APPENDIX B

Cost Effectiveness Analysis for Rule 4702 (Internal Combustion Engines– Phase 2)

July 17, 2003

COST EFFECTIVENESS ANALYSIS and INCREMENTAL COST EFFECTIVENESS ANALYSIS

Rule 4702 Internal Combustion Engines – Phase 2

I. SUMMARY

District staff has performed a cost effectiveness analysis and incremental cost effectiveness analysis for the proposed provisions of new Rule 4702 (Internal Combustion Engines – Phase 2) as required by the California Health and Safety Code. New Rule 4702 is being developed to specify Best Available Retrofit Control Technology (BARCT) emission limits and all feasible measures for permitted spark-ignited internal combustion engines in the District. Cost effectiveness is the total annualized cost, in dollars, of the potential control option divided by emission reduction potential, in tons, of the potential control option.

Five general cases were analyzed for cost effectiveness and for incremental cost effectiveness. The five general cases analyzed for cost effectiveness were:

1. upgrade an existing non-selective catalytic reduction (NSCR) control system for a rich burn engine;
2. install a NSCR system for a rich burn engine;
3. install a NSCR system for a cyclic rich burn engine;
4. upgrade an existing selective catalytic reduction (SCR) control system for a lean burn, engine; and
5. install a SCR system for a lean burn engine.

The five general cases above were analyzed for incremental cost effectiveness where the existing engine was replaced with an electric motor. All cases for the cost effectiveness analysis and incremental cost effectiveness analysis were analyzed at two different operating capacity factors: 25% (2190 hours/year) and 75% (6570 hours/year).

In general, the cost effectiveness analysis indicated that the larger engines with the higher capacity factor had the lower cost effectiveness. The smaller engines with the lower capacity factor had the higher cost effectiveness. District staff feels that the annual compliance costs are reasonable for the five cases analyzed. Although a few of the results indicated a high cost effectiveness, such results are due to the low emission reductions and not from high annual costs. The results of the analyses are at the end of this appendix.

II. REQUIREMENTS OF THE ANALYSES

Pursuant to Section 40920.6 of the California Health and Safety Code, prior to adopting rules or regulations to meet the requirement for BARCT or for a feasible measure, the

District is required to review the information developed to assess the cost effectiveness of the potential control option and to calculate the incremental cost effectiveness for the potential control option. Cost effectiveness is the total annualized cost, in dollars, of the potential control option divided by emission reduction potential, in tons, of the potential control option.

The incremental cost effectiveness is the difference in the dollar costs divided by the difference in the emission reduction potentials between each progressively more stringent control option as compared to the next less expensive control option.

III. COST EFFECTIVENESS ANALYSIS

A. Cost Effectiveness Calculation

The cost effectiveness analysis was performed by calculating the difference (NOx emissions reduced per year) between the estimated current annual NOx emissions from engines complying with Rule 4701 and the estimated potential annual NOx emissions from engines complying with proposed Rule 4702. Installed equipment capital costs and operating and maintenance costs were estimated. Total annual costs were then calculated. The cost effectiveness was calculated by dividing total annual costs by the tons of NOx emissions reduced per year.

The annual current and annual potential NOx emissions were calculated using the following equation:

NOx = (ppmv / K) x hp x 24 hr/day x 365 day/year x C x 1 lb/454 gram / 2,000 lb/ton

Where:
NOx = NOx emissions in tons per year
ppmv = NOx emissions in parts per million corrected to 15% oxygen
K = ppmv to gram/bhp/hr correction factor and
C = Capacity Factor correction value.

The value for K was taken from the EPA Alternative Techniques Document – NOx emissions from Stationary Reciprocating IC engines, page 4-11. For NOx, corrected to 15% oxygen, these factors are:

Rich Burn: 1 g/bhp/hr = 67 ppmv
Lean Burn: 1 g/bhp/hr = 73 ppmv

B. Assumptions for the Cost Effectiveness Calculation

The more significant assumptions made in the Cost Effectiveness analysis are listed below.

1. The engines that will upgrade existing controls are operating at the current NOx limits in Rule 4701: 50 ppmv for Rich Burn and 75 ppmv for Lean Burn. The engines that will install controls are operating at the following NOx limits: 640 ppmv for Rich Burn, 300 ppmv for Cyclic Rich Burn, and 740 ppmv for Lean Burn.

2. The engines will operate at the proposed NOx limits in Rule 4702: 25 ppmv for Rich Burn, 50 ppmv for Cyclic Rich Burn, and 65 ppmv for Lean Burn.

3. The engines operate on natural gas.

4. An engine controlled with an existing NSCR system or SCR system can meet the proposed limit by changing the catalyst element with a more effective material.

5. Equipment has a ten-year life and annual interest rates are 10%.

6. Operators with existing NSCR and SCR control systems already have compliant emissions monitoring systems.

C. Results of the Cost Effectiveness Calculation

The results of the cost effectiveness calculations are contained in Tables 1 through 5 at the end of this appendix.

IV. INCREMENTAL COST EFFECTIVENESS ANALYSIS

A. Incremental Cost Effectiveness Calculation

To calculate the incremental cost effectiveness, the difference in the annual costs was divided by the difference in the emission reduction potentials between the more stringent control option as compared to the next less expensive control option. The next more stringent control option is to replace the engine with an electric motor. The next less expensive control option is the upgrading or installation of an emission control system.

The difference (NOx emissions reduced per year) between the estimated annual NOx emissions from engines complying by using the next more stringent control option (electrification) and the estimated annual NOx emissions from engines complying by using the next less expensive control option (emission control system) was calculated. Installed equipment capital costs and operating and maintenance costs were estimated to determine total annual costs for both options. The difference (total annual costs) between the total annual costs for both options was then calculated. The incremental cost effectiveness was calculated by dividing the difference of the total annual costs by the difference of the NOx emissions reduced per year.

The annual NOx emissions and emission reductions were calculated using the equation in Section III. A above. The amount of electrical power required to operate a motor was calculated as follows:

KW = hp x 0.7457 kw/hp / Motor Efficiency

Where:

KW	=	Electrical power in kilowatts
hp	=	Horsepower of the motor
Motor Efficiency	=	Efficiency of the motor

The annual cost of operating an electric motor was calculated as follows:

Cost/Year = hrs/yr x Cost/KwH x KW

Where:

Cost/Year	=	Annual operating costs of the motor
hrs/yr	=	Number of hours per year that the motor is operated
Cost/KwH	=	Cost of kilowatt hour of electric power
KW	=	Electrical power in kilowatts

B. Assumptions for the Incremental Cost Effectiveness Calculation

The more significant assumptions made in the Incremental Cost Effectiveness analysis are listed below.

1. The engines that will be replaced with an electric motor are operating at the current NOx limits in Rule 4701: 640 ppmv or 50 ppmv for Rich Burn, 740 ppmv or 75 ppmv for Lean Burn, and 300 ppmv for Cyclic Rich Burn.

2. There are no NOx emissions from electric motors.

3. Costs of connecting to the electric power grid are insignificant.

4. Per the RACT/BARCT Determination, maintenance costs are unknown and were not included in the calculations.

5. Equipment has a ten-year life and annual interest rates are 10%.

C. Results of the Incremental Cost Effectiveness Calculation

The results of the incremental cost effectiveness calculations are contained in Tables 6 through 10 at the end of this appendix.

Table 1 RULE 4702 COST EFFECTIVENESS ANALYSIS
Rich Burn ICE Upgrade Existing NSCR Control

Power Output (HP)	Capacity Factor	Current NOx Limit (ppmv)[A]	Annual Current NOx Emissions (tons/yr)[B]	Proposed NOx Limit (ppmv)[C]	Annual Potential NOx Emissions (tons/yr)[D]	Emission Reduction (tons/yr)[E]	Installed Control Equipment Cost ($)[F]	Annualized Equipment Cost ($)[G]	Annual O&M Cost ($)[H]	Total Annual Cost ($)	Cost Effectiveness ($/ton)[I]
50	0.25	50	0.09	25	0.04	0.04	3,375	549	102	651	14,470
200	0.25	50	0.36	25	0.18	0.18	4,625	752	102	854	4,747
500	0.25	50	0.90	25	0.45	0.45	5,125	834	102	936	2,080
1000	0.25	50	1.80	25	0.90	0.90	7,625	1,241	102	1,343	1,492
1500	0.25	50	2.70	25	1.35	1.35	11,750	1,912	102	2,014	1,492
50	0.75	50	0.27	25	0.13	0.13	3,375	549	102	651	4,823
200	0.75	50	1.08	25	0.54	0.54	4,625	752	102	854	1,582
500	0.75	50	2.70	25	1.35	1.35	5,125	834	102	936	693
1000	0.75	50	5.40	25	2.70	2.70	7,625	1,241	102	1,343	497
1500	0.75	50	8.10	25	4.05	4.05	11,750	1,912	102	2,014	497

[A] Current NOx Limit from Rule 4701, Table 3.
[B] Annual Current NOx Emissions = Rated Output x Capacity Factor x Current NOx Limit
[C] Proposed NOx Limit from draft Rule 4702.
[D] Annual Potential NOx Emissions = Rated Output x Capacity Factor x Proposed NOx Limit
[E] Emissions Reduction = Annual Current NOx Emissions - Annual Potential NOx Emissions
[F] The basis for the cost of the control system is the RACT/BARCT Determination.
[G] Annualized Equipment Cost was calculated based on a ten-year life and 10% interest. The annual cost factor is 0.1627.
[H] Annual O&M Costs were based on information from the RACT/BARCT Determination and the Annualized Equipment Costs.
[I] Cost Effectiveness = Total Annual Cost / Emission Reduction

Table 2 RULE 4702 COST EFFECTIVENESS ANALYSIS
Rich Burn ICE Install NSCR Control

Power Output (HP)	Capacity Factor	Current NOx Limit (ppmv)[A]	Annual Current NOx Emissions (tons/yr)[B]	Proposed NOx Limit (ppmv)[C]	Annual Potential NOx Emissions (tons/yr)[D]	Emission Reduction (tons/yr)[E]	Installed Control Equipment Cost ($)[F]	Annualized Equipment Cost ($)[G]	Annual O&M Cost ($)[H]	Total Annual Cost ($)	Cost Effectiveness ($/ton)[I]
50	0.25	640	1.15	25	0.04	1.11	13,500	2,196	7,119	9,315	8,415
200	0.25	640	4.61	25	0.18	4.43	18,500	3,010	7,819	10,829	2,446
500	0.25	640	11.52	25	0.45	11.07	20,500	3,335	8,819	12,154	1,098
1000	0.25	640	23.04	25	0.90	22.14	30,500	4,962	11,319	16,281	735
1500	0.25	640	34.56	25	1.35	33.21	47,000	7,647	18,919	26,566	800
50	0.75	640	3.46	25	0.13	3.32	13,500	2,196	7,199	9,395	2,829
200	0.75	640	13.82	25	0.54	13.28	18,500	3,010	7,819	10,829	815
500	0.75	640	34.56	25	1.35	33.21	20,500	3,335	8,819	12,154	366
1000	0.75	640	69.12	25	2.70	66.42	30,500	4,962	11,319	16,281	245
1500	0.75	640	103.68	25	4.05	99.63	47,000	7,647	18,919	26,566	267

[A] Current NOx Limit from Rule 4701, Table 1.
[B] Annual Current NOx Emissions = Rated Output x Capacity Factor x Current NOx Limit
[C] Proposed NOx Limit from draft Rule 4702.
[D] Annual Potential NOx Emissions = Rated Output x Capacity Factor x Proposed NOx Limit
[E] Emissions Reduction = Annual Current NOx Emissions - Annual Potential NOx Emissions
[F] The basis for the cost of the control system is the RACT/BARCT Determination.
[G] Annualized Equipment Cost was calculated based on a ten-year life and 10% interest. The annual cost factor is 0.1627.
[H] Annual O&M Costs were based on information from the RACT/BARCT Determination and the Annualized Equipment Costs.
[I] Cost Effectiveness = Total Annual Cost / Emission Reduction

Table 3 RULE 4702 COST EFFECTIVENESS ANALYSIS
Cyclic Rich Burn ICE Install NSCR Control

Power Output (HP)	Capacity Factor	Current NOx Limit (ppmv)[A]	Annual Current NOx Emissions (tons/yr)[B]	Proposed NOx Limit (ppmv)[C]	Annual Potential NOx Emissions (tons/yr)[D]	Emission Reduction (tons/yr)[E]	Installed Control Equipment Cost ($)[F]	Annualized Equipment Cost ($)[G]	Annual O&M Cost ($)[H]	Total Annual Cost ($)	Cost Effectiveness ($/ton)[I]
50	0.25	300	0.54	50	0.09	0.45	13,500	2,196	7,119	9,315	20,702
200	0.25	300	2.16	50	0.36	1.80	18,500	3,010	7,819	10,829	6,016
500	0.25	300	5.40	50	0.90	4.50	20,500	3,335	8,819	12,154	2,701
1000	0.25	300	10.80	50	1.80	9.00	30,500	4,962	11,319	16,281	1,809
2500	0.25	300	27.00	50	4.50	22.50	47,000	7,647	18,919	26,566	1,181
50	0.75	300	1.62	50	0.27	1.35	13,500	2,196	7,119	9,315	6,901
200	0.75	300	6.48	50	1.08	5.40	18,500	3,010	7,819	10,829	2,005
500	0.75	300	16.20	50	2.70	13.50	20,500	3,335	8,819	12,154	900
1000	0.75	300	32.40	50	5.40	27.00	30,500	4,962	11,319	16,281	603
2500	0.75	300	81.00	50	13.50	67.50	47,000	7,647	18,919	26,566	394

[A] Current NOx Limit from Rule 4701, Table 3.
[B] Annual Current NOx Emissions = Rated Output x Capacity Factor x Current NOx Limit
[C] Proposed NOx Limit from draft Rule 4702.
[D] Annual Potential NOx Emissions = Rated Output x Capacity Factor x Proposed NOx Limit
[E] Emissions Reduction = Annual Current NOx Emissions - Annual Potential NOx Emissions
[F] The basis for the cost of the control system is the RACT/BARCT Determination.
[G] Annualized Equipment Cost were calculated based on a ten-year life and 10% interest. The annual cost factor is 0.1627.
[H] Annual O&M Cost were based on information from the RACT/BARCT Determination and the Annualized Equipment Costs.
[I] Cost Effectiveness = Total Annual Cost / Emission Reduction

Table 4 RULE 4702 COST EFFECTIVENESS ANALYSIS
Lean Burn ICE Upgrade Existing SCR System

Power Output (HP)	Capacity Factor	Current NOx Limit (ppmv)[A]	Annual Current NOx Emissions (tons/yr)[B]	Proposed NOx Limit (ppmv)[C]	Annual Potential NOx Emissions (tons/yr)[D]	Emission Reduction (tons/yr)[E]	Installed Control Equipment Cost ($)[F]	Annualized Equipment Cost ($)[G]	Annual O&M Cost ($)[H]	Total Annual Cost ($)	Cost Effectiveness ($/ton)[I]
50	0.25	75	0.12	65	0.11	0.02	4,500	732	102	834	50,494
200	0.25	75	0.50	65	0.43	0.07	4,500	732	102	834	12,623
500	0.25	75	1.24	65	1.07	0.17	6,000	976	102	1078	6,527
1000	0.25	75	2.48	65	2.15	0.33	14,900	2,424	102	2526	7,646
1500	0.25	75	3.72	65	3.22	0.50	18,500	3,010	102	3112	6,279
50	0.75	75	0.37	65	0.32	0.05	4,500	732	102	834	16,831
200	0.75	75	1.49	65	1.29	0.20	4,500	732	102	834	4,208
500	0.75	75	3.72	65	3.22	0.50	6,000	976	102	1,078	2,176
1000	0.75	75	7.43	65	6.44	0.99	14,900	2,424	102	2,526	2,549
1500	0.75	75	11.15	65	9.66	1.49	18,500	3,010	102	3,112	2,093

[A] Current NOx Limit from Rule 4701, Table 3.
[B] Annual Current NOx Emissions = Rated Output x Capacity Factor x Current NOx Limit
[C] Proposed NOx Limit from draft Rule 4702.
[D] Annual Potential NOx Emissions = Rated Output x Capacity Factor x Proposed NOx Limit
[E] Emissions Reduction = Annual Current NOx Emissions - Annual Potential NOx Emissions
[F] It was assumed that the control system already exists and that the lower NOx limits could be met by upgrading the existing control system. The basis for the cost of the control system is the RACT/BARCT Determination.
[G] Annualized Equipment Cost was calculated based on a ten-year life and 10% interest. The annual cost factor is 0.1627.
[H] Annual O&M Costs were based on information from the RACT/BARCT Determination and the Annualized Equipment Costs.
[I] Cost Effectiveness = Total Annual Cost / Emission Reduction

Table 5 RULE 4702 COST EFFECTIVENESS ANALYSIS
Lean Burn ICE Install SCR System

Power Output (HP)	Capacity Factor	Current NOx Limit (ppmv)[A]	Annual Current NOx Emissions (tons/yr)[B]	Proposed NOx Limit (ppmv)[C]	Annual Potential NOx Emissions (tons/yr)[D]	Emission Reduction (tons/yr)[E]	Installed Control Equipment Cost ($)[F]	Annualized Equipment Cost ($)[G]	Annual O&M Cost ($)[H]	Total Annual Cost ($)	Cost Effectiveness ($/ton)[I]
50	0.25	740	1.22	65	0.11	1.12	45,000	7,322	20,102	27,424	24,593
200	0.25	740	4.89	65	0.43	4.46	45,000	7,322	26,102	33,424	7,493
500	0.25	740	12.22	65	1.07	11.15	60,000	9,762	35,102	44,864	4,023
1000	0.25	740	24.45	65	2.15	22.30	149,000	24,242	78,102	102,344	4,589
1500	0.25	740	36.67	65	3.22	33.45	185,000	30,100	117,102	147,202	4,400
50	0.75	740	3.67	65	0.32	3.35	45,000	7,322	20,102	27,424	8,198
200	0.75	740	14.67	65	1.29	13.38	45,000	7,322	26,102	33,424	2,498
500	0.75	740	36.67	65	3.22	33.45	60,000	9,762	35,102	44,864	1,341
1000	0.75	740	73.35	65	6.44	66.91	149,000	24,242	78,102	102,344	1,530
1500	0.75	740	110.02	65	9.66	100.36	185,000	30,100	117,102	147,202	1,467

[A] Current NOx Limit from Rule 4701, Table 1.
[B] Annual Current NOx Emissions = Rated Output x Capacity Factor x Current NOx Limit
[C] Proposed NOx Limit from draft Rule 4702.
[D] Annual Potential NOx Emissions = Rated Output x Capacity Factor x Proposed NOx Limit
[E] Emissions Reduction = Annual Current NOx Emissions - Annual Potential NOx Emissions
[F] The basis for the cost of the control system is the RACT/BARCT Determination.
[G] Annualized Equipment Cost was calculated based on a ten-year life and 10% interest. The annual cost factor is 0.1627.
[H] Annual O&M Costs were based on information from the RACT/BARCT Determination and the Annualized Equipment Costs.
[I] Cost Effectiveness = Total Annual Cost / Emission Reduction

Table 6 RULE 4702 INCREMENTAL COST EFFECTIVENESS ANALYSIS
Rich Burn ICE - Upgrade NSCR vs Electrification

Power Output (HP)	Capacity Factor	Current NOx Limit (ppmv)[A]	Elect. Motor Emission Reduction (tons/yr)	NSCR Emission Reduction (tons/yr)[B]	Difference in Emission Reduction (tons/yr)[C]	Elect. Motor Total Annual Cost ($)	NSCR Total Annual Cost ($)	Difference in Total Annual Cost ($)[D]	Incremental Cost Effectiveness ($/ton)[E]
50	0.25	50	0.09	0.04	0.04	12,520	651	11,869	263,761
200	0.25	50	0.36	0.18	0.18	40,138	854	39,284	218,254
500	0.25	50	0.90	0.45	0.45	93,114	936	92,178	204,849
1000	0.25	50	1.80	0.90	0.90	189,433	1,343	188,091	208,999
50	0.75	50	0.27	0.13	0.13	28,578	651	27,927	206,879
200	0.75	50	1.08	0.54	0.54	104,373	854	103,519	191,709
500	0.75	50	2.70	1.35	1.35	253,701	936	252,765	187,241
1000	0.75	50	5.40	2.70	2.70	510,606	1,343	509,264	188,624

[A] Current NOx Limit from Rule 4701, Table 3.
[B] Emission Reduction based on a proposed NOx limit of 25 ppmv from draft Rule 4702.
[C] Difference in Emission Reduction = Elect Motor Emission Reduction - NSCR Emission Reduction
[D] Difference in Total Annual Cost = Elect Motor Total Annual Cost - NSCR Total Annual Cost
[E] Incremental Cost Effectiveness = Difference in Total Annual Cost / Difference in Emission Reduction

Table 7 RULE 4702 INCREMENTAL COST EFFECTIVENESS ANALYSIS
Rich Burn ICE - Install NSCR vs Electrification

Power Output (HP)	Capacity Factor	Current NOx Limit (ppmv)[A]	Elect. Motor Emission Reduction (tons/yr)	NSCR Emission Reduction (tons/yr)[B]	Difference in Emission Reduction (tons/yr)[C]	Elect. Motor Total Annual Cost ($)	NSCR Total Annual Cost ($)	Difference in Total Annual Cost ($)[D]	Incremental Cost Effectiveness ($/ton)[E]
50	0.25	640	1.15	1.11	0.04	12,520	9,315	3,204	71,212
200	0.25	640	4.61	4.43	0.18	40,138	10,829	29,309	162,837
500	0.25	640	11.52	11.07	0.45	93,114	12,154	80,960	179,918
1000	0.25	640	23.04	22.14	0.90	189,433	16,281	173,152	192,399
50	0.75	640	3.46	3.32	0.13	28,578	9,315	19,263	142,695
200	0.75	640	13.82	13.28	0.54	104,373	10,829	93,544	173,237
500	0.75	640	34.56	33.21	1.35	253,701	12,154	241,546	178,931
1000	0.75	640	69.12	66.42	2.70	510,606	16,281	494,325	183,091

[A] Current NOx Limit from Rule 4701, Table 1.
[B] Emission Reduction based on a proposed NOx limit of 25 ppmv from draft Rule 4702.
[C] Difference in Emission Reduction = Elect Motor Emission Reduction - NSCR Emission Reduction
[D] Difference in Total Annual Cost = Elect Motor Total Annual Cost - NSCR Total Annual Cost
[E] Incremental Cost Effectiveness = Difference in Total Annual Cost / Difference in Emission Reduction

Table 8 RULE 4702 INCREMENTAL COST EFFECTIVENESS ANALYSIS
Cyclic Rich Burn ICE - Install NSCR vs Electrification

Power Output (HP)	Capacity Factor	Current NOx Limit (ppmv)[A]	Elect. Motor Emission Reduction (tons/yr)	NSCR Emission Reduction (tons/yr)[B]	Difference in Emission Reduction (tons/yr)[C]	Elect. Motor Total Annual Cost ($)	NSCR Total Annual Cost ($)	Difference in Total Annual Cost ($)[D]	Incremental Cost Effectiveness ($/ton)[E]
50	0.25	300	0.54	0.45	0.09	12,520	9,315	3,204	35,606
200	0.25	300	2.16	1.80	0.36	40,138	10,829	29,309	81,419
500	0.25	300	5.40	4.50	0.90	93,114	12,154	80,960	89,959
1000	0.25	300	10.80	9.00	1.80	189,433	16,281	173,152	96,200
50	0.75	300	1.62	1.35	0.27	28,578	9,315	19,263	71,348
200	0.75	300	6.48	5.40	1.08	104,373	10,829	93,544	86,619
500	0.75	300	16.20	13.50	2.70	253,701	12,154	241,546	89,465
1000	0.75	300	32.40	27.00	5.40	510,606	16,281	494,325	91,546

[A] Current NOx Limit from Rule 4701, Table 3.
[B] Emission Reduction based on a proposed NOx limit of 50 ppmv from draft Rule 4702.
[C] Difference in Emission Reduction = Elect Motor Emission Reduction - NSCR Emission Reduction
[D] Difference in Total Annual Cost = Elect Motor Total Annual Cost - NSCR Total Annual Cost
[E] Incremental Cost Effectiveness = Difference in Total Annual Cost / Difference in Emission Reduction

Table 9 RULE 4702 INCREMENTAL COST EFFECTIVENESS ANALYSIS
Lean Burn ICE - Upgrade SCR vs Electrification

Power Output (HP)	Capacity Factor	Current NOx Limit (ppmv)[A]	Elect. Motor Emission Reduction (tons/yr)	SCR Emission Reduction (tons/yr)[B]	Difference in Emission Reduction (tons/yr)[C]	Elect. Motor Total Annual Cost ($)	SCR Total Annual Cost ($)	Difference in Total Annual Cost ($)[D]	Incremental Cost Effectiveness ($/ton)[E]
50	0.25	75	0.12	0.02	0.11	12,520	834	11,686	108,827
200	0.25	75	0.50	0.07	0.43	40,138	834	39,304	91,508
500	0.25	75	1.24	0.17	1.07	93,114	1,078	92,036	85,711
1000	0.25	75	2.48	0.33	2.15	189,433	2,526	186,907	87,032
50	0.75	75	0.37	0.05	0.32	28,578	834	27,744	86,126
200	0.75	75	1.49	0.20	1.29	104,373	834	103,539	80,353
500	0.75	75	3.72	0.50	3.22	253,701	1,078	252,622	78,421
1000	0.75	75	7.43	0.99	6.44	510,606	2,526	508,080	78,861

[A] Current NOx Limit from Rule 4701, Table 3.
[B] Emission Reduction based on a proposed NOx limit of 65 ppmv from draft Rule 4702.
[C] Difference in Emission Reduction = Elect Motor Emission Reduction - SCR Emission Reduction
[D] Difference in Total Annual Cost = Elect Motor Total Annual Cost - SCR Total Annual Cost
[E] Incremental Cost Effectiveness = Difference in Total Annual Cost / Difference in Emission Reduction

Table 10 RULE 4702 INCREMENTAL COST EFFECTIVENESS ANALYSIS
Lean Burn ICE - Install SCR vs Electrification

Power Output (HP)	Capacity Factor	Current NOx Limit (ppmv)[A]	Elect. Motor Emission Reduction (tons/yr)	SCR Emission Reduction (tons/yr)[B]	Difference in Emission Reduction (tons/yr)[C]	Elect. Motor Total Annual Cost ($)	SCR Total Annual Cost ($)	Difference in Total Annual Cost ($)[D]	Incremental Cost Effectiveness ($/ton)[E]
50	0.25	740	1.22	1.12	0.11	12,520	27,424	-14,904	-138,795
200	0.25	740	4.89	4.46	0.43	40,138	33,424	6,715	15,634
500	0.25	740	12.22	11.15	1.07	93,114	44,864	48,250	44,934
1000	0.25	740	24.45	22.30	2.15	189,433	102,344	87,089	40,552
50	0.75	740	3.67	3.35	0.32	28,578	27,424	1,155	3,585
200	0.75	740	14.67	13.38	1.29	104,373	33,424	70,950	55,062
500	0.75	740	36.67	33.45	3.22	253,701	44,864	208,837	64,829
1000	0.75	740	73.35	66.91	6.44	510,606	102,344	408,262	63,368

[A] Current NOx Limit from Rule 4701, Table 1.
[B] Emission Reduction based on a proposed NOx limit of 65 ppmv from draft Rule 4702.
[C] Difference in Emission Reduction = Elect Motor Emission Reduction - SCR Emission Reduction
[D] Difference in Total Annual Cost = Elect Motor Total Annual Cost - SCR Total Annual Cost
[E] Incremental Cost Effectiveness = Difference in Total Annual Cost / Difference in Emission Reduction