring

Typical Business	Container (77 CHE)
Opacity Monitoring Cost	**$3,850**

Table C-37: Typical Business Costs

Typical business	Container (77 CHE)
Initial Cost – Current and Next 2 Years	($28,900)
Overall Cost – 2011-2020	($20,100)
Ongoing Annual Costs	($3,850)

Note: Negative numbers in parenthesis indicate savings.
Note: Costs express in 2011 dollars at present value
Note: Values have been rounded

D. Impact on Local Government

There are two local agencies that govern ports and also own equipment that will be impacted by the amendments. These local agencies, combined, own a total of 37 pieces of equipment based on the regulation reporting data.

The cost to these local agencies is derived from the type of equipment and number owned similar to the methodology used to calculate the effects on small and typical businesses. These etimates for the local agencies are shown in Tables C-38 through C-43. For these two agencies, combined, an overall savings of $37,900 from 2011 to 2020 would be estimated, as shown in Table C-39.

Table C-38: Local Agencies-Numbers of Equipment Affected by Proposed Amendments During 2011 through 2020

Proposed Amendment	Local Agency A (14 CHE)	Local Agency B (23 CHE)	Total (37 CHE)
# No VDECS	2	2	4
# Low-Use	2	1	3
# Equipment Transfers	0	0	0
# FEL engines	1	1	2

Table C-39: Local Agencies-On-Going Costs/(Savings) During 2011 through 2020 as Result of Proposed Amendments

Proposed Amendment	Local Agency A (14 CHE)	Local Agency B (23 CHE)	Total (37 CHE)
No VDECS	($27,700)	($27,700)	($55,400)
Low-Use	($37,700)	($18,800)	($56,500)
Equipment Transfers			
FEL engine	$27,000	$27,000	$54,000
Opacity	$7,600	$12,400	$20,000
Total	**($30,800)**	**($7,100)**	**($37,900)**

Note: Negative numbers in parenthesis indicate savings.
Note: Costs express in 2011 dollars at present value
Note: Values have been rounded

The initial capital costs for these agencies are shown in Tables C-40 and C-41. These initial capital costs are for bringing in-use equipment into compliance with the CHE Regulation. The compliance deadlines for the in-use equipment are at the end of the calendar year, December 31. Consequently, the capital costs for the 2011, 2012, and 2013 calendar years can be assumed to occur in the latter half of those years and can be applied as the capital costs for the fiscal years (FY) of 2011/2012, 2012/2013, and 2013/2014. The initial capital costs, for the 2011/2012 FY through the 2013/2014 FY are estimated to be a total cost savings of $84,000.

Table C-40: Local Agencies-Numbers of Equipment Affected by Proposed Amendments During 2011 through 2013

Proposed Amendment	Local Agency A (14 CHE)	Local Agency B (23 CHE)	Total (37 CHE)
# No VDECS	1	1	2
# Low-Use	2	1	3
# Equipment Transfers	0	0	0
# FEL engines	0	0	0

Table C-41: Local Agencies-On-Going Costs/(Savings) During 2011 through 2013 as Result of Proposed Amendments

Proposed Amendment	Local Agency A (14 CHE)	Local Agency B (23 CHE)	Total (37 CHE)
No VDECS	($13,900)	($13,900)	($27,700)
Low-Use	($37,600)	($18,800)	($56,500)
Equipment Transfers			
FEL engine			
Total	**($51,500)**	**($32,700)**	**($84,200)**

Note: Negative numbers in parenthesis indicate savings.
Note: Costs express in 2011 dollars at present value
Note: Values have been rounded

The annual ongoing O&M costs are estimated at $60 per engine per year. These costs are estimated to be approximately $2,200 per year, combined for the agencies, shown in Table C-42.

Table C-42: Local Agencies-Annual Operating and Maintenance – Opacity Monitoring

Proposed Amendment	Local Agency A (14 CHE)	Local Agency B (23 CHE)	Total (37 CHE)
Opacity Monitoring Cost	**$840**	**$1,380**	**$2,220**

The total initial costs, capital and O&M, for the 2011/2012 FY through the 2013/2014 FY, are the sum of the capital costs, shown in Table C-41 plus the O&M costs for these fiscal years. As mentioned above, the O&M costs are for the opacity monitoring of the equipment. The regulation includes a phase-in schedule for opacity monitoring, starting 180 days after the effective date of the regulation. If is it is assumed that the amendments become effective by the end of the 2011/2012 FY, then the opacity

monitoring costs would start in the 2012/2013 FY. So two years of opacity monitoring costs must be added to the capital costs for the total costs to local agencies in the 2011/2012 through 2013/2014 FYs. This results in a net cost savings of approximately $80,000 for the local agencies for the fiscal years of 2011/2012 through 2013/2014. All of the costs are summarized in Table C-43.

Table C-43: Fiscal Effect on Local Agencies

Local Agencies	Local Agency A (14 CHE)	Local Agency B (23 CHE)	Total (37 CHE)
Equipment Population	14	23	37
Overall Cost 2011-2020	($30,800)	($7,100)	($37,900)
Initial Capital Costs – 2011/2012 FY through 2013/2014 FY	($51,500)	($32,700)	($84,200)
O&M Costs – 2011/2012 FY through 2013/2014 FY	$1,680	$2,760	$4,440
Total Costs – 2011/2012 FY through 2013/2014 FY	($49,820)	($29,940)	($79,760)

Note: Negative numbers in parenthesis indicate savings.
Note: Costs express in 2011 dollars at present value
Note: Values have been rounded

E. Alternatives

Alternative 1

The first alternative considered would be to provide three additional years of extension for engines for which there are no VDECS available instead of the proposal for two additional years extension. This alternative would extend the small emissions reduction delay an additional year and provide additional cost savings. A comparison is shown in Table C-44 of the predicted annual emissions, in tons, and cost savings with this alternative as compared to the proposed amendments. A net cost savings of approximately $2 million over the years from 2011 to 2020 would be realized with this alternative as compared to the proposed amendments. This delay would result in an additional increase in PM emissions of 6 tons and 81 tons increase in NO_x emissions.

The purpose of this amendment is to allow more time for technologies to become verified for use on CHE. Adding an additional year to the extension would extend the compliance delay out to 2018. Staff believes that this additional year of delay would not provide any significant benefits in terms of additional VDECS becoming verified. Tier 4 engines, which will not require retrofits for final compliance with the CHE Regulation if certified to the non-FEL standards, will be fully available by 2015 and the vast majority of CHE would have been brought into compliance. Consequently, there would be little

incentive for VDECS manufacturers to continue verification efforts into this time frame. Therefore staff rejected this alternative because it is not responsive to the purpose of the amendment.

Table C-44: Alternative 1 Cost and Emissions Comparison

Year	Alternative 1: 3 Year No VDECs Extension			Proposed 2-Year No VDECs Extension		
	NO_x	PM	Cost	NO_x	PM	Cost
2010	1639	57		1639	57	
2011	1482	42	($377,000)	1482	42	($257,000)
2012	1384	30	($883,000)	1384	30	($603,000)
2013	1273	22	($1,712,000)	1272	22	($1,169,000)
2014	1192	20	($1,730,000)	1182	19	($1,181,000)
2015	1180	22	($1,625,000)	1159	20	($1,109,000)
2016	1148	22		1126	21	
2017	1095	22		1072	20	
2018	1035	21		1026	20	
2019	991	20		994	20	
2020	943	20		946	20	
Sum	**10241**	**199**	**($6,327,000)**	**10160**	**193**	**($4,319,000)**
Difference				**-81**	**-6**	**$2,008,000**

Note: Negative numbers in parenthesis indicate savings.
Note: Costs express in 2011 dollars at present value
Note: Values have been rounded

Alternative 2

Alternative 2 is similar to the proposed regulation, but would only affect the non-yard truck equipment purchased with FEL engines. This alternative would be to not require CHE engines certified to the FEL Alt PM emission standards to be retrofitted with highest level VDECS. The net PM emissions impact and cost savings for this alternative, as compared to the proposed amendments, is shown in Table C-45. This alternative would reduce costs by $6 million. The change in diesel PM reduction would be an increase of approximately 48 tons compared to the proposed amendments, during the same 2011 to 2020 timeframe. There would be no change in the NO_x emissions during this time frame. However, this alternative would possibly allow a significant population of engines not meeting the effective Tier 4 PM standards into the CHE inventory as new engines. Staff rejected this alternative because it would not meet the goals of the original CHE Regulation.

Table 7: Alternative 2 Emissions Comparison

Year	Emissions Reductions with Only FEL Amendment		
	NO_x (Tons)	PM (Tons)	FEL Costs
2010	0	0	
2011	0	0	
2012	0	-1.02	$1,018,000
2013	0	-2.24	$1,012,000
2014	0	-3.87	$1,521,000
2015	0	-5.51	$1,348,000
2016	0	-6.90	$1,142,000
2017	0	-7.12	
2018	0	-7.24	
2019	0	-7.22	
2020	0	-6.87	
Sum	**0**	**-48.0**	**$6,041,000**

Note: Costs express in 2011 dollars at present value
Note: Values have been rounded

References:

(ARB, 2005a) California Air Resources Board*, Initial Statement of Reason for Proposed Rulemaking, Regulation for Mobile Cargo Handling Equipment at Ports and Intermodal Rail Yards,* October 2005.

(ARB, 2010a) California Air Resources Board, *Propose Amendment to the Regulation for In-Use Off-Road Diesel-fueled fleets and the Off-Road Large Spark Ignition Fleet Requirements, Appendix F: Cost Methodology*, October 2010. http://www.arb.ca.gov/regact/2010/offroadlsi10/offroadappf.pdf

(ARB, 2007b) California Air Resources Board, *Technical Support Document: Proposed Regulation for In-Use Off-Road Diesel Vehicles, Section C: Methodology for Estimating Cost and Economic Impact*, April 2007. http://www.arb.ca.gov/regact/2007/ordiesl07/TSD.pdf

(ARB,2011f) California Air Resources Board. "Cargo Handling Emissions Inventory Model", July, 2011. http://www.arb.ca.gov/ports/cargo/cheamd2011.htm.

(ARB,2011o) California Air Resources Board. "Cargo Handling Emissions Inventory Model Working Files", July, 2011. http://www.arb.ca.gov//ports/cargo/cheamd2011.htm.

(ARB, 2011g) California Air Resources Board, Economic Analysis Worksheets, http://www.arb.ca.gov/ports/cargo/cheamd2011.htm, 2011.

(ARB, 2011i) California Air Resources Board, Personal correspondence, John Karim, July 21, 2011.

(CCDET, 2011) California Council on Diesel Education and Technology, June, 2011. http://www.arb.ca.gov/enf/hdvip/ccdet/ccdet.htm

(ARB, 2011j) California Air Resources Board, Personal correspondence, Ken Pope, June 9, 2011.

(ARB, 2011k) California Air Resources Board, Personal correspondence, John Karim, June 10, 2011.

(BNR, 2011) BNR Mechanical, Northern California Smoke Opacity Testing Rates, May, 2011.

(CCS, 2011) CARB Compliance Services, Smoke Test Pricing Information, May, 2011. http://www.carb-compliance.com/pricing.html

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