APPENDIX 8.1F

Evaluation of Best Available Control Technology

The following presents a summary of BACT information regarding spark-ignited internal combustion and compression ignition engines. The applicability of the Bay Area Air Quality Management District's (BAAQMD's) BACT threshold of 10 pounds per day (lbs/day) for Eastshore's project emissions of NO_x, CO, POC, PM10, and SO_2 is as follows:

- Spark-ignited internal combustion engine (i.e., lean burn engine) – NO_x, CO, POC, and PM10 emissions are greater than 10 lbs/day and therefore trigger BACT requirements for the lean burn engines. SO_2 emissions are less than 10 lbs/day, and therefore, BACT is not triggered.
- Compression ignition engine (i.e., black start diesel engine) – All criteria pollutant emissions are less than 10 lbs/day, and therefore, BACT requirements are note triggered for the black start diesel engine.

Although BAAQMD BACT is not triggered for SO_2 emissions from the lean burn, and BAAQMD BACT is not triggered for any of the pollutants from the black start diesel engine, information is provided as reference.

Natural Gas-Fired Lean Burn, Spark-Ignited Internal Combustion Engine BACT

To evaluate BACT for the proposed natural gas-fired lean burn, spark-ignited internal combustion (IC) engines, several references were reviewed to determine the general framework for BACT determinations in this source category. Then, more specifics regarding the BAAQMD "Best Available Control Technology (BACT) Guidelines" summary were evaluated. Finally, for the purposes of comparison of the District's guideline, select agencies' summaries of BACT determinations were reviewed.

Tables 8.1F-1 through 8.1F-4 present the results of the BACT evaluation for lean burn engines.

The primary reference was the BAAQMD's BACT guidelines, while other references included other California Districts' guidelines for this source category. Table 8.1F-1 presents a summary of this initial review.

TABLE 8.1F-1
Summary of BACT Guidelines from California Districts' Guidance for Natural Gas-Fired IC Engines

Air District	Units	NO_x	CO	POC	SO_2	PM10
BAAQMD[1]	Ppmvd @ 15% O_2	6 – 12	12 - 74	32	Natural gas fuel	Natural gas fuel
BAAQMD[1]	Grams/bhp-hr	0.07 - 0.15	0.10 - 0.60	0.15	n/d; n/s Natural gas fuel	n/d Natural gas fuel

TABLE 8.1F-1
Summary of BACT Guidelines from California Districts' Guidance for Natural Gas-Fired IC Engines

SDAPCD[2]	Grams/bhp-hr	0.07 - 0.15	none	0.6 - 1.0	no emission limit Low sulfur fuel	0.1 Low sulfur fuel
SJVUAPCD[3]	Grams/bhp-hr	0.15	0.6	0.15	Natural gas fuel	0.02 Natural gas fuel
SCAQMD[3]	Grams/bhp-hr	0.15	0.6	0.15	Natural gas fuel	Natural gas fuel

[1] BACT is specific for natural gas-fired, spark-ignited, lean burn internal combustion engines. The ppmvd and grams/bhp-hr values are equivalent values presented in the BAAQMD's guidelines. No determination or "n/d" is defined by the District as "no BACT determination has been made to date for the source category or BACT category under consideration." Not specified or "n/s" is defined by the District as "a BACT determination has been made but no specific emissions limitation has been set or the detailed equipment/process technology has not been specified."
[2] BACT is specific for natural gas-fired, spark-ignited, lean burn internal combustion engines greater than 2,000 hp.
[3] BACT is general for natural gas-fired, spark-ignited internal combustion engines, i.e., it is applicable to both lean burn and rich burn engines.

The agencies referenced in Table 8.1F-1, which have BACT specific for lean burn engines, have identified the following methods for reducing the criteria pollutant emissions include the following:

- NO_x emissions – lean burn technology with SCR, lean burn technology
- CO emissions – lean burn technology with oxidation catalyst, lean burn technology
- POC emissions – lean burn technology with oxidation catalyst, lean burn technology
- SO_2 emissions – pipeline quality natural gas, low sulfur fuel
- PM10 emissions – California PUC regulated natural gas (e.g., pipeline quality), low sulfur fuel, PCV (positive crankcase ventilation) filter, lean burn technology

Comparison of District BACT and Proposed Project BACT

As mentioned, the lean burn engines are subject to BAAQMD BACT for NO_x, CO, POC and PM10.

In the BAAQMD's guidelines, as presented in Table 8.1F-1, ranges of pollutant emission levels are presented. Two levels are presented as follows.

- Level 1 - The lowest value represents what the BAAQMD considers "technologically feasible/cost-effective." NO_x and CO have Level 1 emission rates and typical control technologies listed. The Level 1 BACT guidelines are based on a specific permitted project – the NEO California Power, LLC facility, located in Red Bluff, California and within the jurisdiction of Tehama County Air Pollution Control District (TCAPCD).
- Level 2 – The higher value represents what the BAAQMD considers "achieved in practice." NO_x, POC, CO, and PM10 have Level 2 emission rates and/or typical control technologies listed. The Level 2 BACT guidelines are based on the California Air Resources Board's September 2001 document titled "*Guidance for the Permitting of Electrical Generation Technologies.*"

Table 8.1F-2 presents a comparison of the BAAQMD BACT guidelines, the proposed Eastshore's emissions and control technology, and the current permitted emission levels and control technology for the BAAQMD's Level 1 and Level 2 benchmarks.

Based on a review of control technology, Eastshore is proposing control technology consistent with the BAAQMD's BACT guidelines as follows:

- NO_x emissions – lean burn technology with SCR,
- CO emissions – lean burn technology with oxidation catalyst,
- POC emissions – lean burn technology with oxidation catalyst,
- PM10 emissions – California PUC regulated, pipeline quality natural gas

Selective catalytic reduction (SCR) will be used to control NO_x emissions; an oxidation catalyst system will be used to control CO and POC emissions. (It should be noted that CO does not trigger the BAAQMD's BACT requirement; CO is in attainment status.) California PUC pipeline-quality natural gas will be used to meet PM10 BACT requirements.

To date, the SCR and oxidation catalyst systems have not yet been formally designed and therefore have not been bid to vendors. However, the catalyst systems will be required to meet the proposed NO_x, CO, and POC emission rates as presented in Table 8.1F-2.

In determining Eastshore's NO_x and CO emissions, TCAPCD was contacted. The NEO Red Bluff facility consists of sixteen (16) Wärtsilä natural gas-fired internal combustion engines, model 18V22OSG, each which drives a 2.8 MWe generator. Based on discussions with the TCAPCD, the NO_x and CO emissions for several of the engines were not consistently achieved. The following resulted in permit revisions to the emission limits:

- NO_x emissions - NO_x permit limits were increased from 6 ppm to 9 ppm.
- CO emissions – CO permit limits were increased from 12 ppm to 56 ppm.

For POC and PM10, Eastshore's proposed emissions were based on a combination of a survey of other agencies' requirements, achieved in practice levels, operating experience of similar engines, and discussions with the engine vendor.

TABLE 8.1F-2
Comparison of Eastshore Proposed BACT to the BAAQMD BACT Guidelines[1]

Pollutant	BAAQMD BACT[2] Emission Rate (ppm)/BACT		Eastshore BACT Emission Rate (ppm)		Tehama County Emissions (ppm)/BACT
	Level 1/ BACT	Level 2/ BACT	Emissions	BACT	
NO_x	6/SCR	12/SCR	5	SCR	9/SCR
POC	N/D	32/Oxidation Catalyst	25	Oxidation Catalyst	25/Oxidation Catalyst
CO	12/Oxidation Catalyst	74/Oxidation Catalyst	13	Oxidation Catalyst	56/Oxidation Catalyst
PM10	N/D	N/S; Natural gas	Natural gas		Natural gas
NH_3 slip[3]	N/A	N/A	20	SCR	10 ppm

[1] Emissions are ppm (parts per million) at 15% O_2, based on dry volume for: NO_x (oxides of nitrogen), POC (precursor organic compounds), CO (carbon monoxide), PM10 (particulate matter with diameter 10 microns or less), and NH_3 (ammonia) slip. SCR is defined as Selective Catalytic Reduction.
[2] Reference from Bay Area Air Quality Management District (BAAQMD), "*IC Engine – Spark Ignition, Natural Gas Fired, Lean Burn Engine, >= 50 HP*", Document # 96.3.3, 05/07/03.

N/D: "No Determination" - No BACT determination has been made to date for the source category or BACT category under consideration.

N/A: "Not Applicable" - For example, the pollutant in question is not a problem for the source category under consideration.

N/S: "Not Specified" - A BACT determination has been made but no specific emissions limitation has been set or the detailed equipment/process technology has not been specified.

[3] NH_3 slip – There is not a listed BACT for NH_3 slip in the BAAQMD's reference document.

Review of Other BACT References

Tables 8.1F-3 and 8.1F-4 present a summary of a recent review of other BACT-related decisions. Table 8.1F-3 presents information from the South Coast Air Quality Management District (SCAQMD) and includes the broader category of gas-fired, spark-ignited engines, i.e., both rich burn and lean burn.

TABLE 8.1F-3
SCAQMD Recent BACT Decisions (Achieved in Practice) for Spark-Ignited Gas Fired IC Engines [1]

Engine HP/Controls	NO_x	CO	VOC	PM10/SO_x
750 w/3 way catalyst + AFRC	0.15 g/bhp-hr	0.6 g/bhp-hr	0.15 g/bhp-hr	Natural gas
1334 w/3 way catalyst +AFRC	1.5 g/bhp-hr	2.0 g/bhp-hr	1.5 g/bhp-hr	Natural gas
93 w/3 way catalyst +AFRC	0.15 g/bhp-hr	0.6 g/bhp-hr	0.15 g/bhp-hr	Natural gas
171 w/3 way catalyst +AFRC	0.15 g/bhp-hr	0.6 g/bhp-hr	0.15 g/bhp-hr	Natural gas
1408 lean burn + AFRC[2]	0.6 g/bhp-hr	2.5 g/bhp-hr	0.8 g/bhp-hr	No BACT limits
1850 no control[3]	0.6 g/bhp-hr	2.5 g/bhp-hr	0.8 g/bhp-hr	No BACT limits
4321 no controls[4]	0.53 g-bhp-hr	-	0.216 g/bhp-hr	Natural gas
3870 lean burn SCR[5]	9 ppmv	56 ppmv	25 ppmv	PM10: 0.02 g/bhp-hr

[1] This compilation presents both rich and lean burn BACT determinations. AFRC is defined as air-to-fuel ratio controller. SCR is defined as selective catalytic reduction.
[2] Source is fired with digester gas and natural gas as an alternative fuel.
[3] Source is fired with landfill gas fuel, turbocharged with AFRC.
[4] Source is a facility located in Santa Barbara. PM10 BACT at 0.66 g/bhp-hr
[5] Source is a facility (NEO Landfill) located in Red Bluff, CA, Tehama County APCD.

The US EPA RACT-BACT-LAER Clearinghouse (RBLC) was also consulted to review recent US EPA BACT decisions for gas fired IC engines with size ratings at least 1,000 bhp (or approximately 745 kW) or greater. These recent BACT decisions are summarized in Table 8.1F-4. Emission levels are presented in g/bhp-hr units, unless otherwise noted.

Table 8.1F-4
Large Gas Fired IC Engines RBLC BACT Determinations (Natural Gas) 2001-2006

RBLC ID	Unit Size BHP	Control Type	NO_x , g/bhp-hr	CO, g/bhp-hr	VOC, g/bhp-hr
AL 0189	4000	Lean Burn	2.2	2.68	1.52
AZ 0047	6MW (7895 BHP)	Not specified	1.5	2.3	-
CA1068	3870	Lean Burn	9 ppmv	56 ppmv	25 ppmv
CO 0058[1]	1775	Lean Burn	0.8	0.21	0.3
GA 0104	4730	Lean Burn	0.7	0.18	0.3
IA 0077	4735	Catalytic Oxidizer	1.0	0.18	0.68
IL 0083	4000	Clean Burn	2	2.2	0.43

Table 8.1F-4
Large Gas Fired IC Engines RBLC BACT Determinations (Natural Gas) 2001-2006

RBLC ID	Unit Size BHP	Control Type	NO_x , g/bhp-hr	CO, g/bhp-hr	VOC, g/bhp-hr
LA 0141	1478	Not specified	-	3.0	0.50
MS 0056	4730	Lean Burn	0.7	-	-
OK 0109	2200	Lean Burn	2	-	-
PA 0201	800	Clean Burn	3	-	-
PA 0209[1]	1088	Lean Burn	1.5	-	-
PA 0230	1665	Not specified	0.7	-	0.9
TX 0364	2400	Not specified	-	1.2	1.2[2]
TX 0364	3105	Not specified	3.2/2.0[3]	4.8[2]	1.6[2]
TX 0408	800	Not specified	2.0	3.0	1.2
WA 0289	1448	Not specified	10	-	-
WV 0019 +0020	4640	Lean Burn	2	2.1	0.7[2]
WY 0060	1252	NSCR and AFRC	1.1	1.6	-

[1] Draft status as presented in the RBLC.
[2] Other permit limit; limit is not specified as BACT as presented in the RBLC.
[3] Hourly/annual limit as presented for this source in the RBLC.

Black Start Diesel Compression Ignition Engine BACT

Similar to the BACT level categories presented in Table 8.1F-2, Level 1 and Level 2 categories are provided for the black start diesel engine category. Also, Level 3 is provided for select pollutants.

Although BAAQMD BACT is not triggered for any of the pollutants from the black start diesel engine, the following is presented for informational purposes. BACT levels, based on the BAAQMD's guidelines for compression ignition engines, are shown in Table 8.1F-5. Given the limited operations of Eastshore's proposed 225 kw (or approximately 302 bhp) black start diesel engine of not more than 1 hour per day, the BAAQMD's BACT threshold of 10 pounds per day is not triggered. Therefore, neither Level 1 nor Level 2 requirements apply to the black start diesel engine. However, because the engine will serve only as an emergency engine with operations not greater than 30 hours per year, Level 3 requirements apply. Eastshore proposes to install an EPA Tier 3 certified engine that would effectively meet the Level 3 requirements. Also, ultra low sulfur diesel fuel oil that is CARB certified will be fired. As a side note, this will also meet the California Air Toxics Control Measure requirements.

TABLE 8.1F-5
Summary of BAAQMD BACT Guidelines for Compression Ignition Engines[1]

	NO_x, g/bhp	CO, g/bhp	POC, g/bhp	SO_x, %S wt.	PM10, g/bhp
Level 1	1.5	n/s	0.30	n/d	n/d
	SCR + Timing Retard + Turbocharger with Intercooler	Catalytic oxidation	Catalytic oxidation, CARB or EPA (or equiv) low-total hydrocarbon emitting certified engine		Catalyst guard bed
Level 2	6.9	2.75	1.5	< 0.5% sulfur	(Note 2)
	Timing Retard ≤ 4° + Turbocharger with Intercooler	CARB or EPA (or equiv) low-CO emitting certified engine	CARB or EPA (or equiv) low-total hydrocarbon emitting certified engine	Fuel selection	Fuel selection
Level 3	6.9	none	None	none	0.1 g/bhp-hr
	Timing Retard ≤ 4° + Turbocharger with Intercooler				CARB or EPA (or equiv) low-particulate matter emitting certified engine, or particulate filter

[1] Reference from Bay Area Air Quality Management District (BAAQMD), "*IC Engine – Compression Ignition, >= 175 HP*", Document # 96.1.2, 01/11/02. No determination or "n/d" is defined by the District as "no BACT determination has been made to date for the source category or BACT category under consideration." Not specified or "n/s" is defined by the District as "a BACT determination has been made but no specific emissions limitation has been set or the detailed equipment/process technology has not been specified."
[2] BAAQMD guidelines state, "If practical, gas-fueled engine or electric motor. If not, "California Diesel Fuel" (fuel oil w/<0.05% by weight sulfur and < 20% by volume aromatic hydrocarbons."