Documentation of Cost Equations in EPA's Control Strategy Tool

David Misenheimer
U.S. EPA, OAQPS
Mail Code C439-02
Research Triangle Park, NC 27711

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1 INTRODUCTION

The purpose of EPA's Control Strategy Tool (CoST) is to model the emission reductions and costs associated with control strategies applied to sources of air pollution. The Control Strategy Tool was developed as a replacement for the AirControlNET (ACN) software tool. It was determined in 2006 that it was an appropriate time to replace the ACN software with newer software that could provide improved effectiveness, functionality, and transparency to support current and upcoming needs. A prototype version of the Control Strategy Tool was developed in 2006 and a fully functional version was developed in 2008.

For many of the control measures in the Control Strategy Tool, a simple cost factor in terms of dollars per ton of pollutant reduced is used to calculate the cost of the control measure when applied to a specific source. However, a few control measures use a more robust cost equation to determine engineering costs that take into account several variables for the source when those variables are available. This document describes these equations.

2 CONTROL STRATEGY TOOL EQUATION TYPES

This document provides a list of equations and associated variables assigned to specific control measures in the Control Strategy Tool. The application of these equations is based on the individual emissions inventory record to which they are applied and the specific characteristics of that record. For example, Equation 1 calculates capital cost largely on the unit's capacity expressed in units of megawatts (MW) and is scaled based on the original control cost calculations. It is applicable to NOx, SO2, and PM emissions at EGU sources. Variable and fixed operating and maintenance (O&M) factors are present in most of the control cost calculations listed in Table 1. Each equation type typically is applied either to a pollutant-major source combination or to a more general grouping of pollutant, source type combinations.

The scaling factors, additional variables, and cross-references by control measure and equation type are detailed in the following tables of this document.

The cost equations incorporated into the Control Strategy Tool are adopted from AirControlNET version 4.1. More specific application examples of these control cost equations can be found in the AirControlNET Development Report Documentation found on EPA's website (http://www.epa.gov/ttn/ecas/models/DevelopmentReport.pdf).

Table 1. Cost Equations Used in Control Strategy Tool

Cost Equation #	Cost Equation Details	Comments
Type 1	Scaling Factor (SF) = (Model Plant boiler capacity / MW) ^ (Scaling Factor Exponential) Capital Cost = TCC x NETDC x SF x 1000 Fixed O&M Cost = OMF x NETDC x 1000 Variable O&M Cost = OMV x NETDC x 1000 x CAPFAC x 8760 /1000 CRF = I x (1+ I) ^ Eq. Life / [(1+ I) ^ Eq. Life - 1] Annualized Capital Cost = Capital Cost x CRF Total Cost = Capital Cost x CRF + O&M Cost	Cost equations are based on capacity in the range of > 0 to < 2000 mmBTU/hr. If capacity is not within range, a cost per ton value is applied. Capital cost equations are in the form of $ = capital multiplier (capacity) ^ capital exponent. Annual costs are in the form of $ = annual multiplier (capacity) ^ annual exponent. Multipliers and exponents are available for a no control baseline and a RACT baseline. Control measure is not applied if boiler capacity is missing.
Type 2	Annual Cost = Annual Cost Multiplier x (Boiler Capacity) ^ Exponent Capital Coat = Capital Cost Multiplier x (Boiler Capacity) ^ Exponent	
Type 3	Capital Cost = Capital Cost factor x Gas Flow Rate factor x Retrofit fator x Min. Stack flow rate Capital Cost = ((1028000/Min. stack flow rate)^0.6)x Capital Cost factor x Gas Flow Rate factor x Retrofit fator x Min. Stack Flow rate O&M Cost = (3.35 + (0.00729 x 8736)) x Min. stack flow rate x 0.9383 Total Cost = (Capital cost x CRF) + O&M Cost	Min Stack Flow Rate >= 1028000 acfm Min Stack Flow Rate < 1028000 acfm Capital Cost factor = $192 / kw Gas flow rate factor = 0.486 KW/acfm
Type 4	Capital Cost = 990000 + 9.836 x Min. Stack flow rate O&M Cost = 75800 + 12.82 x Min. Stack Flow Rate Total Cost = Capital Cost x CRF + O&M Cost	Min Stack flow Rate >= 1028000 acfm Min Stack flow Rate < 1028000 acfm
Type 5	Capital Cost = 2882540 + 244.74 x Min. Stack Flow Rate O&M Cost = 749170 + 148.40 x Min. Stack Flow Rate Total Cost = Capital Cost x CRF + O&M Cost	
Type 6	Capital cost = 3449803 + (135.86 x Min. Stack Flow rate) O&M Cost = 797667 + (58.84 x Min. Stack Flow Rate) Total Cost = Capital Cost x CRF + O&M Cost	
Type 7	Capital cost = 2882540 + (244.74 x Min. Stack Flow Rate) + 93.3 x 1.1 x Min. Stack Flow Rate x 0.9383	

Table 1. Cost Equations Used in Control Strategy Tool

	Capital cost = 2882540 + (244.74 x Min. Stack Flow Rate) + (((1028000 / Min. Stack Flow Rate) ^ 0.6)) x 93.3 x 1.1 x Min. Stack Flow Rate x 0.9383 O&M Cost = 749170 + (148.40 x Min. Stack Flow Rate) + (3.35 + (0.000729 x 8736) x Min. Stack Flow Rate ^ 0.9383)	
Type 8	Capital Cost= Typical Capital Cost x Min. Stack Flow Rate O&M Cost= Typical O&M Cost x Min. Stack Flow Rate Total Cost = Capital Cost x CRF + 0.04 x capital cost + O&M Cost	For Min. Stack flow rate less than 5 cfm , default cost per ton cost effectiveness is used. Min. Stack Flow Rate > 5

2.1 NOx Control Equations

2.1.1 Non-EGU NOx Control Equations

Non-EGU point sources utilizing control cost equations for NOx emission reductions are limited to Equation Type 2 as identified in Table 1. In this equation, the annualized cost of control is estimated using a boiler capacity variable from the input emissions inventory as well as a scaling component which is based on the original Alternative Control Technology or Control Technology Guidelines (ACT/CTG) analyses used to derive these estimates.

Controls are applied only to sources which exceed ten (10) tons NOx per year threshold. Equation based costs are estimated for units that have a positive boiler capacity value which does not exceed 2,000 million Btu per hour (MMBtu/hr). For those sources not meeting the boiler capacity threshold, default cost per ton values are used. Furthermore, a size classification is applied based on the ozone season daily emissions value. A daily emissions value of less than one ton NOx per day designates the source as small and applies control cost parameters consistent with this classification. An additional flag is assigned if the unit already has some NOx control applied in the input inventory. In these cases, units are already assumed to have some Reasonably Available Control Technology (RACT) style control, and control costs associated with incremental controls are based on alternate default cost per ton or alternate control cost variables. These alternate values take into account the incremental ineffectiveness of applying controls to units which already have a level of control assigned.

Table 2 provides a list of the control cost parameters and variables as assigned during the application of Cost Equation Type 2 to non-EGU NOx controls. The O&M costs are calculated as a subtraction of the annualized costs minus the capital costs * capital recovery factor (CRF). In this document, the CRF is always provided as calculated from ACN 4.1. This value can be recalculated in the Control Strategy Tool using the equipment life and interest rate of the specific measure.

For controls which the equation based methods do not apply, default cost per ton values are assigned and applied to the annual emission reduction achieved by the applied control measure. In these applications, a capital to annual cost ratio is applied to estimate the capital cost associated with the control, and as before, the O&M costs are calculated using a subtraction of the capital cost * CRF. The variables used in the default cost per ton equations are provided in Table 3.

Table 2. NOx Non-EGU Control Cost Parameters

					Control Cost Equation Application Parameters								
					Default Application				Incremental Application				
					Capital Cost Variables		Annual Cost Variables		Capital Cost Variables		Annual Cost Variables		Cost Year
Measure	Source Type	Measure Name	CE	CRF	Multiplier	Exponent	Multiplier	Exponent	Multiplier	Exponent	Multiplier	Exponent	($Year)
N0111L	ICI Boilers - Coal/Wall	SNCR	40	0.0944	110487.6	0.423	3440.9	0.7337	67093.8	0.423	7514.2	0.4195	1990
N0113L	ICI Boilers - Coal/Wall	LNB	50	0.1424	53868.7	0.6	11861.1	0.6	53868.7	0.6	11861.1	0.6	1990
N0114L	ICI Boilers - Coal/Wall	SCR	90	0.0944	82400.9	0.65	5555.6	0.7885	79002.2	0.65	8701.5	0.6493	1990
N0121L	ICI Boilers - Coal/FBC	SNCR - Urea	75	0.0944	15972.8	0.6	4970.5	0.6	15972.8	0.6	3059.2	0.6	1990
N0131L	ICI Boilers - Coal/Stoker	SNCR	40	0.0944	110487.6	0.423	3440.9	0.7337	67093.8	0.423	7514.2	0.4195	1990
N0154L	ICI Boilers - Residual Oil	SNCR	50	0.0944	62148.8	0.423	2012.4	0.7229	48002.6	0.423	5244.4	0.4238	1990
N0153L	ICI Boilers - Residual Oil	SCR	80	0.0944	33206.3	0.65	2498.1	0.732	40891.3	0.65	4481.5	0.6501	1990
N0164L	ICI Boilers - Distillate Oil	SNCR	50	0.0944	62148.8	0.423	2012.4	0.723	48002.6	0.423	5244.4	0.4238	1990
N0163L	ICI Boilers - Distillate Oil	SCR	80	0.0944	33206.3	0.65	2498.1	0.732	40891.3	0.65	4481.5	0.6501	1990
N0175L	ICI Boilers - Natural Gas	SNCR	50	0.0944	62148.8	0.423	2012.4	0.723	48002.6	0.423	5244.4	0.4238	1990
N0174L	ICI Boilers - Natural Gas	SCR	80	0.0944	33206.3	0.65	2498.1	0.732	40891.3	0.65	4481.5	0.6501	1990
N0181L	ICI Boilers - Wood/Bark/Stoker	SNCR - Urea	55	0.0944	65820.1	0.3607	17777.1	0.3462	65820.1	0.361	17777.1	0.3462	1990
N0191L	ICI Boilers - Wood/Bark/FBC	SNCR - Ammonia	55	0.0944	9855.6	0.6	4185.4	0.6	9855.6	0.6	4185.4	0.6	1990
N0231L	Gas Turbines - Oil	Water Injection	68	0.1098	54453.5	0.5686	9687.9	0.7597	54453.5	0.5686	9687.9	0.7597	1990
N0232L	Gas Turbines - Oil	SCR + Water Injecti	90	0.1098	123980.2	0.5925	36100.2	0.6564	70538.9	0.6059	28972.5	0.5764	1990
N0241L	Gas Turbines - Natural Gas	Water Injection	76	0.1098	4284.2	1.0142	145.7	1.468	4284.2	1.0142	145.7	1.468	1990
N0242L	Gas Turbines - Natural Gas	Steam Injection	80	0.1098	9693.1	0.9199	764.3	1.1472	9693.1	0.9199	764.3	1.1472	1990
N0243L	Gas Turbines - Natural Gas	LNB	84	0.1098	71281.1	0.505	7826.3	0.505	71281.1	0.505	7826.3	0.505	1990
N0244L	Gas Turbines - Natural Gas	SCR + LNB	94	0.1098	86461.8	0.6448	19916.7	0.6561	33203.7	0.7295	13920	0.6866	1990
N0245L	Gas Turbines - Natural Gas	SCR + Steam Injecti	95	0.1098	90606.2	0.6695	25936.7	0.6903	15278.8	0.8512	5477.9	0.8365	1990
N0246L	Gas Turbines - Natural Gas	SCR + Water Injecti	95	0.1098	121119	0.5891	36298.9	0.6308	18026.5	0.8237	7607	0.7828	1990

Table 3. NOx Non-EGU Default Cost Per Ton Values

Measure	Source Type	Measure Name	CE	Cost Per Ton ($/ton reduced) Default	Cost Per Ton ($/ton reduced) Incremental	Capital to Annual Cost Cost Ratio	CRF	Cost Year ($Year)
N0111	ICI Boilers - Coal/Wall	SNCR	40	950	330	7.2	0.0944	1990
N0111L	ICI Boilers - Coal/Wall	SNCR	40	840	260	6.6	0.0944	1990
N0111S	ICI Boilers - Coal/Wall	SNCR	40	1040	400	7.7	0.0944	1990
N0113	ICI Boilers - Coal/Wall	LNB	50	1280	1280	4.5	0.1424	1990
N0113L	ICI Boilers - Coal/Wall	LNB	50	1090	1090	4.5	0.1424	1990
N0113S	ICI Boilers - Coal/Wall	LNB	50	1460	1460	4.5	0.1424	1990
N0114	ICI Boilers - Coal/Wall	SCR	90	1170	810	6.8	0.0944	1990
N0114L	ICI Boilers - Coal/Wall	SCR	90	1070	700	6.5	0.0944	1990
N0114S	ICI Boilers - Coal/Wall	SCR	90	1260	910	7.1	0.0944	1990
N0121	ICI Boilers - Coal/FBC	SNCR - Urea	75	790	790	5.2	0.0944	1990
N0121L	ICI Boilers - Coal/FBC	SNCR - Urea	75	670	670	5.2	0.0944	1990
N0121S	ICI Boilers - Coal/FBC	SNCR - Urea	75	900	900	5.2	0.0944	1990
N0131	ICI Boilers - Coal/Stoker	SNCR	40	920	791	7.2	0.0944	1990
N0131L	ICI Boilers - Coal/Stoker	SNCR	40	817	703	6.6	0.0944	1990
N0131S	ICI Boilers - Coal/Stoker	SNCR	40	1015	873	7.7	0.0944	1990
N0141	ICI Boilers - Coal/Cyclone	SNCR	35	770	770	7	0.0944	1990
N0141L	ICI Boilers - Coal/Cyclone	SNCR	35	700	700	6.4	0.0944	1990
N0141S	ICI Boilers - Coal/Cyclone	SNCR	35	840	840	7.5	0.0944	1990
N0142	ICI Boilers - Coal/Cyclone	Coal Reburn	50	420	420	2	0.0944	1990
N0142L	ICI Boilers - Coal/Cyclone	Coal Reburn	50	300	300	2	0.0944	1990
N0142S	ICI Boilers - Coal/Cyclone	Coal Reburn	50	1570	1570	2	0.0944	1990
N0143	ICI Boilers - Coal/Cyclone	SCR	90	760	760	6.7	0.0944	1990
N0143L	ICI Boilers - Coal/Cyclone	SCR	90	700	700	6.3	0.0944	1990
N0143S	ICI Boilers - Coal/Cyclone	SCR	90	820	820	7	0.0944	1990
N0144	ICI Boilers - Coal/Cyclone	NGR	55	480	480	2	0.0944	1990
N0144L	ICI Boilers - Coal/Cyclone	NGR	55	300	300	2	0.0944	1990
N0144S	ICI Boilers - Coal/Cyclone	NGR	55	1570	1570	2	0.0944	1990
N0151	ICI Boilers - Residual Oil	LNB	50	410	410	5.5	0.1424	1990
N0151L	ICI Boilers - Residual Oil	LNB	50	430	430	5.5	0.1424	1990
N0151S	ICI Boilers - Residual Oil	LNB	50	400	400	5.5	0.1424	1990
N0152	ICI Boilers - Residual Oil	LNB + FGR	60	760	640	6.7	0.1424	1990
N0152L	ICI Boilers - Residual Oil	LNB + FGR	60	390	190	7.5	0.1424	1990
N0152S	ICI Boilers - Residual Oil	LNB + FGR	60	1120	1080	5.9	0.1424	1990
N0153	ICI Boilers - Residual Oil	SCR	80	1140	1430	9.8	0.0944	1990
N0153L	ICI Boilers - Residual Oil	SCR	80	810	940	9.6	0.0944	1990
N0153S	ICI Boilers - Residual Oil	SCR	80	1480	1910	10	0.0944	1990
N0154	ICI Boilers - Residual Oil	SNCR	50	1810	1250	8.8	0.0944	1990
N0154L	ICI Boilers - Residual Oil	SNCR	50	1050	560	8.2	0.0944	1990
N0154S	ICI Boilers - Residual Oil	SNCR	50	2580	1940	9.4	0.0944	1990
N0161	ICI Boilers - Distillate Oil	LNB	50	1630	1630	5.5	0.1424	1990
N0161L	ICI Boilers - Distillate Oil	LNB	50	2070	2070	5.5	0.1424	1990
N0161S	ICI Boilers - Distillate Oil	LNB	50	1180	1180	5.5	0.1424	1990
N0162	ICI Boilers - Distillate Oil	LNB + FGR	60	1630	730	6.7	0.1424	1990
N0162L	ICI Boilers - Distillate Oil	LNB + FGR	60	760	370	7.5	0.1424	1990
N0162S	ICI Boilers - Distillate Oil	LNB + FGR	60	2490	1090	5.9	0.1424	1990

Measure	Source Type	Measure Name	CE	Cost Per Ton ($/ton reduced) Default	Cost Per Ton ($/ton reduced) Incremental	Capital to Annual Cost Ratio	CRF	Cost Year ($Year)
N0163	ICI Boilers - Distillate Oil	SCR	80	2150	2670	9.8	0.0944	1990
N0163L	ICI Boilers - Distillate Oil	SCR	80	1510	1750	9.6	0.0944	1990
N0163S	ICI Boilers - Distillate Oil	SCR	80	2780	3570	10	0.0944	1990
N0164	ICI Boilers - Distillate Oil	SNCR	50	3270	2240	8.8	0.0944	1990
N0164L	ICI Boilers - Distillate Oil	SNCR	50	1890	1010	8.2	0.0944	1990
N0164S	ICI Boilers - Distillate Oil	SNCR	50	4640	3470	9.4	0.0944	1990
N0171	ICI Boilers - Natural Gas	LNB	50	740	740	5.5	0.1424	1990
N0171L	ICI Boilers - Natural Gas	LNB	50	650	650	5.5	0.1424	1990
N0171S	ICI Boilers - Natural Gas	LNB	50	820	820	5.5	0.1424	1990
N0172	ICI Boilers - Natural Gas	LNB + FGR	60	1580	1380	6.7	0.1424	1990
N0172L	ICI Boilers - Natural Gas	LNB + FGR	60	590	280	7.5	0.1424	1990
N0172S	ICI Boilers - Natural Gas	LNB + FGR	60	2560	2470	5.9	0.1424	1990
N0173	ICI Boilers - Natural Gas	OT + WI	65	500	500	2.9	0.1424	1990
N0173L	ICI Boilers - Natural Gas	OT + WI	65	320	320	2.9	0.1424	1990
N0173S	ICI Boilers - Natural Gas	OT + WI	65	680	680	2.9	0.1424	1990
N0174	ICI Boilers - Natural Gas	SCR	80	1720	2130	9.8	0.0944	1990
N0174L	ICI Boilers - Natural Gas	SCR	80	1210	1410	9.6	0.0944	1990
N0174S	ICI Boilers - Natural Gas	SCR	80	2230	2860	10	0.0944	1990
N0175	ICI Boilers - Natural Gas	SNCR	50	2730	1870	8.8	0.0944	1990
N0175L	ICI Boilers - Natural Gas	SNCR	50	1570	840	8.2	0.0944	1990
N0175S	ICI Boilers - Natural Gas	SNCR	50	3870	2900	9.4	0.0944	1990
N0181	ICI Boilers - Wood/Bark/Stoker	SNCR - Urea	55	1190	1190	6.6	0.0944	1990
N0181L	ICI Boilers - Wood/Bark/Stoker	SNCR - Urea	55	930	930	6.8	0.0944	1990
N0181S	ICI Boilers - Wood/Bark/Stoker	SNCR - Urea	55	1440	1440	6.3	0.0944	1990
N0191	ICI Boilers - Wood/Bark/FBC	SNCR - Ammonia	55	1140	1140	4.1	0.0944	1990
N0191L	ICI Boilers - Wood/Bark/FBC	SNCR - Ammonia	55	960	960	4.1	0.0944	1990
N0191S	ICI Boilers - Wood/Bark/FBC	SNCR - Ammonia	55	1320	1320	4.1	0.0944	1990
N0201	ICI Boilers - MSW/Stoker	SNCR - Urea	55	1470	1470	6.5	0.0944	1990
N0201L	ICI Boilers - MSW/Stoker	SNCR - Urea	55	1250	1250	6.2	0.0944	1990
N0201S	ICI Boilers - MSW/Stoker	SNCR - Urea	55	1690	1690	6.8	0.0944	1990
N0211	Internal Combustion Engines - Oil	IR	25	640	640	0.9	0.1098	1990
N0211L	Internal Combustion Engines - Oil	IR	25	490	490	0.6	0.1098	1990
N0211S	Internal Combustion Engines - Oil	IR	25	770	770	1.1	0.1098	1990
N0214	Internal Combustion Engines - Oil	SCR	90	1630	1630	2	0.1098	1990
N0214L	Internal Combustion Engines - Oil	SCR	80	920	920	2.2	0.1098	1990
N0214S	Internal Combustion Engines - Oil	SCR	80	2340	2340	1.8	0.1098	1990
N0215S	Rich Burn Internal Combustion Engines -	NSCR	90	342	342	2	0.1098	1990
N0215S	Rich Burn Internal Combustion Engines -	NSCR	90	342	342	2	0.1098	1990
N0215S	Rich Burn Internal Combustion Engines -	NSCR	90	342	342	2	0.1098	1990
N0221	Internal Combustion Engines - Gas	IR	20	790	790	1	0.1098	1990
N0221L	Internal Combustion Engines - Gas	IR	20	550	550	0.7	0.1098	1990
N0221S	Internal Combustion Engines - Gas	IR	20	1020	1020	1.2	0.1098	1990
N02210	Internal Combustion Engines - Gas	L-E (Medium Speed)	87	380	380	4.4	0.1098	1990
N02210	Internal Combustion Engines - Gas	L-E (Medium Speed)	87	380	380	4.4	0.1098	1990
N02210	Internal Combustion Engines - Gas	L-E (Medium Speed)	87	380	380	4.4	0.1098	1990
N02211	Internal Combustion Engines - Gas	L-E (Low Speed)	87	176	176	4.3	0.1098	1990
N02211	Internal Combustion Engines - Gas	L-E (Low Speed)	87	630	630	4.4	0.1098	1990

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N02211	Internal Combustion Engines - Gas	L-E (Low Speed)	87	1680	1680	4.2	0.1098	1990
N02212	Internal Combustion Engines - Gas	SCR	90	305	305	1.9	0.1098	1990
N02212	Internal Combustion Engines - Gas	SCR	90	533	533	1.8	0.1098	1990
N02212	Internal Combustion Engines - Gas	SCR	90	2769	2769	2	0.1098	1990
N02213	Internal Combustion Engines - Gas	SNCR	90	342	342	2	0.1098	1990
N02213	Rich Burn Internal Combustion Engines -	NSCR	90	342	342	2	0.1098	1990
N02213	Rich Burn Internal Combustion Engines -	NSCR	90	342	342	2	0.1098	1990
N0224	Internal Combustion Engines - Gas	AF RATIO	20	970	970	2.2	0.1098	1990
N0224L	Internal Combustion Engines - Gas	AF RATIO	20	380	380	1.5	0.1098	1990
N0224S	Internal Combustion Engines - Gas	AF RATIO	20	1570	1570	2.8	0.1098	1990
N0227	Internal Combustion Engines - Gas	AF + IR	30	950	210	1.9	0.1098	1990
N0227L	Internal Combustion Engines - Gas	AF + IR	30	460	150	1.2	0.1098	1990
N0227S	Internal Combustion Engines - Gas	AF + IR	30	1440	270	2.6	0.1098	1990
N0231	Gas Turbines - Oil	Water Injection	68	970	970	2.3	0.1098	1990
N0231L	Gas Turbines - Oil	Water Injection	68	650	650	1.6	0.1098	1990
N0231S	Gas Turbines - Oil	Water Injection	68	1290	1290	2.9	0.1098	1990
N0232	Gas Turbines - Oil	SCR + Water Injecti	90	1660	5070	2.6	0.1098	1990
N0232L	Gas Turbines - Oil	SCR + Water Injecti	90	1010	2280	2.3	0.1098	1990
N0232S	Gas Turbines - Oil	SCR + Water Injecti	90	2300	7850	2.8	0.1098	1990
N0241	Gas Turbines - Natural Gas	Water Injection	76	1120	1120	2.4	0.1098	1990
N0241L	Gas Turbines - Natural Gas	Water Injection	76	730	730	1.6	0.1098	1990
N0241S	Gas Turbines - Natural Gas	Water Injection	76	1510	1510	3.1	0.1098	1990
N0242	Gas Turbines - Natural Gas	Steam Injection	80	770	770	3.3	0.1098	1990
N0242L	Gas Turbines - Natural Gas	Steam Injection	80	500	500	2.9	0.1098	1990
N0242S	Gas Turbines - Natural Gas	Steam Injection	80	1040	1040	3.7	0.1098	1990
N0243	Gas Turbines - Natural Gas	LNB	84	300	200	9.1	0.1098	1990
N0243L	Gas Turbines - Natural Gas	LNB	84	100	140	9.1	0.1098	1990
N0243S	Gas Turbines - Natural Gas	LNB	68	490	540	9.1	0.1098	1990
N0244	Gas Turbines - Natural Gas	SCR + LNB	94	1590	12920	4	0.1098	1990
N0244L	Gas Turbines - Natural Gas	SCR + LNB	94	600	6720	4	0.1098	1990
N0244S	Gas Turbines - Natural Gas	SCR + LNB	94	2570	19120	4	0.1098	1990
N0245	Gas Turbines - Natural Gas	SCR + Steam Injecti	95	1430	6130	3	0.1098	1990
N0245L	Gas Turbines - Natural Gas	SCR + Steam Injecti	95	840	3290	3	0.1098	1990
N0245S	Gas Turbines - Natural Gas	SCR + Steam Injecti	95	2010	8960	3	0.1098	1990
N0246	Gas Turbines - Natural Gas	SCR + Water Injecti	95	1930	6380	2.5	0.1098	1990
N0246L	Gas Turbines - Natural Gas	SCR + Water Injecti	95	1130	3180	2.2	0.1098	1990
N0246S	Gas Turbines - Natural Gas	SCR + Water Injecti	95	2730	9570	2.8	0.1098	1990
N0251	Process Heaters - Distillate Oil	LNB	45	2230	2230	7.3	0.1098	1990
N0251L	Process Heaters - Distillate Oil	LNB	45	970	970	7.3	0.1098	1990
N0251S	Process Heaters - Distillate Oil	LNB	45	3470	3470	7.3	0.1098	1990
N0252L	Process Heaters - Distillate Oil	LNB + FGR	48	1680	16680	6.8	0.1098	1990
N0252S	Process Heaters - Distillate Oil	LNB + FGR	48	4250	19540	7.1	0.1098	1990
N0253	Process Heaters - Distillate Oil	SNCR	60	2450	2450	5.7	0.1098	1990
N0253L	Process Heaters - Distillate Oil	SNCR	60	1720	1720	5.2	0.1098	1990
N0253S	Process Heaters - Distillate Oil	SNCR	60	3180	3180	6.2	0.1098	1990
N0254	Process Heaters - Distillate Oil	ULNB	74	1380	1380	7.3	0.1098	1990
N0254L	Process Heaters - Distillate Oil	ULNB	74	610	610	7.3	0.1098	1990

Measure	Source Type	Measure Name	CE	Cost Per Ton ($/ton reduced) Default	Cost Per Ton ($/ton reduced) Incremental	Capital to Annual Cost Ratio	CRF	Cost Year ($Year)
N0254S	Process Heaters - Distillate Oil	ULNB	74	2140	2140	7.3	0.1098	1990
N0255	Process Heaters - Distillate Oil	SCR	75	7630	7630	6.7	0.1098	1990
N0255L	Process Heaters - Distillate Oil	SCR	75	6030	6030	7	0.1098	1990
N0255S	Process Heaters - Distillate Oil	SCR	75	9230	9230	6.4	0.1098	1990
N0256	Process Heaters - Distillate Oil	LNB + SNCR	78	2750	3490	6.2	0.1098	1990
N0256L	Process Heaters - Distillate Oil	LNB + SNCR	78	1880	3150	5.9	0.1098	1990
N0256S	Process Heaters - Distillate Oil	LNB + SNCR	78	3620	3830	6.5	0.1098	1990
N0257	Process Heaters - Distillate Oil	LNB + SCR	92	7190	12390	6.8	0.1098	1990
N0257L	Process Heaters - Distillate Oil	LNB + SCR	92	5250	9430	7	0.1098	1990
N0257S	Process Heaters - Distillate Oil	LNB + SCR	92	9120	15350	6.5	0.1098	1990
N0261L	Process Heaters - Residual Oil	LNB + FGR	34	1380	1380	6.8	0.1098	1990
N0261S	Process Heaters - Residual Oil	LNB + FGR	34	3490	3490	7.1	0.1098	1990
N0262	Process Heaters - Residual Oil	LNB	37	1620	1620	7.3	0.1098	1990
N0262L	Process Heaters - Residual Oil	LNB	37	710	710	7.3	0.1098	1990
N0262S	Process Heaters - Residual Oil	LNB	37	2520	2520	7.3	0.1098	1990
N0263	Process Heaters - Residual Oil	SNCR	60	1510	1510	5.4	0.1098	1990
N0263L	Process Heaters - Residual Oil	SNCR	60	1100	1100	4.8	0.1098	1990
N0263S	Process Heaters - Residual Oil	SNCR	60	1930	1930	6	0.1098	1990
N0264	Process Heaters - Residual Oil	ULNB	73	830	830	7.3	0.1098	1990
N0264L	Process Heaters - Residual Oil	ULNB	73	360	360	7.3	0.1098	1990
N0264S	Process Heaters - Residual Oil	ULNB	73	1290	1290	7.3	0.1098	1990
N0265	Process Heaters - Residual Oil	LNB + SNCR	75	1770	1930	6	0.1098	1990
N0265L	Process Heaters - Residual Oil	LNB + SNCR	75	1240	1760	5.5	0.1098	1990
N0265S	Process Heaters - Residual Oil	LNB + SNCR	75	2300	2080	6.4	0.1098	1990
N0266	Process Heaters - Residual Oil	SCR	75	4470	4470	6.7	0.1098	1990
N0266L	Process Heaters - Residual Oil	SCR	75	3590	3590	6.9	0.1098	1990
N0266S	Process Heaters - Residual Oil	SCR	75	5350	5350	6.5	0.1098	1990
N0267	Process Heaters - Residual Oil	LNB + SCR	91	4290	6260	6.8	0.1098	1990
N0267L	Process Heaters - Residual Oil	LNB + SCR	91	3160	4840	7	0.1098	1990
N0267S	Process Heaters - Residual Oil	LNB + SCR	91	5420	7680	6.6	0.1098	1990
N0271	Process Heaters - Natural Gas	LNB	50	2000	2000	7.3	0.1098	1990
N0271L	Process Heaters - Natural Gas	LNB	50	1800	1800	7.3	0.1098	1990
N0271S	Process Heaters - Natural Gas	LNB	50	2200	2200	7.3	0.1098	1990
N0272L	Process Heaters - Natural Gas	LNB + FGR	55	2470	9160	6.8	0.1098	1990
N0272S	Process Heaters - Natural Gas	LNB + FGR	55	3190	15580	6.9	0.1098	1990
N0273	Process Heaters - Natural Gas	SNCR	60	2400	2400	6.1	0.1098	1990
N0273L	Process Heaters - Natural Gas	SNCR	60	1950	1950	5.7	0.1098	1990
N0273S	Process Heaters - Natural Gas	SNCR	60	2850	2850	6.4	0.1098	1990
N0274	Process Heaters - Natural Gas	ULNB	75	1350	1350	7.3	0.1098	1990
N0274L	Process Heaters - Natural Gas	ULNB	75	1200	1200	7.3	0.1098	1990
N0274S	Process Heaters - Natural Gas	ULNB	75	1500	1500	7.3	0.1098	1990
N0275	Process Heaters - Natural Gas	SCR	75	10110	10110	6.5	0.1098	1990
N0275L	Process Heaters - Natural Gas	SCR	75	8160	8160	6.3	0.1098	1990
N0275S	Process Heaters - Natural Gas	SCR	75	12040	12040	6.7	0.1098	1990
N0276	Process Heaters - Natural Gas	LNB + SNCR	80	3050	5250	6.6	0.1098	1990
N0276L	Process Heaters - Natural Gas	LNB + SNCR	80	2590	3900	6.4	0.1098	1990
N0276S	Process Heaters - Natural Gas	LNB + SNCR	80	3520	6600	6.7	0.1098	1990

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N0277	Process Heaters - Natural Gas	LNB + SCR	88	9800	22110	6.6	0.1098	1990
N0277L	Process Heaters - Natural Gas	LNB + SCR	88	8020	16310	6.4	0.1098	1990
N0277S	Process Heaters - Natural Gas	LNB + SCR	88	11560	27910	6.8	0.1098	1990
N0281	Adipic Acid Manufacturing	Thermal Reduction	81	420	420	2.3	0.1424	1990
N0281L	Adipic Acid Manufacturing	Thermal Reduction	81	420	420	2.3	0.1424	1990
N0281S	Adipic Acid Manufacturing	Thermal Reduction	81	420	420	2.3	0.1424	1990
N0282	Adipic Acid Manufacturing	Extended Absorption	86	90	90	6.7	0.1424	1990
N0282L	Adipic Acid Manufacturing	Extended Absorption	86	90	90	6.7	0.1424	1990
N0282S	Adipic Acid Manufacturing	Extended Absorption	86	90	90	6.7	0.1424	1990
N0291	Nitric Acid Manufacturing	Extended Absorption	95	480	480	8.1	0.1424	1990
N0291L	Nitric Acid Manufacturing	Extended Absorption	95	480	480	8.1	0.1424	1990
N0291S	Nitric Acid Manufacturing	Extended Absorption	95	480	480	8.1	0.1424	1990
N0292	Nitric Acid Manufacturing	SCR	97	590	590	2.5	0.1424	1990
N0292L	Nitric Acid Manufacturing	SCR	97	590	590	2.5	0.1424	1990
N0292S	Nitric Acid Manufacturing	SCR	97	590	590	2.5	0.1424	1990
N0293	Nitric Acid Manufacturing	NSCR	98	550	550	2.4	0.1424	1990
N0293L	Nitric Acid Manufacturing	NSCR	98	550	550	2.4	0.1424	1990
N0293S	Nitric Acid Manufacturing	NSCR	98	550	550	2.4	0.1424	1990
N0301	Glass Manufacturing - Container	Electric Boost	10	7150	7150	0	0.1424	1990
N0301L	Glass Manufacturing - Container	Electric Boost	10	7150	7150	0	0.1424	1990
N0301S	Glass Manufacturing - Container	Electric Boost	10	7150	7150	0	0.1424	1990
N0302	Glass Manufacturing - Container	Cullet Preheat	25	940	940	4.5	0.1424	1990
N0302L	Glass Manufacturing - Container	Cullet Preheat	25	940	940	4.5	0.1424	1990
N0302S	Glass Manufacturing - Container	Cullet Preheat	25	940	940	4.5	0.1424	1990
N0303	Glass Manufacturing - Container	LNB	40	1690	1690	2.2	0.1424	1990
N0303L	Glass Manufacturing - Container	LNB	40	1690	1690	2.2	0.1424	1990
N0303S	Glass Manufacturing - Container	LNB	40	1690	1690	2.2	0.1424	1990
N0304	Glass Manufacturing - Container	SNCR	40	1770	1770	2.4	0.1424	1990
N0304L	Glass Manufacturing - Container	SNCR	40	1770	1770	2.4	0.1424	1990
N0304S	Glass Manufacturing - Container	SNCR	40	1770	1770	2.4	0.1424	1990
N0305	Glass Manufacturing - Container	SCR	75	2200	2200	1.8	0.1424	1990
N0305L	Glass Manufacturing - Container	SCR	75	2200	2200	1.8	0.1424	1990
N0305S	Glass Manufacturing - Container	SCR	75	2200	2200	1.8	0.1424	1990
N0306	Glass Manufacturing - Container	OXY-Firing	85	4590	4590	2.7	0.1424	1990
N0306L	Glass Manufacturing - Container	OXY-Firing	85	4590	4590	2.7	0.1424	1990
N0306S	Glass Manufacturing - Container	OXY-Firing	85	4590	4590	2.7	0.1424	1990
N0311	Glass Manufacturing - Flat	Electric Boost	10	2320	2320	0	0.1424	1990
N0311L	Glass Manufacturing - Flat	Electric Boost	10	2320	2320	0	0.1424	1990
N0311S	Glass Manufacturing - Flat	Electric Boost	10	2320	2320	0	0.1424	1990
N0312	Glass Manufacturing - Flat	LNB	40	700	700	2.2	0.3811	1990
N0312L	Glass Manufacturing - Flat	LNB	40	700	700	2.2	0.3811	1990
N0312S	Glass Manufacturing - Flat	LNB	40	700	700	2.2	0.3811	1990
N0313	Glass Manufacturing - Flat	SNCR	40	740	740	2.4	0.1424	1990
N0313L	Glass Manufacturing - Flat	SNCR	40	740	740	2.4	0.1424	1990
N0313S	Glass Manufacturing - Flat	SNCR	40	740	740	2.4	0.1424	1990
N0314	Glass Manufacturing - Flat	SCR	75	710	710	2.2	0.1424	1990
N0314L	Glass Manufacturing - Flat	SCR	75	710	710	2.2	0.1424	1990

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N0314S	Glass Manufacturing - Flat	SCR	75	710	710	2.2	0.1424	1990
N0315	Glass Manufacturing - Flat	OXY-Firing	85	1900	1900	2.7	0.1424	1990
N0315L	Glass Manufacturing - Flat	OXY-Firing	85	1900	1900	2.7	0.1424	1990
N0315S	Glass Manufacturing - Flat	OXY-Firing	85	1900	1900	2.7	0.1424	1990
N0321	Glass Manufacturing - Pressed	Electric Boost	10	8760	8760	0	0.1424	1990
N0321L	Glass Manufacturing - Pressed	Electric Boost	10	8760	8760	0	0.1424	1990
N0321S	Glass Manufacturing - Pressed	Electric Boost	10	8760	8760	0	0.1424	1990
N0322	Glass Manufacturing - Pressed	Cullet Preheat	25	810	810	4.5	0.1424	1990
N0322L	Glass Manufacturing - Pressed	Cullet Preheat	25	810	810	4.5	0.1424	1990
N0322S	Glass Manufacturing - Pressed	Cullet Preheat	25	810	810	4.5	0.1424	1990
N0323	Glass Manufacturing - Pressed	LNB	40	1500	1500	2.2	0.1424	1990
N0323L	Glass Manufacturing - Pressed	LNB	40	1500	1500	2.2	0.1424	1990
N0323S	Glass Manufacturing - Pressed	LNB	40	1500	1500	2.2	0.1424	1990
N0324	Glass Manufacturing - Pressed	SNCR	40	1640	1640	2.4	0.1424	1990
N0324L	Glass Manufacturing - Pressed	SNCR	40	1640	1640	2.4	0.1424	1990
N0324S	Glass Manufacturing - Pressed	SNCR	40	1640	1640	2.4	0.1424	1990
N0325	Glass Manufacturing - Pressed	SCR	75	2530	2530	1.3	0.1424	1990
N0325L	Glass Manufacturing - Pressed	SCR	75	2530	2530	1.3	0.1424	1990
N0325S	Glass Manufacturing - Pressed	SCR	75	2530	2530	1.3	0.1424	1990
N0326	Glass Manufacturing - Pressed	OXY-Firing	85	3900	3900	2.7	0.1424	1990
N0326L	Glass Manufacturing - Pressed	OXY-Firing	85	3900	3900	2.7	0.1424	1990
N0326S	Glass Manufacturing - Pressed	OXY-Firing	85	3900	3900	2.7	0.1424	1990
N0331	Cement Manufacturing - Dry	Mid-Kiln Firing	30	55	55	3.4	0.1098	1997
N0331L	Cement Manufacturing - Dry	Mid-Kiln Firing	30	55	55	3.4	0.1098	1997
N0331S	Cement Manufacturing - Dry	Mid-Kiln Firing	30	55	55	3.4	0.1098	1997
N0332	Cement Manufacturing - Dry	LNB	25	440	440	5	0.1098	1997
N0332L	Cement Manufacturing - Dry	LNB	25	440	440	5	0.1098	1997
N0332S	Cement Manufacturing - Dry	LNB	25	440	440	5	0.1098	1997
N0333	Cement Manufacturing - Dry	SNCR - Urea Based	50	770	770	2.1	0.1098	1990
N0333L	Cement Manufacturing - Dry	SNCR - Urea Based	50	770	770	2.1	0.1098	1990
N0333S	Cement Manufacturing - Dry	SNCR - Urea Based	50	770	770	2.1	0.1098	1990
N0334	Cement Manufacturing - Dry	SNCR - NH3 Based	50	850	850	3.3	0.1098	1990
N0334L	Cement Manufacturing - Dry	SNCR - NH3 Based	50	850	850	3.3	0.1098	1990
N0334S	Cement Manufacturing - Dry	SNCR - NH3 Based	50	850	850	3.3	0.1098	1990
N0335	Cement Manufacturing - Dry	SCR	80	3370	3370	4.4	0.1098	1990
N0335L	Cement Manufacturing - Dry	SCR	80	3370	3370	4.4	0.1098	1990
N0335S	Cement Manufacturing - Dry	SCR	80	3370	3370	4.4	0.1098	1990
N0341	Cement Manufacturing - Wet	Mid-Kiln Firing	30	55	55	3.6	0.1098	1997
N0341L	Cement Manufacturing - Wet	Mid-Kiln Firing	30	55	55	3.6	0.1098	1997
N0341S	Cement Manufacturing - Wet	Mid-Kiln Firing	30	55	55	3.6	0.1098	1997
N0342	Cement Manufacturing - Wet	LNB	25	440	440	5	0.1098	1997
N0342L	Cement Manufacturing - Wet	LNB	25	440	440	5	0.1098	1997
N0342S	Cement Manufacturing - Wet	LNB	25	440	440	5	0.1098	1997
N0343	Cement Manufacturing - Wet	SCR	80	2880	2880	4.4	0.1098	1990
N0343L	Cement Manufacturing - Wet	SCR	80	2880	2880	4.4	0.1098	1990
N0343S	Cement Manufacturing - Wet	SCR	80	2880	2880	4.4	0.1098	1990
N0351	Iron & Steel Mills - Reheating	LEA	13	1320	1320	3.8	0.1424	1990

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N0351L	Iron & Steel Mills - Reheating	LEA	13	1320	1320	3.8	0.1424	1990
N0351S	Iron & Steel Mills - Reheating	LEA	13	1320	1320	3.8	0.1424	1990
N0352	Iron & Steel Mills - Reheating	LNB	66	300	300	4.1	0.2439	1990
N0352L	Iron & Steel Mills - Reheating	LNB	66	300	300	4.1	0.2439	1990
N0352S	Iron & Steel Mills - Reheating	LNB	66	300	300	4.1	0.2439	1990
N0353	Iron & Steel Mills - Reheating	LNB + FGR	77	380	150	4.1	0.2439	1990
N0353L	Iron & Steel Mills - Reheating	LNB + FGR	77	380	150	4.1	0.2439	1990
N0353S	Iron & Steel Mills - Reheating	LNB + FGR	77	380	150	4.1	0.2439	1990
N0361	Iron & Steel Mills - Annealing	LNB	50	570	570	7	0.1424	1990
N0361L	Iron & Steel Mills - Annealing	LNB	50	570	570	7	0.1424	1990
N0361S	Iron & Steel Mills - Annealing	LNB	50	570	570	7	0.1424	1990
N0362	Iron & Steel Mills - Annealing	LNB + FGR	60	750	250	7	0.1424	1990
N0362L	Iron & Steel Mills - Annealing	LNB + FGR	60	750	250	7	0.1424	1990
N0362S	Iron & Steel Mills - Annealing	LNB + FGR	60	750	250	7	0.1424	1990
N0363	Iron & Steel Mills - Annealing	SNCR	60	1640	1640	2.7	0.1424	1990
N0363L	Iron & Steel Mills - Annealing	SNCR	60	1640	1640	2.7	0.1424	1990
N0363S	Iron & Steel Mills - Annealing	SNCR	60	1640	1640	2.7	0.1424	1990
N0364	Iron & Steel Mills - Annealing	LNB + SNCR	80	1720	1320	3.7	0.1424	1990
N0364L	Iron & Steel Mills - Annealing	LNB + SNCR	80	1720	1320	3.7	0.1424	1990
N0364S	Iron & Steel Mills - Annealing	LNB + SNCR	80	1720	1320	3.7	0.1424	1990
N0365	Iron & Steel Mills - Annealing	SCR	85	3830	3830	5	0.1424	1990
N0365L	Iron & Steel Mills - Annealing	SCR	85	3830	3830	5	0.1424	1990
N0365S	Iron & Steel Mills - Annealing	SCR	85	3830	3830	5	0.1424	1990
N0366	Iron & Steel Mills - Annealing	LNB + SCR	90	4080	3720	5.1	0.1424	1990
N0366L	Iron & Steel Mills - Annealing	LNB + SCR	90	4080	3720	5.1	0.1424	1990
N0366S	Iron & Steel Mills - Annealing	LNB + SCR	90	4080	3720	5.1	0.1424	1990
N0371	Iron & Steel Mills - Galvanizing	LNB	50	490	490	6.5	0.1535	1990
N0371L	Iron & Steel Mills - Galvanizing	LNB	50	490	490	6.5	0.1535	1990
N0371S	Iron & Steel Mills - Galvanizing	LNB	50	490	490	6.5	0.1535	1990
N0372	Iron & Steel Mills - Galvanizing	LNB + FGR	60	580	190	6.5	0.1535	1990
N0372L	Iron & Steel Mills - Galvanizing	LNB + FGR	60	580	190	6.5	0.1535	1990
N0372S	Iron & Steel Mills - Galvanizing	LNB + FGR	60	580	190	6.5	0.1535	1990
N0381	Municipal Waste Combustors	SNCR	45	1130	1130	4.1	0.0944	1990
N0381L	Municipal Waste Combustors	SNCR	45	1130	1130	4.1	0.0944	1990
N0381S	Municipal Waste Combustors	SNCR	45	1130	1130	4.1	0.0944	1990
N0391	Medical Waste Incinerators	SNCR	45	4510	4510	4.1	0.0944	1990
N0391L	Medical Waste Incinerators	SNCR	45	4510	4510	4.1	0.0944	1990
N0391S	Medical Waste Incinerators	SNCR	45	4510	4510	4.1	0.0944	1990
N0411	ICI Boilers - Process Gas	LNB	50	740	740	5.5	0.1424	1990
N0411L	ICI Boilers - Process Gas	LNB	50	650	650	5.5	0.1424	1990
N0411S	ICI Boilers - Process Gas	LNB	50	820	820	5.5	0.1424	1990
N0412	ICI Boilers - Process Gas	LNB + FGR	60	1580	1380	6.7	0.1424	1990
N0412L	ICI Boilers - Process Gas	LNB + FGR	60	590	280	7.5	0.1424	1990
N0412S	ICI Boilers - Process Gas	LNB + FGR	60	2560	2470	5.9	0.1424	1990
N0413	ICI Boilers - Process Gas	OT + WI	65	500	500	2.9	0.1424	1990
N0413L	ICI Boilers - Process Gas	OT + WI	65	320	320	2.9	0.1424	1990
N0413S	ICI Boilers - Process Gas	OT + WI	65	680	680	2.9	0.1424	1990

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N0414	ICI Boilers - Process Gas	SCR	80	1720	2130	9.8	0.0944	1990
N0414L	ICI Boilers - Process Gas	SCR	80	1210	1410	9.6	0.0944	1990
N0414S	ICI Boilers - Process Gas	SCR	80	2230	2860	10	0.0944	1990
N0421	ICI Boilers - Coke	SNCR	40	950	330	7.2	0.0944	1990
N0421L	ICI Boilers - Coke	SNCR	40	840	260	6.6	0.0944	1990
N0421S	ICI Boilers - Coke	SNCR	40	1040	400	7.7	0.0944	1990
N0423	ICI Boilers - Coke	LNB	50	1280	1280	4.5	0.1424	1990
N0423L	ICI Boilers - Coke	LNB	50	1090	1090	4.5	0.1424	1990
N0423S	ICI Boilers - Coke	LNB	50	1460	1460	4.5	0.1424	1990
N0424	ICI Boilers - Coke	SCR	70	1170	810	6.8	0.0944	1990
N0424L	ICI Boilers - Coke	SCR	70	1070	700	6.5	0.0944	1990
N0424S	ICI Boilers - Coke	SCR	70	1260	910	7.1	0.0944	1990
N0431	ICI Boilers - LPG	LNB	50	1630	1630	5.5	0.1424	1990
N0431L	ICI Boilers - LPG	LNB	50	2070	2070	5.5	0.1424	1990
N0431S	ICI Boilers - LPG	LNB	50	1180	1180	5.5	0.1424	1990
N0432	ICI Boilers - LPG	LNB + FGR	60	1630	730	6.7	0.1424	1990
N0432L	ICI Boilers - LPG	LNB + FGR	60	760	370	7.5	0.1424	1990
N0432S	ICI Boilers - LPG	LNB + FGR	60	2490	1090	5.9	0.1424	1990
N0433	ICI Boilers - LPG	SCR	80	2150	2670	9.8	0.0944	1990
N0433L	ICI Boilers - LPG	SCR	80	1510	1750	9.6	0.0944	1990
N0433S	ICI Boilers - LPG	SCR	80	2780	3570	10	0.0944	1990
N0434	ICI Boilers - LPG	SNCR	50	3270	2240	8.8	0.0944	1990
N0434L	ICI Boilers - LPG	SNCR	50	1890	1010	8.2	0.0944	1990
N0434S	ICI Boilers - LPG	SNCR	50	4640	3470	9.4	0.0944	1990
N0441	ICI Boilers - Bagasse	SNCR - Urea	55	1190	1190	6.6	0.0944	1990
N0441L	ICI Boilers - Bagasse	SNCR - Urea	55	930	930	6.8	0.0944	1990
N0441S	ICI Boilers - Bagasse	SNCR - Urea	55	1440	1440	6.3	0.0944	1990
N0451	ICI Boilers - Liquid Waste	LNB	50	410	410	5.5	0.1424	1990
N0451L	ICI Boilers - Liquid Waste	LNB	50	430	430	5.5	0.1424	1990
N0451S	ICI Boilers - Liquid Waste	LNB	50	400	400	5.5	0.1424	1990
N0452	ICI Boilers - Liquid Waste	LNB + FGR	60	760	640	6.7	0.1424	1990
N0452L	ICI Boilers - Liquid Waste	LNB + FGR	60	390	190	7.5	0.1424	1990
N0452S	ICI Boilers - Liquid Waste	LNB + FGR	60	1120	1080	5.9	0.1424	1990
N0453	ICI Boilers - Liquid Waste	SCR	80	1140	1430	9.8	0.0944	1990
N0453L	ICI Boilers - Liquid Waste	SCR	80	810	940	9.6	0.0944	1990
N0453S	ICI Boilers - Liquid Waste	SCR	80	1480	1910	10	0.0944	1990
N0454	ICI Boilers - Liquid Waste	SNCR	50	1810	1250	8.8	0.0944	1990
N0454L	ICI Boilers - Liquid Waste	SNCR	50	1050	560	8.2	0.0944	1990
N0454S	ICI Boilers - Liquid Waste	SNCR	50	2580	1940	9.4	0.0944	1990
N0461	IC Engines - Gas, Diesel, LPG	IR	25	640	640	0.9	0.1098	1990
N0461L	IC Engines - Gas, Diesel, LPG	IR	25	490	490	0.6	0.1098	1990
N0461S	IC Engines - Gas, Diesel, LPG	IR	25	770	770	1.1	0.1098	1990
N0464	IC Engines - Gas, Diesel, LPG	SCR	80	1630	1630	2	0.1098	1990
N0464L	IC Engines - Gas, Diesel, LPG	SCR	80	920	920	2.2	0.1098	1990
N0464S	IC Engines - Gas, Diesel, LPG	SCR	80	2340	2340	1.8	0.1098	1990
N0465S	Rich Burn IC Engines - Gas, Diesel, LPG	NSCR	90	342	342	2	0.1098	1990
N0465S	Rich Burn IC Engines - Gas, Diesel, LPG	NSCR	90	342	342	2	0.1098	1990

Measure	Source Type	Measure Name	CE	Cost Per Ton ($/ton reduced) Default	Cost Per Ton ($/ton reduced) Incremental	Capital to Annual Cost Ratio	CRF	Cost Year ($Year)
N0465S	Rich Burn IC Engines - Gas, Diesel, LPG	NSCR	90	342	342	2	0.1098	1990
N0471	Process Heaters - Process Gas	LNB	50	2000	2000	7.3	0.1098	1990
N0471L	Process Heaters - Process Gas	LNB	50	1800	1800	7.3	0.1098	1990
N0471S	Process Heaters - Process Gas	LNB	50	2200	2200	7.3	0.1098	1990
N0472	Process Heaters - Process Gas	LNB + FGR	55	2830	12380	6.9	0.1098	1990
N0472L	Process Heaters - Process Gas	LNB + FGR	55	2470	9160	6.8	0.1098	1990
N0472S	Process Heaters - Process Gas	LNB + FGR	55	3190	15580	6.9	0.1098	1990
N0473	Process Heaters - Process Gas	SNCR	60	2400	2400	6.1	0.1098	1990
N0473L	Process Heaters - Process Gas	SNCR	60	1950	1950	5.7	0.1098	1990
N0473S	Process Heaters - Process Gas	SNCR	60	2850	2850	6.4	0.1098	1990
N0474	Process Heaters - Process Gas	ULNB	75	1350	1350	7.3	0.1098	1990
N0474L	Process Heaters - Process Gas	ULNB	75	1200	1200	7.3	0.1098	1990
N0474S	Process Heaters - Process Gas	ULNB	75	1500	1500	7.3	0.1098	1990
N0475	Process Heaters - Process Gas	SCR	75	10110	10110	6.5	0.1098	1990
N0475L	Process Heaters - Process Gas	SCR	75	8160	8160	6.3	0.1098	1990
N0475S	Process Heaters - Process Gas	SCR	75	12040	12040	6.7	0.1098	1990
N0476	Process Heaters - Process Gas	LNB + SNCR	80	3050	5250	6.6	0.1098	1990
N0476L	Process Heaters - Process Gas	LNB + SNCR	80	2590	3900	6.4	0.1098	1990
N0476S	Process Heaters - Process Gas	LNB + SNCR	80	3520	6600	6.7	0.1098	1990
N0477	Process Heaters - Process Gas	LNB + SCR	88	9800	22110	6.6	0.1098	1990
N0477L	Process Heaters - Process Gas	LNB + SCR	88	8020	16310	6.4	0.1098	1990
N0477S	Process Heaters - Process Gas	LNB + SCR	88	11560	27910	6.8	0.1098	1990
N0481	Process Heaters - LPG	LNB	45	2230	2230	7.3	0.1098	1990
N0481L	Process Heaters - LPG	LNB	45	970	970	7.3	0.1098	1990
N0481S	Process Heaters - LPG	LNB	45	3470	3470	7.3	0.1098	1990
N0482	Process Heaters - LPG	LNB + FGR	48	2970	18110	7	0.1098	1990
N0482L	Process Heaters - LPG	LNB + FGR	48	1680	16680	6.8	0.1098	1990
N0482S	Process Heaters - LPG	LNB + FGR	48	4250	19540	7.1	0.1098	1990
N0483	Process Heaters - LPG	SNCR	60	2450	2450	5.7	0.1098	1990
N0483L	Process Heaters - LPG	SNCR	60	1720	1720	5.2	0.1098	1990
N0483S	Process Heaters - LPG	SNCR	60	3180	3180	6.2	0.1098	1990
N0484	Process Heaters - LPG	ULNB	74	1380	1380	7.3	0.1098	1990
N0484L	Process Heaters - LPG	ULNB	74	610	610	7.3	0.1098	1990
N0484S	Process Heaters - LPG	ULNB	74	2140	2140	7.3	0.1098	1990
N0485	Process Heaters - LPG	SCR	75	7630	7630	6.7	0.1098	1990
N0485L	Process Heaters - LPG	SCR	75	6030	6030	7	0.1098	1990
N0485S	Process Heaters - LPG	SCR	75	9230	9230	6.4	0.1098	1990
N0486	Process Heaters - LPG	LNB + SNCR	78	2750	3490	6.2	0.1098	1990
N0486L	Process Heaters - LPG	LNB + SNCR	78	1880	3150	5.9	0.1098	1990
N0486S	Process Heaters - LPG	LNB + SNCR	78	3620	3830	6.5	0.1098	1990
N0487	Process Heaters - LPG	LNB + SCR	92	7190	12390	6.8	0.1098	1990
N0487L	Process Heaters - LPG	LNB + SCR	92	5250	9430	7	0.1098	1990
N0487S	Process Heaters - LPG	LNB + SCR	92	9120	15350	6.5	0.1098	1990
N0491	Process Heaters - Other Fuel	LNB + FGR	34	2430	2430	7	0.1098	1990
N0491L	Process Heaters - Other Fuel	LNB + FGR	34	1380	1380	6.8	0.1098	1990
N0491S	Process Heaters - Other Fuel	LNB + FGR	34	3490	3490	7.1	0.1098	1990
N0492	Process Heaters - Other Fuel	LNB	37	1620	1620	7.3	0.1098	1990

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N0492L	Process Heaters - Other Fuel	LNB	37	710	710	7.3	0.1098	1990
N0492S	Process Heaters - Other Fuel	LNB	37	2520	2520	7.3	0.1098	1990
N0493	Process Heaters - Other Fuel	SNCR	60	1510	1510	5.4	0.1098	1990
N0493L	Process Heaters - Other Fuel	SNCR	60	1100	1100	4.8	0.1098	1990
N0493S	Process Heaters - Other Fuel	SNCR	60	1930	1930	6	0.1098	1990
N0494	Process Heaters - Other Fuel	ULNB	73	830	830	7.3	0.1098	1990
N0494L	Process Heaters - Other Fuel	ULNB	73	360	360	7.3	0.1098	1990
N0494S	Process Heaters - Other Fuel	ULNB	73	1290	1290	7.3	0.1098	1990
N0495	Process Heaters - Other Fuel	LNB + SNCR	75	1770	1930	6	0.1098	1990
N0495L	Process Heaters - Other Fuel	LNB + SNCR	75	1240	1760	5.5	0.1098	1990
N0495S	Process Heaters - Other Fuel	LNB + SNCR	75	2300	2080	6.4	0.1098	1990
N0496	Process Heaters - Other Fuel	SCR	75	4470	4470	6.7	0.1098	1990
N0496L	Process Heaters - Other Fuel	SCR	75	3590	3590	6.9	0.1098	1990
N0496S	Process Heaters - Other Fuel	SCR	75	5350	5350	6.5	0.1098	1990
N0497	Process Heaters - Other Fuel	LNB + SCR	91	4290	6260	6.8	0.1098	1990
N0497L	Process Heaters - Other Fuel	LNB + SCR	91	3160	4840	7	0.1098	1990
N0497S	Process Heaters - Other Fuel	LNB + SCR	91	5420	7680	6.6	0.1098	1990
N0501	Gas Turbines - Jet Fuel	Water Injection	68	970	970	2.3	0.1098	1990
N0501L	Gas Turbines - Jet Fuel	Water Injection	68	650	650	1.6	0.1098	1990
N0501S	Gas Turbines - Jet Fuel	Water Injection	68	1290	1290	2.9	0.1098	1990
N0502	Gas Turbines - Jet Fuel	SCR + Water Injecti	90	1660	5070	2.6	0.1098	1990
N0502L	Gas Turbines - Jet Fuel	SCR + Water Injecti	90	1010	2280	2.3	0.1098	1990
N0502S	Gas Turbines - Jet Fuel	SCR + Water Injecti	90	2300	7850	2.8	0.1098	1990
N0541	Space Heaters - Distillate Oil	LNB	50	1630	1630	5.5	0.1424	1990
N0541L	Space Heaters - Distillate Oil	LNB	50	2070	2070	5.5	0.1424	1990
N0541S	Space Heaters - Distillate Oil	LNB	50	1180	1180	5.5	0.1424	1990
N0542	Space Heaters - Distillate Oil	LNB + FGR	60	1630	730	6.7	0.1424	1990
N0542L	Space Heaters - Distillate Oil	LNB + FGR	60	760	370	7.5	0.1424	1990
N0542S	Space Heaters - Distillate Oil	LNB + FGR	60	2490	1090	5.9	0.1424	1990
N0543	Space Heaters - Distillate Oil	SCR	80	2150	2670	9.8	0.0944	1990
N0543L	Space Heaters - Distillate Oil	SCR	80	1510	1750	9.6	0.0944	1990
N0543S	Space Heaters - Distillate Oil	SCR	80	2780	3570	10	0.0944	1990
N0544	Space Heaters - Distillate Oil	SNCR	50	3270	2240	8.8	0.0944	1990
N0544L	Space Heaters - Distillate Oil	SNCR	50	1890	1010	8.2	0.0944	1990
N0544S	Space Heaters - Distillate Oil	SNCR	50	4640	3470	9.4	0.0944	1990
N0551	Space Heaters - Natural Gas	LNB	50	740	740	5.5	0.1424	1990
N0551L	Space Heaters - Natural Gas	LNB	50	650	650	5.5	0.1424	1990
N0551S	Space Heaters - Natural Gas	LNB	50	820	820	5.5	0.1424	1990
N0552	Space Heaters - Natural Gas	LNB + FGR	60	1580	1380	6.7	0.1424	1990
N0552L	Space Heaters - Natural Gas	LNB + FGR	60	590	280	7.5	0.1424	1990
N0552S	Space Heaters - Natural Gas	LNB + FGR	60	2560	2470	5.9	0.1424	1990
N0553	Space Heaters - Natural Gas	OT + WI	65	500	500	2.9	0.1424	1990
N0553L	Space Heaters - Natural Gas	OT + WI	65	320	320	2.9	0.1424	1990
N0553S	Space Heaters - Natural Gas	OT + WI	65	680	680	2.9	0.1424	1990
N0554	Space Heaters - Natural Gas	SCR	80	1720	2130	9.8	0.0944	1990
N0554L	Space Heaters - Natural Gas	SCR	80	1210	1410	9.6	0.0944	1990
N0554S	Space Heaters - Natural Gas	SCR	80	2230	2860	10	0.0944	1990

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N0555	Space Heaters - Natural Gas	SNCR	50	2730	1870	8.8	0.0944	1990
N0555L	Space Heaters - Natural Gas	SNCR	50	1570	840	8.2	0.0944	1990
N0555S	Space Heaters - Natural Gas	SNCR	50	3870	2900	9.4	0.0944	1990
N0561	Ammonia - NG-Fired Reformers	LNB	50	740	740	5.5	0.1424	1990
N0561L	Ammonia - NG-Fired Reformers	LNB	50	650	650	5.5	0.1424	1990
N0561S	Ammonia - NG-Fired Reformers	LNB	50	820	820	5.5	0.1424	1990
N0562	Ammonia - NG-Fired Reformers	LNB + FGR	60	1580	1380	6.7	0.1424	1990
N0562L	Ammonia - NG-Fired Reformers	LNB + FGR	60	590	280	7.5	0.1424	1990
N0562S	Ammonia - NG-Fired Reformers	LNB + FGR	60	2560	2470	5.9	0.1424	1990
N0563	Ammonia - NG-Fired Reformers	OT + WI	65	500	500	2.9	0.1424	1990
N0563L	Ammonia - NG-Fired Reformers	OT + WI	65	320	320	2.9	0.1424	1990
N0563S	Ammonia - NG-Fired Reformers	OT + WI	65	680	680	2.9	0.1424	1990
N0564	Ammonia - NG-Fired Reformers	SCR	80	1720	2130	9.8	0.0944	1990
N0564L	Ammonia - NG-Fired Reformers	SCR	80	1210	1410	9.6	0.0944	1990
N0564S	Ammonia - NG-Fired Reformers	SCR	80	2230	2860	10	0.0944	1990
N0565	Ammonia - NG-Fired Reformers	SNCR	50	2730	1870	8.8	0.0944	1990
N0565L	Ammonia - NG-Fired Reformers	SNCR	50	1570	840	8.2	0.0944	1990
N0565S	Ammonia - NG-Fired Reformers	SNCR	50	3870	2900	9.4	0.0944	1990
N0571	Ammonia - Oil-Fired Reformers	LNB	50	410	410	5.5	0.1424	1990
N0571L	Ammonia - Oil-Fired Reformers	LNB	50	430	430	5.5	0.1424	1990
N0571S	Ammonia - Oil-Fired Reformers	LNB	50	400	400	5.5	0.1424	1990
N0572	Ammonia - Oil-Fired Reformers	LNB + FGR	60	760	640	6.7	0.1424	1990
N0572L	Ammonia - Oil-Fired Reformers	LNB + FGR	60	390	190	7.5	0.1424	1990
N0572S	Ammonia - Oil-Fired Reformers	LNB + FGR	60	1120	1080	5.9	0.1424	1990
N0573	Ammonia - Oil-Fired Reformers	SCR	80	1140	1430	9.8	0.0944	1990
N0573L	Ammonia - Oil-Fired Reformers	SCR	80	810	940	9.6	0.0944	1990
N0573S	Ammonia - Oil-Fired Reformers	SCR	80	1480	1910	10	0.0944	1990
N0574	Ammonia - Oil-Fired Reformers	SNCR	50	1810	1250	8.8	0.0944	1990
N0574L	Ammonia - Oil-Fired Reformers	SNCR	50	1050	560	8.2	0.0944	1990
N0574S	Ammonia - Oil-Fired Reformers	SNCR	50	2580	1940	9.4	0.0944	1990
N0581	Lime Kilns	Mid-Kiln Firing	30	460	460	3.4	0.1098	1990
N0581L	Lime Kilns	Mid-Kiln Firing	30	460	460	3.4	0.1098	1990
N0581S	Lime Kilns	Mid-Kiln Firing	30	460	460	3.4	0.1098	1990
N0582	Lime Kilns	LNB	30	560	560	5	0.1098	1990
N0582L	Lime Kilns	LNB	30	560	560	5	0.1098	1990
N0582S	Lime Kilns	LNB	30	560	560	5	0.1098	1990
N0591	Comm./Inst. Incinerators	SNCR	45	1130	1130	4.1	0.0944	1990
N0591L	Comm./Inst. Incinerators	SNCR	45	1130	1130	4.1	0.0944	1990
N0591S	Comm./Inst. Incinerators	SNCR	45	1130	1130	4.1	0.0944	1990
N0601	Indust. Incinerators	SNCR	45	1130	1130	4.1	0.0944	1990
N0601L	Indust. Incinerators	SNCR	45	1130	1130	4.1	0.0944	1990
N0601S	Indust. Incinerators	SNCR	45	1130	1130	4.1	0.0944	1990
N0611	Sulfate Pulping - Recovery Furnaces	LNB	50	740	740	5.5	0.1424	1990
N0611L	Sulfate Pulping - Recovery Furnaces	LNB	50	650	650	5.5	0.1424	1990
N0611S	Sulfate Pulping - Recovery Furnaces	LNB	50	820	820	5.5	0.1424	1990
N0612	Sulfate Pulping - Recovery Furnaces	LNB + FGR	60	1580	1380	6.7	0.1424	1990
N0612L	Sulfate Pulping - Recovery Furnaces	LNB + FGR	60	590	280	7.5	0.1424	1990

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N0612S	Sulfate Pulping - Recovery Furnaces	LNB + FGR	60	2560	2470	5.9	0.1424	1990
N0613	Sulfate Pulping - Recovery Furnaces	OT + WI	65	500	500	2.9	0.1424	1990
N0613L	Sulfate Pulping - Recovery Furnaces	OT + WI	65	320	320	2.9	0.1424	1990
N0613S	Sulfate Pulping - Recovery Furnaces	OT + WI	65	680	680	2.9	0.1424	1990
N0614	Sulfate Pulping - Recovery Furnaces	SCR	80	1720	2130	9.8	0.0944	1990
N0614L	Sulfate Pulping - Recovery Furnaces	SCR	80	1210	1410	9.6	0.0944	1990
N0614S	Sulfate Pulping - Recovery Furnaces	SCR	80	2230	2860	10	0.0944	1990
N0615	Sulfate Pulping - Recovery Furnaces	SNCR	50	2730	1870	8.8	0.0944	1990
N0615L	Sulfate Pulping - Recovery Furnaces	SNCR	50	1570	840	8.2	0.0944	1990
N0615S	Sulfate Pulping - Recovery Furnaces	SNCR	50	3870	2900	9.4	0.0944	1990
N0622	Ammonia Prod; Feedstock Desulfurization	LNB + FGR	60	1580	1380	6.7	0.1424	1990
N0622L	Ammonia Prod; Feedstock Desulfurization	LNB + FGR	60	590	280	7.5	0.1424	1990
N0622S	Ammonia Prod; Feedstock Desulfurization	LNB + FGR	60	2560	2470	5.9	0.1424	1990
N0632	Plastics Prod-Specific; (ABS) Resin	LNB + FGR	55	2830	1140	6.9	0.1098	1990
N0632L	Plastics Prod-Specific; (ABS) Resin	LNB + FGR	55	2470	830	6.8	0.1098	1990
N0632S	Plastics Prod-Specific; (ABS) Resin	LNB + FGR	55	3190	1430	6.9	0.1098	1990
N0642	Starch Mfg; Combined Operations	LNB + FGR	55	2830	1140	6.9	0.1098	1990
N0642L	Starch Mfg; Combined Operations	LNB + FGR	55	2470	830	6.8	0.1098	1990
N0642S	Starch Mfg; Combined Operations	LNB + FGR	55	3190	1430	6.9	0.1098	1990
N0653	By-Product Coke Mfg; Oven Underfiring	SNCR	60	1640	1640	2.7	0.1424	1990
N0653L	By-Product Coke Mfg; Oven Underfiring	SNCR	60	1640	1640	2.7	0.1424	1990
N0653S	By-Product Coke Mfg; Oven Underfiring	SNCR	60	1640	1640	2.7	0.1424	1990
N0662	Pri Cop Smel; Reverb Smelt Furn	LNB + FGR	60	750	250	7	0.1424	1990
N0662L	Pri Cop Smel; Reverb Smelt Furn	LNB + FGR	60	750	250	7	0.1424	1990
N0662S	Pri Cop Smel; Reverb Smelt Furn	LNB + FGR	60	750	250	7	0.1424	1990
N0673	Iron Prod; Blast Furn; Blast Htg Stoves	LNB + FGR	77	380	150	4.1	0.2439	1990
N0673L	Iron Prod; Blast Furn; Blast Htg Stoves	LNB + FGR	77	380	150	4.1	0.2439	1990
N0673S	Iron Prod; Blast Furn; Blast Htg Stoves	LNB + FGR	77	380	150	4.1	0.2439	1990
N0682	Steel Prod; Soaking Pits	LNB + FGR	60	750	250	7	0.1424	1990
N0682L	Steel Prod; Soaking Pits	LNB + FGR	60	750	250	7	0.1424	1990
N0682S	Steel Prod; Soaking Pits	LNB + FGR	60	750	250	7	0.1424	1990
N0692	Fuel Fired Equip; Process Htrs; Pro Gas	LNB + FGR	55	2830	1140	6.9	0.1098	1990
N0692L	Fuel Fired Equip; Process Htrs; Pro Gas	LNB + FGR	55	2470	830	6.8	0.1098	1990
N0692S	Fuel Fired Equip; Process Htrs; Pro Gas	LNB + FGR	55	3190	1430	6.9	0.1098	1990
N0701	Sec Alum Prod; Smelting Furn/Reverb	LNB	50	570	570	7	0.1424	1990
N0701L	Sec Alum Prod; Smelting Furn/Reverb	LNB	50	570	570	7	0.1424	1990
N0701S	Sec Alum Prod; Smelting Furn/Reverb	LNB	50	570	570	7	0.1424	1990
N0711	Steel Foundries; Heat Treating Furn	LNB	50	570	570	7	0.1424	1990
N0711L	Steel Foundries; Heat Treating Furn	LNB	50	570	570	7	0.1424	1990
N0711S	Steel Foundries; Heat Treating Furn	LNB	50	570	570	7	0.1424	1990
N0721	Fuel Fired Equip; Furnaces; Natural Gas	LNB	50	570	570	7	0.1424	1990
N0721L	Fuel Fired Equip; Furnaces; Natural Gas	LNB	50	570	570	7	0.1424	1990
N0721S	Fuel Fired Equip; Furnaces; Natural Gas	LNB	50	570	570	7	0.1424	1990
N0731	Asphaltic Conc; Rotary Dryer; Conv Plant	LNB	50	2000	2000	7.3	0.1098	1990
N0731L	Asphaltic Conc; Rotary Dryer; Conv Plant	LNB	50	1800	1800	7.3	0.1098	1990
N0731S	Asphaltic Conc; Rotary Dryer; Conv Plant	LNB	50	2200	2200	7.3	0.1098	1990
N0741	Ceramic Clay Mfg; Drying	LNB	50	2000	2000	7.3	0.1098	1990

Measure	Source Type	Measure Name	CE	Cost Per Ton ($/ton reduced) Default	Cost Per Ton ($/ton reduced) Incremental	Capital to Annual Cost Ratio	CRF	Cost Year ($Year)
N0741L	Ceramic Clay Mfg; Drying	LNB	50	1800	1800	7.3	0.1098	1990
N0741S	Ceramic Clay Mfg; Drying	LNB	50	2200	2200	7.3	0.1098	1990
N0753	Coal Cleaning-Thrml Dryer; Fluidized Bed	LNB	50	1280	1280	4.5	0.1424	1990
N0753L	Coal Cleaning-Thrml Dryer; Fluidized Bed	LNB	50	1090	1090	4.5	0.1424	1990
N0753S	Coal Cleaning-Thrml Dryer; Fluidized Bed	LNB	50	1460	1460	4.5	0.1424	1990
N0763	Fbrglass Mfg; Txtle-Type Fbr; Recup Furn	LNB	40	1690	1690	2.2	0.3811	1990
N0763L	Fbrglass Mfg; Txtle-Type Fbr; Recup Furn	LNB	40	1690	1690	2.2	0.3811	1990
N0763S	Fbrglass Mfg; Txtle-Type Fbr; Recup Furn	LNB	40	1690	1690	2.2	0.3811	1990
N0772	Sand/Gravel; Dryer	LNB + FGR	55	2830	1140	6.9	0.1098	1990
N0772L	Sand/Gravel; Dryer	LNB + FGR	55	2470	830	6.8	0.1098	1990
N0772S	Sand/Gravel; Dryer	LNB + FGR	55	3190	1430	6.9	0.1098	1990
N0782	Fluid Cat Cracking Units; Cracking Unit	LNB + FGR	55	2830	1140	6.9	0.1098	1990
N0782L	Fluid Cat Cracking Units; Cracking Unit	LNB + FGR	55	2470	830	6.8	0.1098	1990
N0782S	Fluid Cat Cracking Units; Cracking Unit	LNB + FGR	55	3190	1430	6.9	0.1098	1990
N0791	Conv Coating of Prod; Acid Cleaning Bath	LNB	50	2000	2000	7.3	0.1098	1990
N0791L	Conv Coating of Prod; Acid Cleaning Bath	LNB	50	1800	1800	7.3	0.1098	1990
N0791S	Conv Coating of Prod; Acid Cleaning Bath	LNB	50	2200	2200	7.3	0.1098	1990
N08012	Natural Gas Prod; Compressors	SCR	20	1651	1651	1.9	0.1098	1990
N08012	Natural Gas Prod; Compressors	SCR	20	533	533	1.8	0.1098	1990
N08012	Natural Gas Prod; Compressors	SCR	20	2769	2769	2	0.1098	1990
N0813	In-Process; Bituminous Coal; Cement Kiln	SNCR - urea based	50	770	770	1.6	0.1098	1990
N0813L	In-Process; Bituminous Coal; Cement Kiln	SNCR - urea based	50	770	770	1.6	0.1098	1990
N0813S	In-Process; Bituminous Coal; Cement Kiln	SNCR - urea based	50	770	770	1.6	0.1098	1990
N0823	In-Process; Bituminous Coal; Lime Kiln	SNCR - urea based	50	770	770	1.6	0.1098	1990
N0823L	In-Process; Bituminous Coal; Lime Kiln	SNCR - urea based	50	770	770	1.6	0.1098	1990
N0823S	In-Process; Bituminous Coal; Lime Kiln	SNCR - urea based	50	770	770	1.6	0.1098	1990
N0831	In-Process Fuel Use;Bituminous Coal; Gen	SNCR	40	1100	1100	1.2	0.0944	1990
N0831L	In-Process Fuel Use;Bituminous Coal; Gen	SNCR	40	940	940	1.2	0.0944	1990
N0831S	In-Process Fuel Use;Bituminous Coal; Gen	SNCR	40	1260	1260	1.2	0.0944	1990
N0842	In-Process Fuel Use; Residual Oil; Gen	LNB	37	1620	1620	7.3	0.1098	1990
N0842L	In-Process Fuel Use; Residual Oil; Gen	LNB	37	710	710	7.3	0.1098	1990
N0842S	In-Process Fuel Use; Residual Oil; Gen	LNB	37	2520	2520	7.3	0.1098	1990
N0851	In-Process Fuel Use; Natural Gas; Gen	LNB	50	2000	2000	7.3	0.1098	1990
N0851L	In-Process Fuel Use; Natural Gas; Gen	LNB	50	1800	1800	7.3	0.1098	1990
N0851S	In-Process Fuel Use; Natural Gas; Gen	LNB	50	2200	2200	7.3	0.1098	1990
N0862	In-Proc;Process Gas;Coke Oven/Blast Furn	LNB + FGR	55	2830	1140	6.9	0.1098	1990
N0862L	In-Proc;Process Gas;Coke Oven/Blast Furn	LNB + FGR	55	2470	830	6.8	0.1098	1990
N0862S	In-Proc;Process Gas;Coke Oven/Blast Furn	LNB + FGR	55	3190	1430	6.9	0.1098	1990
N0871	In-Process; Process Gas; Coke Oven Gas	LNB	50	2000	2000	7.3	0.1098	1990
N0871L	In-Process; Process Gas; Coke Oven Gas	LNB	50	1800	1800	7.3	0.1098	1990
N0871S	In-Process; Process Gas; Coke Oven Gas	LNB	50	2200	2200	7.3	0.1098	1990
N0881	Surf Coat Oper;Coating Oven Htr;Nat Gas	LNB	50	2000	2000	7.3	0.1098	1990
N0881L	Surf Coat Oper;Coating Oven Htr;Nat Gas	LNB	50	1800	1800	7.3	0.1098	1990
N0881S	Surf Coat Oper;Coating Oven Htr;Nat Gas	LNB	50	2200	2200	7.3	0.1098	1990
N0891	Solid Waste Disp;Gov;Other Incin;Sludge	SNCR	45	1130	1130	4.1	0.0944	1990
N0891L	Solid Waste Disp;Gov;Other Incin;Sludge	SNCR	45	1130	1130	4.1	0.0944	1990
N0891S	Solid Waste Disp;Gov;Other Incin;Sludge	SNCR	45	1130	1130	4.1	0.0944	1990

Measure	Source Type	Measure Name	CE	Cost Per Ton ($/ton reduced) Default	Cost Per Ton ($/ton reduced) Incremental	Capital to Annual Cost Cost Ratio	CRF	Cost Year ($Year)
NCEMK	Cement Kilns	Biosolid Injection Technology	23	310	310	7.3	0.1098	1997

2.1.2 EGU NOx Control Equations

EGU point sources utilizing control cost equations for NOx emission reductions are limited to Equation Type 1 as identified in Table 1. In this equation, model plant capacities are used along with scaling factors and the emission inventory's unit-specific boiler characteristics (boiler capacity, stack parameters) to generate a control cost for an applied technology.

Like non-EGU controls, these equations are applied only to sources which exceed ten (10) tons NOx per year threshold. But unlike the non-EGU application, any source which is missing a boiler capacity does not receive control measure application. Default cost per ton reduced values are not considered in the application of NOx control measures to EGU point sources.

This applied equation type involves the application of a scaling factor to adjust the capital cost associated with a control measure to the boiler size (MW) based on the original control technologies documentation. As noted in Table 4, a scaling factor model plant size and exponent are provided for this estimate.

For SCR control applied to coal fired EGU boilers, a scaling factor is applied when the emission inventory source size is less than 600MW. If the unit is greater than or equal to the 600 MW threshold, the scaling factor is set to unity (1.0). For all other boiler-fuel combinations, the scaling factor is calculated and applied when the inventory boiler size is less than 500 MW.

The capital cost associated with these EGU NOx control measures is then a straightforward calculation of the capital cost multiplier, the unit's boiler capacity (in MW), and the scaling factor (when appropriate).

The fixed O&M component is also based on the unit's capacity while the variable O&M includes an additional estimate for the unit's capacity factor. This factor is the unit's efficiency rating based on existing utilization and operation. A value of 1.00 would represent a completely efficient operation with no losses of production due to heat loss or other factors. ACN 4.1 provides a list of pre-calculated capacity factor calculations ranging from 65% to 85% (0.65 to 0.85).

The annualized cost is then estimated using the unit's capital cost times the CRF (derived with the equipment specific interest rate and lifetime expectancy) and the sum of the fixed and variable O&M costs.

Table 4. NOx EGU Control Cost Parameters

				Control Cost Equation Variables								
					O&M Cost Multiplier		Scaling Factor					
Measure	Source Type	Measure Name	CE	Capital Cost Multiplier	Fixed	Variable	Model Size (MW)	Exponent	Capacity Factor	Interest Rate	Equipment Life	Cost Year ($Year)
N00101	Utility Boiler - Coal/Wall	SNCR	35	15.8	0.24	0.73	100	0.681	0.65	0.07	20	1990
N00102	Utility Boiler - Coal/Wall	NGR	50	26.9	0.41	0	200	0.35	0.65	0.07	20	1990
N00103*	Utility Boiler - Coal/Wall	SCR	90	100	0.66	0.6	243	0.27	0.65	0.07	20	1999
N00201	Utility Boiler - Coal/Tangential	SNCR	35	15.8	0.24	0.73	100	0.681	0.65	0.07	20	1990
N00202	Utility Boiler - Coal/Tangential	NGR	50	26.9	0.41	0	200	0.35	0.65	0.07	20	1990
N00203*	Utility Boiler - Coal/Tangential	SCR	90	100	0.66	0.6	243	0.27	0.65	0.07	20	1999
N00501	Utility Boiler - Oil-Gas/Wall	SNCR	50	7.8	0.12	0.37	200	0.577	0.65	0.07	20	1990
N00502	Utility Boiler - Oil-Gas/Wall	NGR	50	16.4	0.25	0.02	200	0.35	0.65	0.07	20	1990
N00503	Utility Boiler - Oil-Gas/Wall	SCR	80	23.3	0.72	0.08	200	0.35	0.65	0.07	20	1990
N00601	Utility Boiler - Oil-Gas/Tangential	SNCR	50	7.8	0.12	0.37	200	0.577	0.65	0.07	20	1990
N00602	Utility Boiler - Oil-Gas/Tangential	NGR	50	16.4	0.25	0.02	200	0.35	0.65	0.07	20	1990
N00603	Utility Boiler - Oil-Gas/Tangential	SCR	80	23.3	0.72	0.08	200	0.35	0.65	0.07	20	1990
N00701	Utility Boiler - Cyclone	SNCR	35	8	0.12	1.05	100	0.577	0.65	0.07	20	1990
N00702	Utility Boiler - Cyclone	NGR	50	26.9	0.41	0	200	0.35	0.65	0.07	20	1990
N00703	Utility Boiler - Cyclone	SCR	90	90	0.53	0.37	200	0.35	0.65	0.07	20	1999
N00901	Utility Boiler - Coal/Wall	LNB	41	17.3	0.26	0.05	300	0.359	0.85	0.07	15	1999
N00902	Utility Boiler - Coal/Wall	LNBO	55.9	23.4	0.36	0.07	300	0.359	0.85	0.07	15	1999
N00903	Utility Boiler - Coal/Tangential	LNC1	33.1	9.1	0.14	0	300	0.359	0.85	0.07	15	1999
N00904	Utility Boiler - Coal/Tangential	LNC2	12.71	12.7	0.19	0.02	300	0.359	0.85	0.07	15	1999
N00905	Utility Boiler - Coal/Tangential	LNC3	53.1	14.5	0.22	0.02	300	0.359	0.85	0.07	15	1999
N00906	Utility Boiler - Coal/Wall	LNB	40.3	17.3	0.26	0.05	300	0.359	0.85	0.07	15	1999
N00907	Utility Boiler - Coal/Wall	LNBO	55.3	23.4	0.36	0.07	300	0.359	0.85	0.07	15	1999
N00908	Utility Boiler - Coal/Tangential	LNC1	43.3	9.1	0.14	0	300	0.359	0.85	0.07	15	1999
N00909	Utility Boiler - Coal/Tangential	LNC2	48.3	12.7	0.19	0.02	300	0.359	0.85	0.07	15	1999
N00910	Utility Boiler - Coal/Tangential	LNC3	58.3	14.5	0.22	0.02	300	0.359	0.85	0.07	15	1999

***Notes:** For measures N00103 and N00203, the source size scaling factor is applied to units under 600 MW.
For all other measures, the source size scaling factor is applied to units under 500 MW.

2.2 SO2 Control Equations

2.2.1 Non-EGU SO2 Control Equations

Non-EGU point sources utilizing control cost equations for SO2 emission reductions are varied depending on the control measure applied. However, each of the reviewed equations does use the unit's stack flow rate (in scfm) as the primary variable for control cost calculation. Similar to the EGU boiler capacity value, if a unit's stack flow is missing or equal to zero, the control measure is not applied to the specific unit. For a select set of SO2 controls, boiler capacity (in MMBtu/hr) is used to assign a default cost per ton reduced which is used to derive the unit's control cost.

Controls are applied only to sources which exceed ten (10) tons SO2 per year threshold. Large and small source classifications do not apply to SO2 controls for non-EGU sources so a daily emissions value is not required for control cost application and calculation.

If the unit already has some SO2 control applied in the input inventory, incremental controls are applied only if their control efficiency value exceeds that of the input control. Control costs do not differ in these cases and the cost associated with incremental controls are the same as those applied on uncontrolled sources.

Table 5 provides a list of the control cost equations assigned to various non-EGU control measures in ACN. In all of these instances, the interest rate is 7% and equipment life is fifteen years (CRF = 0.1098). Other necessary variables associated with each equation type are found in Table 1 of this document.

An additional list of non-EGU controls are assigned to SO2 reductions but involve the application of default cost per ton measures to estimate the costs assigned with each control. These measures and their cost per ton reduced values (some based on boiler capacity size bins) are presented in Table 6. For these controls where the equation based methods do not apply, default cost per ton values are assigned and applied to the annual emission reduction achieved by the applied control measure. In these applications, a capital to annual cost ratio is applied to estimate the capital cost associated with the control. The O&M costs are calculated using a subtraction of the capital cost * CRF.

Table 5. SO2 Non-EGU Control Cost Assignments

Measure	Source Type	Measure Name	CE (%)	Cost Equation Type #	Cost Year ($Year)
S0201	Sulfuric Acid Plants - Contact Absorber (99% Conversion)	Increase % Conversion ro Meet NSPS (99.7)	75	4	1990
S0301	Sulfuric Acid Plants - Contact Absorber (98% Conversion)	Increase % Conversion ro Meet NSPS (99.7)	85	4	1990
S0401	Sulfuric Acid Plants - Contact Absorber (97% Conversion)	Increase % Conversion ro Meet NSPS (99.7)	90	4	1990
S0501	Sulfuric Acid Plants - Contact Absorber (93% Conversion)	Increase % Conversion ro Meet NSPS (99.7)	95	4	1990
S0601	Sulfur Recovery Plants - Elemental Sulfur (Claus: 2 Stage w/o control (92-95% removal))	Amine Scrubbing	98.4	5	1990
S0701	Sulfur Recovery Plants - Elemental Sulfur (Claus: 3 Stage w/o control (95-96% removal))	Amine Scrubbing	97.8	5	1990
S0801	Sulfur Recovery Plants - Elemental Sulfur (Claus: 3 Stage w/o control (96-97% removal))	Amine Scrubbing	97.1	5	1990
S1101	Inorganic Chemical Manufacture	FGD	90	3	1990
S1201	By-Product Coke Manufacturing (Coke Oven Plants)	Coke Oven Gas Desulfurization	90	6	1990
S1201	By-Product Coke Manufacturing (Other Processes)	FGD	90	3	1990
S1301	Process Heaters (Oil and Gas Production Industry)	FGD	90	3	1990
S1401	Primary Metals Industry	Sulfuric Acid Plant	70	3	1990
S1501	Secondary Metal Production	FGD	90	3	1990
S1601	Mineral Products Industry	FGD	50	3	1990
S1701	Pulp and Paper Industry (Sulfate Pulping)	FGD	90	3	1990
S1801	Petroleum Industry	FGD	90	3	1990
S1901	Bituminous/Subbituminous Coal (Industrial Boilers)	FGD	90	3	1990
S2001	Residual Oil (Industrial Boilers)	FGD	90	3	1990
S2101	Bituminous/Subbituminous Coal (Commercial/Institutional Boilers)	FGD	90	3	1990
S2201	In-process Fuel Use - Bituminous/Subbituminous Coal	FGD	90	3	1990
S2301	Lignite (Industrial Boilers)	FGD	90	3	1990
S2401	Residual Oil (Commercial/Institutional Boilers)	FGD	90	3	1990
S2601	Steam Generating Unit-Coal/Oil	FGD	90	3	1990
S2801	Primary Lead Smelters - Sintering	Dual absorption	99	4	1990
S2901	Primary Zinc Smelters - Sintering	Dual absorption	99	4	1990

Table 6. SO2 Non-EGU Default Cost Per Ton Values

Measure	Source Type	Measure Name	CE (%)	Boiler Capacity Bin (MMBtu/hr)	Cost Per Ton Reduced ($/ton)	Equipment Life	Interest Rate	Cost Year ($Year)
S0602	Sulfur Recovery Plants - Elemental Sulfur (Claus: 2 Stage w/o control (92-95% removal))	Sulfur Recovery and/or Tail Gas Treatment	99.84	All Sizes	643	15	0.07	1990
S0702	Sulfur Recovery Plants - Elemental Sulfur (Claus: 3 Stage w/o control (95-96% removal))	Sulfur Recovery and/or Tail Gas Treatment	99.78	All Sizes	643	15	0.07	1990
S0802	Sulfur Recovery Plants - Elemental Sulfur (Claus: 3 Stage w/o control (96-97% removal))	Sulfur Recovery and/or Tail Gas Treatment	99.71	All Sizes	643	15	0.07	1990
S0901	Sulfur Recovery Plants - Sulfur Removal Process (99.9% removal)	Sulfur Recovery and/or Tail Gas Treatment	90	All Sizes	643	15	0.07	1990
S1001	Sulfur Recovery Plants - Elemental Sulfur Production (Not Classified)	Sulfur Recovery and/or Tail Gas Treatment	90	All Sizes	643	15	0.07	1990
S3000	Bituminous/Subbituminous Coal (Industrial Boilers)	IDIS	40	100 > 250	1,526	30	0.07	1999
S3000	Bituminous/Subbituminous Coal (Industrial Boilers)	IDIS	40	250 >	1,110	30	0.07	1999
S3000	Bituminous/Subbituminous Coal (Industrial Boilers)	IDIS	40	All Others	2,107	30	0.07	1999
S3001	Bituminous/Subbituminous Coal (Industrial Boilers)	SDA	90	100 > 250	1,341	30	0.07	1999
S3001	Bituminous/Subbituminous Coal (Industrial Boilers)	SDA	90	250 >	804	30	0.07	1999
S3001	Bituminous/Subbituminous Coal (Industrial Boilers)	SDA	90	All Others	1,973	30	0.07	1999
S3002	Bituminous/Subbituminous Coal (Industrial Boilers)	Wet FGD	90	100 > 250	1,535	30	0.07	1999
S3002	Bituminous/Subbituminous Coal (Industrial Boilers)	Wet FGD	90	250 >	1,027	30	0.07	1999
S3002	Bituminous/Subbituminous Coal (Industrial Boilers)	Wet FGD	90	All Others	1,980	30	0.07	1999
S3003	Lignite (Industrial Boilers)	IDIS	40	100 > 250	1,526	30	0.07	1999
S3003	Lignite (Industrial Boilers)	IDIS	40	250 >	1,110	30	0.07	1999
S3003	Lignite (Industrial Boilers)	IDIS	40	All Others	2,107	30	0.07	1999
S3004	Lignite (Industrial Boilers)	SDA	90	100 > 250	1,341	30	0.07	1999
S3004	Lignite (Industrial Boilers)	SDA	90	250 >	804	30	0.07	1999
S3004	Lignite (Industrial Boilers)	SDA	90	All Others	1,973	30	0.07	1999
S3005	Lignite (Industrial Boilers)	Wet FGD	90	100 > 250	1,535	30	0.07	1999
S3005	Lignite (Industrial Boilers)	Wet FGD	90	250 >	1,027	30	0.07	1999
S3005	Lignite (Industrial Boilers)	Wet FGD	90	All Others	1,980	30	0.07	1999
S3006	Residual Oil (Industrial Boilers)	Wet FGD	90	100 > 250	3,489	30	0.07	1999
S3006	Residual Oil (Industrial Boilers)	Wet FGD	90	250 >	2,295	30	0.07	1999
S3006	Residual Oil (Industrial Boilers)	Wet FGD	90	All Others	4,524	30	0.07	1999

2.2.2 EGU SO2 Control Equations

EGU point sources utilizing control cost equations for SO2 emission reductions are limited to Equation Type 1 as identified in Table 1 and to two low coal switching default cost per ton equation calculations. In Equation Type 1, model plant capacities are used along with scaling factors and the emission inventory's unit-specific boiler characteristics (boiler capacity, stack parameters) to generate a control cost for an applied technology.

Like NOx EGU controls, these equations are applied only to sources which exceed ten (10) tons SO2 per year threshold. Also consistent with the NOx EGU control application, any source which is missing a boiler capacity does not receive control measure application. Default cost per ton reduced values are not considered in the application of SO2 control measures to EGU point sources with the exception of two low sulfur coal switching options.

These two low sulfur coal options are applied based on the emission inventory provided sulfur content of the coal burned. Three classifications of coal are assigned, medium sulfur (<= 2% S by weight), high sulfur (2-3% S by weight), and very high sulfur (>3% S by weight).

Equation Type 1 involves the application of a scaling factor to adjust the capital cost associated with a control measure to the boiler size (MW) based on the original control technologies documentation. As noted in Table 4, a scaling factor model plant size and exponent are provided for this estimate.

For SO2 controls applied to EGU boilers, a scaling factor is applied when the emission inventory source size is less than 500 MW. If the unit is greater than or equal to the 500 MW threshold, the scaling factor is set to unity (1.0).

The capital cost associated with these EGU NOx control measures is then a straightforward calculation of the capital cost multiplier, the unit's boiler capacity (in MW), and the scaling factor (when appropriate).

The fixed O&M component is also based on the unit's capacity while the variable O&M includes an additional estimate for the unit's capacity factor. This factor is the unit's efficiency rating based on existing utilization and operation. A value of 1.00 would represent a completely efficient operation with no losses of production due to heat loss or other factors. ACN 4.1 provides a list of pre-calculated capacity factor calculations ranging from 65% to 85% (0.65 to 0.85).

The annualized cost is then estimated using the unit's capital cost times the CRF (derived with the equipment specific interest rate and lifetime expectancy) and the sum of the fixed and variable O&M costs.

Table 7. SO2 EGU Control Cost Parameters

			Control Cost Equation Variables										
				O&M Cost Multiplier		Scaling Factor		Applicable					
Source Type	Measure Name	CE (%)	Capital Cost Multiplier	Fixed	Variable	Model Size (MW)	Exponent	Sulfur Content Level	Capacity Factor	Equipment Life	Interest Rate	Cost Year ($Year)
Utility Boilers - Medium Sulfur Content	FGD Wet Scrubber	90	149	5.4	0.83	500	0.6	%S<=2	0.65	15	0.07	1990
Utility Boilers - High Sulfur Content	FGD Wet Scrubber	90	166	6	6.3	500	0.6	2 > %S => 3	0.65	15	0.07	1990
Utility Boilers - Very High Sulfur Conte	FGD Wet Scrubber	90	174	6.3	1.8	500	0.6	3 > %S	0.65	15	0.07	1990
Utility Boilers - Coal Fired	Repowering to Natural Gas	99	1566	25.44	2.42	500	0.6	All	0.65	10	0.07	1998

Table 8. SO2 EGU Low Sulfur Coal Fuel Switching Options

Measure	Source Type	Measure Name	CE (%)	Applicable Sulfur Content Level	Cost Per Ton Reduced ($/ton)	Cost Year ($Year)
SUT-S	Utility Boilers - High Sulfur Content	Fuel Switch - High to Low S Content	60	%S > 2	140	1995
SUT-W	Utility Boilers - Coal Fired	Coal Washing	35	All	320	1997

2.3 PM Control Equations

2.3.1 Non-EGU PM Control Equations

Non-EGU point sources utilizing control cost equations for PM emission reductions are limited to Equation Type 8 in Table 1. This equation uses the unit's stack flow rate (in scfm) as the primary variable for control cost calculation. If a unit's stack flow is less than 5 cubic feet per minute (cfm), then the control cost equation is not applied to the specific unit instead a default cost per ton value calculation is used.

Additionally, controls are applied only to sources which exceed ten (10) tons uncontrolled PM-10 per year threshold. Although applicability and control costs are based on PM-10 emissions, PM-2.5 reductions also occur when the above limits are met. There are no PM-2.5 specific thresholds identified in the code.

If the unit already has PM controls applied in the input inventory, incremental controls are applied only if their control efficiency value exceeds that of the input control. Control costs do not differ in these cases and the cost associated with incremental controls are the same as those applied on uncontrolled sources.

Table 9 provides a list of the control cost equations assigned to various non-EGU PM control measures in ACN. Both the control efficiencies for PM-10 and PM-2.5 are provided in this table. Values are representative of typical cost values and although not provided as options in the ACN output, low and high cost values are also available in the source tables. Table 10 presents the default cost per ton values used when a unit's stack flow rate is out of the recommended range. Three variables are available for this calculation; a capital cost multiplier, an O&M cost multiplier, and an annualized cost multiplier.

Table 9. PM Non-EGU Control Cost Equation Factors

Measure	Source Type	Measure Name	Control Efficiency (%)		Equipment Life	Typical Control Cost Equation-Based Factors		Cost Year ($Year)
			PM-10	PM-2.5		Capital	O&M	
P2011	Industrial Boilers - Coal	Fabric Filter (Pulse Jet Type)	99	99	20	13	11	1998
P2012	Industrial Boilers - Coal	Dry ESP-Wire Plate Type	98	95	20	27	16	1995
P2013	Industrial Boilers - Coal	Fabric Filter - Reverse-Air Cleaned Type	99	99	20	34	13	1998
P2014	Industrial Boilers - Coal	Venturi Scrubber	82	50	10	11	42	1995
P2021	Industrial Boilers - Wood	Fabric Filter (Pulse Jet Type)	99	99	20	13	11	1998
P2022	Industrial Boilers - Wood	Dry ESP-Wire Plate Type	98	95	20	27	16	1995
P2023	Industrial Boilers - Wood	Fabric Filter - Reverse-Air Cleaned Type	99	99	20	34	13	1998
P2024	Industrial Boilers - Wood	Venturi Scrubber	93	92	10	11	42	1995
P2031	Industrial Boilers - Oil	Dry ESP-Wire Plate Type	98	95	20	27	16	1995
P2032	Industrial Boilers - Oil	Venturi Scrubber	92	89	10	11	42	1995
P2041	Industrial Boilers - Liquid Waste	Dry ESP-Wire Plate Type	98	95	20	27	16	1995
P2051	Commercial Institutional Boilers - Coal	Fabric Filter (Pulse Jet Type)	99	99	20	13	11	1998
P2052	Commercial Institutional Boilers - Coal	Dry ESP-Wire Plate Type	98	95	20	27	16	1995
P2053	Commercial Institutional Boilers - Coal	Fabric Filter - Reverse-Air Cleaned Type	99	99	20	34	13	1998
P2061	Commercial Institutional Boilers - Wood	Fabric Filter (Pulse Jet Type)	80	80	20	13	11	1998
P2062	Commercial Institutional Boilers - Wood	Dry ESP-Wire Plate Type	90	90	20	27	16	1995
P2063	Commercial Institutional Boilers - Wood	Fabric Filter - Reverse-Air Cleaned Type	80	80	20	34	13	1998
P2071	Commercial Institutional Boilers - Oil	Dry ESP-Wire Plate Type	98	95	20	27	16	1995
P2081	Non-Ferrous Metals Processing - Copper	Fabric Filter (Mech. Shaker Type)	99	99	20	29	11	1998
P2082	Non-Ferrous Metals Processing - Copper	Dry ESP-Wire Plate Type	98	95	20	27	16	1995
P2083	Non-Ferrous Metals Processing - Copper	Wet ESP - Wire Plate Type	99	95	20	40	19	1995
P2084	Non-Ferrous Metals Processing - Copper	Fabric Filter - Reverse-Air Cleaned Type	99	99	20	34	13	1998
P2091	Non-Ferrous Metals Processing - Lead	Fabric Filter (Mech. Shaker Type)	99	99	20	29	11	1998
P2092	Non-Ferrous Metals Processing - Lead	Dry ESP-Wire Plate Type	98	95	20	27	16	1995
P2093	Non-Ferrous Metals Processing - Lead	Wet ESP - Wire Plate Type	99	95	20	40	19	1995
P2094	Non-Ferrous Metals Processing - Lead	Fabric Filter - Reverse-Air Cleaned Type	99	99	20	34	13	1998
P2101	Non-Ferrous Metals Processing - Zinc	Fabric Filter (Mech. Shaker Type)	99	99	20	29	11	1998
P2102	Non-Ferrous Metals Processing - Zinc	Dry ESP-Wire Plate Type	98	95	20	27	16	1995
P2103	Non-Ferrous Metals Processing - Zinc	Wet ESP - Wire Plate Type	99	95	20	40	19	1995
P2104	Non-Ferrous Metals Processing - Zinc	Fabric Filter - Reverse-Air Cleaned Type	99	99	20	34	13	1998
P2111	Non-Ferrous Metals Processing - Aluminum	Fabric Filter (Mech. Shaker Type)	99	99	20	29	11	1998

Measure	Source Type	Measure Name	Control Efficiency (%)		Equipment Life	Typical Control Cost Equation-Based Factors		Cost Year ($Year)
			PM-10	PM-2.5		Capital	O&M	
P2112	Non-Ferrous Metals Processing - Aluminum	Dry ESP-Wire Plate Type	98	95	20	27	16	1995
P2113	Non-Ferrous Metals Processing - Aluminum	Wet ESP - Wire Plate Type	99	95	20	40	19	1995
P2114	Non-Ferrous Metals Processing - Aluminum	Fabric Filter - Reverse-Air Cleaned Type	99	99	20	34	13	1998
P2121	Non-Ferrous Metals Processing - Other	Fabric Filter (Mech. Shaker Type)	99	99	20	29	11	1998
P2122	Non-Ferrous Metals Processing - Other	Dry ESP-Wire Plate Type	98	95	20	27	16	1995
P2123	Non-Ferrous Metals Processing - Other	Wet ESP - Wire Plate Type	99	95	20	40	19	1995
P2124	Non-Ferrous Metals Processing - Other	Fabric Filter - Reverse-Air Cleaned Type	99	99	20	34	13	1998
P2131	Ferrous Metals Processing - Coke	Fabric Filter (Mech. Shaker Type)	99	99	20	29	11	1998
P2132	Ferrous Metals Processing - Coke	Fabric Filter - Reverse-Air Cleaned Type	99	99	20	34	13	1998
P2133	Ferrous Metals Processing - Coke	Venturi Scrubber	93	89	10	11	42	1995
P2141	Ferrous Metals Processing - Ferroalloy Production	Fabric Filter (Mech. Shaker Type)	99	99	20	29	11	1998
P2142	Ferrous Metals Processing - Ferroalloy Production	Dry ESP-Wire Plate Type	98	95	20	27	16	1995
P2143	Ferrous Metals Processing - Ferroalloy Production	Fabric Filter - Reverse-Air Cleaned Type	99	99	20	34	13	1998
P2151	Ferrous Metals Processing - Iron & Steel Production	Fabric Filter (Pulse Jet Type)	99	99	20	13	11	1998
P2152	Ferrous Metals Processing - Iron & Steel Production	Fabric Filter (Mech. Shaker Type)	99	99	20	29	11	1998
P2153	Ferrous Metals Processing - Iron & Steel Production	Dry ESP-Wire Plate Type	98	95	20	27	16	1995
P2154	Ferrous Metals Processing - Iron & Steel Production	Wet ESP - Wire Plate Type	99	95	20	40	19	1995
P2155	Ferrous Metals Processing - Iron & Steel Production	Fabric Filter - Reverse-Air Cleaned Type	99	99	20	34	13	1998
P2156	Ferrous Metals Processing - Iron & Steel Production	Venturi Scrubber	73	25	10	11	42	1995
P2161	Ferrous Metals Processing - Gray Iron Foundaries	Fabric Filter (Mech. Shaker Type)	99	99	20	29	11	1998
P2163	Ferrous Metals Processing - Gray Iron Foundaries	Fabric Filter - Reverse-Air Cleaned Type	99	99	20	34	13	1998
P2164	Ferrous Metals Processing - Gray Iron Foundaries	Impingement-plate scrubber	64	64	10	7	25	1995
P2165	Ferrous Metals Processing - Gray Iron Foundaries	Venturi Scrubber	94	94	10	11	42	1995
P2171	Ferrous Metals Processing - Steel Foundaries	Fabric Filter (Pulse Jet Type)	99	99	20	13	11	1998
P2172	Ferrous Metals Processing - Steel Foundaries	Fabric Filter (Mech. Shaker Type)	99	99	20	29	11	1998
P2175	Ferrous Metals Processing - Steel Foundaries	Fabric Filter - Reverse-Air Cleaned Type	99	99	20	34	13	1998
P2176	Ferrous Metals Processing - Steel Foundaries	Venturi Scrubber	73	25	10	11	42	1995
P2181	Mineral Products - Cement Manufacture	Fabric Filter (Pulse Jet Type)	99	99	20	13	11	1998
P2182	Mineral Products - Cement Manufacture	Fabric Filter (Mech. Shaker Type)	99	99	20	29	11	1998
P2183	Mineral Products - Cement Manufacture	Dry ESP-Wire Plate Type	98	95	20	27	16	1995
P2184	Mineral Products - Cement Manufacture	Paper/Nonwoven Filters - Cartridge Collector Type	99	99	20	9	14	1998
P2185	Mineral Products - Cement Manufacture	Fabric Filter - Reverse-Air Cleaned Type	99	99	20	34	13	1998
P2191	Mineral Products - Coal Cleaning	Fabric Filter (Pulse Jet Type)	99	99	20	13	11	1998

Measure	Source Type	Measure Name	Control Efficiency (%)		Equipment Life	Typical Control Cost Equation-Based Factors		Cost Year ($Year)
			PM-10	PM-2.5		Capital	O&M	
P2192	Mineral Products - Coal Cleaning	Fabric Filter (Mech. Shaker Type)	99	99	20	29	11	1998
P2193	Mineral Products - Coal Cleaning	Paper/Nonwoven Filters - Cartridge Collector Type	99	99	20	9	14	1998
P2194	Mineral Products - Coal Cleaning	Fabric Filter - Reverse-Air Cleaned Type	99	99	20	34	13	1998
P2195	Mineral Products - Coal Cleaning	Venturi Scrubber	99	98	10	11	42	1995
P2201	Mineral Products - Stone Quarrying & Processing	Fabric Filter (Pulse Jet Type)	99	99	20	13	11	1998
P2202	Mineral Products - Stone Quarrying & Processing	Fabric Filter (Mech. Shaker Type)	99	99	20	29	11	1998
P2203	Mineral Products - Stone Quarrying & Processing	Dry ESP-Wire Plate Type	98	95	20	27	16	1995
P2204	Mineral Products - Stone Quarrying & Processing	Wet ESP - Wire Plate Type	99	95	20	40	19	1995
P2205	Mineral Products - Stone Quarrying & Processing	Paper/Nonwoven Filters - Cartridge Collector Type	99	99	20	9	14	1998
P2206	Mineral Products - Stone Quarrying & Processing	Fabric Filter - Reverse-Air Cleaned Type	99	99	20	34	13	1998
P2207	Mineral Products - Stone Quarrying & Processing	Venturi Scrubber	95	90	10	11	42	1995
P2211	Mineral Products - Other	Fabric Filter (Pulse Jet Type)	99	99	20	13	11	1998
P2212	Mineral Products - Other	Fabric Filter (Mech. Shaker Type)	99	99	20	29	11	1998
P2213	Mineral Products - Other	Dry ESP-Wire Plate Type	98	95	20	27	16	1995
P2214	Mineral Products - Other	Wet ESP - Wire Plate Type	99	95	20	40	19	1995
P2215	Mineral Products - Other	Paper/Nonwoven Filters - Cartridge Collector Type	99	99	20	9	14	1998
P2216	Mineral Products - Other	Fabric Filter - Reverse-Air Cleaned Type	99	99	20	34	13	1998
P2221	Asphalt Manufacture	Fabric Filter (Pulse Jet Type)	99	99	20	13	11	1998
P2222	Asphalt Manufacture	Fabric Filter (Mech. Shaker Type)	99	99	20	29	11	1998
P2223	Asphalt Manufacture	Paper/Nonwoven Filters - Cartridge Collector Type	99	99	20	9	14	1998
P2224	Asphalt Manufacture	Fabric Filter - Reverse-Air Cleaned Type	99	99	20	34	13	1998
P2231	Grain Milling	Fabric Filter (Pulse Jet Type)	99	99	20	13	11	1998
P2232	Grain Milling	Paper/Nonwoven Filters - Cartridge Collector Type	99	99	20	9	14	1998
P2233	Grain Milling	Fabric Filter - Reverse-Air Cleaned Type	99	99	20	34	13	1998
P2241	Wood Pulp & Paper	Dry ESP-Wire Plate Type	98	95	20	27	16	1995
P2242	Wood Pulp & Paper	Wet ESP - Wire Plate Type	99	95	20	40	19	1995
P2251	Chemical Manufacture	Wet ESP - Wire Plate Type	99	95	20	40	19	1995
P2261	Municipal Waste Incineration	Dry ESP-Wire Plate Type	98	95	20	27	16	1995
P2271	Fabricated Metal Products - Abrasive Blasting	Paper/Nonwoven Filters - Cartridge Collector Type	99	99	20	9	14	1998
P2281	Fabricated Metal Products - Machining	Paper/Nonwoven Filters - Cartridge Collector Type	99	99	20	9	14	1998
P2291	Fabricated Metal Products - Welding	Paper/Nonwoven Filters - Cartridge Collector Type	99	99	20	9	14	1998

* Note: Default Cost Per Ton Values used when stack flow rate < 5 cfm.

Measure	Source Type	Measure Name	Control Efficiency (%) PM-10	Control Efficiency (%) PM-2.5	Equipment Life	Typical Control Cost Equation-Based Factors Capital	Typical Control Cost Equation-Based Factors O&M	Cost Year ($Year)
	Each factor is multiplied by the PM-10 emission reduction associated with the control.							
	Interest rate = 7% for all control measures.							

Table 10. PM Non-EGU Default Cost Per Ton Factors

Measure	Source Type	Measure Name	Control Efficiency (%)		Typical Default Cost Per Ton Factors*			Cost Year
			PM-10	PM-2.5	Capital	O&M	Annualized	($Year)
P2011	Industrial Boilers - Coal	Fabric Filter (Pulse Jet Type)	99	99	380	28	117	1998
P2012	Industrial Boilers - Coal	Dry ESP-Wire Plate Type	98	95	710	41	110	1995
P2013	Industrial Boilers - Coal	Fabric Filter - Reverse-Air Cleaned Type	99	99	0	0	148	1998
P2014	Industrial Boilers - Coal	Venturi Scrubber	82	50	189	713	751	1995
P2021	Industrial Boilers - Wood	Fabric Filter (Pulse Jet Type)	99	99	380	28	117	1998
P2022	Industrial Boilers - Wood	Dry ESP-Wire Plate Type	98	95	710	41	110	1995
P2023	Industrial Boilers - Wood	Fabric Filter - Reverse-Air Cleaned Type	99	99	0	0	148	1998
P2024	Industrial Boilers - Wood	Venturi Scrubber	93	92	189	713	751	1995
P2031	Industrial Boilers - Oil	Dry ESP-Wire Plate Type	98	95	710	41	110	1995
P2032	Industrial Boilers - Oil	Venturi Scrubber	92	89	189	713	751	1995
P2041	Industrial Boilers - Liquid Waste	Dry ESP-Wire Plate Type	98	95	710	41	110	1995
P2051	Commercial Institutional Boilers - Coal	Fabric Filter (Pulse Jet Type)	99	99	380	28	117	1998
P2052	Commercial Institutional Boilers - Coal	Dry ESP-Wire Plate Type	98	95	710	41	110	1995
P2053	Commercial Institutional Boilers - Coal	Fabric Filter - Reverse-Air Cleaned Type	99	99	0	0	148	1998
P2061	Commercial Institutional Boilers - Wood	Fabric Filter (Pulse Jet Type)	80	80	380	28	117	1998
P2062	Commercial Institutional Boilers - Wood	Dry ESP-Wire Plate Type	90	90	710	41	110	1995
P2063	Commercial Institutional Boilers - Wood	Fabric Filter - Reverse-Air Cleaned Type	80	80	0	0	148	1998
P2071	Commercial Institutional Boilers - Oil	Dry ESP-Wire Plate Type	98	95	710	41	110	1995
P2081	Non-Ferrous Metals Processing - Copper	Fabric Filter (Mech. Shaker Type)	99	99	412	62	126	1998
P2082	Non-Ferrous Metals Processing - Copper	Dry ESP-Wire Plate Type	98	95	710	41	110	1995
P2083	Non-Ferrous Metals Processing - Copper	Wet ESP - Wire Plate Type	99	95	923	135	220	1995
P2084	Non-Ferrous Metals Processing - Copper	Fabric Filter - Reverse-Air Cleaned Type	99	99	0	0	148	1998
P2091	Non-Ferrous Metals Processing - Lead	Fabric Filter (Mech. Shaker Type)	99	99	412	62	126	1998
P2092	Non-Ferrous Metals Processing - Lead	Dry ESP-Wire Plate Type	98	95	710	41	110	1995
P2093	Non-Ferrous Metals Processing - Lead	Wet ESP - Wire Plate Type	99	95	923	135	220	1995
P2094	Non-Ferrous Metals Processing - Lead	Fabric Filter - Reverse-Air Cleaned Type	99	99	0	0	148	1998
P2101	Non-Ferrous Metals Processing - Zinc	Fabric Filter (Mech. Shaker Type)	99	99	412	62	126	1998
P2102	Non-Ferrous Metals Processing - Zinc	Dry ESP-Wire Plate Type	98	95	710	41	110	1995
P2103	Non-Ferrous Metals Processing - Zinc	Wet ESP - Wire Plate Type	99	95	923	135	220	1995
P2104	Non-Ferrous Metals Processing - Zinc	Fabric Filter - Reverse-Air Cleaned Type	99	99	0	0	148	1998

			Control Efficiency (%)		Typical Default Cost Per Ton Factors*			Cost Year
Measure	**Source Type**	**Measure Name**	**PM-10**	**PM-2.5**	**Capital**	**O&M**	**Annualized**	**($Year)**
P2111	Non-Ferrous Metals Processing - Aluminum	Fabric Filter (Mech. Shaker Type)	99	99	412	62	126	1998
P2112	Non-Ferrous Metals Processing - Aluminum	Dry ESP-Wire Plate Type	98	95	710	41	110	1995
P2113	Non-Ferrous Metals Processing - Aluminum	Wet ESP - Wire Plate Type	99	95	923	135	220	1995
P2114	Non-Ferrous Metals Processing - Aluminum	Fabric Filter - Reverse-Air Cleaned Type	99	99	0	0	148	1998
P2121	Non-Ferrous Metals Processing - Other	Fabric Filter (Mech. Shaker Type)	99	99	412	62	126	1998
P2122	Non-Ferrous Metals Processing - Other	Dry ESP-Wire Plate Type	98	95	710	41	110	1995
P2123	Non-Ferrous Metals Processing - Other	Wet ESP - Wire Plate Type	99	95	923	135	220	1995
P2124	Non-Ferrous Metals Processing - Other	Fabric Filter - Reverse-Air Cleaned Type	99	99	0	0	148	1998
P2131	Ferrous Metals Processing - Coke	Fabric Filter (Mech. Shaker Type)	99	99	412	62	126	1998
P2132	Ferrous Metals Processing - Coke	Fabric Filter - Reverse-Air Cleaned Type	99	99	0	0	148	1998
P2133	Ferrous Metals Processing - Coke	Venturi Scrubber	93	89	189	713	751	1995
P2141	Ferrous Metals Processing - Ferroalloy Production	Fabric Filter (Mech. Shaker Type)	99	99	412	62	126	1998
P2142	Ferrous Metals Processing - Ferroalloy Production	Dry ESP-Wire Plate Type	98	95	710	41	110	1995
P2143	Ferrous Metals Processing - Ferroalloy Production	Fabric Filter - Reverse-Air Cleaned Type	99	99	0	0	148	1998
P2151	Ferrous Metals Processing - Iron & Steel Production	Fabric Filter (Pulse Jet Type)	99	99	380	28	117	1998
P2152	Ferrous Metals Processing - Iron & Steel Production	Fabric Filter (Mech. Shaker Type)	99	99	412	62	126	1998
P2153	Ferrous Metals Processing - Iron & Steel Production	Dry ESP-Wire Plate Type	98	95	710	41	110	1995
P2154	Ferrous Metals Processing - Iron & Steel Production	Wet ESP - Wire Plate Type	99	95	923	135	220	1995
P2155	Ferrous Metals Processing - Iron & Steel Production	Fabric Filter - Reverse-Air Cleaned Type	99	99	0	0	148	1998
P2156	Ferrous Metals Processing - Iron & Steel Production	Venturi Scrubber	73	25	189	713	751	1995
P2161	Ferrous Metals Processing - Gray Iron Foundaries	Fabric Filter (Mech. Shaker Type)	99	99	412	62	126	1998
P2163	Ferrous Metals Processing - Gray Iron Foundaries	Fabric Filter - Reverse-Air Cleaned Type	99	99	0	0	148	1998
P2164	Ferrous Metals Processing - Gray Iron Foundaries	Impingement-plate scrubber	64	64	87	417	431	1995
P2165	Ferrous Metals Processing - Gray Iron Foundaries	Venturi Scrubber	94	94	189	713	751	1995
P2171	Ferrous Metals Processing - Steel Foundaries	Fabric Filter (Pulse Jet Type)	99	99	380	28	117	1998
P2172	Ferrous Metals Processing - Steel Foundaries	Fabric Filter (Mech. Shaker Type)	99	99	412	62	126	1998
P2175	Ferrous Metals Processing - Steel Foundaries	Fabric Filter - Reverse-Air Cleaned Type	99	99	0	0	148	1998
P2176	Ferrous Metals Processing - Steel Foundaries	Venturi Scrubber	73	25	189	713	751	1995
P2181	Mineral Products - Cement Manufacture	Fabric Filter (Pulse Jet Type)	99	99	380	28	117	1998
P2182	Mineral Products - Cement Manufacture	Fabric Filter (Mech. Shaker Type)	99	99	412	62	126	1998
P2183	Mineral Products - Cement Manufacture	Dry ESP-Wire Plate Type	98	95	710	41	110	1995
P2184	Mineral Products - Cement Manufacture	Paper/Nonwoven Filters - Cartridge Collector Type	99	99	0	0	142	1998
P2185	Mineral Products - Cement Manufacture	Fabric Filter - Reverse-Air Cleaned Type	99	99	0	0	148	1998

Measure	Source Type	Measure Name	Control Efficiency (%)		Typical Default Cost Per Ton Factors*			Cost Year
			PM-10	PM-2.5	Capital	O&M	Annualized	($Year)
P2191	Mineral Products - Coal Cleaning	Fabric Filter (Pulse Jet Type)	99	99	380	28	117	1998
P2192	Mineral Products - Coal Cleaning	Fabric Filter (Mech. Shaker Type)	99	99	412	62	126	1998
P2193	Mineral Products - Coal Cleaning	Paper/Nonwoven Filters - Cartridge Collector Type	99	99	0	0	142	1998
P2194	Mineral Products - Coal Cleaning	Fabric Filter - Reverse-Air Cleaned Type	99	99	0	0	148	1998
P2195	Mineral Products - Coal Cleaning	Venturi Scrubber	99	98	189	713	751	1995
P2201	Mineral Products - Stone Quarrying & Processing	Fabric Filter (Pulse Jet Type)	99	99	380	28	117	1998
P2202	Mineral Products - Stone Quarrying & Processing	Fabric Filter (Mech. Shaker Type)	99	99	412	62	126	1998
P2203	Mineral Products - Stone Quarrying & Processing	Dry ESP-Wire Plate Type	98	95	710	41	110	1995
P2204	Mineral Products - Stone Quarrying & Processing	Wet ESP - Wire Plate Type	99	95	923	135	220	1995
P2205	Mineral Products - Stone Quarrying & Processing	Paper/Nonwoven Filters - Cartridge Collector Type	99	99	0	0	142	1998
P2206	Mineral Products - Stone Quarrying & Processing	Fabric Filter - Reverse-Air Cleaned Type	99	99	0	0	148	1998
P2207	Mineral Products - Stone Quarrying & Processing	Venturi Scrubber	95	90	189	713	751	1995
P2211	Mineral Products - Other	Fabric Filter (Pulse Jet Type)	99	99	380	28	117	1998
P2212	Mineral Products - Other	Fabric Filter (Mech. Shaker Type)	99	99	412	62	126	1998
P2213	Mineral Products - Other	Dry ESP-Wire Plate Type	98	95	710	41	110	1995
P2214	Mineral Products - Other	Wet ESP - Wire Plate Type	99	95	923	135	220	1995
P2215	Mineral Products - Other	Paper/Nonwoven Filters - Cartridge Collector Type	99	99	0	0	142	1998
P2216	Mineral Products - Other	Fabric Filter - Reverse-Air Cleaned Type	99	99	0	0	148	1998
P2221	Asphalt Manufacture	Fabric Filter (Pulse Jet Type)	99	99	380	28	117	1998
P2222	Asphalt Manufacture	Fabric Filter (Mech. Shaker Type)	99	99	412	62	126	1998
P2223	Asphalt Manufacture	Paper/Nonwoven Filters - Cartridge Collector Type	99	99	0	0	142	1998
P2224	Asphalt Manufacture	Fabric Filter - Reverse-Air Cleaned Type	99	99	0	0	148	1998
P2231	Grain Milling	Fabric Filter (Pulse Jet Type)	99	99	380	28	117	1998
P2232	Grain Milling	Paper/Nonwoven Filters - Cartridge Collector Type	99	99	0	0	142	1998
P2233	Grain Milling	Fabric Filter - Reverse-Air Cleaned Type	99	99	0	0	148	1998
P2241	Wood Pulp & Paper	Dry ESP-Wire Plate Type	98	95	710	41	110	1995
P2242	Wood Pulp & Paper	Wet ESP - Wire Plate Type	99	95	923	135	220	1995
P2251	Chemical Manufacture	Wet ESP - Wire Plate Type	99	95	923	135	220	1995
P2261	Municipal Waste Incineration	Dry ESP-Wire Plate Type	98	95	710	41	110	1995
P2271	Fabricated Metal Products - Abrasive Blasting	Paper/Nonwoven Filters - Cartridge Collector Type	99	99	0	0	142	1998
P2281	Fabricated Metal Products - Machining	Paper/Nonwoven Filters - Cartridge Collector Type	99	99	0	0	142	1998
P2291	Fabricated Metal Products - Welding	Paper/Nonwoven Filters - Cartridge Collector Type	99	99	0	0	142	1998

			Control Efficiency (%)		Typical Default Cost Per Ton Factors*			Cost Year
Measure	**Source Type**	**Measure Name**	**PM-10**	**PM-2.5**	**Capital**	**O&M**	**Annualized**	**($Year)**

* Note: Default Cost Per Ton Values used when stack flow rate < 5 cfm.
Each factor is multiplied by the PM-10 emission reduction associated with the control.

2.3.2 EGU PM Control Equations

Two types of equations are utilized in the control cost calculation for EGU PM controls. One equation has been described in the non-EGU PM section of this report. Equation Type 8 in Table 1 uses the unit's stack flow rate (in scfm) as the primary variable for control cost calculation. If a unit's stack flow is outside of a range of values (15,000 => stack flow rate (cfm) => 1,400,000), then the control measure is not applied to the specific unit; instead a default cost per ton value calculation is used.

The second equation has not been provided in any EPA documentation directly transferred to date but found to be included in the ACN source code as well as documented in the AirControlNET Documentation Report found on EPA's website. This equation also uses a unit's stack flow rate (scfm) with capital and O&M cost factors as noted in the equation below:

Equation 1. EGU PM Control Cost Calculation.

Capital Costs (TCC)= [(tecs * stkflow) +teci] * ec_to_cc

Where,

Stackflow: stkflow (ft^3 / min),
Total Equipment Cost Factor: tecs,
Total Equipment Cost Constant: teci, and
Equipment to Capital Cost Multiplier: ec_to_cc

O&M = [(els*stkflow) + eli] + [(dds *stkflow) + ddi] + [(brs * stkflow) +bri]

Where,

Electricity Factor: els,
Electricity Constant: eli,
Dust Disposal Factor: dds,
Dust Disposal Constant: ddi,
Bag Replacement Factor: brs, and
Bag Replacement Constant: bri

Total Costs = (CRF * TCC) + O&M

In both cases, controls are applied only to sources which exceed ten (10) tons uncontrolled PM-10 per year threshold. Although applicability and control costs are based on PM-10 emissions, PM-2.5 reductions also occur when the above limits are met. There are no PM-2.5 specific thresholds identified in the code.

Table 11 provides a list of the control cost equations assigned to various non-EGU PM control measures in ACN. Both the control efficiencies for PM-10 and PM-2.5 are provided in this table. Values are representative of typical cost values and although not provided as options in the ACN output, low and high cost values are also available in the source tables. This table also presents the default cost per ton values used when a unit's stack flow rate is out of the

recommended range. Three variables are available for this calculation; a capital cost multiplier, an O&M cost multiplier, and an annualized cost multiplier. Table 12 provides the capital and O&M factors associated with the new equation type described in Equation 1 above. The new equation application does not appear to have any default cost per ton backup calculation in the event of stack flow rates being outside of the acceptable range, however, it is noted that a description of the control measures utilizing this new equation (Fabric Filter – Mechanical Shaker) is also represented in the Equation Type 8 control measure list.

If the unit already has PM controls applied in the input inventory, incremental controls are applied only if their control efficiency value exceeds that of the input control. Control costs do not differ in these cases and the cost associated with incremental controls are the same as those applied on uncontrolled sources.

Table 11. PM EGU Control Cost Equation Factors (Equation Type 8)

			Control Efficiency (%)		Typical Control Cost Equation-Based Factors		Typical Default Cost Per Ton Factors*			Cost Year
Measure	**Source Type**	**Measure Name**	**PM-10**	**PM-2.5**	**Capital**	**O&M**	**Capital**	**O&M**	**Annualized**	**($Year)**
PUDESP	Utility Boilers - Coal	Dry ESP-Wire Plate Type	98	95	27	16	710	41	110	1995
PUMECH	Utility Boilers - Coal	Fabric Filter (Mech. Shaker Type)	99.5	99	29	11	412	62	126	1998
PUPUJT	Utility Boilers - Coal	Fabric Filter (Pulse Jet Type)	99	99	13	11	380	28	117	1998
PUREVA	Utility Boilers - Coal	Fabric Filter (Reverse-Air Cleaned Type)	99	99	34	13	0	0	148	1998
PUDESP	Utility Boilers - Coal	Dry ESP-Wire Plate Type	98	95	27	16	710	41	110	1995
PUMECH	Utility Boilers - Coal	Fabric Filter (Mech. Shaker Type)	99.5	99	29	11	412	62	126	1998
PUPUJT	Utility Boilers - Coal	Fabric Filter (Pulse Jet Type)	99	99	13	11	380	28	117	1998
PUREVA	Utility Boilers - Coal	Fabric Filter (Reverse-Air Cleaned Type)	99	99	34	13	0	0	148	1998
PUDESP	Utility Boilers - Oil	Dry ESP-Wire Plate Type	98	95	27	16	710	41	110	1995

* Note: Default Cost Per Ton Values used when 15,000 >= stack flow rate (cfm) >= 1,400,000.
Each factor is multiplied by the PM-10 emission reduction associated with the control.
Equipment life = 20 years and interest rate = 7% for all control measures.

Table 12. PM EGU Control Cost Equation Factors (New Equation Type)

				Control Cost Equation Factors									Cost Year
			PM10/PM2.5	Capital Cost Variables			O&M Cost Variables						
Measure	**Source Type**	**Measure Name**	**CE (%)**	**tecs**	**teci**	**ec_to_cc**	**els**	**eli**	**dds**	**ddi**	**brs**	**bri**	**($Year)**
PUTILC	Utility Boilers - Coal	Fabric Filter - Mechanical Shaker	95	5.7019	77489	2.17	0.1941	-15.956	0.7406	1.1461	0.2497	1220.7	1990
PUTILG	Utility Boilers - Gas/Oil	Fabric Filter - Mechanical Shaker	95	5.7019	77489	2.17	0.1876	-19.576	0.0007	0.1895	0.2411	1224.2	1990

* Note: Equipment life = 15 years and interest rate = 7% for all control measures.

3 IPM EQUATION TYPES

EPA uses the Integrated Planning Model (IPM) to analyze the projected impact of environmental policies on the electric power sector in the 48 contiguous states and the District of Columbia. Developed by ICF Consulting, Inc. and used to support public and private sector clients, IPM is a multi-regional, dynamic, deterministic linear programming model of the U.S. electric power sector. It provides forecasts of least-cost capacity expansion, electricity dispatch, and emission control strategies for meeting energy demand and environmental, transmission, dispatch, and reliability constraints. IPM can be used to evaluate the cost and emissions impacts of proposed policies to limit emissions of sulfur dioxide (SO_2), nitrogen oxides (NO_x), carbon dioxide (CO_2), and mercury (Hg) from the electric power sector.

In this analysis, we have extracted equations and associated variables and reference data from the latest published version of IPM (v.3.0) Base Case 2006 as made available on EPA's website (http://www.epa.gov/AIRMARKET/progsregs/epa-ipm/#docs) for combustion and post-combustion control measures applicable to the reduction of SO2 and NOx. Table 13 provides a listing of these control technology retrofit options.

Table 13. Summary of Emission Control Technology Retrofit Options in EPA Base Case 2006

SO2 Control Technology Options	NOx Control Technology Options
Limestone Forced Oxidation (LSFO) Scrubber	Selective Catalytic Reduction (SCR) System
Lime Spray Dryer (LSD) Scrubber	Selective Non-Catalytic Reduction (SNCR) System
	Combustion Controls

For both pollutants, the equations documented by EPA are simple and the development of code and application of factors should be straightforward. However, the emission inventory-based input to the control cost equations does not regularly exist in the EPA emission inventories.

The equations published in the IPM documentation adhere to the following variable format; capital cost is represented as $/kW, fixed O&M (FOM) cost is represented as $/kW-yr, and variable O&M (VOM) is represented as mills/kWh. These factors and the derived variables applicable to individual control technologies have assumptions as to operating characteristics of units built into them. Factors like capacity utilization, heat content of fuel, and heat rate of the operation have been assumed at certain values to allow for the generalization of these equations. Scalars do appear in some control technology cost calculations and are specified in the following tables. These will need to be implemented into the calculations when appropriate.

Equation 2 details the calculations (minus scalars) to which these three factors are assigned in order to estimate capital, O&M, and annualized costs for the IPM-based control technologies.

Equation 2. IPM Control Cost Equations.

Capital Cost = Unit Capacity * 1000 (kW/MW) * Capital Cost Factor

Where,

Unit Capacity: nameplate boiler capacity (MW), and
Capital Cost Factor: Technology specific factor ($/kW).

Fixed O&M = Unit Capacity * 1000 (kW/MW) * FOM Factor

Where,

Unit Capacity: nameplate boiler capacity (MW), and
FOM Factor: Fixed O&M factor ($/kW-yr).

Variable O&M = Unit Capacity * ($/1000 mills) * (8,760,000 kWh/MW)* CF * VOM Factor

Where,

Unit Capacity: nameplate boiler capacity (MW),
CF: unit capacity factor (unitless, ratio of the actual output of a power plant over a period of time and its output if it had operated a full capacity of that time period), and
VOM Factor: Variable O&M Factor (mills/kWh).

Total Costs = (CRF * Capital Cost) + Fixed O&M + Variable O&M

3.1 SO2 Control Technologies

The EPA Base Case 2006 includes two commercially available wet and semi-dry Flue Gas Desulfurization (FGD) technology options for removing SO2 produced by coal-fired power plants. One wet FGD technologies — Limestone Forced Oxidation (LSFO) — and one semi-dry FGD technology — Lime Spray Dryer (LSD) — are available to "unscrubbed" existing units and "scrubbed" units with reported removal efficiencies of less than fifty percent. Existing units with scrubbers reporting removal efficiencies less than 50% are considered to have an injection technology and are given the option to retrofit with one of the two scrubber options. The scrubber retrofit costs for these units are the same as unscrubbed units retrofitting with a scrubber.

As shown in Table 14, existing unscrubbed units that are selected to be retrofit by the model with scrubbers achieve removal efficiencies ranging from 90% to 95%, depending on the type of scrubber used.

Table 14. Summary of SO2 Retrofit Emission Control Performance Assumptions

	Limestone Forced Oxidation (LSFO)	Lime Spray Dryer (LSD)
Percent Removal	95% with a floor of 0.06 lbs/MMBtu	90% with a floor of 0.09 lbs/MMBtu
Capacity Penalty	- 1.65%	- 0.7%
Heat Rate Penalty	1.68%	0.71%

Table Source: Documentation for EPA Base Case 2006; Section 5: Emission Control Technologies; Table 5-2.

For examples of the typical costs for the two FGD options presented in this section, see Table 15. This table shows the capital, fixed O&M, and variable O&M costs that would result with each of the scrubber technologies for a representative set of coal unit capacities and heat rates. It should be noted that each of the FGD technologies carries a capacity penalty (noted in Table 14). That is, the power required to operate the scrubber reduces the maximum amount of electricity that is available for sale to the grid by a certain percent. In addition, to capture the total fuel used for generation both for sale to the grid and for internal load (i.e., operating the scrubber) the model scales up the heat rate by a comparable amount. This "heat rate penalty" is a modeling procedure only and does represent an increase in the unit's actual heat rate (i.e., a decrease in the unit's generation efficiency).

To facilitate incorporating the cost functions in IPM, polynomial fits, not the original engineering equations, were used in the model equation examples presented here. In actuality, separate rational polynomials were derived for capital cost, fixed operation and maintenance cost, and variable operating and maintenance cost.

Since complete documentation is unavailable at this time for the EPA Base Case 2006 version of IPM, these cost functions were unable to be used to provide additional guidance on the development of control cost equations in this memorandum. However, it is recommended that alternate polynomial equations could be derived using the control cost result from Table 15.

An alternate approach would be to match the "closest fit" capacity and heat rate to the existing table and use available capital and O&M variables to estimate control costs.

3.2 Nitrogen Oxides Control Technology

The EPA Base Case 2006 includes two categories of NOx reduction technologies: combustion and post-combustion controls. Combustion controls reduce NOx emissions during the combustion process by regulating flame characteristics such as temperature and fuel-air mixing. Post-combustion controls operate downstream of the combustion process and remove NOx emissions from the flue gas. All the specific combustion and post-combustion technologies included in EPA Base Case 2006 are commercially available and currently in use in numerous power plants.

3.2.1 Combustion Controls

Equations for state-of-the-art NOx combustion controls were developed for EPA Base Case 2006. The equations are tailored to the boiler type, coal type, and combustion controls already in place and allow appropriate additional combustion controls to be exogenously applied to generating units based on the NOx emission limits they face. The EPA Base Case 2006 cost assumptions for NOx Combustion Controls are summarized in Table 16. Control efficiency values for these control types were not provided in the EPA documentation. Values may need to be derived using controlled and uncontrolled emission factor estimates or taken directly from ACN estimates.

Table 15. Illustrative Scrubber Costs (2004$) for Representative MW and Heat Rates from EPA Base Case 2006

Scrubber Type	Capacity (MW)	Heat Rate (Btu/kWh)			Cost
		9,000	10,000	11,000	
LSFO	100	466	468	470	Capital Cost ($/kW)
Minimum Cutoff: ≥ 100 MW		19	19	19	Fixed O&M ($/kW-yr)
Maximum Cutoff: None		1.3	1.4	1.5	Variable O&M (mills/kWh)
Assuming 5.0 lbs/MMBtu SO_2 Coal	300	228	230	232	Capital Cost ($/kW)
		11	11	11	Fixed O&M ($/kW-yr)
		1.3	1.4	1.5	Variable O&M (mills/kWh)
	500	171	174	176	Capital Cost ($/kW)
		9	9	9	Fixed O&M ($/kW-yr)
		1.3	1.4	1.5	Variable O&M (mills/kWh)
	700	140	142	144	Capital Cost ($/kW)
		8	8	8	Fixed O&M ($/kW-yr)
		1.3	1.4	1.5	Variable O&M (mills/kWh)
	1000	118	120	123	Capital Cost ($/kW)
		7	7	7	Fixed O&M ($/kW-yr)
		1.3	1.4	1.5	Variable O&M (mills/kWh)
LSD	100	279	286	293	Capital Cost ($/kW)
Minimum Cutoff: ≥ 100 MW		11	13	12	Fixed O&M ($/kW-yr)
Maximum Cutoff: None		2.1	2.4	2.6	Variable O&M (mills/kWh)
Assuming 3.0 lbs/MMBtu SO_2 Coal	300	148	155	163	Capital Cost ($/kW)
		8	8	8	Fixed O&M ($/kW-yr)
		2.1	2.4	2.6	Variable O&M (mills/kWh)
	500	124	131	139	Capital Cost ($/kW)
		6	6	6	Fixed O&M ($/kW-yr)
		2.1	2.4	2.6	Variable O&M (mills/kWh)
	700	111	118	126	Capital Cost ($/kW)
		5	5	5	Fixed O&M ($/kW-yr)
		2.1	2.4	2.6	Variable O&M (mills/kWh)
	1000	104	112	120	Capital Cost ($/kW)
		4	4	4	Fixed O&M ($/kW-yr)
		2.1	2.4	2.6	Variable O&M (mills/kWh)

Table Source: Documentation for EPA Base Case 2006; Section 5: Emission Control Technologies; Table 5-3.

Table 16. Cost (2004$) of NOx Combustion Controls for Coal Boilers (300 MW Size)

Boiler Type	Technology	Capital ($/kW)	Fixed O&M ($/kW-yr)	Variable O&M (mills/kWh)
Dry Bottom Wall-Fired	Low NO_x Burner without Overfire Air (LNB without OFA)	19.24	0.29	0.06
	Low NO_x Burner with Overfire Air (LNB with OFA)	26.12	0.40	0.08
Tangentially-Fired	Low NO_x Coal-and-Air Nozzles with Close-Coupled Overfire Air (LNC1)	10.14	0.16	0.00
	Low NO_x Coal-and-Air Nozzles with Separated Overfire Air (LNC2)	14.17	0.21	0.027
	Low NO_x Coal-and-Air Nozzles with Close-Coupled and Separated Overfire Air (LNC3)	16.19	0.25	0.027

Scaling Factor

For all of the above combustion controls the following scaling factor is used to obtain the capital and fixed operating and maintenance costs applicable to the capacity (in MW) of the unit taking on combustion controls. No scaling factors is applied in calculating the variable operating and maintenance cost.

$$(\$ \text{ for X MW Unit}) = (\$ \text{ for 300 MW Unit}) \times \left(\frac{300}{X}\right)^{0.359}$$

where

($ for 300 MW Unit) is the value obtained using the factors shown in the above table and
X is the capacity (in MW) of the unit taking on combustion controls.

Table Source: Documentation for EPA Base Case 2006; Section 5: Emission Control Technologies; Table 5-4.

3.2.2 Post-Combustion Controls

The EPA Base Case 2006 includes two post-combustion retrofit control technologies for existing coal and oil/gas steam units: Selective Catalytic Reduction (SCR) and Selective Non-Catalytic Reduction (SNCR). Table 17 summarizes the performance assumptions for each NOx control technology.

The cost assumptions for SCR retrofits at coal plants were revised in EPA Base Case 2006 based on an engineering assessment of recent SCR installations. To capture economies of scale for installation and operation of post-combustion controls, the costs of the controls are expressed as functions of capacity. Revisions were also made to the scaling factors applied to these costs, as illustrated in Table 18. Table 19 summarizes the SCR and SNCR cost assumptions for oil/gas steam units implemented in EPA Base Case 2006.

Table 17. Summary of Retrofit NOx Emission Control Performance Assumptions

	Selective Catalytic Reduction (SCR)		Selective Non-Catalytic Reduction (SNCR)	
Unit Type	Coal	Oil/Gas	Coal	Oil/Gas
Percent Removal	90% down to 0.06 lb/mmBtu	80%	Pulverized Coal: 35% Fluidized Bed: 50%	50%
Size Applicability	Units ≥ 100 MW	Units ≥ 25 MW	Units ≥ 25 MW and Units < 200 MW (for non FBC units)	Units ≥ 25 MW

Table Source: Documentation for EPA Base Case 2006; Section 5: Emission Control Technologies; Table 5-5.

Table 18. Post-Combustion NOx Controls for Coal Plants (2004$)

Post-Combustion Control Technology	Capital ($/kW)	Fixed O&M ($/kW/Yr)	Variable O&M (mills/kWh)	Percent Removal
SCR[2]	111.48	0.74	0.67	90%[1]
SNCR[3]	Term 1 - 19.06 Term 2 - 21.74	Term 1 - 0.28 Term 2 - 0.33	0.98	35%
SNCR[4] (Cyclone)	11.04	0.16	1.46	35%
SNCR[5] (Fluidized Bed)	19.10	0.29	See Note 5	50%

Notes:

[1] Cannot provide reductions any further beyond 0.06 lbs/mmBtu.

[2] SCR Cost Scaling Factor:
SCR Capital and Fixed O&M Costs: (242.72/MW)$^{0.27}$
SCR Variable O&M Costs: (242.72/MW)$^{0.71}$
Scaling factor applies up to 600 MW.

[3] SNCR Cost Scaling Factor:
SNCR Capital and Fixed O&M Costs: (Term1*(200/MW)$^{0.077}$ + Term2*(100/MW)$^{0.651}$)/2

[4] Cyclone Cost Scaling Factor:
High NO_x Coal SNCR—Cyclone Capital and Fixed O&M Costs: (300/MW)$^{0.077}$
VO&M = 1.27 for MW ≤ 300,
VO&M = 1.27 – ((MW – 300)/100) * 0.015 for MW > 300.

[5] Fluidized Bed Cost Scaling Factor:
SNCR - Fluidized Bed Capital and Fixed O&M Costs: (200/MW)$^{0.077}$
VO&M = .65

Table Source: Documentation for EPA Base Case 2006; Section 5: Emission Control Technologies; Table 5-6.

Table 19. Post-Combustion NOx Controls for Oil/Gas Plants (2004$)

Post-Combustion Control Technology	Capital ($/kW)	Fixed O&M ($/kW/Yr)	Variable O&M (mills/kWh)	Percent Removal
SCR[1]	322	0.99	0.11	80%
SNCR[2]	108	0.17	0.50	50%

Notes:

[1] SCR Cost Scaling Factor:
SCR and Gas Reburn Capital Cost and fixed O&M: $(200/MW)^{0.35}$
Scaling factor applies up to 500 MW

[2] SNCR Cost Scaling Factor: :
SNCR Capital Cost and fixed O&M: $(200/MW)^{0.127}$
Scaling factor applies up to 500 MW

Table Source: Documentation for EPA Base Case 2006; Section 5: Emission Control Technologies; Table 5-7.