APPENDIX A

ACRONYMS

A

AFC - Application for Certification

APCD - Air Pollution Control District

APCO - Air Pollution Control Officer

ATC - Authority to Construct

B

BACT - Best Available Control Technology

C

CAA - U.S. Clean Air Act

CAAQS - California Ambient Air Quality Standards

CAPCOA - California Air Pollution Control Officers Association

CARB - California Air Resources Board

CCAA - California Clean Air Act

CEC - California Energy Commission (Please note that the Energy Commission prefers to not use the acronym "CEC" because of possible confusion with other agencies or companies with the same acronym. This document uses Energy Commission or just Commission instead.)

CEM - continuous emissions monitoring

CEQA - California Environmental Quality Act

cfm - cubic feet per minute

CFR - Code of Federal Regulations

cfs - cubic feet per second

CO - carbon monoxide

CO_2 - carbon dioxide

CPM - Compliance Project Manager

CT - combustion turbine

CTG - combustion turbine generator

D

E

EIR - Environmental Impact Report

Energy Commission – California Energy Commission

EPA - U.S. Environmental Protection Agency

F

FCAA - Federal Clean Air Act

FSA - Final Staff Assessment

G

g - grains

GEP - good engineering practice

gpd - gallons per day

gpm - gallons per minute

H

HHV - higher heating value

HRA - Health Risk Assessment

HRSG - heat recovery steam generator

I

J

kV - kilovolt

kW - kilowatt

L

LAER - Lowest Achievable Emission Rate

bs - pounds

lbs/hr - pounds per hour

lbs/MMBtu - pounds per million British thermal units

LORS - laws, ordinances, regulations and standards

M

m (M) - meter, million, mega, milli or thousand

MCF - thousand cubic feet

mgd - million gallons per day

MW - megawatt (million watts)

MWh - megawatt hour

N

NAAQS - National Ambient Air Quality Standards

NESHAPS - National Emission Standards for Hazardous Air Pollutants

NO - nitrogen oxide

NO_2 - nitrogen dioxide

NO_x - nitrogen oxides

NSPS - New Source Performance Standards

NSR - New Source Review

O

O_3 - Ozone

O&M - operation and maintenance

P

PCAPCD – Placer County Air Pollution Control District

PDOC - Preliminary Determination of Compliance

PM - particulate matter

PM10 - particulate matter 10 microns and smaller in diameter

PM2.5 - particulate matter 2.5 microns and smaller in diameter

ppb - parts per billion

ppm - parts per million

ppmvd - parts per million by volume, dry

PSA – Energy Commission Preliminary Staff Assessment

PSD - Prevention of Significant Deterioration

PTO - Permit to Operate

Q

QA/QC - Quality Assurance/Quality Control

R

REP – Roseville Energy Park

S

SCFM - standard cubic feet per minute

SCR - Selective Catalytic Reduction

SIC - Standard industrial classification

SIP - State Implementation Plan

SNCR - Selective Noncatalytic Reduction

SO2 - sulfur dioxide

SOx - sulfur oxides

SO4 - sulfates

T

TAC - Toxic Air Contaminant

TCF - trillion cubic feet

TPY - tons per year

TSP - total suspended particulate matter

U

USEPA - U.S. Environmental Protection Agency

V

VOC - volatile organic compounds

W

W - Watt

WAA - Warren-Alquist Act

APPENDIX B

BACT ANALYSIS

August 20, 2004

Mr. John Finnell
Placer County Air Pollution Control District
11464 B Avenue
Auburn, CA. 95603

Re: Roseville Electric Revised BACT Evalutation

Dear Mr. Finnell:

On behalf of Roseville Electric (RE), Atmospheric Dynamics, Inc. is submitting an addendum to the Best Available Control Technology evaluation (BACT) that summarizes the incremental cost difference between CO emissions controlled to 2.0 ppm vs the applicant's proposed control down to 4.0 ppm. This addendum is based upon our phone conversation and EPA Region 9 request to provide an economic analysis of the cost differential for CO at 4.0 ppm down to 2.0 ppm.

A summary of the capital and annual costs associated with the installation of larger oxidation catalyst is presented in Table1. The detailed cost analysis for the oxidation catalyst is shown in Table 2. The cost of the larger oxidation catalyst system includes extra catalyst, larger catalyst housing, HRSG modifications, and balance of plant equipment. Capital costs are based on vendor supplied data from previous budgetary quotations from equipment manufacturers and other engineering estimates. It should be noted that the cost estimates were for systems of similar size and control efficiency. As shown, the per turbine/HRSG total installed capital cost increase for the 2.0 ppm oxidation catalyst system is $879,900.

The annual operating costs associated with the two alternative approaches are also presented in Table 1.   The annual operating costs include catalyst replacement, energy impacts due to increased fuel usage, operating personnel, and maintenance. Throughout the life of the facility, the catalyst will require periodic replacement. Catalyst manufacturers are currently willing to guarantee a three-year catalyst life. Maintenance consists of the routine catalyst replacement costs. Labor for the operation and maintenance of the combustion control system is considered a part of the facilities normal operating expenses. The estimated annual operating cost associated with the oxidation catalyst system is $196,773.

Table 1   Summary of CO BACT Evaluation Results*

Control	Capital Cost	Annual Operating Cost
Oxidation Catalyst	$879,900	$196,773

* All costs are presented on a per gas turbine/HRSG basis from 4.0 to 2.0 ppm

RE expects to receive guarantees of performance at 4.0 ppmvd CO on a 3-hour rolling average at 15% oxygen from manufacturers and this emission limitation would be equal to or more stringent than any emission limitation that has been demonstrated in practice to be achievable. Some other projects have been recently permitted to operate at 2.0 ppm, but these facilities have yet to commence operation. Thus, the CO emission rate of 2.0 ppm has not been achieved in practice and presents certain technological risks.

EPA's national combustion turbine project spreadsheet is considered a principal reference for identifying potential control technologies and emission rates used in past permitting of similar sources. The database was queried for entries with CO emissions involving combustion turbines and duct burners. Based on the review, the RE emission rates proposed are consistent with the entries in the EPA listing for past BACT evaluations, especially those for sources with similar MMBtu/hr and MW ratings.

Good combustion control is considered the baseline control technology for CO emissions. The addition of a CO oxidation catalyst to reduce outlet emissions to 4 ppmv was evaluated in the RE permit application. This requires a control efficiency of 80 percent or better, which is achievable in practice and can be guaranteed. The BACT evaluation that follows considered the energy, environmental, and economic impacts of project if a 2.0 ppmv emissions limit would be proposed.

Energy Impacts: There is a pressure drop associated with add on controls. This pressure drop results in a backpressure on the CT which in turn increases the CT's heat rate (i.e., decreases the CT's efficiency). The end result is an energy impact in the form of additional fuel to make the same amount of electricity. Based on vendor information the increased backpressure on the CT associated with oxidation catalyst systems is 1.5 inch w.c. Each inch w.c. of backpressure on the CT results in a 0.15% increase in the CTs heat rate (i.e., Btu/kwh). As a result there is an increased fuel requirement to generate the same amount of power output. This penalty is included as an annual cost. It should also be noted that the additional fuel firing also results in additional emissions of some pollutants

Environmental Impacts: The spent oxidation catalyst is comprised of precious metals that are not considered toxic. This allows the catalyst to be handled and disposed of following normal waste procedures. Because of its precious metal content, the catalyst is often recycled by the manufacturer to recover the metals. The effective power reduction due to the increase pressure drop across the add-on control technology increases the emission rate of other criteria pollutants, such as NO_X, on a per unit of power output.

Economic Impacts: The capital cost associated with the installation of additional catalyst includes the catalyst; catalyst housing, HRSG modifications; and balance of plant equipment. Capital costs are based on estimates from previous budgetary quotations from equipment manufacturers and other engineering estimates. As shown, the per CT total installed capital cost for the oxidation catalyst system is $879,000.

The annual operating costs associated with the use of a CO catalyst to go from 4.0 ppm down to 2.0 ppm would increase. The annual operating costs include catalyst replacement, energy impacts due to increased fuel usage, operating personnel, and maintenance. Throughout the life of the facility, the catalyst will require periodic replacement. Catalyst manufacturers are currently willing to guarantee a three-year catalyst life. As stated above, both add-on control systems increase the energy requirements of the facility. Maintenance consists of the routine catalyst replacement costs. The labor costs for the oxidation catalyst system include general maintenance of the system. The estimated increase in annual operating cost associated with the oxidation catalyst at 2.0 ppm is $196,773. The emission reduction from 4.0 ppm down to 2.0 ppm (or a 10.3 ton per year reduction) would yield an incremental control cost effectiveness of $34,500 per ton. At this cost, the proposed limit of 2.0 ppm would not be considered economical.

The use of good combustion control technology and a catalyst to limit CO emissions to 4 ppmvd (@15% O_2) with and without duct firing is proposed as BACT for the RE Project based on the following rational:

- At $3,200/ton of CO removal at 4.0 ppm, the application of CO Catalyst technology is considered BACT
- With an incremental cost of $34,500 the application of oxidation catalyst down to 2.0 ppm is not considered BACT,
- Installation of a larger oxidation catalyst system will have negative energy and environmental impacts. This increased control increases the backpressure on the CT, resulting in decreased efficiency and increased fuel consumption. The increased fuel consumption and decreased efficiency is and energy impact that also results in increases in other pollutant emissions.
- The use of a CO catalyst at 4.0 ppm has previously been recognized as BACT for CO control by regulatory agencies.

Therefore, the use of an oxidation catalyst to meet BACT requirements of 4 ppm (3 hour average during the unit steady operation) is proposed and it is at least equal to or more stringent than other BACT determinations for similar power plants.

If you have any questions or wish to discuss this BACT determination, please call me at 805-569-6555. Thank you for your assistance.

Very truly yours,
ATMOSPHERIC DYNAMICS, INC.

Gregory Darvin

Gregory Darvin

attachment

Table 2
Roseville Energy Park
Roseville, CA.
CO Catalyst Control Costs/Combined Cycle
CAPITAL COST SUMMARY

***** Incremental Costs for CO Control from 4 to 2 ppmv *****

DIRECT CAPITAL COSTS (2003 $)		Explanation of Cost Estimates
		per Turbine/HRSG
1. Purchased Equipment:		Base Cost
A) Pollution Control Equipment	$400,000	Additional catalyst cost per NE and EPA*
B) Instrumentation & Controls(No CEMS)	$40,000	EPA1998 10% of Base Cost
C) Freight & Taxes	$57,200	8% Taxes; 5% Freight; on 1A & 1B
Total Purchased Equip. Costs (TEC):	$497,200	Sum 1A,1B,1C
2. Installation Costs:		
A) Foundation & Supports	$39,800	EPA1998 8% of TEC
B) Erection and Handling	$69,600	EPA1998 14% of TEC
C) Electrical	$19,900	EPA1998 4% of TEC
D) Piping	$9,900	EPA1998 2% of TEC
E) Insulation	$5,000	1% of TEC
F) Painting	$5,000	EPA1998 1% of TEC
G) Site Preparation	$0	0% of TEC
Total Installation Costs (TINC):	$149,200	Sum 2A,2B,2C,2D,2E,2F,2G
Total Direct Capital Costs (TDCC):	$646,400	Sum TEC,TINC
INDIRECT CAPITAL COSTS		
1. Engineering & Supervision	$49,700	EPA1998 10% of TEC
2. Construction and Field Exp.	$24,900	OAQPS 5% of TEC
3. Contractor Fees	$49,700	OAQPS 10% of TEC
4. Start-up	$9,900	OAQPS 2% of TEC
5. Performance Testing	$5,000	OAQPS 1% of TEC
Total Indirect Capital Costs (TICC):	$139,200	Sum 1,2,3,4,5,6
Total Direct & Indirect Capital Costs (TDICC):	$785,600	Sum TDCC,TICC
Contingency (@12%):	$94,300	20% TDICC (std engineering accuracy)

TOTAL CAPITAL COSTS (TCC):	$879,900	Sum TDICC,Contingency

Table 2 Cont'd
Roseville Energy Park
Roseville, CA.
CO Catalyst Control Costs/Combined Cycle
ANNUAL OPERATING COST SUMMARY

DIRECT OPERATING COSTS (2003 $)		Explanation of Cost Estimates
		per Turbine/HRSG
1. Operating Labor	$45,443	EPA1998 3 hr/day, @41.50 hr
2. Supervisory Labor	$6,800	OAQPS 15% Operating Labor
3. Maintenance Labor & Materials	$45,295	2 hr/day, $41.50/hr, + 100% materials
4. Electricity Expense ($0.0527/kWh)	$0	
5. Catalyst Cost (replace)	$169,600	LVC Data @ 2X 4ppm costs
6. Fuel Penalty ($0.0041/scf gas)	$34,600	.15% fuel increse/inch wc, assumed 1.5" bp/same as 5 above
7. Annual Catalyst Cost	$64,635	CRF, 7%, 3 yrs
Total Direct Operating Costs (TDOC):	$196,773	Sum 1 through 7
INDIRECT OPERATING COSTS		
1. Overhead	$27,300	OAQPS 60% Total Labor
Total Indirect Operating Costs (TIOC):	$27,300	Sum 1
CAPITAL CHARGES COSTS		
1. Property Tax	$8,800	OAQPS 1% TCC
2. Insurance	$8,800	OAQPS 1% TCC
3. General Administrative	$17,600	OAQPS 2% TCC
4. Capital Recovery Cost (7%, 15 years)	$96,600	10.98%, TCC
Total Capital Charges Costs (TCCC):	$131,800	Sum 1,2,3,4
TOTAL ANNUALIZED OPERATING COSTS:	$355,873	Sum TDOC,TIOC,TCCC

Table 2 Cont'd

Roseville Energy Park

Roseville, CA.
CO Catalyst Control Costs/Combined Cycle

Controlled Case Emissions		**per Turbine/HRSG**
Base Concentration-Controlled	4	ppm
Annual Emission Rate	20.7	tpy
		Startup emissions not included
Incremental Controlled Emissions Case		
CO Concentration	2.0	ppm
Annual Emission Rate:	10	tpy
CO Reduction from Uncontrolled Case:	10.3	tpy
Control Cost Effectiveness:	**$34,500**	per ton CO

References:
OAQPS - OAQPS Cost Control Manual, 5th ED., February 1996.
EPA1998 - Cost Effectiveness fo Oxidation Catalyst Control of HAP Emissions from Stationary Combustion Turbines, EPA, 1998.
* NE estimated cost for additional catalyst to achieve 90% control of CO per EPA study.
* EPA memo dated 12-30-99, Emissions Stds Division, Docket A-95-51, and May 14, 1999 memo on Stationary CT control cost options.

BACT DETERMINATION
COMBUSTION TURBINES

In preparing this analysis, the PCAPCD staff reviewed the BACT determinations for combined cycle gas turbines listed in the CARB Guidance for Power Plant Siting and Best Available Control Technology, South Coast Air Quality Management District BACT Guidelines, San Joaquin Valley Air Quality Management District Guidelines, Bay Area Air Quality Management Guidelines and power projects approved by the Energy Commission.

CARB's Guidance for Power Plant Siting and Best Available Control Technology (June,1999) provided a comprehensive guidance on BACT determinations for power plants. This document identified BACT for combined cycle turbines as shown in Table B1.

TABLE B1 - CARB's Guidance for Power Plant Siting And Best Available Control Technology

CO	NOx	PM-10	SOX	VOCs
6 ppmvd @ 15% O_2, 3-hour rolling average	2.5 ppmvd @ 15% O_2, 1-hour average OR 2.0 ppmvd @ 15% O_2, 3-hour rolling average	An emission limit corresponding to natural gas with fuel sulfur content of no more than 1 grain/100 scf.	An emission limit corresponding to natural gas with fuel sulfur content of no more than 1 grain/100 scf (no more than 0.55 ppmvd @ 15% O_2)	2 ppmvd @ 15% O_2, 1-hour rolling average OR 0.0027 pounds per Mate (based on higher heating value)

Recent BACT determinations listed in BACT guidelines for combined cycle gas turbines by other air districts are summarized in the following table:

TABLE B2 - RECENT DETERMINATIONS LISTED IN BACT GUIDELINES for SCAQMD, SJVAPCD, and BAAQMD

District and Date	CO	NOx	PM-10	SOX	VOCs
BAAQMD (07/18/03)	4 ppmvd @ 15% O_2	2.0 ppmvd @ 15% O_2	An emission limit corresponding to natural gas with fuel sulfur content of no more than 1 grain/100 scf.	An emission limit corresponding to natural gas with fuel sulfur content of no more than 1 grain/100 scf	(POCs) 2 ppmvd @ 15% O_2

SJVAPCD (3/30/01)	6 ppmvd @ 15% O_2	2.0 ppmvd @ 15% O_2	An emission limit corresponding to natural gas with fuel sulfur content of no more than 0.75 grain/100 scf.	An emission limit corresponding to natural gas with fuel sulfur content of no more than 0.75 grain/100 scf (no more than 0.55 ppmvd @ 15% O_2)	2.0 ppmvd @ 15% O_2 (1.5 ppmv @ 15% Technologically feasible)
SCAQMD (1/30/04)	2 ppmvd @ 15% O_2, 3-hour average*	2.0 ppmvd @ 15% O_2, 1-hour average	An emission limit corresponding to natural gas with fuel sulfur content of no more than 1 grain/100 scf.	An emission limit corresponding to natural gas with fuel sulfur content of no more than 1 grain/100 scf (no more than 0.55 ppmvd @ 15% O_2)	2.0 ppmvd @ 15% O_2, 1-hour average

*1/30/2004 Vernon City Power and Light, Alstom GTX turbine. This level proposed by applicant to minimize CO offsets required. A BACT determination was not made at the time.

The BACT determinations found in Commission Decisions for large combined cycle power projects are summarized in the following table:

TABLE B3 - BACT DETERMINATIONS FOR GAS TURBINES
PROJECTS RECENTLY APPROVED BY THE CALIFORNIA ENERGY COMISSION

PROJECT	DATE	CO	NOx	PM-10	SOx	VOCs
Blythe Energy Blyth Energy LLC 520 MW	2/9/00	5 ppmvd @ 15% O_2, 3-hour rolling average 8.4 ppmvd with duct firing or when between 70 and 80 percent of full load	2.5 ppmvd @ 15% O_2, 1-hour average	Natural gas with fuel sulfur content of no more than 0.5 grain/100 scf on a rolling 12 month average	Natural gas with fuel sulfur content of no more than 0.5 grain/100 scf on a rolling 12 month average	1 ppmvd @ 15% O_2, 1-hour rolling average OR 0.0027 pounds per MMBtu (based on higher heating value)
Contra Costa Unit 8	5/30/01	6 ppmvd @ 15% O_2, 3-	2.5 ppmvd @ 15% O_2, 1-hour	.00588 lbs/MMbtu	0.0028 lbs/hr	.0025 lb/MMbtu

Southern Energy 530 MW		hour rolling average	average	without duct burners, and 0.00584 with duct burners in operation		
Delta Energy Center Calpine and Bechtel 880 MW	2/9/00	10 ppmvd @ 15% O_2, 3-hour rolling average	2.5 ppmvd @ 15% O_2, 1-hour average	.00565 lb/MMBtu	.0007 lb/MMbtu	.00251 lbs/MMbtu
Elk Hills Sempra/OXY 500 MW	12/6/00	4 ppmvd @ 15% O_2, 3-hour rolling average	2.5 ppmvd @ 15% O_2, 1-hour average	.0012 g/dscf, 1hour average @3% CO_2	1.24 lbs/hr	2 ppmvd @ 15% O_2, 1-hour rolling average
High Desert Inland Group and Constellation Energy 720 MW	5/3/00	4 ppmvd @ 15% O_2, 24-hour average	2.5 ppmvd @ 15% O_2, 1-hour average	25.41 lbs/hr	1.51 lbs/hr (based on 1 ppmvd)	1 ppmvd @ 15% O_2, 1-hour rolling average
La Paloma Generating Co. McKittrick, CA 1048 MW	5/26/99	6 ppmvd @ 15% O_2, 3-hour rolling average at loads greater than 73% and 10 ppmv @15% O_2 at loads equal to or less than 73% on 3 hour average.	2.5 ppmvd @ 15% O_2, 1-hour average Dry low NOx combustors, SCR with ammonia injection and natural gas fuel	Natural gas fuel with sulfur content of no more than 0.75 grain/100 scf. Air inlet filter cooler, lube oil vent coalescer and natural gas fuel and less than 5% opacity visible emissions at lube oil vent	Natural gas fuel with sulfur content of no more than 0.75 grain/ 100 scf. Utility quality natural gas	0.4 ppmv @ 15% O_2 as propane (equivalent to 1.1 ppmv as CH_4
Los Medanos Energy Center (Formerly Pittsburg District Energy Center) 555 MW	8/17/99	6 ppmvd @ 15% O_2, 3-hour rolling average	2.5 ppmvd @ 15% O_2, 1-hour average	Natural gas fuel with sulfur content of no more than 0.75 grain/100 scf.	Natural gas fuel with sulfur content of no more than 0.75 grain/ 100 scf.	.0017 lbs/MMBtu
(Western) Midway Sunset	3/21/01	6 ppmvd @ 15% O_2, 3-hour rolling	2.5 ppmvd @ 15% O_2, 1-hour average			1.4 ppmvd @ 15% O_2, 1-

Arco 500 MW		average				hour rolling average
Moss Landing Duke Energy 1,060 MW	10/25/00	6 ppmvd @ 15% O_2, 3-hour rolling average	2.5 ppmvd @ 15% O_2, 1-hour average			
Moutainview Thermo Ecotek 1,056 MW	3/21/01	6 ppmvd @ 15% O_2, 1-hour rolling average	2.5 ppmvd @ 15% O_2, 1-hour average	An emission limit corresponding to natural gas with fuel sulfur content of no more than 0.25 grain/100 scf.(Corresponds to .006 lbs/MMBtu	An emission limit corresponding to natural gas with fuel sulfur content of no more than .25 grain/100 scf (no more than 0..00071 lb/MMBtu	1.4 ppmvd @ 15% O_2, 1-hour rolling average
Otay Mesa Otay Mesa Generating Co. (Calpine) 510 MW	4/18/01	6 ppmvd @ 15% O2, 3-hour rolling average	2.0 ppmvd @ 15% O2, 3-hour average			2.0 ppmvd @ 15% O2, 3-hour average
Pastoria Enron 750 MW	12/10/00	6.0 ppmvd @ 15% O_2, 3-hour average	2.0 ppmvd @ 15% O_2, 3-hour average			2.0 ppmvd @ 15% O_2, 24-hour average
Sutter Power Plant Calpine Corp. Yuba City, CA 540 MW	4/19/99	4 ppmv @ 15% O_2 calendar day average	2.5 ppmvd @ 15% O_2, 1-hour average	PUC grade fuel corresponding to 0.7 gr/dscf	1 ppmv on a calendar day average	1 ppmv on a calendar day average
Three Mountain	5/16/01	4 ppmvd @	2.5 ppmvd @	.0012 g/dscf,	1.24 lbs/hr	2

Power Odgen Pacific Power 500 MW		15% O_2, 3-hour rolling average	15% O_2, 1-hour average	1hour average @3% CO_2		ppmvd @ 15% O_2, 1-hour rolling average
City of Vernon		2 ppmvd @ 15% O_2, 3-hour average (No BACT determination – proposed by applicant to minimize CO offsets required)	2.0 ppmvd @ 15% O_2, 1-hour average	An emission limit corresponding to natural gas with fuel sulfur content of no more than 1 grain/100 scf.	An emission limit corresponding to natural gas with fuel sulfur content of no more than 1 grain/100 scf (no more than 0.55 ppmvd @ 15% O_2)	2.0 ppmvd @ 15% O_2, 1-hour average
SMUD Consumnes River Project 500 MW Unit 1	9/03	4 ppmvd @ 15% O_2, 3-hour rolling average	2.0 ppmvd @ 15% O_2, 1-hour average	Natural gas fuel with sulfur content of no more than 1 grain/100 scf and 9 lbs/hr	Natural gas fuel with sulfur content of no more than 1 grain/100 scf	1.4 ppmvd, 3hr average
Walnut Energy Center 250 MW	2/04	4. @ 15% O_2, 3-hour rolling average 0 ppmv @	2.0 ppmvd @ 15% O_2, 1-hour average	7.0 lbs/hr	1.05 lbs/hr	1.4 ppmvd @ actual stack % O_2

BACT Analysis for Nitrogen Oxide (NOx)

For the turbines the following potential NOx control technologies were identified:

Water Injection
Steam Injection
Catalytic combustors (XONON)
Dry Low-NOx combustor design (DLN)
Selective non-catalytic reduction (SNCR) (i.e. ammonia or urea injection)
Non-selective catalytic reduction (NSCR) (i.e. 3-way catalyst)
Selective catalytic reduction (SCR)
SCONOx

Water injection is a feasible option. Small amounts of water are injected into the combustor burner flame. NOx emissions are reduced by cooling the combustion temperatures. Water injection typically results in NOx control efficiency of 70% and emission levels below 42 ppmv at 15% O2.

Steam injection is a feasible option. Small amounts of steam are injected into the combustor flame. NOx emissions are reduced by cooling the combustion temperatures. Steam injection typically results in NOx control efficiency of 82% and emission levels below 25 ppmv at 15% O2.

Catalytic combustors use a catalyst bed to oxidize the fuel at lower temperatures than required in standard thermal combustion. The fuel is burned without a flame. The XONON combustors have been demonstrated in a 1.5 MW natural gas fired turbine at Silicon Valley Power in Santa Clara, California.

Dry Low NOx combustors are a feasible option. Lower NOx emission rates are achieved by minimizing combustion temperatures. Air and fuel are mixed before the combustion chamber. A lean air/fuel mixture optimizes the mixing of combustion air and fuel at peak flame temperatures. Dry Low NOx combustors can achieve reductions of up to 94%to 9 ppmvd of NOx at 15% O2.

Selective non-catalytic reduction (SNCR) involves the injection of ammonia or urea directly into the exhaust gases without use of a catalyst. This technology requires exhaust temperatures in the range of 1200° to 2000°F and is mainly associated with boiler or heater NOx control. The exhaust gas temperature is below the required temperature. This option was determined to be not feasible.

Non-selective catalytic reduction (NSCR) uses a catalyst without injected reagents. NSCR is only effective in a stoichiometric or fuel rich environment when combustion gas is nearly deplete of oxygen. Typical oxygen concentration in turbine exhaust is 14 to 16 percent. Therefore, NSCR is not technologically feasible for gas turbines.

Selective catalytic reduction (SCR) is a feasible option. SCR systems reduce NOx by injecting ammonia (NH3) into the exhaust stream followed by a catalyst. NOx, ammonia and water react to form nitrogen (N2) and water. The catalyst is installed downstream of the turbine in the heat recovery steam generator. SCR systems can achieve reductions of 80% to 95%.

The SCONOX system uses a catalyst to oxidize NO to NO2. NO2 is absorbed into the catalytic surface with a potassium carbonate coating. SCONOX does not inject agents and there no ammonia emissions. Operating data from Federal Cogeneration indicates SCONOX can achieve up to 98% control. SCONOX has also been demonstrated on a 22 MW turbine at the Sunlaw facility in Vernon, California.

The remaining feasible control technologies or combination of technologies are:

1. Dry low NOx Combustors with SCR or XONON or SCONOX.
2. Steam Injection with SCR or XONON or SCONOX
3. Water injection with SCR or XONON or SCONOX

Each option appears to be capable of meeting the latest BACT emission levels. Roseville Electric has proposed the use of dry low NOx combustors with SCR for the Alstom CGT option or water injection with SCR for the CGT to reduce NOx emissions to 2.0 ppmv @15% O2 on a 1 hour average basis. Our review of other recent BACT determinations found other approved projects that required this level as BACT for NOx.

BACT for NOx was determined to be 2.0 ppmv @15% O2 on a 1 hour average basis.

BACT Analysis for Carbon Monoxide

The following potential control techniques were identified: (1) use of natural gas fuel combustion controls and (2) installation of an oxidation catalyst were identified as a potential control technique.

Combustion controls can reduce CO emissions and the addition of an oxidation catalyst can achieve 80% to 90% reduction in CO emissions. The oxidation catalyst is the most effective control technique and has been achieved in practice.

The applicant proposes to utilize the combustion controls and oxidation catalyst to meet a level of 4 ppmvd @15% O2 on a three-hour average for CO

This level is at least as stringent as control techniques CARB's Guidance for Power Plant Siting and Best Available Control Technology (June,1999) BACT determination. The most recent determinations in the San Joaquin Valley AQMD BACT determination and the Bay Area Air Quality Management District indicate BACT for CO as 6 ppmv @ 15% O2 and 4 ppmv @ 15% O2 respectively, 3 hour average.

A recent determination (1/30/04) was listed by South Coast AQMD as 2 ppmvd @15% O2. This was for an Alstom GTX100 turbine at the City of Vernon. PCAPCD contacted South Coast AQMD (SCAMD) and discussed the requirement to meet 2 ppmv @15% O2 of CO for the City of Vernon project which includes an Alstom Turbine of the same size as this project.

SCAQMD staff indicated that this level was proposed by the applicant to minimize the quantity of CO ERCs required to offset the project. SCAQMD is designated severe nonattainment for CO and offsets are required for CO. A BACT determination was not made. Construction of the City of Vernon plant has not been completed. PCAPCD concludes that that CO 2 ppmv @15% O2 on a three hour average has <u>not</u> been achieved in practice.

REP provided an additional CO BACT analysis upon request along with a cost effective analysis. This is included in this Appendix. Their cost analysis indicates a cost effectiveness of $34,500 per ton.

The most recently Energy Commission approved power plant using combined cycle CTGs was the Walnut Energy Center. This project was approved at 4 ppmvd @ 15% O2, three-hour average.

This analysis determined BACT for CO is 4 ppmvd @15% O2 three-hour rolling average.

BACT Analysis for VOCs

VOC emissions from CTGs are controlled by the same technology as CO emissions. These are combustion controls and oxidation catalysts.

The applicant proposes to utilize combustion controls and oxidation catalyst to reduce emissions to a level of 2 ppmvd @15% O2 on a three-hour average. This level is consistent with the BACT determinations by CARB's Guidance for Power Plant Siting and Best Available Control Technology (June, 1999) BACT determination, BAAQMD, SJVAQMD BACT Guidelines and SCAQMD Guidelines shown in Tables B1 and B2.

This analysis determined BACT for VOCs is 2 ppmvd @15% O2 on a one hour average.

BACT Analysis for PM-10

This analysis has found no specific control equipment available to reduce emissions of PM-10 from CTGs. CARB's Guidance for Power Plant Siting and Best Available Control Technology (June, 1999) BACT Determination indicates the emissions are directly related to the fuel sulfur content of the natural gas available in the pipeline. In California, the natural gas is expected to have no more than 1 grain of sulfur per 100 standard cubic feet.

Natural gas provided by utilities in California should contain no more than 1 grain (g) per 100 standard cubic feet (scf) of total sulfur. This level is considered BACT. Roseville Electric has proposed that the natural gas will have no more than 0.5 grains per 100 standard cubic feet. The applicant's calculations for SOx are base on 0.5 g/dscf and the applicant bears the responsibility of assuring that natural gas is provided with this low sulfur content.

The use of natural gas with a sulfur content of no more than 0.5 grains per 100 standard cubic feet is considered BACT for PM-10.

BACT Analysis for SOx

This analysis has found no specific control equipment available to reduce emissions of SOx from CTGs. CARB's Guidance for Power Plant Siting and Best Available Control Technology (June, 1999) BACT Determination indicates the emissions are directly related to the fuel sulfur content of the natural gas available in the pipeline. In California, the natural gas is expected to have no more than 1 grain of sulfur per 100 standard cubic feet.

Roseville Electric has proposed that the natural gas will have no more than 0.5 grains per 100 standard cubic feet.

The use of natural gas with a sulfur content of no more than 0.5 grains per 100 standard cubic feet is considered BACT for SOx.

BACT DETERMINATION
AUXILIARY BOILER

BACT is triggered for NOx for the Auxiliary Boiler. The following BACT Guidelines were reviewed for this size boiler:

TABLE B4 – RECENT BACT DETERMINATIONS FOR NOX FOR BOILERS	
San Joaquin Valley APCD > 20 MMBtu/hr	15 ppmvd @3% O2 achieved in practice 9.0 ppmvd @ 3% O2 technologically feasible with SCR
Bay Area Air Quality Management District > 50 MMBtu/hr	9.0 ppmvd @ 3% O2
South Coast Air Quality Management District 21 MMBtu/hr	9.0 ppmvd @ 3% O2

The most recent BACT determination at Placer County was a standby boiler that was being retrofitted. The determination concluded NOx BACT for a standby boiler was 20 ppmv @ 3% O2. This review did not find other specific NOx BACT determinations for auxiliary boilers with limited hours of operation at other Districts.

The applicant has proposed meeting a NOx level 9.0 ppmvd @ 3% O2. This review concluded that 9.0 ppmvd has been achieved in practice in some cases for this size boiler and is considered BACT for this project.

BACT DETERMINATION
Diesel Engine – Emergency Use

The standby generator and fire pump are driven by diesel engines. Both units trigger BACT for NOx.

The PCAPCD recent BACT determinations have considered BACT for NOx from emergency diesel engines as 6.9 grams per horsepower-hour. The fire pump diesel engine meets this level. The standby generator diesel engine listed in the application is above this level at 7.2 grams per horsepower-hour. The applicant was notified of this issue and agrees to provide an engine that meets this level.

APPENDIX C

Roseville Electric Emission Tables and Offset Tables

Roseville Electric provided to the PCAPCD the following revised NOx emission calculations shown in the Table C1. The columns with the LM6000 heading represent the GE LM6000 turbine option. The columns showing the Alstom represent the Alstom GX100 turbine option.

In the table, the GE LM6000 quarterly NOx emissions were scaled back to match the available proposed offsets of 31.09 tons per year. The Alstom GX100 emissions shown were not scaled back to match 31.09 tons per year. The consultant who provided this table indicated verbally that the Alstom GX100 operations would also need to be reduced such that emissions would match the available offsets.

The PCAPCD prepared the Table C2 to show a scenario by which emissions could be reduced to match available offsets. The LM6000 columns were not changed. The Alstom columns indicate a possible scenario to reduce emissions to the available offset level.

The NOx emissions shown amend the NOx emissions shown in the emissions submittal to the District dated replace those shown in the emission calculations submitted to PCAPCD on April 9, 2004.

TABLE C1 – NO_X Emission Calculations, Submitted by Roseville Electric

	Q1		Q2		Q3		Q4		Total Annual LM 6000	Total Annual Alstom
	LM 6000	Alstom	LM 6000	Alstom	LM 6000	Alstom	LM 6000	Alstom		
Start Up Emissions for Two Turbines lbs/qtr	1339	3753	2305	6090	521	1084	1474	3867		
Base Load Emissions Per Turbine	4530	4712.5	3730	4059.5	4250	4450.5	4410	4628.5		
Base Load Emissions Two Turbine	9060	9425	7460	8119	8500	8901	8820	9257		
Peak Load Emissions Per Turbine	2500	2560	1600	1640	4237.5	4510	2564	2600		
Peak Load Emissions Two Turbine	5000	5120	3200	3280	8475	8680	5128	5200		
Turbine Total Pounds	15399	18298	12965	17489	17496	18665	15422	18324		
Turbine Total Tons	7.6995	9.149	6.4825	8.7445	8.748	9.3325	7.711	9.162		
Fire Pump Emission Rate(pound/test)	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72		
test/Quarter fire pump	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5		
Fire Pump Emission	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5		
Emergency Generator Emission Rate (lb/test)	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24		
test/Quarter Emergency Generator	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5		
Emergency Generator Emission lb/qtr	28	28	28	28	28	28	28	28		
Cooling Tower (lb/hr)	0	0	0	0	0	0	0	0		
Hrs/Quarter Cooling Tower	2160	2160	2184	2184	2208	2208	2208	2208		
Cooling Tower Emissions	0	0	0	0	0	0	0	0		
Auxiliary Boiler (lb/hr)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7		
Hrs/Quarter Auxiliary Boiler	140	140	568	568	143	143	143	143		
Auxiliary Boiler Emissions	98	98	397.6	397.6	100.1	100.1	100.1	100.1		
Turbine Total Pounds	15399	18298	12965	17489	17496	18665	15422	18324		
Total Pounds	15546.5	15546.5	13412.1	13412.1	17645.6	17645.6	15571.6	15571.6	**62175.8**	**62175.8**
Total Tons	7.77	7.77	6.71	6.71	8.82	8.82	7.79	7.79	**31.09**	**31.09**

TABLE C2 – NO_X Emission Calculations, Operating Scenario by PCAPCD

	Q1		Q2		Q3		Q4		Total Annual LM 6000	Total Annual Alstom
	LM 6000	**Alstom**	**LM 6000**	**Alstom**	**LM 6000**	**Alstom**	**LM 6000**	**Alstom**		
Start Up Emissions for Two Turbines lbs/qtr	1339	3158.4	2305	4514.6578	521	1016.1084	1474	3254.5773		
Base Load Emissions Per Turbine	4530	3965.89	3730	3009.4012	4250	4171.7626	4410	3895.4774		
Base Load Emissions Two Turbine	9060	7931.77	7460	6018.8024	8500	8343.5251	8820	7790.9547		
Peak Load Emissions Per Turbine	2500	2154.41	1600	1215.7699	4237.5	4510	2564	2188.234		
Peak Load Emissions Two Turbine	5000	4308.83	3200	2431.5398	8475	8136.3665	5128	4376.468		
Turbine Total Pounds	15399	15399	12965	12965	17496	17496	15422	15422		
Turbine Total Tons	7.6995	7.6995	6.4825	6.4825	8.748	8.748	7.711	7.711		
Fire Pump Emission Rate(pound/test)	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72		
test/Quarter fire pump	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5		
Fire Pump Emission	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5		
Emergency Generator Emission Rate (lb/test)	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24		
test/Quarter Emergency Generator	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5		
Emergency Generator Emission lb/qtr	28	28	28	28	28	28	28	28		
Cooling Tower (lb/hr)	0	0	0	0	0	0	0	0		
Hrs/Quarter Cooling Tower	2160	2160	2184	2184	2208	2208	2208	2208		
Cooling Tower Emissions	0	0	0	0	0	0	0	0		
Auxiliary Boiler (lb/hr)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7		
Hrs/Quarter Auxiliary Boiler	140	140	568	568	143	143	143	143		
Auxiliary Boiler Emissions	98	98	397.6	397.6	100.1	100.1	100.1	100.1		
Turbine Total Pounds	15399	15399	12965	12965	17496	17496	15422	15422		
Total Pounds	15546.5	15546.5	13412.1	13412.1	17645.6	17645.6	15571.6	15571.6	**62175.8**	**62175.8**
Total Tons	7.77	7.77	6.71	6.71	8.82	8.82	7.79	7.79	**31.09**	**31.09**

Roseville Energy Park
Annual Emissions - General Electric LM6000 PC SPRINT

	Quarter				Maximum Quarter	Total Annual
	1st	2nd	3rd	4th		
Combustion Turbines/HRSGs - Operating Baseload						
NOx, as NO_2, tons	4.51	3.73	4.25	4.42	4.51	16.91
CO, tons	5.49	4.54	5.18	5.38	5.49	20.59
VOC, as CH_4, tons	1.57	1.30	1.48	1.54	1.57	5.90
PM_{10}, tons	4.19	3.46	3.95	4.11	4.19	15.71
SO_2, tons	0.87	0.72	0.82	0.85	0.87	3.26
Combustion Turbines/HRSGs - Operating w/ Duct Firing						
NOx, as NO_2, tons	2.50	1.60	4.24	2.54	4.24	10.88
CO, tons	3.04	1.95	5.16	3.10	5.16	13.25
VOC, as CH_4, tons	0.87	0.56	1.48	0.89	1.48	3.79
PM_{10}, tons	2.31	1.48	3.92	2.35	3.92	10.06
SO_2, tons	0.48	0.31	0.81	0.49	0.81	2.09
Combustion Turbines/HRSGs - Hot Starts						
NOx, as NO_2, lbs	222.2	491.9	365.0	301.5	491.9	1,380.6
CO, lbs	228.6	506.2	375.6	310.3	506.2	1,420.7
VOC, as CH_4, lbs	32.3	71.5	53.0	43.8	71.5	200.6
PM_{10}, lbs	88.6	196.3	145.6	120.3	196.3	550.9
SO_2, lbs	18.4	40.8	30.2	25.0	40.8	114.4
Combustion Turbines/HRSGs - Warm Starts						
NOx, as NO_2, lbs	964.1	1,139.4	58.4	701.2	1,139.4	2,863.0
CO, lbs	909.4	1,074.8	55.1	661.4	1,074.8	2,700.8
VOC, as CH_4, lbs	149.4	176.6	9.1	108.7	176.6	443.8
PM_{10}, lbs	417.9	493.9	25.3	303.9	493.9	1,241.0
SO_2, lbs	86.8	102.6	5.3	63.1	102.6	257.7
Combustion Turbines/HRSGs - Cold Starts						
NOx, as NO_2, lbs	149.2	646.6	49.7	447.7	646.6	1,293.2
CO, lbs	126.5	548.0	42.2	379.4	548.0	1,096.0
VOC, as CH_4, lbs	19.8	85.9	6.6	59.5	85.9	171.8
PM_{10}, lbs	57.0	246.9	19.0	171.0	246.9	493.9
SO_2, lbs	11.8	51.3	3.9	35.5	51.3	102.6
Combustion Turbines/HRSGs - Starts Total						
NOx, as NO_2, lbs	1,335.5	2,277.9	473.2	1,450.3	2,277.9	5,536.9
CO, lbs	1,264.5	2,129.0	472.8	1,351.0	2,129.0	5,217.4
VOC, as CH_4, lbs	201.5	334.0	68.7	212.0	334.0	816.2
PM_{10}, lbs	563.5	937.1	190.0	595.2	937.1	2,285.8
SO_2, lbs	117.0	194.6	39.4	123.6	194.6	474.6

Roseville Energy Park

Annual Emissions - General Electric LM6000 PC SPRINT

Combustion Turbines/HRSGs - Starts Total						
NOx, as NO_2, tons	0.67	1.14	0.24	0.73	1.14	2.77
CO, tons	0.63	1.06	0.24	0.68	1.06	2.61
VOC, as CH_4, tons	0.10	0.17	0.03	0.11	0.17	0.41
PM_{10}, tons	0.28	0.47	0.09	0.30	0.47	1.14
SO_2, tons	0.06	0.10	0.02	0.06	0.10	0.24
Combustion Turbines/HRSGs - Total						
NOx, as NO_2, tons	7.68	6.47	8.73	7.69	8.73	30.56
CO, tons	9.17	7.56	10.57	9.16	10.57	36.45
VOC, as CH_4, tons	2.55	2.03	2.99	2.53	2.99	10.10
PM_{10}, tons	6.78	5.41	7.96	6.76	7.96	26.91
SO_2, tons	1.41	1.12	1.65	1.40	1.65	5.59
Auxiliary Boiler						
NOx, as NO_2, tons	0.05	0.19	0.05	0.05	0.19	0.33
CO, tons	0.16	0.63	0.16	0.16	0.63	1.10
VOC, as CH_4, tons	0.02	0.07	0.02	0.02	0.07	0.13
PM_{10}, tons	0.04	0.17	0.04	0.04	0.17	0.29
SO_2, tons	0.01	0.02	0.01	0.01	0.02	0.04
Standy Generator						
NOx, as NO_2, tons	0.028	0.028	0.028	0.028	0.028	0.112
CO, tons	0.010	0.010	0.010	0.010	0.01	0.042
VOC, as CH_4, tons	0.002	0.002	0.002	0.002	0.00	0.008
PM_{10}, tons	0.002	0.002	0.002	0.002	0.00	0.007
SO_2, tons	0.001	0.001	0.001	0.001	0.00	0.005
Fire Pump						
NOx, as NO_2, tons	0.021	0.021	0.021	0.021	0.02	0.086
CO, tons	0.001	0.001	0.001	0.001	0.00	0.004
VOC, as CH_4, tons	0.001	0.001	0.001	0.001	0.00	0.002
PM_{10}, tons	0.000	0.000	0.000	0.000	0.00	0.001
SO_2, tons	0.001	0.001	0.001	0.001	0.00	0.002
Cooling Tower						
PM_{10}, tons	0.73	0.74	0.75	0.75	0.75	2.98
Total						
NOx, as NO_2, tons	7.77	6.71	8.82	7.79	8.82	31.09
CO, tons	9.33	8.20	10.74	9.33	10.74	37.60
VOC, as CH_4, tons	2.57	2.10	3.02	2.56	3.02	10.24
PM_{10}, tons	7.56	6.32	8.76	7.55	8.76	30.19
SO_2, tons	1.42	1.15	1.66	1.41	1.66	5.64
Total						
NOx, as NO_2, lbs	15,544.8	13,412.2	17,645.5	15,571.6	17,645.5	62,174.1
CO, lbs	18,668.5	16,395.5	21,489.2	18,653.4	21,489.2	75,206.6
VOC, as CH_4, lbs	5,130.8	4,201.8	6,031.3	5,110.6	6,031.3	20,474.5
PM_{10}, lbs	15,118.7	12,649.2	17,514.9	15,100.6	17,514.9	60,383.3
SO_2, lbs	2,831.6	2,298.3	3,322.3	2,820.9	3,322.3	11,273.0
Actual NOx Limits for ERC's =	15,546.0	13,412.0	17,646.0	15,572.0		62,176.0

Roseville Energy Park
Annual Emissions - Alstom GTX100

	Quarter				Maximum Quarter	Total Annual
	1st	2nd	3rd	4th		
Combustion Turbines/HRSGs - Operating Baseload						
NOx, as NO_2, tons	4.59	3.80	4.33	4.50	4.59	17.22
CO, tons	5.59	4.62	5.27	5.48	5.59	20.96
VOC, as CH_4, tons	0.48	0.40	0.45	0.47	0.48	1.80
PM_{10}, tons	4.27	3.52	4.02	4.18	4.27	15.99
SO_2, tons	0.89	0.73	0.83	0.87	0.89	3.32
Combustion Turbines/HRSGs - Operating w/ Duct Firing						
NOx, as NO_2, tons	2.56	1.64	4.34	2.60	4.34	11.14
CO, tons	3.11	2.00	5.29	3.17	5.29	13.57
VOC, as CH_4, tons	0.89	0.57	1.51	0.91	1.51	3.89
PM_{10}, tons	2.36	1.52	4.01	2.41	4.01	10.30
SO_2, tons	0.49	0.32	0.83	0.50	0.83	2.14
Combustion Turbines/HRSGs - Hot Starts						
NOx, as NO_2, lbs	477.6	1,057.5	784.6	648.2	1,057.5	2,967.9
CO, lbs	2,251.8	4,986.2	3,699.4	3,056.0	4,986.2	13,993.5
VOC, as CH_4, lbs	543.8	1,204.1	893.4	738.0	1,204.1	3,379.3
PM_{10}, lbs	90.2	199.7	148.2	122.4	199.7	560.6
SO_2, lbs	18.7	41.5	30.8	25.4	41.5	116.4
Combustion Turbines/HRSGs - Warm Starts						
NOx, as NO_2, lbs	2,906.6	3,435.1	176.2	2,113.9	3,435.1	8,631.8
CO, lbs	6,208.4	7,337.2	376.3	4,515.2	7,337.2	18,437.1
VOC, as CH_4, lbs	2,532.7	2,993.1	153.5	1,841.9	2,993.1	7,521.2
PM_{10}, lbs	425.2	502.6	25.8	309.3	502.6	1,262.9
SO_2, lbs	88.3	104.4	5.4	64.2	104.4	262.2
Combustion Turbines/HRSGs - Cold Starts						
NOx, as NO_2, lbs	368.5	1,596.9	122.8	1,105.6	1,596.9	3,193.9
CO, lbs	614.4	2,662.5	204.8	1,843.3	2,662.5	5,325.1
VOC, as CH_4, lbs	235.9	1,022.1	78.6	707.6	1,022.1	2,044.2
PM_{10}, lbs	58.0	251.3	19.3	174.0	251.3	502.6
SO_2, lbs	12.0	52.2	4.0	36.1	52.2	104.4
Combustion Turbines/HRSGs - Starts Total						
NOx, as NO_2, lbs	3,752.7	6,089.6	1,083.6	3,867.6	6,089.6	14,793.6
CO, lbs	9,074.7	14,985.9	4,280.5	9,414.5	14,985.9	37,755.7
VOC, as CH_4, lbs	3,312.3	5,219.4	1,125.5	3,287.5	5,219.4	12,944.7
PM_{10}, lbs	573.4	953.6	193.3	605.7	953.6	2,326.0
SO_2, lbs	119.1	198.0	40.1	125.8	198.0	483.0

Roseville Energy Park

Annual Emissions - Alstom GTX100

Combustion Turbines/HRSGs - Starts						
NOx, as NO_2, tons	1.88	3.04	0.54	1.93	3.04	7.40
CO, tons	4.54	7.49	2.14	4.71	7.49	18.88
VOC, as CH_4, tons	1.66	2.61	0.56	1.64	2.61	6.47
PM_{10}, tons	0.29	0.48	0.10	0.30	0.48	1.16
SO_2, tons	0.06	0.10	0.02	0.06	0.10	0.24
Combustion Turbines/HRSGs - Total						
NOx, as NO_2, tons	9.03	8.48	9.21	9.04	9.21	35.75
CO, tons	13.24	14.11	12.69	13.36	14.11	53.41
VOC, as CH_4, tons	3.03	3.58	2.53	3.02	3.58	12.16
PM_{10}, tons	6.91	5.52	8.13	6.89	8.13	27.45
SO_2, tons	1.44	1.15	1.69	1.43	1.69	5.70
Auxiliary Boiler						
NOx, as NO_2, tons	0.05	0.19	0.05	0.05	0.19	0.33
CO, tons	0.16	0.63	0.16	0.16	0.63	1.10
VOC, as CH_4, tons	0.02	0.07	0.02	0.02	0.07	0.13
PM_{10}, tons	0.04	0.17	0.04	0.04	0.17	0.29
SO_2, tons	0.01	0.02	0.01	0.01	0.02	0.04
Standy Generator						
NOx, as NO_2, tons	0.056	0.056	0.056	0.056	0.06	0.224
CO, tons	0.010	0.010	0.010	0.010	0.01	0.042
VOC, as CH_4, tons	0.002	0.002	0.002	0.002	0.00	0.008
PM_{10}, tons	0.002	0.002	0.002	0.002	0.00	0.007
SO_2, tons	0.001	0.001	0.001	0.001	0.00	0.005
Fire Pump						
NOx, as NO_2, tons	0.021	0.021	0.021	0.021	0.02	0.086
CO, tons	0.001	0.001	0.001	0.001	0.00	0.004
VOC, as CH_4, tons	0.001	0.001	0.001	0.001	0.00	0.002
PM_{10}, tons	0.000	0.000	0.000	0.000	0.00	0.001
SO_2, tons	0.001	0.001	0.001	0.001	0.00	0.002
Cooling Tower						
PM_{10}, tons	0.73	0.74	0.75	0.75	0.75	2.98
Total						
NOx, as NO_2, tons	9.15	8.74	9.33	9.16	9.33	36.39
CO, tons	13.41	14.75	12.86	13.53	14.75	54.56
VOC, as CH_4, tons	3.05	3.65	2.55	3.04	3.65	12.30
PM_{10}, tons	7.69	6.43	8.92	7.68	8.92	30.72
SO_2, tons	1.44	1.17	1.70	1.44	1.70	5.75
Total						
NOx, as NO_2, lbs	18,298.6	17,489.7	18,665.9	18,324.3	18,665.9	72,778.5
CO, lbs	26,820.3	29,508.1	25,727.9	27,057.2	29,508.1	109,113.5
VOC, as CH_4, lbs	6,097.0	7,307.4	5,099.5	6,086.1	7,307.4	24,590.0
PM_{10}, lbs	15,384.4	12,857.1	17,841.2	15,365.9	17,841.2	61,448.6
SO_2, lbs	2,886.8	2,341.5	3,390.0	2,876.0	3,390.0	11,494.2

Roseville Electric provided to the PCAPCD the following tables to show the available emission reduction credits for PM-10 and NOx.

The annual and quarterly NOx emission in the following tables were superseded by those shown in Table C2.

The annual and quarterly NOx emission in the following tables were superseded by those shown in Table C2.

REVISED EMISSIONS TABLES SUBMITTED BY ROSEVILLE ELECTRIC TO PCAPCD (4/9/04.)

The following tables replace those in the Authority to Construct application filed with the District.

Table 3.1-8. Expected total annual emission rate (tons/yr).

	NO_X	SO_2	CO	VOC	PM_{10}
LM 6000 PC SPRINT	36.24	6.69	44.09	12.17	35.28
Alstom GTX100	39.56	6.83	59.86	13.42	35.95

Table 3.1-12. Hourly emission rates for each turbine (lb/hr)[1].

Constituent	GE LM 6000 PC SPRINT		Alstom GTX100		ppmvd @15% O_2
	Peak lb/hr	Base lb/hr	Peak lb/hr	Base lb/hr	
NO_x	5	3.4	5.1	3.5	2
CO	6.1	4.2	6.2	4.2	4
VOC	1.7	1.2	1.8	0.4	--
PM_{10}	4.6	3.2	4.7	3.2	--
SO_2	1.0	0.7	1.0	0.7	--
NH_3	9.2	6.3	9.5	6.4	10

1 – Values correspond to the maximum hourly rates, and are based on an ambient temperature of 34°F; data shown in Appendix 3.1-A.

Table 3.1-14. Startup emissions summary.

	General Electric LM6000 PC Sprint	Alstom GTX100
Hot Start:		
Maximum hour (worst-case turbine)		
NO_x lb/hr	8.8	22.6
CO lb/hr	9.2	83.5
VOC lb/hr	1.4	19.6
PM_{10} lb/hr	3.2	3.2
SO_2 lb/hr	0.7	0.7
Total per start (both turbines combined)[1]		
NO_x lbs	15.9	34.1
CO lbs	16.3	160.8
VOC lbs	2.3	38.8
PM_{10} lbs	6.3	6.4
SO_2 lb/hr	1.3	1.3
Warm Start:		
Maximum hour (worst-case turbine)		
NO_x lb/hr	12.2	37.1
CO lb/hr	10.8	89.5
VOC lb/hr	1.4	19.7
PM_{10} lb/hr	3.2	3.2
SO_2 lb/hr	0.7	0.7
Total per start (both turbines combined)[1]		
NO_x lbs	29.2	88.1
CO lbs	27.6	188.1
VOC lbs	4.5	76.7
PM_{10} lbs	12.7	12.9
SO_2 lb/hr	2.6	2.7
Cold Start:		
Maximum hour (worst-case turbine)		
NO_x lb/hr	19.3	37.1
CO lb/hr	14.3	89.5
VOC lb/hr	1.4	19.7
PM_{10} lb/hr	3.2	3.2
SO_2 lb/hr	0.7	0.7
Total per start (both turbines combined) [1]		
NO_x lbs	49.7	122.8
CO lbs	42.2	204.8
VOC lbs	6.6	78.6
PM_{10} lbs	19.0	19.3
SO_2 lb/hr	3.9	4.0

1 – Values correspond to the emissions for each startup event.
See Appendix 3.1-A for details.

Table 3.1-15. Maximum operation emission rates.

	NO_X		SO_2		CO		VOC		PM_{10}	
	LM6000	GTX100	LM6000	GTX100	LM6000	GTX100	LM6000	GTX100	LM6000	GTX100
Maximum hourly[1] pounds per hour	43.8	79.3	2.09	2.14	31.7	182.1	3.9	39.8	10.6	10.8
Maximum daily pounds per day[2]	288.9	425.4	48.07	49.15	354.8	683.6	89.9	229.4	252.4	257.6
Maximum quarterly[3] tons/quarter	9.68	10.27	1.82	1.85	11.75	16.94	3.30	3.73	9.50	9.69
Maximum annual[3] tons/yr	36.24	39.56	6.69	6.83	44.09	59.86	12.17	13.42	35.28	35.95

1 – See Appendix 3.1-E10 for details.
2 – See Appendix 3.1-E11 for details.
3 – See Appendix 3.1-E12 for details.

Table 3.1-27. Comparison of emissions increase with PSD significance emissions levels.

Pollutant	Emissions (tons per year)		Significant emission levels (tons per year)	Significant?
	GE LM6000	Alstom GTX100		
NO_x	36.24	39.56	100	no
SO_2	6.69	6.83	100	no
VOC	12.17	13.42	100	no
CO	44.09	59.86	100	no
PM_{10}[1]	35.28	35.95	100	no

1 – Including cooling tower.

Table 3.1-30. Maximum potential to emit in pounds

	NO_X		SO_2		CO		VOC		PM_{10}	
	LM6000	Alstom	LM6000	Alstom	LM6000	Alstom	LM6000	Alstom	LM6000	Alstom
Quarterly[1]	19,360.8	20,544.9	3,630.4	3,709.2	23,499.7	33,872.4	6,596.2	7,455.0	18,998.6	19,378.0
Annual	72,486.7	79,112.3	13,385.3	13,665.1	88,183.4	119,710.4	24,344.6	26,848.5	70,555.3	71,902.9

1 – Values are taken from the highest total quarterly values shown in Appendix 3.1-E. This is a copy of Table 3.1-E12.

APPENDIX 3.1E
CALCULATION OF STARTUP, MAXIMUM HOURLY, DAILY,
QUARTERLY, AND ANNUAL EMISSIONS

Table 3.1E-1 shows the quarterly startup schedule which is based on the data presented in Table 3.1-10.

Table 3.1E-2 shows the emissions of pollutants for each quarter associated with hot start, warm start and cold starts using the startup schedule from Table 3.1-11 and the emissions for each event data from Table 3.1-15.

Total quarterly and annual emissions for each pollutant associated with startups are summarized and shown in Table 3.1E-3. Table 3.1E-4 shows the baseload and peak load quarterly emissions for each quarter for each turbine.

Tables 3.1E-5 through 3.1E-9 show the total quarterly emissions for each turbine, including startups, based load, and peak load operations. Also, the tables summarize total new emissions, including turbines, fire pump, emergency generator, auxiliary boiler and cooling tower for each pollutant.

Calculation of Maximum Hourly Emissions

a. Turbines/HRSGs

As hourly NO_x, CO and VOC emissions from the turbines are higher during startup than during peak load operation, highest hourly emissions occur while both turbines are in startup mode. Except for startup, maximum hourly emissions from the turbines occur while operating at peak load and 34 degF with power augmentation and duct firing. Emissions under this operating mode are higher than under part load or high temperature operations. Emissions under peak and base, and minimum load conditions at 99 degF, 62 degF, and 34 degF temperature conditions are shown in Appendix 3.1A.

Both turbines may be started up within the same 1 hour timeframe. Therefore highest hourly emissions from the turbines will occur when both turbines are starting up within the same 1 hour timeframe.

b. Auxiliary Boiler

Auxiliary boiler will operate in all four quarters.

c. Emergency Generator and Fire Pump

Emergency generator set and fire pump testing will not occur during turbine startups. Each test takes 30 minutes. Emergency generator will operate at 50% load during testing.

d. Cooling Tower

Maximum hourly emissions occur while the cooling tower is operating at full capacity.

Calculation of Maximum Daily Emissions

a. Turbines/HRSGs

As discussed above for the hourly emissions calculations, hourly NO_x, CO and VOC emissions are highest during startup. The operating conditions having the next highest hourly emissions are peak load operation at 34 degF with power augmentation and duct firing, followed by peak load operation at 34 degF. Therefore maximum daily turbine emissions will occur on a day when each turbine has one hot and one cold start, operates at full load with power augmentation and duct firing. Again, both turbines can be in startup mode at the same time.

b. Auxiliary Boiler

Auxiliary boiler will operate in all four quarters.

c. Emergency Generator and Fire Pump

Emergency generator set or fire pump is proposed for REP. Testing will not occur during days with startups. Each test takes 30 minutes. Emergency generator will operate at 50% load during testing.

d. Cooling Tower

Maximum daily cooling tower emissions will occur while the cooling tower is in operation for 24 hours.

Maximum Annual Emissions

a. Turbines/HRSGs

Maximum annual emissions are calculated based on the dispatch schedule of Table 3.1-10.

b. Auxiliary Boiler

Auxiliary boiler will operate in all four quarters.

c. Emergency Generator and Fire Pump

Emergency generator and fire pump will be tested 50 times per year.

Maximum Quarterly Emissions

a. Turbines/HRSGs

Quarterly turbine emission rates are calculated based on the proposed plant dispatch schedule for each quarter.

b. Auxiliary Boiler

Auxiliary boiler will operate in all four quarters.

c. Emergency Generator and Fire Pump

It is assumed that these units will be tested 12.5 times per quarter.

Table 3.1E-1. Quarterly startup schedule.[(1)]

	1st	**2nd**	**3rd**	**4th**
Number of hot starts	25	71	29	42
Hours of hot starts[(1)]	25	71	29	42
Number of warm starts	8	20	1	1
Hours of warm start[(3)]	16	40	2	2
Number of cold starts	1	2	1	1
Hours of cold starts[(4)]	3	6	3	3

1 – Based on Table 3.1-11.
2 – Hot start takes 1 hour.
3 – Warm start takes 2 hours.
4 – Cold start takes 3 hours.

Table 3.1E-2. Quarterly startup emissions (both turbines).(1)

	NO_X	CO	VOC	PM_{10}	SO_2
Quarter 1					
LM6000 PC Sprint					
Hot start emissions lbs/qtr	396.7	408.2	57.6	158.3	32.9
Warm start emission lbs/qtr	233.7	220.5	36.2	101.3	21.0
Cold start emission lbs/qtr	49.7	42.2	6.6	19.0	3.9
Total Quarter 1	680.2	670.9	100.5	278.6	57.9
Alstom GTX100					
Hot start emissions lbs/qtr	852.8	4,021.1	971.1	161.1	33.4
Warm start emission lbs/qtr	704.6	1,505.1	614.0	103.1	21.4
Cold start emission lbs/qtr	122.8	204.8	78.6	19.3	4.0
Total Quarter 1	1,680.3	5,731.0	1,663.7	283.5	58.9
Quarter 2					
LM6000 PC Sprint					
Hot start emissions lbs/qtr	1,126.7	1,159.4	163.7	449.6	93.4
Warm start emission lbs/qtr	584.3	551.2	90.6	253.3	52.6
Cold start emission lbs/qtr	99.5	84.3	13.2	38.0	7.9
Total Quarter 2	1,810.5	1,794.9	267.5	740.8	153.8
Alstom GTX100					
Hot start emissions lbs/qtr	2,422.0	11,420.0	2,757.8	457.5	95.0
Warm start emission lbs/qtr	1,761.6	3,762.7	1,534.9	257.7	53.5
Cold start emission lbs/qtr	245.7	409.6	157.2	38.7	8.0
Total Quarter 2	4,429.3	15,592.3	4,450.0	753.8	156.5
Quarter 3					
LM6000 PC Sprint					
Hot start emissions lbs/qtr	460.2	473.6	66.9	183.6	38.1
Warm start emission lbs/qtr	29.2	27.6	4.5	12.7	2.6
Cold start emission lbs/qtr	49.7	42.2	6.6	19.0	3.9
Total Quarter 3	539.2	543.3	78.0	215.3	44.7
Alstom GTX100					
Hot start emissions lbs/qtr	989.3	4,664.5	1,126.4	186.9	38.8
Warm start emission lbs/qtr	88.1	188.1	76.7	12.9	2.7
Cold start emission lbs/qtr	122.8	204.8	78.6	19.3	4.0
Total Quarter 3	1,200.2	5,057.4	1,281.8	219.1	45.5
Quarter 4					
LM6000 PC Sprint					
Hot start emissions lbs/qtr	666.5	685.8	96.8	265.9	55.2
Warm start emission lbs/qtr	29.2	27.6	4.5	12.7	2.6
Cold start emission lbs/qtr	49.7	42.2	6.6	19.0	3.9
Total Quarter 4	745.5	755.5	108.0	297.6	61.8
Alstom GTX100					
Hot start emissions lbs/qtr	1,432.8	6,755.5	1,631.4	270.6	56.2
Warm start emission lbs/qtr	88.1	188.1	76.7	12.9	2.7
Cold start emission lbs/qtr	122.8	204.8	78.6	19.3	4.0
Total Quarter 4	1,643.7	7,148.4	1,786.7	302.8	62.9

1 – Emissions are calculated from the number of events shown in Table 3.1-11 and the emission rates shown in Appendix 8.A.

2 – SO_2 emissions are conservatively estimated based on the highest emission rates for the turbine 50% load conditions, from Appendix 8.A.

3 – Warm start takes 2 hours.

4 – Cold start takes 3 hours.

Table 3.1E-3. Summary total quarterly and annual startup emissions for two turbines combined (pounds).[1]

	Turbine	Q1	Q2	Q3	Q4	Total
NO_X	LM6000 PC Sprint	680.2	1,810.5	539.2	745.5	3,775.3
	Alston GTX 100	1,680.3	4,429.3	1,200.2	1,643.7	8,953.5
CO	LM6000 PC Sprint	670.9	1,794.9	543.3	755.5	3,764.5
	Alston GTX 100	5,731.0	15,592.3	5,057.4	7,148.4	33,529.1
VOC	LM6000 PC Sprint	100.5	267.5	78.0	108.0	553.9
	Alston GTX 100	1,663.7	4,450.0	1,281.8	1,786.7	9,182.2
PM_{10}	LM6000 PC Sprint	278.6	740.8	215.3	297.6	1,532.3
	Alston GTX 100	283.5	753.8	219.1	302.8	1,559.2
SO_2	LM6000 PC Sprint	57.9	153.8	44.7	61.8	318.2
	Alston GTX 100	58.9	156.5	45.5	62.9	323.8

1 – This table summarizes the emissions shown in Table 3.1E-2.

Table 3.1E-10. Maximum hourly emissions, lb/hr[1].

	NO_X		SO_2[2]		CO		VOC		PM_{10}	
	LM6000	**Alstom**	**LM6000**	**Alstom**	**LM6000**	**Alstom**	**LM6000**	**Alstom**	**LM6000**	**Alstom**
2 combustion turbines/peak	10	10.2	2	2	12.2	12.5	3.5	3.6	9.2	9.5
2 combustion turbine/startup	38.7	74.2	1.3	1.3	28.7	179.0	2.9	39.4	6.3	6.4
Auxiliary Boiler	0.7	0.7	0.08	0.08	2.2	2.2	0.3	0.3	0.6	0.6
Highest	39.4	74.9	2.08	2.08	30.9	181.2	3.7	39.7	9.8	10.1
Standby generator[3]	4.48		0.094		0.84		0.16		0.13	
Fire pump[4]	1.72		0.050		0.09		0.05		0.03	
Cooling tower	--		--		--		--		0.7	
Subtotal	6.9		0.22		3.13		0.51		1.47	
Maximum hourly emissions	39.4	74.9	2.17	2.17	30.9	181.2	386	39.7	10.6	10.9

1 – Standby generator and fire pump testing do not occur during CTG startups.

2 – Maximum hourly SO_2 emissions correspond to peak load operation for the turbines and other equipment running at the same time.

3 – Emergency standby generator is only tested for 30 minutes, operating at 50% load.

4 – The fire pump testing is for 30 minutes at 100% load.

Table 3.1E-11. Maximum daily emissions, lb/day

	NO_X		SO_2		CO		VOC		PM_{10}	
	LM6000	**Alstom**	**LM6000**	**Alstom**	**LM6000**	**Alstom**	**LM6000**	**Alstom**	**LM6000**	**Alstom**
1 startup (cold)	49.7	122.8	3.9	4.0	42.2	204.8	6.6	78.6	19.0	19.3
1 startup (warm)	29.2	88.1	2.6	2.7	27.6	188.1	4.5	76.7	12.7	12.9
19 hrs peak operating	190	194.3	36.4	37.3	231.1	236.6	66.2	67.8	175.5	179.6
Subtotal	268.7	405.2	43.0	44.0	300.8	629.5	77.3	223.1	207.1	211.8
2 combustion turbine peak	239.7	245.4	46.0	47.1	291.9	298.8	83.6	85.6	221.6	226.8
Highest	268.7	405.2	46.0	47.1	300.8	629.5	83.6	223.1	221.6	226.8
Cooling tower									16.3	16.3
Emergency generator[(1)]	4.48		0.094		0.84		0.16		0.13	
Fire pump[(1)]	1.72		0.05		0.09		0.05		0.03	
Auxiliary Boiler	15.7		1.95		53.2		6.1		14.0	
Maximum daily emissions[(2)]	288.9	425.4	48.0	49.1	354.8.	683.5	89.9	229.4	252.4	257.6

1 – 30 minute operation for each testing period. They do not run during startup. So their emissions are not included in the maximum daily emissions, which includes startups.

2 – The highest daily emissions assumes 1 cold startups, 1 warm startups, and 19 hours of peak load operation at 34°F. It is assumed that the auxiliary boiler is also operating during that day.

Table 3.1E-12. Maximum total quarterly and annual emissions (pounds)

	NO_X		SO_2		CO		VOC		PM_{10}	
	LM6000	**Alstom**	**LM6000**	**Alstom**	**LM6000**	**Alstom**	**LM6000**	**Alstom**	**LM6000**	**Alstom**
Quarterly[1]	19,360.8	20,544.9	3,630.4	3,709.2	23,499.7	33,872.4	6,596.2	7,455.0	18,998.6	19,378.0
Annual	72,486.7	79,112.3	13,385.3	13,665.1	88,183.4	119,710.4	24,344.6	26,848.5	70,555.3	71,902.9

1 – Values are taken from the highest total quarterly values shown in Tables 3.1E-5 through 3.1E-9.

Roseville Energy Park

Annual Emissions - General Electric LM6000 PC SPRINT

	Quarter				Maximum Quarter	Total Annual
	1st	2nd	3rd	4th		
Combustion Turbines/HRSGs - Operating Baseload						
NOx, as NO_2, tons	3.83	4.05	2.56	2.90	4.05	13.34
CO, tons	4.66	4.93	3.12	3.54	4.93	16.24
VOC, as CH_4, tons	1.33	1.41	0.89	1.01	1.41	4.65
PM_{10}, tons	3.56	3.76	2.38	2.70	3.76	12.39
SO_2, tons	0.74	0.78	0.49	0.56	0.78	2.57
Combustion Turbines/HRSGs - Operating w/ Duct Firing						
NOx, as NO_2, tons	4.64	2.79	6.73	6.22	6.73	20.38
CO, tons	5.65	3.40	8.19	7.58	8.19	24.82
VOC, as CH_4, tons	1.62	0.97	2.35	2.17	2.35	7.11
PM_{10}, tons	4.29	2.58	6.22	5.75	6.22	18.84
SO_2, tons	0.89	0.54	1.29	1.19	1.29	3.91
Combustion Turbines/HRSGs - Hot Starts						
NOx, as NO_2, lbs	396.7	1,126.7	460.2	666.5	1,126.7	2,650.1
CO, lbs	408.2	1,159.4	473.6	685.8	1,159.4	2,727.0
VOC, as CH_4, lbs	57.6	163.7	66.9	96.8	163.7	385.0
PM_{10}, lbs	158.3	449.6	183.6	265.9	449.6	1,057.4
SO_2, lbs	32.9	93.4	38.1	55.2	93.4	219.6
Combustion Turbines/HRSGs - Warm Starts						
NOx, as NO_2, lbs	233.7	584.3	29.2	29.2	584.3	876.4
CO, lbs	220.5	551.2	27.6	27.6	551.2	826.8
VOC, as CH_4, lbs	36.2	90.6	4.5	4.5	90.6	135.9
PM_{10}, lbs	101.3	253.3	12.7	12.7	253.3	379.9
SO_2, lbs	21.0	52.6	2.6	2.6	52.6	78.9
Combustion Turbines/HRSGs - Cold Starts						
NOx, as NO_2, lbs	49.7	99.5	49.7	49.7	99.5	248.7
CO, lbs	42.2	84.3	42.2	42.2	84.3	210.8
VOC, as CH_4, lbs	6.6	13.2	6.6	6.6	13.2	33.0
PM_{10}, lbs	19.0	38.0	19.0	19.0	38.0	95.0
SO_2, lbs	3.9	7.9	3.9	3.9	7.9	19.7
Combustion Turbines/HRSGs - Starts Total						
NOx, as NO_2, lbs	680.2	1,810.5	539.2	745.5	1,810.5	3,775.3
CO, lbs	670.9	1,794.9	543.3	755.5	1,794.9	3,764.5
VOC, as CH_4, lbs	100.5	267.5	78.0	108.0	267.5	553.9
PM_{10}, lbs	278.6	740.8	215.3	297.6	740.8	1,532.3
SO_2, lbs	57.9	153.8	44.7	61.8	153.8	318.2
Combustion Turbines/HRSGs - Starts Total						

NOx, as NO_2, tons	0.34	0.91	0.27	0.37	0.91	1.89
CO, tons	0.34	0.90	0.27	0.38	0.90	1.88
VOC, as CH_4, tons	0.05	0.13	0.04	0.05	0.13	0.28
PM_{10}, tons	0.14	0.37	0.11	0.15	0.37	0.77
SO_2, tons	0.03	0.08	0.02	0.03	0.08	0.16
Combustion Turbines/HRSGs - Total						
NOx, as NO_2, tons	8.81	7.75	9.56	9.50	9.56	35.61
CO, tons	10.65	9.23	11.58	11.49	11.58	42.94
VOC, as CH_4, tons	3.00	2.52	3.28	3.24	3.28	12.04
PM_{10}, tons	7.98	6.71	8.70	8.60	8.70	32.00
SO_2, tons	1.66	1.39	1.81	1.79	1.81	6.65
Auxiliary Boiler						
NOx, as NO_2, tons	0.05	0.19	0.05	0.05	0.19	0.33
CO, tons	0.16	0.63	0.16	0.16	0.63	1.10
VOC, as CH_4, tons	0.02	0.07	0.02	0.02	0.07	0.13
PM_{10}, tons	0.04	0.17	0.04	0.04	0.17	0.29
SO_2, tons	0.01	0.02	0.01	0.01	0.02	0.04
Standby Generator						
NOx, as NO_2, tons	0.056	0.056	0.056	0.056	0.06	0.224
CO, tons	0.010	0.010	0.010	0.010	0.01	0.042
VOC, as CH_4, tons	0.002	0.002	0.002	0.002	0.00	0.008
PM_{10}, tons	0.002	0.002	0.002	0.002	0.00	0.007
SO_2, tons	0.001	0.001	0.001	0.001	0.00	0.005
Fire Pump						
NOx, as NO_2, tons	0.021	0.021	0.021	0.021	0.02	0.086
CO, tons	0.001	0.001	0.001	0.001	0.00	0.004
VOC, as CH_4, tons	0.001	0.001	0.001	0.001	0.00	0.002
PM_{10}, tons	0.000	0.000	0.000	0.000	0.00	0.001
SO_2, tons	0.001	0.001	0.001	0.001	0.00	0.002
Cooling Tower						
PM_{10}, tons	0.734	0.742	0.751	0.751	0.751	2.98
Total						
NOx, as NO_2, tons	8.93	8.01	9.68	9.62	9.68	36.24
CO, tons	10.81	9.87	11.75	11.66	11.75	44.09
VOC, as CH_4, tons	3.02	2.59	3.30	3.26	3.30	12.17
PM_{10}, tons	8.76	7.62	9.50	9.39	9.50	35.28
SO_2, tons	1.67	1.42	1.82	1.79	1.82	6.69
Total						
NOx, as NO_2, lbs	17,860.6	16,018.6	19,360.8	19,246.7	19,360.8	72,486.7
CO, lbs	21,625.2	19,736.5	23,499.7	23,321.9	23,499.7	88,183.3
VOC, as CH_4, lbs	6,046.3	5,187.7	6,596.2	6,514.5	6,596.2	24,344.6
PM_{10}, lbs	17,523.0	15,246.0	18,998.6	18,787.7	18,998.6	70,555.3
SO_2, lbs	3,330.8	2,837.5	3,630.4	3,586.6	3,630.4	13,385.3

Roseville Energy Park

Annual Emissions - Alstom GTX100

	Quarter				Maximum Quarter	Total Annual
	1st	2nd	3rd	4th		
Combustion Turbines/HRSGs - Operating Baseload						
NOx, as NO_2, tons	3.90	4.12	2.61	2.96	4.12	13.58
CO, tons	4.74	5.02	3.17	3.60	5.02	16.53
VOC, as CH_4, tons	0.41	0.43	0.27	0.31	0.43	1.42
PM_{10}, tons	3.62	3.83	2.42	2.74	3.83	12.61
SO_2, tons	0.75	0.79	0.50	0.57	0.79	2.62
Combustion Turbines/HRSGs - Operating w/ Duct Firing						
NOx, as NO_2, tons	4.75	2.86	6.89	6.37	6.89	20.87
CO, tons	5.78	3.48	8.39	7.76	8.39	25.41
VOC, as CH_4, tons	1.66	1.00	2.40	2.22	2.40	7.28
PM_{10}, tons	4.39	2.64	6.37	5.89	6.37	19.29
SO_2, tons	0.91	0.55	1.32	1.22	1.32	4.00
Combustion Turbines/HRSGs - Hot Starts						
NOx, as NO_2, lbs	852.8	2,422.0	989.3	1,432.8	2,422.0	5,696.9
CO, lbs	4,021.1	11,420.0	4,664.5	6,755.5	11,420.0	26,861.0
VOC, as CH_4, lbs	971.1	2,757.8	1,126.4	1,631.4	2,757.8	6,486.6
PM_{10}, lbs	161.1	457.5	186.9	270.6	457.5	1,076.0
SO_2, lbs	33.4	95.0	38.8	56.2	95.0	223.4
Combustion Turbines/HRSGs - Warm Starts						
NOx, as NO_2, lbs	704.6	1,761.6	88.1	88.1	1,761.6	2,642.4
CO, lbs	1,505.1	3,762.7	188.1	188.1	3,762.7	5,644.0
VOC, as CH_4, lbs	614.0	1,534.9	76.7	76.7	1,534.9	2,302.4
PM_{10}, lbs	103.1	257.7	12.9	12.9	257.7	386.6
SO_2, lbs	21.4	53.5	2.7	2.7	53.5	80.3
Combustion Turbines/HRSGs - Cold Starts						
NOx, as NO_2, lbs	122.8	245.7	122.8	122.8	245.7	614.2
CO, lbs	204.8	409.6	204.8	204.8	409.6	1,024.0
VOC, as CH_4, lbs	78.6	157.2	78.6	78.6	157.2	393.1
PM_{10}, lbs	19.3	38.7	19.3	19.3	38.7	96.6
SO_2, lbs	4.0	8.0	4.0	4.0	8.0	20.1
Combustion Turbines/HRSGs - Starts Total						
NOx, as NO_2, lbs	1,680.3	4,429.3	1,200.2	1,643.7	4,429.3	8,953.5
CO, lbs	5,731.0	15,592.3	5,057.4	7,148.4	15,592.3	33,529.1
VOC, as CH_4, lbs	1,663.7	4,450.0	1,281.8	1,786.7	4,450.0	9,182.2
PM_{10}, lbs	283.5	753.8	219.1	302.8	753.8	1,559.2
SO_2, lbs	58.9	156.5	45.5	62.9	156.5	323.8
Combustion Turbines/HRSGs - Starts						

NOx, as NO_2, tons	0.84	2.21	0.60	0.82	2.21	4.48
CO, tons	2.87	7.80	2.53	3.57	7.80	16.76
VOC, as CH_4, tons	0.83	2.22	0.64	0.89	2.22	4.59
PM_{10}, tons	0.14	0.38	0.11	0.15	0.38	0.78
SO_2, tons	0.03	0.08	0.02	0.03	0.08	0.16
Combustion Turbines/HRSGs - Total						
NOx, as NO_2, tons	9.49	9.19	10.09	10.15	10.15	38.92
CO, tons	13.39	16.30	14.09	14.93	16.30	58.71
VOC, as CH_4, tons	2.90	3.65	3.32	3.42	3.65	13.29
PM_{10}, tons	8.15	6.85	8.89	8.78	8.89	32.67
SO_2, tons	1.69	1.42	1.85	1.82	1.85	6.78
Auxiliary Boiler						
NOx, as NO_2, tons	0.05	0.19	0.05	0.05	0.19	0.33
CO, tons	0.16	0.63	0.16	0.16	0.63	1.10
VOC, as CH_4, tons	0.02	0.07	0.02	0.02	0.07	0.13
PM_{10}, tons	0.04	0.17	0.04	0.04	0.17	0.29
SO_2, tons	0.01	0.02	0.01	0.01	0.02	0.04
Standby Generator						
NOx, as NO_2, tons	0.056	0.056	0.056	0.056	0.06	0.224
CO, tons	0.010	0.010	0.010	0.010	0.01	0.042
VOC, as CH_4, tons	0.002	0.002	0.002	0.002	0.00	0.008
PM_{10}, tons	0.002	0.002	0.002	0.002	0.00	0.007
SO_2, tons	0.001	0.001	0.001	0.001	0.00	0.005
Fire Pump						
NOx, as NO_2, tons	0.021	0.021	0.021	0.021	0.02	0.086
CO, tons	0.001	0.001	0.001	0.001	0.00	0.004
VOC, as CH_4, tons	0.001	0.001	0.001	0.001	0.00	0.002
PM_{10}, tons	0.000	0.000	0.000	0.000	0.00	0.001
SO_2, tons	0.001	0.001	0.001	0.001	0.00	0.002
Cooling Tower						
PM_{10}, tons	0.73	0.74	0.75	0.75	0.75	2.98
Total						
NOx, as NO_2, tons	9.61	9.46	10.22	10.27	10.27	39.56
CO, tons	13.56	16.94	14.26	15.10	16.94	59.86
VOC, as CH_4, tons	2.92	3.73	3.34	3.44	3.73	13.42
PM_{10}, tons	8.93	7.76	9.69	9.58	9.69	35.95
SO_2, tons	1.70	1.45	1.85	1.83	1.85	6.83
Total						
NOx, as NO_2, lbs	19,218.6	18,915.4	20,433.4	20,544.9	20,544.9	79,112.3
CO, lbs	27,121.1	33,872.4	28,515.1	30,201.8	33,872.4	119,710.4
VOC, as CH_4, lbs	5,832.3	7,455.0	6,671.6	6,889.7	7,455.0	26,848.5
PM_{10}, lbs	17,854.4	15,512.5	19,378.0	19,157.9	19,378.0	71,902.9
SO_2, lbs	3,399.6	2,892.9	3,709.2	3,663.4	3,709.2	13,665.1