APPENDIX D

CONSTRUCTION EMISSIONS AND IMPACT ANALYSIS

D.1 Onsite Construction

Construction of the project is expected to last approximately 12 months. Construction activities will occur in the following four main phases:

- Site preparation;
- Foundation work;
- Installation of major equipment; and
- Construction/installation of major structures.

Site preparation includes grading, excavation of footings and foundations, and backfilling operations. After site preparation is finished, the construction of the foundations and structures is expected to begin. Once the foundations and structures are finished, installation and assembly of the mechanical and electrical equipment are scheduled to commence.

Fugitive dust emissions from the construction of the project will result from:

- Dust entrained during site preparation and grading/excavation at the construction site;
- Dust entrained during onsite travel on paved and unpaved surfaces;
- Dust entrained during aggregate and soil loading and unloading operations; and
- Wind erosion of areas disturbed during construction activities.

Combustion emissions during construction will result from:

- Exhaust from the Diesel construction equipment used for site preparation, grading, excavation, trenching and construction of onsite structures;
- Exhaust from water trucks used to control construction dust emissions;
- Exhaust from Diesel-powered welding machines;
- Exhaust from pickup trucks and Diesel trucks used to transport workers and materials around the construction site;
- Exhaust from Diesel trucks used to deliver concrete, fuel, and construction supplies to the construction site; and
- Exhaust from automobiles used by workers to commute to the construction site.

To determine the potential worst-case daily construction impacts, exhaust and dust emission rates have been evaluated for each source of emissions. Maximum short-term impacts are calculated assuming that all equipment is operating simultaneously with the peak workforce (225 persons) on-site. Annual emissions are based on the average equipment mix during the 12-month construction period.

D.2 Linear Facilities

The linear facilities that were constructed for the existing PEF project have adequate capacity to supply process water, natural gas fuel and potable water for the expansion project. No additional linear facilities will be constructed as a result of the proposed expansion project.

D.3 Available Mitigation Measures

The following typical mitigation measures are proposed to control exhaust emissions from the Diesel heavy equipment and potential emissions of fugitive dust during construction of the project:

- All unpaved roads and disturbed areas in the project construction site shall be watered as frequently as necessary to prevent fugitive dust plumes. The frequency of watering can be reduced or eliminated during periods of precipitation.
- No vehicle shall exceed 10 miles per hour within the construction site.
- The construction site entrances shall be posted with visible speed limit signs.
- All construction equipment vehicle tires shall be inspected and washed as necessary to be cleaned free of dirt prior to entering paved roadways.
- Gravel ramps of at least 20 feet in length must be provided at the tire washing/cleaning station.
- All unpaved exits from the construction site shall be graveled or treated to prevent track-out to public roadways.
- All construction vehicles shall enter the construction site through the treated entrance roadways, unless an alternative route has been submitted to and approved by the Compliance Project Manager.
- Construction areas adjacent to any paved roadway shall be provided with sandbags or other measures as specified in the Storm Water Pollution Prevention Plan (SWPPP) to prevent run-off to roadways.
- All paved roads within the construction site shall be swept at least twice daily (or less during periods of precipitation) on days when construction activity occurs to prevent the accumulation of dirt and debris.
- At least the first 500 feet of any public roadway exiting from the construction site shall be swept at least twice daily (or less during periods of precipitation) on days when construction activity occurs or on any other day when dirt or runoff from the construction site is visible on the public roadways.
- All soil storage piles and disturbed areas that remain inactive for longer than 10 days shall be covered, or shall be treated with appropriate dust suppressant compounds.
- All vehicles that are used to transport solid bulk material on public roadways and that have potential to cause visible emissions shall be provided with a cover, or

the materials shall be sufficiently wetted and loaded onto the trucks in a manner to provide at least one foot of freeboard.

- Wind erosion control techniques (such as windbreaks, water, chemical dust suppressants, and/or vegetation) shall be used on all construction areas that may be disturbed. Any windbreaks installed to comply with this condition shall remain in place until the soil is stabilized or permanently covered with vegetation.

An on-site Air Quality Construction Mitigation Manager will be responsible for directing and documenting compliance construction-related mitigation conditions.

D.4 Estimates of Emissions with Mitigation Measures

D.4.1 Onsite Construction

Tables D-1 and D-2 show the estimated maximum daily and annual heavy equipment exhaust and fugitive dust emissions with recommended mitigation measures for onsite construction activities. Detailed emission calculations are included as Attachment D-1.

Table D-1
Maximum Daily Emissions During Onsite Construction, Pounds Per Day

	NOx	CO	VOC	SOx	PM_{10}	$PM_{2.5}$
Onsite						
Construction Equipment	94.6	30.6	5.8	0.1	4.0	4.0
Fugitive Dust	--	--	--	--	14.7	1.8
Offsite						
Worker Travel, Truck Deliveries	115.3	244.6	23.2	0.3	3.4	3.4
Total Emissions						
Total	209.9	275.2	29.1	0.4	22.0	9.1

Table D-2
Annual Emissions During Construction, Tons Per Year

	NOx	CO	VOC	SOx	PM_{10}	$PM_{2.5}$
Onsite						
Construction Equipment	5.8	2.0	0.4	0.01	0.2	0.2
Fugitive Dust	--	--	--	--	1.1	0.1
Offsite						
Worker Travel, Truck Deliveries	7.6	19.2	1.8	0.02	0.2	0.2
Total Emissions						
Total	13.4	21.2	2.2	0.03	1.6	0.6

D.5 Analysis of Ambient Impacts from Onsite Construction

Ambient air quality impacts from emissions during construction of the project were estimated using an air quality dispersion modeling analysis. The modeling analysis considers the construction site location, the surrounding topography, and the sources of emissions during construction, including vehicle and equipment exhaust emissions and fugitive dust.

D.5.1 Existing Ambient Levels

As with the modeling analysis of project operating impacts (Section 5.2.2), ambient monitoring data from Bakersfield was used to establish the ambient background levels for the construction impact modeling analysis. Table D-3 shows the maximum concentrations of NOx, SO_2, CO, and PM_{10} recorded for 2001 through 2004 in Bakersfield. Background concentrations for 2001 are included because no SO_2 data have been collected in Kern County since that year.

Table D-3
Maximum Background Concentrations, 2001-2004 (µg/m3)

Pollutant	Averaging Time	2001[a]	2002	2003	2004
NO_2	1-hour	--	201.2	159.8	156.0
	Annual	--	39.6	37.7	35.8
SO_2[a]	1-hour	78	n/a	n/a	n/a
	3-hour	39			
	24-hour	13.1			
	Annual	5.3			
CO	1-hour	--	5,625	5,625	4,125
	8-hour	--	2,778	3,400	2,667
PM_{10}	24-hour	--	100	110	95
	Annual	--	49	48	44
$PM_{2.5}$	24-hour[b]	--	73	59	62
	Annual	--	22.8	16.8	15.5

a. No SO_2 data were collected in Kern County in 2002 or 2003.

b. $PM_{2.5}$ 24-hr average concentrations shown are 98th percentile values rather than highest values because compliance with the standard is based on 98th percentile readings.

D.5.2 Dispersion Model

As in the analysis of project operating impacts, the EPA-approved Industrial Source Complex Short Term (ISCST3) model was used to estimate ambient impacts from construction activities. A detailed discussion of the ISCST3 dispersion model is included in Section 5.2.5.3.1.

The emission sources for the construction site were grouped into three categories: exhaust emissions, construction dust emissions and windblown dust emissions. The exhaust and construction dust emissions were modeled as volume sources. The

windblown dust emissions were modeled as area sources. For the volume sources, the vertical dimension was set to 6 meters. For combustion sources in the project site area, the horizontal dimension was set to 71.48 meters, with sigma-y = 16.62 meters (based on the width of the construction area). For combustion sources in the construction laydown area, the horizontal dimension was set to 248.66 meters, with sigma-y = 57.83 meters.

For the windblown dust sources, the area covers the active construction area. An effective plume height of 0.5 meters was used in the modeling analysis. The exhaust and dust emissions were modeled as a single area source that covered the total area of the construction site, with 80 percent of the emissions allocated to the project site and 20 percent to the laydown area. The construction impacts modeling analysis used the same receptor locations as used for the project operating impact analysis. A detailed discussion of the receptor locations is included in Section 5.2.5.3.1.

To determine the construction impacts on short-term ambient standards (24 hours and less), the worst-case daily onsite construction emission levels shown in Table D-1 were used. For pollutants with annual average ambient standards, the annual onsite emission levels shown in Table D-2 were used. As with the health risk assessment, the meteorological data used for the construction emission impacts analysis is the 1963 Bakersfield met data set.

D-4.5.3 Modeling Results

Based on the emission rates of NOx, SO_2, CO, and PM_{10} and the meteorological data, the ISCST3 model calculates hourly and annual ambient impacts for each pollutant. As mentioned above, the modeled 1-hour, 3-hour, 8-hour, and 24-hour ambient impacts are based on the worst-case daily emission rates of NOx, SO_2, CO, and PM_{10}. The annual impacts are based on the annual emission rates of these pollutants.

The one-hour and annual average concentrations of NO_2 were computed following the revised EPA guidance for computing these concentrations (August 9, 1995 *Federal Register,* 60 FR 40465). The ISC_OLM model was used for the one-hour average NO_2 impacts; uncorrected one-hour impacts are also reported for comparison. The annual average was calculated using the ambient ratio method (ARM) with the national default value of 0.75 for the annual average NO_2/NOx ratio.

The modeling analysis results are shown in Table D-4. Also included in the table are the maximum background levels that have occurred in the last 3 years and the resulting total ambient impacts. Construction impacts alone for all modeled pollutants are expected to be below the most stringent state and national standards. With the exception of the 24-hour and annual average PM_{10}, construction activities are not expected to cause the violation of any state or federal ambient air quality standard. However, the state 24-hour and annual average PM_{10} standards are exceeded in the absence of the construction emissions for the project.

The dust mitigation measures already proposed by the applicant are expected to be very effective in minimizing fugitive dust emissions. The attached isopleth diagrams show the

extent of the modeled impacts from construction PM_{10} and $PM_{2.5}$ for the 24-hour and annual averaging periods.

Table D-4

Modeled Maximum Onsite Construction Impacts

Pollutant	Averaging Time	Maximum Construction Impacts (µg/m^3)	Background (µg/m^3)	Total Impact (µg/m^3)	Standard (µg/m^3)	Federal Standard (µg/m^3)
NO_2[a]	1-hour	252.7	201.2	453.9	470	--
	Annual	5.1	39.6	44.7	--	100
SO_2	1-hour	1.8	78	80	650	--
	24-hour	0.2	13.1	13	109	365
	Annual	0.01	5.3	5.3	--	80
CO	1-hour	554.9	5,625	6,180	23,000	40,000
	8-hour	162.5	3,400	3,562	10,000	10,000
PM_{10}[b]	24-hour	51.7	110	162	50	150
	Annual	1.9	49	51	20	50
$PM_{2.5}$[b]	24-hour	39.2	73	112	--	65
	Annual	0.5	23	24	12	15

Notes:

a. Ozone limiting method applied for 1-hour average, using concurrent O_3 data (1992). ARM applied for annual average, using national default 0.75 ratio.

b. PM_{10} and $PM_{2.5}$ impacts shown are from fugitive dust as well as combustion sources. 24-hour average $PM_{2.5}/PM_{10}$ impact from combustion sources only is 25.0 µg/m^3; annual average impact from combustion sources is 0.3 µg/m^3.

As shown on these isopleths, while maximum impacts occur next to the project site fenceline, concentrations decrease rapidly at locations only a couple of hundred meters away from the project site. For example, maximum modeled 24-hour average PM_{10} impacts along the fenceline are approximately 52 µg/m^3. However, as shown on the isopleths, impacts are reduced by half within 200 meters of the facility fenceline.

It is also important to note that emissions in an exhaust plume are dispersed through the entrainment of ambient air, which dilutes the concentration of the emissions as they are carried away from the source by winds. The process of mixing the pollutants with greater and greater volumes of cleaner air is controlled primarily by the turbulence in the atmosphere. This dispersion occurs both horizontally, as the exhaust plume rises above the emission point, and vertically, as winds carry the plume horizontally away from its source.

The rise of a plume above its initial point of release is a significant contributing factor to the reductions in ground-level concentrations, both because a rising plume entrains more ambient air as it travels downwind, and because it travels farther downwind (and thus also undergoes more horizontal dispersion) before it impacts the ground. Vertical plume rise occurs as a result of buoyancy (plume is hotter than ambient air, and hot air, being less dense, tends to rise) and/or momentum (plume has an initial vertical velocity).

In ISCST3, area sources are not considered to have either buoyant or momentum plume rise, and therefore the model assumes that there is no vertical dispersion taking place. Thus a significant source of plume dilution is ignored when sources are modeled as area sources. The project construction site impacts are not unusual in comparison to most construction sites; construction sites that use good dust suppression techniques and low-emitting vehicles typically do not cause violations of air quality standards. The input and output modeling files are being provided electronically.

D-5.4 Health Risk of Diesel Exhaust

The combustion portion of annual PM_{10} emissions from Table D-3 above was modeled separately to determine the annual average Diesel PM_{10} exhaust concentration. This was used with HARP-derived risk values for Diesel exhaust particulate[2] for a 70-year lifetime to determine the potential carcinogenic risk from Diesel exhaust during construction. The exposure was also adjusted by a factor of 12/840, or 0.0143, to correct for the 12-month exposure.

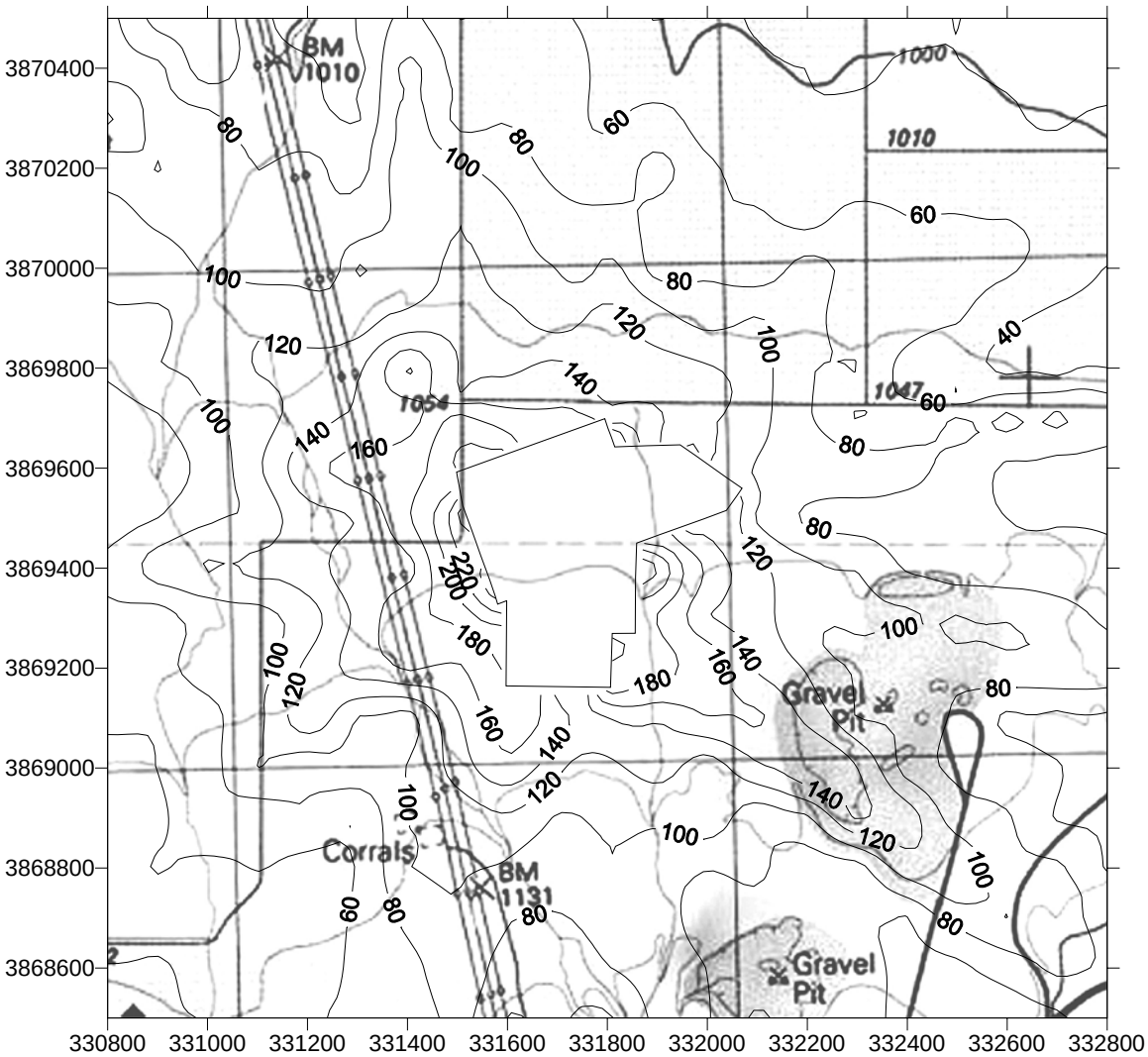
The maximum modeled annual average concentration of Diesel exhaust PM_{10} at any location is 0.281 $\mu g/m^3$. The risk values obtained from HARP range from 2.86×10^{-4} (average point estimate value) to 4.15×10^{-4} (derived OEHHA and high end risk estimates). Using the range of risk values and adjustment factors described above, the carcinogenic risk due to exposure to Diesel exhaust during construction activities is expected to be between approximately 1.2 and 1.7 in one million. This is well below the 10 in one million level considered by the CEC and BAAQMD staffs to be significant.

It is also important to note that these impacts are highly localized near the project site. As shown in the attached annual average Diesel combustion PM_{10} isopleth diagram (Figure D-3), the area in which the risk may exceed 1 in one million (Diesel PM_{10} impact greater than or equal to 0.168 $\mu g/m^3$) barely extends beyond the facility fenceline. This analysis remains conservative because, as discussed above, the modeled PM_{10} concentrations from construction operations are overpredicted by the ISCST3 model.

[2] See Appendix C for a discussion of the use of the HARP model to derive cancer risk values.

Figure D-1

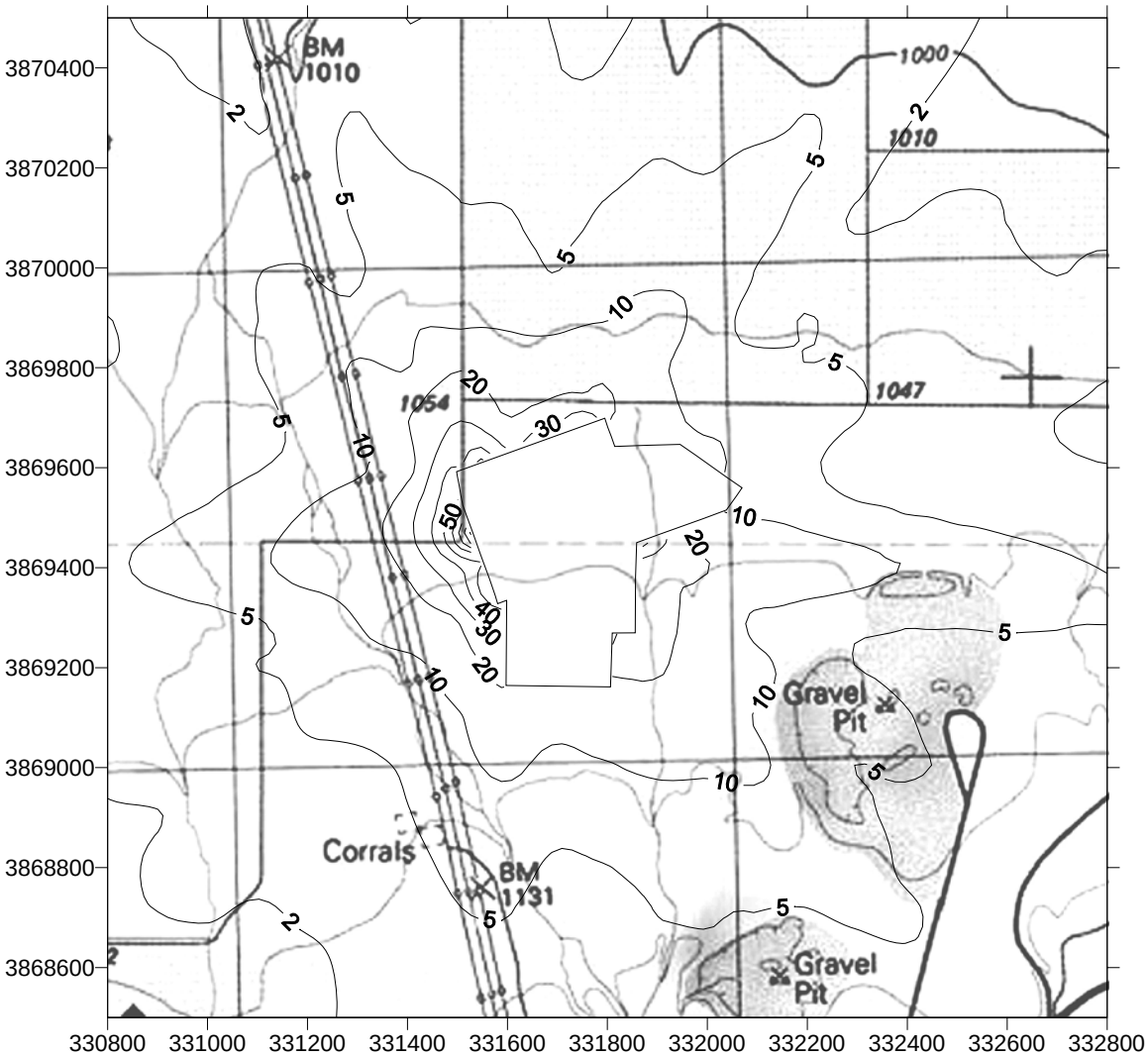
Maximum One-Hour Average NO_2 Impacts During Construction Activities
(Ozone-Limited)



Concentrations are shown in µg/m^3.

Figure D-2

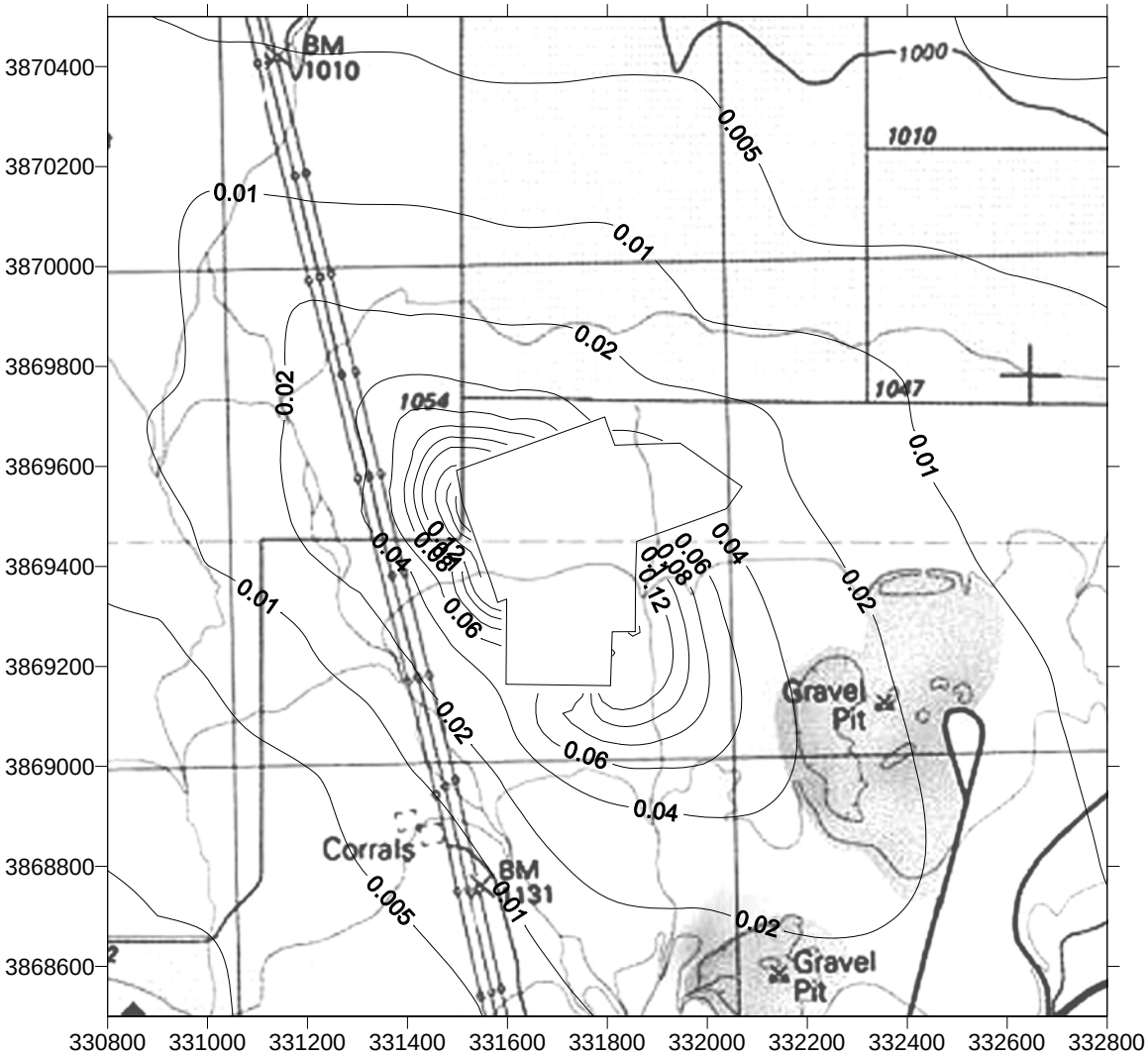
Maximum 24-Hour Average PM_{10} Impacts During Construction Activities, All Sources



Concentrations are shown in µg/m^3.

Figure D-3

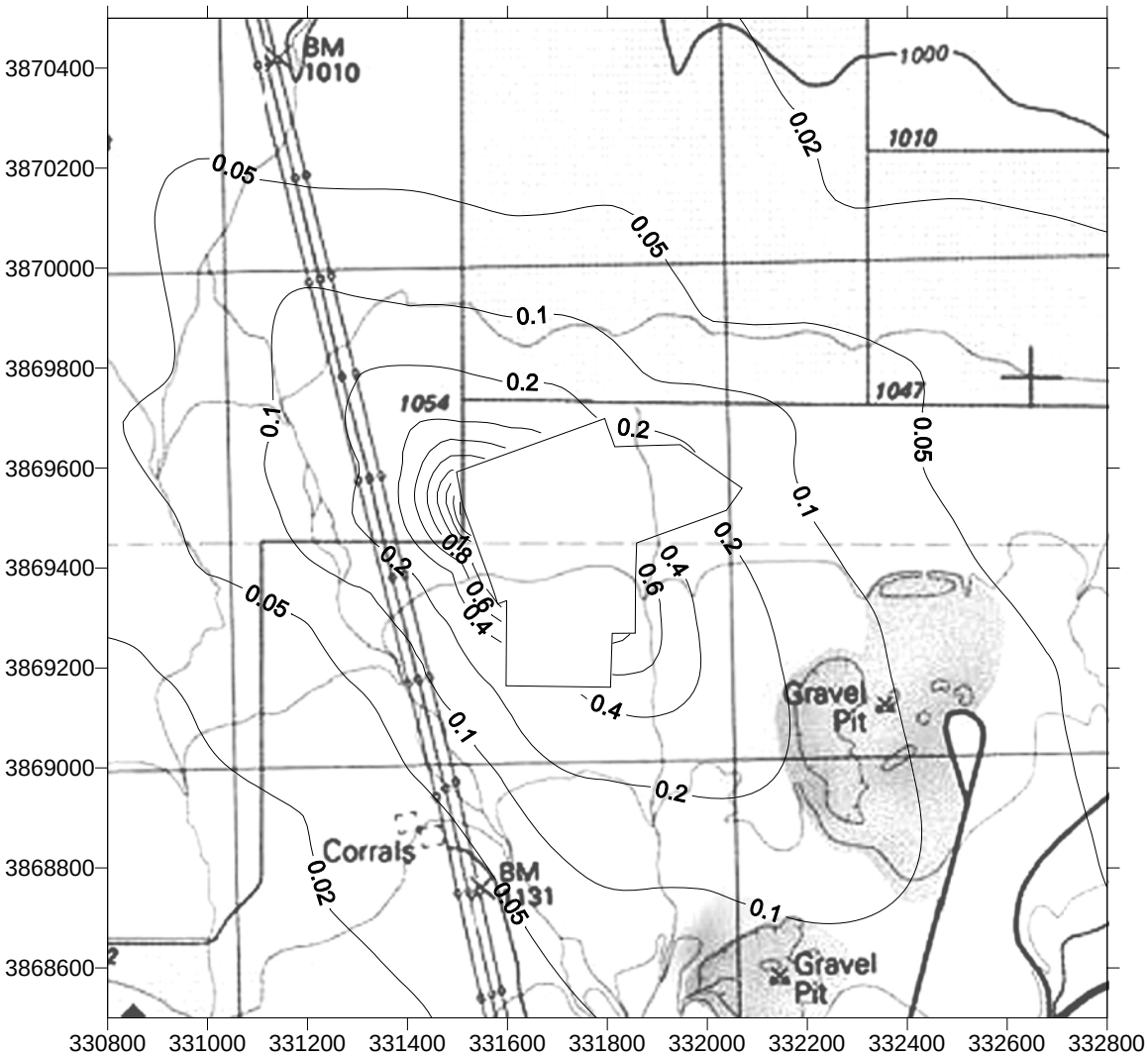
Maximum Annual Average $PM_{10}/PM_{2.5}$ Impacts During Construction Activities, Combustion Sources



Concentrations are shown in µg/m^3.

Figure D-4

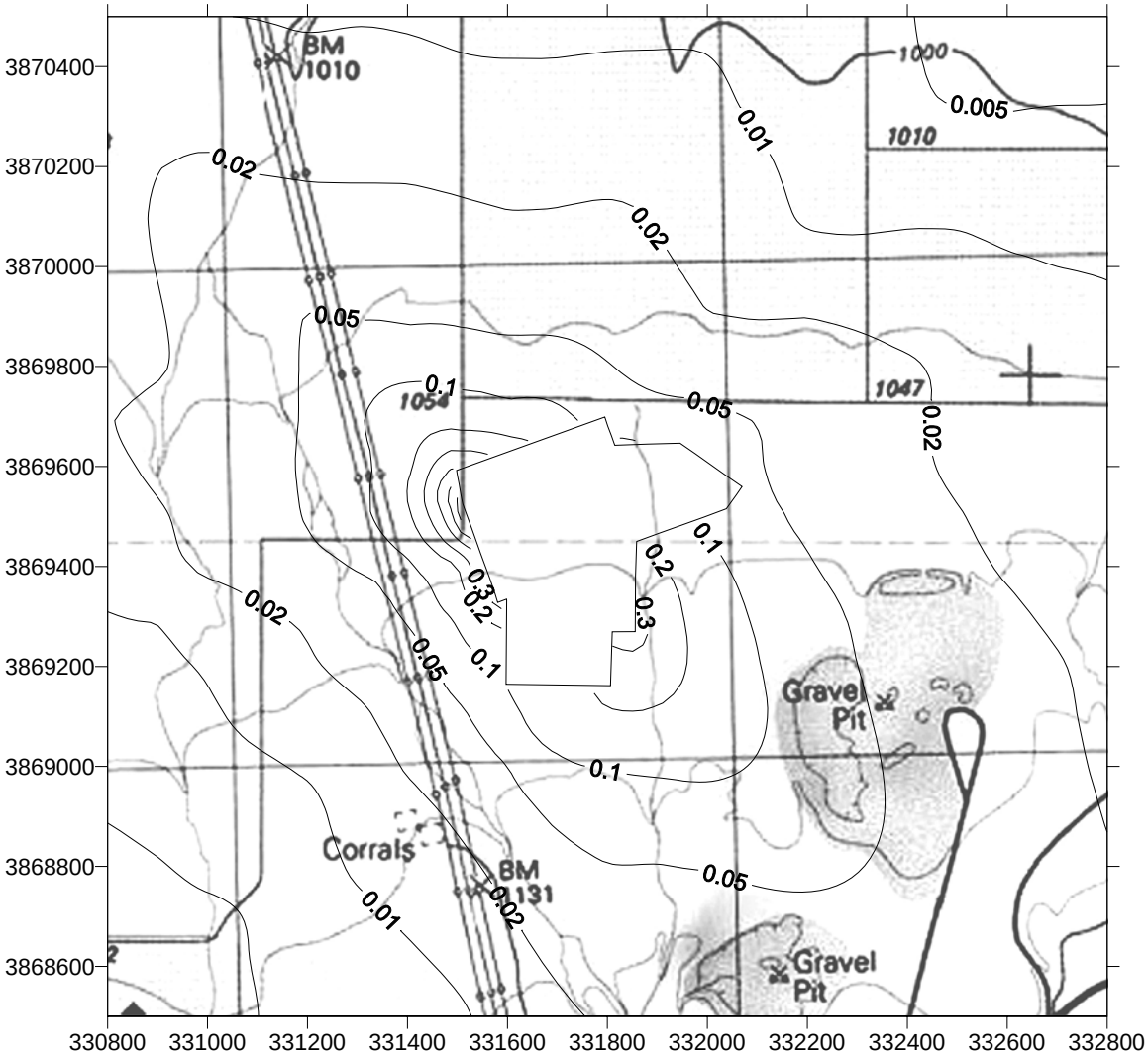
Maximum Annual Average PM_{10} Impacts During Construction Activities, All Sources



Concentrations are shown in µg/m^3.

Figure D-5

Maximum Annual Average $PM_{2.5}$ Impacts During Construction Activities, All Sources



Concentrations are shown in µg/m^3.

Attachment D-1

Detailed Construction Emissions Calculations

Daily Construction Emissions (peak month)						
(lbs/day)						
	NOx	CO	VOC	SOx	PM2.5	PM10
Onsite						
Construction Equipment	94.63	30.58	5.83	0.10	3.96	3.96
Fugitive Dust					1.82	14.67
Subtotal =	94.63	30.58	5.83	0.10	5.78	18.63
Offsite						
Worker Travel	19.44	198.44	16.33	0.14	1.27	1.27
Truck Deliveries	95.86	46.16	6.91	0.16	2.08	2.08
Subtotal =	115.30	244.60	23.24	0.30	3.35	3.35
Total =	209.93	275.19	29.07	0.40	9.13	21.98

Annual Construction Emissions (12-month period) (tons/yr)						
	NOx	CO	VOC	SOx	PM2.5	PM10
Onsite						
Construction Equipment	5.84	1.99	0.38	0.01	0.24	0.24
Fugitive Dust					0.14	1.13
Subtotal =	5.84	1.99	0.38	0.01	0.38	1.37
Offsite						
Worker Travel	1.60	16.36	1.35	0.01	0.10	0.10
Truck Deliveries	5.97	2.87	0.43	0.01	0.13	0.13
Subtotal =	7.57	19.23	1.78	0.02	0.23	0.23
Total =	13.41	21.22	2.16	0.03	0.62	1.61

Delivery Truck Daily Emissions (Maximum Monthly)												
Number of Deliveries Per Day(1)	Average Round Trip Haul Distance (miles)	Vehicle Miles Traveled Per Day	Emission Factors (lbs/vmt)(1)					Daily Emissions (lbs/day)				
			NOx	CO	POC	SOx	PM10	NOx	CO	POC	SOx	PM10
43	70	3010	0.0318	0.0153	0.0023	0.0001	0.0007	95.86	46.16	6.91	0.16	2.08
Idle exhaust (2)												0.1806

Notes:
(1) See notes for combustion emissions.
(2) 39 trucks per day times 1 hr idle time per visit times 0.0042 lb/hr.

Delivery Truck Annual Emissions												
Number of Deliveries Per Year	Average Round Trip Haul Distance (miles)	Vehicle Miles Traveled Per Year	Emission Factors (lbs/vmt)(1)					Annual Emissions (tons/yr)				
			NOx	CO	POC	SOx	PM10	NOx	CO	POC	SOx	PM10
5352	70	374640.00	0.0318	0.0153	0.0023	0.0001	0.0007	5.97	2.87	0.43	0.01	0.13
Idle exhaust (2,3)												0.01124

Notes:
(1) See notes for combustion emissions.
(2) Annual average of 10 trucks per day, 240 days per year times 1 hr idle time per visit times 0.0042 lb/hr
(3) Based on 1.91 g/hr idle emission rate for the composite HDD truck fleet in 2001 from EPA's PART5 model.

Worker Travel Daily Emissions (Maximum Daily)														
Number of Workers Per Day(1)	Average Vehicle Occupancy (person/veh.)	Number of Round Trips Per Day	Average Round Trip Haul Distance (Miles)	Vehicle Miles Traveled Per Day (Miles)	Emission Factors (lbs/vmt)(1)					Daily Emissions (lbs/day)				
					NOx	CO	POC	SOx	PM10	NOx	CO	POC	SOx	PM10
225	1	225	70	15,750	0.0012	0.0126	0.0010	0.0000	0.0001	19.44	198.44	16.33	0.14	1.27

Notes:
(1) See notes for combustion emissions.

Worker Travel Annual Emissions															
Average Number of Workers Per Day	Average Vehicle Occupancy (person/veh.)	Number of Round Trips Per Day	Average Round Trip Haul Distance (Miles)	Days per Year	Vehicle Miles Traveled Per Year	Emission Factors (lbs/vmt)(1)					Annual Emissions (tons/yr)				
						NOx	CO	POC	SOx	PM10	NOx	CO	POC	SOx	PM10
155	1	155	70	240	2,597,000	0.0012	0.0126	0.0010	0.0000	0.0001	1.60	16.36	1.35	0.01	0.10

Notes:
(1) See notes for combustion emissions.

Combustion Emission Ranking

Equipment	Hrs/Day Per Unit (1)	Gals/Hr Per Unit	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12
Backhoe	7	2.25	16	32	32	32	**32**	16	16	16	0	0	0	0
Boom Truck	7	3.13	0	22	22	44	**44**	44	44	44	22	22	22	22
Cranes, 15 ton	7	4.00	0	0	28	28	**28**	28	28	28	28	28	28	0
Cranes, 230 ton	7	7.50	0	0	0	105	**105**	105	53	53	0	0	0	0
Cranes, 25 ton	7	4.00	0	28	28	28	**56**	56	56	56	28	28	0	0
Dozer	7	4.00	0	0	0	0	**0**	0	0	0	0	0	0	0
Dump Truck, 2 ton	7	3.13	44	44	44	44	**44**	22	22	0	0	0	0	0
Excavator	7	3.70	0	26	26	26	**26**	26	0	0	0	0	0	0
Forklift	7	1.70	12	12	12	12	**24**	24	24	12	12	12	0	0
Manlift, 60 ft	7	1.72	0	0	0	0	**24**	24	24	24	24	24	0	0
Motor Grader	7	3.00	0	0	0	0	**0**	0	0	0	0	0	0	0
Pile Driving Eqt	7	7.50	0	0	0	0	**0**	0	0	0	0	0	0	0
Tandem Dump, 30 CY	7	3.13	22	22	22	0	**0**	0	0	0	0	0	0	0
Scrapers	7	7.50	0	0	0	0	**0**	0	0	0	0	0	0	0
Roller Compactors	7	3.25	23	23	23	23	**23**	0	0	0	0	0	0	0
Water truck	7	3.13	22	22	22	22	**22**	22	22	22	22	22	22	0
Welding Machine, Portable	7	1.27	0	9	9	27	**27**	27	27	18	9	9	9	0
Concrete Pumps	7	3.13	0	22	22	22	**0**	0	0	0	0	0	0	0
		Total =	138	260	288	411	453	393	314	272	145	145	81	22
		12-month Total =												2923

Note: (1) 7 hours of equipment operation during 10 hrs/day of construction activity.

Construction Equipment Daily Fuel Use (peak period)

Equipment	Gasoline/ Diesel	Number of Units	Hrs/Day Per Unit	Gals/Hr Per Unit	Total Fuel Use (Gals/day)
Backhoe	D	2	7	2.25	31.50
Boom Truck	D	2	7	3.13	43.82
Cranes, 15 ton	D	1	7	4.00	28.00
Cranes, 230 ton	D	2	7	7.50	105.00
Cranes, 25 ton	D	2	7	4.00	56.00
Dozer	D	0	7	4.00	0.00
Dump Truck, 2 ton	D	2	7	3.13	43.82
Excavator	D	1	7	3.70	25.90
Forklift	D	2	7	1.70	23.80
Manlift, 60 ft	D	2	7	1.72	24.14
Motor Grader	D	0	7	3.00	0.00
Pile Driving Eqt	D	0	7	7.50	0.00
Tandem Dump, 30 CY	D	0	7	3.13	0.00
Scrapers	D	0	7	7.50	0.00
Roller Compactors	D	1	7	3.25	22.75
Water truck	D	1	7	3.13	21.91
Welding Machine, Portable	D	3	7	1.27	26.67
Concrete Pump Truck	D	0	7	3.13	0.00

Total = 453.31

Construction Equipment Annual Fuel Use (12-month construction period)

Equipment	Gasoline/ Diesel	12-Month Average Number of Units Per Year(1)	Peak 12-Month Average Number of Units Per Year(1)	Average Operating Hrs/Day Per Unit	Gals/Hr Per Unit	Average Operating Days per Year	12-Month Average Total Fuel Use (Gals/yr)	Peak 12-Month Average Total Fuel Use (Gals/yr)
Backhoe	D	1.00	1.00	7	2.25	240	3,780	3,780
Boom Truck	D	1.33	1.33	7	3.13	240	7,011	7,011
Cranes, 15 ton	D	0.75	0.75	7	4.00	240	5,040	5,040
Cranes, 230 ton	D	0.67	0.67	7	7.50	240	8,400	8,400
Cranes, 25 ton	D	1.08	1.08	7	4.00	240	7,280	7,280
Dozer	D	0.00	0.00	7	4.00	240	0	0
Dump Truck, 2 ton	D	1.00	1.00	7	3.13	240	5,258	5,258
Excavator	D	0.42	0.42	7	3.70	240	2,590	2,590
Forklift	D	1.08	1.08	7	1.70	240	3,094	3,094
Manlift, 60 ft	D	1.00	1.00	7	1.72	240	2,896	2,896
Motor Grader	D	0.00	0.00	7	3.00	240	0	0
Pile Driving Eqt	D	0.00	0.00	7	7.50	240	0	0
Tandem Dump, 30 CY	D	0.25	0.25	7	3.13	240	1,315	1,315
Scrapers	D	0.00	0.00	7	7.50	240	0	0
Roller Compactors	D	0.42	0.42	7	3.25	240	2,275	2,275
Water truck	D	0.92	0.92	7	3.13	240	4,820	4,820
Welding Machine, Portable	D	1.58	1.58	7	1.27	240	3,378	3,378
Concrete Pump Truck	D	0.25	0.25	7	3.13	240	1,315	1,315

Total = 58,452 58,452

Onsite Combustion Emissions

			Base Factors g/bhp, if Tier 1 >50 hp (1)						Appendix A Table A3 Adjustment (2)						Adjustment (3)	Adjusted Factors (g/bhp)					
Equipment	HP Cat.	Tier	BSFC lb/h	NOx	CO	VOC	SOx	PM10	Adj. Type	NOx	CO	VOC	SOx	PM10	PM10 Fuel S	BSFC	NOx	CO	VOC	SOx	PM10
Backhoe	100-175	1	0.367	5.6523	0.8667	0.3384	0.00499	0.2799	LoLF	1.10	2.57	2.29	1.18	1.97	-0.101	0.433	6.22	2.23	0.77	0.0057	0.45
Boom Truck	Onroad	na	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad
Cranes, 15 ton	175-300	1	0.367	5.5772	0.7475	0.3085	0.00499	0.2521	None	1.00	1.00	1.00	1.00	1.00	-0.086	0.367	5.58	0.75	0.31	0.0049	0.17
Cranes, 230 ton	600-700	1	0.367	5.8215	1.3272	0.1473	0.00499	0.2201	None	1.00	1.00	1.00	1.00	1.00	-0.086	0.367	5.82	1.33	0.15	0.0049	0.13
Cranes, 23 ton	175-300	1	0.367	5.5772	0.7475	0.3085	0.00499	0.2521	None	1.00	1.00	1.00	1.00	1.00	-0.086	0.367	5.58	0.75	0.31	0.0049	0.17
Dozer	100-175	1	0.367	5.6523	0.8667	0.3384	0.00499	0.2799	Hi LF	0.95	1.53	1.05	1.01	1.23	-0.087	0.371	5.37	1.33	0.36	0.0049	0.26
Dump Truck, 2 ton	Onroad	na	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad
Excavator	175-300	1	0.367	5.5772	0.7475	0.3085	0.00499	0.2521	Hi LF	0.95	1.53	1.05	1.01	1.23	-0.087	0.371	5.30	1.14	0.32	0.0049	0.22
Forklift	50-100	1	0.408	5.5988	2.3655	0.5213	0.00555	0.4730	Hi LF	0.95	1.53	1.05	1.01	1.23	-0.096	0.412	5.32	3.62	0.55	0.0055	0.49
Manlift, 60 ft	25-50	1	0.408	4.7279	1.5323	0.2789	0.00555	0.3389	Hi LF	0.95	1.53	1.05	1.01	1.23	-0.096	0.412	4.49	2.34	0.29	0.0055	0.32
Motor Grader	100-175	1	0.367	5.6523	0.8667	0.3384	0.00499	0.2799	Hi LF	0.95	1.53	1.05	1.01	1.23	-0.087	0.371	5.37	1.33	0.36	0.0049	0.26
Pile Driving Eqt	600-700	1	0.367	5.8215	1.3272	0.1473	0.00499	0.2201	None	1.00	1.00	1.00	1.00	1.00	-0.086	0.367	5.82	1.33	0.15	0.0049	0.13
Tandem Dump, 30 CY	Onroad	na	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad
Scrapers	175-300	1	0.367	5.5772	0.7475	0.3085	0.00499	0.2521	Hi LF	0.95	1.53	1.05	1.01	1.23	-0.087	0.371	5.30	1.14	0.32	0.0049	0.22
Roller Compactors	100-175	1	0.367	5.6523	0.8667	0.3384	0.00499	0.2799	Hi LF	0.95	1.53	1.05	1.01	1.23	-0.087	0.371	5.37	1.33	0.36	0.0049	0.26
Water truck	Onroad	na	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad
Welding Machine, Portable	50-100	1	0.408	5.5988	2.3655	0.5213	0.00555	0.4730	Hi LF	0.95	1.53	1.05	1.01	1.23	-0.096	0.412	5.32	3.62	0.55	0.0055	0.49
Concrete Pump Truck	Onroad	na	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad

	Adjusted factors lbs/1000 gallon (4)						Total Daily Fuel Use(5) (Gals/day)	Daily Emissions Lbs/day					Total Annual Fuel Use(6) (Gals/yr)	Annual Emissions Lbs/yr				
Equipment	Tier	NOx	CO	VOC	SOx	PM10		NOx	CO	VOC	SOx	PM10		NOx	CO	VOC	SOx	PM10
Backhoe	1	224.73	80.51	28.01	0.21	16.27	31.50	7.08	2.54	0.88	0.01	0.51	3,780	849.47	304.32	105.88	0.78	61.49
Boom Truck	na	148.13	71.33	10.68	0.24	3.21	43.82	6.49	3.13	0.47	0.01	0.14	7,011	1038.57	500.14	74.91	1.69	22.53
Cranes, 15 ton	1	237.87	31.88	13.16	0.21	7.09	28.00	6.66	0.89	0.37	0.01	0.20	5,040	1198.85	160.68	66.31	1.05	35.74
Cranes, 230 ton	1	248.29	56.61	6.28	0.21	5.73	105.00	26.07	5.94	0.66	0.02	0.60	8,400	2085.61	475.48	52.77	1.75	48.09
Cranes, 23 ton	1	237.87	31.88	13.16	0.21	7.09	56.00	13.32	1.79	0.74	0.01	0.40	7,280	1731.68	232.09	95.79	1.51	51.62
Dozer	1	226.75	56.00	15.00	0.21	10.88	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00
Dump Truck, 2 ton	na	148.13	71.33	10.68	0.21	3.21	43.82	6.49	3.13	0.47	0.01	0.14	5,258	778.93	375.10	56.18	1.10	16.90
Excavator	1	223.74	48.29	13.68	0.21	9.43	25.90	5.79	1.25	0.35	0.01	0.24	2,590	579.48	125.08	35.43	0.54	24.43
Forklift	1	202.03	137.47	20.79	0.21	18.44	23.80	4.81	3.27	0.49	0.00	0.44	3,094	625.09	425.34	64.33	0.64	57.04
Manlift, 60 ft	1	170.61	89.05	11.12	0.21	12.17	24.14	4.12	2.15	0.27	0.01	0.29	2,896	494.11	257.91	32.22	0.60	35.25
Motor Grader	1	226.75	56.00	15.00	0.21	10.88	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00
Pile Driving Eqt	1	248.29	56.61	6.28	0.21	5.73	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00
Tandem Dump, 30 CY	na	148.13	71.33	10.68	0.24	3.21	0.00	0.00	0.00	0.00	0.00	0.00	1,315	194.73	93.78	14.05	0.32	4.22
Scrapers	1	223.74	48.29	13.68	0.21	9.43	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00
Roller Compactors	1	226.75	56.00	15.00	0.21	10.88	22.75	5.16	1.27	0.34	0.00	0.25	2,275	515.86	127.39	34.13	0.47	24.74
Water truck	na	148.13	71.33	10.68	0.24	3.21	21.91	3.25	1.56	0.23	0.01	0.07	4,820	714.02	343.84	51.50	1.16	15.49
Welding Machine, Portable	1	202.03	137.47	20.79	0.21	18.44	26.67	5.39	3.67	0.55	0.01	0.49	3,378	682.51	464.41	70.24	0.70	62.28
Concrete Pump Truck	na	148.13	71.33	10.68	0.24	3.21	0.00	0.00	0.00	0.00	0.00	0.00	1,315	194.73	93.78	14.05	0.32	4.22
Total =							453.31	94.63	30.58	5.83	0.10	3.78	58,452.43	11,683.64	3,979.35	767.77	12.64	464.06
														5.84	1.99	0.38	0.01	0.23 tons/yr

(1) - Steady State Emission Factors from Table A2 of EPA November 2002 NR-009b Publication.
(2) - In use adjustment factors per Table A3 EPA November 2002 NR-009b Publication.
(3) - PM10 and SO2 adjustments due to Equation 5 and Equation 7 on pages 18 and 19, Respectively of EPA Report No. NR-009b
(4) - Calculation uses adjusted BSFC and assumed 7.1 lbs/gallon. The onroad emission factors are not adjusted.
(5) - Daily fuel use based on peak combustion month equipment schedule.
(6) - Annual fuel use based on average level during peak 12-month period.

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Run Date : 03/05/05 15:05:26
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Area : Kern County Average
I/M Stat : I and M program in effect
Emissions: Tons Per Day

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	LDA-NCAT	LDA-CAT	LDA-DSL	LDA-TOT	LDT1-NCAT	LDT1-CAT	LDT1-DSL	LDT1-TOT	LDT2-NCA	LDT2-CAT	LDT2-DSL	LDT2-TOT	MDV-NCAT	MDV-CAT	MDV-DSL
Vehicles	4298	238506	639	243444	3584	109631	2916	116132	2129	80825	857	83811	712	30552	816
VMT/1000	59	10968	17	11044	102	4881	116	5099	60	3613	37	3709	21	1368	36
Trips	17818	1506150	3580	1527550	15073	686953	17832	719858	9097	509194	5306	523598	3146	191944	5152
Reactive Organic Gas Emissions															
Run Exh	0.39	0.86	0	1.25	0.7	0.65	0.02	1.37	0.4	0.51	0	0.91	0.16	0.27	0
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start Ex	0.11	1.13	0	1.24	0.09	0.58	0	0.67	0.05	0.48	0	0.54	0.02	0.25	0
Total Ex	0.51	1.98	0	2.49	0.79	1.23	0.02	2.04	0.45	0.99	0	1.45	0.18	0.52	0
Diurnal	0.04	0.3	0	0.34	0.04	0.18	0	0.21	0.02	0.11	0	0.14	0	0.05	0
Hot Soak	0.06	0.18	0	0.24	0.05	0.1	0	0.15	0.03	0.07	0	0.1	0.01	0.03	0
Running	0.35	0.98	0	1.34	0.19	0.76	0	0.95	0.1	0.54	0	0.64	0.02	0.21	0
Resting	0.02	0.09	0	0.1	0.01	0.05	0	0.07	0.01	0.03	0	0.04	0	0.02	0
Total	0.98	3.53	0	4.51	1.08	2.33	0.02	3.42	0.61	1.74	0	2.36	0.22	0.83	0
Carbon Monoxide Emissions															
Run Exh	5.39	32.96	0.01	38.36	9.27	25.9	0.08	35.25	5.27	18.32	0.02	23.62	2.74	7.62	0.02
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start Ex	0.62	12.82	0	13.44	0.53	7.72	0	8.25	0.31	5.83	0	6.14	0.17	2.74	0
Total Ex	6.02	45.77	0.01	51.8	9.8	33.63	0.08	43.5	5.59	24.15	0.02	29.76	2.91	10.36	0.02
Oxides of Nitrogen Emissions															
Run Exh	0.32	3.6	0.03	3.95	0.54	2.75	0.18	3.48	0.31	2.73	0.06	3.11	0.15	1.45	0.06
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start Ex	0.03	0.8	0	0.82	0.02	0.38	0	0.41	0.01	0.48	0	0.49	0.01	0.21	0
Total Ex	0.35	4.39	0.03	4.77	0.56	3.14	0.18	3.88	0.32	3.21	0.06	3.6	0.16	1.66	0.06
Carbon Dioxide Emissions (000)															
Run Exh	0.03	4.39	0.01	4.43	0.05	2.4	0.04	2.49	0.03	1.78	0.01	1.83	0.01	0.93	0.01
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start Ex	0	0.12	0	0.13	0	0.07	0	0.07	0	0.05	0	0.05	0	0.03	0
Total Ex	0.04	4.51	0.01	4.55	0.06	2.46	0.04	2.56	0.03	1.83	0.01	1.88	0.01	0.95	0.01
PM10 Emissions															
Run Exh	0	0.14	0	0.14	0	0.07	0.01	0.08	0	0.1	0	0.1	0	0.04	0
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start Ex	0	0.01	0	0.01	0	0.01	0	0.01	0	0.01	0	0.01	0	0	0
Total Ex	0	0.15	0	0.15	0	0.07	0.01	0.08	0	0.11	0	0.11	0	0.04	0
TireWear	0	0.1	0	0.1	0	0.04	0	0.04	0	0.03	0	0.03	0	0.01	0
BrakeWr	0	0.15	0	0.15	0	0.07	0	0.07	0	0.05	0	0.05	0	0.02	0
Total	0	0.4	0	0.4	0.01	0.18	0.01	0.2	0	0.19	0	0.2	0	0.07	0
Lead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SOx	0	0.04	0	0.04	0	0.02	0	0.03	0	0.02	0	0.02	0	0.01	0
Fuel Consumption (000 gallons)															
Gasoline	4.74	469.95	0	474.68	7.68	258.06	0	265.73	4.47	191.85	0	196.32	1.89	99.62	0
Diesel	0	0	0.61	0.61	0	0	3.99	3.99	0	0	1.27	1.27	0	0	1.24

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	MDV-TOT	LHDT1-NC	LHDT1-CA	LHDT1-DSI	LHDT1-TO	LHDT2-NC	LHDT2-CA	LHDT2-DSI	LHDT2-TO	MHDT-NCA	MHDT-CAT	MHDT-DSL	MHDT-TOT	HHDT-NCA	HHDT-CAT	HHDT-DSL	HHDT-TOT	LHV-NCAT	LHV-CAT
Vehicles	32080	194	7030	1437	8661	0	1785	1437	3222	294	1763	5448	7505	55	322	6114	6491	0	0
VMT/1000	1425	2	503	118	623	0	113	98	211	3	94	395	492	1	31	1126	1158	0	0
Trips	200242	6420	232460	18079	256960	14	59011	18075	77100	13406	80525	152761	246692	2510	14696	30941	48147	0	0
Reactive Organic Gas Emissions																			
Run Exh	0.43	0.02	0.09	0.05	0.16	0	0.04	0.06	0.1	0.02	0.09	0.15	0.26	0.02	0.13	0.91	1.05	0	0
Idle Exh	0	0	0.01	0	0.01	0	0	0	0	0	0	0	0.01	0	0	0.05	0.05	0	0
Start Ex	0.28	0.05	0.14	0	0.19	0	0.05	0	0.05	0.16	0.15	0	0.31	0.06	0.09	0	0.15	0	0
Total Ex	0.71	0.07	0.24	0.05	0.36	0	0.1	0.06	0.16	0.18	0.24	0.15	0.58	0.07	0.22	0.96	1.25	0	0
Diurnal	0.05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hot Soak	0.04	0.01	0.01	0	0.01	0	0	0	0	0.01	0.01	0	0.02	0	0	0	0	0	0
Running	0.23	0.04	0.14	0	0.18	0	0.08	0	0.08	0.06	0.2	0	0.26	0.01	0.06	0	0.07	0	0
Resting	0.02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1.05	0.12	0.39	0.05	0.56	0	0.18	0.06	0.24	0.25	0.46	0.15	0.86	0.09	0.28	0.96	1.33	0	0
Carbon Monoxide Emissions																			
Run Exh	10.38	0.34	0.93	0.18	1.46	0	0.56	0.17	0.74	0.53	1.33	1.03	2.88	0.62	1.98	3.61	6.21	0	0
Idle Exh	0	0	0.06	0	0.06	0	0.02	0	0.02	0	0.02	0.02	0.04	0	0	0.3	0.3	0	0
Start Ex	2.91	0.3	1.44	0	1.74	0	0.6	0	0.6	0.94	2.77	0	3.71	0.86	1.51	0	2.37	0	0
Total Ex	13.29	0.65	2.43	0.18	3.26	0	1.18	0.18	1.35	1.47	4.12	1.04	6.63	1.48	3.49	3.91	8.88	0	0
Oxides of Nitrogen Emissions																			
Run Exh	1.66	0.01	0.23	0.71	0.94	0	0.1	0.64	0.75	0.01	0.33	4.17	4.51	0.03	0.52	16.8	17.35	0	0
Idle Exh	0	0	0	0	0.01	0	0	0	0	0	0	0.05	0.05	0	0	0.92	0.92	0	0
Start Ex	0.22	0	0.42	0	0.42	0	0.13	0	0.13	0.02	0.27	0	0.29	0.01	0.16	0	0.17	0	0
Total Ex	1.88	0.01	0.65	0.71	1.37	0	0.24	0.65	0.89	0.03	0.6	4.22	4.85	0.04	0.68	17.72	18.44	0	0
Carbon Dioxide Emissions (000)																			
Run Exh	0.95	0	0.54	0.07	0.61	0	0.12	0.06	0.18	0	0.07	0.66	0.73	0	0.02	2.69	2.71	0	0
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.05	0.05	0	0
Start Ex	0.03	0	0.01	0	0.01	0	0	0	0	0	0	0	0.01	0	0	0	0	0	0
Total Ex	0.98	0	0.55	0.07	0.62	0	0.12	0.06	0.18	0.01	0.07	0.66	0.74	0	0.02	2.73	2.75	0	0
PM10 Emissions																			
Run Exh	0.04	0	0.01	0.01	0.02	0	0	0.01	0.01	0	0	0.13	0.13	0	0	0.32	0.32	0	0
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.02	0.02	0	0
Start Ex	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Ex	0.05	0	0.01	0.01	0.02	0	0	0.01	0.01	0	0	0.13	0.13	0	0	0.34	0.34	0	0
TireWear	0.01	0	0.01	0	0.01	0	0	0	0	0	0	0.01	0.01	0	0	0.04	0.05	0	0
BrakeWr	0.02	0	0.01	0	0.01	0	0	0	0	0	0	0.01	0.01	0	0	0.02	0.02	0	0
Total	0.08	0	0.02	0.01	0.04	0	0.01	0.01	0.02	0	0	0.14	0.14	0	0	0.4	0.4	0	0
Lead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SOx	0.01	0	0.01	0	0.01	0	0	0	0	0	0	0.01	0.01	0	0	0.03	0.03	0	0
Fuel Consumption (000 gallons)																			
Gasoline	101.5	0.5	56.77	0	57.28	0	12.9	0	12.91	0.85	8.4	0	9.25	0.38	2.72	0	3.09	0	0
Diesel	1.24	0	0	6.14	6.14	0	0	5.16	5.16	0	0	59.2	59.2	0	0	245.88	245.88	0	0

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	LHV-DSL	LHV-TOT	SBUS-NCA	SBUS-CAT	SBUS-DSL	SBUS-TOT	UB-NCAT	UB-CAT	UB-DSL	UB-TOT	MH-NCAT	MH-CAT	MH-DSL	MH-TOT	MCY-NCAT	MCY-CAT	MCY-DSL	MCY-TOT	ALL-TOT
Vehicles	0	0	28	146	754	929	50	195	274	518	801	7638	538	8978	8842	1745	0	10587	522357
VMT/1000	0	0	1	8	40	49	7	30	42	79	13	142	10	166	94	21	0	115	24168
Trips	0	0	113	585	3017	3715	199	779	1095	2073	80	764	54	898	17682	3490	0	21172	3628010
Reactive Organic Gas Emissions																			
Run Exh	0	0	0.01	0.02	0.03	0.06	0.08	0.22	0.05	0.34	0.09	0.12	0	0.22	0.45	0.05	0	0.5	6.66
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.07
Start Ex	0	0	0	0	0	0	0	0.01	0	0.01	0	0	0	0	0.05	0.01	0	0.06	3.5
Total Ex	0	0	0.01	0.03	0.03	0.07	0.08	0.23	0.05	0.35	0.09	0.12	0	0.22	0.51	0.06	0	0.56	10.24
Diurnal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0.02	0	0.03	0.78
Hot Soak	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0.01	0.58
Running	0	0	0	0	0	0.01	0	0	0	0.01	0	0	0	0	0.06	0.02	0	0.08	3.86
Resting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0.24
Total	0	0	0.02	0.03	0.03	0.08	0.08	0.23	0.05	0.36	0.09	0.13	0	0.23	0.59	0.11	0	0.7	15.69
Carbon Monoxide Emissions																			
Run Exh	0	0	0.28	0.29	0.19	0.76	1.57	1.02	0.22	2.81	2.28	2.93	0.02	5.23	6.71	0.72	0	7.43	135.11
Idle Exh	0	0	0	0.01	0.01	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0.45
Start Ex	0	0	0.01	0.05	0	0.06	0.02	0.09	0	0.11	0.01	0.02	0	0.03	0.16	0.07	0	0.23	39.59
Total Ex	0	0	0.29	0.35	0.2	0.84	1.59	1.11	0.22	2.92	2.29	2.95	0.02	5.26	6.87	0.79	0	7.66	175.15
Oxides of Nitrogen Emissions																			
Run Exh	0	0	0.01	0.04	0.6	0.65	0.03	0.22	1.05	1.3	0.05	0.38	0.12	0.55	0.15	0.03	0	0.18	38.43
Idle Exh	0	0	0	0	0.04	0.04	0	0	0	0	0	0	0	0	0	0	0	0	1.01
Start Ex	0	0	0	0	0	0	0	0.01	0	0.01	0	0	0	0	0.01	0	0	0.01	2.98
Total Ex	0	0	0.01	0.04	0.64	0.68	0.03	0.23	1.05	1.31	0.05	0.38	0.12	0.56	0.16	0.03	0	0.19	42.42
Carbon Dioxide Emissions (000)																			
Run Exh	0	0	0	0.01	0.07	0.07	0.01	0.02	0.13	0.16	0.01	0.11	0.02	0.13	0.01	0	0	0.01	14.3
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.06
Start Ex	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3
Total Ex	0	0	0	0.01	0.07	0.08	0.01	0.02	0.13	0.16	0.01	0.11	0.02	0.13	0.01	0	0	0.02	14.66
PM10 Emissions																			
Run Exh	0	0	0	0	0.02	0.02	0	0	0.02	0.02	0	0	0	0	0.01	0	0	0.01	0.9
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.02
Start Ex	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.04
Total Ex	0	0	0	0	0.02	0.02	0	0	0.02	0.02	0	0	0	0	0.01	0	0	0.01	0.95
TireWear	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.25
BrakeWr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.33
Total	0	0	0	0	0.03	0.03	0	0	0.02	0.02	0	0	0	0.01	0.01	0	0	0.01	1.54
Lead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SOx	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.14
Fuel Consumption (000 gallons)																			
Gasoline	0	0	0.18	0.75	0	0.93	0.91	2.79	0	3.71	1.42	11.56	0	12.98	2.5	0.46	0	2.96	1141.33
Diesel	0	0	0	0	6.09	6.09	0	0	11.68	11.68	0	0	1.52	1.52	0	0	0	0	342.78

Notes - Combustion Emissions

(1) For Construction Equipment
For Diesel construction equipment, emission factors based on equipment meeting EPA Tier I off-road Diesel standards and use of CARB ultra low-sulfur fuel.
For trucks, depending on size of truck, emissions factors based on EMFAC 2002 v.2.2 for heavy-heavy duty or medium duty Diesel trucks, fleet average for calendar year 2007.

(2) For Delivery Trucks
From EMFAC 2002 V.2.2, heavy-heavy duty Diesel trucks, fleet average for calendar year 2007, Kern County.

(3) For Worker Travel
From EMFAC 2002 v.2.2, average of light duty automobiles and light duty trucks, fleet average for calendar year 2007.

	Emission Factors (1)				
	NOx	CO	VOC	SOx	PM10
Truck Hauling (lbs/vmt)	0.03185	0.01534	0.00230	0.00005	0.00069
Truck Hauling (lbs/1000 gals)	148.13030	71.33390	10.68402	0.24099	3.21324

Notes:
(1) From EMFAC 2002 V.2.2, heavy-heavy duty Diesel trucks, fleet average for calendar year 2007, Kern County.

	Emission Factors				
	NOx	CO	POC	SOx	PM10
Light Duty Trucks/Cars (lbs/vmt)(1)	0.00123	0.01260	0.00104	0.00001	0.00008
Light Duty Trucks (lbs/1000 gals)(2)	32.01301	313.53919	24.73733	0.21399	1.71193
Medium Duty Trucks (lbs/1000 gals)(3)	36.60	258.71	20.44	0.19	1.56

Notes:
(1) From EMFAC 2002 v.2.2, average of light duty automobiles and light duty trucks, fleet average for calendar year 2007, Kern County.
(2) From EMFAC 2002 v2.2, light duty trucks (gasoline and Diesel), fleet average for calendar year 2007, Kern County.
(3) From EMFAC 2002 v2.2, medium duty trucks (gasoline and Diesel), fleet average for calendar year 2007, Kern County.

Gasoline Equipment Factors - Small Engines

			(gm/bhp-hr)		
	NOx	CO	POC	SO2	PM10
Small Equipment(1) (g/bhp-hr)	2.03	353.00	19.13	0.00	0.06
Small Equipment(1) (lb/1000 gal)	79.44	13813.38	748.58	0.00	2.35

Notes:

(1) From EPA's "Non-road Engine and Vehicle Emission Study Report", 11/91, Table 2-07, for generator sets, welders, pumps, and air compressors less than 50 hp.

Dust Emission Ranking

Equipment	Hrs/Day Per Unit (1	PM10 lbs/hr Per Unit	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12
Backhoe	7	0.19	1.33	2.66	2.66	2.66	**2.66**	1.33	1.33	1.33	0.00	0.00	0.00	0.00
Boom Truck	7	1.26	0.00	8.83	8.83	17.65	**17.65**	17.65	17.65	17.65	8.83	8.83	8.83	8.83
Cranes, 15 ton	7	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cranes, 230 ton	7	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cranes, 25 ton	7	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dozer	7	0.42	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dump Truck, 2 ton	7	0.19	2.66	2.66	2.66	2.66	**2.66**	1.33	1.33	0.00	0.00	0.00	0.00	0.00
Excavator	7	0.19	0.00	1.33	1.33	1.33	**1.33**	1.33	0.00	0.00	0.00	0.00	0.00	0.00
Forklift, CAT V200	7	0.18	1.26	1.26	1.26	1.26	**2.52**	2.52	2.52	1.26	1.26	1.26	0.00	0.00
Manlift, 60 ft	7	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Motor Grader	7	0.06	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pile Driving Eqt	7	--	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tandem Dump, 30 CY	7	0.19	1.33	1.33	1.33	0.00	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Scrapers	7	0.42	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Roller Compactors	7	0.06	0.42	0.42	0.42	0.42	**0.42**	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Water truck	7	0.30	2.10	2.10	2.10	2.10	**2.10**	2.10	2.10	2.10	2.10	2.10	2.10	0.00
Welding Machine, Portable	7	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Concrete Pumps	7	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Total =	9.1	20.6	20.6	28.1	29.3	26.3	24.9	22.3	12.2	12.2	10.9	8.8
			31%	70%	70%	96%	**100%**	90%	85%	76%	42%	42%	37%	30%
		12-month Total =												225

Note: (1) 7 hours of equipment operation during 10 hrs/day of construction activity.

Daily Fugitive Dust Emissions (peak month)									
Equipment	Number of Units	Daily Process Rate Per Unit	Total Process Rate	Units	PM2.5 Emission Factor(1) (lbs/unit)	PM10 Emission Factor(1) (lbs/unit)	Control Factor(1) (%)	PM2.5 Emissions (lbs/day)	PM10 Emissions (lbs/day)
Backhoe	2	882.0	1,764.0	tons	5.305E-05	0.0015	0%	0.09	2.66
Boom Truck	2	1.1	2.3	vmt	0.22	1.4328	89%	0.06	0.37
Dozer	0	7.0	0.0	hr	0.23	0.4194	0%	0.00	0.00
Compactor - Unpaved Road Travel	1	6.8	6.8	vmt	0.02	0.2754	0%	0.13	1.88
Scraper - Excavation	0	7.0	0.0	hr	0.23	0.4194	0%	0.00	0.00
Scraper - Unpaved Road Travel	0	11.4	0.0	vmt	0.53	3.4638	89%	0.00	0.00
Excavator	1	735.0	735.0	tons	3.2E-05	0.0001	0%	0.02	0.07
Water Truck Unpaved Road Travel	1	6.8	6.8	vmt	0.44	2.8400	89%	0.34	2.19
Forklift Unpaved Road Travel	2	3.4	6.8	vmt	0.26	1.7100	89%	0.20	1.32
Dump Truck Unpaved Road Travel	2	3.0	6.0	vmt	0.46	2.9806	89%	0.31	2.01
Dump Truck Unloading	2	367.5	735.0	tons	3.2E-05	0.0001	0%	0.02	0.07
Motor Grader	0	6.8	0.0	vmt	0.02	0.2754	89%	0.00	0.00
Manlift, 60 ft	0	3.4	0.0	vmt	0.22	1.4328	89%	0.00	0.00
Tandem Dump Unpaved Road Travel	0	3.6	0.0	vmt	0.46	2.9806	89%	0.00	0.00
Tandem Dump Unloading	0	882.0	0.0	tons	3.20E-05	0.0001	0%	0.00	0.00
Windblown Dust (active construction area)	N/A	43,200.0	43,200.0	sq.ft.	6.728E-06	1.682E-05	89%	0.03	0.08
Worker Gravel Road Travel	225	0.1	29.2	vmt	0.12	0.7705	89%	0.39	2.55
Delivery Truck Gravel Road Travel	43	0.1	5.6	vmt	0.35	2.3088	89%	0.22	1.46
Total =								1.82	14.67

Notes:
(1) See notes for fugitive dust emission calculations.

Annual Fugitive Dust Emissions					
Activity	Average Daily PM2.5 Emissions(1) (lbs/day)	Average Daily PM10 Emissions(1) (lbs/day)	Days per Year	Annual PM2.5 Emissions (tons/yr)	Annual PM10 Emissions (tons/yr)
Construction Activities	1.15	9.34	240	0.14	1.12
Windblown Dust	0.02	0.05	365	0.00	0.01
Total =				0.14	1.13

Notes:
(1) Based on average of daily emissions during 12-month construction period.

Notes - Fugitive Dust Emission Calculations

(1) Wind erosion of active construction area - 'Source: "Improvement of Specific Emission Factors (BACM Project No. 1), Final Report", prepared for South Coast AQMD by Midwest Research Institute, March 1996

Level 2 Emission Factor =	0.011	ton/acre-month
Construction Schedule =	30	days/month
=	0.7	lbs/acre-day
=	1.682E-05	PM10 lbs/scf-day
	6.7278E-06	PM2.5 lbs/scf-day

(2) Material Unloading - Source: AP-42, p. 13.2.4-3, 1/95

E = (k)(0.0032)[(U/5)^1.3]/[(M/2)^1.4]

k = particle size constant =	0.35	for PM10
k = particle size constant =	0.11	for PM2.5
U = average wind speed =	3.10	m/sec (based on project area wind data)
=	6.92	mph
M = moisture content =	15.0%	(SCAQMD CEQA Handbook, Table A9-9-G-1, moist soil)
E = PM10 emission factor =	0.0001	lb/ton
E = PM2.5 emission factor =	0.00003	lb/ton

(3) Loader Unpaved Road Travel - Source: AP-42, Section 13.2.2, 12/03

E = (k)[(s/12)^0.9][(W/3)^0.45]

k = particle size constant =	1.5	for PM10
k = particle size constant =	0.23	for PM2.5
s = surface silt content =	8.50	(AP-42, Table 13.2.2-1, 12/03, construction haul route)
W = avg. vehicle weight =	10.35	tons (avg. of loaded and unloaded weights, 966F loader, Caterpillar Performance Handbook, 10/97)
E = PM10 emission factor =	1.92	lb PM10/VMT
E = PM2.5 emission factor =	0.29	lb PM2.5/VMT
Soil Density =	1.05	ton/yd3 (Caterpillar Performance Handbook, 10/89)
Loader Bucket Capacity =	5	yd3 (966F loader, Caterpillar Performance Handbook, 10/97)
=	5.25	ton/load
Daily Soil Transfer Rate =	735	ton/day (operating 7 hrs/day)
Daily Loader Trips =	140	loading trips/day
Loading Travel Distance =	50	ft/load (estimated)
Daily Loader Travel Distance =	7,000	ft/day
=	1.3	mi/day

Notes - Fugitive Dust Emission Calculations

(5) Unpaved Road Travel - Source: AP-42, Section 13.2.2, 12/03.

E = (k)[(s/12)^0.9*(W/3)^0.45

k = particle size constant =	1.5	for PM10
k = particle size constant =	0.23	for PM2.5
s = silt fraction =	8.50	(AP-42, Table 13.2.2-1, 12/03, constructior
W = water truck avg. veh. weight =	10.0	tons empty (estimated)
=	39.4	tons loaded (estimated with 8,000 gallon water capacity)
=	24.7	tons average
W = dump truck avg. veh. weight =	15.0	tons (for heavy duty Diesel trucks)
=	40.0	tons (for heavy duty Diesel trucks)
=	27.5	tons (for heavy duty Diesel trucks)
W = forklift avg. veh. weight =	8.0	tons empty (estimated)
W = auto/pickup avg. vehicle weight =	2.4	tons (CARB Area Source Manual, 9/97)
W = delivery truck avg. veh. wt. =	27.5	tons (for heavy duty Diesel trucks)
W = 3 ton truck avg. veh. Wt =	5.4	tons (estimate)
W = scraper avg. veh. wt. =	28.2	tons empty (615 scraper, Caterpillar Performance Handbook, 10/89)
	48.6	tons loaded (615 scraper, Caterpillar Performance Handbook, 10/89)
	38.4	tons mean weight
W = fuel truck avg. veh. weight =	8.0	tons empty (estimated)
=	18.2	tons loaded (estimated with 3,000 gallons Diesel fuel capacity)
=	13.1	tons average
E = water truck emission factor =	2.84	lb PM10/VMT
E = dump truck emission factor =	2.98	lb PM10/VMT
E = forklift emiss. factor =	1.71	lb PM10/VMT
E = auto/pickup emiss. factor =	0.99	lb PM10/VMT
E = delivery truck emiss. factor =	2.98	lb PM10/VMT
E = 3-ton truck emiss. factor =	1.43	lb PM10/VMT
E = scraper emiss. factor =	3.46	lb PM10/VMT
E = fuel truck emiss. factor =	2.13	lb PM10/VMT
E = water truck emission factor =	0.44	lb PM2.5/VMT
E = dump truck emission factor =	0.46	lb PM2.5/VMT
E = forklift emiss. factor =	0.26	lb PM2.5/VMT
E = auto/pickup emiss. factor =	0.15	lb PM2.5/VMT
E = delivery truck emiss. factor =	0.46	lb PM2.5/VMT
E = 3-ton truck emiss. factor =	0.22	lb PM2.5/VMT
E = scraper emiss. factor =	0.53	lb PM2.5/VMT
E = fuel truck emiss. factor =	0.33	lb PM2.5/VMT

Gravel Road Travel - Source: AP-42, Section 13.2.2, 12/03.

E = (k)[(s/12)^0.9*(W/3)^0.45

k = particle size constant =	1.5	for PM10
k = particle size constant =	0.23	for PM2.5
s = silt fraction =	6.40	(AP-42, Table 13.2.2-1, 12/03, gravel road)
W = water truck avg. veh. weight =	10.0	tons empty (estimated)
=	39.4	tons loaded (estimated with 8,000 gallon water capacity)
=	24.7	tons average
W = dump truck avg. veh. weight =	15.0	tons (for heavy duty Diesel trucks)
=	40.0	tons (for heavy duty Diesel trucks)
=	27.5	tons (for heavy duty Diesel trucks)
W = forklift avg. veh. weight =	8.0	tons empty (estimated)
W = auto/pickup avg. vehicle weight =	2.4	tons (CARB Area Source Manual, 9/97)
W = delivery truck avg. veh. wt. =	27.5	tons (for heavy duty Diesel trucks)
E = auto/pickup emiss. factor =	0.77	lb PM10/VMT
E = delivery truck emiss. factor =	2.31	lb PM10/VMT
E = auto/pickup emiss. factor =	0.12	lb PM2.5/VMT
E = delivery truck emiss. factor =	0.35	lb PM2.5/VMT

Notes - Fugitive Dust Emission Calculations

(6) Unpaved Road Travel and Active Excavation Area Control - Source: Control of Open Fugitive Dust Sources, U.S EPA, 9/88

C = 100 - (0.8)(p)(d)(t)/(i)

p = potential average hourly daytime		
evaporation rate =	0.52	mm/hr (EPA document, Figure 3-2, summer)
evaporation rate =	0.392	mm/hr (EPA document, Figure 3-2, annual)
d = average hourly daytime traffic rate =	37.0	vehicles/hr (estimated)
t = time between watering applications =	1.00	hr/application (estimated)
i = application intensity =	1.4	L/m2 (typical level in EPA document, page 3-23)
C = average summer watering control efficienc	88.7%	
C = average annual watering control efficiency	91.5%	

(7) Finish Grading - Source: AP-42, Table 11.9-1, 7/98

E = (0.60)(0.051)(S^2.0)

S = mean vehicle speed =	3.0	mph (estimate)
E = emission factor =	0.2754	PM10 lb/VMT
E = emission factor =	0.0193	PM2.5 lb/VMT

(8) Bulldozer Operation and Scraper Excavation - Source: AP-42, Table 11.9.1, 7/98

E = (0.75)(s^1.5)/(M^1.4)

s = silt content =	8.5%	(AP-42, Table 13.2.2-1, 9/98, construction haul route)
M = moisture content =	15.0%	(SCAQMD CEQA Handbook, Table A9-9-G-1)
E = emission factor =	0.42	PM10 lb/hr
E = emission factor =	0.23	PM2.5 lb/hr

(9) Scraper Travel

W = mean vehicle weight =	28.2	tons empty (615E scraper, Caterpillar Performance Handbook, 10/89)
=	48.6	tons loaded (615E scraper, Caterpillar Performance Handbook, 10/89)
=	38.4	tons mean weight
Daily Scraper Haul Tonnage =	1,428	ton/day (estimated)
Scraper Load =	20.4	ton (615E scraper, Caterpillar Performance Handbook, 10/89)
Daily Scraper Loads =	70.00	loads/day
Daily Scraper Hauling Distance =	0.08	miles/load (estimated)
Daily Scraper Travel =	10.61	miles/day

Excavator - pipeline construction

Excavating Rate =	90.0	yd3/hr (based on 0.5 yd3 bucket on a Cat. 307 excavator backhoe and a 20 sec. cycle time)
	630	yd3/day for 1 excavator @ 7 hrs/day of operation
Soil Density =	1.05	ton/yd3 (Caterpillar Performance Handbook, 10/89)
Daily Soil Transfer Rate =	662	ton/day (estimated)

Notes - Fugitive Dust Emission Calculations

(1) Wind erosion emission factor for active construction area is based on "Improvement of Specific Emission Factors (BACM Project No. 1), Final Report", prepared for South Coast AQMD by Midwest Research Institute, March 1996.
(2) Material unloading emission factors are based on AP-42, p. 13.2.4-3, 1/95.
(Based on average annual wind speed recorded onsite and default soil moisture contents.)
(3) Trenching emission factor is based on AP-42, Table 11.9-2 (dragline operations), 1/95.
(Based on default soil moisture content.)
(4) Unpaved surface travel emission factors for water trucks, loaders, dump trucks, forklifts, delivery trucks, are based on AP-42, Section 13.2.2, 12/2003.
(Based on default soil silt content.)
(5) Dust control efficiency for unpaved road travel and active excavation area is based on "Control of Open Fugitive Dust Sources", U.S. EPA, 9/88.
(Based on default evaporation rate shown in EPA document, Figure 3-2, 9/88, and typical water application rate shown in EPA document, page 3-23, 9/88.)

PEF Expansion CTG
Construction Modeling

Short Term Impacts (24 hours and less)					
	NOx	CO	SOx	PM2.5	PM10
TOTAL					
Combustion (lbs/day)	94.6	30.6	0.10	3.96	3.96
Construction Dust (lbs/day)				1.79	14.59
Windblown Dust (lbs/day)				0.03	0.08
ACTIVE CONSTRUCTION AREA					
Combustion (lbs/day)	75.70014	24.4676	0.0772	3.1663	3.1663
Construction Dust (lbs/day)				1.79	14.587
Windblown Dust (lbs/day)				0.03	0.0822
LAYDOWN AREA					
Combustion (lbs/day)	18.9250	6.1169	0.0193	0.7916	0.7916
Construction Dust (lbs/day)				0	0
Windblown Dust (lbs/day)				0	0

Long Term Impacts (annual)					
	NOx	CO	SOx	PM2.5	PM10
TOTAL					
Combustion (tons/yr)	5.84	1.99	0.01	0.24	0.24
Construction Dust (tons/yr)				0.14	1.12
Windblown Dust (tons/yr)				0.00	0.01
ACTIVE CONSTRUCTION AREA					
Combustion (tons/yr)	4.6734551	1.5917	0.0051	0.1946	0.1946
Construction Dust (tons/yr)				0.14	1.120
Windblown Dust (tons/yr)				0.00	0.0096
LAYDOWN AREA					
Combustion (tons/yr)	1.1684	0.3979	0.0013	0.0487	0.0487
Construction Dust (tons/yr)				0	0
Windblown Dust (tons/yr)				0	0

APPENDIX E

EVALUATION OF BEST AVAILABLE CONTROL TECHNOLOGY

Rule 2201 requires the application of BACT to any new or modified emissions unit if the new unit or modification results in an increase in permitted daily emissions (defined in §3.26 as Potential to Emit) greater than BACT trigger levels. BACT is the most stringent emission limitation or control technique of the following:

3.9.1 Achieved in practice for such emissions unit and class of source; or

3.9.2 Contained in any State Implementation Plan approved by the Environmental Protection Agency for such category and class of source. A specific limitation or control technique shall not apply if the owner or operator of the proposed emissions unit demonstrates to the satisfaction of the APCO that such limitation or control technique is not presently achievable; or

3.9.3 Contained in an applicable federal New Source Performance Standard; or

3.9.4 Any other emission limitation or control technique, including process and equipment changes of basic or control equipment, found by the APCO to be cost effective and technologically feasible for such class or category of sources or for a specific source.

The combustion gas turbine emission rates exceed 2 lb/day of NOx, VOC, PM_{10}, and SOx, and 100 ton/yr of CO. Therefore, BACT will be required for these pollutants, as discussed in the following sections.

As discussed in the following sections, this BACT analysis concludes the following:

- NOx emission limit of 2.5 ppmv @ 15% O_2 constitutes BACT for natural gas-fired simple cycle combustion gas turbines. At a design exhaust NOx concentration of 2.5 ppmv at 15% O_2, the proposed combustion gas turbine will comply with the BACT NOx emission limit.
- VOC emission limit of 2 ppmv @ 15% O_2 constitutes BACT for natural gas-fired simple cycle combustion gas turbines. At a design exhaust VOC concentration of 2 ppmv at 15% O_2, the proposed combustion gas turbine would comply with the BACT VOC emission limit.
- CO emission limit of 6 ppmv @ 15% O_2 constitutes BACT for natural gas-fired simple cycle combustion gas turbines. At a design exhaust CO concentration of 6 ppmv at 15% O_2, the proposed combustion gas turbine would comply with the BACT CO emission limit.
- BACT for PM_{10} and SOx is the use of natural gas as the fuel source.

E.1 Top-Down BACT Analysis for Control of Nitrogen Oxides

The following "top-down" BACT analysis for NO_x has been prepared in accordance with EPA's 1990 Draft New Source Review Workshop Manual. A "top-down" BACT analysis takes into account energy, environmental, economic, and other costs associated with each alternative technology.

E.1.1 Identify All Control Technologies

The baseline NOx emission rate for this analysis is considered to be 9 ppmvd @ 15% O_2, based on the proposed new source performance standard (40 CFR 60 Subpart KKKK). This emission rate provides the frame of reference for the evaluation of control effectiveness and feasibility. The maximum degree of control, resulting in the minimum emission rate, is a combination of water injection and either selective catalytic reduction or SCONOx to achieve a long-term NOx limit of approximately 2.5 ppmvd. Several intermediate levels of control are also evaluated.

There are three basic means of controlling NOx emissions from combustion turbines: wet combustion controls, dry combustion controls, and post-combustion controls. Wet and dry combustion controls act to reduce the formation of NOx during the combustion process, while post-combustion controls remove NOx from the exhaust stream. Potential NOx control technologies for combustion gas turbines include the following:

Wet combustion controls

- Water injection
- Steam injection

Dry combustion controls

- Dry low-NOx combustor design
- Catalytic combustors (e.g., XONON)
- Other combustion modifications

Post-combustion controls

- Selective non-catalytic reduction (SNCR)
- Non-selective catalytic reduction (NSCR)
- Selective catalytic reduction (SCR)
- SCONOx

E.1.2 Eliminate Technically Infeasible Options

The performance and technical feasibility of available NOx control technologies are discussed in more detail below.

Combustion Modifications

Wet Combustion Controls

Steam or water injection directly into the turbine combustor is one of the most common NOx control techniques for combustion turbines. These wet injection techniques lower the flame temperature in the combustor and thereby reduce thermal NOx formation. The water or steam-to-fuel injection ratio is the most significant factor affecting the performance of wet controls. Steam injection techniques can reduce NOx emissions in gas-fired turbines to between 15 and 25 ppmv at 15% O_2; the practical limit of water injection has been demonstrated at approximately 25-42 ppmv @ 15% O_2 before combustor damage becomes significant. Higher diluent:fuel ratios (especially with steam) not only result in greater NOx reductions, but also increase emissions of CO and hydrocarbons, reduce turbine efficiency, and may increase turbine maintenance requirements. The principal NOx control mechanisms are identical for water and steam injection. Water or steam is injected into the primary combustion chamber to act as a heat sink, lowering the peak flame temperature of combustion and thus lowering the quantity of thermal NOx formed. The injected water or steam exits the turbine as part of the exhaust.

Because water has a higher heat absorbing capacity than steam (due to the temperature and to the latent heat of vaporization associated with water), it takes more steam than water to achieve an equivalent level of NOx control. Typical steam injection ratios are 0.5 to 2.0 pounds steam per pound fuel; water injection ratios are generally below 1.0 pound water per pound fuel.

Although the lower peak flame temperature has a beneficial effect on NOx emissions, it can also reduce combustion efficiency and prevent complete combustion. As a result, CO and VOC emissions increase as water/steam-to-fuel ratios increase. Thus, the higher steam-to-fuel ratio required for NOx control will tend to cause higher CO and VOC emissions from steam-injected turbines than from water-injected turbines, due to the kinetic effect of the water molecules interfering with the combustion process. However, steam injection can reduce the heat rate of the turbine so that equivalent power output can be achieved with reduced fuel consumption and reduced SO_2 emission rates.

Water and steam injection have been in use on both oil- and gas-fired combustion turbines in all size ranges for many years, so these NOx control technologies are clearly technologically feasible and widely available.

Dry Combustion Controls

Combustion modifications that lower NOx emissions without wet injection include lean combustion, reduced combustor residence time, lean premixed combustion, and two-stage rich/lean combustion. Lean combustion uses excess air (greater than stoichiometric air-to-fuel ratio) in the combustor primary combustion zone to cool the flame, thereby reducing the rate of thermal NOx formation. Reduced combustor residence times are achieved by introducing dilution air between the combustor and the turbine sooner than with standard combustors. The combustion gases are at high temperatures for a shorter time, which also has the effect of reducing the rate of thermal NOx formation.

The most advanced combination of combustion controls for NOx is referred to as dry low-NOx (DLN) combustors. DLN technology uses lean, premixed combustion to keep peak combustion temperatures low, thus reducing the formation of thermal NOx. This technology is effective in achieving NOx emission levels comparable to levels achieved using wet injection without the need for large volumes of purified water and without the increases in CO and VOC emissions that result from wet injection. This control technology is used on the Frame 7FA CTG that will be used for the expansion project.

Catalytic combustors use a catalytic reactor bed mounted within the combustor to burn a very lean fuel-air mixture. This technology has been commercially demonstrated under the trade name XONON in a 1.5 MW natural gas-fired combustion turbine in Santa Clara, California. The technology has also been announced as commercially available for some models of small combustion turbines, generally 10 MW in size and less. The technology has not been announced commercially for the engine to be used at the PEF expansion. No turbine vendor, other than General Electric, has indicated the commercial availability of catalytic combustion systems at the present time; therefore, catalytic combustion controls are not available for this specific application and are not discussed further.

Post-Combustion Controls

SCR is a post-combustion technique that controls both thermal and fuel NOx emissions by reducing NOx with a reagent (generally ammonia or urea) in the presence of a catalyst to form water and nitrogen. NOx conversion is sensitive to exhaust gas temperature, and performance can be limited by contaminants in the exhaust gas that may mask the catalyst (sulfur compounds, particulates, heavy metals, and silica). SCR is used in numerous gas turbine installations throughout the United States, almost exclusively in conjunction with other wet or dry NOx combustion controls. SCR requires the consumption of a reagent (ammonia or urea) and requires periodic catalyst replacement. Estimated levels of NOx control are in excess of 90%.

Selective non-catalytic reduction (SNCR) involves injection of ammonia or urea with proprietary conditioners into the exhaust gas stream without a catalyst. SNCR technology requires gas temperatures in the range of 1200° to 2000° F and is most

commonly used in boilers. The exhaust temperatures for the PEF expansion CTG are in the 800° F range, which is well below the minimum SNCR operating temperature. Some method of exhaust gas reheat, such as additional fuel combustion, would be required to achieve exhaust temperatures compatible with SNCR operations, and this requirement makes SNCR technologically infeasible for this application. Even when technically feasible, SNCR is unlikely to achieve NOx reductions in excess of 80%-85%.

Nonselective catalytic reduction (NSCR) uses a catalyst without injected reagents to reduce NOx emissions in an exhaust gas stream. NSCR is typically used in automobile exhaust and rich-burn stationary IC engines, and employs a platinum/rhodium catalyst. NSCR is effective only in a stoichiometric or fuel-rich environment where the combustion gas is nearly depleted of oxygen, and this condition does not occur in turbine exhaust where the oxygen concentrations are typically between 14 and 16%. For this reason, NSCR is not technologically feasible for this application.

SCONOx is a proprietary catalytic oxidation and adsorption technology that uses a single catalyst for the control of NOx, CO, and VOC emissions. The catalyst is a monolithic design, made from a ceramic substrate with both a proprietary platinum-based oxidation catalyst and a potassium carbonate adsorption coating. The catalyst simultaneously oxidizes NO to NO_2, CO to CO_2, and VOCs to CO_2 and water, while NO_2 is adsorbed onto the catalyst surface where it is chemically converted to and stored as potassium nitrates and nitrites. The SCONOx potassium carbonate layer has a limited adsorption capability and requires regeneration approximately every 12-15 minutes in normal service.[1] Each regeneration cycle requires approximately 3-5 minutes. At any point in time, approximately 20% of the compartments in a SCONOx system would be in regeneration mode, and the remaining 80% of the compartments would be in oxidation/absorption mode.[2]

Regeneration of the adsorption layer requires exposure of the catalyst to hydrogen gas. In practice, this is accomplished by reforming natural gas with high-pressure steam to produce a gas mixture consisting of methane, carbon dioxide, and hydrogen that is passed over the catalyst beds.[3] Initial attempts by the developer of the process to create regeneration gases from natural gas and steam within the SCONOx catalyst bed (internal autothermal regeneration) failed to produce consistent results; this approach was abandoned in favor of the current offering, which uses an external steam-heated reformer that partially reforms the natural gas to produce the gas mixture that is introduced into the catalyst bed.[4] The reformation reaction continues to some extent within the catalyst bed

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[1] Personal communication, ABB Environmental, 1/18/00.

[2] Stone & Webster, "Independent Technical Review – SCONOx Technology and Design Review", February 2000.

[3] Stone & Webster, op cit

[4] ABB Environmental, op cit

due to the presence of steam and the temperature of the catalyst surface, but some methane and VOCs from the natural gas remain.

Because the active regenerant gas is hydrogen, the regeneration process must be performed in an atmosphere of low oxygen to prevent dilution of the hydrogen. In practice, the oxygen present in the exhaust gas of combustion turbines is excluded from the catalyst bed by dividing the catalyst bed into a number of individual cells or compartments that are equipped with front and rear dampers that are closed at the beginning of each regeneration cycle. Proper regeneration of the SCONOx catalyst system depends upon the proper functioning and sealing of these sets of dampers approximately 4 times per hour so that an adequate concentration of hydrogen can be maintained in each module to accomplish complete regeneration of the catalyst before the dampers are opened and the compartment is placed back in service.

Because the SCONOx catalyst can be "poisoned" or rendered inactive by even the very small amounts of sulfur compounds present in natural gas, a SCOSOx catalyst bed (or "guard bed") that is intended to remove trace quantities of sulfur-bearing compounds from the exhaust gas stream is installed upstream of the SCONOx catalyst bed. Like the SCONOx catalyst, the SCOSOx catalyst must be regenerated. Regeneration of the two catalyst types occurs at the same time, with the same regeneration gas supply provided to both; however, the sulfur-bearing regeneration gases for the SCOSOx catalyst exit the SCONOx modules separately from the SCONOx regeneration gases to avoid contaminating the SCONOx catalyst beds. Both regeneration gas streams are returned to the gas turbine exhaust stream downstream of the SCONOx module.[5]

The external reformer used to create the regeneration gases is supplied with steam and natural gas. For one F-class turbine, an estimated 15,000 to 20,000 lbs/hr of 600°F steam is required, along with approximately 100 pounds per hour (2.2 MMbtu/hr) of natural gas.[6] To avoid poisoning the reformer catalyst, the natural gas supplied to the reformer passes through an activated carbon filter to remove some of the sulfur-bearing compounds that are added to natural gas to facilitate leak detection.[7]

The regeneration cycle time is expected to be controlled using a feedback system based on NOx emission rates.[8] That is, the higher the NOx emissions are relative to the design level, the shorter the absorption cycle, and regeneration cycles will occur more frequently. This is analogous to the use of feedback systems for controlling reagent (ammonia or urea) flow rates in an SCR system.

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[5] ABB Environmental, op cit

[6] Ibid

[7] Stone & Webster, op cit

[8] Ibid

Maintenance requirements for SCONOx systems are expected to include periodic replacement of the reformer fuel sulfur carbon unit, periodic replacement of the reformer catalyst, periodic washings of the SCOSOx and SCONOx catalyst beds, and periodic replacement of the SCOSOx and SCONOx catalyst beds. The replacement frequency for the reformer sulfur carbon unit and reformer catalyst is unknown to the applicant at present. The SCOSOx catalyst is expected to require washing several times per year. The lead (upstream) SCONOx catalyst bed is also expected to require washing several times per year, while the trailing (downstream) SCONOx catalyst bed(s) are expected to require washing less frequently. The annual catalyst washing process is expected to take approximately three days for an F-class machine, at an estimated annual cost of $200,000.[9] The estimated catalyst life is reported to be 7 washings;[10] the guaranteed catalyst life is 3 years.[11]

The adsorption temperature operating range for the SCONOx system is 300°F to 700°F, with an optimal temperature of approximately 600°F.[12] However, regeneration cycles are not initiated unless the catalyst bed temperature is above 450°F to avoid the creation of hydrogen sulfide during the regeneration of the SCOSOx catalyst.[13]

Estimates of control system efficiency vary. ABB Environmental has indicated that the SCONOx system is capable of achieving a 90% reduction in NOx; a 90% reduction in CO, to a level of 2 ppm; and an 80%-85% reduction in VOC emissions.[14] (This VOC reduction is not likely to be achieved with low VOC inlet concentrations, in the 1–2 ppm range.[15]) Commercially quoted NOx emission rates for the SCONOx system range from 2.0 ppm on a 3-hour average basis, representing a 78% reduction,[16] to 1.0 ppm with no averaging period specified (96% reduction).[17] The SCONOx system does not control or reduce emissions of sulfur oxides or particulate matter from the combustion device.[18]

The SCONOx system has been applied at the Sunlaw Federal Cogeneration Plant in Vernon California since December 1996, and at the Genetics Institute Facility in Massachusetts. The Sunlaw facility uses an LM-2500 gas turbine, rated at a nominal 23 MW, and the Genetics Institute facility has a 5 MW Solar gas turbine.

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[9] Ibid

[10] Ibid

[11] Letter from ABB Alstom Power to Bibb & Associates dated May 5, 2000. (ABB Three Mountain Power or ABB TMP)

[12] Ibid

[13] ABB Environmental, op cit. Stone & Webster, op cit

[14] ABB Environmental, op cit

[15] Ibid

[16] ABB TMP, op cit

[17] Letter from ABB Alstom Power to Sunlaw Energy Corporation dated February 11, 2000. (ABB Sunlaw)

[18] ABB Environmental, op cit

The SCONOx system was proposed for use by PG&E Generating Company at its La Paloma facility; however, PG&E Generating no longer plans to use the SCONOx system at that site.[19] The SCONOx system was also proposed for demonstration by PG&E Generating Company at the Otay Mesa Generating Project; however, PG&E Generating Company sold the project to Calpine and Calpine has indicated that it no longer plans to use SCONOx. Although the technology's co-developer, Sunlaw, proposed to use the technology in conjunction with ABB gas turbines at the Nueva Azalea site in Southern California, the Nueva Azalea project has been withdrawn from the CEC licensing process.

The University of California, San Diego, operates two SoLoNox Titan 130S combustion turbines that are equipped with SCONOx. Each CTG is rated at approximately 13 MW and has NOx and CO emissions limits of 2.5 and 5.0 ppmvd @ 15% O_2, 3-hour average, respectively. Quarterly emission reports for the first 3 quarters of 2002 showed that Unit 1 had 5219 hours of operation with 9 3-hour periods of excess emissions, while Unit 2 had 5294 hours of operation with no exceedances of the 2.5 ppm NOx limit. In 2002, the SCONOx catalyst had to be washed three times, with the units taken off-line each time.

Redding Electric Utility operates a 43 MW Alstom Power Model GTX 100 CTG that is equipped with SCONOx at its Redding power plant. The unit has NOx and CO limits of 2.5 and 6.0 ppmvd @ 15% O_2, one-hour average basis, respectively, with a "demonstration" NOx limit of 2.0 ppm. Despite initial compliance problems, the turbine is currently operating in compliance with the 2.5 ppm NOx limit, but the operator is having to wash the catalyst more often than expected. The unit has not been able to consistently meet the 2.0 ppm "demonstration" limit.

The following information is taken from the ARB's draft report to the legislature, titled "Gas-Fired Power Plant NOx Emission Controls and Related Environmental Impacts," May 2004.

> University of California San Diego
>
> The system at the University of California San Diego has been in operation since July 2001. This installation operates at 420 F to treat the exhaust gases from two Solar SoLoNOx Titan 130S gas turbines (26 MW) at a cogeneration plant. Initially, the facility was under a variance with the San Diego County Air Pollution Control District—the turbines passed the start-up source test, but failed their Relative Accuracy Test Audit (RATA).[20] The facility installed a multi-point probe and subsequently passed the test. The plant operator reports that the permit limits are

[19] Ibid

[20] The RATA is essentially an on-site analyzer comparison test between the CEMS analyzers and those used by a RATA testing company. Both systems sample the same source and the results are subjected to statistical analysis and compared. The average accuracy of the CEMS analyzer relative to the RATA analyzer must be within a specific percentage.

The system at the City of Redding Power Plant in Redding, California, has been in operation since June 2002 and has accumulated approximately 8,300 hours of run time. This installation operates at 600 F to treat the exhaust gases from an Alstom Power GTX 100 gas turbine (43 MW) at a combined-cycle plant. Redding Power owns the dampers but has a 15-year lease agreement on the catalyst from Alstom. As such, Alstom is in charge of ongoing catalyst maintenance. The Shasta County Air Quality Management District reports that there have been no major compliance issues in meeting the 2.5 ppmvd at 15% O_2 NOx permit limit. To date, the SCONOx catalyst has required washing about three times per year, and the SCOSOx catalyst has not yet required washing. The wash process is generally completed over a weekend. The SCONOx reactor contains three layers of SCONOx catalyst. Since installation, the leading layer of SCONOx catalyst has been replaced—the second and third layers are the originals.

As discussed further below, there are serious questions about the probability of a successful commercial demonstration and the commercial availability of the technology for application to the PEF Expansion, as well as the levels of emission control that can be consistently achieved. However, based on the preceding discussion, the SCONOx system will be considered as technologically feasible for the purposes of this analysis.

Based on the discussions above, the following NOx control technologies are available and potentially technologically feasible for the proposed project:

- Water injection
- Selective Catalytic Reduction
- SCONOx

E.1.3 Rank Remaining Control Technologies by Control Effectiveness

The remaining technically feasible control technologies are ranked by NOx control effectiveness in Table E-1.

TABLE E-1
NOx Control Alternatives

NOx Control Alternative	Available?	Technically Feasible?	NOx Emissions (@ 15% O_2)	Environmental Impact	Energy Impacts
Water Injection	Yes	Yes	25 ppm	Increased CO/VOC	Decreased Efficiency
Steam Injection	No	No	15 – 25 ppm	Increased CO/VOC	Increased Efficiency
Dry Low-NOx Combustors	No	No	9-25 ppm	Reduced CO/VOC	Increased Efficiency
Selective Catalytic Reduction	Yes	Yes	>90% reduction 1 – 2.5 ppm	Ammonia slip	Decreased Efficiency
SCONOx	Yes	Yes	>90% reduction 1 – 2.5 ppm	Reduced CO; potential reduction in VOC	Decreased Efficiency

E.1.4 Available Control Options and Technical Feasibility

In a March 24, 2000 letter sent to local air pollution control districts, EPA Region 9 stated that the SCONOx Catalytic Adsorption System should be included in any BACT/LAER analysis for combined cycle combustion turbine power plant projects since it can achieve the BACT/LAER emission specification for NO_x of 2.5 ppmvd @ 15% O_2, averaged over one hour or 2.0 ppmvd @ 15% O_2, averaged over three hours. In this letter, EPA stated that ABB Alstom Power, the exclusive licensee for SCONOx applications, has conducted "full-scale damper testing" that demonstrates that SCONOx is technically feasible for utility-scale combustion turbines. Stone & Webster Management Consultants, Inc. of Denver, Colorado was subsequently hired by ABB to conduct an independent technical review of the SCONOx technology as well as the full-scale damper testing program. According to the report by Stone & Webster, modifications to the actuators, fiberglass seals, and louver shaft-seal interface are being incorporated to resolve unacceptable reliability and leakage problems. However, no subsequent testing of the redesigned components has occurred to determine if the problems have been solved. Because the feasibility of the "scale-up" of the SCONOx system for large turbines has not been demonstrated, SCONOx is not considered to be a demonstrated NO_x control technology for projects of the size of the Pastoria Expansion. Further, the Pastoria Expansion consists of a simple-cycle and not a combined-cycle combustion turbine.

Although SCONOx is not considered to be a demonstrated control alternative for this project, it may be considered a technically feasible technology, and thus we have

analysis shown in Table E-2 applies to one GE 7FA combustion turbine equipped with dry low-NOx combustor and an uncontrolled NO_x emission rate of 9 ppmvd @ 15% O_2. Details of the calculations are shown in Tables E-4 and E-5.

TABLE E-2
Top-Down BACT Analysis Summary for NOx

Control Technology	Controlled Emissions, tpy[a]	Emissions Controlled, tpy[b]	Average Cost-Effectiveness, $/ton[c]	Electricity Cost Impact, $/kwh[d]	Collateral Toxic Impacts?	Incremental Energy Impact, MMBtu/yr[e]
SCONOx	82.1	177.3	$27,441	0.00362	No	128,881
SCR	82.1	177.3	$10,659	0.00141	No	71,730

a. From Table A-5, based on 2.5 ppmvd controlled emission rate.
b. Based on 9 ppmvd uncontrolled emission rate from turbines, 72% control.
c. Total annual costs from ONSITE SYCOM Energy Corporation report for US DOE: "Cost Analysis of NOx Control Alternatives for Stationary Gas Turbines, Contract No. DE-FC02-97CHIO877," October 15, 1999.
d. Electricity cost from Ref c.
e. "Towantic Energy Project Revised BACT Analysis", RW Beck, February 18, 2000; based upon increased fuel use required to overcome catalyst bed back pressure.

Energy Impacts

As shown in Table E-2, the use of SCR does not result in any significant or unusual energy penalties or benefits when compared to SCONOx. Although the operation and maintenance of SCONOx does result in a greater energy penalty when compared to that of SCR, this is not considered significant enough to eliminate SCONOx as a control alternative.

Economic Impacts

According to EPA's 1990 Draft New Source Review Workshop Manual, "Average and incremental cost effectiveness are the two economic criteria that are considered in the BACT analysis."

As shown in Table E-2, the average cost-effectiveness of both SCR and SCONOx exceed the District cost-effectiveness guideline of $9700 per ton of NO_x abated. However, the average cost-effectiveness of SCR is approximately 40% of the average cost-effectiveness of SCONOx. These figures are based on total annualized cost figures from a cost analysis conducted by ONSITE SYCOM Energy Corporation[21], updated from 1999 to 2005 dollars. Although SCONOx will result in greater economic impact as quantified by average cost effectiveness, this impact is not considered adverse enough to eliminate SCONOx as a control alternative. Incremental cost-effectiveness does not apply since SCR and SCONOx both achieve the BACT standard for NO_x of 2.5 ppmvd @ 15% O_2,

[21] ONSITE SYCOM Energy Corporation for US DOE: "Cost Analysis of NOx Control Alternatives for Stationary Gas Turbines," Contract No. DE-FC02-97CHIO877, October 15, 1999.

by average cost effectiveness, this impact is not considered adverse enough to eliminate SCONOx as a control alternative. Incremental cost-effectiveness does not apply since SCR and SCONOx both achieve the BACT standard for NO_x of 2.5 ppmvd @ 15% O_2, averaged over three hours and therefore achieve the same NO_x emission reduction in tons per year.

Environmental Impacts

The use of SCR will result in ammonia emissions due to an allowable ammonia slip limit of 10 ppmvd @ 15% O_2. A health risk screening analysis of the proposed project using air dispersion modeling showed an acute hazard index and a chronic hazard index to be each much less than 1, resulting from an ammonia slip limit of 10 ppmv @ 15% O_2. In accordance with the District Toxic Risk Management Policy and currently accepted practice, a hazard index of less than 1.0 or above is considered not significant. Therefore, the toxic impact of the ammonia slip resulting from the use of SCR is deemed to be not significant and is not a sufficient reason to eliminate SCR as a control alternative.

The ammonia emissions resulting from the use of SCR may have another environmental impact through its potential to form secondary particulate matter such as ammonium nitrate. Because of the complex nature of the chemical reactions and dynamics involved in the formation of secondary particulates, it is difficult to estimate the amount of secondary particulate matter that will be formed from the emission of a given amount of ammonia. However, the District staff has pointed out that any ammonia converted to particulate matter in the stack will be measured as particulate emissions and is therefore required to be offset. Ammonia emissions from the proposed SCR system are not expected to contribute significantly to the formation of secondary particulate matter within the SJVAPCD.

A second potential environmental impact that may result from the use of SCR involves the storage and transport of anhydrous ammonia. Although ammonia is toxic if swallowed or inhaled and can irritate or burn the skin, eyes, nose, or throat, it is a commonly used material that is typically handled safely and without incident. The PEF will be required to maintain a Risk Management Plan (RMP) and implement a Risk Management Program to prevent accidental releases (see Section 5.15 of the AFC). The RMP will provide information on the hazards of the substance handled at the facility and the programs in place to prevent and respond to accidental releases. The accident prevention and emergency response requirements reflect existing safety regulations and sound industry safety codes and standards. In addition, the modeling analyses of the health impacts arising from a catastrophic release of ammonia due to spontaneous storage tank failure at the PEF shows that the impact would not be significant. Thus the potential environmental impact due to anhydrous ammonia storage at the PEF does not justify the elimination of SCR as a control alternative.

Conclusion

Because both SCR and SCONOx can achieve the proposed BACT NO_x emission limit of 2.5 ppmvd @ 15% O_2 averaged over three hours and neither will cause significant energy, economic, or environmental impacts, neither can be eliminated as viable control alternatives. The concern remains regarding the long-term effectiveness of SCONOx as a control technology as the technology has not been demonstrated on the turbines used in this project. For this reason, and because SCR is already in use at the facility, SCR has been selected as the NOx control technology to be used for the Pastoria Expansion turbine.

E.2 Determination of BACT Emission Rates

E.2.1 Nitrogen Oxides

The BACT analysis performed for NOx control includes the following:

- Review of published BACT guidelines for natural gas-fired simple cycle combustion gas turbines;
- Review of federal NSPS for natural gas-fired simple cycle combustion gas turbines; and
- Review of published prohibitory rules for natural gas-fired simple cycle combustion gas turbines.

Published BACT Guidelines

Published BACT determinations from the following agencies were reviewed to identify any previously established BACT guidelines:

- CARB;
- San Joaquin Valley Air Pollution Control District (SJVAPCD);
- Bay Area Air Quality Management District (BAAQMD); and
- South Coast Air Quality Management District (SCAQMD).

CARB's BACT Clearinghouse contained determinations by the Sacramento Metropolitan Air Quality Management District (SMAQMD) that specified water injection and SCR achieving an emission limit of 5 ppmv @ 15% O_2 as BACT for the following facilities:

- Carson Energy Group cogeneration plant in Sacramento, California; and
- Sacramento Cogeneration Authority cogeneration plant in Sacramento, California.

The SJVAPCD's BACT guidelines contained a determination for gas turbines rated at greater than 50 MW with variable load and without heat recovery. The SJVAPCD concluded that a NOx exhaust concentration of 5 ppmv @ 15% O_2 constituted BACT that had been achieved in practice and 3 ppmv @ 15% O_2 constituted BACT that is

had been achieved in practice and 3 ppmv @ 15% O_2 constituted BACT that is technologically feasible.

The BAAQMD's BACT guidelines specify that, for natural gas-fired simple cycle combustion gas turbines greater than 40 MW, a NOx limit of 2.5 ppmv @ 15% O_2 has been "achieved in practice." This BACT guideline was established in CARB's Guidance for Power Plant Sitting and Best Available Control Technology (June 1999).

The SCAQMD database did not contain BACT guidelines for NOx emissions from natural gas-fired simple cycle combustion gas turbines.

Federal NSPS

The NSPS applicable to new natural gas-fired combustion gas turbines are found in

Title 40 CFR Part 60 Subparts GG and KKKK (proposed). As presented previously in Section 5.2.2, the Subpart GG NOx emission limit applicable to the proposed combustion gas turbine will be 109 ppmv @ 15% O_2, while the Subpart KKKK limit will be 0.39 lb/MW-hr. The proposed BACT limit of 2.5 ppmvd @ 15% O_2 (equivalent to 0.10 lb/MW-hr) is well below these NSPS limits.

District Prohibitory Rules

Published prohibitory rules from the SJVAPCD, BAAQMD, SMAQMD, San Diego County Air Pollution Control District (SDCAPCD), and SCAQMD were reviewed to identify the NOx standards that govern existing natural gas-fired simple cycle combustion gas turbines.

- The SJVAPCD adopted Rule 4703 (Stationary Gas Turbines) to limit NOx emissions from these devices. Rule 4703 specifies an efficiency-adjusted enhanced Tier II NOx emission limit of 3 ppmv @ 15% O_2 for natural gas-fired combustion gas turbines rated at greater than 10 MW, with SCR (April 30, 2008 deadline).
- BAAQMD adopted Rule 9-9 (Nitrogen Oxides from Stationary Gas Turbines) to limit NOx emissions from these devices. Rule 9-9 specifies an efficiency-adjusted NOx emission limit of 13.0 ppmv @ 15% O_2 for natural gas-fired combustion gas turbines rated at no less than 10 MW, rated at 9,420 Btu/kW-hr, and equipped with SCR.
- The SMAQMD adopted Rule 413 (Stationary Gas Turbines) to limit NOx emissions from these devices. Rule 413 specifies a NOx emission limit of 9 ppmv @ 15% O_2 for natural gas-fired combustion gas turbines rated at no less than 10 MW and equipped with SCR.
- The SCAQMD adopted Rule 1134 (Emissions of Oxides of Nitrogen from Stationary Gas Turbines) to limit NOx emissions from these devices. Rule 1134

specifies an efficiency-adjusted NOx emission limit of 13.0 ppmv @ 15% O_2 for natural gas-fired combustion gas turbines rated at 10 MW or greater, rated at 9,420 Btu/kW-hr, and equipped with SCR.

Conclusions

BACT must be at least as stringent as the most stringent BACT determination, federal NSPS, or district prohibitory rule. Based upon the results of this analysis, the NOx BACT determination of 2.5 ppm @ 15% O_2 for the natural gas-fired simple cycle combustion gas turbines made in the SJVAPCD BACT guidelines reflects the most stringent NOx emission limit. Therefore, BACT for NOx emissions for natural gas-fired simple cycle combustion gas turbines is 2.5 ppmv @ 15% O_2. The Pastoria Expansion CTG will be designed to meet a NOx level of 2.5 ppmv @ 15% O_2.

E.2.2 Carbon Monoxide

The BACT analysis performed for CO control includes the following:

- Review of published BACT guidelines for natural gas-fired simple cycle combustion gas turbines;
- Review of federal NSPS for natural gas-fired simple cycle combustion gas turbines; and
- Review of published prohibitory rules for natural gas-fired simple cycle combustion gas turbines.

Published BACT Guidelines

As discussed previously in Section E.2.1, published BACT determinations from the following agencies were reviewed to identify any previously established BACT guidelines:

- CARB;
- SJVAPCD;
- BAAQMD; and
- SCAQMD.

The SJVAPCD's BACT guidelines contained a determination for gas turbines rated at greater than 50 MW with uniform load and without heat recovery. The SJVAPCD concluded that a CO exhaust concentration of 6 ppmv @ 15% O_2 constituted BACT that had been achieved in practice.

The BAAQMD's BACT guidelines specify that, for natural gas-fired simple cycle combustion gas turbines, a CO limit of 6 ppmv @ 15% O_2 has been "achieved in practice." CO emissions from the gas turbine will meet the District BACT requirements.

The CO emission rate from the gas turbine at the outlet of the exhaust stack will not exceed 6 ppmvd, corrected to 15% O_2 during base load operations.

A BACT guideline of 6 ppmv @ 15% O_2 was established in CARB's Guidance for Power Plant Sitting and Best Available Control Technology (June 1999). As discussed above, the CO emission rate from the proposed gas turbine at the outlet of the exhaust stack will not exceed 6 ppmvd, corrected to 15% O_2.

The SCAQMD database did not contain BACT guidelines for CO emissions from natural gas-fired simple cycle combustion gas turbines.

Federal NSPS

The NSPS applicable to new natural gas-fired combustion gas turbines are found in Title 40 CFR Part 60 Subparts GG and KKKK (proposed). These NSPS do not specify an emission limit for CO.

District Prohibitory Rules

Published prohibitory rules from the SJVAPCD, BAAQMD, SMAQMD, SDCAPCD, and SCAQMD were reviewed to identify the CO standards that govern existing natural gas-fired simple cycle combustion gas turbines. Of the five prohibitory rules reviewed, the SJVAPCD prohibitory rule for combustion gas turbines is the only one that includes an emission limit for CO (200 ppmv @ 15% O_2). Generic prohibitory rules (i.e., not device specific) from each of these districts were also reviewed; emission limits are 2000 ppmv at actual operating conditions.

Conclusions

BACT must be at least as stringent as the most stringent BACT determination, federal NSPS, or district prohibitory rule. Based upon the results of this analysis, the BAAQMD BACT determination for natural gas-fired simple cycle combustion gas turbines, obtained from CARB's Guidance for Power Plant Sitting and Best Available Control Technology, reflects the most stringent CO emission limit. Therefore, BACT for CO emissions from natural gas-fired simple cycle combustion gas turbines is 6 ppmv @ 15% O_2.

E.2.3 Volatile Organic Compounds

The BACT analysis performed for VOC control includes the following:

- Review of published BACT guidelines for natural gas-fired simple cycle combustion gas turbines;
- Review of federal NSPS for natural gas-fired simple cycle combustion gas turbines; and
- Review of published prohibitory rules for natural gas-fired simple cycle combustion gas turbines.

Published BACT Guidelines

As discussed previously in Section E.2.1, published BACT determinations from the following agencies were reviewed to identify any previously established BACT guidelines:

- CARB;
- SJVAPCD;
- BAAQMD; and
- SCAQMD.

CARB's BACT Clearinghouse contained SMAQMD determinations that specified an oxidation catalyst achieving an emission limit of 2.1 ppmv @ 15% O_2 as BACT for the following facilities:

- Carson Energy Group cogeneration plant in Sacramento, California; and
- Sacramento Cogeneration Authority cogeneration plant in Sacramento, California.

The SJVAPCD's BACT guidelines contained a determination for gas turbines rated at greater than 50 MW with uniform load and without heat recovery. The SJVAPCD concluded that a VOC exhaust concentration of 2.0 ppmv @ 15% O_2 constituted BACT that had been achieved in practice.

The BAAQMD's BACT guidelines specify that, for natural gas-fired simple cycle combustion gas turbines, a VOC limit of 2 ppmv @ 15% O_2 has been "achieved in practice." This BACT guideline was established in CARB's Guidance for Power Plant Sitting and Best Available Control Technology (June 1999).

The SCAQMD database did not contain BACT guidelines for VOC emissions from natural gas-fired simple cycle combustion gas turbines.

Federal NSPS

The NSPS applicable to new natural gas-fired combustion gas turbines are found in Title 40 CFR Part 60 Subparts GG and KKKK. These NSPS do not specify an emission limit for VOC.

District Prohibitory Rules

Published prohibitory rules from the SJVAPCD, BAAQMD, SMAQMD, SDCAPCD, and SCAQMD were reviewed to identify the VOC standards that govern existing natural gas-fired simple cycle combustion gas turbines. None of the prohibitory rules for combustion gas turbines, discussed previously in Section IV.A.3, specify an emission limit for VOC. Generic prohibitory rules (i.e., not device specific) from each of these districts were also reviewed; none contain an emission limit for VOC.

Conclusions

BACT must be at least as stringent as the most stringent BACT determination, federal NSPS, or district prohibitory rule. Based upon the results of this analysis, the BAAQMD BACT determination for natural gas-fired simple cycle combustion gas turbines, obtained from CARB's Guidance for Power Plant Sitting and Best Available Control Technology, reflects the most stringent VOC emission limit. The BAAQMD established VOC emission limits of 2 ppmv @ 15% O_2 for natural gas-fired simple cycle combustion gas turbines. Therefore, BACT for VOC emissions from natural gas-fired simple cycle combustion gas turbines is 2 ppmv @ 15% O_2.

E.2.4. Particulate Matter Less Than 10 Microns in Diameter (PM_{10})

The following tasks were performed for the PM_{10} BACT analysis:

- Reviewed published BACT guidelines for natural gas-fired simple cycle combustion turbines;
- Reviewed federal NSPS for natural gas-fired simple cycle combustion gas turbines; and
- Reviewed published prohibitory rules for natural gas-fired simple cycle combustion gas turbines.

Published BACT Guidelines

Published BACT determinations from the following agencies were reviewed to identify any previously established BACT guidelines:

- CARB;
- SJVAPCD;
- BAAQMD; and
- SCAQMD.

The CARB BACT Clearinghouse, as well as the SJVAPCD and BAAQMD BACT guidelines, identify the use of natural gas as the primary fuel as "achieved in practice" for the control of PM_{10} for simple cycle combustion gas turbines.

The SJVAPCD's BACT guidelines contained a determination for gas turbines rated at greater than 50 MW with uniform load and without heat recovery. The SJVAPCD concluded that the use of an air inlet cooler/filter, a lube oil vent coalescer (or equal) and either PUC- regulated natural gas, LPG, or non-PUC-regulated gas with < 0.75 grains of sulfur per 100 dscf constitutes BACT that has been achieved in practice for PM_{10}. PEF will limit the sulfur content of the PUC-regulated natural gas to <0.75 gr/100 dscf and will utilize an air inlet cooler and a lube oil vent coalescer and will comply with this BACT requirement.

The SCAQMD database contained BACT determinations for the Los Angeles Department of Power and Water plant in Sun Valley, CA, and the Indigo Energy Facility in North Palm Springs, CA. The SCAQMD concluded that an exhaust PM_{10} concentration of 0.01 gr/dscf constituted BACT.

Federal NSPS

Title 40 CFR Part 60 Subparts GG and KKKK (proposed) contain the applicable NSPS for combustion gas turbines. Section 5.2.4.2.7 previously identified the requirements of Subparts GG and KKKK applicable to the proposed combustion gas turbine; neither subpart regulates PM_{10} emissions.

District Prohibitory Rules

Published prohibitory rules from the SJVAPCD, BAAQMD, SCAQMD, SMAQMD, and SDCAPCD were reviewed to identify the PM_{10} standards that govern existing natural gas-fired combustion gas turbines:

- The SJVAPCD adopted Rule 4703 (Stationary Gas Turbines) to limit NOx emissions from these devices. Rule 4703 does not regulate PM_{10} emissions.
- SJVAPCD Rule 4201 (Particulate Matter - Concentration) specifies a PM emission limit of 0.1 gr/dscf for sources of PM emissions.
- SJVAPCD Rule 4301 (Fuel Burning Equipment) specifies a PM emission limit of 0.1 gr/dscf @ 12% CO_2 for combustion sources.
- BAAQMD adopted Rule 9-9 (Nitrogen Oxides from Stationary Gas Turbines) to limit NOx emissions from these devices. Rule 9-9 does not regulate PM_{10} emissions.
- BAAQMD Regulation 6 (Particulate Matter and Visible Emissions) specifies a PM emission limit of 0.15 gr/dscf for sources of PM emissions.
- The SMAQMD adopted Rule 413 (Stationary Gas Turbines) to limit NOx emissions from these devices. Rule 413 does not regulate PM_{10} emissions.
- SMAQMD Rule 404 (Particulate Matter) specifies a PM emission limit of 0.1

gr/dscf for sources of PM emissions.

- SMAQMD Rule 406 (Specific Contaminants) specifies a PM emission limit of 0.1 gr/dscf @ 12% CO_2 for combustion sources.
- The SDCAPCD adopted Rule 69.3.1 (Stationary Gas Turbine Engines – Best Available Retrofit Control Technology) to limit NOx emissions from these devices. Rule 69.3.1 does not regulate PM_{10} emissions.
- SDCAPCD Rule 52 (Particulate Matter) specifies a PM_{10} emission limit of 0.1 gr/dscf for sources of PM emissions.
- SDCAPCD Rule 53 (Specific Air Contaminants) specifies a PM emission limit of 0.1 gr/dscf @ 12% CO_2 for combustion sources.
- The SCAQMD adopted Rule 1134 (Emissions of Oxides of Nitrogen from Stationary Gas Turbines) to limit NOx emissions from these devices. Rule 1134 does not regulate PM_{10} emissions.
- SCAQMD Rule 404 (Particulate Matter - Concentration) specifies a PM emission limit of 0.0437 gr/dscf for sources of PM emissions.
- SCAQMD Rule 409 (Combustion Contaminants) specifies a PM emission limit of 0.1 gr/dscf @ 12% CO_2 for combustion sources.

Conclusions

BACT must be at least as stringent as the most stringent BACT determination, federal NSPS, or district prohibitory rule. Based upon the results of this analysis, the SJVAPCD BACT guideline reflects the most stringent PM_{10} emission limit. Therefore, the use of natural gas as the sole fuel source, along with an air inlet cooler and lube vent coalescer, constitutes BACT for PM_{10} emissions from small simple cycle combustion gas turbines.

3.2.5 Sulfur Oxides

The following tasks were performed for the SOx BACT analysis:

- Reviewed published BACT guidelines for natural gas-fired simple cycle combustion turbines;
- Reviewed federal NSPS for natural gas-fired simple cycle combustion gas turbines; and
- Reviewed published prohibitory rules for natural gas-fired simple cycle combustion gas turbines.

Published BACT Guidelines

Published BACT determinations from the following agencies were reviewed to identify any previously established BACT guidelines:

- CARB;
- SJVAPCD;
- BAAQMD; and
- SCAQMD.

The CARB BACT Clearinghouse, as well as the SJVAPCD and BAAQMD BACT guidelines, identify the use of PUC-quality natural gas or natural gas with a limit on the sulfur content (i.e., 1 grain/100 scf) as the primary fuel as "achieved in practice" for the control of SOx for simple cycle combustion gas turbines. The two most recent BACT determinations in the SCAQMD did not indicate BACT for SOx.

Federal NSPS

Title 40 CFR Part 60 Subparts GG and KKKK (proposed) contain the applicable NSPS for combustion gas turbines. Section III.B previously identified the requirements of these subparts that are potentially applicable to the proposed PEF Expansion peaking turbine. Under Subpart GG, s combustion gas turbine is subject to a SO_2 emission limit of 0.015% by volume (150 ppmv) @ 15% O_2. Subpart GG also limits the sulfur content of fuel to 0.8% by weight. Subpart KKKK limits SO_2 emissions from gas turbines to 0.023 lb/MW-hr. The proposed SO_2 limit based on the maximum fuel sulfur content limit of 0.75 gr/dscf is well below these NSPS-based limits.

District Prohibitory Rules

Published prohibitory rules from the SJVAPCD, BAAQMD, and SCAQMD were reviewed to identify the SO_2 standards that govern existing gas turbines.

- SJVAPCD Rule 4703 (Stationary Gas Turbines) is the SJVAPCD's only prohibitory rule that specifically addresses gas turbines but does not limit SO_2 emissions. The SJVAPCD adopted Rule 4301 (Fuel Burning Equipment) to limit SO_2 emissions from these devices. Rule 4301 specifies a SO_2 emission limit of 200 pounds per hour. The SJVAPCD also adopted Rule 4801 (Sulfur Compounds) to limit emissions of sulfur compounds. Rule 4801 specifies a SO_2 emission limit of 0.2%, or 2,000 ppm.
- BAAQMD Rule 9-9 (Nitrogen Oxides from Stationary Gas Turbines) is the BAAQMD's only prohibitory rule that specifically addresses gas turbines but does not limit SO_2 emissions. The BAAQMD adopted Rule 9-1 (Sulfur Dioxide) to limit SO_2 emissions from all sources. Rule 9-1 prohibits SO_2 emissions in excess of 300 ppm. No other BAAQMD Rule or Regulation contains a relevant

prohibitory rule regulating either the sulfur content in the fuel or the emission of SO_2 from gas turbines.

- SCAQMD Rule 1134 (Emissions of Oxides of Nitrogen from Stationary Gas Turbines) is the SCAQMD's only prohibitory rule that specifically addresses gas turbines but does not limit SO_2 emissions. The SCAQMD adopted Rule 431.1 (Sulfur Content of Gaseous Fuels) to reduce SOx emissions from the burning of gaseous fuels in stationary equipment. Rule 431.1 specifies a sulfur limit of 16 grains/100 scf (as H_2S) in natural gas sold within the SCAQMD. The SCAQMD also adopted Rule 407 (Liquid and Gaseous Air Contaminants) to limit SO_2 emissions from all sources. Rule 407 specifies an emission limit of 2,000 ppm for sulfur compounds (calculated as SO_2).

Conclusions

BACT must be at least as stringent as the most stringent BACT determination, federal NSPS, or district prohibitory rule. Based upon the results of this analysis, the CARB database and SJVAPCD and BAAQMD BACT guidelines reflect the most stringent SOx emission limit. These sources established a requirement for the use of natural gas as the primary fuel to control SOx emissions from combustion gas turbines. Therefore, the use of natural gas as the sole fuel source constitutes BACT for SOx emissions from simple cycle combustion gas turbines.

E.3.3 Summary

The criteria that constitute BACT for the proposed natural gas-fired simple cycle combustion gas turbine are summarized in Table E-3 and compared with the design criteria for the proposed combustion gas turbine.

Table E-3
Summary of Emission Limits and BACT Requirements

Pollutant	BACT	Proposed Control Level
NOx	Emission Limit = 2.5 ppmv @ 15% O_2	Design Exhaust Concentration = 2.5 ppmv @ 15% O_2
CO	Emission Limit = 6 ppmv @ 15% O_2	Design Exhaust Concentration = 6 ppmv @ 15% O_2
VOC	Emission Limit = 2 ppmv @ 15% O_2	Design Exhaust Concentration = 2 ppmv @ 15% O_2
SOx	Natural gas fuel	Natural gas fuel
PM_{10}	Natural gas fuel	Natural gas fuel

Table E-4
SCR Cost-Effectiveness Calculation

			5 MW Class	25 MW Class	150 MW Class
Turbine Model			Solar Centaur 50	GE LM2500	GE Frame 7FA
Turbine Output			4.2 MW	23 MW	160 MW
Direct Capital Costs (DC)		Source			
Purchased Equip. Cost (PE)		MHIA			
Basic Equipment (A)		MHIA	$ 240,000	$ 660,000	$ 2,100,000
Ammonia injection skid and storage	0.00 x A	MHIA	included	included	included
Instrumentation	0.00 x A	OAQPS	included	included	included
Taxes and freight	0.08 A x B	OAQPS	$ 19,015	$ 52,746	$ 169,530
PE Total			$ 256,704	$ 712,066	$ 2,288,649
Direct Installation Costs (DI)					
Foundation & supports	0.08 x PE	OAQPS	$ 20,536	$ 56,965	$ 183,092
Handling and erection	0.14 x PE	OAQPS	$ 35,939	$ 99,689	$ 320,411
Electrical	0.04 x PE	OAQPS	$ 10,268	$ 28,483	$ 91,546
Piping	0.02 x PE	OAQPS	$ 5,134	$ 14,241	$ 45,773
Insulation	0.01 x PE	OAQPS	$ 2,567	$ 7,121	$ 22,886
Painting	0.01 x PE	OAQPS	$ 2,567	$ 7,121	$ 22,886
DI Total			$ 77,011	$ 213,620	$ 686,595
DC Total			$ 333,715	$ 925,686	$ 2,975,244
Indirect Costs (IC)					
Engineering:			$ 25,670	$ 71,207	$ 100,000
Construction and field expenses			$ 12,835	$ 35,603	$ 114,432
Contrctor fees			$ 25,670	$ 71,207	$ 228,865
Start-up			$ 5,134	$ 14,241	$ 45,773
Performance testing			$ 2,567	$ 7,121	$ 22,886
Contingencies			$ 7,701	$ 21,362	$ 68,659
IC Total			$ 79,578	$ 220,740	$ 580,616
Total Capital Investment (TCI = DC + IC)			$ 413,293	$ 1,146,426	$ 3,555,860
Direct Annual Costs (DAC)					
Operating Costs (O)	24 hrs/day, 7 days/wk, 50 wks/yr				
Operator	0.5 hrs/shift $25/hr	OAQPS	$ 13,125	$ 13,125	$ 13,125
Supervisor	15% of Operator	OAQPS	$ 1,969	$ 1,969	$ 1,969
Maintenance Costs (M)					
Labor	0.5 hrs/shift $25/hr	OAQPS	$ 13,125	$ 13,125	$ 13,125
Material	100% of labor cost	OAQPS	$ 13,125	$ 13,125	$ 13,125
Utility Costs					
Perf Loss	0.50%				
Electricity cost	0.06 ($/kwh) performance penalt	variable	$ 10,584	$ 57,960	$ 403,200
Catalyst replacement		MHIA	$ 10,352	$ 56,690	$ 396,833
Catalyst disposal		OAQPS	$ 388	$ 2,126	$ 14,881
Ammonia	$360/ton * tons NOx*17/46	variable	$ 3,510	$ 14,820	$ 108,257
NH3 injection skid		MHIA	$ 5,040	$ 7,560	$ 27,720
Total DAC			$ 71,218	$ 180,500	$ 992,235
Indirect Annual Costs (IAC)					
Overhead	60% of O&M		$ 24,806	$ 24,806	$ 24,806
Administrative	0.02 x TCI		$ 8,266	$ 22,929	$ 71,117
Insurance	0.01 x TCI		$ 4,133	$ 11,464	$ 35,559
Property tax	0.01 x TCI		$ 4,133	$ 11,464	$ 35,559
Capital recovery	10% interest rate, 15 yr period				
	0.13 x TCI		$ 53,037	$ 147,119	$ 456,316
Total IAC			$ 94,375	$ 217,782	$ 623,357
Total Annual Cost (DAC + IAC), 1999 dollars			$ 165,593	$ 398,282	$ 1,615,592
Total Annual Cost (DAC + IAC), 2005 dollars (note 1)					$ 1,890,242

NOx Emission Rate (tons/yr) at 9 ppm		259.455	
NOx Removed (TPY) at 2.5 ppm	72% removal efficiency	177.33	tpy
Cost Effectiveness ($/ton)		$10,659	/ton
Electricity Cost Impact (c/kwh)		0.141	
Increased natural gas use		67,900	MCF
	1056.4 Btu/scf	71,730	MMBtu

Note 1: Inflation rate of 1.17 from Federal Reserve Bank of Minneapolis CPI calculator, 1999 to 2005.
http://woodrow.mpls.frb.fed.us/research/data/us/calc/

Table E-5
SCONOx Cost-Effectiveness Calculation

			5 MW Class	25 MW Class	150 MW Class
Turbine			Solar Centaur		GE Frame
Model			50	GE LM2500	7FA
Turbine Output			4.2 MW	23 MW	160 MW
Direct Capital Costs (DC)		Source			
Purchased Equip. Cost (PE)		Goalline			
Basic Equipment (A)		Goalline	$ 620,000	$ 1,960,000	$ 7,700,000
Ammonia injection skid and storage	0.00 x A	Goalline	included	included	included
Instrumentation	0.00 x A	OAQPS	included	included	included
Taxes and freight	0.08 A x B	OAQPS	$ 49,760	$ 157,105	$ 612,238
PE Total			$ 671,760	$ 2,120,916	$ 8,265,208
Direct Installation Costs (DI)					
Foundation & supports	0.08 x PE	OAQPS	$ 53,741	$ 169,673	$ 661,217
Handling and erection	0.14 x PE	OAQPS	$ 94,046	$ 296,928	$ 1,157,129
Electrical	0.04 x PE	OAQPS	$ 26,870	$ 84,837	$ 330,608
Piping	0.02 x PE	OAQPS	$ 13,435	$ 42,418	$ 165,304
Insulation	0.01 x PE	OAQPS	$ 6,718	$ 21,209	$ 82,652
Painting	0.01 x PE	OAQPS	$ 6,718	$ 21,209	$ 82,652
DI Total			$ 201,528	$ 636,275	$ 2,479,562
DC Total			$ 873,288	$ 2,757,191	$ 10,744,770
Indirect Costs (IC)					
Engineering:			$ 67,176	$ 212,092	$ 826,521
Construction and field expenses			$ 33,588	$ 106,046	$ 413,260
Contrctor fees			$ 67,176	$ 212,092	$ 826,521
Start-up			$ 13,435	$ 42,418	$ 165,304
Performance testing			$ 6,718	$ 21,209	$ 82,652
Contingencies			$ 20,153	$ 63,627	$ 247,956
IC Total			$ 208,246	$ 657,484	$ 2,562,214
Total Capital Investment (TCI = DC + IC)			$ 1,081,534	$ 3,414,675	$ 13,306,985
Direct Annual Costs (DAC)					
Operating Costs (O)	24 hrs/day, 7 days/wk, 50 wks/yr				
Operator	0.5 hrs/shift $25/hr	OAQPS	$ 13,125	$ 13,125	$ 13,125
Supervisor	15% of Operator	OAQPS	$ 1,969	$ 1,969	$ 1,969
Maintenance Costs (M)					
Labor	0.5 hrs/shift $25/hr	OAQPS	$ 13,125	$ 13,125	$ 13,125
Material	100% of labor cost	OAQPS	$ 13,125	$ 13,125	$ 13,125
Utility Costs					
Perf Loss	0.50%				
Electricity cost	0.06 ($/kwh) perf penalty	variable	$ 10,584	$ 57,960	$ 403,200
Catalyst replacement	(note 2)		$ 25,880	$ 106,295	$ 785,655
Catalyst disposal	precious metal recovery: 1/3 replacement cost		$ (8,618)	$ (35,396)	$ (261,623)
H2 carrier steam	(note 3)		$ 19,686	$ 107,806	$ 796,824
H2 reforming	(note 4)		$ 1,916	$ 10,495	$ 77,589
H2 skid demand	(note 5) (0.6 kW/MW capacity)		$ 1,270	$ 6,955	$ 51,408
Total DAC			$ 92,062	$ 295,459	$ 1,894,397
Indirect Annual Costs (IAC)					
Overhead	60% of O&M		$ 24,806	$ 24,806	$ 24,806
Administrative	0.02 x TCI		$ 21,631	$ 68,293	$ 266,140
Insurance	0.01 x TCI		$ 10,815	$ 34,147	$ 133,070
Property tax	0.01 x TCI		$ 10,815	$ 34,147	$ 133,070
Capital recovery	10% interest rate, 15 yr period				
	0.13 x TCI		$ 138,791	$ 438,198	$ 1,707,659
Total IAC			$ 206,859	$ 599,592	$ 2,264,744
Total Annual Cost (DAC + IAC), 1999 dollars			$ 298,920	$ 895,050	$ 4,159,141
Total Annual Cost (DAC + IAC), 2005 dollars					$ 4,866,195

NOx Emission Rate (tons/yr) at 9 ppm		259.46	
NOx Removed (TPY) at 2.5 ppm	90% removal efficiency	177.33	
Cost Effectiveness ($/ton)		$27,441	/ton
Electricity Cost Impact (c/kwh)		0.362	
Increased natural gas use		122,000	MCF
	1056.4 Btu/scf	128,881	MMBtu

Note 2: 300 kcfh/MW; s.v.=20 kcfh/ft^3; $1,500/ft^3 catalyst; 7 yr. life
Note 3: 391, 2139, 15810 lb/hr for 5, 25, 150 MW class respectively
Note 4: 59, 322, 2380 CH4 ft3/hr for 5, 25, 150 MW class respectively
Note 5: 3, 14, 102 kW for 5, 25, 150 MW class respectively
Note 6: Inflation rate of 1.17 from Federal Reserve Bank of Minneapolis CPI calculator, 1999 to 2005.
http://woodrow.mpls.frb.fed.us/research/data/us/calc/

San Joaquin Valley
Unified Air Pollution Control District

Best Available Control Technology (BACT) Guideline 3.4.7*

Last Update: October 1, 2002

Emission Unit: Gas Turbine - $\geq$ 50 MW , Uniform Load, without Heat Recovery

Pollutant	Achieved in Practice or contained in SIP	Technologically Feasible	Alternate Basic Equipment
NOx	5.0 ppmvd** @ 15% O_2, based on a three-hour average (high temp SCR, or equal).	1. 2.5 ppmvd** @ 15% O_2, based on a one-hour average (high temperature Selective Catalytic Reduction (SCR), or equal). 2. 3.0 ppmvd** @ 15% O_2, based on a three-hour average (high temp SCR, or equal).	
CO	6.0 ppmvd** @ 15% O_2, based on a three-hour average (Oxidation catalyst, or equal).		
VOC	2.0 ppmvd** @ 15% O_2, based on a three-hour average (Oxidation catalyst, or equal).	1. 0.6 ppmvd** @ 15% O_2, based on a three-hour average (Oxidation catalyst). 2. 1.3 ppmvd** @ 15% O_2, based on a three-hour average (Oxidation catalyst, or equal).	
PM10	Air inlet cooler/filter, lube oil vent coalescer (or equal) and either PUC-regulated natural gas, LPG, or non-PUC-regulated gas with $\leq$ 0.75 grams S/100 dscf.		
SOx	PUC-regulated natural gas, LPG, or Non-PUC-regulated gas with $\leq$ 0.75 grams S/100 dscf.		

** Except during startup and shutdown

This is a Summary Page for this Class of Source - Permit Specific BACT Determinations on Next Page(s)

Appendix F

Emission Reduction Credits for the PEF Expansion

Table F-1
PEF Expansion Project
Emission Reduction Credits

	Q1 (lbs)	Q2 (lbs)	Q3 (lbs)	Q4 (lbs)	Annual, lbs	
NOx	90	91	92	92	365	Exclusion
Project Emissions	40,500	40,950	41,400	41,400	164,250	
Project Emissions Subject to Offset	40,500	40,950	41,400	41,400	164,250	
Required Offsets (1.5 ratio)	60,750	61,425	62,100	62,100	246,375	
ERC Cert S-1554-2 (Note a)	109,935	121,484	127,922	117,272	476,613	
ERC Cert S-1543-2	10,354	8,381	11,018	11,467	41,220	
Surplus NOx ERCs	59,539	68,440	76,840	66,639	271,458	
Additional NOx ERCs for PM10	52,877	53,464	54,052	54,052	214,445	
Net Surplus NOx ERCs	6,662	14,976	22,788	12,587	57,013	
VOC						
Project Emissions	10,641	10,759	10,877	10,877	43,154	
Project Emissions Subject to Offset	10,641	10,759	10,877	10,877	43,154	
Required Offsets (1.5 ratio)	15,961	16,139	16,316	16,316	64,732	
ERC Cert N-444-1 (Note b)	47,635	37,534	40,666	32,156	157,991	
ERC Cert S-1666-1	0	0	0	9	9	
Net Surplus VOC ERCs	31,674	21,395	24,350	15,849	93,268	
SOx						
Project Emissions	7,549	7,633	7,717	7,717	30,616	
Project Emissions Subject to Offset	7,549	7,633	7,717	7,717	30,616	
Required Offsets (1.5 ratio)	11,324	11,450	11,575	11,575	45,924	
ERC Cert S-1344-5	25,521	30,054	14,242	12,127	81,944	
Net Surplus SOx ERCs	14,197	18,604	2,667	552	36,020	
PM10						
Project Emissions	19,440	19,656	19,872	19,872	78,840	
Project Emissions Subject to Offset	19,440	19,656	19,872	19,872	78,840	
Required Offsets (1.5 ratio)	29,160	29,484	29,808	29,808	118,260	Ratio w/ dist
PM10 from NOx ERCs (2.72 ratio) (Note c)	52,877	53,464	54,052	54,052	214,445	2.72
Surplus NOx ERCs Used for PM10	52,877	53,464	54,052	54,052	214,445	
Net Surplus PM10 ERCs	0	0	0	0	0	

Notes:
a. These ERCs are surplus to those previously allocated for Pastoria and SJVEC.
b. These ERCs are surplus to those allocated for SJVEC (formerly Cert N-303-1).
c. The District has previously approved a NOx:PM10 ratio for Pastoria of 2.72 to 1, including the offset ratio.

Table F-2
Emission Reduction Credit Certificates to be Used for PEF Expansion Project Offsets

ERC Certificate	Location of Emission Reduction	Date of Emission Reduction	Method of Emission Reduction	Owner
NO_x/PM_{10}				
S-1543-2	Section 16, Township 27S, Range 28E Heavy Oil Central Stationary Source	pre-1990	Addition of O_2 controllers to steam generators.	Pastoria Energy Facility
S-1554-2	Elk Hills Gas Plant, Kern County	12/05/1990	Retrofit of 31 IC Engines with pre-combustion chambers	Pastoria Energy Facility
VOC				
N-444-1	757 11th St, Tracy	1/31/1998	Shutdown of emissions units	Calpine Corp.
S-1666-1	526 Mettler Frontage Rd East	post-1990	Shutdown of cotton gin	Calpine Corp.
SO_X				
S-1344-5	Midway Premier Lease Section 32, Township 27S, Range 27E	post-1990	Convert steam generator to natural gas firing	Pastoria Energy Facility