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MEMORANDUM

DATE: January 29, 2010

SUBJECT: Control Costs for Existing Stationary CI RICE

FROM: Bradley Nelson, EC/R, Inc.

TO: Melanie King, EPA OAQPS/SPPD/ESG

1.0 PURPOSE

The purpose of this memorandum is to present information on the costs of control technology options for reducing hazardous air pollutants (HAP) emissions from stationary compression ignition (CI) reciprocating internal combustion engines (RICE). These estimates will be used for the above-the-floor maximum achievable control technology (MACT) analysis and generally available control technology (GACT) regulatory alternatives for RICE at major and area sources. This memorandum presents the cost of retrofitting control technology on existing engines.

2.0 INTRODUCTION

EPA has determined that diesel oxidation catalysts (DOC), catalyzed diesel particulate filters (CDPF), closed crankcase ventilation (CCV) and open crankcase ventilation (OCV) are applicable controls for HAP reduction from stationary CI RICE. To determine the capital and annual costs for these control technologies, equipment cost information was obtained from a cost study[1] performed by the California (CA) Air Resources Board (ARB) and cost data obtained from vendors. The annualized cost and capital cost equations were used to estimate the national impacts of controlling emissions from existing stationary CI engines.

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[1] Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles, California Environmental Protection Agency, Air Resources Board, Stationary Source Division, Mobile Source Control Division, October 2000. http://www.arb.ca.gov/diesel/documents/rrpapp.htm

3.0 METHODOLOGY FOR DETERMINING COST EQUATIONS

The following section describes the methodology used to derive the capital and annual costs for each of these control technologies. The capital and annual costs were determined using the costing methodology in the EPA Control Cost Manual.[2] A summary of the methodologies, equations, and assumptions used to estimate the capital and annual cost are described in the following sections.

3.1 Total Capital Costs

The total capital cost includes the direct and indirect costs of purchasing and installing the control equipment. The direct cost includes the cost of purchasing the equipment and instrumentation, cost of shipping, and the cost of installing the control equipment. The indirect cost includes the costs for engineering, contractor fees, testing costs, and also includes costs for contingencies, such as additional modifications, or delays in startup. The total capital cost equation can be summarized as follows;

Total Capital Cost (TCC) = Direct Costs (DC) + Indirect Costs (IC)

The direct costs include the costs of purchasing and installing the control equipment and can be summarized using the following equation;

DC = Purchased Equipment Cost (PEC) + Direct Installation Costs (DIC).

A summary of the cost assumptions for PEC includes the following:

- Control Device and Auxiliary Equipment (EC);
- Instrumentation (10% of EC);
- Sales Tax (3% of EC);
- Freight (5% of EC);

and can be summarized as:

PEC = 118% EC.

A summary of the cost assumptions for DIC includes the following:

- Foundations and Supports (8% of PEC);
- Handling and Erection (14% of PEC);
- Electrical (4% of PEC);
- Piping (2% of PEC);
- Insulation for Ductwork (1% of PEC);

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[2] EPA Air Pollution Control Cost Manual, Sixth Edition, January 2002, EPA/452/B-02-001.

- Painting (1% of PEC);

and can be summarized as:

DIC = 30% PEC = 0.3 PEC.

Therefore, the direct costs can be simplified using the following equation:

DC = PEC + 0.3 PEC = 1.3 PEC.

The indirect costs include the costs of engineering and contractor fees and contingencies and can be summarized using the following equation:

IC = Indirect Installation Costs (ICC) + Contingencies (C).

A summary of the cost assumptions for ICC includes the following:

- Engineering (10% of PEC);
- Construction and Field Expenses (5% of PEC);
- Contractor Fees (10% of PEC);
- Startup (2% of PEC);
- Performance Test (1% of PEC);

and can be summarized as:

IIC = 28% PEC = 0.28 PEC.

A summary of the cost assumptions for C includes the following:

- Equipment Redesign and Modifications;
- Cost Escalations;
- Delays in Startup;

and is assumed to be:

C = 3% PEC = 0.03 PEC.

Therefore, the IC can be summarized using the following equation:

IC = 0.28 PEC + 0.03 PEC = 0.31 PEC,

and the simplified TCC equation can be expressed as:

TCC = 1.3 PEC + 0.31 PEC = 1.61 PEC = 1.61 (1.18 EC) = 1.9 EC

3.2 Total Annual Costs

The total annual cost includes the direct and indirect annual costs of operating and maintaining the control equipment. The direct annual cost includes the cost of the utilities, operating labor, and control device cleaning and maintenance. The indirect annual cost includes the overhead costs such as spare parts for the control equipment, administrative charges, and the capital recovery of the control technology. The total annual cost equation can be summarized as follows:

Total Annual Cost (TAC) = Direct Annual Costs (DAC) + Indirect Annual Costs (IAC).

A summary of the cost assumptions for DAC includes the following:

- Utilities;
- Operating Labor;
- Maintenance;
- Annual Compliance Test;
- Catalyst Cleaning;
- Catalyst Replacement;
- Catalyst Disposal.

A summary of the cost assumptions for DAC includes the following:

- Overhead (60% of operating labor and maintenance costs);
- Fuel Penalty;
- Property Tax (1% of TCC);
- Insurance (1% of TCC);
- Administrative Charges (2% of TCC);
- Capital Recovery = $\{I(1+I)^n/((1+I)^n-1)*TCC\}$ where I is the interest rate, and n is the equipment life.

The DAC and fuel penalty costs will be estimated using information obtained for each of the control technologies. The other annual costs will be calculated using the assumed percentages.

4.0 CONTROL COST EQUATIONS

4.1 Diesel Oxidation Catalysts

The cost of retrofitting a DOC to an existing CI engine was estimated using cost data obtained from a diesel engine control technology study performed by the California ARB.[3] The study provided equipment cost ranges for 40, 100, 275, 400, and 1,400 horsepower (HP) diesel engines. The average cost in the cost range for each of the engine sizes was used to develop the capital and annual cost for each of the engines. The capital cost was calculated using the EPA Control Cost methodology and includes the direct, indirect, and contingency costs of installation of the DOC. The total annual cost was also calculated using the EPA Control Cost methodology and includes the direct and indirect annual costs of operating and maintaining the DOC. Maintenance costs were estimated using the average of the cost range provided in the California ARB study. The study estimated the maintenance costs to range from $64 to $712 per year; $50 to $100 for thermal cleaning and 1 hour labor ($78) once every other year to 4 times a year. For estimating the annual maintenance cost, the thermal cleaning was estimated to cost $153 ($75 for cleaning + $78 for 1 hour labor) and the thermal cleaning would occur twice a year for a total maintenance cost of $306 per year. An equipment life of 10 years and an interest rate of 7 percent were used to estimate the indirect annual costs. The 10 year equipment life is consistent with the average life of control equipment. The fuel penalty associated with operating a DOC was assumed to be negligible. The capital and annual costs were adjusted to 2008 dollars using the Marshall & Swift Equipment Cost Index.

The calculated annual cost was plotted against the engine HP and the resulting graph showed a straight line relationship between the annual cost and engine HP. Therefore a linear regression was performed using the calculated annual cost and the engine HP to develop an equation that estimates annual costs when an engine HP is input into the equation. A summary of the calculated annual costs, graph, and linear regression analysis is presented in Appendix A of this memorandum. The annualized cost equation for retrofitting a DOC on a CI engine was estimated to be:

$$\text{DOC Annual Cost} = \$4.99*\text{HP} + \$480$$

where;

HP = engine size in HP.

The linear equation has a correlation coefficient of 0.9938, which shows the data fit the equation very closely. Therefore, this equation was used to estimate annualized cost for DOC for RICE at major and area sources.

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[3] Appendix IX, Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles, California Environmental Protection Agency, Air Resources Board, Stationary Source Division, Mobile Source Control Division, October 2000. http://www.arb.ca.gov/diesel/documents/rrpapp9.PDF

For capital cost, a graph of the calculated capital cost and the engine HP showed a straight line relationship between the two variables. Therefore a linear regression was performed using the calculated capital cost and the engine HP to develop an equation that estimates capital costs when an engine HP is input into the equation. A summary of the calculated capital costs, graph, and linear regression analysis is presented in Appendix A of this memorandum. The capital cost equation for retrofitting a DOC on a CI engine was estimated to be:

$$\text{DOC Capital Cost} = \$27.4 * \text{HP} - \$939$$

where;

HP = engine size in HP.

The linear equation has a correlation coefficient of 0.9938, which shows the data fit the equation very closely. Therefore, this equation was used to estimate capital cost for DOC for RICE at major and area sources.

4.2 Catalyzed Diesel Particulate Filters

The CDPF is a control technology that reduces the emissions of HAP from CI engines. However, it is primarily installed on engines for the reduction of PM from the CI engine exhaust. The catalyst element in the CDPF is also effective in reducing the emissions of CO and volatile organic compounds (VOC). The filter system of the CDPF can be either active or passive. The passive CDPF uses heat from the engine to regenerate the filter media, whereas the active filter uses an electric heater or fuel burners to regenerate the filter media. The catalyzed coating in each of the two systems reduces emissions of CO, VOC, and HAP emissions.

The cost of retrofitting an active or passive CDPF to an existing CI engine was estimated using cost data obtained from a diesel engine control technology study performed by the California ARB.[4] The cost study did not distinguish equipment costs between the active and passive CDPF, therefore the equipment costs were assumed to be the same for both technologies. The study provided equipment cost ranges for 40, 100, 275, 400, and 1,400 HP diesel engines. The average cost in the cost range for each of these engine HPs and the EPA Control Cost methodology were used to develop the capital and annual cost for each of the engines. An equipment life of 10 years and an interest rate of 7 percent were used to estimate the indirect annual costs. The 10 year equipment life is consistent with the average life of control equipment. The fuel penalty associated with operating a CDPF was assumed to be negligible. The capital and annual costs were adjusted to 2008 dollars using the Marshall & Swift Equipment Cost Index.

The calculated annual cost for the CDPF was plotted against the engine HP and the resulting graph showed a straight line relationship between the annual cost and engine HP.

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[4] Appendix IX, Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles, California Environmental Protection Agency, Air Resources Board, Stationary Source Division, Mobile Source Control Division, October 2000. http://www.arb.ca.gov/diesel/documents/rrpapp9.PDF

Therefore a linear regression was performed using the calculated annual cost and the engine HP to develop an equation that estimates annual costs when an engine HP is input into the equation. A summary of the calculated annual costs, graph, and linear regression analysis is presented in Appendix A of this memorandum. The annualized cost equation for retrofitting a CDPF on a CI engine was estimated to be:

$$\text{CDPF Annual Cost} = \$11.6*\text{HP} + 1414$$

where;

HP = engine size in HP.

The linear equation has a correlation coefficient of 0.9897, which shows the data fit the equation very closely. Therefore, this equation was used to estimate annualized cost for retrofitting CDPF for CI at major and area sources.

For capital cost, a graph of the calculated capital cost and the engine HP showed a straight line relationship between the two variables. Therefore a linear regression was performed using the calculated capital cost and the engine HP to develop an equation that estimates capital costs when an engine HP is input into the equation. A summary of the calculated capital costs, graph, and linear regression analysis is presented in Appendix A of this memorandum. The capital cost equation for retrofitting a CDPF on a CI engine was estimated to be:

$$\text{CDPF Capital Cost} = \$63.4*\text{HP} + \$5699$$

where;

HP = engine size in HP.

The linear equation has a correlation coefficient of 0.9897, which shows the data fit the equation very closely. Therefore, this equation was used to estimate capital cost for CDPF for RICE at major and area sources.

4.3 Open and Closed Crankcase Ventilation

In diesel engines, the crankcase exhaust is either exhausted to the atmosphere (open crankcase) or routed to the air intake to be used as combustion air (closed crankcase). Crankcase ventilation systems use filtration or centrifugal force to remove oil mist and particulates from the crankcase exhaust stream in both open and closed crankcase diesel engines. The OCV system is installed on diesel engines with open crankcases, whereas the CCV system is installed on diesel engines with closed crankcases. The filtration or separator units used for both OCV and CCV are the same and have essentially the same cost. Therefore for this analysis, it is assumed that the capital and annual cost of OCV and CCV are the same.

The cost of retrofitting an OCV on an existing CI engine was estimated based on information obtained from a distributor of the OCV technology (see Appendix B). The distributor sells and installs three different models of the OCV system and provided information on the installation costs and maintenance required. These models were applied to engine sizes of 100, 150, 200, 300, 500, 750, 1,000, 1,250, and 1,500 HP to estimate capital and annual costs using the EPA Control Cost methodology. An equipment life of 10 years and an interest rate of 7 percent were used to estimate the indirect annual costs. The 10 year equipment life is consistent with the average life of control equipment. The calculated annual cost and engine size were graphed and a straight line relationship was observed. A linear regression analysis was done on the data set and the linear equation for annualized cost was;

$$\text{OCV Annual Cost} = \$0.065*\text{HP} + \$254$$

where;

HP = engine size in HP.

The linear equation has a correlation coefficient of 0.8154, which is due to the same annual cost being calculated for several different sized CI engines. This is due to the fact that the same model OCV can be retrofit on several different engine sizes, because the OCV are based on the flow rate of the crankcase exhaust. However, it is believed that the equation represents a representative average annual cost of retrofitting an OCV on a CI engine.

For capital cost, a graph of the calculated capital cost and the engine HP showed a straight line relationship between the two variables. Therefore a linear regression was performed using the calculated capital cost and the engine HP to develop an equation that estimates capital costs when an engine HP is input into the equation. A summary of the calculated capital costs, graph, and linear regression analysis is presented in Appendix A of this memorandum. The capital cost equation for retrofitting a OCV on a CI engine was estimated to be:

$$\text{OCV Capital Cost} = \$0.26*\text{HP} + \$997$$

where;

HP = engine size in HP.

The linear equation has a correlation coefficient of 0.7920, where again the capital cost was calculated to be the same for several different sized CI engines. However, it is believed that the cost equation provides a representative estimate of the average capital cost of retrofitting an OCV on a CI engine.

5.0 SUMMARY

The following table presents a summary of the costs for control devices to reduce HAP emissions from stationary CI engines.

Table 1. Summary of Annual and Capital Costs Equations for CI HAP Controls

HAP Control Device	Annual Cost ($)	Capital Cost ($)
DOC	$4.99*HP + $480	$27.4*HP - $939
CDPF	$11.6*HP + $1414	$63.4*HP + $5699
OCV	$0.065*HP + $254	$0.26*HP + $997

Appendix A

Control Cost Summary and Linear Regression Statistics

Diesel Oxidation Catalyst Cost

Data obtained from CARB Appendix IX, Diesel PM Control Technologies

Capital and Annual Cost Equations are from EPA Air Pollution Control Cost Manual, Sixth Edition (EPA/452/B-02-001)

			Direct Costs		**Indirect Costs**									
Engine Size (HP)	**Equipment Cost ($2000)**	**Equipment Cost ($2008)**	**PEC**	**DIC**	**IIC**	**C**	**Total Capital Cost**	**Regression Capital Cost**		**Direct Annual Cost**	**Indirect Annual Cost**	**Total Annual Cost**	**Regression Annual Cost**	**Annual Cost/Hp**
40	$500	$665	$785	$236	$220	$24	$1,264	$156		$407	$475	$882	680	$22.05
100	$1,018	$1,355	$1,599	$480	$448	$48	$2,574	$1,798		$407	$714	$1,121	979	$11.21
275	$2,350	$3,128	$3,690	$1,107	$1,033	$111	$5,942	$6,587		$407	$1,328	$1,735	1,853	$6.31
400	$3,250	$4,325	$5,104	$1,531	$1,429	$153	$8,217	$10,008		$407	$1,743	$2,150	2,477	$5.38
1400	$15,000	$19,963	$23,556	$7,067	$6,596	$707	$37,925	$37,374		$407	$7,161	$7,568	7,468	$5.41
														$10.07

Assumptions:

PEC = 118% of purchased equipment cost (PEC).

DIC = 30% of purchased equipment cost (PEC) and includes cost of installation.

IIC = 28% of purchased equipment cost (PEC).

C = 3% of purchased equipment cost (PEC).

Direct Annual Cost = 0, equipment certified by engine manufacturer.

Indirect Annual Cost = 60% of direct annual cost + 4% of total capital cost + capital recovery.

Capital Recovery assumes equipment life of 10 years and 7% interest rate. 0.1423775

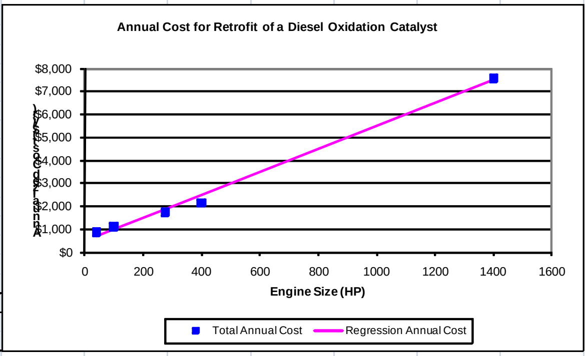
SUMMARY OUTPUT - Annual Cost

Regression Statistics	
Multiple R	0.99687955
R Square	0.99376884
Adjusted R S	0.99169179
Standard Err	252.645997
Observations	5

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	30539570.1	30539570.1	478.45167	0.00020915
Residual	3	191490	63830		
Total	4	30731060.1			

	Coefficients	*Standard Erro*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*
Intercept	480.351703	151.603431	3.16847514	0.05053998	-2.1180765	962.821482	-2.1180765
Engine Size	4.99102525	0.2281764	21.8735381	0.00020915	4.2648661	5.7171844	4.2648661



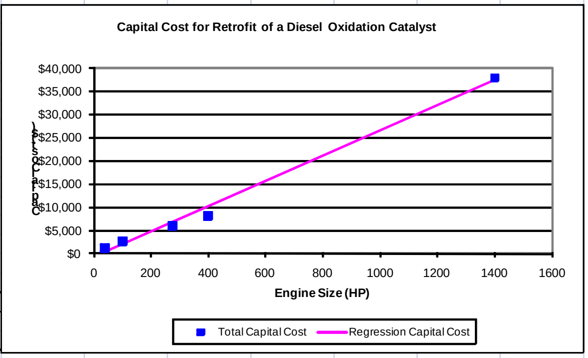
SUMMARY OUTPUT - Capital Cost

Regression Statistics	
Multiple R	0.99687955
R Square	0.99376884
Adjusted R S	0.99169179
Standard Err	1385.29146
Observations	5

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	918164273	918164273	478.45167	0.00020915
Residual	3	5757097.3	1919032.43		
Total	4	923921370			

	Coefficients	*Standard Erro*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*
Intercept	-938.90096	831.26169	-1.129489	0.34084422	-3584.3467	1706.54473	-3584.3467
Engine Size	27.3664524	1.25112143	21.8735381	0.00020915	23.3848256	31.3480792	23.3848256



Catalyzed Diesel Particulate Filter Cost
Data obtained from CARB Appendix IX, Diesel PM Control Technologies
Capital and Annual Cost Equations are from EPA Air Pollution Control Cost Manual, Sixth Edition (EPA/452/B-02-001)

			Direct Costs		**Indirect Costs**								
Engine Size (HP)	**Equipment Cost ($2000)**	**Equipment Cost ($2008)**	**PEC**	**DIC**	**IIC**	**C**	**Total Capital Cost**	**Regression Capital Cost**	**Direct Annual Cost**	**Indirect Annual Cost**	**Total Annual Cost**	**Regression Annual Cost**	**Annual Cost/Hp**
40	$4,150	$5,523	$6,517	$1,955	$1,825	$196	$10,493	$8,237	$234	$2,054	$2,288	1,877	$57.20
100	$6,250	$8,318	$9,815	$2,945	$2,748	$294	$15,802	$12,043	$234	$3,022	$3,256	2,571	$32.56
275	$7,950	$10,580	$12,485	$3,745	$3,496	$375	$20,100	$23,146	$234	$3,806	$4,040	4,596	$14.69
400	$10,500	$13,974	$16,489	$4,947	$4,617	$495	$26,548	$31,076	$234	$4,982	$5,216	6,042	$13.04
1400	$38,000	$50,572	$59,675	$17,903	$16,709	$1,790	$96,078	$94,518	$234	$17,663	$17,897	17,612	$12.78
													$26.06

Assumptions:
PEC = 118% of purchased equipment cost (PEC).
DIC = 30% of purchased equipment cost (PEC) and includes cost of installation.
IIC = 28% of purchased equipment cost (PEC).
C = 3% of purchased equipment cost (PEC).
Direct Annual Cost = 0, equipment certified by engine manufacturer.
Indirect Annual Cost = 60% of direct annual cost + 4% of total capital cost + capital recovery.
Capital Recovery assumes equipment life of 10 years and 7% interest rate. 0.1423775

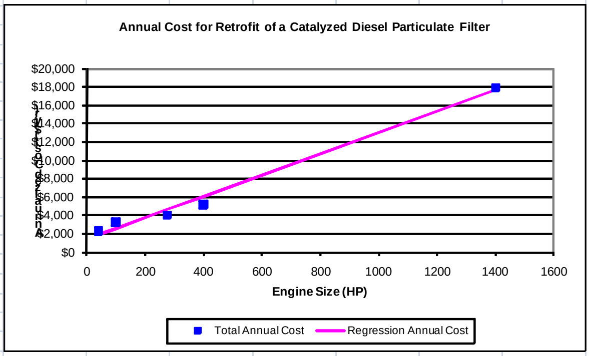
SUMMARY OUTPUT - Annual Cost

Regression Statistics	
Multiple R	0.99482924
R Square	0.98968521
Adjusted R S	0.98624695
Standard Err	755.115259
Observations	5

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	164128740	164128740	287.844638	0.00044599
Residual	3	1710597.16	570199.054		
Total	4	165839337			

	Coefficients	*Standard Erro*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	1413.79818	453.116477	3.12016501	0.0524648	-28.22068	2855.81703
Engine Size	11.57046	0.68197987	16.9659847	0.00044599	9.40009569	13.7408243



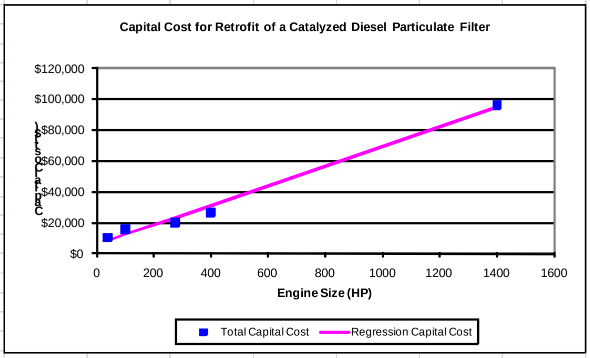
SUMMARY OUTPUT - Capital Cost

Regression Statistics	
Multiple R	0.99482924
R Square	0.98968521
Adjusted R S	0.98624695
Standard Err	4140.39697
Observations	5

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	4934488108	4934488108	287.844638	0.00044599
Residual	3	51428661.1	17142887		
Total	4	4985916769			

	Coefficients	*Standard Erro*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	5699.15785	2484.49765	2.2938874	0.10557881	-2207.6225	13605.9382
Engine Size	63.4423645	3.73938592	16.9659847	0.00044599	51.5419696	75.3427594



Crankcase Filtration Cost Equations
Data obtained from Telephone Communications with Mid-Atlantic Engine Supply Corporation
Capital and Annual Cost Equations are from EPA Air Pollution Control Cost Manual, Sixth Edition (EPA/452/B-02-001)

			Direct Costs		Indirect Costs								
Engine Size (HP)	**Equipment Cost ($2008)**	**PEC**	**DIC**	**IIC**	**C**	**Total Capital Cost**	**Regression Capital Cost**		**Direct Annual Cost**	**Indirect Annual Cost**	**Total Annual Cost**	**Regression Annual Cost**	**Annual Cost/Hp**
100	$500	$590	$177	$165	$18	$950	$1,022		$45	$200	$245	260	$2.45
150	$500	$590	$177	$165	$18	$950	$1,035		$45	$200	$245	264	$1.63
200	$600	$708	$212	$198	$21	$1,140	$1,048		$50	$238	$288	267	$1.44
300	$600	$708	$212	$198	$21	$1,140	$1,074		$50	$238	$288	273	$0.96
500	$600	$708	$212	$198	$21	$1,140	$1,125		$50	$238	$288	286	$0.58
750	$600	$708	$212	$198	$21	$1,140	$1,190		$50	$238	$288	302	$0.38
1000	$700	$826	$248	$231	$25	$1,330	$1,254		$60	$279	$339	319	$0.34
1250	$700	$826	$248	$231	$25	$1,330	$1,318		$60	$279	$339	335	$0.27
1500	$700	$826	$248	$231	$25	$1,330	$1,382		$60	$279	$339	351	$0.23
													$0.92

Assumptions:
PEC = 118% of purchased equipment cost (PEC).
DIC = 30% of purchased equipment cost (PEC) and includes cost of installation.
IIC = 28% of purchased equipment cost (PEC).
C = 3% of purchased equipment cost (PEC).
Direct Annual Cost = 0, equipment certified by engine manufacturer.
Indirect Annual Cost = 60% of direct annual cost + 4% of total capital cost + capital recovery.
Capital Recovery assumes equipment life of 10 years and 7% interest rate. 0.1423775

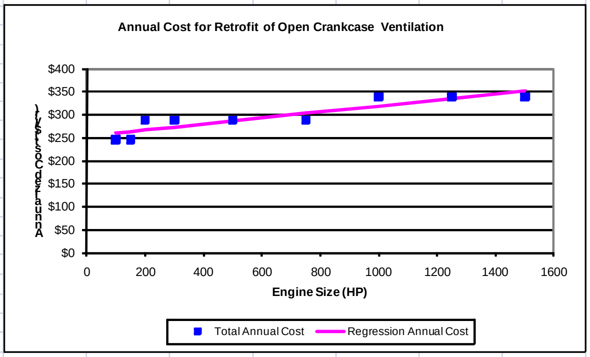
SUMMARY OUTPUT - Annual Cost

Regression Statistics	
Multiple R	0.90297617
R Square	0.81536597
Adjusted R S	0.78898968
Standard Err	16.909021
Observations	9

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	8838.44377	8838.44377	30.9128379	0.00085098
Residual	7	2001.40494	285.914991		
Total	8	10839.8487			

	Coefficients	*Standard Erro*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	253.982196	9.3261336	27.233386	2.3087E-08	231.929395	276.034998
Engine Size	0.06466166	0.01162994	5.55993147	0.00085098	0.03716122	0.09216209



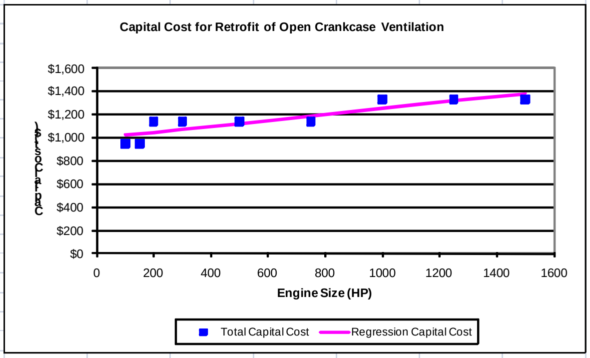
SUMMARY OUTPUT - Capital Cost

Regression Statistics	
Multiple R	0.88999704
R Square	0.79209473
Adjusted R S	0.76239398
Standard Err	72.3930199
Observations	9

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	139766.49	139766.49	26.6691805	0.00130337
Residual	7	36685.2453	5240.74934		
Total	8	176451.735			

	Coefficients	*Standard Erro*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	996.708476	39.928212	24.9625121	4.2234E-08	902.293257	1091.12369
Engine Size	0.25713456	0.04979155	5.16422119	0.00130337	0.13939626	0.37487286



Appendix B

Contact Report

CONTACT REPORT

Date/Time	Project Name	Project Number
November 20, 2009 10:00pm	RICE NESHAP	MME-304
EC/R Originator	Contact	Phone Number
Bradley Nelson	Chuck Cook – Mid-Atlantic Engine Supply	(800) 257-8133

General Subject

The purpose of the telephone call was to discuss the feasibility of retrofitting existing stationary diesel engines with an open or closed crankcase ventilation system, and obtain equipment and installation costs for the retrofit. I spoke with General Manager of the company who stated that their company had installed numerous open and closed crankcase ventilation systems on both stationary and nonroad engines. He stated that the OCV and CCV systems are the same products with the only difference being the installation kit needed to retrofit the unit. The OCV system is installed in the open crankcase ventilation port, whereas the CCV is installed somewhere along the crankcase exhaust line before it reaches the intake manifold. He noted that engines that are enclosed in a housing or other shelter emit an oil mist from the crankcase that accumulates on the radiator and reduces the radiators effectiveness in cooling the engine. He noted that the Racor systems they sell reduce oil mist emissions by 95% using a filtration system. The equipment costs for the systems are;

CCV4500 Series – Maximum Flow 10 CFM (< 160 HP diesel engines)	$500
CCV6000 Series – Maximum Flow 20 CFM (160-800 HP diesel engines)	$600
CCV8000 Series – Maximum Flow 40 CFM (> 800 HP diesel engines)	$700

The filter needs to be replaced every 750 hours and the replacement cost is $45 for the 4500, $50 for the 6000, and $60 for the 8000. The contact also stated it takes roughly 1-2 hours for installation, therefore at $80 per hour, installation would cost roughly $160.

http://www.maesco.com/products/racor/r_ccv_intro/r_ccv_intro.html