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Docket Number:	15-AFC-01
Project Title:	Puente Power Project
TN #:	212637
Document Title:	City of Oxnard's Comments on Ventura County APCD's Preliminary Determination of Compliance-Puente Power Plant
Description:	N/A
Filer:	Patty Paul
Organization:	Shute, Mihaly & Weinberger LLP/Edward T. Schexnayder for City of Oxnard
Submitter Role:	Intervenor
Submission Date:	8/5/2016 8:54:50 AM
Docketed Date:	8/5/2016

396 HAYES STREET, SAN FRANCISCO, CA 94102
T: (415) 552-7272 F: (415) 552-5816
www.smwlaw.com

EDWARD T. SCHEXNAYDER
Attorney
schexnayder@smwlaw.com

July 29, 2016

Via E-Mail and U.S. Mail

Kerby E. Zozula
Engineering Division Manager
Ventura County APCD
669 County Square Drive
Ventura, CA 93003
kerby@vcapcd.org

Re: City of Oxnard's Comments on Ventura County APCD's Preliminary Determination of Compliance-Puente Power Plant

Dear Mr. Zozula:

This Firm represents the City of Oxnard in matters related to NRG's proposed Puente Power Plant ("Project"). As you are aware, the City has numerous concerns with NRG's proposal, which would locate a new gas-fired peaker plant on the City's coast and negatively impact the health, safety, and welfare of the City's residents. Among these concerns are the public health and air quality impacts of the proposed Project.

The City appreciates the efforts of the Ventura County Air Pollution Control District staff in preparing the Preliminary Determination of Compliance ("PDOC") for the Project. The City's review of the PDOC, however, has revealed deficiencies throughout the document. Most troubling is the PDOC's failure to analyze whether the Project would trigger the requirement for the applicant to obtain a Clean Air Act prevention of significant deterioration ("PSD") permit. That analysis is legally required and should be performed. Indeed, the City's analysis of the available data shows that the Project would require a PSD permit for PM2.5 emissions. The District should therefore revise its analysis to reflect this permitting requirement.

As further discussed below and in the attached comments of the City's air quality expert, Dr. Phyllis Fox, which are fully incorporate herein by reference, the PDOC is deficient in other respects. *See* Attachment A, Phyllis Fox, Ph.D., PE, Comments on the Puente Power Project, Ventura County Preliminary Determination of Compliance and California Energy Commission Revised Preliminary Staff Assessment, July 29, 2016. For instance, many of the proposed PDOC permit limits are not enforceable, the PDOC's proposed conditions fail to require necessary offsets for the Project's PM10 emissions, and the PDOC lacks a legally-adequate analysis of alternatives to NRG's proposed Project. Until it revises the PDOC's analysis to correct these and other deficiencies, the District cannot permit the construction and operation of the proposed Project.

I. The PDOC Erred in Failing to Conduct PSD Review.

The PDOC generally evaluates the proposed Project's compliance with the District's New Source Review permitting rules, but refuses to apply the rules that determine whether the Project will require a PSD permit. Instead, the PDOC accepts NRG's assertion "that PSD does not apply to the proposed Puente Power Project" and suggests that the District need not evaluate PSD applicability because the District "does not have the authority to implement and enforce the requirements of PSD at this time." PDOC at pdf. p. 7. This approach is both inconsistent with the requirements of the District's rules and inappropriate given the PDOC's separate analysis that relies on NRG's asserted PSD inapplicability.

Under the District's rule, the District cannot issue an authority to construct permit until it determines that the "emissions unit will comply with *all* applicable federal, state, or District orders, rules or regulations." District Rule 15(A) (emphasis added); *see also* 20 C.C.R. § 1744.5 (requiring the local air pollution control officer to determine compliance with all district regulations, including applicable new source review rules). As the PDOC acknowledges, the federal PSD permitting regulations (40 C.F.R. § 52.21) apply to NRG's proposed Project. *See* PDOC at pdf. p. 7. Similarly District Rule 12.13, which adopts the federal PSD permitting regulations, applies to any source that would be regulated under the federal PSD rules. District Rule 12.13(A), (D)(1).

The PDOC suggests that District Rule 12.13 does not apply to the District's analysis because EPA has not yet approved this rule as part of California's State Implementation Plan. But the District's rule is already in effect. The current version of District Rule 12.13 became effective when the Ventura County APCD Board adopted it in November 2015.[1] *See* District Rule 5 ("All Rules are effective for all equipment as of the effective date of their adoption, unless indicated otherwise."). The District's New Source Review rules require an application to be evaluated based on the rules in effect when "such application is deemed complete." District Rules 26(A), 26.8(A). NRG submitted the current version of its application to the Air District on December 10, 2015. *See* NRG Application for an Authority to Construct/Determination of Compliance for the Proposed Puente Power Project (TN# 206918). Thus, even if the EPA is still currently responsible for issuing a PSD permit, the District must evaluate the proposed Project's need for a PSD permit using the District PSD rules that were in effect at that time.[2]

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[1] *See* http://www.vcapcd.org/rules_division.htm; (documents cited in this letter and in Attachment A are also being provided to Ventura County APCD via a CD).

[2] To the extent that the District believes that NRG's authority to construct application was sufficiently complete on May 28, 2015, the District would also need to evaluate the application under the version of Rule 12.13 in effect at that time.

The PDOC's failure to evaluate compliance with the District's own PSD rules is especially troubling because the PDOC relies on NRG's assertion about PSD inapplicability to employ an unauthorized air quality monitoring approach. The PDOC relies on the a modeling beta option called "Adjusted U*" to evaluate compliance with state and federal ambient air quality standards. PDOC, Appendix G at 20-23. But as Sierra Club explained in a letter to the District earlier this year, Adjusted U* has not been approved as a default modeling approach by EPA and is less accurate and underestimates air quality impacts compared to the EPA-approved versions of AERMOD and AERMET. *See* Sierra Club Letter to Kerby Zozula, VCAPCD (April 11, 2016). The PDOC itself confirms this critique, showing that the use of Adjusted U* significantly deflates modeled air impacts across multiple modeling runs. PDOC, Appendix G at 20-23.

To justify its modeling approach, the PDOC asserts that the "District will allow use of the Adjusted U* [modeling] option" for this Project because "this is not a PSD project." PDOC, Appendix G at 15. Notably, the PDOC fails to cite any authority supporting the contention that PSD applicability somehow determines the modeling approach used to determine compliance with state and federal ambient air quality standards. Moreover, without actually conducting a PSD analysis, the PDOC cannot ultimately determine whether the Project would trigger PSD permitting.

II. The Project Requires a PSD Permit.

In light of the PDOC's failure to evaluate NRG's claim that PSD permitting does not apply to its Project, Dr. Phyllis Fox independently evaluated NRG's assertion. *See* Attachment A. Dr. Fox's analysis revealed numerous errors in NRG's PSD calculations. Most notably, NRG used incorrect baseline calculations and an incorrect baseline period when performing its PSD applicability calculations. Additionally, there is no basis to assume, much less ensure, that the Project's potential to emit PM will be as low as NRG claims. Correcting these errors in the PSD calculations shows that the Project requires a PSD permit for PM2.5 emissions.

A. NRG's PSD Analysis Uses an Incorrect Baseline.

To determine whether a Project requires a PSD permit, the PSD regulations require a "netting analysis" that compares the new or modified source's potential to emit against a two-year average of actual baseline emissions from the Project. The netting analysis then subtracts the baseline emissions from the source's calculated potential to emit to determine whether emission increases will trigger PSD review. (The PSD threshold for emissions of PM2.5 is 10 tons per year.) NRG's PSD calculations incorrectly inflate baseline emissions from Mandalay Generating Station Unit 2, thereby underestimating the Project's net increase in PM2.5 emissions. Correcting this error shows that the Project requires a PSD permit.

1. NRG Use of an Outdated Emission Factor to Determine Its PM2.5 Baseline Was Improper.

PSD regulations require the use of "baseline *actual* emissions" to determine PSD applicability. 40 C.F.R. § 52.21(a)(2)(iv)(c) (emphasis added); *see also* 40 C.F.R. § 52.21(b)(48)(i). In conducting its PSD calculation, NRG did not comply with this regulation. Instead, it employed a generic, decades-old emission factor to calculate assumed emissions from Mandalay Unit 2. *See* Attachment A. As a legal matter, use of this emission factor cannot satisfy the requirement to demonstrate "actual" emissions at the Mandalay Generating Station during this baseline period. The *actual* emissions from the facility must be provided.

This error is especially problematic because the outdated AP-42 emission factor that NRG used is known to significantly overestimate actual PM emissions from natural gas-fired boilers like Mandalay Unit 2. *See* Attachment A at 6-13. As Dr. Fox notes, this outdated emission factor was based on faulty test methods and EPA does not recommend using it to determine emissions from individual facilities (as NRG has attempted to do here). *Id*. at 8-13. Consequently, using this emission factor to calculate baseline emissions artificially inflates baseline PM2.5 emissions from Mandalay Unit 2.

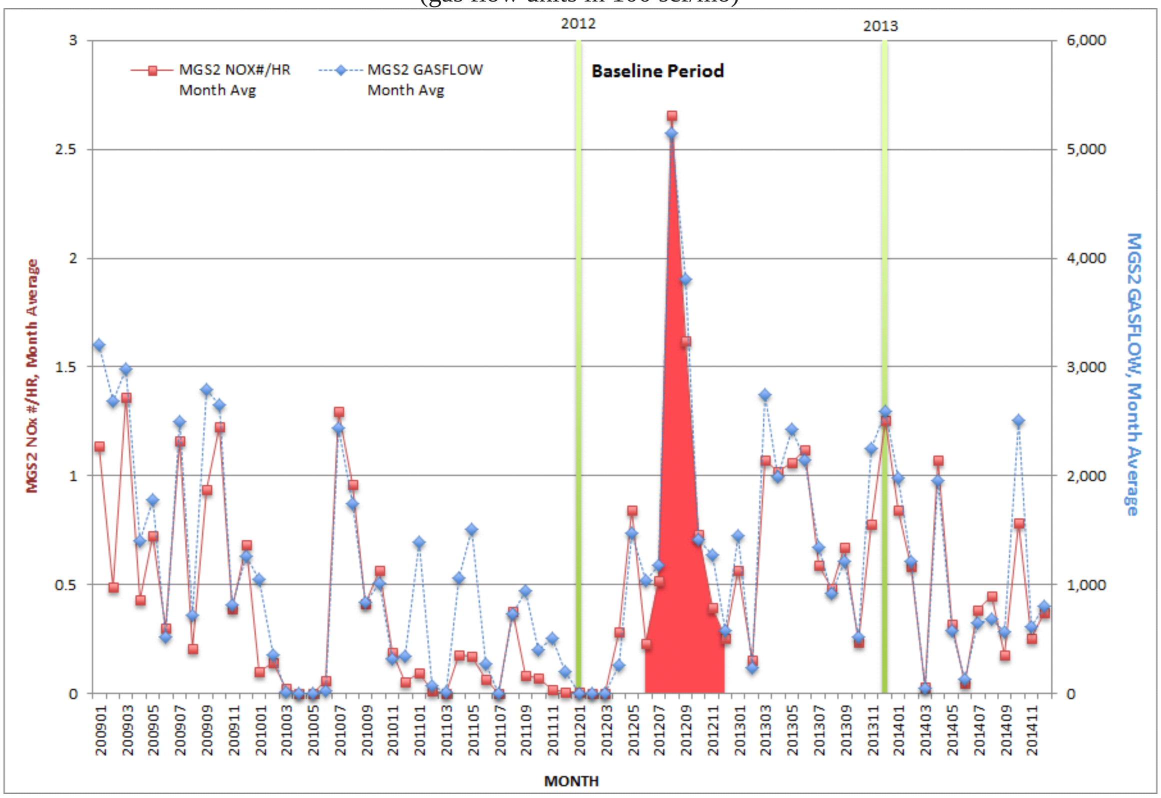
Agencies have subsequently released other emission factors that more closely represent actual PM2.5 emissions from gas-fired boiler units. *Id*. at 11-14. Dr. Fox's analysis demonstrates that using *any* of these more accurate emission factors substantially reduces the assumed baseline emissions from Mandalay Unit 2 and shows that NRG must obtains a PSD permit for the Project's PM2.5 emissions. *Id*. at 9-14.

2. NRG Used the Two Years of Highest Emissions for Its Baseline.

The PSD permitting program determines baseline emissions using average emissions from a two-year period within a five-year "lookback" window. 40 C.F.R. § 52.21(b)(48)(i); *see also* District Rule 26.C (also requiring use of a two-year baseline period). NRG selected 2012-2013 as its baseline period within its 2010-2014 lookback window. Evaluation of fuel use data from Mandalay Unit 2 during this period shows that 2012 and 2013 were the years of Unit 2's highest fuel use, and therefore emissions. Attachment A at 14-18.

NRG and the PDOC attempt to justify using the highest years of emissions for the baseline by asserting that this two-year period "was determined to be the most representative as it best reflects current electricity market." PDOC at pdf p. 20. There is no evidence or analysis to support this assertion. Indeed, evaluation of the available NOx and fuel use data for Mandalay Unit 2 show that the 2012-2013 period included a dramatic spike in Unit 2 operations, which were five-times higher than that unit's average monthly operations during the lookback period. Attachment A at 15, n.64. Dr. Fox's evaluation reveals that this spike in operations corresponded with hundreds of violations of Mandalay Unit 2's PM2.5 permit limit. *Id*. at 16.

Monthly NOx and Fuel Use 2009-2014
(gas flow units in 100 scf/mo)



Neither the federal PSD regulations, nor the District's rules, allow using periods of permit violations to establish a unit's actual emissions. 40 C.F.R. § 52.21(b)(48)(i)(*b*); District Rule 26.C. PSD applicability should instead be determined by using a two-year operating period that is reflective of a unit's normal, permitted operations. Correcting this error[3] further decreases the assumed baseline emissions of Mandalay Unit 2 and shows that the Project requires a PSD permit. Attachment A at 16.

B. NRG Understates the Project's Potential to Emit.

In addition to overstating baseline emissions from Mandalay Unit 2, NRG's PSD analysis incorrectly *understates* the new Puente Project's potential to emit PM2.5. Correcting the Project's potential to emit would further demonstrate that a PSD permit is required for PM2.5 emissions.

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[3] This baseline error extends beyond NRG's PSD calculations and affects other sections of the PDOC, including the calculated increase in NOx emissions. *See* PDOC pdf pp. 20-23. At a minimum, the PDOC's analysis must be revised to adjust baseline emissions to exclude periods of permit violations and accurately represent Unit 2's operations.

First, relying on a one paragraph emissions "guarantee" letter from GE, the turbine vendor, NRG has asserted that the Project's turbine will emit 10.1 pounds/hour of total particulates. PDOC, Appendix B at pdf p. 55. There are numerous problems with relying on these asserted PM emissions to calculate the Project's potential to emit. *See* Attachment A at 19-22. For instance, the GE letter does not specify the test methods that would be used to determine the Project's PM emissions. As Dr. Fox notes, this is especially problematic because "GE's particulate matter guarantees are typically based on non-standard PM2.5 test methods that yield lower emissions than standard EPA compliance test methods." *Id*. at 20. Using standard test methods to determine the turbine's PM emissions could consequently show increased PM emissions from the turbine. However, if testing is conducted infrequently, exceedances of the potential to emit would not be detected.

Additionally, the GE letter only guarantees emissions during periods when ambient temperatures range from 38.9 F to 82 F. PDOC, Appendix B at pdf p. 55. Yet temperatures in Oxnard can exceed the maximum temperature in this range,[4] and these periods of warmer weather are exactly the times when more peaking capacity will be required due to increased electricity demands. *Id*. at 21. The GE letter provides no information on what PM emissions will be like during these periods of warm weather.

Moreover, the letter does not account for increased PM emissions that will occur as the GE turbine ages. "As turbines age, their efficiency declines, requiring the combustion of more fuel to reach the same output. Because emissions depend directly on the amount of fuel that is burned, PM2.5 emissions will increase over the life of the facility." *Id*. at 21. Neither the GE letter nor NRG's PSD analysis account for this increase in the turbine's potential to emit PM2.5 over the Project's lifetime.

Second, the proposed PM2.5 emission limits in the PDOC and PSA are neither federally or practically enforceable and cannot actually be relied on to ensure that the Project's PM emissions do not exceed NRG's asserted 10.68 tons per year. Most troubling, these proposed limits do not require stack testing during startup and shutdown periods, and only require testing during 0.1 percent of normal operating hours in a given year. Attachment A. The District must require more robust testing to confirm that the PM2.5 limits are being met or the Project could easily exceed the 10.1 pound per hour emission levels asserted in the GE letter. Attachment A at 23-26. Without enforceable emission limits, the PDOC cannot conclude that the Project will not exceed the 10 ton per year PSD threshold.

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[4] *See, e.g.*, Weather Underground, Oxnard, CA Weather History for KOXR – Oct. 2015 https://www.wunderground.com/history/airport/KOXR/2015/10/28/MonthlyCalendar.html?req_city=Oxnard&req_state=CA&req_statename=&reqdb.zip=93035&reqdb.magic=3&reqdb.wmo=99999.

III. The PDOC Fails to Require Offsets for the Project's PM10 Emissions.

In addition to requiring a PSD permit, the Project also must offset its anticipated PM10 emissions. The PDOC fails to correctly calculate the Project's expected PM10 emissions, and, as a result, fails to require necessary offsets for those emissions. The PDOC claims that the Project satisfies the definition of a "Replacement Emissions Unit" (PDOC at pdf p. 22), but this is not the case. A replacement unit is a unit that "serves the identical function as the emission unit being replaced." District Rule 26.1(29). The Project will not serve an identical function as the old gas-fired steam boiler that it is purportedly replacing. Indeed, NRG's own press materials for the Project assert that the new turbine's fast ramp time is needed accommodate increasing renewable infiltration into the energy market, not to "replace" the outdated and retiring Mandalay gas-fired boiler.[5]

Instead of replacing Mandalay Unit 2, the Project constitutes a "new emission unit" under the District's rules. District Rule 26.1(21). Although the PDOC asserts that the Project will reduce PM10 emissions, using the correct emission calculation rules for new emission units shows that the Project will *increase* PM10 emissions by at least 9.06 tons per year.[6] Because Mandalay Generating Station's total PM10 potential-to-emit would exceed 15 tons per year if the Project is built, NRG must obtain emission reduction credits to offset its increase in PM10 emissions. District Rule 26.2(B); PDOC at pdf p. 28. The PDOC must be revised to reflect this requirement.

IV. The PDOC's Consideration of Alternatives Is Legally Deficient.

District Rule 26.2(E), Analysis of Alternatives, mandates that the District:

> shall deny an application for an Authority to Construct for any new major source or major modification unless the applicant provides an analysis as required by Section 173(a)(5) of the federal Clean Air Act, of alternative sites, sizes, production processes, and environmental control techniques for the proposed source

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[5] *See* http://www.nrg.com/generation/projects/puente-power/; http://www.nrg.com/documents/business/puente-power-fact-sheet.pdf

[6] District rules require use of a new unit's potential to emit to determine emission increases. District Rule 26.6.D.1. The PDOC reports a 10.68 tons per year potential to emit for PM10 (although this value is very likely understated, as noted by Dr. Fox). PDOC at pdf p. 23. Even subtracting the asserted 1.62 tons per year of baseline PM10 emissions from Mandalay Unit 2 (PDOC at pdf p. 20) yields a net PM10 increase of least 9.06 tons per year. In fact, because NRG has overstated the baseline PM emissions from Mandalay Unit 2 (as explained by Dr. Fox), the actual net PM10 emission increase is likely much higher. *See* Section II.A; Attachment A.

> demonstrating that the benefits of the proposed source significantly outweigh the environmental and social costs imposed as a result of its location, construction, or modification.

Like other requirements in the District's Rules, an applicant must meet the requirements of Rule 26.2(E). *See* 20 C.C.R. § 1744.5(a). The PDOC cites this rule, and states that the "applicant has provided an analysis of alternatives," which is attached to the PDOC as Appendix J. PDOC at pdf p. 31. But the PDOC does not analyze, or even discuss, whether that attached alternatives analysis satisfies the standards of District Rule 26.2(E) and Clean Air Act section 173(a)(5). Even a cursory review of alternatives discussion in Appendix J demonstrates that it does not meet these standards.

Appendix J was prepared by NRG's consultant as part of NRG's application for certification. That document sets forth NRG's initial position on the required alternatives analysis under the California Environmental Quality Act ("CEQA"), not the District's rules or the Clean Air Act. Notably, as the AFC acknowledges, CEQA's alternative requirement obligates agencies to consider project alternatives "which would feasibly attain most of the basic objectives of the project but would avoid or substantially lessen any of the significant effects of the project, and evaluate the comparative merits of the alternatives." PDOC, Appendix J at 5-1 (citing CEQA Guidelines § 15126.6(a)). Because it focuses on a CEQA alternatives analysis, this document does not attempt to demonstrate that "benefits of the proposed source *significantly outweigh the environmental and social costs* imposed as a result of its location, construction, or modification." District Rule 26.2(E) (emphasis added).[7]

Indeed, given the Project's proposed location on the City of Oxnard's coastline, inconsistency with the City's General Plan, and perpetuation of unjust industrial resource siting within Oxnard, it is very unlikely that NRG can show that the benefits of the proposed Project significantly outweigh the social and environmental impacts of locating the Project at the Mandalay Generating Station. Ultimately, without an alternative assessment that satisfies District Rule 26.2(E) and Clean Air Act section 173(a)(5), the proposed Project cannot be approved.

V. Conclusion

The City of Oxnard appreciates Ventura County APCD's consideration of its comments. Unfortunately, the PDOC, as currently drafted, does not comply with the District's own rules or applicable federal and state regulations. The City looks forward to continuing to engage the District on these issues to correct the PDOC's deficiencies.

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[7] NRG's alternatives analysis is further deficient because it refused to consider alternative sites to the proposed Mandalay Generating Station location for the Project (*see* AFC 5-3 through 5-4), despite the express requirement that an "applicant provide[] an analysis . . . of alternative sites." Commission staff recognized this flaw in NRG's AFC roughly a year ago. Puente Power Project (15-AFC-01) Issues Identification Report (August 10, 2015) at 4-6 (TN# 205664).

Very truly yours,

SHUTE, MIHALY & WEINBERGER LLP

Edward T. Schexnayder

cc: California Energy Commission
Gerardo Rios, U.S. EPA Region IX (Rios.Gerardo@epa.gov)
Tung Le, California Air Resources Board (ttle@arb.ca.gov)

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ATTACHMENT A

Comments

on the

Puente Power Project

Ventura County APCD
Preliminary Determination of Compliance

and

California Energy Commission
Revised Preliminary Staff Assessment

July 29, 2016

Phyllis Fox, Ph.D., PE
745 White Pine Ave.
Rockledge, FL 32955
phyllisfox@gmail.com
321-626-6885

I. INTRODUCTION, SUMMARY AND CONCLUSIONS.

The Applicant, NRG, proposes to replace two aging gas-fired, steam-generating boiler units (Mandalay Generating Station Units 1 and 2) with a new General Electric (GE) Frame 7HA.01 262 MW (nominal net) gas-fired combustion turbine generator and associated auxiliaries. Existing Mandalay Generating Station (MGS) Unit 2 would be shutdown at the end of the commissioning of the new gas turbine, and existing MGS Unit 1 will continue to operate until December 31, 2020. The gas turbine will be operated in simple-cycle mode to provide peaking power with an annual capacity factor of 25%. A new 500-ft long natural gas pipeline will connect a new gas metering station with a new 3,200 hp (198,000 lb/hr) gas compressor to the turbine interface. An existing backup diesel generator will be retired and replaced with a new Tier 4 certified Caterpillar 500 kW backup diesel generator. The "Project" is this collection of changes to the Mandalay Generating Station.[1]

The Applicant asserts that the Project will not trigger federal Prevention of Significant Deterioration (PSD) review for any pollutant.[2] The Ventura County Air Pollution Control District's (VCAPCD's) Preliminary Determination of Compliance (PDOC)[3] and the California Energy Commission's (CEC's) Revised Preliminary Staff Assessment (PSA)[4] accepted this conclusion. I was asked to review the Applicant's conclusion that PSD review is not triggered. My review shows that PSD review is triggered for PM2.5.[5] The Applicant's netting analysis significantly overestimates the reduction in emissions from shutting down existing MGS Unit 2 and underestimates the potential to emit PM2.5 from the new gas turbine. When either of these errors is corrected, the increase in PM2.5 emissions equals or exceeds the PM2.5 PSD significance threshold of 10 ton/yr, triggering PSD review.

My resume is included in Exhibit 1 to these Comments. I have M.S. and Ph.D. degrees in environmental engineering from the University of California at Berkeley. I am a licensed professional engineer (chemical) in California. I have over 40 years of experience in the field of environmental engineering, including PSD review; air emissions and air pollution control

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[1] NRG Oxnard Energy Center, LLC (NRG), Puente Power Project (P3) Application for Certification (AFC), Docket Number 15-AFC-01, Section 2.0: Project Description (TN # 204219-5) (April 15, 2015) [hereinafter AFC Section 2.0], as revised in Latham & Watkins LLP, Applicant's Responses to CEC Data Request, Set 2, Appendix 49-1 (TN # 206791) (Nov. 30, 2015) [hereinafter Applicant's Responses to CEC Set 2].

[2] NRG, AFC, Appendix C: Air Quality, Table C-2.14 (TN # 204220-3) (April 15, 2015), pdf 64, as revised in Applicant's Responses to CEC Set 2 (Nov. 30, 2015) (TN # 206791); *see also* VCAPCD, Notice of Preliminary Determination of Compliance (PDOC), pdf 4 (May 20, 2016) (TN # 211570).

[3] PDOC at pdf 7 (TN # 211570).

[4] Revised Preliminary Staff Assessment (Revised PSA), Part 1 (TN # 211885-1) pdf 70, 106, 111 (June 20, 2016) ("P3 is not expected to trigger a major source modification under [PSD];" "this is not a PSD project;" "P3 has been determined to not require PSD permitting…").

[5] In these comments, consistent with the AFC, PDOC and PSA, I assume PM = PM10 = PM2.5. As PSD review is triggered for PM2.5, I use PM2.5 throughout these comments.

including BACT, LAER, MACT, and RACT; greenhouse gas (GHG) emission inventory and control; environmental permitting; environmental impact reports, including CEQA/NEPA documentation; risk assessments; and litigation support. I have presented testimony before the California Energy Commission in many similar cases, as well as in state and federal court and before regulatory commissions in other states.

II. THE PROJECT TRIGGERS PSD REVIEW FOR PM2.5.

A. Background on the PSD Netting Analysis.

The applicability of PSD review at an existing major source in an attainment area is determined by comparing the net change in emissions with PSD significance thresholds.[6] The Applicant determined the net increase in emissions using the actual-to-potential test[7] calculated as follows:

Net Change in Emissions =
Potential to Emit of New Equipment –Baseline Emissions from Shutdown Equipment.

The new equipment includes a new gas turbine and diesel generator and the shutdown equipment includes MGS Unit 2 and an existing diesel generator. As the diesel generator contributes <0.01 ton/yr to the netting calculations, it is not further discussed. The net change in emissions calculated from this equation triggers PSD review if it equals or exceeds certain emission rates, including 10 tons per year (ton/yr) of direct PM2.5.[8]

The "potential to emit" means "the maximum capacity of a stationary source to emit a pollutant under its physical and operational design. Any physical or operational limitation on the capacity of the source to emit a pollutant, including air pollution control equipment and restrictions on hours of operation or on the type or amount of material combusted, stored, or processed, shall be treated as part of its design if the limitation or the effect it would have on emissions is federally enforceable."[9] This condition is only satisfied if the limit is both federally and practically enforceable.[10]

Baseline emissions for any existing electric utility steam generating unit "…means the average rate, in tons per year, at which the unit actually emitted the pollutant during any

[6] 40 C.F.R. § 52.21(a)(2) and (b)(23); New Source Review Workshop Manual at A.35 [hereinafter NSR Manual] available at https://www.epa.gov/nsr/nsr-workshop-manual-draft-october-1990.

[7] 40 C.F.R. § 52.21(a)(2)(iv)(d).

[8] 40 C.F.R. § 52.21(b)(23)(i).

[9] 40 C.F.R. § 52.21(b)(4).

[10] NSR Manual at A.9, C.1; Memorandum from Terrell E. Hunt, Office of Enforcement and Compliance Monitoring, and John S. Seitz, Office of Air Quality Planning and Standards, Guidance on Limiting Potential to Emit in New Source Permitting (June 13, 1989) [hereinafter 6/13/89 Hunt and Seitz Memo) available at https://www3.epa.gov/airtoxics/pte/june13_89.pdf.

consecutive 24-month period selected by the owner or operator within the 5-year period immediately preceding when the owner or operator begins actual construction of the Project. The Administrator shall allow the use of a different time period upon a determination that it is more representative of normal source operation."[11]

If the resulting net change in emissions equals or exceeds a PSD significance threshold for any criteria pollutant, PSD review is triggered for that pollutant.[12] While this general methodology was followed by the Applicant and is correct, the specific methods used to estimate the potential to emit of the new turbine and the baseline emissions from the shutdown of MGS Unit 2 are fundamentally flawed.

B. Correcting Fundamental Errors in the Applicant's Netting Analysis Shows that the Project Triggers PSD Review.

The Preliminary Determination of Compliance (PDOC) prepared by the Ventura County Air Pollution Control District (VCAPCD) concluded pursuant to Rule 26.13, based on the applicant's analysis that:

> The applicant has determined that PSD does not apply to the proposed Puente Power Project. Rule 26.13 implements the requirements of 40 CFR 52.21 – Prevention of Significant Deterioration (PSD). This rule has not been approved by U.S. EPA. As such, any implementation of PSD requirements, including applicability determinations and/or determination of compliance with PSD requirements can only be performed by U.S. EPA. The Ventura County ACPD does not have the authority to implement and enforce the requirements of PSD at this time. Since the applicant has stated that PSD does not apply, this DOC does not include a discussion or calculations of greenhouse gases (GHGs).[13]

The Revised Preliminary Staff Assessment (PSA) also accepted the Applicant's analysis, asserting: "The applicant has stipulated to emission levels that ensure that the Project's net emission increase of pollutants would be below PSD permit trigger levels."[14] Because both of these documents depend on the Applicant's assertions about PSD applicability, my analysis focuses on information and methodologies relied on by the Applicant to estimate the net change in PM2.5 emissions.

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[11] 40 C.F.R. § 52.21(b)(48)(i).

[12] 40 C.F.R. § 52.21(b)(23)(i)-(iv); *see also* NSR Manual, Chapter A, p. A-1-A-2.

[13] PDOC at 7 (TN # 211570).

[14] Revised PSA, Part 1, pdf 125 (TN # 211885-1).

1. <u>The Applicant's Netting Analysis</u>

The Applicant originally estimated a net increase in PM2.5 emissions in the AFC of 9.8 ton/yr,[15] compared to the PSD significance threshold for PM2.5 of 10 ton/yr or greater, as summarized in Table 1.

Table 1:
Initial PSD Netting Analysis[16]

	Emissions (tons/year)					
	NOx Emissions	CO Emissions	ROC Emissions	PM10 Emissions	PM2.5 Emissions	SOx Emissions
Emissions New Equipment =	36.1	57.9	11.8	12.8	12.8	2.2
Emission Reductions Units 1 and 2[1] =	4.9	48.0	1.7	3.0	3.0	0.7
Net Emission Change =	31.2	9.9	10.1	9.8	9.8	1.5
Major Modification Thresholds[1] =	40	100	40	15	10	40
Major Modification?	no	no	no	no	no	no
Triggers PSD?	no	no	no	no	no	no

This analysis was based on two key assumptions: (1) an alleged vendor "guarantee"[17] for the new gas turbine for "total particulates" of 10.6 lb/hr qualified as "steady state stack emissions during emission compliance mode"[18] and baseline emissions from the shutdown of Mandalay Units 1 and 2 for baseline years of 2012 and 2013.

Based on this analysis, the Applicant incorrectly concluded in the AFC that PSD review was not triggered for PM2.5 because 9.8 ton/yr is less than 10 ton/yr. However, the PM2.5 significance threshold is expressed to the nearest ten (10 ton/yr). Thus, the emissions that are compared with this threshold should be rounded to the nearest ten. Therefore, 9.8 ton/yr rounds up to 10 ton/yr. Further, as discussed in Comments section II.B.2.c.ii, the Applicant failed to adjust its baseline emissions to remove violations of its permitted PM emission limits. When the violating hours are adjusted, the PM2.5 emission increase equals 10 ton/yr. As the significance threshold is 10 ton/yr or greater, the AFC calculation demonstrated that PSD review for PM2.5 was triggered.

Apparently in recognition of the potential to trigger PSD review for PM2.5, the Applicant withdrew its AFC emission calculations in Table 1 and secured a lower particulate matter (PM=PM10=PM2.5) emission rate guarantee from the turbine vendor, GE. The revised GE

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[15] AFC, Appendix C, Table C-2.14, pdf 64 (TN # 204220-3).

[16] *Ibid.*

[17] Latham & Watkins LLP, Responses to City of Oxnard Data Requests Set 1 (1-46), Response 5-1 (TN # 206009) (Sept. 3, 2015) ("The emission values identified in the January 9, 2015 letter from GE are guarantee values specified in GE's confidential Technical Specification for the project.") [hereinafter Applicant's Responses to City Set 1].

[18] AFC, Appendix C-2, Letter from Andrew Dicke, PGP Environmental Marketing Manager, to Steve Rose, Sr. Director – Development Engineering, Houston, TX, January 9, 2015, pdf 38 (TN # 204220-3).

"guarantee" letter (which is not actually a guarantee as explained elsewhere) reduced the new turbine PM emission rate from 10.6 lb/hr to 10.1 lb/hr.[19]

The Applicant also reduced baseline emissions from 3.0 ton/yr for Units 1 and 2 to 1.4 ton/yr for one existing unit, assumed to be MGS Unit 2,[20] which would be shutdown at the end of commissioning of the new gas turbine. The 1.4 ton/yr for MGS Unit 2 was an error that was subsequently corrected in the PDOC and Revised PSA to 1.62 ton/yr for existing MGS Unit 2.[21] The revised PSD netting analysis, as corrected in the PDOC and the PSA, is included in Table 2. This revised analysis indicates a net increase in PM2.5 emissions of 9.06 ton/yr, compared to the PM2.5 significance threshold of 10 ton/yr.

Table 2:
Revised PSD Netting Analysis[22]

Emission Source	Pollutant (tons/year)				
	NOx	CO[a]	VOC	SOx	PM[b]
P3 Expected Maximum Annual Emissions[c]	32.97	54.53	10.85	7.87	10.68
Mandalay Generating Station (MGS Unit 2 only) Emissions Baseline[d]	-3.04	-25.96	-0.91	-0.39	-1.62
MGS Existing 154 BHP Emergency Engine	-0.05	-0.01	0.0	0.0	0.0
MGS Existing 201 BHP Emergency Engine	-0.07	-0.01	0.0	0.0	0.0
P3 Net Emissions Change	+29.8	+28.55	+9.94	+7.48	+9.06

This revised netting analysis suggests that the Project would not trigger PSD review for PM2.5 because 9.06 ton/yr of PM2.5 is less than the significance threshold of 10 ton/yr. The following comments discuss the errors in this analysis.

1. <u>The Applicant Incorrectly Determined the MGS Unit 2 Baseline</u>

There are two parts to the baseline emission calculation: (1) the determination of the "actual" baseline emissions and (2) the determination of the baseline years. These are separately discussed below. These were both incorrectly determined in a manner that overestimates Unit 2 baseline emissions and thus underestimates the net change in PM2.5 emissions. Either of these errors taken alone increases the net change in PM2.5 emissions enough to equal or exceed the

[19] Applicant's Responses to CEC Set 2, Letter from Andrew Dicke, GE Power and Water, Emissions and Permitting Application Engineer, to NRG Puente Power Team, Re: NRG Puente Power, GE IPS: 976085, GE PM10 Emissions Guarantee, October 28, 2015, pdf 65 (TN # 206791); *see also* PDOC, Appendix B, Emissions Data (TN # 211570).

[20] Applicant's Responses to CEC Set 2, pdf 72 (TN # 206791); *see also* pdf 83 (showing the Applicant is assuming PM2.5 emissions from MGS Unit 1 equals PM2.5 emissions from MGS Unit 2).

[21] PDOC, Table VII-16, pdf 20 (TN # 211570); Revised PSA, Part 1, Table 22, p. 4.1-31, pdf 98 (TN # 211885-1). Calculated as: (2.5 lb/MMscf)(1,297.75 MMscf/yr)/2000 lb/ton = 1.62 ton/yr. Fuel flow of 1,297.75 MMscf/yr from PDOC, Appendix D for 2012 and 2013.

[22] Revised PSA, Part 1, Table 22, pdf 98 (TN #211885-1).

PM2.5 significance threshold, trigging PSD review for PM2.5. In addition to these errors, there are other errors and omissions, not addressed in the PDOC or PSA, which virtually assure that the net change in PM2.5 emissions will equal or exceed 10 ton/yr. These issues are discussed below.

a. MGS Unit 2 Baseline Emissions Must Be Actual Emissions

The actual-to-projected actual applicability test used by the applicant requires the use of "baseline actual emissions."[23] For any existing electric utility steam generating unit, such as MGS Unit 2, "baseline actual emissions means the average rate, in tons per year, at which the unit actually emitted the pollutant…"[24] Thus, baseline emissions for purposes of calculating the net increase under the PSD regulations are "actual" emissions that occurred during the baseline years. The plain language meaning of actual is "existing or occurring at the time."[25]

Despite this regulatory requirement, the Applicant calculated baseline emissions for MGS Unit 2 from a generic PM2.5 emission factor expressed in pounds of PM2.5 emitted per unit of fuel burned and actual fuel use. The use of a generic emission factor, developed for a different facility or facilities, does not yield "actual" emissions for MGS Unit 2. While the use of a generic emission factor may be substituted when it is not feasible to measure "actual" emissions,[26] this is not the case here. The applicant had ample opportunity prior to submitting its application to collect representative "actual" test data at MGS Unit 2. Instead, the Applicant used a two-decades old, superseded generic emission factor that is not representative of "actual" emissions at MGS Unit 2 and is widely known to yield very high and inaccurate results. An artificially high PM2.5 baseline underestimates the net increase in PM2.5 emissions.

b. PM2.5 Emission Factor

The PM2.5 emission factor used to estimate baseline emissions is 2.50 lb/MMscf, based on VCAPCD emission inventory factors.[27] The Applicant produced the VCAPCD emission inventories in response to a City data request, which confirm baseline PM2.5 emissions are based on the VCAPCD emission factor.[28] The VCAPCD emission factor is not based on testing at MGS Unit 2 and thus does not represent "actual" emissions. Rather, it is based on a generic and

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[23] 40 C.F.R. § 52.21(a)(2)(iv)(c).

[24] 40 C.F.R. § 52.21(b)(48)(i).

[25] Merriam-Webster, Full Definition of Actual (3), available at http://www.merriam-webster.com/dictionary/actual.

[26] Examples of infeasibility include the subject unit is shutdown or there is no accessible monitoring point.

[27] Applicant's Responses to CEC Set 2, Appendix 2, Revised Detailed Emission (TN # 206791); AFC, Appendix C, Modeling Input Tables, pdf 71 (TN # 204220-3).

[28] Latham & Watkins LLP, Applicant's Responses to City of Oxnard Data Requests Set 3, Request #69, Appendix A-1, pdf 7 (TN # 206458) (Oct. 30, 2015) [hereinafter Applicant's Responses to City Set 3].

outdated PM emission factor from the 1995 version of AP-42.[29] As explained below, the 1995 AP-42 emission factor is widely known to substantially overestimate actual PM2.5 emissions from natural gas fired boilers because the PM test methods in use at that time were inaccurate, yielding results biased high. Overestimating actual baseline emissions underestimates the change in PM2.5 emissions from the Project.

When confronted with this error in City Data Request 69, the Applicant asserted that "[i]t is appropriate to use the VCAPCD emission inventory data to establish the baseline emissions for MGS Units 1 and 2 because this inventory data…is used by both the VCAPCD and California Air Resources Board (CARB) for air quality regulatory planning purposes…and conservatively uses natural gas fired boiler emission factors from the 1995 version of AP-42, which are lower than the emission factors in the current (1998) version of AP-42."[30] This assertion is wrong. These cited uses of AP-42 emissions factors are not equivalent to "actual" emissions at a specific source under the federal PSD regulations.

i. Testing Should Be Used To Estimate Actual Emissions

"Actual" emissions should be determined by measuring the emissions with either a continuous emission monitoring system (CEMs) or in stack tests in which a sample of gas is collected from the stack and analyzed. This calculation was properly conducted for NOx. However, baseline emissions of all other criteria pollutants were not determined using measured data, but rather were estimated using inappropriate generic emission factors.

In Data Request 69, the City specifically requested "any primary source data that you have to support these emissions factors, including actual stack tests for MGS Units 1 and 2. If such evidence is in the possession of GE or Sierra Research, please request this information from them."[31] The Applicant declined to produce the information and instead responded with boilerplate objections alleging that the information was outside of the applicant's control.[32] The VCAPCD also asserted, in response to a PRA request from the City, that it has no particulate matter stack tests for the Mandalay units.[33] As I demonstrate below, this is precisely the type of

[29] EPA, AP-42 Fifth Ed., Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, (Jan. 1995), available at https://www3.epa.gov/ttn/chief/ap42/oldeditions/5th_edition/ap42_5thed_orig.pdf [hereinafter 1995 AP-42].

[30] Applicant's Responses to City Set 3, Data Request 69, pdf 7 (TN # 206458).

[31] Shute, Mihaly & Weinberger LLP, City of Oxnard's Data Requests, Set 3, Request 69 (TN # 206248) (Oct. 1, 2015).

[32] Latham & Watkins LLP, Objections to City of Oxnard's Data Requests, Set 3, Objection 69, pdf 2 (TN # 206410) (Oct. 21, 2015) [hereinafter Applicant's Objections to City's Requests Set 3].

[33] Email from Kerby E. Zozula, Manager Engineering Division, VCAPCD, to Anna P. Gunderson and Laura Kranzler, Shute Mihaly Weinberger, RE: Public Records Request, June 23, 2016.

data that is required to establish "actual" emissions and to determine if the Project triggers PSD review for PM2.5. The applicant had ample opportunity to collect actual PM2.5 test data.

ii. Generic Emission Factors Should Not Be Used to Determine Actual Emissions

The "actual" emissions in the PM2.5 netting analysis were estimated using generic emission factors expressed as pounds of pollutant per million standard cubic feet of gas burned (lb/MMscf) taken from the 1995 version of EPA's emission estimating report, known as "AP-42".[34] These emissions factors do not yield "actual" emissions. In fact, they significantly overestimate actual PM2.5 emissions due to widely recognized measurement problems. Overestimating "actual" baseline PM2.5 emissions underestimates the net change in PM2.5 emissions from the Project, leading to the faulty conclusion that PSD review is not triggered for PM2.5.

The EPA specifically recommends that the 1995 AP-42 emission factors relied on by the Applicant not be used to determine emissions from individual facilities and explains that "[d]ata from source-specific emission tests or continuous emission monitors are usually preferred for estimating a source's emissions…" Emission factors "are simply averages of all available data of acceptable quality, and are generally assumed to be representative of long-term averages for all facilities in the source category (i.e., a population average)."[35] Thus, they are not useful for determining actual emissions from a single unit, MGS Unit 2, during specific baseline years to satisfy the PSD definition of "actual" emissions.

The fact that VCAPCD and CARB may rely on this inventory data (which relied on emission factors from the 1995 AP-42) for other purposes is not relevant to establishing baseline emissions from MGS Unit 2 under federal PSD regulations. Emission inventories typically sum the emissions from all sources in a region on an annual basis to determine trends. If the same erroneous emission factor is used from a source or group of sources from year to year, as here, it does not affect the trend. Emissions used in a PSD netting analysis, on the other hand, must be calculated consistent with 40 CFR 52.21, which requires "actual" emissions for a 2 year period in a specific baseline.

My review of the 1995 version of AP-42[36] indicates that it reported a range for particulate matter of 1 to 5 lb/MMscf.[37] The VCAPCD apparently selected a value near the mid-point of the range, 2.5 lb/MMscf, which the Applicant adopted to represent "actual" PM2.5 emissions for the 2012-2013 baseline period. Since 1995, numerous studies have demonstrated that using AP-42 emission factors for gas-fired sources result in significantly overestimated PM2.5 emissions due

[34] Applicant's Responses to City Set 3, Response 69 and Table DR69, pdf 7 (TN # 206458).

[35] 1998 AP-42, Introduction, pp. 1-2 available at https://www3.epa.gov/ttn/chief/ap42/c00s00.pdf.

[36] 1995 AP-42, Table 1.4-1, p. 1.4-3 pdf 121.

[37] *Ibid.*

to various measurement problems.[38] If VCAPCD had selected the lower end of the AP-42 range, 1 lb/MMscf, which is warranted based on the well-known fact that measurements based on test methods used in that era were biased high,[39] it would have found that the net increase in PM2.5 emissions (**10 ton/yr**)[40] triggers PSD review for PM2.5.

The EPA's AP-42 website cautions against using the 1995 version of AP-42, explaining: "This information is available for historical purposes only. For the most recent emission factors, supported by the EPA, please go to the current AP 42 web site."[41] The current version of AP-42 reports a higher total PM emission factor, 7.6 lb/MMscf, for similar boilers, but rates it as D,[42] which means that "tests are based on a generally unacceptable method, but the method may provide an order-of-magnitude value for the source."[43] This "D" notation should alert any emission expert that this emission factor should not be used to estimate "actual" emissions from a specific source. Thus, the current version of AP-42 does not contain any relevant data for estimating actual emissions. In this situation, standard practice in the industry is to collect source-specific data.

The current AP-42 website (June 2016) directs the user to EPA's "Webfire" database.[44] Each emission factor in this data base contains a section called "Emission Factor Applicability" that explains the limitations of emission factors, especially for regulatory purposes. The relevant portion of the discussion is reproduced here:[45]

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[38] Louis Corio and Karen Olson, The Need for Alternate PM2.5 Emission Factors for Gas-Fired Combustion Units, Power Magazine (July 1, 2015), available at http://www.powermag.com/the-need-for-alternate-pm2-5-emission-factors-for-gas-fired-combustion-units/?pagenum=1.

[39] *See, e.g.*, Karen Olson and Louis Corio, PM Emission Factors: Past, Present and Future, p. 4, available at https://content.lib.utah.edu/utils/getfile/collection/AFRC/id/14494/filename/14501.pdf; EPA Method 202 Best Practices Handbook, p. 3 (Jan. 2016), available at: https://www3.epa.gov/ttn/emc/methods/m202-best-practices-handbook.pdf; EPA Revised PM Emission Factor Spreadsheet, Tab: References ("EPA believes that the current AP-42 factors for condensable emissions are too high…"), available at https://www.epa.gov/.../natgas_procgas_lpg_pm_efs_not_ap42_032012_revisions.xls.

[40] Revised netting calculation based on 1 lb/MMscf: 10.68 ton/yr – ((1 lb/MMscf)(1,297.75 MMscf/yr)/2,000 lb/ton) = 10.68 ton/yr - 0.65 ton/yr = **10. 03 ton/yr.**

[41] *See*, Older Editions of AP-42, Compilation of Air Pollutant Emission Factors, available at https://www3.epa.gov/ttn/chief/ap42/oldeditions.html.

[42] 1998 AP-42, Table 1.4-2, pdf 6, available at https://www3.epa.gov/ttn/chief/ap42/ch01/final/c01s04.pdf.

[43] 1998 AP-42, Introduction, p. 9.

[44] EPA, WebFIRE, available at https://www3.epa.gov/ttn/chief/webfire/index.html.

[45] EPA, Emissions Factors Applicability (emphasis added), available at https://cfpub.epa.gov/webfire/fire/view/Applicability.html.

"Emissions Factors Applicability.

Emissions factors published in this database and in most other such compilations typically 1) are arithmetic averages of available source test data, 2) are based on limited numbers of emissions tests, 3) represent only a few hours of process operating time per test, 4) represent limited ranges of process operating conditions, and 5) represent a limited sample of operating units within any source category. *As a result, site-specific emissions estimates based on emissions factors will include significant data uncertainty. Such uncertainties can easily range over more than one order of magnitude in determining emissions from any one specific facility.* ***Use of emissions factors should be restricted to broad area-wide and multiple source emissions cataloging applications***[46] ***that will tend to mitigate the uncertainty associated with quantifying site-specific emissions.***

[...]

Because of the uncertainties inherent in the use of average emissions factors for facility-specific emissions determinations, emissions from potentially large numbers of permitted sources are characterized incorrectly in permitting and compliance applications. ***Further, emissions factors at best are imprecise tools for establishing emissions limits (e.g., permit limits based on best available control technology or BACT, lowest achievable emission rate or LAER, source category limitations to reduces emissions in a geographic regions or SIP's) or standards (e. g., National Emission Standard for Hazardous Air Pollutants or NESHAP, New Source Performance Standards or NSPS).*** *The emissions reductions determined during regulatory standard setting done without regard to the uncertainty in emissions factors will be open to question. For these reasons, we recommend against use of source category emissions factors (whether derived from AP-42, FIRE, or elsewhere) for site-specific emissions determinations or regulatory development.* ***We recommend instead the use of alternatives to emissions factors (see below).***

We recognize that emissions factors are often used in many applications including site-specific applicability determinations, establishing operating permit fees, and establishing applicable emissions limits even though such use is inappropriate. If you must apply emissions factors for site-specific applications, we strongly recommend due consideration of the uncertainty inherent in the data. ***Applying emissions factors without accounting for uncertainty will result in doubtful applicability determinations****, ineffective emissions reductions requirements, and poorly supported compliance determinations or enforcement actions.*

[...]

Alternatives to Emissions Factors

Data from frequent and representative source-specific emissions tests or continuous emissions monitoring systems can provide measures of actual pollutant emissions from a source that are much more reliable than emissions factors. *Note that site-specific measurement data from a limited number of emissions tests will improve the certainty of the emissions data but will also represent only the conditions existing at the time of the testing or monitoring. To improve the estimate of longer-term (e.g., daily, monthly, yearly) emissions, conditions under which tests occur should be numerous and representative of the source's expected range of operations. Data from continuous emissions monitoring systems provide the most complete assessment of a source's emissions in many cases. If you are unable to collect representative source-specific data, emissions information from process and control equipment vendors,*

[46] The VCAPCD and CARB used AP-42 emission factors for inventory purposes, consistent with this EPA guidance.

particularly emissions performance guarantees or emissions test data from similar equipment, is a better source of information for most permitting decisions than source-category emissions factors."

iii. The AP-42 Emission Factor Is Based on Faulty Test Methods

The generic PM2.5 emission factor used by the Applicant is based on superseded and discredited test methods. The standard particulate matter test methods that were historically used to measure particulate matter and to develop AP-42 emission factors -- EPA Methods 5, 201 and 202 -- were widely known to overestimate PM, PM10, and PM2.5 emissions at the time the Applicant prepared the Project netting analysis and during the selected baseline years.[47] These problems include positive biases (i.e., overestimates) from conversion of gases to the particulate form in the test apparatus[48] and from contamination of the test apparatus and solvents used in the test method.

To address the PM2.5 measurement problems, a comprehensive research program was conducted between 2000 and 2004 to develop a more accurate particulate matter test method. This program was co-sponsored by many parties including the New York State Energy Research and Development Authority (NYSERDA), the U.S. Department of Energy, the California Energy Commission, General Electric Energy and Environmental Research Corp., the Gas Research Institute, and the American Petroleum Institute (API). This program developed the dilution sampling method to measure PM2.5 emissions and used it to determine emission factors for various gas-fired sources.[49] The EPA subsequently published a dilution sampling test method, CTM-039[50] and incorporated the results of these studies in its PM2.5 emission factors used in the National Emission Inventory.[51]

Figure 1 compares the results of these studies with AP-42 emission factors, relied on by the Applicant to establish the baseline. This figure shows that AP-42 emission factors

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[47] See, for example, the discussion of test method errors in Memorandum from Steven D. Page, EPA Office of Air Quality Planning and Standards, to EPA Regional Air Division Directors, (April 8, 2014), available at https://www.epa.gov/sites/production/files/2015-07/documents/cpm14.pdf; Louis Corio and Karen Olson, A Brief History of In-Stack PM Measurement, Power Magazine, (July 1, 2015), available at http://www.powermag.com/a-brief-history-of-in-stack-pm-measurement/.

[48] Sulfur dioxide, SO_2, for example, converts to sulfuric acid mist, H_2SO_4 in the water-cooled impinger solutions of Method 202 and is incorrectly measured as condensable PM2.5.

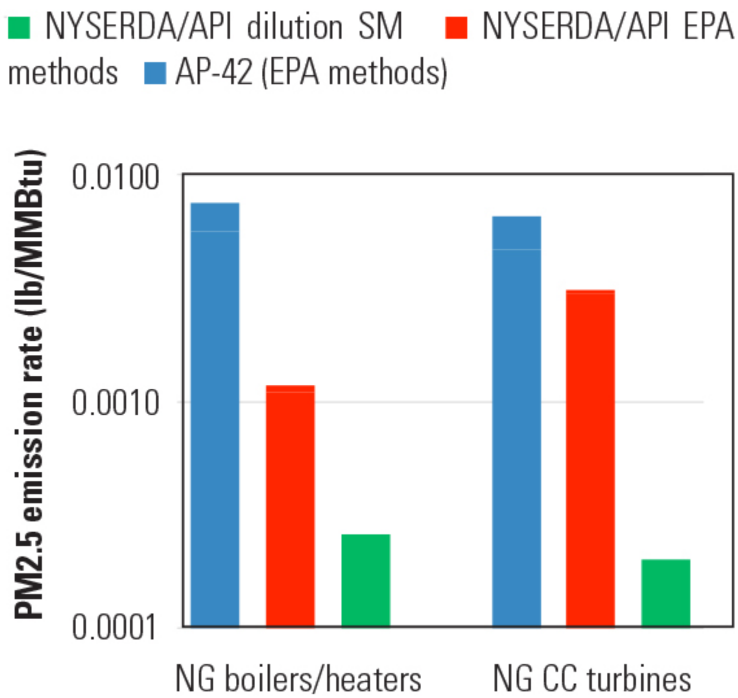
[49] Glenn C. England, Development of Fine Particulate Emission Factors and Speciation Profiles for Oil- and Gas-Fired Combustion Systems, Final Report, (Oct. 20, 2004), available at http://www.netl.doe.gov/kmd/cds/disk23/F-Air%20Projects/15327%5CBC15327-FinalRpt.pdf.

[50] Conditional Test Method (CTM) 039, Measurement of PM2.5 and PM10 Emissions by Dilution Sampling (Constant Sampling Rate Procedures) (July 2004), available at https://www3.epa.gov/ttnemc01/ctm/ctm-039.pdf.

[51] *See* EPA, EPA Revised PM Emission Factor Spreadsheet, available at https://www.epa.gov/sites/production/files/2015-08/natgas_procgas_lpg_pm_efs_not_ap42_032012_revisions.xls.

overestimate actual baseline emissions by significant amounts compared to modern testing methods.

Figure 1: Comparison of PM2.5 as Reported in AP-42 with Recent Measurements Using Improved Testing Methods.[52]



The results of these investigations for gas-fired boilers and steam generators, such as MGS Unit 2, are summarized in Table 3. These revised emission factors have been used in EPA National Emission Inventories and to permit new sources.[53] The revised PM2.5 emission factor for gas-fired boilers and steam generators (0.35 lb/MMscf[54]) is a factor of seven lower than the AP-42 emission factor of 2.5 lb/MMscf used in the Applicant's PM2.5 netting analysis.[55] Using

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[52] Corio and Olson, The Need for Alternate PM2.5 Emission Factors for Gas-Fired Combustion Units, July 1, 2015, Power Magazine, p. 4 (July 1, 2015), available at http://www.powermag.com/the-need-for-alternate-pm2-5-emission-factors-for-gas-fired-combustion-units/?pagenum=4.

[53] *Id.* at 4-5.

[54] Converting 3.4E-04 lb/MMBtu from Table 3 to units of lb/MMscf, the units used in Application: (3.4E-4 lb/MMBtu)(1018 Btu/scf) = **0.346 lb/MMscf.** Higher Heating Value (HHV) of natural gas (1018 Btu/scf) from AFC, Appendix C-3, pdf 43 (TN # 204220-3); NRG Energy Center Oxnard LLC, Data Adequacy Supplemental Response, Attachment A-3, Corrected Air Quality Section 4.1, Revised Table 4.1-15, pdf 61 (TN # 204859) (June 2, 2015) [hereinafter NRG Data Adequacy Supplemental Response].

[55] Applicant's Responses to CEC Set 2, Table C-2.12, (Revised Nov. 18, 2015), pdf 71 (TN # 206791) (2.50 lb/MMscf).

this revised PM2.5 emission factor but otherwise using the Applicant's assumptions, yields a net change in PM2.5 emission of **10.4 ton/yr**.[56] This change alone results in an exceedance of the PM2.5 significance threshold and triggers PSD review for PM2.5.

Table 3:[57]

Table 3-1. PM2.5 Mass Emission Factors for Gas-Fired Boilers and Steam Generators.

Source	Description	Units	Value
Site C (API, 2001c)	Natural Gas-fired Steam Generator	lb/MMBtu	1.7E-05
Site C (API, 2001c)	Natural Gas-fired Steam Generator	lb/MMBtu	5.6E-05
Site C (API, 2001c)	Natural Gas-fired Steam Generator	lb/MMBtu	9.6E-05
Site A (API, 2001a)	Refinery Gas-fired Boiler	lb/MMBtu	2.7E-04
Site A (API, 2001a)	Refinery Gas-fired Boiler	lb/MMBtu	3.8E-04
Site Delta (Wien et al., 2004c)	Dual Fuel-fired Institutional Boiler (Nat. Gas)	lb/MMBtu	3.8E-04
Site A (API, 2001a)	Refinery Gas-fired Boiler	lb/MMBtu	4.3E-04
Site Delta (Wien et al., 2004c)	Dual Fuel-fired Institutional Boiler (Nat. Gas)	lb/MMBtu	5.6E-04
Site Delta (Wien et al., 2004c)	Dual Fuel-fired Institutional Boiler (Nat. Gas)	lb/MMBtu	5.7E-04
Site Delta (Wien et al., 2004c)	Dual Fuel-fired Institutional Boiler (Nat. Gas)	lb/MMBtu	6.3E-04
Average (mean)		**lb/MMBtu**	**3.4E-04**
Uncertainty (at 95% Confidence Level), %		%	46
95% Confidence Upper Bound, lb/MMBtu		lb/MMBtu	4.7E-04
5th Percentile		lb/MMBtu	3.4E-05
95th Percentile		lb/MMBtu	6.0E-04

The EPA issued revised test methods, CTM-039[58] and Methods 201A/202[59], based on the NYSERDA and other studies to improve the measurement of fine particulate matter by eliminating some of the measurement biases. The AP-42 gas-fired boiler emission factor relied on by the Applicant to estimate actual PM2.5 emissions has not been updated to reflect these new test results.

iv. Revised Emission Factors for Gas-Fried Utility Boilers

If an emission factor must be used because, for example, testing is not feasible (which is not the case here), the emission factor should be accurate and applicable to the source at hand. The EPA has updated emission factors for gas-fired boilers based on the above NYSERDA studies and recent testing using modified test methods. EPA has not yet officially incorporated these emission factors into AP-42, but has published them elsewhere.

At the request of states in EPA Region 5, the EPA developed and made available in 2010 a spreadsheet that presents revised PM10/PM2.5 emission factors for various sources firing

[56] Revised netting calculation based on 0.35 lb/MMscf: 10.68 ton/yr – ((0.35 lb/MMscf)(1,297.75 MMscf/yr)/2,000 lb/ton) = 10.68 ton/yr - 0.23 ton/yr = **10.45 ton/yr**, which rounds to 10.4 ton/yr.

[57] England at Table 3-1.

[58] Conditional Test Method (CTM) 039, Measurement of PM2.5 and PM10 Emissions by Dilution Sampling, (July 2004), available at https://www3.epa.gov/ttn/emc/ctm/ctm-039.pdf.

[59] 75 Fed. Reg. 80,118 (Dec. 21, 2010).

natural gas, including boilers. This EPA spreadsheet shows that the AP-42 emission factor that the Applicant relied on is at least a factor of five too high.[60]

An updated version of this spreadsheet reports an average PM2.5 emission factor for natural gas fired boilers of 0.43 lb/MMscf[61] compared to 0.35 lb/MMscf from the 2004 England study, summarized in Table 3. This revised EPA PM2.5 emission factor for gas-fired boilers (0.43 lb/MMscf) yields a net change in PM2.5 emission of **10.4 ton/yr**.[62] This also exceeds the PM2.5 significance threshold and triggers PSD review for PM2.5 emission from the Project.

In sum, superseded and inaccurate generic, two-decades old, population-based emission factors developed with test methods known to overestimate PM2.5 emissions are not a reasonable basis to establish "actual" baseline emissions for MGS Unit 2 during the baseline period. The most recent test data indicate that a more accurate estimate of "actual" baseline PM2.5 emissions for MGS Unit 2 is 0.2 to 0.3 ton/yr, compared to the Applicant's estimate of 1.62 ton/yr.

c. Baseline Period

The Applicant provided fuel use data and NOx CEMS data for the period 2009 to 2014[63] and selected 2012-2013 as the baseline period, based on VCAPCD Rule 26.6C, as it asserted this two consecutive year period is the most representative "as it best reflects current electricity market."[64] However, the Applicant did not provide any evidence that this two year period best reflects the current electricity market, or any support for the assumption that the "current electricity market" is the correct criterion for selecting the baseline period. VCAPCD Rule 26.6C requires a "representative period." My analysis below indicates that 2012-2013 is not "representative" of normal operation.

i. <u>2012-2013 Are Not Representative of Normal Operation</u>

My analysis of the applicant's NOx and fuel use CEMS data, summarized in Figure 2, indicates that the 2012-2013 period selected as the baseline is not representative of normal

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[60] Exhibit 3, EPA Spreadsheet, available at https://www.pca.state.mn.us/sites/default/files/aq-ei1-08.xls.

[61] Exhibit 4, EPA Spreadsheet, Tab: "Final Table with NG Adjustments, Row 2: "Boilers >100 Million Btu/hr except Tangential," Cell: K2, "New PM2.5-PRI Factor (lb/Million dscf) = **0.43 lb/MMscf**;" available at https://www.epa.gov/sites/production/files/2015-08/natgas_procgas_lpg_pm_efs_not_ap42_032012_revisions.xls.

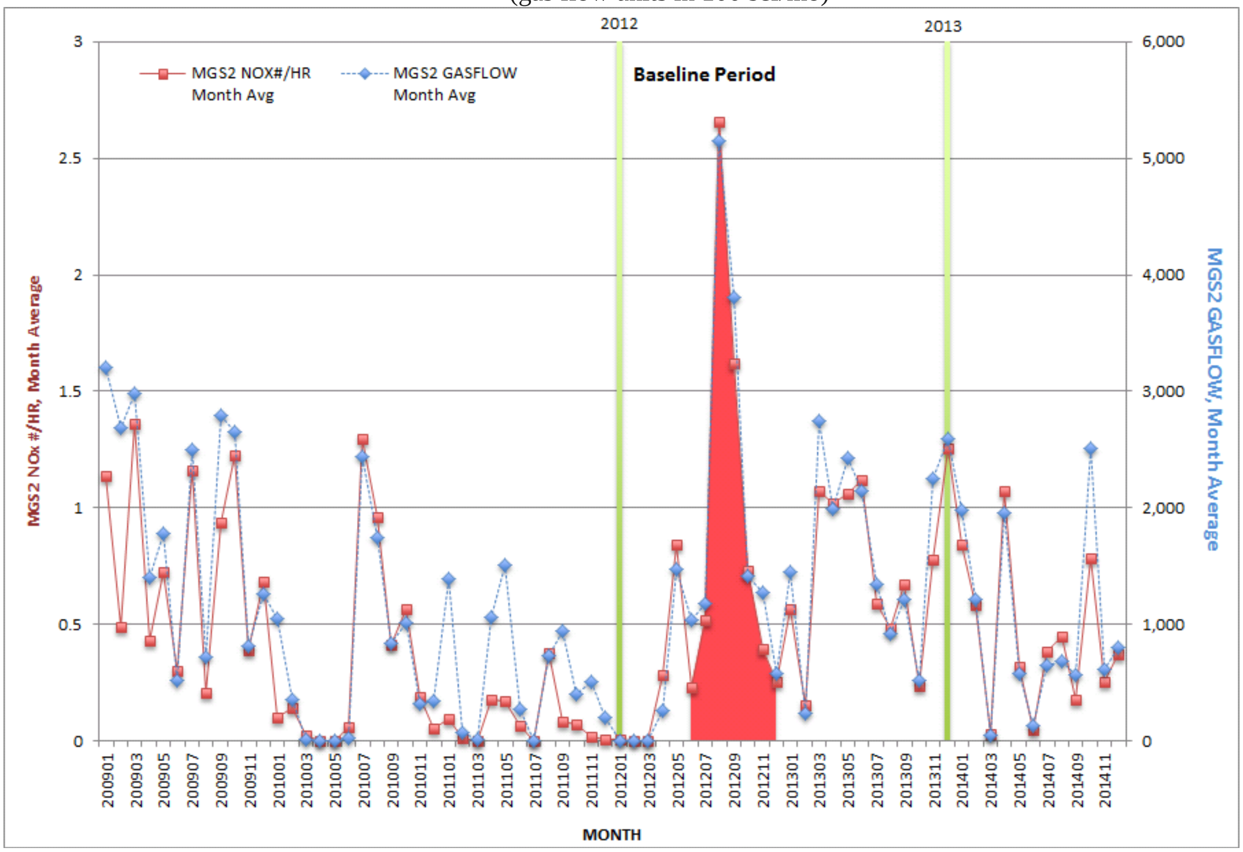
[62] Revised netting calculation based on 0.43 lb/MMscf: 10.68 ton/yr – ((0.43 lb/MMscf)(1,297.75 MMscf/yr)/2,000 lb/ton) = 10.68 ton/yr - 0.28 ton/yr = **10.40 ton/yr**, which rounds to 10.4 ton/yr.

[63] PDOC, Appendix D (TN # 211570); NRG Data Adequacy Supplemental Response, Response to Request 1, Attachment 1 pdf 15 (TN # 204859).

[64] PDOC, pdf 11 (TN # 211570).

operation. In fact, it is the two year period that yields the highest baseline emissions for all pollutants, rather than representative baseline emissions.

Figure 2: Monthly NOx and Fuel Use 2009-2014
(gas flow units in 100 scf/mo)



First, the 2012-2013 period includes a very large spike in August and September of 2012.[65] A similar spike is not found elsewhere in the record.

Second, my analysis of this data, summarized in Table 4, indicates that the Applicant picked the two year period that yields the lowest net change in PM2.5 emissions from among the four possible consecutive two-year combinations (10.0, 9.63, **9.06**, 9.27 ton/yr). It is not apparent how a spike in fuel use and emissions, including many violations of permit limits[66] as discussed in Comment section II.B.2.c.ii satisfies VCAPCD Rule 26.6C.

[65] The spike occurs in August 2012, when CEMS monthly average gas flow for MGS Unit 2 was recorded as 515 MMscf/mo. The average monthly gas flow over the selected baseline period of 2010 to 2014 is 105 MMscf/mo.

[66] VCAPCD Part 70 Permit Number 00013, Mandalay Generating Station, Table 4, pdf 32 (July 10, 2015) [hereinafter VCAPCD Permit].

Table 4: Net Increase in PM2.5 Emissions for Different Baseline Years and PM2.5 Emission Factors[67]

Year	Fuel Use (MMscf/yr)		PM2.5 Emission Factor (lb/MMscf)			PM2.5 Emission Factor (lb/MMscf)		
	Unit 2	2-yr Avg	2.5	1	0.35	2.5	1	0.35
			PM2.5 BASELINE EMISSIONS (ton/yr)			INCREASE IN PM2.5 EMISSIONS (ton/yr)		
2010	587.6							
2011	507.8	547.7	0.68	0.27	0.10	10.00	10.41	10.58
2012	1166.5	837.15	1.05	0.42	0.15	9.63	10.26	10.53
2013	1429	1297.75	1.62	0.65	0.23	9.06	10.03	10.45
2014	828.9	1128.95	1.41	0.56	0.20	9.27	10.12	10.48

Note: Yellow identifies Applicant's baseline fuel use and increase in PM2.5 emissions

If the Applicant had selected any other consecutive two year period, the change in PM2.5 emissions would have been much higher, exceeding the PM2.5 significance threshold in two out of the four possible combinations even when using the Applicant's erroneous emission factor and in all four cases when other, more accurate PM2.5 emission factors (1 lb/MMscf or 0.35 lb/MMscf) are used.

ii. Non-Compliant Emissions Were Not Excluded

The applicable federal regulation requires that "[t]he average rate shall be adjusted downward to exclude any non-compliant emissions that occurred while the source was operating above any emission limitation that was legally enforceable during the consecutive 24-month period."[68] VCAPCD Rule 26.6C likewise requires that "…the actual emissions shall be adjusted to reflect the level of emissions that would have occurred if such violation did not occur." My analysis of this data indicate that the selected baseline period includes 452 violations of the PM permit limit,[69] or about 4% of the operating hours,[70] as summarized in Figure 3.

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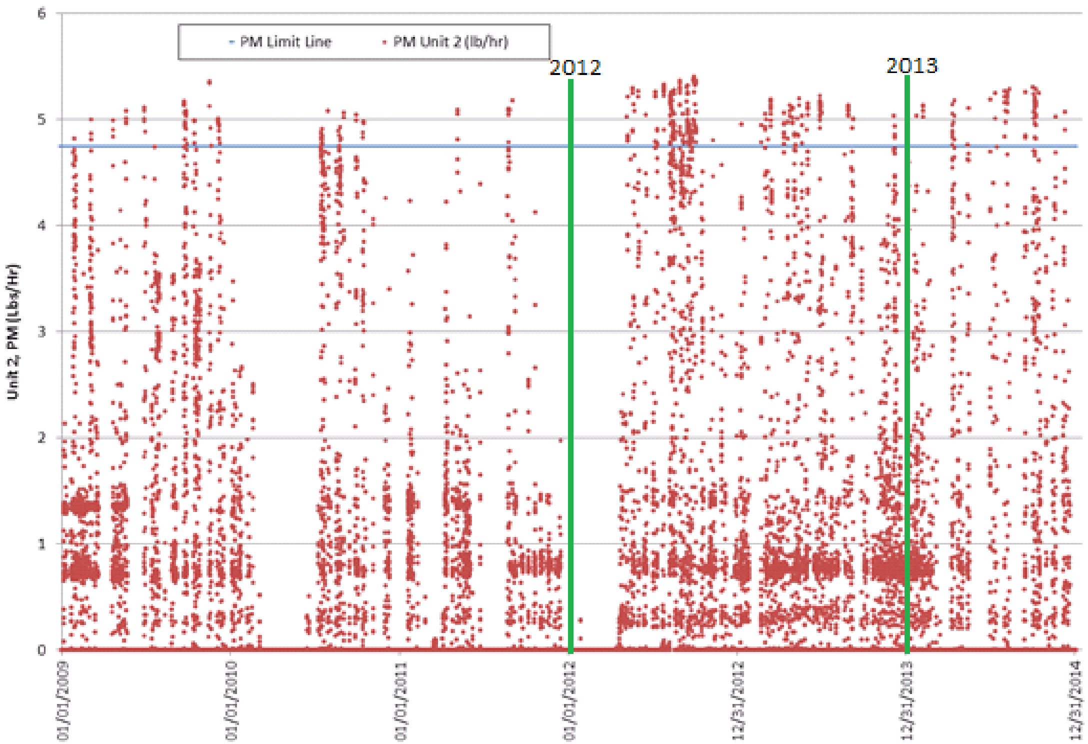
[67] The emission factors evaluated in Table 4 are: (1) **2.5 lb/MMscf** is the Applicant's baseline emission factor; (2) **1 lb/MMscf** is the lower end of the 1995 AP-42 emission factor for natural gas fired boilers, as discussed in Comment section II.B.2(b); (3) **0.35 lb/MMscf** is EPA's revised PM2.5 emission factor for natural gas fired boilers, as discussed in Comment II.B.2(b).

[68] 40 C.F.R. § 52.21(b)(48)(i)(*b*).

[69] VCAPCD Permit, Table 4, pdf 32. This table limits hourly emissions from MGS Units 1 and 2 combined to 9.48 lb/hr, or 4.74 lb/hr for each unit.

[70] In the two years from 2012 – 2013, Unit 2 operated 11,187 hours. There were 452 PM violations (PM>4.74 lb/day) during 2012 -2013. Because each violation accounts for one hour, 452 hr / 11,187 hr = .0404, which rounds to 4%.

Figure 3. Hourly PM2.5 Emissions from MGS Unit 2.[71]

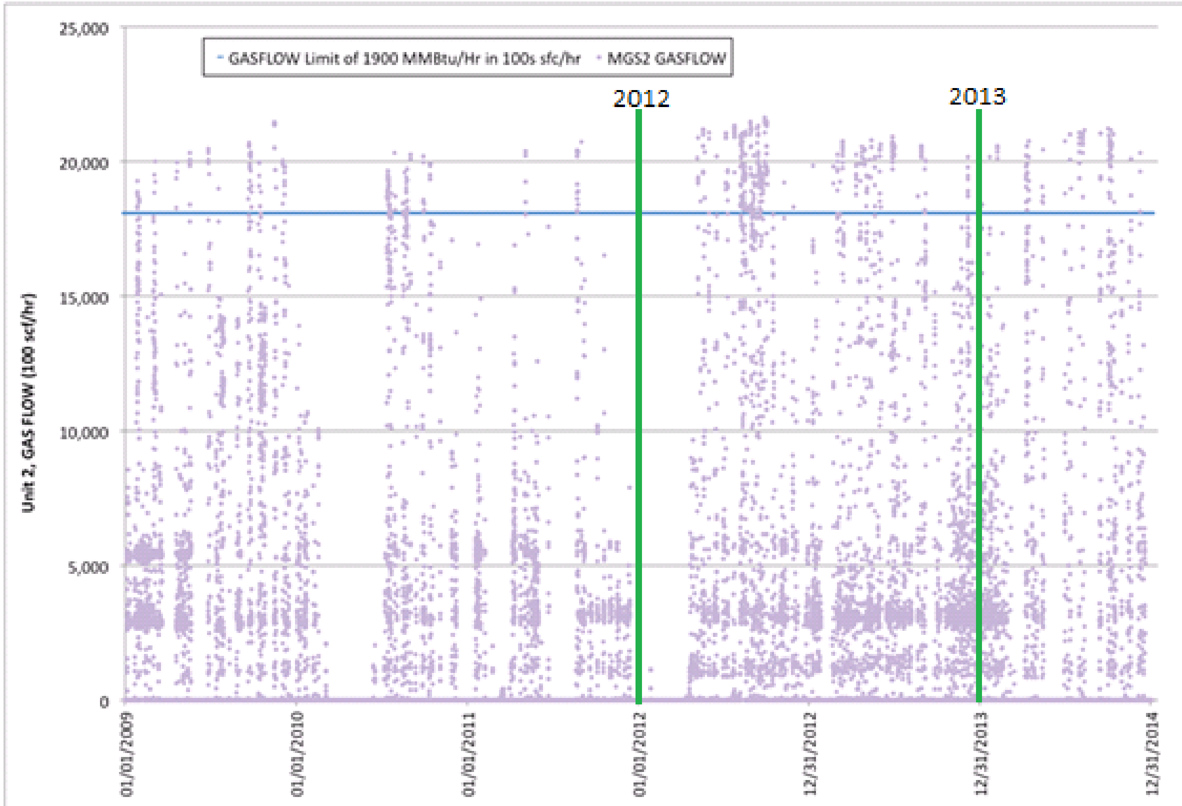


Further, MGS Unit 2 is permitted as a Babcock & Wilcox natural gas steam generator with a maximum heat input of 1990 MMBtu/hr.[72] The Applicant's CEMS data also indicates that the unit operated at higher maximum heat inputs during the baseline period.

[71] PM emissions calculated assuming the Applicant's emission factor of 2.5 lb/MMscf and hourly fuel use in 100 scf from the provided CEMs data. NRG NOx CEMS Data for Mandalay Generating Station Units 1 and 2 (TN # 206008).

[72] VCAPCD Permit, Table 4 provides that: (1900E+6 Btu/hr)/(100*1050 Btu/scf) = 18,095 hundreds of scf/hr, assuming a maximum higher heating value (HHV) of the natural gas of 1050 BTU/scf and fuel use reported in 100 scf, as provided by the Applicant.

Figure 4. Hourly Gas Flow for MGS Unit 2.



C. The Applicant's Analysis Understates the New Turbine's Potential to Emit.

The net change in emissions is calculated as the difference between the potential to emit of the new turbine and the baseline emissions of MGS Unit 2, which will be shutdown at the end of the new turbine commissioning period. The previous section discussed the Applicant's errors in estimating baseline emissions. This section discusses the Applicant's errors in estimating potential to emit.

The potential to emit must be federally enforceable, which requires that it be practically enforceable.[73] This requirement has not been satisfied by the conditions recommended in the PDOC and PSA. As VCAPCD's Rule 26.13 has not been incorporated into the State Implementation Plan, the proposed conditions of certifications are *per se* not federally enforceable and thus fail to establish the potential to emit for purposes of netting out of PSD review.

In addition, for any permit limit or condition to be federally enforceable, it must be practically enforceable.[74] "Practical enforceability means the source and/or enforcement

[73] 40 C.F.R. § 52.21(b)(17).

[74] NSR Manual, p. A.5, citing *U.S. v. Louisiana-Pacific Corporation*, 682 F. Supp. 1122, (D. Colorado, March 22, 1988), A.9; 6/13/89 Hunt and Seitz Memo, 1.

authority must be able to show continual compliance (or noncompliance) with each limitation or requirement. In other words, adequate testing, monitoring, and record-keeping procedures must be included either in an applicable federally issued permit, or in the applicable federally approved SIP or the permit issued under same."[75] As demonstrated below, the proposed conditions of certification are not practically enforceable and thus cannot be relied on to establish the potential to emit.

1. <u>Vendor Guarantee</u>

The PM10/PM2.5 potential to emit of 10.68 ton/yr for the new gas turbine used in the PSD netting analysis in the PDOC and PSA is based on an hourly PM2.5 emissions rate of 10.1 lb/hr under all operating conditions, including startup, shutdown, and normal operation. This emission rate is based on a one paragraph letter from the turbine vendor, GE, that states:[76]

> The NRG Puente Power Plant, will utilize the 7HA.01 gas turbine technology installed in a simple cycle configuration equipped with an air attemperated simple cycle SCR and CO catalyst. For this installation, GE is offering a Particulate Matter emission guarantee of 10.1 lbs/hr as measured at the emission sampling ports located at the turbine stack exit. This guarantee shall apply for the entire load range from minimum emission compliant load (MECL) through base load operation and across the guarantee ambient temperature range of 38.9 to 82 deg F.

This GE letter replaced a similar GE letter that was in the initial Application for the Authority to Construct (ATC):[77]

> Per your request, GE confirms that the NRG Mandalay Bay 7HA.01 gas turbine, installed in a simple cycle configuration and equipped with an SCR and CO catalyst will achieve the following steady state operation emission values.

Constituent	Steady state stack emissions during emission compliance mode
NOx	2.5 ppmvd, Ref 15%O2
CO	4.0 ppmvd, Ref 15%O2
VOC	2.0 ppmvd, Ref 15%O2
NH3	5.0 ppmvd, Ref 15%O2
Total Particulates	10.6 lbs/hr

[75] NSR Manual, p. A.5.

[76] Applicant's Responses to CEC Set 2, Letter from Andrew Dicke, GE Power and Water, Emissions and Permitting Application Engineer, to NRG Puente Power Team, Re: NRG Puente Power, GE IPS: 976085, GE PM10 Emissions Guarantee, October 28, 2015, pdf 65 (TN # 206791); *see also* PDOC, Appendix B: Emissions Data, pdf 55 (TN # 211570).

[77] NRG Application for Authority to Construct (Mar. 19, 2015), pdf 42; Latham & Watkins, Letter Regarding Withdrawal of Prior Responses to CEC Staff Data Request No. 2, attaching revised GE letter (TN # 206503) (Nov. 3, 2005).

No explanation is offered for the change in total particulates from 10.6 lb/hr to 10.1 lb/hr. The reduction was apparently designed to avoid triggering PSD review for PM2.5. See Tables 1 and 2. A reduction could be due to several factors, including modifications to: (a) the turbine, (b) PM test method, or (c) conditions under which the guarantee is valid. The PDOC's and PSA's proposed conditions of certification rely exclusively on this letter and attached performance runs to confirm compliance with PM2.5 emissions during startups and shutdowns. No testing is required to confirm the emissions in the GE letter during startups and shutdowns. This GE letter is not an acceptable basis for establishing the potential to emit under PSD regulations as it is not federally or practically enforceable.

First, the revised letter is not an emission "guarantee," as known in the trade, because it does not legally bind the vendor to any particulate emission rate. A valid vendor guarantee is a much more elaborate document.[78]

Second, the "guarantee" does not indicate whether the "Particulate Matter emission guarantee of 10.1 lb/hr" is for total particulate matter, comprising the sum of filterable plus particulate emissions or just the filterable fraction. An authentic guarantee specifies the particulate fraction(s) that are included in the guarantee either stated directly or via test method(s).

Third, the "guarantee" does not specify the test method(s) that would be used to measure particulate matter. It is well known that for particulate matter, the test method defines the results. Nuances of testing techniques are critical and can result in significant differences when PM2.5 emissions are low, such as those proposed for the new gas turbine. There are several methods and combinations of methods, *e.g.*, EPA 201A/202, EPA 201A/SCAQMD 5.1, EPA CTM-039, each potentially using various blank correction methods.

In my professional experience, GE's particulate matter guarantees are typically based on non-standard PM2.5 test methods that yield lower emissions than standard EPA test methods that would be used for compliance. GE has asserted that all standard regulatory test methods are invalid. Thus, its guarantees are typically based on certain "add-on method improvements" which are "a non-negotiable requirement to be able to offer the low PM guarantees and must be included in the proposal and final contract."[79] These methods might not be approved by EPA for compliance.

Thus, the plant's potential to emit could be higher than the 10.6 ton/yr used in the netting calculations because PM2.5 emissions depend on the test method, and GE's test method is not known and is not required to be revealed in the proposed conditions of certification. Basing the

[78] See sample vendor guarantee in Exhibit 2 to these comments.

[79] Charles W. Powers and Craig Matis, Particulate Matter Emissions, Guarantees and Testing Considerations, GE Report GER4285 (May 2009), available at https://powergen.gepower.com/content/dam/gepower-pgdp/global/en_US/documents/technical/ger/ger-4285-particulate-matter-emissions-guarantees-testing-considerations.pdf [hereinafter GE Report].

potential to emit on GE's test method rather than the EPA compliance method that will be used to confirm compliance with the potential to emit compares apples with oranges.

Fourth, the GE "guarantee" does not disclose the "minimum emission compliant load (MECL)" over which the "guarantee" is valid. If an emission exceedance occurred outside of the MECL, GE would have no liability but the Applicant would still have to comply. Thus, there is no guarantee that the PM2.5 emission limit will be met at loads below the MECL.

Fifth, the GE "guarantee" is only valid for ambient temperatures ranging from 38.9 F to 82 F.[80] Higher and lower ambient temperatures have been reported at Oxnard.[81] Global warming could further increase the upper end of the range. Higher ambient temperatures than 82 F typically coincide with periods when significant peaking capacity may be needed due to heating and cooling demand.

Sixth, the attached performance runs are not part of the guarantee and are typically marked "NOT FOR GUARANTEE." Notably, the vendor's heading for these performance runs is missing.

Seventh, formal vendor guarantees are typically based on "new and clean conditions" (typically less than 200 to 300 hours of operation, sometimes up to one year) and require that each unit operate at base load for 3 to 4 hours just prior to commencing the compliance test. As turbines age, their efficiency declines, requiring the combustion of more fuel to reach the same output. Because emissions depend directly on the amount of fuel that is burned, PM2.5 emissions will increase over the life of the facility. Further, as turbines age, hot gas path attrition contributes erosion and corrosion products to PM2.5 emissions. The restricted conditions in limited guarantees do not represent normal operating conditions under all conditions over the life of the facility. The GE "guarantee" is silent on these important issues that would be found in a binding vendor guarantee.

A make-right guarantee, on the other hand, is good for the life of the equipment and requires the vendor to return the equipment to the guaranteed emission level if it fails to meet the guaranteed level. This record does not disclose the existence of a make-right guarantee, which is required if potential to emit is based on a vendor guarantee.

Thus, the potential to emit must be adjusted upwards to account for conditions that increase PM2.5 emissions, but which are excluded from the guarantee.

The GE "guarantee" letter is not a legally binding guarantee but rather an informal letter. A typical legally-binding guarantee contains numerous escape clauses that allow exceedances of guaranteed levels when conditions are not met, e.g., load ranges, gas turbine compressor wash prior to testing, testing when ambient dust levels are low, temperature ranges, operating

[80] PDOC, Appendix D, pdf 4 (TN # 211570).

[81] *See* Historic Average: Oxnard, California, available at http://www.intellicast.com/Local/History.aspx?location=USCA0819; Oxnard, CA Climate: Summary Graph, available at http://www.climatespy.com/climate/summary/united-states/california/oxnard---ventura-county.

conditions during emission tests, test methods,[82] etc., as discussed above. However, to comply with federal PSD at 40 CFR 52.21, escape clauses are not allowed. The potential to emit must be based on the maximum potential annual emissions under all operating conditions, without exceptions.

In sum, the Applicant cannot rely on the GE "guarantee" letter to establish the potential to emit PM2.5 used in the netting analysis. The actual potential to emit as measured by the applicant in compliance tests would likely be higher. If it were only 5% higher than estimated based on GE's "guarantee" letter of 10.1 lb/hr, PSD review would be triggered for all combinations of two year baselines as summarized in Table 4 using the Applicant's erroneous baseline PM2.5 emission factor.[83]

2. Production Limit

Any issued permit must limit the potential to emit of all pollutants, because the proposed emission limits do not reflect the maximum emissions of the new turbine operating at full design capacity. In other words, if the new turbine is operated more than the assumed 2,150 hours per year, the potential to emit PM2.5 of 10.68 ton/yr could be exceeded, triggering PSD review.

All permits issued pursuant to 40 CFR 52.21 must contain a production or operational limit in addition to an emission limit when the emission limit does not reflect the maximum emissions of the source at full design capacity, as here.[84] The draft conditions in the PDOC has correctly limited both hours of operation and emissions.[85]

However, the Applicant has proposed eliminating the limit on hours of operation, which is accurately and directly measured, by a much more complex method that is not directly measured and is subject to substantial error. The Applicant recommends replacing the hourly limit with a limit on heat input. The heat input would be calculated from measured gas turbine hourly fuel use and natural gas higher heating value (HHV). The proposed conditions do not require that the HHV be routinely measured, but rather only determined on request.[86] Compliance with the annual PM2.5 limit would then be determined by multiplying an emission

[82] *See, e.g.,* Powers and Matis, GE Report; Stephanie Wien, Jeanne Beres, and Brahim Richani, Air Emissions Terms, Definitions and General Information, GE Report GER-4249 (Aug. 2005), available at https://powergen.gepower.com/content/dam/gepower-pgdp/global/en_US/documents/technical/ger/ger-4249-air-emissions-terms-definitions-general-information.pdf.

[83] Net change in emissions assuming a 5% increase in the PM2.5 emission factor: (1.05)(10.68 ton/yr) - 1.62 ton/yr = 9.59 ton/yr, which rounds up to 10 ton/yr.

[84] 6/13/89 Hunt and Seitz Memo, p. 5-6.

[85] PDOC, Appendix K, Conditions 31 and 48, pdf 159, 163(TN # 211570).

[86] PDOC, Appendix K, Condition 25, pdf 157 (TN # 211570).

factor in lbs/MMBtu or lbs/MMscf determined in stack tests by "total rolling 12-month total fuel use during the CTG's normal operation."[87]

The Applicant argues this is warranted as the limits on hours in the PDOC were established at a time when achievable PM2.5 limits were believed to be higher than those currently supported by GE.[88] However, any such margin is warranted because compliance with the PM2.5 emission limit would be based on a single annual stack test, which would be used to represent every hour of operation. As PM2.5 emissions are highly variable, actual emissions during many of these hours could be higher than measured in a single stack test, justifying the claimed margin. Further, a heat input limit would not be enforceable as the HHV of the natural gas would not be measured. A more direct method to address the Applicant's concern would be to increase the hours of operation. This more direct approach likely was not selected as it would trigger PSD review for PM2.5.

The proposed annual PM2.5 limit that would be met using the Applicant's proposed method is not disclosed, but appears to exclude startups, shutdowns, and unplanned load changes, so would be less than 10.68 ton/yr assumed in the netting analysis. However, without a stated cap on hours, with no monitoring of HHV, and with only a single PM2.5 stack test per year, actual PM2.5 emissions could greatly exceed the unstated cap without detection. In contrast, a limit on hours of operation is easily enforceable and essential to assure PM2.5 emissions remain below the potential to emit.

3. <u>Enforceability</u>

As previously explained, the potential to emit must be federally enforceable.[89] This has been interpreted by the EPA to mean that "the source and/or enforcement authority must be able to show continual compliance (or noncompliance) with each limitation or requirement. In other words, adequate testing, monitoring, and record-keeping procedures must be included either in an applicable federally issued permit, or in the applicable federally approved SIP or the permit issued" thereunder.[90]

The VCAPCD's proposed Determination of Compliance (DOC) conditions[91] and the CEC's proposed Conditions of Certification (COC),[92] which are substantively identical, do not

[87] Lathan & Watkins LLP, Letter to VCAPCD re Comments on Preliminary Determination of Compliance, Letter from George L. Piantka, Sr. Director, Regulatory Environmental Services, NRG Energy, Inc., to Kerby E. Zozula, Manager, Engineering Division, VCAPCD, (June 23, 2016) pp. 8-10 (TN # 211989) [hereinafter Applicant Comments on PDOC].

[88] Applicant Comments on PDOC, p. 9 (TN # 211989) ("this permit condition does not account for the lower hourly emissions that will occur during low-load operation of the new gas turbine.").

[89] 40 C.F.R. § 52.21(b)(4).

[90] NSR Manual, p. A.5.

[91] PDOC, Appendix K (TN # 211570).

satisfy this test. They do not assure that the increase in PM2.5 emissions from the new gas turbine and diesel generator are federally and practically enforceable and thus will be achieved in practice. The proposed conditions allow increases that are much higher than assumed in the PSD netting analysis. Further, the Applicant's comments on these conditions further weaken their ability to limit the potential to emit.

a. PM10/PM2.5 During Startups And Shutdowns

The proposed limits on PM10, ROC, NOx, and CO[93] emissions during new turbine startups and shutdowns in the PDOC[94] and Revised PSA[95] are not practically enforceable as they do not require *any* monitoring. Compliance is verified solely by reliance on the "CTG manufacturer's emissions data." This data is not routinely available to regulatory agencies and has not been produced in response to the City's data requests. While the proposed conditions require continuous emission monitors for NOx and CO, the proposed conditions explicitly exempt compliance during startup and shutdown periods based on CEMS, substituting reliance on the vendor guarantee.[96]

Further, the proposed PM2.5 limits (startup = 8.75 lb/hr; shutdown = 9.58 lb/hr) are lower than the vendor guarantee of 10.1 lb/hr. The routine use of these unsupported limits in calculating annual emissions when no monitoring is required to verify them could leave the false impression that annual limits are met. This problem is compounded by the Applicant's request to remove the limit on annual operating hours.[97]

Vendor guarantees do not represent actual emissions during operation of the facility. They are narrowly specified to protect the vendor, using escape clauses as explained in Comment section II.B.1. Thus, actual emissions can vary significantly from the guarantee. These variances would not be detected without adequate monitoring. The Applicant has refused to produce the guarantees and supporting data, so these exceptions cannot be identified and evaluated. The PDOC and PSA conditions should be modified to require routine stack testing during two randomly selected turbine startups and shutdowns each year. They further should be modified to not rely on undisclosed and unvetted vendor emission guarantees.

b. PM10/PM2.5 During Normal Operation

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[92] Revised PSA, Part 1, Conditions AQ-1 to AQ-61, pp. 4.1-76 - 4.1-94, pdf 143-161 (TN # 211885-1); PDOC, Conditions 1 - 61, pp. K-1 - K-14, pdf 153-166 (TN # 211570).

[93] PM10 = PM2.5.

[94] PDOC, Conditions 27-28, pp. K-5 - K-6, pdf 157-158 (TN # 211570).

[95] Revised PSA, Part 1, Conditions AQ-27-28, pp. 4.1-81 – 4.1-82, pdf 149-150 (TN # 211885-1).

[96] PDOC, Appendix K, pdf 7-8 (TN # 211570).

[97] Applicant Comments on PDOC, pp. 7-8, pdf 9-10 (TN # 211989).

According to the proposed PSA conditions, compliance with the PM10 hourly (10.10 lb/hr) and annual (10.68 ton/yr) limits during normal operations "shall be verified by initial and annual source testing…"[98] In the case of the annual limit, the lb/hr emission rate measured in the stack test is used with annual operating hours to calculate ton/yr.[99]

The 10.10 lb/hr limit, coupled with startup, shutdown, and normal operation operating hours, was used by the Applicant to estimate the Project's potential to emit PM10 of 10.68 ton/yr.[100] This annual limit, in turn, was then used in the PSD netting analysis to conclude that PSD review is not triggered. See Table 2. The permit must contain enforceable conditions to ensure that these limits are achieved in practice.

An annual stack test measures PM2.5 emissions typically during 3 operating hours. Assuming the unit operates only 25% of the time, stack testing would measure only about 0.1% of the operating hours in any given year.[101] In my experience, given the high variability of a turbine's PM emissions, PM2.5 measurements during 3 hours out of every year is not adequate to determine emissions during any other hour or on an annual basis due to factors such as turbine age, turbine operating mode, emission control equipment operation, ambient debris levels, sample collection time, and artifact sulfate formation.[102] The permit must include adequate monitoring to assure that the hourly and annual emissions relied on to net out of PSD review for PM2.5 would actually be met in practice over the lifetime of the facility because PM2.5 emissions are highly variable.

Further, it is well known that "[m]anual stack tests are generally performed under optimum operating conditions, and as such, do not reflect the full-time emission conditions from a source."[103] A widely used handbook on CEMs explains, with respect to PM_{10} source tests: "Due to the planning and preparations necessary for these manual methods, the source is usually

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[98] Revised PSA, Part 1, Conditions AQ-29 and AQ-31 pdf 150, 152 (TN #211885-1); PDOC, Conditions 29 and 31, pdf 159- 160 (TN # 211570).

[99] Revised PSA, Part 1, Condition AQ-31, pp. 4.1-84 – 4.1-85, pdf 151-152 (TN #211885-1).

[100] *See* Applicant's Responses to CEC Set 2.

[101] Percent operating hours measured for a facility with a 25% capacity factor = [3 hr/(8,760 hr * 0.25)]100 = **0.14%.**

[102] W. Steven Lanier and Glenn C. England, Development of Fine Particulate Emission Factors and Speciation Profiles for Oil- and Gas-Fired Combustion Systems; Technical Memorandum: Conceptual Model of Sources of Variability in Combustion Turbine PM10 Emissions (Nov. 5, 2004) https://webcache.googleusercontent.com/search?q=cache:bmHN_-SFqHEJ:https://www.nyserda.ny.gov/-/media/Files/Publications/Research/Environmental/EMEP/Fine-Particulate-Emission-Conceptual-Model.pdf+&cd=1&hl=en&ct=clnk&gl=cz.

[103] 40 Fed. Reg. 46,241 (Oct. 6, 1975).

notified prior to the actual testing. This lead time allows the source to optimize both operations and control equipment performance in order to pass the tests."[104]

Thus, I recommend that more frequent source tests be required as a condition of certification to assure that the low PM2.5 hourly and annual emissions used to net out of PSD review are actually met day in and day out, as they must be. Specifically, I recommend the following source testing conditions: (1) quarterly source tests should be conducted at least once every five years over the life of the facility and annually every other year; (2) each source test should be conducted at three different load levels to limit the ability of the operator to manipulate results by testing during known high efficiency periods; and (3) source tests should not be conducted following maintenance when the turbine would operate at peak efficiency. As efficiency degrades over time, and emissions increase as efficiency declines, the peak does not represent normal operating conditions. I further recommend that tests be unannounced to the extent feasible, to assure an unbiased test. More frequent source testing is consistent with federal guidelines. This is particularly important here because this is a new GE model with limited commercial operating experience.[105]

c. Other Issues

The PDOC and PSA both assume that PM10 equals PM2.5. While this is generally true for natural gas combustion in isolation, it is not universally true. Other factors, such as turbine degradation and ambient air particulates, may increase the filterable PM10 fraction. Further, test methods are likely to be further refined, disclosing distinctions. As PSD review is triggered for PM2.5, but not PM10, the PDOC and PSA conditions should specifically limit PM2.5.

The PDOC's proposed stack test methods are ambiguous. The conditions specify "EPA Method 5 (front half and back half) or EPA Method 201A."[106] EPA Method 5 as specified measures total particulates, comprising the sum of total filterable (front half) and condensable (back half). However, these two options are not interchangeable. EPA Method 201A only measures filterable PM10 and PM2.5 particulate matter, but not the condensable fraction. The Applicant also noted this anomaly and recommended adding EPA Method 202 to measure condensable (back half) PM2.5.[107] I agree with this change and recommend that the VCAPCD adopt it.

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[104] James A. Jahnke, Continuous Emission Monitoring p. 241 (2nd Ed., John Wiley & Sons, Inc., 2nd ed. 2000).

[105] Thomas W. Overton, GE's New HA Turbines Nearing Delivery, Power Magazine (May 1, 2015) available at http://www.powermag.com/ges-new-ha-turbines-nearing-delivery-2/.

[106] PDOC, Appendix K, Condition 38, pdf 161 (TN # 211570).

[107] Applicant Comments on PDOC, p. 8, pdf 10 (TN # 211989).

4. *Revised Potential to Emit*

The proposed limits are neither federally nor practically enforceable. Thus, the potential to emit must be based on full capacity and year-round operation.[108] The potential to emit for purposes of PM2.5 PSD netting should be 44.2 ton/yr,[109] unless a federally enforceable permit is issued that assures continuous compliance.

[108] NSR Manual, p. A.9, C.45; 6/13/89 Hunt and Seitz Memo.

[109] Revised potential to emit = (10.1 lb/hr)(8,760 hr/yr)/2,000 lb/ton = **44.24 ton/yr.**

List of Sources

(1) NRG Oxnard Energy Center, LLC, Puente Power Project (P3) Application for Certification, Docket Number 15-AFC-01, Section 2.0: Project Description (TN # 204219-5) (April 15, 2015)

(2) Latham & Watkins LLP, Applicant's Responses to CEC Data Request, Set 2 (TN # 206791) (Nov. 30, 2015)

(3) NRG, AFC, Appendix C: Air Quality (TN # 204220-3) (April 15, 2015)

(4) VCAPCD, Notice of Preliminary Determination of Compliance (PDOC) (TN # 211570)

(5) Revised Preliminary Staff Assessment (Revised PSA), Part 1 (TN # 211885-1) (June 20, 2016)

(6) New Source Review Workshop Manual (1990)

(7) Memorandum from Terrell E. Hunt, Office of Enforcement and Compliance Monitoring, and John S. Seitz, Office of Air Quality Planning and Standards, Guidance on Limiting Potential to Emit in New Source Permitting (June 13, 1989)

(8) Latham & Watkins LLP, Responses to City of Oxnard Data Requests Set 1 (1-46) (TN # 206009) (Sept. 3, 2015)

(9) Latham & Watkins LLP, Applicant's Responses to City of Oxnard Data Requests Set 3 (TN # 206458) (Oct. 30, 2015)

(10) EPA, AP-42 Fifth Ed., Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, (Jan. 1995)

(11) Shute, Mihaly & Weinberger LLP, City of Oxnard's Data Requests, Set 3, Request 69 (TN # 206248) (Oct. 1, 2015)

(12) Latham & Watkins LLP, Objections to City of Oxnard's Data Requests, Set 3 (TN # 206410) (Oct. 21, 2015)

(13) 1998 AP-42, Introduction

(14) Louis Corio and Karen Olson, The Need for Alternate PM2.5 Emission Factors for Gas-Fired Combustion Units, Power Magazine (July 1, 2015)

(15) Karen Olson and Louis Corio, PM Emission Factors: Past, Present and Future

(16) EPA Method 202 Best Practices Handbook (Jan. 2016)

(17) EPA Revised PM Emission Factor Spreadsheet, Tab: References

(18) Older Editions of AP-42, Compilation of Air Pollutant Emission Factors

(19) 1998 AP-42, Table 1.4-2

(20) EPA, WebFIRE

(21) EPA, Emissions Factors Applicability

(22) Memorandum from Steven D. Page, EPA Office of Air Quality Planning and Standards, to EPA Regional Air Division Directors, (April 8, 2014)

(23) Louis Corio and Karen Olson, A Brief History of In-Stack PM Measurement, Power Magazine, (July 1, 2015)

(24) Glenn C. England, Development of Fine Particulate Emission Factors and Speciation Profiles for Oil- and Gas-Fired Combustion Systems, Final Report, (Oct. 20, 2004)

(25) Conditional Test Method (CTM) 039, Measurement of PM2.5 and PM10 Emissions by Dilution Sampling (Constant Sampling Rate Procedures) (July 2004)

(26) NRG Energy Center Oxnard LLC, Data Adequacy Supplemental Response (TN # 204859) (June 2, 2015)

(27) EPA Emission Spreadsheets (Exhibits 3 and 4)

(28) VCAPCD Part 70 Permit Number 00013, Mandalay Generating Station (July 10, 2015)

(29) NRG NOx CEMS Data for Mandalay Generating Station Units 1 and 2 (TN # 206008)

(30) NRG Application for Authority to Construct (Mar. 19, 2015)

(31) Latham & Watkins, Letter Regarding Withdrawal of Prior Responses to CEC Staff Data Request No. 2 (TN # 206503) (Nov. 3, 2005)

(32) Charles W. Powers and Craig Matis, Particulate Matter Emissions, Guarantees and Testing Considerations, GE Report GER4285 (May 2009)

(33) Historic Average: Oxnard, California

(34) Oxnard, CA Climate: Summary Graph

(35) Stephanie Wien, Jeanne Beres, and Brahim Richani, Air Emissions Terms, Definitions and General Information, GE Report GER-4249 (Aug. 2005)

(36) Lathan & Watkins LLP, Letter to VCAPCD re Comments on Preliminary Determination of Compliance, Letter from George L. Piantka, Sr. Director, Regulatory Environmental Services,

NRG Energy, Inc., to Kerby E. Zozula, Manager, Engineering Division, VCAPCD, (June 23, 2016) (TN # 211989)

(37) W. Steven Lanier and Glenn C. England, Development of Fine Particulate Emission Factors and Speciation Profiles for Oil- and Gas-Fired Combustion Systems; Technical Memorandum: Conceptual Model of Sources of Variability in Combustion Turbine PM10 Emissions, (Nov. 5, 2004)

(38) James A. Jahnke, Continuous Emission Monitoring p. 241 (2nd Ed., John Wiley & Sons, Inc., 2nd ed. 2000)

(39) Thomas W. Overton, GE's New HA Turbines Nearing Delivery, Power Magazine (May 1, 2015)

EXHIBIT 1

Phyllis Fox
Ph.D, PE, BCEE
Environmental Management
745 White Pine Ave.
Rockledge, FL 32955
321-626-6885
PhyllisFox@gmail.com

Dr. Fox has over 40 years of experience in the field of environmental engineering, including air pollution control (BACT, BART, MACT, LAER, RACT), PSD permitting, greenhouse gas emissions and control, cost effectiveness analyses, water quality and water supply investigations, hydrology, hazardous waste investigations, environmental permitting, nuisance investigations (odor, noise), environmental impact reports, CEQA/NEPA documentation, risk assessments, and litigation support.

EDUCATION

Ph.D. Environmental/Civil Engineering, University of California, Berkeley, 1980.
M.S. Environmental/Civil Engineering, University of California, Berkeley, 1975.
B.S. Physics (with high honors), University of Florida, Gainesville, 1971.

REGISTRATION

Registered Professional Engineer: Arizona (2001-2014: #36701; retired), California (2002-present; CH 6058), Florida (2001-present; #57886), Georgia (2002-2014; #PE027643; retired), Washington (2002-2014; #38692; retired), Wisconsin (2005-2014; #37595-006; retired)
Board Certified Environmental Engineer, American Academy of Environmental Engineers, Certified in Air Pollution Control (DEE #01-20014), 2002-present (retired)
Qualified Environmental Professional (QEP), Institute of Professional Environmental Practice (2001-2015: QEP #02-010007, retired)

PROFESSIONAL HISTORY

Environmental Management, Principal, 1981-present
Lawrence Berkeley National Laboratory, Principal Investigator, 1977-1981
University of California, Berkeley, Program Manager, 1976-1977
Bechtel, Inc., Engineer, 1971-1976, 1964-1966

PROFESSIONAL AFFILIATIONS

American Chemical Society (1981-2010)
Phi Beta Kappa (1970-present)
Sigma Pi Sigma (1970-present)

Who's Who Environmental Registry, PH Publishing, Fort Collins, CO, 1992.
Who's Who in the World, Marquis Who's Who, Inc., Chicago, IL, 11th Ed., p. 371, 1993-present.
Who's Who of American Women, Marquis Who's Who, Inc., Chicago, IL, 13th Ed., p. 264, 1984-present.
Who's Who in Science and Engineering, Marquis Who's Who, Inc., New Providence, NJ, 5th Ed., p. 414, 1999-present.
Who's Who in America, Marquis Who's Who, Inc., 59th Ed., 2005.
Guide to Specialists on Toxic Substances, World Environment Center, New York, NY, p. 80, 1980.
National Research Council Committee on Irrigation-Induced Water Quality Problems (Selenium), Subcommittee on Quality Control/Quality Assurance (1985-1990).
National Research Council Committee on Surface Mining and Reclamation, Subcommittee on Oil Shale (1978-80)

REPRESENTATIVE EXPERIENCE

Performed environmental and engineering investigations, as outlined below, for a wide range of industrial and commercial facilities including: petroleum refineries and upgrades thereto; reformulated fuels projects; refinery upgrades to process heavy sour crudes, including tar sands and light sweet crudes from the Eagle Ford and Bakken Formations; petroleum distribution terminals; coal, coke, and ore/mineral export terminals; LNG export, import, and storage terminals; crude-by-rail projects; shale oil plants; crude oil/condensate marine and rail terminals; coal gasification & liquefaction plants; oil and gas production, including conventional, thermally enhanced, hydraulic fracking, and acid stimulation techiques; underground storage tanks; pipelines; compressor stations; gasoline stations; landfills; railyards; hazardous waste treatment facilities; nuclear, hydroelectric, geothermal, wood, biomass, waste, tire-derived fuel, gas, oil, coke and coal-fired power plants; transmission lines; airports; hydrogen plants; petroleum coke calcining plants; coke plants; activated carbon manufacturing facilities; asphalt plants; cement plants; incinerators; flares; manufacturing facilities (e.g., semiconductors, electronic assembly, aerospace components, printed circuit boards, amusement park rides); lanthanide processing plants; ammonia plants; nitric acid plants; urea plants; food processing plants; almond hulling facilities; composting facilities; grain processing facilities; grain elevators; ethanol production facilities; soy bean oil extraction plants; biodiesel plants; paint formulation plants; wastewater treatment plants; marine terminals and ports; gas processing plants; steel mills; iron nugget production facilities; pig iron plant, based on blast furnace technology; direct reduced iron plant; acid regeneration facilities; railcar refinishing facility; battery manufacturing plants; pesticide manufacturing and repackaging facilities; pulp and paper mills; olefin plants; methanol plants; ethylene crackers; desalination plants; selective catalytic reduction (SCR) systems; selective noncatalytic reduction (SNCR) systems; halogen acid furnaces; contaminated property redevelopment projects (e.g., Mission Bay, Southern Pacific Railyards, Moscone Center expansion, San Diego Padres Ballpark); residential developments; commercial office parks, campuses, and shopping centers; server farms; transportation plans; and a wide range of mines including sand and gravel, hard rock, limestone, nacholite, coal, molybdenum, gold, zinc, and oil shale.

EXPERT WITNESS/LITIGATION SUPPORT

- For the California Attorney General, assist in determining compliance with probation terms in the matter of People v. Chevron USA.
- For plaintiffs, assist in developing Petitioners' proof brief for National Parks Conservation Association et al v. U.S. EPA, Petition for Review of Final Administrative Action of the U.S. EPA, In the U.S. Court of Appeals for the Third Circuit, Docket No. 14-3147.
- For plaintiffs, expert witness in civil action relating to alleged violations of the Clean Air Act, Prevention of Significant Deterioration, for historic modifications (1997-2000) at the Cemex cement plant in Lyons, Colorado. Reviewed produced documents, prepared expert and rebuttal reports on PSD applicability based on NOx emission calculations for a collection of changes considered both individually and collectively. Deposed August 2011. *United States v. Cemex, Inc.*, In U.S. District Court for the District of Colorado (Civil Action No. 09-cv-00019-MSK-MEH). Case settled June 13, 2013.
- For plaintiffs, in civil action relating to alleged violations of the Clean Air Act, Prevention of Significant Deterioration, for historic modifications (1988 – 2000) at James De Young Units 3, 4, and 5. Reviewed produced documents, analyzed CEMS and EIA data, and prepared netting and BACT analyses for NOx, SO2, and PM10 (PSD case). Expert report February 24, 2010 and affidavit February 20, 2010. *Sierra Club v. City of Holland, et al.*, U.S. District Court, Western District of Michigan (Civil Action 1:08-cv-1183). Case settled. Consent Decree 1/19/14.
- For plaintiffs, in civil action alleging failure to obtain MACT permit, expert on potential to emit hydrogen chloride (HCl) from a new coal-fired boiler. Reviewed record, estimated HCl emissions, wrote expert report June 2010 and March 2013 (Cost to Install a Scrubber at the Lamar Repowering Project Pursuant to Case-by-Case MACT), deposed August 2010 and March 2013. *Wildearth Guardian et al. v. Lamar Utilities Board*, Civil Action No. 09-cv-02974, U.S. District Court, District of Colorado. Case settled August 2013.
- For plaintiffs, expert witness on permitting, emission calculations, and wastewater treatment for coal-to-gasoline plant. Reviewed produced documents. Assisted in preparation of comments on draft minor source permit. Wrote two affidavits on key issues in case. Presented direct and rebuttal testimony 10/27 - 10/28/10 on permit enforceability and failure to properly calculate potential to emit, including underestimate of flaring emissions and

omission of VOC and CO emissions from wastewater treatment, cooling tower, tank roof landings, and malfunctions. *Sierra Club, Ohio Valley Environmental Coalition, Coal River Mountain Watch, West Virginia Highlands Conservancy v. John Benedict, Director, Division of Air Quality, West Virginia Department of Environmental Protection and TransGas Development System, LLC*, Appeal No. 10-01-AQB. Virginia Air Quality Board remanded the permit on March 28, 2011 ordering reconsideration of potential to emit calculations, including: (1) support for assumed flare efficiency; (2) inclusion of startup, shutdown and malfunction emissions; and (3) inclusion of wastewater treatment emissions in potential to emit calculations.

- For plaintiffs, expert on BACT emission limits for gas-fired combined cycle power plant. Prepared declaration in support of CBE's Opposition to the United States' Motion for Entry of Proposed Amended Consent Decree. Assisted in settlement discussions. *U.S. EPA, Plaintiff, Communities for a Better Environment, Intervenor Plaintiff, v. Pacific Gas & Electric Company, et al.*, U.S. District Court, Northern District of California, San Francisco Division, Case No. C-09-4503 SI.
- Technical expert in confidential settlement discussions with large coal-fired utility on BACT control technology and emission limits for NOx, SO2, PM, PM2.5, and CO for new natural gas fired combined cycle and simple cycle turbines with oil backup. (July 2010). Case settled.
- For plaintiffs, expert witness in remedy phase of civil action relating to alleged violations of the Clean Air Act, Prevention of Significant Deterioration, for historic modifications (1998-99) at Gallagher Units 1 and 3. Reviewed produced documents, prepared expert and rebuttal reports on historic and current-day BACT for SO2, control costs, and excess emissions of SO2. Deposed 11/18/09. *United States et al. v. Cinergy, et al.*, In U.S. District Court for the Southern District of Indiana, Indianapolis Division, Civil Action No. IP99-1693 C-M/S. Settled 12/22/09.
- For plaintiffs, expert witness on MACT, BACT for NOx, and enforceability in an administrative appeal of draft state air permit issued for four 300-MW pet-coke-fired CFBs. Reviewed produced documents and prepared prefiled testimony. Deposed 10/8/09 and 11/9/09. Testified 11/10/09. *Application of Las Brisas Energy Center, LLC for State Air Quality Permit*; before the State Office of Administrative Hearings, Texas. Permit remanded 3/29/10 as LBEC failed to meet burden of proof on a number of issues including MACT. Texas Court of Appeals dismissed an appeal to reinstate the permit. The Texas Commission on Environmental Quality and Las Brisas Energy Center, LLC sought to overturn the Court of Appeals decision but moved to have their appeal dismissed in August 2013.
- For defense, expert witness in unlawful detainer case involving a gasoline station, minimart, and residential property with contamination from leaking underground storage tanks. Reviewed agency files and inspected site. Presented expert testimony on July 6, 2009, on

causes of, nature and extent of subsurface contamination. *A. Singh v. S. Assaedi,* in Contra Costa County Superior Court, CA. Settled August 2009.

- For plaintiffs, expert witness on netting and enforceability for refinery being upgraded to process tar sands crude. Reviewed produced documents. Prepared expert and rebuttal reports addressing use of emission factors for baseline, omitted sources including coker, flares, tank landings and cleaning, and enforceability. Deposed. *In the Matter of Objection to the Issuance of Significant Source Modification Permit No. 089-25484-00453 to BP Products North America Inc., Whiting Business Unit, Save the Dunes Council, Inc., Sierra Club., Inc., Hoosier Environmental Council et al., Petitioners, B. P. Products North American, Respondents/Permittee,* before the Indiana Office of Environmental Adjudication. Case settled.
- For plaintiffs, expert witness on BACT, MACT, and enforceability in appeal of Title V permit issued to 600 MW coal-fired power plant burning Powder River Basin coal. Prepared technical comments on draft air permit. Reviewed record on appeal, drafted BACT, MACT, and enforceability pre-filed testimony. Drafted MACT and enforceability pre-filed rebuttal testimony. Deposed March 24, 2009. Testified June 10, 2009. *In Re: Southwestern Electric Power Company,* Arkansas Pollution Control and Ecology Commission, Consolidated Docket No. 08-006-P. Recommended Decision issued December 9, 2009 upholding issued permit. Commission adopted Recommended Decision January 22, 2010.
- For plaintiffs, expert witness in remedy phase of civil action relating to alleged violations of the Clean Air Act, Prevention of Significant Deterioration, for historic modifications (1989-1992) at Wabash Units 2, 3 and 5. Reviewed produced documents, prepared expert and rebuttal report on historic and current-day BACT for NOx and SO2, control costs, and excess emissions of NOx, SO2, and mercury. Deposed 10/21/08. *United States et al. v. Cinergy, et al.,* In U.S. District Court for the Southern District of Indiana, Indianapolis Division, Civil Action No. IP99-1693 C-M/S. Testified 2/3/09. Memorandum Opinion & Order 5-29-09 requiring shutdown of Wabash River Units 2, 3, 5 by September 30, 2009, run at baseline until shutdown, and permanently surrender SO2 emission allowances.
- For plaintiffs, expert witness in liability phase of civil action relating to alleged violations of the Clean Air Act, Prevention of Significant Deterioration, for three historic modifications (1997-2001) at two portland cement plants involving three cement kilns. Reviewed produced documents, analyzed CEMS data covering subject period, prepared netting analysis for NOx, SO_2 and CO, and prepared expert and rebuttal reports. *United States v. Cemex California Cement,* In U.S. District Court for the Central District of California, Eastern Division, Case No. ED CV 07-00223-GW (JCRx). Settled 1/15/09.
- For intervenors Clean Wisconsin and Citizens Utility Board, prepared data requests, reviewed discovery and expert report. Prepared prefiled direct, rebuttal and surrebuttal testimony on cost to extend life of existing Oak Creek Units 5-8 and cost to address future regulatory requirements to determine whether to control or shutdown one or more of the

units. Oral testimony 2/5/08. Application for a Certificate of Authority to Install Wet Flue Gas Desulfurization and Selective Catalytic Reduction Facilities and Associated Equipment for Control of Sulfur Dioxide and Nitrogen Oxide Emissions at Oak Creek Power Plant Units 5, 6, 7 and 8, WPSC Docket No. 6630-CE-299.

- For plaintiffs, expert witness on alternatives analysis and BACT for NOx, SO2, total PM10, and sulfuric acid mist in appeal of PSD permit issued to 1200 MW coal fired power plant burning Powder River Basin and/or Central Appalachian coal (Longleaf). Assisted in drafting technical comments on NOx on draft permit. Prepared expert disclosure. Presented 8+ days of direct and rebuttal expert testimony. Attended all 21 days of evidentiary hearing from 9/5/07 – 10/30/07 assisting in all aspects of hearing. *Friends of the Chatahooche and Sierra Club v. Dr. Carol Couch, Director, Environmental Protection Division of Natural Resources Department, Respondent, and Longleaf Energy Associates, Intervener*. ALJ Final Decision 1/11/08 denying petition. ALJ Order vacated & remanded for further proceedings, Fulton County Superior Court, 6/30/08. Court of Appeals of GA remanded the case with directions that the ALJ's final decision be vacated to consider the evidence under the correct standard of review, July 9, 2009. The ALJ issued an opinion April 2, 2010 in favor of the applicant. Final permit issued April 2010.
- For plaintiffs, expert witness on diesel exhaust in inverse condemnation case in which Port expanded maritime operations into residential neighborhoods, subjecting plaintiffs to noise, light, and diesel fumes. Measured real-time diesel particulate concentrations from marine vessels and tug boats on plaintiffs' property. Reviewed documents, depositions, DVDs, and photographs provided by counsel. Deposed. Testified October 24, 2006. *Ann Chargin, Richard Hackett, Carolyn Hackett, et al. v. Stockton Port District*, Superior Court of California, County of San Joaquin, Stockton Branch, No. CV021015. Judge ruled for plaintiffs.
- For plaintiffs, expert witness on NOx emissions and BACT in case alleging failure to obtain necessary permits and install controls on gas-fired combined-cycle turbines. Prepared and reviewed (applicant analyses) of NOx emissions, BACT analyses (water injection, SCR, ultra low NOx burners), and cost-effectiveness analyses based on site visit, plant operating records, stack tests, CEMS data, and turbine and catalyst vendor design information. Participated in negotiations to scope out consent order. *United States v. Nevada Power.* Case settled June 2007, resulting in installation of dry low NOx burners (5 ppm NOx averaged over 1 hr) on four units and a separate solar array at a local business.
- For plaintiffs, expert witness in appeal of PSD permit issued to 850 MW coal fired boiler burning Powder River Basin coal (Iatan Unit 2) on BACT for particulate matter, sulfuric acid mist and opacity and emission calculations for alleged historic violations of PSD. Assisted in drafting technical comments, petition for review, discovery requests, and responses to discovery requests. Reviewed produced documents. Prepared expert report on BACT for particulate matter. Assisted with expert depositions. Deposed February 7, 8, 27, and 28,

2007. *In Re PSD Construction Permit Issued to Great Plains Energy, Kansas City Power & Light – Iatan Generating Station, Sierra Club v. Missouri Department of Natural Resources, Great Plains Energy, and Kansas City Power & Light.* Case settled March 27, 2007, providing offsets for over 6 million ton/yr of CO2 and lower NOx and SO_2 emission limits.

- For plaintiffs, expert witness in remedy phase of civil action relating to alleged violations of the Clean Air Act, Prevention of Significant Deterioration, for historic modifications of coal-fired boilers and associated equipment. Reviewed produced documents, prepared expert report on cost to retrofit 24 coal-fired power plants with scrubbers designed to remove 99% of the sulfur dioxide from flue gases. Prepared supplemental and expert report on cost estimates and BACT for SO2 for these 24 complaint units. Deposed 1/30/07 and 3/14/07. *United States and State of New York et al. v. American Electric Power*, In U.S. District Court for the Southern District of Ohio, Eastern Division, Consolidated Civil Action Nos. C2-99-1182 and C2-99-1250. Settlement announced 10/9/07.
- For plaintiffs, expert witness on BACT, enforceability, and alternatives analysis in appeal of PSD permit issued for a 270-MW pulverized coal fired boiler burning Powder River Basin coal (City Utilities Springfield Unit 2). Reviewed permitting file and assisted counsel draft petition and prepare and respond to interrogatories and document requests. Reviewed interrogatory responses and produced documents. Assisted with expert depositions. Deposed August 2005. Evidentiary hearings October 2005. *In the Matter of Linda Chipperfield and Sierra Club v. Missouri Department of Natural Resources.* Missouri Supreme Court denied review of adverse lower court rulings August 2007.
- For plaintiffs, expert witness in civil action relating to plume touchdowns at AEP's Gavin coal-fired power plant. Assisted counsel draft interrogatories and document requests. Reviewed responses to interrogatories and produced documents. Prepared expert report "Releases of Sulfuric Acid Mist from the Gavin Power Station." The report evaluates sulfuric acid mist releases to determine if AEP complied with the requirements of CERCLA Section 103(a) and EPCRA Section 304. This report also discusses the formation, chemistry, release characteristics, and abatement of sulfuric acid mist in support of the claim that these releases present an imminent and substantial endangerment to public health under Section 7002(a)(1)(B) of the Resource Conservation and Recovery Act ("RCRA"). *Citizens Against Pollution v. Ohio Power Company*, In the U.S. District Court for the Southern District of Ohio, Eastern Division, Civil Action No. 2-04-cv-371. Case settled 12-8-06.
- For petitioners, expert witness in contested case hearing on BACT, enforceability, and emission estimates for an air permit issued to a 500-MW supercritical Power River Basin coal-fired boiler (Weston Unit 4). Assisted counsel prepare comments on draft air permit and respond to and draft discovery. Reviewed produced file, deposed (7/05), and prepared expert report on BACT and enforceability. Evidentiary hearings September 2005. *In the Matter of an Air Pollution Control Construction Permit Issued to Wisconsin Public Service*

Corporation for the Construction and Operation of a 500 MW Pulverized Coal-fired Power Plant Known as Weston Unit 4 in Marathon County, Wisconsin, Case No. IH-04-21. The Final Order, issued 2/10/06, lowered the NOx BACT limit from 0.07 lb/MMBtu to 0.06 lb/MMBtu based on a 30-day average, added a BACT SO2 control efficiency, and required a 0.0005% high efficiency drift eliminator as BACT for the cooling tower. The modified permit, including these provisions, was issued 3/28/07. Additional appeals in progress.

- For plaintiffs, adviser on technical issues related to Citizen Suit against U.S. EPA regarding failure to update New Source Performance Standards for petroleum refineries, 40 CFR 60, Subparts J, VV, and GGG. *Our Children's Earth Foundation and Sierra Club v. U.S. EPA et al.* Case settled July 2005. CD No. C 05-00094 CW, U.S. District Court, Northern District of California – Oakland Division. Proposed revisions to standards of performance for petroleum refineries published 72 FR 27178 (5/14/07).
- For interveners, reviewed proposed Consent Decree settling Clean Air Act violations due to historic modifications of boilers and associated equipment at two coal-fired power plants. In response to stay order, reviewed the record, selected one representative activity at each of seven generating units, and analyzed to identify CAA violations. Identified NSPS and NSR violations for NOx, SO_2, PM/PM10, and sulfuric acid mist. Summarized results in an expert report. *United States of America, and Michael A. Cox, Attorney General of the State of Michigan, ex rel. Michigan Department of Environmental Quality, Plaintiffs, and Clean Wisconsin, Sierra Club, and Citizens' Utility Board, Intervenors, v. Wisconsin Electric Power Company, Defendant*, U.S. District Court for the Eastern District of Wisconsin, Civil Action No. 2:03-CV-00371-CNC. Order issued 10-1-07 denying petition.
- For a coalition of Nevada labor organizations (ACE), reviewed preliminary determination to issue a Class I Air Quality Operating Permit to Construct and supporting files for a 250-MW pulverized coal-fired boiler (Newmont). Prepared about 100 pages of technical analyses and comments on BACT, MACT, emission calculations, and enforceability. Assisted counsel draft petition and reply brief appealing PSD permit to U.S. EPA Environmental Appeals Board (EAB). Order denying review issued 12/21/05. *In re Newmont Nevada Energy Investment, LLC, TS Power Plant*, PSD Appeal No. 05-04 (EAB 2005).
- For petitioners and plaintiffs, reviewed and prepared comments on air quality and hazardous waste based on negative declaration for refinery ultra low sulfur diesel project located in SCAQMD. Reviewed responses to comments and prepared responses. Prepared declaration and presented oral testimony before SCAQMD Hearing Board on exempt sources (cooling towers) and calculation of potential to emit under NSR. Petition for writ of mandate filed March 2005. Case remanded by Court of Appeals to trial court to direct SCAQMD to re-evaluate the potential environmental significance of NOx emissions resulting from the project in accordance with court's opinion. California Court of Appeals, Second Appellate Division, on December 18, 2007, affirmed in part (as to baseline) and denied in part. *Communities for a Better Environment v. South Coast Air Quality Management District and*

ConocoPhillips and Carlos Valdez et al v. South Coast Air Quality Management District and ConocoPhillips. Certified for partial publication 1/16/08. Appellate Court opinion upheld by CA Supreme Court 3/15/10. *(2010) 48 Cal.4th 310*.

- For amici seeking to amend a proposed Consent Decree to settle alleged NSR violations at Chevron refineries, reviewed proposed settlement, related files, subject modifications, and emission calculations. Prepared declaration on emission reductions, identification of NSR and NSPS violations, and BACT/LAER for FCCUs, heaters and boilers, flares, and sulfur recovery plants. *U.S. et al. v. Chevron U.S.A.*, Northern District of California, Case No. C 03-04650. Memorandum and Order Entering Consent Decree issued June 2005. Case No. C 03-4650 CRB.
- For petitioners, prepared declaration on enforceability of periodic monitoring requirements, in response to EPA's revised interpretation of 40 CFR 70.6(c)(1). This revision limited additional monitoring required in Title V permits. 69 FR 3203 (Jan. 22, 2004). *Environmental Integrity Project et al. v. EPA* (U.S. Court of Appeals for the District of Columbia). Court ruled the Act requires all Title V permits to contain monitoring requirements to assure compliance. *Sierra Club v. EPA*, 536 F.3d 673 (D.C. Cir. 2008).
- For interveners in application for authority to construct a 500 MW supercritical coal-fired generating unit before the Wisconsin Public Service Commission, prepared pre-filed written direct and rebuttal testimony with oral cross examination and rebuttal on BACT and MACT (Weston 4). Prepared written comments on BACT, MACT, and enforceability on draft air permit for same facility.
- For property owners in Nevada, evaluated the environmental impacts of a 1,450-MW coal-fired power plant proposed in a rural area adjacent to the Black Rock Desert and Granite Range, including emission calculations, air quality modeling, comments on proposed use permit to collect preconstruction monitoring data, and coordination with agencies and other interested parties. Project cancelled.
- For environmental organizations, reviewed draft PSD permit for a 600-MW coal-fired power plant in West Virginia (Longview). Prepared comments on permit enforceability; coal washing; BACT for SO_2 and PM10; Hg MACT; and MACT for HCl, HF, non-Hg metallic HAPs, and enforceability. Assist plaintiffs draft petition appealing air permit. Retained as expert to develop testimony on MACT, BACT, offsets, enforceability. Participate in settlement discussions. Case settled July 2004.
- For petitioners, reviewed record produced in discovery and prepared affidavit on emissions of carbon monoxide and volatile organic compounds during startup of GE 7FA combustion turbines to successfully establish plaintiff standing. *Sierra Club et al. v. Georgia Power Company* (Northern District of Georgia).
- For building trades, reviewed air quality permitting action for 1500-MW coal-fired power plant before the Kentucky Department for Environmental Protection (Thoroughbred).

- For petitioners, expert witness in administrative appeal of the PSD/Title V permit issued to a 1500-MW coal-fired power plant. Reviewed over 60,000 pages of produced documents, prepared discovery index, identified and assembled plaintiff exhibits. Deposed. Assisted counsel in drafting discovery requests, with over 30 depositions, witness cross examination, and brief drafting. Presented over 20 days of direct testimony, rebuttal and sur-rebuttal, with cross examination on BACT for NOx, SO_2, and PM/PM10; MACT for Hg and non-Hg metallic HAPs; emission estimates for purposes of Class I and II air modeling; risk assessment; and enforceability of permit limits. Evidentiary hearings from November 2003 to June 2004. *Sierra Club et al. v. Natural Resources & Environmental Protection Cabinet, Division of Air Quality and Thoroughbred Generating Company et al.* Hearing Officer Decision issued August 9, 2005 finding in favor of plaintiffs on counts as to risk, BACT (IGCC/CFB, NOx, SO_2, Hg, Be), single source, enforceability, and errors and omissions. Assist counsel draft exceptions. Cabinet Secretary issued Order April 11, 2006 denying Hearing Offer's report, except as to NOx BACT, Hg, 99% SO2 control and certain errors and omissions.
- For citizens group in Massachusetts, reviewed, commented on, and participated in permitting of pollution control retrofits of coal-fired power plant (Salem Harbor).
- Assisted citizens group and labor union challenge issuance of conditional use permit for a 317,000 ft^2 discount store in Honolulu without any environmental review. In support of a motion for preliminary injunction, prepared 7-page declaration addressing public health impacts of diesel exhaust from vehicles serving the Project. In preparation for trial, prepared 20-page preliminary expert report summarizing results of diesel exhaust and noise measurements at two big box retail stores in Honolulu, estimated diesel PM10 concentrations for Project using ISCST, prepared a cancer health risk assessment based on these analyses, and evaluated noise impacts.
- Assisted environmental organizations to challenge the DOE Finding of No Significant Impact (FONSI) for the Baja California Power and Sempra Energy Resources Cross-Border Transmissions Lines in the U.S. and four associated power plants located in Mexico (DOE EA-1391). Prepared 20-page declaration in support of motion for summary judgment addressing emissions, including CO_2 and NH_3, offsets, BACT, cumulative air quality impacts, alternative cooling systems, and water use and water quality impacts. Plaintiff's motion for summary judgment granted in part. U.S. District Court, Southern District decision concluded that the Environmental Assessment and FONSI violated NEPA and the APA due to their inadequate analysis of the potential controversy surrounding the project, water impacts, impacts from NH_3 and CO_2, alternatives, and cumulative impacts. *Border Power Plant Working Group v. Department of Energy and Bureau of Land Management*, Case No. 02-CV-513-IEG (POR) (May 2, 2003).
- For Sacramento school, reviewed draft air permit issued for diesel generator located across from playfield. Prepared comments on emission estimates, enforceability, BACT, and health impacts of diesel exhaust. Case settled. BUG trap installed on the diesel generator.

- Assisted unions in appeal of Title V permit issued by BAAQMD to carbon plant that manufactured coke. Reviewed District files, identified historic modifications that should have triggered PSD review, and prepared technical comments on Title V permit. Reviewed responses to comments and assisted counsel draft appeal to BAAQMD hearing board, opening brief, motion to strike, and rebuttal brief. Case settled.
- Assisted California Central Coast city obtain controls on a proposed new city that would straddle the Ventura-Los Angeles County boundary. Reviewed several environmental impact reports, prepared an air quality analysis, a diesel exhaust health risk assessment, and detailed review comments. Governor intervened and State dedicated the land for conservation purposes April 2004.
- Assisted Central California city to obtain controls on large alluvial sand quarry and asphalt plant proposing a modernization. Prepared comments on Negative Declaration on air quality, public health, noise, and traffic. Evaluated process flow diagrams and engineering reports to determine whether proposed changes increased plant capacity or substantially modified plant operations. Prepared comments on application for categorical exemption from CEQA. Presented testimony to County Board of Supervisors. Developed controls to mitigate impacts. Assisted counsel draft Petition for Writ. Case settled June 2002. Substantial improvements in plant operations were obtained including cap on throughput, dust control measures, asphalt plant loadout enclosure, and restrictions on truck routes.
- Assisted oil companies on the California Central Coast in defending class action citizen's lawsuit alleging health effects due to emissions from gas processing plant and leaking underground storage tanks. Reviewed regulatory and other files and advised counsel on merits of case. Case settled November 2001.
- Assisted oil company on the California Central Coast in defending property damage claims arising out of a historic oil spill. Reviewed site investigation reports, pump tests, leachability studies, and health risk assessments, participated in design of additional site characterization studies to assess health impacts, and advised counsel on merits of case. Prepare health risk assessment.
- Assisted unions in appeal of Initial Study/Negative Declaration ("IS/ND") for an MTBE phaseout project at a Bay Area refinery. Reviewed IS/ND and supporting agency permitting files and prepared technical comments on air quality, groundwater, and public health impacts. Reviewed responses to comments and final IS/ND and ATC permits and assisted counsel to draft petitions and briefs appealing decision to Air District Hearing Board. Presented sworn direct and rebuttal testimony with cross examination on groundwater impacts of ethanol spills on hydrocarbon contamination at refinery. Hearing Board ruled 5 to 0 in favor of appellants, remanding ATC to district to prepare an EIR.
- Assisted Florida cities in challenging the use of diesel and proposed BACT determinations in prevention of significant deterioration (PSD) permits issued to two 510-MW simple cycle

peaking electric generating facilities and one 1,080-MW simple cycle/combined cycle facility. Reviewed permit applications, draft permits, and FDEP engineering evaluations, assisted counsel in drafting petitions and responding to discovery. Participated in settlement discussions. Cases settled or applications withdrawn.

- Assisted large California city in federal lawsuit alleging peaker power plant was violating its federal permit. Reviewed permit file and applicant's engineering and cost feasibility study to reduce emissions through retrofit controls. Advised counsel on feasible and cost-effective NOx, SOx, and PM10 controls for several 1960s diesel-fired Pratt and Whitney peaker turbines. Case settled.
- Assisted coalition of Georgia environmental groups in evaluating BACT determinations and permit conditions in PSD permits issued to several large natural gas-fired simple cycle and combined-cycle power plants. Prepared technical comments on draft PSD permits on BACT, enforceability of limits, and toxic emissions. Reviewed responses to comments, advised counsel on merits of cases, participated in settlement discussions, presented oral and written testimony in adjudicatory hearings, and provided technical assistance as required. Cases settled or won at trial.
- Assisted construction unions in review of air quality permitting actions before the Indiana Department of Environmental Management ("IDEM") for several natural gas-fired simple cycle peaker and combined cycle power plants.
- Assisted coalition of towns and environmental groups in challenging air permits issued to 523 MW dual fuel (natural gas and distillate) combined-cycle power plant in Connecticut. Prepared technical comments on draft permits and 60 pages of written testimony addressing emission estimates, startup/shutdown issues, BACT/LAER analyses, and toxic air emissions. Presented testimony in adjudicatory administrative hearings before the Connecticut Department of Environmental Protection in June 2001 and December 2001.
- Assisted various coalitions of unions, citizens groups, cities, public agencies, and developers in licensing and permitting of over 110 coal, gas, oil, biomass, and pet coke-fired power plants generating over 75,000 MW of electricity. These included base-load, combined cycle, simple cycle, and peaker power plants in Alaska, Arizona, Arkansas, California, Colorado, Georgia, Florida, Illinois, Indiana, Kentucky, Michigan, Missouri, Ohio, Oklahoma, Oregon, Texas, West Virginia, Wisconsin, and elsewhere. Prepared analyses of and comments on applications for certification, preliminary and final staff assessments, and various air, water, wastewater, and solid waste permits issued by local agencies. Presented written and oral testimony before various administrative bodies on hazards of ammonia use and transportation, health effects of air emissions, contaminated property issues, BACT/LAER issues related to SCR and SCONOx, criteria and toxic pollutant emission estimates, MACT analyses, air quality modeling, water supply and water quality issues, and methods to reduce water use, including dry cooling, parallel dry-wet cooling, hybrid cooling, and zero liquid discharge systems.

- Assisted unions, cities, and neighborhood associations in challenging an EIR issued for the proposed expansion of the Oakland Airport. Reviewed two draft EIRs and prepared a health risk assessment and extensive technical comments on air quality and public health impacts. The California Court of Appeals, First Appellate District, ruled in favor of appellants and plaintiffs, concluding that the EIR "2) erred in using outdated information in assessing the emission of toxic air contaminants (TACs) from jet aircraft; 3) failed to support its decision not to evaluate the health risks associated with the emission of TACs with meaningful analysis," thus accepting my technical arguments and requiring the Port to prepare a new EIR. See *Berkeley Keep Jets Over the Bay Committee, City of San Leandro, and City of Alameda et al. v. Board of Port Commissioners* (August 30, 2001) 111 Cal.Rptr.2d 598.
- Assisted lessor of former gas station with leaking underground storage tanks and TCE contamination from adjacent property. Lessor held option to purchase, which was forfeited based on misrepresentation by remediation contractor as to nature and extent of contamination. Remediation contractor purchased property. Reviewed regulatory agency files and advised counsel on merits of case. Case not filed.
- Advised counsel on merits of several pending actions, including a Proposition 65 case involving groundwater contamination at an explosives manufacturing firm and two former gas stations with leaking underground storage tanks.
- Assisted defendant foundry in Oakland in a lawsuit brought by neighbors alleging property contamination, nuisance, trespass, smoke, and health effects from foundry operation. Inspected and sampled plaintiff's property. Advised counsel on merits of case. Case settled.
- Assisted business owner facing eminent domain eviction. Prepared technical comments on a negative declaration for soil contamination and public health risks from air emissions from a proposed redevelopment project in San Francisco in support of a CEQA lawsuit. Case settled.
- Assisted neighborhood association representing residents living downwind of a Berkeley asphalt plant in separate nuisance and CEQA lawsuits. Prepared technical comments on air quality, odor, and noise impacts, presented testimony at commission and council meetings, participated in community workshops, and participated in settlement discussions. Cases settled. Asphalt plant was upgraded to include air emission and noise controls, including vapor collection system at truck loading station, enclosures for noisy equipment, and improved housekeeping.
- Assisted a Fortune 500 residential home builder in claims alleging health effects from faulty installation of gas appliances. Conducted indoor air quality study, advised counsel on merits of case, and participated in discussions with plaintiffs. Case settled.
- Assisted property owners in Silicon Valley in lawsuit to recover remediation costs from insurer for large TCE plume originating from a manufacturing facility. Conducted investigations to demonstrate sudden and accidental release of TCE, including groundwater

modeling, development of method to date spill, preparation of chemical inventory, investigation of historical waste disposal practices and standards, and on-site sewer and storm drainage inspections and sampling. Prepared declaration in opposition to motion for summary judgment. Case settled.

- Assisted residents in east Oakland downwind of a former battery plant in class action lawsuit alleging property contamination from lead emissions. Conducted historical research and dry deposition modeling that substantiated claim. Participated in mediation at JAMS. Case settled.
- Assisted property owners in West Oakland who purchased a former gas station that had leaking underground storage tanks and groundwater contamination. Reviewed agency files and advised counsel on merits of case. Prepared declaration in opposition to summary judgment. Prepared cost estimate to remediate site. Participated in settlement discussions. Case settled.
- Consultant to counsel representing plaintiffs in two Clean Water Act lawsuits involving selenium discharges into San Francisco Bay from refineries. Reviewed files and advised counsel on merits of case. Prepared interrogatory and discovery questions, assisted in deposing opposing experts, and reviewed and interpreted treatability and other technical studies. Judge ruled in favor of plaintiffs.
- Assisted oil company in a complaint filed by a resident of a small California beach community alleging that discharges of tank farm rinse water into the sanitary sewer system caused hydrogen sulfide gas to infiltrate residence, sending occupants to hospital. Inspected accident site, interviewed parties to the event, and reviewed extensive agency files related to incident. Used chemical analysis, field simulations, mass balance calculations, sewer hydraulic simulations with SWMM44, atmospheric dispersion modeling with SCREEN3, odor analyses, and risk assessment calculations to demonstrate that the incident was caused by a faulty drain trap and inadequate slope of sewer lateral on resident's property. Prepared a detailed technical report summarizing these studies. Case settled.
- Assisted large West Coast city in suit alleging that leaking underground storage tanks on city property had damaged the waterproofing on downgradient building, causing leaks in an underground parking structure. Reviewed subsurface hydrogeologic investigations and evaluated studies conducted by others documenting leakage from underground diesel and gasoline tanks. Inspected, tested, and evaluated waterproofing on subsurface parking structure. Waterproofing was substandard. Case settled.
- Assisted residents downwind of gravel mine and asphalt plant in Siskiyou County, California, in suit to obtain CEQA review of air permitting action. Prepared two declarations analyzing air quality and public health impacts. Judge ruled in favor of plaintiffs, closing mine and asphalt plant.

- Assisted defendant oil company on the California Central Coast in class action lawsuit alleging property damage and health effects from subsurface petroleum contamination. Reviewed documents, prepared risk calculations, and advised counsel on merits of case. Participated in settlement discussions. Case settled.
- Assisted defendant oil company in class action lawsuit alleging health impacts from remediation of petroleum contaminated site on California Central Coast. Reviewed documents, designed and conducted monitoring program, and participated in settlement discussions. Case settled.
- Consultant to attorneys representing irrigation districts and municipal water districts to evaluate a potential challenge of USFWS actions under CVPIA section 3406(b)(2). Reviewed agency files and collected and analyzed hydrology, water quality, and fishery data. Advised counsel on merits of case. Case not filed.
- Assisted residents downwind of a Carson refinery in class action lawsuit involving soil and groundwater contamination, nuisance, property damage, and health effects from air emissions. Reviewed files and provided advise on contaminated soil and groundwater, toxic emissions, and health risks. Prepared declaration on refinery fugitive emissions. Prepared deposition questions and reviewed deposition transcripts on air quality, soil contamination, odors, and health impacts. Case settled.
- Assisted residents downwind of a Contra Costa refinery who were affected by an accidental release of naphtha. Characterized spilled naphtha, estimated emissions, and modeled ambient concentrations of hydrocarbons and sulfur compounds. Deposed. Presented testimony in binding arbitration at JAMS. Judge found in favor of plaintiffs.
- Assisted residents downwind of Contra Costa County refinery in class action lawsuit alleging property damage, nuisance, and health effects from several large accidents as well as routine operations. Reviewed files and prepared analyses of environmental impacts. Prepared declarations, deposed, and presented testimony before jury in one trial and judge in second. Case settled.
- Assisted business owner claiming damages from dust, noise, and vibration during a sewer construction project in San Francisco. Reviewed agency files and PM10 monitoring data and advised counsel on merits of case. Case settled.
- Assisted residents downwind of Contra Costa County refinery in class action lawsuit alleging property damage, nuisance, and health effects. Prepared declaration in opposition to summary judgment, deposed, and presented expert testimony on accidental releases, odor, and nuisance before jury. Case thrown out by judge, but reversed on appeal and not retried.
- Presented testimony in small claims court on behalf of residents claiming health effects from hydrogen sulfide from flaring emissions triggered by a power outage at a Contra Costa County refinery. Analyzed meteorological and air quality data and evaluated potential health

risks of exposure to low concentrations of hydrogen sulfide. Judge awarded damages to plaintiffs.

- Assisted construction unions in challenging PSD permit for an Indiana steel mill. Prepared technical comments on draft PSD permit, drafted 70-page appeal of agency permit action to the Environmental Appeals Board challenging permit based on faulty BACT analysis for electric arc furnace and reheat furnace and faulty permit conditions, among others, and drafted briefs responding to four parties. EPA Region V and the EPA General Counsel intervened as amici, supporting petitioners. EAB ruled in favor of petitioners, remanding permit to IDEM on three key issues, including BACT for the reheat furnace and lead emissions from the EAF. Drafted motion to reconsider three issues. Prepared 69 pages of technical comments on revised draft PSD permit. Drafted second EAB appeal addressing lead emissions from the EAF and BACT for reheat furnace based on European experience with SCR/SNCR. Case settled. Permit was substantially improved. See *In re: Steel Dynamics, Inc.*, PSD Appeal Nos. 99-4 & 99-5 (EAB June 22, 2000).
- Assisted defendant urea manufacturer in Alaska in negotiations with USEPA to seek relief from penalties for alleged violations of the Clean Air Act. Reviewed and evaluated regulatory files and monitoring data, prepared technical analysis demonstrating that permit limits were not violated, and participated in negotiations with EPA to dismiss action. Fines were substantially reduced and case closed.
- Assisted construction unions in challenging PSD permitting action for an Indiana grain mill. Prepared technical comments on draft PSD permit and assisted counsel draft appeal of agency permit action to the Environmental Appeals Board challenging permit based on faulty BACT analyses for heaters and boilers and faulty permit conditions, among others. Case settled.
- As part of a consent decree settling a CEQA lawsuit, assisted neighbors of a large west coast port in negotiations with port authority to secure mitigation for air quality impacts. Prepared technical comments on mobile source air quality impacts and mitigation and negotiated a $9 million CEQA mitigation package. Represented neighbors on technical advisory committee established by port to implement the air quality mitigation program. Program successfully implemented.
- Assisted construction unions in challenging permitting action for a California hazardous waste incinerator. Prepared technical comments on draft permit, assisted counsel prepare appeal of EPA permit to the Environmental Appeals Board. Participated in settlement discussions on technical issues with applicant and EPA Region 9. Case settled.
- Assisted environmental group in challenging DTSC Negative Declaration on a hazardous waste treatment facility. Prepared technical comments on risk of upset, water, and health risks. Writ of mandamus issued.

- Assisted several neighborhood associations and cities impacted by quarries, asphalt plants, and cement plants in Alameda, Shasta, Sonoma, and Mendocino counties in obtaining mitigations for dust, air quality, public health, traffic, and noise impacts from facility operations and proposed expansions.
- For over 100 industrial facilities, commercial/campus, and redevelopment projects, developed the record in preparation for CEQA and NEPA lawsuits. Prepared technical comments on hazardous materials, solid wastes, public utilities, noise, worker safety, air quality, public health, water resources, water quality, traffic, and risk of upset sections of EIRs, EISs, FONSIs, initial studies, and negative declarations. Assisted counsel in drafting petitions and briefs and prepared declarations.
- For several large commercial development projects and airports, assisted applicant and counsel prepare defensible CEQA documents, respond to comments, and identify and evaluate "all feasible" mitigation to avoid CEQA challenges. This work included developing mitigation programs to reduce traffic-related air quality impacts based on energy conservation programs, solar, low-emission vehicles, alternative fuels, exhaust treatments, and transportation management associations.

SITE INVESTIGATION/REMEDIATION/CLOSURE

- Technical manager and principal engineer for characterization, remediation, and closure of waste management units at former Colorado oil shale plant. Constituents of concern included BTEX, As, 1,1,1-TCA, and TPH. Completed groundwater monitoring programs, site assessments, work plans, and closure plans for seven process water holding ponds, a refinery sewer system, and processed shale disposal area. Managed design and construction of groundwater treatment system and removal actions and obtained clean closure.
- Principal engineer for characterization, remediation, and closure of process water ponds at a former lanthanide processing plant in Colorado. Designed and implemented groundwater monitoring program and site assessments and prepared closure plan.
- Advised the city of Sacramento on redevelopment of two former railyards. Reviewed work plans, site investigations, risk assessment, RAPS, RI/FSs, and CEQA documents. Participated in the development of mitigation strategies to protect construction and utility workers and the public during remediation, redevelopment, and use of the site, including buffer zones, subslab venting, rail berm containment structure, and an environmental oversight plan.
- Provided technical support for the investigation of a former sanitary landfill that was redeveloped as single family homes. Reviewed and/or prepared portions of numerous documents, including health risk assessments, preliminary endangerment assessments, site investigation reports, work plans, and RI/FSs. Historical research to identify historic waste

disposal practices to prepare a preliminary endangerment assessment. Acquired, reviewed, and analyzed the files of 18 federal, state, and local agencies, three sets of construction field notes, analyzed 21 aerial photographs and interviewed 14 individuals associated with operation of former landfill. Assisted counsel in defending lawsuit brought by residents alleging health impacts and diminution of property value due to residual contamination. Prepared summary reports.

- Technical oversight of characterization and remediation of a nitrate plume at an explosives manufacturing facility in Lincoln, CA. Provided interface between owners and consultants. Reviewed site assessments, work plans, closure plans, and RI/FSs.
- Consultant to owner of large western molybdenum mine proposed for NPL listing. Participated in negotiations to scope out consent order and develop scope of work. Participated in studies to determine premining groundwater background to evaluate applicability of water quality standards. Served on technical committees to develop alternatives to mitigate impacts and close the facility, including resloping and grading, various thickness and types of covers, and reclamation. This work included developing and evaluating methods to control surface runoff and erosion, mitigate impacts of acid rock drainage on surface and ground waters, and stabilize nine waste rock piles containing 328 million tons of pyrite-rich, mixed volcanic waste rock (andesites, rhyolite, tuff). Evaluated stability of waste rock piles. Represented client in hearings and meetings with state and federal oversight agencies.

REGULATORY (PARTIAL LIST)

- In June 2016, prepared comments on an Ordinance (1) Amending the Oakland Municipal Code to Prohibit the Storage and Handling of Coal and Coke at Bulk Material Facilities or Terminals Throughout the City of Oakland and (2) Adopting CEQA Exemption Findings and supporting technical reports. Council approved Ordinance on an 8 to 0 vote on June 27, 2016.
- In May 2016, prepared comments on Draft Title V Permit and Draft Environmental Impact Report for the Tesoro Los Angeles Refinery Integration and Compliance Project.
- In March 2016, prepared comments on Valero’s Appeal of Planning Commission’s Denial of Valero Crude-by-Rail Project
- In February 2016, prepared comments on Final Environmental Impact Report, Santa Maria Rail Spur Project.
- In February 2016, prepared comments on Final Environmental Impact Report, Valero Benicia Crude by Rail Project.

- In January 2016, prepared comments on Draft Programmatic Environmental Impact Report for the Southern California Association of Government's (SCAG) 2016-2040 Regional Transportation Plan/Sustainable Communities Strategy.
- In November 2015, prepared comments on Final Environmental Impact Report for Revisions to the Kern County Zoning Ordinance – 2015(C) (Focused on Oil and Gas Local Permitting), November 2015.
- In October 2015, prepared comments on Revised Draft Environmental Report, Valero Benicia Crude by Rail Project.
- In September 2015, prepared report, "Environmental, Health and Safety Impacts of the Proposed Oakland Bulk and Oversized Terminal" and presented oral testimony on September 21, 2015 before Oakland City Council on behalf of the Sierra Club.
- In September 2015, prepared comments on revisions to two chapters of EPA's Air Pollution Control Cost Manual: Docket ID No. EPA-HQ-OAR-2015-0341.
- In June 2015, prepared comments on DEIR for the CalAm Monterey Peninsula Water Supply Project.
- In April 2015, prepared comments on proposed Title V Operating Permit Revision and Prevention of Significant Deterioration Permit for Arizona Public Service's Ocotillo Power Plant Modernization Project (5 GE LMS100 105-MW simple cycle turbines operated as peakers), in Tempe, Arizona; Final permit appealed to EAB.
- In March 2015, prepared "Comments on Proposed Title V Air Permit, Yuhuang Chemical Inc. Methanol Plant, St. James, Louisiana".
- In January 2015, prepared cost effectiveness analysis for SCR for a 500-MW coal fire power plant, to address unpermitted upgrades in 2000.
- In January 2015, prepared comments on Revised Final Environmental Impact Report for the Phillips 66 Propane Recovery Project.
- In December 2014, prepared "Report on Bakersfield Crude Terminal Permits to Operate." In response, the U.S. EPA cited the Terminal for 10 violations of the Clean Air Act.
- In December 2014, prepared comments on Revised Draft Environmental Impact Report for the Phillips 66 Propane Recovery Project.
- In November 2014, prepared comments on Revised Draft Environmental Impact Report for Phillips 66 Rail Spur Extension Project and Crude Unloading Project, Santa Maria, CA to allow the import of tar sands crudes.
- In November 2014, prepared comments on Draft Environmental Impact Report for Phillips 66 Ultra Low Sulfur Diesel Project, responding to the California Supreme Court Decision,

Communities for a Better Environment v. South Coast Air Quality Management Dist. (2010) 48 Cal.4th 310.

- In November 2014, prepared comments on Draft Environmental Impact Report for the Tesoro Avon Marine Oil Terminal Lease Consideration.
- In October 2014, prepared: "Report on Hydrogen Cyanide Emissions from Fluid Catalytic Cracking Units", pursuant to the Petroleum Refinery Sector Risk and Technology Review and New Source Performance Standards, 79 FR 36880.
- In October 2014, prepared technical comments on Final Environmental Impact Reports for Alon Bakersfield Crude Flexibility Project to build a rail terminal to allow the import/export of tar sands and Bakken crude oils and to upgrade an existing refinery to allow it to process a wide range of crudes.
- In October 2014, prepared technical comments on the Title V Permit Renewal and three De Minimus Significant Revisions for the Tesoro Logistics Marine Terminal in the SCAQMD.
- In September 2014, prepared technical comments on the Draft Environmental Impact Report for the Valero Crude by Rail Project.
- In August 2014, for EPA Region 6, prepared technical report on costing methods for upgrades to existing scrubbers at coal-fired power plants.
- In July 2014, prepared technical comments on Draft Final Environmental Impact Reports for Alon Bakersfield Crude Flexibility Project to build a rail terminal to allow the import/export of tar sands and Bakken crude oils and to upgrade an existing refinery to allow it to process a wide range of crudes.
- In June 2014, prepared technical report on Initial Study and Draft Negative Declaration for the Tesoro Logistics Storage Tank Replacement and Modification Project.
- In May 2014, prepared technical comments on Intent to Approve a new refinery and petroleum transloading operation in Utah.
- In March and April 2014, prepared declarations on air permits issued for two crude-by-rail terminals in California, modified to switch from importing ethanol to importing Bakken crude oils by rail and transferring to tanker cars. Permits were issued without undergoing CEQA review. One permit was upheld by the San Francisco Superior Court as statute of limitations had run. The Sacramento Air Quality Management District withdrew the second one due to failure to require BACT and conduct CEQA review.
- In March 2014, prepared technical report on Negative Declaration for a proposed modification of the air permit for a bulk petroleum and storage terminal to the allow the import of tar sands and Bakken crude oil by rail and its export by barge, under the New York State Environmental Quality Review Act (SEQRA).

- In February 2014, prepared technical report on proposed modification of air permit for midwest refinery upgrade/expansion to process tar sands crudes.
- In January 2014, prepared cost estimates to capture, transport, and use CO2 in enhanced oil recovery, from the Freeport LNG project based on both Selexol and Amine systems.
- In January 2014, prepared technical report on Draft Environmental Impact Report for Phillips 66 Rail Spur Extension Project, Santa Maria, CA. Comments addressed project description (piecemealing, crude slate), risk of upset analyses, mitigation measures, alternative analyses and cumulative impacts.
- In November 2013, prepared technical report on the Phillips 66 Propane Recovery Project, Rodeo, CA. Comments addressed project description (piecemealing, crude slate) and air quality impacts.
- In September 2013, prepared technical report on the Draft Authority to Construct Permit for the Casa Diablo IV Geothermal Development Project Environmental Impact Report and Declaration in Support of Appeal and Petition for Stay, U.S. Department of the Interior, Board of Land Appeals, Appeal of Decision Record for the Casa Diablo IV Geothermal Development Project.
- In September 2013, prepared technical report on Effluent Limitation Guidelines for Best Available Technology Economically Available (BAT) for Bottom Ash Transport Waters from Coal-Fired Power Plants in the Steam Electric Power Generating Point Source Category.
- In July 2013, prepared technical report on Initial Study/Mitigated Negative Declaration for the Valero Crude by Rail Project, Benicia, California, Use Permit Application 12PLN-00063.
- In July 2013, prepared technical report on fugitive particulate matter emissions from coal train staging at the proposed Coyote Island Terminal, Oregon, for draft Permit No. 25-0015-ST-01.
- In July 2013, prepared technical comments on air quality impacts of the Finger Lakes LPG Storage Facility as reported in various Environmental Impact Statements.
- In July 2013, prepared technical comments on proposed Greenhouse Gas PSD Permit for the Celanese Clear Lake Plant, including cost analysis of CO2 capture, transport, and sequestration.
- In June/July 2013, prepared technical comments on proposed Draft PSD Preconstruction Permit for Greenhouse Gas Emission for the ExxonMobil Chemical Company Baytown Olefins Plant, including cost analysis of CO2 capture, transport, and sequestration.
- In June 2013, prepared technical report on a Mitigated Negative Declaration for a new rail terminal at the Valero Benicia Refinery to import increased amounts of "North American"

crudes. Comments addressed air quality impacts of refining increased amounts of tar sands crudes.

- In June 2013, prepared technical report on Draft Environmental Impact Report for the California Ethanol and Power Imperial Valley 1 Project.
- In May 2013, prepared comments on draft PSD permit for major expansion of midwest refinery to process 100% tar sands crudes, including a complex netting analysis involving debottlenecking, piecemealing, and BACT analyses.
- In April 2013, prepared technical report on the Draft Supplemental Environmental Impact Statement (DSEIS) for the Keystone XL Pipeline on air quality impacts from refining increased amount of tar sands crudes at Refineries in PADD 3.
- In October 2012, prepared technical report on the Environmental Review for the Coyote Island Terminal Dock at the Port of Morrow on fugitive particulate matter emissions.
- In October 2012-October 2014, review and evaluate Flint Hills West Application for an expansion/modification for increased (Texas, Eagle Ford Shale) crude processing and related modification, including netting and BACT analysis. Assist in settlement discussions.
- In February 2012, prepared comments on BART analysis in PA Regional Haze SIP, 77 FR 3984 (Jan. 26, 2012). On Sept. 29, 2015, a federal appeals court overturned the U.S. EPA's approval of this plan, based in part on my comments, concluding "..we will vacate the 2014 Final Rule to the extent it approved Pennsylvania's source-specific BART analysis and remand to the EPA for further proceedings consistent with this Opinion." Nat'l Parks Conservation Assoc. v. EPA, 3d Cir., No. 14-3147, 9/19/15.
- Prepared cost analyses and comments on New York's proposed BART determinations for NOx, SO2, and PM and EPA's proposed approval of BART determinations for Danskammer Generating Station under New York Regional Haze State Implementation Plan and Federal Implementation Plan, 77 FR 51915 (August 28, 2012).
- Prepared cost analyses and comments on NOx BART determinations for Regional Haze State Implementation Plan for State of Nevada, 77 FR 23191 (April 18, 2012) and 77 FR 25660 (May 1, 2012).
- Prepared analyses of and comments on New Source Performance Standards for Greenhouse Gas Emissions for New Stationary Sources: Electric Utility Generating Units, 77 FR 22392 (April 13, 2012).
- Prepared comments on CASPR-BART emission equivalency and NOx and PM BART determinations in EPA proposed approval of State Implementation Plan for Pennsylvania Regional Haze Implementation Plan, 77 FR 3984 (January 26, 2012).
- Prepared comments and statistical analyses on hazardous air pollutants (HAPs) emission controls, monitoring, compliance methods, and the use of surrogates for acid gases, organic

HAPs, and metallic HAPs for proposed National Emission Standards for Hazardous Air Pollutants from Coal- and Oil-Fired Electric Utility Steam Generating Units, 76 FR 24976 (May 3, 2011).

- Prepared cost analyses and comments on NOx BART determinations and emission reductions for proposed Federal Implementation Plan for Four Corners Power Plant, 75 FR 64221 (October 19, 2010).
- Prepared cost analyses and comments on NOx BART determinations for Colstrip Units 1- 4 for Montana State Implementation Plan and Regional Haze Federal Implementation Plan, 77 FR 23988 (April 20, 2010).
- For EPA Region 8, prepared report: Revised BART Cost Effectiveness Analysis for Tail-End Selective Catalytic Reduction at the Basin Electric Power Cooperative Leland Olds Station Unit 2 Final Report, March 2011, in support of 76 FR 58570 (Sept. 21, 2011).
- For EPA Region 6, prepared report: Revised BART Cost-Effectiveness Analysis for Selective Catalytic Reduction at the Public Service Company of New Mexico San Juan Generating Station, November 2010, in support of 76 FR 52388 (Aug. 22, 2011).
- For EPA Region 6, prepared report: Revised BART Cost-Effectiveness Analysis for Flue Gas Desulfurization at Coal-Fired Electric Generating Units in Oklahoma: Sooner Units 1 & 2, Muskogee Units 4 & 5, Northeastern Units 3 &4, October 2010, in support of 76 FR 16168 (March 26, 2011). My work was upheld in: *State of Oklahoma v. EPA*, App. Case 12-9526 (10th Cri. July 19, 2013).
- Identified errors in N_2O emission factors in the Mandatory Greenhouse Gas Reporting Rule, 40 CFR 98, and prepared technical analysis to support Petition for Rulemaking to Correct Emissions Factors in the Mandatory Greenhouse Gas Reporting Rule, filed with EPA on 10/28/10.
- Assisted interested parties develop input for and prepare comments on the Information Collection Request for Petroleum Refinery Sector NSPS and NESHAP Residual Risk and Technology Review, 75 FR 60107 (9/29/10).
- Technical reviewer of EPA's "Emission Estimation Protocol for Petroleum Refineries," posted for public comments on CHIEF on 12/23/09, prepared in response to the City of Houston's petition under the Data Quality Act (March 2010).
- Prepared comments on SCR cost effectiveness for EPA's Advanced Notice of Proposed Rulemaking, Assessment of Anticipated Visibility Improvements at Surrounding Class I Areas and Cost Effectiveness of Best Available Retrofit Technology for Four Corners Power Plant and Navajo Generating Station, 74 FR 44313 (August 28, 2009).
- Prepared comments on Proposed Rule for Standards of Performance for Coal Preparation and Processing Plants, 74 FR 25304 (May 27, 2009).

- Prepared comments on draft PSD permit for major expansion of midwest refinery to process up to 100% tar sands crudes. Participated in development of monitoring and controls to mitigate impacts and in negotiating a Consent Decree to settle claims in 2008.
- Reviewed and assisted interested parties prepare comments on proposed Kentucky air toxic regulations at 401 KAR 64:005, 64:010, 64:020, and 64:030 (June 2007).
- Prepared comments on proposed Standards of Performance for Electric Utility Steam Generating Units and Small Industrial-Commercial-Industrial Steam Generating Units, 70 FR 9706 (February 28, 2005).
- Prepared comments on Louisville Air Pollution Control District proposed Strategic Toxic Air Reduction regulations.
- Prepared comments and analysis of BAAQMD Regulation, Rule 11, Flare Monitoring at Petroleum Refineries.
- Prepared comments on Proposed National Emission Standards for Hazardous Air Pollutants; and, in the Alternative, Proposed Standards of Performance for New and Existing Stationary Sources: Electricity Utility Steam Generating Units (MACT standards for coal-fired power plants).
- Prepared Authority to Construct Permit for remediation of a large petroleum-contaminated site on the California Central Coast. Negotiated conditions with agencies and secured permits.
- Prepared Authority to Construct Permit for remediation of a former oil field on the California Central Coast. Participated in negotiations with agencies and secured permits.
- Prepared and/or reviewed hundreds of environmental permits, including NPDES, UIC, Stormwater, Authority to Construct, Prevention of Significant Deterioration, Nonattainment New Source Review, Title V, and RCRA, among others.
- Participated in the development of the CARB document, *Guidance for Power Plant Siting and Best Available Control Technology*, including attending public workshops and filing technical comments.
- Performed data analyses in support of adoption of emergency power restoration standards by the California Public Utilities Commission for "major" power outages, where major is an outage that simultaneously affects 10% of the customer base.
- Drafted portions of the Good Neighbor Ordinance to grant Contra Costa County greater authority over safety of local industry, particularly chemical plants and refineries.
- Participated in drafting BAAQMD Regulation 8, Rule 28, Pressure Relief Devices, including participation in public workshops, review of staff reports, draft rules and other

technical materials, preparation of technical comments on staff proposals, research on availability and costs of methods to control PRV releases, and negotiations with staff.

- Participated in amending BAAQMD Regulation 8, Rule 18, Valves and Connectors, including participation in public workshops, review of staff reports, proposed rules and other supporting technical material, preparation of technical comments on staff proposals, research on availability and cost of low-leak technology, and negotiations with staff.
- Participated in amending BAAQMD Regulation 8, Rule 25, Pumps and Compressors, including participation in public workshops, review of staff reports, proposed rules, and other supporting technical material, preparation of technical comments on staff proposals, research on availability and costs of low-leak and seal-less technology, and negotiations with staff.
- Participated in amending BAAQMD Regulation 8, Rule 5, Storage of Organic Liquids, including participation in public workshops, review of staff reports, proposed rules, and other supporting technical material, preparation of technical comments on staff proposals, research on availability and costs of controlling tank emissions, and presentation of testimony before the Board.
- Participated in amending BAAQMD Regulation 8, Rule 18, Valves and Connectors at Petroleum Refinery Complexes, including participation in public workshops, review of staff reports, proposed rules and other supporting technical material, preparation of technical comments on staff proposals, research on availability and costs of low-leak technology, and presentation of testimony before the Board.
- Participated in amending BAAQMD Regulation 8, Rule 22, Valves and Flanges at Chemical Plants, etc, including participation in public workshops, review of staff reports, proposed rules, and other supporting technical material, preparation of technical comments on staff proposals, research on availability and costs of low-leak technology, and presentation of testimony before the Board.
- Participated in amending BAAQMD Regulation 8, Rule 25, Pump and Compressor Seals, including participation in public workshops, review of staff reports, proposed rules, and other supporting technical material, preparation of technical comments on staff proposals, research on availability of low-leak technology, and presentation of testimony before the Board.
- Participated in the development of the BAAQMD Regulation 2, Rule 5, Toxics, including participation in public workshops, review of staff proposals, and preparation of technical comments.
- Participated in the development of SCAQMD Rule 1402, Control of Toxic Air Contaminants from Existing Sources, and proposed amendments to Rule 1401, New Source Review of Toxic Air Contaminants, in 1993, including review of staff proposals and preparation of technical comments on same.

- Participated in the development of the Sunnyvale Ordinance to Regulate the Storage, Use and Handling of Toxic Gas, which was designed to provide engineering controls for gases that are not otherwise regulated by the Uniform Fire Code.
- Participated in the drafting of the Statewide Water Quality Control Plans for Inland Surface Waters and Enclosed Bays and Estuaries, including participation in workshops, review of draft plans, preparation of technical comments on draft plans, and presentation of testimony before the SWRCB.
- Participated in developing Se permit effluent limitations for the five Bay Area refineries, including review of staff proposals, statistical analyses of Se effluent data, review of literature on aquatic toxicity of Se, preparation of technical comments on several staff proposals, and presentation of testimony before the Bay Area RWQCB.
- Represented the California Department of Water Resources in the 1991 Bay-Delta Hearings before the State Water Resources Control Board, presenting sworn expert testimony with cross examination and rebuttal on a striped bass model developed by the California Department of Fish and Game.
- Represented the State Water Contractors in the 1987 Bay-Delta Hearings before the State Water Resources Control Board, presenting sworn expert testimony with cross examination and rebuttal on natural flows, historical salinity trends in San Francisco Bay, Delta outflow, and hydrodynamics of the South Bay.
- Represented interveners in the licensing of over 20 natural-gas-fired power plants and one coal gasification plant at the California Energy Commission and elsewhere. Reviewed and prepared technical comments on applications for certification, preliminary staff assessments, final staff assessments, preliminary determinations of compliance, final determinations of compliance, and prevention of significant deterioration permits in the areas of air quality, water supply, water quality, biology, public health, worker safety, transportation, site contamination, cooling systems, and hazardous materials. Presented written and oral testimony in evidentiary hearings with cross examination and rebuttal. Participated in technical workshops.
- Represented several parties in the proposed merger of San Diego Gas & Electric and Southern California Edison. Prepared independent technical analyses on health risks, air quality, and water quality. Presented written and oral testimony before the Public Utilities Commission administrative law judge with cross examination and rebuttal.
- Represented a PRP in negotiations with local health and other agencies to establish impact of subsurface contamination on overlying residential properties. Reviewed health studies prepared by agency consultants and worked with agencies and their consultants to evaluate health risks.

WATER QUALITY/RESOURCES

- Directed and participated in research on environmental impacts of energy development in the Colorado River Basin, including contamination of surface and subsurface waters and modeling of flow and chemical transport through fractured aquifers.
- Played a major role in Northern California water resource planning studies since the early 1970s. Prepared portions of the Basin Plans for the Sacramento, San Joaquin, and Delta basins including sections on water supply, water quality, beneficial uses, waste load allocation, and agricultural drainage. Developed water quality models for the Sacramento and San Joaquin Rivers.
- Conducted hundreds of studies over the past 40 years on Delta water supplies and the impacts of exports from the Delta on water quality and biological resources of the Central Valley, Sacramento-San Joaquin Delta, and San Francisco Bay. Typical examples include:

    1. Evaluate historical trends in salinity, temperature, and flow in San Francisco Bay and upstream rivers to determine impacts of water exports on the estuary;
    2. Evaluate the role of exports and natural factors on the food web by exploring the relationship between salinity and primary productivity in San Francisco Bay, upstream rivers, and ocean;
    3. Evaluate the effects of exports, other in-Delta, and upstream factors on the abundance of salmon and striped bass;
    4. Review and critique agency fishery models that link water exports with the abundance of striped bass and salmon;
    5. Develop a model based on GLMs to estimate the relative impact of exports, water facility operating variables, tidal phase, salinity, temperature, and other variables on the survival of salmon smolts as they migrate through the Delta;
    6. Reconstruct the natural hydrology of the Central Valley using water balances, vegetation mapping, reservoir operation models to simulate flood basins, precipitation records, tree ring research, and historical research;
    7. Evaluate the relationship between biological indicators of estuary health and down-estuary position of a salinity surrogate (X2);
    8. Use real-time fisheries monitoring data to quantify impact of exports on fish migration;
    9. Refine/develop statistical theory of autocorrelation and use to assess strength of relationships between biological and flow variables;
    10. Collect, compile, and analyze water quality and toxicity data for surface waters in the Central Valley to assess the role of water quality in fishery declines;

11. Assess mitigation measures, including habitat restoration and changes in water project operation, to minimize fishery impacts;
12. Evaluate the impact of unscreened agricultural water diversions on abundance of larval fish;
13. Prepare and present testimony on the impacts of water resources development on Bay hydrodynamics, salinity, and temperature in water rights hearings;
14. Evaluate the impact of boat wakes on shallow water habitat, including interpretation of historical aerial photographs;
15. Evaluate the hydrodynamic and water quality impacts of converting Delta islands into reservoirs;
16. Use a hydrodynamic model to simulate the distribution of larval fish in a tidally influenced estuary;
17. Identify and evaluate non-export factors that may have contributed to fishery declines, including predation, shifts in oceanic conditions, aquatic toxicity from pesticides and mining wastes, salinity intrusion from channel dredging, loss of riparian and marsh habitat, sedimentation from upstream land alternations, and changes in dissolved oxygen, flow, and temperature below dams.

- Developed, directed, and participated in a broad-based research program on environmental issues and control technology for energy industries including petroleum, oil shale, coal mining, and coal slurry transport. Research included evaluation of air and water pollution, development of novel, low-cost technology to treat and dispose of wastes, and development and application of geohydrologic models to evaluate subsurface contamination from in-situ retorting. The program consisted of government and industry contracts and employed 45 technical and administrative personnel.
- Coordinated an industry task force established to investigate the occurrence, causes, and solutions for corrosion/erosion and mechanical/engineering failures in the waterside systems (e.g., condensers, steam generation equipment) of power plants. Corrosion/erosion failures caused by water and steam contamination that were investigated included waterside corrosion caused by poor microbiological treatment of cooling water, steam-side corrosion caused by ammonia-oxygen attack of copper alloys, stress-corrosion cracking of copper alloys in the air cooling sections of condensers, tube sheet leaks, oxygen in-leakage through condensers, volatilization of silica in boilers and carry over and deposition on turbine blades, and iron corrosion on boiler tube walls. Mechanical/engineering failures investigated included: steam impingement attack on the steam side of condenser tubes, tube-to-tube-sheet joint leakage, flow-induced vibration, structural design problems, and mechanical failures due to stresses induced by shutdown, startup and cycling duty, among others. Worked with

electric utility plant owners/operators, condenser and boiler vendors, and architect/engineers to collect data to document the occurrence of and causes for these problems, prepared reports summarizing the investigations, and presented the results and participated on a committee of industry experts tasked with identifying solutions to prevent condenser failures.

- Evaluated the cost effectiveness and technical feasibility of using dry cooling and parallel dry-wet cooling to reduce water demands of several large natural-gas fired power plants in California and Arizona.
- Designed and prepared cost estimates for several dry cooling systems (e.g., fin fan heat exchangers) used in chemical plants and refineries.
- Designed, evaluated, and costed several zero liquid discharge systems for power plants.
- Evaluated the impact of agricultural and mining practices on surface water quality of Central Valley steams. Represented municipal water agencies on several federal and state advisory committees tasked with gathering and assessing relevant technical information, developing work plans, and providing oversight of technical work to investigate toxicity issues in the watershed.

AIR QUALITY/PUBLIC HEALTH

- Prepared or reviewed the air quality and public health sections of hundreds of EIRs and EISs on a wide range of industrial, commercial and residential projects.
- Prepared or reviewed hundreds of NSR and PSD permits for a wide range of industrial facilities.
- Designed, implemented, and directed a 2-year-long community air quality monitoring program to assure that residents downwind of a petroleum-contaminated site were not impacted during remediation of petroleum-contaminated soils. The program included real-time monitoring of particulates, diesel exhaust, and BTEX and time integrated monitoring for over 100 chemicals.
- Designed, implemented, and directed a 5-year long source, industrial hygiene, and ambient monitoring program to characterize air emissions, employee exposure, and downwind environmental impacts of a first-generation shale oil plant. The program included stack monitoring of heaters, boilers, incinerators, sulfur recovery units, rock crushers, API separator vents, and wastewater pond fugitives for arsenic, cadmium, chlorine, chromium, mercury, 15 organic indicators (e.g., quinoline, pyrrole, benzo(a)pyrene, thiophene, benzene), sulfur gases, hydrogen cyanide, and ammonia. In many cases, new methods had to be developed or existing methods modified to accommodate the complex matrices of shale plant gases.
- Conducted investigations on the impact of diesel exhaust from truck traffic from a wide range of facilities including mines, large retail centers, light industrial uses, and sports

facilities. Conducted traffic surveys, continuously monitored diesel exhaust using an aethalometer, and prepared health risk assessments using resulting data.

- Conducted indoor air quality investigations to assess exposure to natural gas leaks, pesticides, molds and fungi, soil gas from subsurface contamination, and outgasing of carpets, drapes, furniture and construction materials. Prepared health risk assessments using collected data.
- Prepared health risk assessments, emission inventories, air quality analyses, and assisted in the permitting of over 70 1 to 2 MW emergency diesel generators.
- Prepare over 100 health risk assessments, endangerment assessments, and other health-based studies for a wide range of industrial facilities.
- Developed methods to monitor trace elements in gas streams, including a continuous real-time monitor based on the Zeeman atomic absorption spectrometer, to continuously measure mercury and other elements.
- Performed nuisance investigations (odor, noise, dust, smoke, indoor air quality, soil contamination) for businesses, industrial facilities, and residences located proximate to and downwind of pollution sources.

PUBLICATIONS AND PRESENTATIONS (Partial List - Representative Publications)

J.P. Fox, P.H. Hutton, D.J. Howes, A.J. Draper, and L. Sears, Reconstructing the Natural Hydrology of the San Francisco Bay-Delta Watershed, Hydrology and Earth System Sciences, Special Issue: Predictions under Change: Water, Earth, and Biota in the Anthropocene, v. 19, pp. 4257-4274, 2015. http://www.hydrol-earth-syst-sci.net/19/4257/2015/hess-19-4257-2015.pdf.

D. Howes, P. Fox, and P. Hutton, Evapotranspiration from Natural Vegetation in the Central Valley of California: Monthly Grass Reference Based Vegetation Coefficients and the Dual Crop Coefficient Approach, *Journal of Hydrologic Engineering*, v.20, no. 10, October 2015.

Phyllis Fox and Lindsey Sears, *Natural Vegetation in the Central Valley of California*, June 2014, Prepared for State Water Contractors and San Luis & Delta-Mendota Water Authority, 311 pg.

J.P. Fox, T.P. Rose, and T.L. Sawyer, Isotope Hydrology of a Spring-fed Waterfall in Fractured Volcanic Rock, 2007.

C.E. Lambert, E.D. Winegar, and Phyllis Fox, Ambient and Human Sources of Hydrogen Sulfide: An Explosive Topic, Air & Waste Management Association, June 2000, Salt Lake City, UT.

San Luis Obispo County Air Pollution Control District and San Luis Obispo County Public Health Department, *Community Monitoring Program*, February 8, 1999.

The Bay Institute, *From the Sierra to the Sea. The Ecological History of the San Francisco Bay-Delta Watershed*, 1998.

J. Phyllis Fox, *Well Interference Effects of HDPP's Proposed Wellfield in the Victor Valley Water District*, Prepared for the California Unions for Reliable Energy (CURE), October 12, 1998.

J. Phyllis Fox, *Air Quality Impacts of Using CPVC Pipe in Indoor Residential Potable Water Systems*, Report Prepared for California Pipe Trades Council, California Firefighters Association, and other trade associations, August 29, 1998.

J. Phyllis Fox and others, *Authority to Construct Avila Beach Remediation Project*, Prepared for Unocal Corporation and submitted to San Luis Obispo Air Pollution Control District, June 1998.

J. Phyllis Fox and others, *Authority to Construct Former Guadalupe Oil Field Remediation Project*, Prepared for Unocal Corporation and submitted to San Luis Obispo Air Pollution Control District, May 1998.

J. Phyllis Fox and Robert Sears, *Health Risk Assessment for the Metropolitan Oakland International Airport Proposed Airport Development Program*, Prepared for Plumbers & Steamfitters U.A. Local 342, December 15, 1997.

Levine-Fricke-Recon (Phyllis Fox and others), *Preliminary Endangerment Assessment Work Plan for the Study Area Operable Unit, Former Solano County Sanitary Landfill, Benicia, California*, Prepared for Granite Management Co. for submittal to DTSC, September 26, 1997.

Phyllis Fox and Jeff Miller, "Fathead Minnow Mortality in the Sacramento River," *IEP Newsletter*, v. 9, n. 3, 1996.

Jud Monroe, Phyllis Fox, Karen Levy, Robert Nuzum, Randy Bailey, Rod Fujita, and Charles Hanson, *Habitat Restoration in Aquatic Ecosystems. A Review of the Scientific Literature Related to the Principles of Habitat Restoration*, Part Two, Metropolitan Water District of Southern California (MWD) Report, 1996.

Phyllis Fox and Elaine Archibald, *Aquatic Toxicity and Pesticides in Surface Waters of the Central Valley*, California Urban Water Agencies (CUWA) Report, September 1997.

Phyllis Fox and Alison Britton, *Evaluation of the Relationship Between Biological Indicators and the Position of X2*, CUWA Report, 1994.

Phyllis Fox and Alison Britton, *Predictive Ability of the Striped Bass Model*, WRINT DWR-206, 1992.

J. Phyllis Fox, *An Historical Overview of Environmental Conditions at the North Canyon Area of the Former Solano County Sanitary Landfill*, Report Prepared for Solano County Department of Environmental Management, 1991.

J. Phyllis Fox, *An Historical Overview of Environmental Conditions at the East Canyon Area of the Former Solano County Sanitary Landfill*, Report Prepared for Solano County Department of Environmental Management, 1991.

Phyllis Fox, *Trip 2 Report, Environmental Monitoring Plan, Parachute Creek Shale Oil Program*, Unocal Report, 1991.

J. P. Fox and others, "Long-Term Annual and Seasonal Trends in Surface Salinity of San Francisco Bay," *Journal of Hydrology*, v. 122, p. 93-117, 1991.

J. P. Fox and others, "Reply to Discussion by D.R. Helsel and E.D. Andrews on Trends in Freshwater Inflow to San Francisco Bay from the Sacramento-San Joaquin Delta," *Water Resources Bulletin*, v. 27, no. 2, 1991.

J. P. Fox and others, "Reply to Discussion by Philip B. Williams on Trends in Freshwater Inflow to San Francisco Bay from the Sacramento-San Joaquin Delta," *Water Resources Bulletin*, v. 27, no. 2, 1991.

J. P. Fox and others, "Trends in Freshwater Inflow to San Francisco Bay from the Sacramento-San Joaquin Delta," *Water Resources Bulletin*, v. 26, no. 1, 1990.

J. P. Fox, "Water Development Increases Freshwater Flow to San Francisco Bay," *SCWC Update*, v. 4, no. 2, 1988.

J. P. Fox, *Freshwater Inflow to San Francisco Bay Under Natural Conditions*, State Water Contracts, Exhibit 262, 58 pp., 1987.

J. P. Fox, "The Distribution of Mercury During Simulated In-Situ Oil Shale Retorting," *Environmental Science and Technology*, v. 19, no. 4, pp. 316-322, 1985.

J. P. Fox, "El Mercurio en el Medio Ambiente: Aspectos Referentes al Peru," (Mercury in the Environment: Factors Relevant to Peru) Proceedings of Simposio Los Pesticidas y el Medio Ambiente," ONERN-CONCYTEC, Lima, Peru, April 25-27, 1984. (Also presented at Instituto Tecnologico Pesquero and Instituto del Mar del Peru.)

J. P. Fox, "Mercury, Fish, and the Peruvian Diet," *Boletin de Investigacion*, Instituto Tecnologico Pesquero, Lima, Peru, v. 2, no. 1, pp. 97-116, l984.

J. P. Fox, P. Persoff, A. Newton, and R. N. Heistand, "The Mobility of Organic Compounds in a Codisposal System," *Proceedings of the Seventeenth Oil Shale Symposium*, Colorado School of Mines Press, Golden, CO, 1984.

P. Persoff and J. P. Fox, "Evaluation of Control Technology for Modified In-Situ Oil Shale Retorts," *Proceedings of the Sixteenth Oil Shale Symposium*, Colorado School of Mines Press, Golden, CO, 1983.

J. P. Fox, *Leaching of Oil Shale Solid Wastes: A Critical Review*, University of Colorado Report, 245 pp., July 1983.

J. P. Fox, *Source Monitoring for Unregulated Pollutants from the White River Oil Shale Project*, VTN Consolidated Report, June 1983.

A. S. Newton, J. P. Fox, H. Villarreal, R. Raval, and W. Walker II, *Organic Compounds in Coal Slurry Pipeline Waters*, Lawrence Berkeley Laboratory Report LBL-15121, 46 pp., Sept. 1982.

M. Goldstein et al., *High Level Nuclear Waste Standards Analysis, Regulatory Framework Comparison*, Battelle Memorial Institute Report No. BPMD/82/E515-06600/3, Sept. 1982.

J. P. Fox et al., *Literature and Data Search of Water Resource Information of the Colorado, Utah, and Wyoming Oil Shale Basins*, Vols. 1-12, Bureau of Land Management, 1982.

A. T. Hodgson, M. J. Pollard, G. J. Harris, D. C. Girvin, J. P. Fox, and N. J. Brown, *Mercury Mass Distribution During Laboratory and Simulated In-Situ Retorting*, Lawrence Berkeley Laboratory Report LBL-12908, 39 pp., Feb. 1982.

E. J. Peterson, A. V. Henicksman, J. P. Fox, J. A. O'Rourke, and P. Wagner, *Assessment and Control of Water Contamination Associated with Shale Oil Extraction and Processing*, Los Alamos National Laboratory Report LA-9084-PR, 54 pp., April 1982.

P. Persoff and J. P. Fox, *Control Technology for In-Situ Oil Shale Retorts*, Lawrence Berkeley Laboratory Report LBL-14468, 118 pp., Dec. 1982.

J. P. Fox, *Codisposal Evaluation: Environmental Significance of Organic Compounds*, Development Engineering Report, 104 pp., April 1982.

J. P. Fox, *A Proposed Strategy for Developing an Environmental Water Monitoring Plan for the Paraho-Ute Project*, VTN Consolidated Report, Sept. 1982.

J. P. Fox, D. C. Girvin, and A. T. Hodgson, "Trace Elements in Oil Shale Materials," *Energy and Environmental Chemistry, Fossil Fuels*, v.1, pp. 69-101, 1982.

M. Mehran, T. N. Narasimhan, and J. P. Fox, "Hydrogeologic Consequences of Modified In-situ Retorting Process, Piceance Creek Basin, Colorado," *Proceedings of the Fourteenth Oil Shale Symposium*, Colorado School of Mines Press, Golden, CO, 1981 (LBL-12063).

U. S. DOE (J. P. Fox and others), *Western Oil Shale Development: A Technology Assessment*, v. 1-9, Pacific Northwest Laboratory Report PNL-3830, 1981.

J. P. Fox (ed), "Oil Shale Research," Chapter from the *Energy and Environment Division Annual Report 1980*, Lawrence Berkeley Laboratory Report LBL-11989, 82 pp., 1981 (author or co-author of four articles in report).

D.C. Girvin and J.P. Fox, On-Line Zeeman Atomic Absorption Spectroscopy for Mercury Analysis in Oil Shale Gases, U.S. EPA Report EPA-600/7-80-130, June 1980.

J. P. Fox, *The Partitioning of Major, Minor, and Trace Elements during In-Situ Oil Shale Retorting*, Ph.D. Dissertation, U. of Ca., Berkeley, also Report LBL-9062, 441 pp., 1980 (*Diss. Abst. Internat.*, v. 41, no. 7, 1981).

J.P. Fox, "Elemental Composition of Simulated *In Situ* Oil Shale Retort Water," *Analysis of Waters Associated with Alternative Fuel Production, ASTM STP 720*, L.P. Jackson and C.C. Wright, Eds., American Society for Testing and Materials, pp. 101-128, 1981.

J. P. Fox, P. Persoff, P. Wagner, and E. J. Peterson, "Retort Abandonment -- Issues and Research Needs," in *Oil Shale: the Environmental Challenges*, K. K. Petersen (ed.), p. 133, 1980 (Lawrence Berkeley Laboratory Report LBL-11197).

J. P. Fox and T. E. Phillips, "Wastewater Treatment in the Oil Shale Industry," in *Oil Shale: the Environmental Challenges*, K. K. Petersen (ed.), p. 253, 1980 (Lawrence Berkeley Laboratory Report LBL-11214).

R. D. Giauque, J. P. Fox, J. W. Smith, and W. A. Robb, "Geochemical Studies of Two Cores from the Green River Oil Shale Formation," *Transactions*, American Geophysical Union, v. 61, no. 17, 1980.

J. P. Fox, "The Elemental Composition of Shale Oils," Abstracts of Papers, 179th National Meeting, ISBN 0-8412-0542-6, Abstract No. FUEL 17, 1980.

J. P. Fox and P. Persoff, "Spent Shale Grouting of Abandoned In-Situ Oil Shale Retorts," *Proceedings of Second U.S. DOE Environmental Control Symposium*, CONF-800334/1, 1980 (Lawrence Berkeley Laboratory Report LBL-10744).

P. K. Mehta, P. Persoff, and J. P. Fox, "Hydraulic Cement Preparation from Lurgi Spent Shale," *Proceedings of the Thirteenth Oil Shale Symposium*, Colorado School of Mines Press, Golden, CO, 1980 (Lawrence Berkeley Laboratory Report LBL-11071).

F. E. Brinckman, K. L. Jewett, R. H. Fish, and J. P. Fox, "Speciation of Inorganic and Organoarsenic Compounds in Oil Shale Process Waters by HPLC Coupled with Graphite Furnace Atomic Absorption (GFAA) Detectors," Abstracts of Papers, Div. of Geochemistry, Paper No. 20, Second Chemical Congress of the North American Continent, August 25-28, 1980, Las Vegas (1980).

J. P. Fox, D. E. Jackson, and R. H. Sakaji, "Potential Uses of Spent Shale in the Treatment of Oil Shale Retort Waters," *Proceedings of the Thirteenth Oil Shale Symposium*, Colorado School of Mines Press, Golden, CO, 1980 (Lawrence Berkeley Laboratory Report LBL-11072).

J. P. Fox, *The Elemental Composition of Shale Oils*, Lawrence Berkeley Laboratory Report LBL-10745, 1980.

R. H. Fish, J. P. Fox, F. E. Brinckman, and K. L. Jewett, *Fingerprinting Inorganic and Organoarsenic Compounds in Oil Shale Process Waters Using a Liquid Chromatograph Coupled with an Atomic Absorption Detector*, Lawrence Berkeley Laboratory Report LBL-11476, 1980.

National Academy of Sciences (J. P. Fox and others), *Surface Mining of Non-Coal Minerals, Appendix II: Mining and Processing of Oil Shale and Tar Sands*, 222 pp., 1980.

J. P. Fox, "Elemental Composition of Simulated In-Situ Oil Shale Retort Water," in *Analysis of Waters Associated with Alternative Fuel Production*, ASTM STP 720, L. P. Jackson and C. C. Wright (eds.), American Society for Testing and Materials, pp. 101-128, 1980.

R. D. Giauque, J. P. Fox, and J. W. Smith, *Characterization of Two Core Holes from the Naval Oil Shale Reserve Number 1*, Lawrence Berkeley Laboratory Report LBL-10809, 176 pp., December 1980.

B. M. Jones, R. H. Sakaji, J. P. Fox, and C. G. Daughton, "Removal of Contaminative Constituents from Retort Water: Difficulties with Biotreatment and Potential Applicability of Raw and Processed Shales," *EPA/DOE Oil Shale Wastewater Treatability Workshop*, December 1980 (Lawrence Berkeley Laboratory Report LBL-12124).

J. P. Fox, *Water-Related Impacts of In-Situ Oil Shale Processing*, Lawrence Berkeley Laboratory Report LBL-6300, 327 p., December 1980.

M. Mehran, T. N. Narasimhan, and J. P. Fox, *An Investigation of Dewatering for the Modified In-Situ Retorting Process, Piceance Creek Basin, Colorado*, Lawrence Berkeley Laboratory Report LBL-11819, 105 p., October 1980.

J. P. Fox (ed.) "Oil Shale Research," Chapter from the *Energy and Environment Division Annual Report 1979*, Lawrence Berkeley Laboratory Report LBL-10486, 1980 (author or coauthor of eight articles).

E. Ossio and J. P. Fox, *Anaerobic Biological Treatment of In-Situ Oil Shale Retort Water*, Lawrence Berkeley Laboratory Report LBL-10481, March 1980.

J. P. Fox, F. H. Pearson, M. J. Kland, and P. Persoff, *Hydrologic and Water Quality Effects and Controls for Surface and Underground Coal Mining -- State of Knowledge, Issues, and Research Needs*, Lawrence Berkeley Laboratory Report LBL-11775, 1980.

D. C. Girvin, T. Hadeishi, and J. P. Fox, "Use of Zeeman Atomic Absorption Spectroscopy for the Measurement of Mercury in Oil Shale Offgas," *Proceedings of the Oil Shale Symposium: Sampling, Analysis and Quality Assurance*, U.S. EPA Report EPA-600/9-80-022, March 1979 (Lawrence Berkeley Laboratory Report LBL-8888).

D. S. Farrier, J. P. Fox, and R. E. Poulson, "Interlaboratory, Multimethod Study of an In-Situ Produced Oil Shale Process Water," *Proceedings of the Oil Shale Symposium: Sampling,*

Analysis and Quality Assurance, U.S. EPA Report EPA-600/9-80-022, March 1979 (Lawrence Berkeley Laboratory Report LBL-9002).

J. P. Fox, J. C. Evans, J. S. Fruchter, and T. R. Wildeman, "Interlaboratory Study of Elemental Abundances in Raw and Spent Oil Shales," *Proceedings of the Oil Shale Symposium: Sampling, Analysis and Quality Assurance*, U.S. EPA Report EPA-600/9-80-022, March 1979 (Lawrence Berkeley Laboratory Report LBL-8901).

J. P. Fox, "Retort Water Particulates," *Proceedings of the Oil Shale Symposium: Sampling, Analysis and Quality Assurance*, U.S. EPA Report EPA-600/9-80-022, March 1979 (Lawrence Berkeley Laboratory Report LBL-8829).

P. Persoff and J. P. Fox, "Control Strategies for In-Situ Oil Shale Retorts," *Proceedings of the Twelfth Oil Shale Symposium*, Colorado School of Mines Press, Golden, CO, 1979 (Lawrence Berkeley Laboratory Report LBL-9040).

J. P. Fox and D. L. Jackson, "Potential Uses of Spent Shale in the Treatment of Oil Shale Retort Waters," *Proceedings of the DOE Wastewater Workshop*, Washington, D. C., June 14-15, 1979 (Lawrence Berkeley Laboratory Report LBL-9716).

J. P. Fox, K. K. Mason, and J. J. Duvall, "Partitioning of Major, Minor, and Trace Elements during Simulated In-Situ Oil Shale Retorting," *Proceedings of the Twelfth Oil Shale Symposium*, Colorado School of Mines Press, Golden, CO, 1979 (Lawrence Berkeley Laboratory Report LBL-9030).

P. Persoff and J. P. Fox, *Control Strategies for Abandoned In-Situ Oil Shale Retorts*, Lawrence Berkeley Laboratory Report LBL-8780, 106 pp., October 1979.

D. C. Girvin and J. P. Fox, *On-Line Zeeman Atomic Absorption Spectroscopy for Mercury Analysis in Oil Shale Gases*, Environmental Protection Agency Report EPA-600/7-80-130, 95 p., August 1979 (Lawrence Berkeley Laboratory Report LBL-9702).

J. P. Fox, *Water Quality Effects of Leachates from an In-Situ Oil Shale Industry*, Lawrence Berkeley Laboratory Report LBL-8997, 37 pp., April 1979.

J. P. Fox (ed.), "Oil Shale Research," Chapter from the *Energy and Environment Division Annual Report 1978*, Lawrence Berkeley Laboratory Report LBL-9857 August 1979 (author or coauthor of seven articles).

J. P. Fox, P. Persoff, M. M. Moody, and C. J. Sisemore, "A Strategy for the Abandonment of Modified In-Situ Oil Shale Retorts," *Proceedings of the First U.S. DOE Environmental Control Symposium*, CONF-781109, 1978 (Lawrence Berkeley Laboratory Report LBL-6855).

E. Ossio, J. P. Fox, J. F. Thomas, and R. E. Poulson, "Anaerobic Fermentation of Simulated In-Situ Oil Shale Retort Water," *Division of Fuel Chemistry Preprints*, v. 23, no. 2, p. 202-213, 1978 (Lawrence Berkeley Laboratory Report LBL-6855).

J. P. Fox, J. J. Duvall, R. D. McLaughlin, and R. E. Poulson, "Mercury Emissions from a Simulated In-Situ Oil Shale Retort," *Proceedings of the Eleventh Oil Shale Symposium*, Colorado School of Mines Press, Golden, CO, 1978 (Lawrence Berkeley Laboratory Report LBL-7823).

J. P. Fox, R. D. McLaughlin, J. F. Thomas, and R. E. Poulson, "The Partitioning of As, Cd, Cu, Hg, Pb, and Zn during Simulated In-Situ Oil Shale Retorting," *Proceedings of the Tenth Oil Shale Symposium*, Colorado School of Mines Press, Golden, CO, 1977.

Bechtel, Inc., *Treatment and Disposal of Toxic Wastes*, Report Prepared for Santa Ana Watershed Planning Agency, 1975.

Bay Valley Consultants, *Water Quality Control Plan for Sacramento, Sacramento-San Joaquin and San Joaquin Basins*, Parts I and II and Appendices A-E, 750 pp., 1974.

POST GRADUATE COURSES
(Partial)

S-Plus Data Analysis, MathSoft, 6/94.
Air Pollutant Emission Calculations, UC Berkeley Extension, 6-7/94
Assessment, Control and Remediation of LNAPL Contaminated Sites, API and USEPA, 9/94
Pesticides in the TIE Process, SETAC, 6/96
Sulfate Minerals: Geochemistry, Crystallography, and Environmental Significance, Mineralogical Society of America/Geochemical Society, 11/00.
Design of Gas Turbine Combined Cycle and Cogeneration Systems, Thermoflow, 12/00
Air-Cooled Steam Condensers and Dry- and Hybrid-Cooling Towers, Power-Gen, 12/01
Combustion Turbine Power Augmentation with Inlet Cooling and Wet Compression, Power-Gen, 12/01
CEQA Update, UC Berkeley Extension, 3/02
The Health Effects of Chemicals, Drugs, and Pollutants, UC Berkeley Extension, 4-5/02
Noise Exposure Assessment: Sampling Strategy and Data Acquisition, AIHA PDC 205, 6/02
Noise Exposure Measurement Instruments and Techniques, AIHA PDC 302, 6/02
Noise Control Engineering, AIHA PDC 432, 6/02
Optimizing Generation and Air Emissions, Power-Gen, 12/02
Utility Industry Issues, Power-Gen, 12/02
Multipollutant Emission Control, Coal-Gen, 8/03
Community Noise, AIHA PDC 104, 5/04
Cutting-Edge Topics in Noise and Hearing Conservation, AIHA 5/04
Selective Catalytic Reduction: From Planning to Operation, Power-Gen, 12/05
Improving the FGD Decision Process, Power-Gen, 12/05
E-Discovery, CEB, 6/06
McIlvaine Hot Topic Hour, FGD Project Delay Factors, 8/10/06
McIlvaine Hot Topic Hour, What Mercury Technologies Are Available, 9/14/06
McIlvaine Hot Topic Hour, SCR Catalyst Choices, 10/12/06
McIlvaine Hot Topic Hour, Particulate Choices for Low Sulfur Coal, 10/19/06
McIlvaine Hot Topic Hour, Impact of PM2.5 on Power Plant Choices, 11/2/06
McIlvaine Hot Topic Hour, Dry Scrubbers, 11/9/06
Cost Estimating and Tricks of the Trade – A Practical Approach, PDH P159, 11/19/06
Process Equipment Cost Estimating by Ratio & Proportion, PDH G127 11/19/06
Power Plant Air Quality Decisions, Power-Gen 11/06
McIlvaine Hot Topic Hour, WE Energies Hg Control Update, 1/12/07
Negotiating Permit Conditions, EEUC, 1/21/07
BACT for Utilities, EEUC, 1/21/07
McIlvaine Hot Topic Hour, Chinese FGD/SCR Program & Impact on World, 2/1/07
McIlvaine Hot Topic Hour, Mercury Control Cost & Performance, 2/15/07
McIlvaine Hot Topic Hour, Mercury CEMS, 4/12/07

Coal-to-Liquids – A Timely Revival, 9th Electric Power, 4/30/07
Advances in Multi-Pollutant and CO_2 Control Technologies, 9th Electric Power, 4/30/07
McIlvaine Hot Topic Hour, Measurement & Control of PM2.5, 5/17/07
McIlvaine Hot Topic Hour, Co-firing and Gasifying Biomass, 5/31/07
McIlvaine Hot Topic Hour, Mercury Cost and Performance, 6/14/07
Ethanol 101: Points to Consider When Building an Ethanol Plant, BBI International, 6/26/07
Low Cost Optimization of Flue Gas Desulfurization Equipment, Fluent, Inc., 7/6/07.
McIlvaine Hot Topic Hour, CEMS for Measurement of NH3, SO3, Low NOx, 7/12/07
McIlvaine Hot Topic Hour, Mercury Removal Status & Cost, 8/9/07
McIlvaine Hot Topic Hour, Filter Media Selection for Coal-Fired Boilers, 9/13/07
McIlvaine Hot Topic Hour, Catalyst Performance on NOx, SO3, Mercury, 10/11/07
PRB Coal Users Group, PRB 101, 12/4/07
McIlvaine Hot Topic Hour, Mercury Control Update, 10/25/07
Circulating Fluidized Bed Boilers, Their Operation, Control and Optimization, Power-Gen, 12/8/07
Renewable Energy Credits & Greenhouse Gas Offsets, Power-Gen, 12/9/07
Petroleum Engineering & Petroleum Downstream Marketing, PDH K117, 1/5/08
Estimating Greenhouse Gas Emissions from Manufacturing, PDH C191, 1/6/08
McIlvaine Hot Topic Hour, NOx Reagents, 1/17/08
McIlvaine Hot Topic Hour, Mercury Control, 1/31/08
McIlvaine Hot Topic Hour, Mercury Monitoring, 3/6/08
McIlvaine Hot Topic Hour, SCR Catalysts, 3/13/08
Argus 2008 Climate Policy Outlook, 3/26/08
Argus Pet Coke Supply and Demand 2008, 3/27/08
McIlvaine Hot Topic Hour, SO3 Issues and Answers, 3/27/08
McIlvaine Hot Topic Hour, Mercury Control, 4/24/08
McIlvaine Hot Topic Hour, Co-Firing Biomass, 5/1/08
McIlvaine Hot Topic Hour, Coal Gasification, 6/5/08
McIlvaine Hot Topic Hour, Spray Driers vs. CFBs, 7/3/08
McIlvaine Hot Topic Hour, Air Pollution Control Cost Escalation, 9/25/08
McIlvaine Hot Topic Hour, Greenhouse Gas Strategies for Coal Fired Power Plant Operators, 10/2/08
McIlvaine Hot Topic Hour, Mercury and Toxics Monitoring, 2/5/09
McIlvaine Hot Topic Hour, Dry Precipitator Efficiency Improvements, 2/12/09
McIlvaine Hot Topic Hour, Coal Selection & Impact on Emissions, 2/26/09
McIlvaine Hot Topic Hour, 98% Limestone Scrubber Efficiency, 7/9/09
McIlvaine Hot Topic Hour, Carbon Management Strategies and Technologies, 6/24/10
McIlvaine Hot Topic Hour, Gas Turbine O&M, 7/22/10

McIlvaine Hot Topic Hour, Industrial Boiler MACT – Impact and Control Options, March 10, 2011

McIlvaine Hot Topic Hour, Fuel Impacts on SCR Catalysts, June 30, 2011.
Interest Rates, PDH P204, 3/9/12
Mechanics Liens, PDHOnline, 2/24/13.
Understanding Concerns with Dry Sorbent Injection as a Coal Plant Pollution Control, Webinar #874-567-839 by Cleanenergy.Org, March 4, 2013
Webinar: Coal-to-Gas Switching: What You Need to Know to Make the Investment, sponsored by PennWell Power Engineering Magazine, March 14, 2013. Available at: https://event.webcasts.com/viewer/event.jsp?ei=1013472.

EXHIBIT 2

APPENDIX A

EQUIPMENT INFORMATION

- **Gas Turbine Specifications**
- **Emissions Control Systems Specifications**
- **Evaporative Cooling Tower Specifications**

Turbine Performance Specifications
LM6000PC Sprint
Riverside Energy Resource Center

	Spinning 20%	25% Load	50% Load	75% Load	100% Load
Fuel Consumption (MM Btu/hr – LHV) (LHV = 912 Btu/cf)	159.7	243.8	329.8	329.8	425.6
Fuel Consumption (Btu-hr – HHV) (HHV = 1050 Btu/cf)	183.9	280.7	379.7	379.7	490.0
Fuel Consumption (MMcf/hr)	0.175	0.267	0.362	0.362	0.467
Gross Power Output @ 72oF, w/ chiller/cooler (KW/hr)	10000	12450	24709	37350	49800
Net Power Output @ (KW/hr)	9518	11968	24421	35941	48391
Water Injection @ 115oF (lb/hr)	4062	5066	10884	16745	27851
Exhaust Temp (oF) @ 72.2oF	788	806	863	803	830 Normal / 868 Max.
Stack Exhaust Flow (lb/hr) @72.2oF	538561	567996	713782	933301	1064462
Stack Exhaust (ACFM w/quench air)	227366	319264	450294	450294	575520
O2 (Mole % dry) @72.2oF	16.753	16.485	15.445	15.228	14.388
H20 (% vol wet)					10.76

TURBINE GEN SET PERFORMANCE
FOR
RPU - City of Riverside - Capacity Addition

GUARANTEED PARAMETERS		JOBSITE LOCATION: Riverside, CA	Emissions per Unit with GE Supplied SCR
			100% to 50% Load
Btu/kW·hr, LHV	AT	NET PLANT KW	NOx EMISSIONS
8973		96783	2.5 PPMVD AT 15% O2
(kJ/kW·hr, LHV)			CO EMISSIONS
9467		GUARANTEE	6 PPMVD AT 15% O2
			VOC EMISSIONS
			2 PPMVD AT 15% O2
			PM EMISSIONS
		Date: 1/6/2004	3 lb/hr Per Unit.
			NH3 SLIP
NOT VALID WITHOUT STAMP			5 PPMVD AT 15 % O2

BASIS OF GUARANTEE:	BASE LOAD, GAS FUEL NOZZLE SYSTEM NO BLEED OR EXTRACTED POWER
ENGINE:	(2) GE LM6000PC GAS TURBINE w/SPRINT & VIGVs
FUEL:	21153 Btu/lb / (49201 kJ/kg) LHV, GAS FUEL (#900-744)
FUEL TEMP:	50°F(28°C) above dew point,@ GEAEP BASEPLATE Maximum Fuel Temperature 250°F(121.1°C)
Fuel Specification:	MID-TD-0000-1 Latest Revision
GENERATOR OUTPUT:	13.8 kV, 60 Hz
POWER FACTOR:	≥ .9
AMBIENT TEMP:	100.0°F / (37.8°C)
AMBIENT WET BULB:	68.0°F / (20°C)
INLET CONDITIONING:	CHILL TO 46.0°F / (7.8°C), 95% INLET REL HUM
ALTITUDE:	730.0 ft/ (222.5 m)
INLET FILTER LOSS:	≤ 5.00 inH_2O/ (127.0 mmH_2O)
EXHAUST LOSS:	≤ 12.00 inH_2O/ (304.8 mmH_2O)
NOX CONTROL:	WATER
Water Specification:	MID-TD-0000-3 Latest Revision
INJECTION RATE:	22960 PPH/ (10414.5kG/hr) ±20% FLOW
INJECTION TEMP:	100 °F/ (37.8 °C) @ GEAEP BASEPLATE
ENGINE CONDITION:	NEW AND CLEAN ≤ 200 SITE FIRED HOURS
FIELD TEST METHODS	
PERFORMANCE:	GE AERO ENERGY PRODUCTS SGTGPTM
NOx EMISSION:	SCAQMD Method 100.1
CO EMISSION:	SCAQMD Method 100.1
VOC EMISSION:	SCAQMD Method 25.3
***PM**	SCAQMD Method 5.1
NH3 SLIP	CTM O27

**** SI values are for reference purposes only**

THIS GUARANTEE SUPERSEDES ANY PREVIOUS GUARANTEES PRESENTED

*** Conditions for PM Guarantee** requires that each unit have more that 300 fired hours of operation prior to testing. Also, each unit must operate at **Base Load 3 to 4 hours** just prior to commencing PM Compliance Test.

TURBINE GEN SET PERFORMANCE
FOR
RPU - City of Riverside - Capacity Addition

GUARANTEED PARAMETERS JOBSITE LOCATION: Riverside, CA

Far Field Noise:
70 dBA for 2 main units at a distance of 90 ft from any nearest point of the GTG/SCR Scope of Supply equipment as measured 5 ft above grade over a flat hard ground plane in a free field condition.

This guarantee coincides with the previous guarantee issued on 12/15/2003

TG6000-0000401202-100
14765 14754

GUARANTEE

Date: 12/15/2003

Near Field Noise:
84 dba average around the package (Vertical Distance of 5ft. above grade at a horizontal distance of 3ft. from the exterior plane of equipment or if equipment enclosed, its enclosure)

NOT VALID WITHOUT STAMP

BASIS OF GUARANTEE:	BASE LOAD, GAS FUEL NOZZLE SYSTEM NO BLEED OR EXTRACTED POWER
ENGINE:	(2) GE LM6000PC GAS TURBINE w/SPRINT & VIGVs
FUEL:	21153 Btu/lb / (49201 kJ/kg) LHV, GAS FUEL (#900-744)
FUEL TEMP:	50°F(28°C) above dew point,@ GEAEP BASEPLATE Maximum Fuel Temperature 250°F(121.1°C)
GENERATOR OUTPUT:	13.8 kV, 60 Hz
POWER FACTOR:	≥ .9
AMBIENT TEMP:	100.0°F / (37.8°C)
AMBIENT WET BULB:	68.0°F / (20°C)
INLET CONDITIONING:	CHILL TO 46.0°F / (7.8°C), 95% INLET REL HUM
ALTITUDE:	730.0 ft/ (222.5 m)
INLET FILTER LOSS:	≤ 5.00 inH_2O/ (127.0 mmH_2O)
EXHAUST LOSS:	≤ 12.00 inH_2O/ (304.8 mmH_2O)
NOX CONTROL:	WATER
INJECTION RATE:	22960 PPH/ (10414.5kG/hr) ±20% FLOW
INJECTION TEMP:	100 °F/ (37.8 °C) @ GEAEP BASEPLATE
ENGINE CONDITION:	NEW AND CLEAN ≤ 200 SITE FIRED HOURS
FIELD TEST METHODS	
PERFORMANCE:	GE AERO ENERGY PRODUCTS SGTGPTM
NEAR FIELD NOISE:	ANSI / ASME PTC - 36

** SI values are for reference purposes only

THIS GUARANTEE SUPERSEDES ANY PREVIOUS GUARANTEES PRESENTED

TURBINE GEN SET PERFORMANCE
FOR
RPU - City of Riverside - Capacity Addition

GUARANTEED PARAMETERS JOBSITE LOCATION: Riverside, CA
Availability and Starting Reliability and Forced Outage Rate

RPU Formula: SR % = 100 – {100 x (SF+FOE) / (SF+SS)}	RPU Formula: FOR= FOH/(FOH+SH)	RPU Formula: A % = 100 x {(PH-FOH-MOH-POH-AOH)/ (PH- POH-AOH)}
97.49	1.80	98.09

This guarantee coincides with the previous guarantee issued on 12/15/2003

TG6000-0000401202-100

GUARANTEE

Kenneth Lup

Date: 12/12/2003

NOT VALID WITHOUT STAMP

BASIS OF GUARANTEE:	BASE LOAD, GAS FUEL NOZZLE SYSTEM NO BLEED OR EXTRACTED POWER
ENGINE:	(2) GE LM6000PC GAS TURBINE w/SPRINT & VIGVs
FUEL:	21153 Btu/lb / (49201 kJ/kg) LHV, GAS FUEL (#900-744)
FUEL TEMP:	50°F(28°C) above dew point,@ GEAEP BASEPLATE Maximum Fuel Temperature 250°F(121.1°C)
GENERATOR OUTPUT:	13.8 kV, 60 Hz
POWER FACTOR:	≥ .9
AMBIENT TEMP:	100.0°F / (37.8°C)
AMBIENT WET BULB:	68.0°F / (20°C)
INLET CONDITIONING:	CHILL TO 46.0°F / (7.8°C), 95% INLET REL HUM
ALTITUDE:	730.0 ft/ (222.5 m)
INLET FILTER LOSS:	≤ 5.00 inH_2O/ (127.0 mmH_2O)
EXHAUST LOSS:	≤ 12.00 inH_2O/ (304.8 mmH_2O)
NOX CONTROL:	WATER
INJECTION RATE:	22960 PPH/ (10414.5kG/hr) ±20% FLOW
INJECTION TEMP:	100 °F/ (37.8 °C) @ GEAEP BASEPLATE
ENGINE CONDITION:	NEW AND CLEAN ≤ 200 SITE FIRED HOURS

NOTES:
- Basis for each is SPS - ORAP.
- ORAP definitions for Availability and Starting Reliability are slightly different than the formulas in the spec, and both have been included attached graphs.

** SI values are for reference purposes only

THIS GUARANTEE SUPERSEDES ANY PREVIOUS GUARANTEES PRESENTED

GE AERO ENERGY PRODUCTS/ GE LM6000PC SPRINT w/ VGVs Standard Estimated Average Engine Performance NOT FOR GUARANTEE
GENERATOR: 290ERT 60Hz 13.80kV 0.90pf
City of Riverside - Capacity Addition

CASE #	100
AMBIENT	
DB, °F	100.0
WB, °F	68.0
RH, %	19.0
ALT, FT	730.0
Ambient Pressure, psia	14.313
ENGINE INLET	
TEMP, °F	46.0
RH, %	95.0
CONDITIONING	CHILL
TONS or kBTU	1293
kW, Gen Terms	49800
Est. Btu/kW-hr, LHV	8545
Guar. Btu/kW-hr, LHV	8719
Aux and BOP Loads, kW	2818
FUEL	
MMBTU/HR, LHV	426
PPH	20118
NOZZLE WATER	
PPH	22960
TEMP °F	59
NOZZLE STEAM	
PPH	0
TEMP °F	0
SPRINT	LPC
PPH	4891
INLET LOSS, INH2O	5
VOLUTE LOSS, INH2O	4
EXHAUST LOSS,INH2O	12
HP COMP, RPM	3600
LP COMP, RPM	10567
COMP DISCH, PSIA	439
COMP DISCH, °F	997
T48, °R	2046
EXHAUST PARAMETERS	
°F	830
PPS	296
PPH	1064462

Net Plant
96783 kW
8794 Est. Btu/kW-hr, LHV
8973 Guar. Btu/kW-hr, LHV

EMISSIONS (NOT FOR USE IN ENVIRONMENTAL PERMITS, NOX & CO PPMVD ARE @ 15% O2)

NOx, PPMVD	25
NOx, PPH	43
CO, PPMVD	42
CO, PPH	44
HC, PPMVD	10
HC, PPH	7
VOC, PPMVD	3
VOC, PPH	2
PM10, PPH	11

EXH WGHT % WET (NOT FOR USE IN ENVIRONMENTAL PERMITS)

AR	1.2278
N_2	72.0007
O_2	14.6215
CO_2	5.1900
H_2O	6.9544
SO_2	0.0000
CO	0.0027
HC	0.0002
$NO + NO_2$	0.0028

EXH MOLE % DRY (NOT FOR USE IN ENVIRONMENTAL PERMITS)

AR	0.9677
N_2	80.9253
O_2	14.3877
CO_2	3.7132
SO_2	0.0000
CO	
HC	0.0030
NOX	0.0003
	0.0028

EXH MOLE % WET (NOT FOR USE IN ENVIRONMENTAL PERMITS)

AR	0.8629
N_2	72.1550
O_2	12.8285
CO_2	3.3108
H_2O	10.8375
SO_2	0.0000
CO	0.0027
HC	0.0003
NOX	0.0025

Aero Energy Fuel Number	**900-744**	
	Volume %	**Weight %**
Hydrogen	0.0000	0.0000
Methane	98.5565	96.8910
Ethane	0.6290	1.1590
Ethylene	0.0000	0.0000
Propane	0.0655	0.1770
Propylene	0.0000	0.0000
Butane	0.0177	0.0630
Butylene	0.0000	0.0000
Butadiene	0.0000	0.0000
Pentane	0.0043	0.0190
Cyclopentane	0.0000	0.0000
Hexane	0.0034	0.0180
Heptane	0.0000	0.0000
Carbon Monoxide	0.0000	0.0000
Carbon Dioxide	0.4394	1.1851
Nitrogen	0.2842	0.4879
Water Vapor	0.0000	0.0000
Oxygen	0.0000	0.0000
Hydrogen Sulfide	0.0000	0.0000
Ammonia	0.0000	0.0000

Btu/lb, LHV	21153
Btu/scf, LHV	912
Btu/scf, HHV	1012
Btu/lb, HHV	23465
Fuel Temp, °F	77.0
NOx Scalar	0.991
Specific Gravity	0.56

TOTAL SPRINT FLOW, PPH	4891.382429
HPC SPRINT FLOW, GPM	0
LPC SPRINT FLOW, GPM	9.77
GT OUTPUT, SHP	67949
GT AVG HR, BTU/HP-HR	6263
GENERATOR EFFICIENCY	0.982852944
EXHAUST TEMPERATURE, °R	1290.1
MEDIA INJ TEMP, °R	518.67
MEDIA INJ FLOW, PPH	22960
FUEL FLOW, PPH	20118
FUEL LHV, BTU/LB	21153
T48, °F	1586.0
INLET FLOW, PPS	286.12
EXHAUST AVG MW	28.2

Estimated Average Engine Performance NOT FOR GUARANTEE

GE Aero Energy
A GE Power Systems Business

Performance By: Johnny Metcalf
Project Info:

Engine: LM6000 PC-SPRINT w/ VIGVs
Deck Info: GE125M - Multiple Cardpacks being used, See Cardpack Row Below
Generator: 290ERT 60Hz, 13.8kV, 0.9PF (14839)
Fuel: Site Gas Fuel#900-744, 21153 Btu/lb,LHV

Date: 01/29/2004
Time: 11:32:25 AM
Version: 3.0.16

			NOx, lbs	CO, lbs
Startup Ramp Rate:	11173 kW/min	Total Emissions at Startup	2.5	3.9

Case #	**100**	**101**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**	**112**	**113**	**114**	**115**	**116**	**117**
Ambient Conditions																		
Dry Bulb, °F	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8
Wet Bulb, °F	63.2	63.2	63.2	63.2	63.2	63.2	63.2	63.2	63.2	63.2	63.2	63.2	63.2	63.2	63.2	63.2	63.2	63.2
RH, %	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0
Altitude, ft	730.0	730.0	730.0	730.0	730.0	730.0	730.0	730.0	730.0	730.0	730.0	730.0	730.0	730.0	730.0	730.0	730.0	730.0
Ambient Pressure, psia	14.313	14.313	14.313	14.313	14.313	14.313	14.313	14.313	14.313	14.313	14.313	14.313	14.313	14.313	14.313	14.313	14.313	14.313
Engine Inlet																		
Temperature, °F	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8
RH, %	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0
Conditioning	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
Tons or kBtu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pressure Losses																		
Inlet Loss, inH20	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Volute Loss, inH20	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Exhaust Loss, inH20	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
Time, min	10.0000	9.25	9.08	8.92	8.76	8.60	8.44	8.27	8.11	7.95	7.79	7.62	7.46	7.30	7.14	6.95	6.89	6.82
kW, Gen Terms	**44693**	**36274**	**34468**	**32655**	**30842**	**29029**	**27215**	**25402**	**23589**	**21777**	**19964**	**18152**	**16340**	**14527**	**12716**	**10657**	**9916**	**9174**
Est. Btu/kW-hr, LHV	**8659**	**8878**	**8970**	**9081**	**9212**	**9365**	**9534**	**9718**	**9929**	**10196**	**10501**	**10863**	**11317**	**11873**	**12612**	**13458**	**13975**	**14584**
Guar. Btu/kW-hr, LHV	**8836**	**9060**	**9153**	**9266**	**9400**	**9556**	**9728**	**9916**	**10131**	**10404**	**10715**	**11085**	**11548**	**12115**	**12869**	**13733**	**14260**	**14881**
Fuel Flow																		
MMBtu/hr, LHV	387.0	322.1	309.2	296.5	284.1	271.9	259.5	246.9	234.2	222.0	209.6	197.2	184.9	172.5	160.4	143.4	138.6	133.8
lb/hr	18295	15225	14616	14019	13431	12852	12266	11670	11073	10497	9911	9322	8742	8154	7582	6781	6551	6325
lb/min	305	254	244	234	224	214	204	195	185	175	165	155	146	136	126	113	109	105
scfm	7073	5887	5651	5419	5193	4970	4743	4513	4280	4058	3831	3604	3379	3153	2932	2621	2533	2445
lbs	1096.6	866.8	825.8	786.3	748.4	712.1	677.3	644.1	612.6	582.6	554.2	527.5	502.3	478.6	456.6	433.3	425.8	418.6
scf	25433.1	20103.5	19151.9	18234.9	17355.6	16513.0	15706.2	14936.6	14204.4	13510.2	12851.8	12230.6	11646.1	11097.7	10586.7	10046.5	9872.6	9704.4
NOx Control	**Water**	**Water**	**Water**	**Water**	**Water**	**Water**	**Water**	**Water**	**Water**	**Water**	**Water**	**Water**	**Water**	**Water**	**Water**	**NONE**	**NONE**	**NONE**
Water Injection																		
lb/hr	19755	15764	14711	13653	12581	11619	10686	9744	8828	8019	7188	6385	5655	4902	4210	0	0	0
Temperature, °F	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0	0.0	0.0
SPRINT	**LPC**	**OFF**	**OFF**	**OFF**	**OFF**	**OFF**	**OFF**	**OFF**	**OFF**	**OFF**	**OFF**	**OFF**	**OFF**	**OFF**	**OFF**	**OFF**	**OFF**	**OFF**
lb/hr	7093	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Control Parameters																		
HP Speed, RPM	10565	10340	10256	10187	10122	10057	9994	9929	9863	9777	9691	9620	9555	9479	9400	9307	9267	9227
LP Speed, RPM	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
CDP, psia	425.599	380.575	369.976	358.511	346.106	333.349	320.201	306.364	291.416	281.222	271.016	260.793	250.344	240.110	229.283	216.355	211.689	206.943
CDT, °F	998.0	1001.0	989.5	976.7	962.0	946.5	931.8	916.8	901.3	887.1	872.6	857.5	842.2	826.6	810.6	789.9	782.9	775.9
T48, °R	2023	1963	1945	1929	1915	1902	1889	1877	1869	1845	1819	1791	1761	1728	1697	1672	1656	1640
Exhaust Parameters																		
Temperature, °F	832.3	816.0	810.7	807.6	806.9	807.5	809.3	812.6	819.5	811.3	801.4	790.3	779.6	766.5	755.8	751.6	745.4	739.7
lb/sec	277.3	253.3	247.5	240.9	233.4	225.6	217.4	208.7	198.9	193.3	187.7	182.2	176.4	170.9	164.8	157.2	154.6	151.8
lb/hr	998176	911750	890957	867189	840246	812237	782805	751283	716063	695839	675835	655872	635061	615218	593262	565787	556385	546634
Energy, Btu/s- ref 0 °R	93135	83037	80688	78247	75702	73156	70554	67849	64998	62647	60252	57836	55410	52991	50551	47684	46619	45558
Cp, Btu/lb-R	0.2778	0.2739	0.2733	0.2729	0.2726	0.2723	0.2721	0.2720	0.2721	0.2714	0.2705	0.2696	0.2688	0.2678	0.2670	0.2647	0.2643	0.2640
Emissions (NOT FOR USE IN ENVIRONMENTAL PERMITS)																		
REF @ 15% O2	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
NOx ppmvd Ref 15% O2	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	66	63	60
NOx as NO2, lb/hr	39	32	31	30	28	27	26	25	23	22	21	20	19	17	16	38	35	32
NOx, min	0.65	0.54	0.52	0.50	0.47	0.45	0.43	0.41	0.39	0.37	0.35	0.33	0.31	0.29	0.27	0.63	0.58	0.54
CO ppmvd Ref 15% O2	19	13	13	13	13	13	13	13	13	13	12	12	12	11	11	13	14	16
CO, lb/hr	17.85	10.46	10.06	9.56	8.97	8.75	8.39	7.87	7.36	6.95	6.37	5.81	5.37	4.79	4.29	4.39	4.74	5.18
CO, min	0.30	0.17	0.17	0.16	0.15	0.15	0.14	0.13	0.12	0.12	0.11	0.10	0.09	0.08	0.07	0.07	0.08	0.09
HC ppmvd Ref 15% O2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
HC, lb/hr	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00
Total Emissions From Startup To Full Load																		
NOx, lbs	**2.5**	2.0	1.9	1.8	1.7	1.6	1.6	1.5	1.4	1.4	1.3	1.3	1.2	1.1	1.1	1.1	1.0	1.0
CO, lbs	**3.9**	3.6	3.6	3.6	3.6	3.5	3.5	3.5	3.5	3.5	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.3
Exh Wght % Wet (NOT FOR USE IN ENVIRONMENTAL PERMITS)																		
AR	1.2256	1.2312	1.2326	1.2339	1.2351	1.2361	1.2372	1.2382	1.2391	1.2406	1.2423	1.2440	1.2456	1.2475	1.2492	1.2593	1.2595	1.2598
N2	71.8713	72.1998	72.2798	72.3549	72.4259	72.4879	72.5481	72.6092	72.6624	72.7505	72.8482	72.9491	73.0444	73.1523	73.2528	73.8409	73.8566	73.8719
O2	14.7876	15.5782	15.7180	15.8348	15.9275	16.0100	16.0885	16.1606	16.2044	16.3796	16.5744	16.7821	16.9870	17.2205	17.4371	17.9278	18.0152	18.0999
CO2	5.0486	4.5723	4.4927	4.4278	4.3788	4.3350	4.2934	4.2566	4.2376	4.1352	4.0212	3.8991	3.7777	3.6392	3.5108	3.2955	3.2384	3.1830
H20	7.0622	6.4148	6.2734	6.1451	6.0291	5.9275	5.8293	5.7321	5.6531	5.4908	5.3106	5.1227	4.9423	4.7377	4.5475	3.6711	3.6251	3.5804
SO2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
CO	0.0018	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0010	0.0010	0.0010	0.0009	0.0009	0.0008	0.0008	0.0007	0.0008	0.0009	0.0009
HC	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
NOX	0.0027	0.0024	0.0024	0.0024	0.0023	0.0023	0.0023	0.0023	0.0023	0.0022	0.0021	0.0021	0.0020	0.0019	0.0019	0.0046	0.0043	0.0041
Exh Mole % Dry (NOT FOR USE IN ENVIRONMENTAL PERMITS)																		
AR	0.9668	0.9635	0.9629	0.9624	0.9621	0.9617	0.9614	0.9612	0.9610	0.9603	0.9595	0.9587	0.9578	0.9569	0.9560	0.9544	0.9541	0.9537
N2	80.8494	80.5659	80.5181	80.4790	80.4490	80.4223	80.3970	80.3744	80.3620	80.3020	80.2356	80.1648	80.0949	80.0155	79.9422	79.8087	79.7775	79.7473
O2	14.5637	15.2190	15.3294	15.4198	15.4891	15.5508	15.6093	15.6616	15.6902	15.8287	15.9823	16.1459	16.3074	16.4909	16.6601	16.9642	17.0366	17.1067
CO2	3.6151	3.2478	3.1858	3.1350	3.0961	3.0615	3.0287	2.9993	2.9833	2.9055	2.8193	2.7275	2.6368	2.5339	2.4389	2.2673	2.2266	2.1873
H20	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SO2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
CO	0.0020	0.0013	0.0013	0.0012	0.0012	0.0012	0.0012	0.0012	0.0011	0.0011	0.0010	0.0010	0.0009	0.0009	0.0008	0.0008	0.0009	0.0010
HC	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001
NOX	0.0027	0.0024	0.0024	0.0023	0.0023	0.0023	0.0022	0.0022	0.0022	0.0021	0.0021	0.0020	0.0019	0.0019	0.0018	0.0044	0.0041	0.0039
Exh Mole % Wet (NOT FOR USE IN ENVIRONMENTAL PERMITS)																		
AR	0.8605	0.8670	0.8685	0.8700	0.8713	0.8725	0.8737	0.8749	0.8759	0.8776	0.8795	0.8815	0.8834	0.8855	0.8875	0.8990	0.8993	0.8996
N2	71.9596	72.4962	72.6257	72.7469	72.8612	72.9610	73.0580	73.1562	73.2413	73.3857	73.5461	73.7121	73.8696	74.0483	74.2149	75.1706	75.1987	75.2259
O2	12.9624	13.6946	13.8268	13.9384	14.0282	14.1081	14.1844	14.2550	14.2999	14.4654	14.6498	14.8463	15.0400	15.2611	15.4665	15.9783	16.0588	16.1368

Estimated Average Engine Performance NOT FOR GUARANTEE

GE Aero Energy
A GE Power Systems Business

Performance By: Johnny Metcalf
Project Info:

Engine: LM6000 PC-SPRINT w/ VIGVs
Deck Info: GE12504 - Multiple Cardpacks being used, See Cardpack Row Below
Generator: 290BRT 60Hz, 13.8kV, 0.9PF (14830)
Fuel: Site Gas Fuel#900-744, 21153 Btu/lb,LHV

Date: 01/29/2004
Time: 11:32:25 AM
Version: 3.8.16

NOx, lbs , CO, lbs

CO2	3.2176	2.9224	2.8735	2.8338	2.8041	2.7774	2.7522	2.7300	2.7189	2.6552	2.5842	2.5079	2.4319	2.3449	2.2642	2.1355	2.0988	2.0632
H2O	10.9955	10.0163	9.8021	9.6077	9.4319	9.2777	9.1285	8.9807	8.8809	8.6130	8.3374	8.0493	7.7723	7.4676	7.1644	5.8115	5.7395	5.6697
SO2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
CO	0.0018	0.0012	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0010	0.0010	0.0010	0.0009	0.0009	0.0008	0.0007	0.0008	0.0009	0.0010
HC	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
NOX	0.0024	0.0022	0.0021	0.0021	0.0021	0.0021	0.0020	0.0020	0.0020	0.0020	0.0019	0.0019	0.0018	0.0017	0.0017	0.0041	0.0039	0.0037

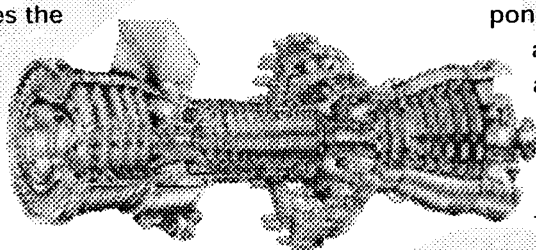
Aero Energy Fuel Number	900-744	
	Volume %	Weight %
Hydrogen	0.0000	0.0000
Methane	98.5565	96.8910
Ethane	0.6290	1.1590
Ethylene	0.0000	0.0000
Propane	0.0655	0.1770
Propylene	0.0000	0.0000
Butane	0.0177	0.0630
Butylene	0.0000	0.0000
Butadiene	0.0000	0.0000
Pentane	0.0043	0.0190
Cyclopentane	0.0000	0.0000
Hexane	0.0034	0.0180
Heptane	0.0000	0.0000
Carbon Monoxide	0.0000	0.0000
Carbon Dioxide	0.4394	1.1851
Nitrogen	0.2842	0.4879
Water Vapor	0.0000	0.0000
Oxygen	0.0000	0.0000
Hydrogen Sulfide	0.0000	0.0000
Ammonia	0.0000	0.0000
Btu/lb, LHV	21153	
Btu/scf, LHV	912	
Btu/scf, HHV	1012	
Btu/lb, HHV	23465	
Fuel Temp, °F	77.0	
NOx Scalar	0.991	
Specific Gravity	0.56	

Engine Exhaust																		
Exhaust MW	28.0	28.1	28.1	28.2	28.2	28.2	28.2	28.2	28.2	28.3	28.3	28.3	28.3	28.4	28.4	28.5	28.5	28.5
Exhaust Flow, ACFM	557320	501214	487398	472930	457727	442464	428817	410503	393204	379357	365264	351046	336715	322451	307974	291293	284928	278571
Exhaust Flow, SCFM	212288	193652	188020	183083	177644	171372	164834	157895	150198	145844	141531	137231	132762	128497	123798	117497	115527	113485
Exhaust Flow, Btu/lb	336	328	326	325	324	324	324	325	327	324	321	317	314	310	307	303	302	300
Exhaust Flow, Calories/s	23409963	20925279	20333299	19718293	19076843	18435414	17779645	17097855	16379433	15787056	15183426	14574627	13963368	13353613	12738952	12016385	11747907	11480529
Inlet Flow Wet, pps	268.2	247.9	242.9	238.7	235.2	231.2	225.9	219.3	212.0	212.1	212.1	212.1	212.2	212.1	212.3	212.4	212.4	212.3
Inlet Flow Dry, pps	265.4	245.3	240.4	236.2	232.7	228.7	223.5	217.0	209.8	209.8	209.9	209.9	210.0	209.9	210.0	210.1	210.1	210.1
Shaft HP	61014	49603	47158	44704	42252	39800	37349	34899	32450	30002	27555	25109	22664	20219	17776	15000	14000	13000
Generator Information																		
Capacity kW	60333	60333	60333	60333	60333	60333	60333	60333	60333	60333	60333	60333	60333	60333	60333	60333	60333	60333
Efficiency	0.982	0.981	0.980	0.980	0.979	0.978	0.977	0.976	0.975	0.973	0.972	0.969	0.967	0.964	0.959	0.953	0.950	0.946
Inlet Temp, °F	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8
Gear Box Loss	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8th Stage Bleed																		
Flow, pps	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pressure, psia	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Temperature, °R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CDP Bleed																		
Flow, pps	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pressure, psia	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Est. Gas Pressure at Baseplate, psi	549.8	481.3	466.4	451.0	434.9	418.6	401.9	384.5	366.2	361.9	337.5	323.0	308.5	294.1	279.4	260.7	254.5	248.4
CardPack	81e	7tx	7tx	7tx	7tx	7tx	7tx	7tx	7tx	7tx	7tx	7tx	7tx	7tx	7tx	7tx	7tx	7tx
NSI	327	305	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NSI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NSI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

LM6000 SPRINT™ Gas Turbine Generator Set

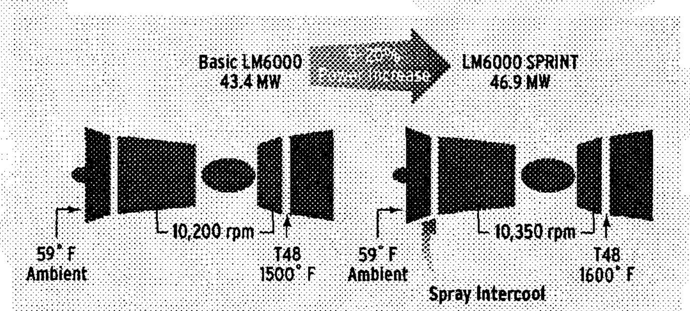
The Inter-cooled Engine that Increases Power Output

The LM6000 SPRINT™ combines the best simple-cycle heat rate of any industrial gas turbine in its class today with a spray inter-cooling design that significantly increases the mass airflow by cooling the air during the compression process. The result is more power, a better heat rate and a gas turbine without any increase in maintenance costs.



The Hotter It Gets, The More Effectively It Runs

SPRINT's™ effectiveness is even more pronounced in hot weather—power output is increased by 9% at ISO and is increased by more than 20% on 90° days. It is like having an evaporative cooler built within the gas turbine. As ambient temperature rises, the benefits of a SPRINT™ engine become more significant.

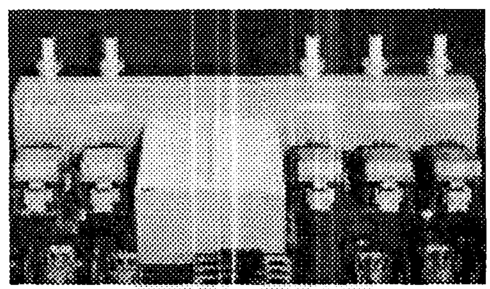


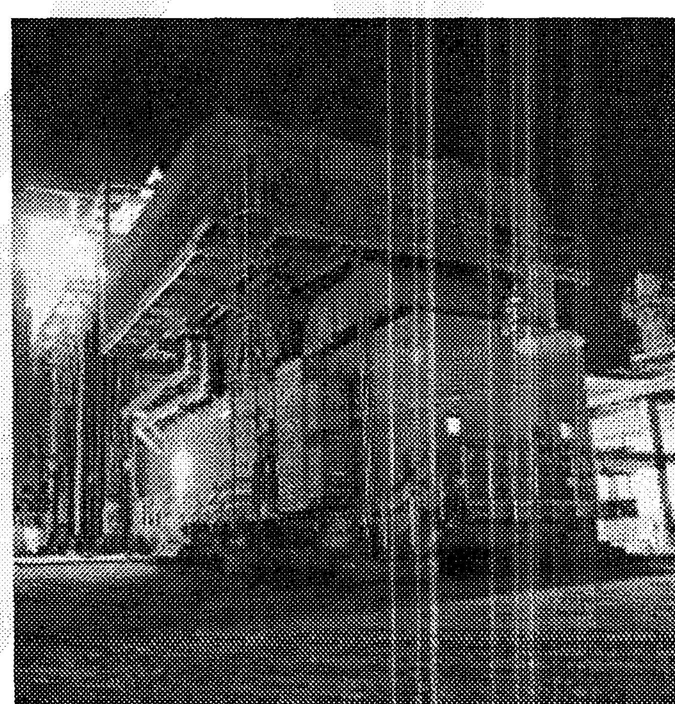
The SPRINT™ Solution

The SPRINT™ system is based on an atomized water spray injected through spray nozzles into the compressor. Water is atomized using high-pressure air taken off of eighth stage air bleed. The water-flow rate is metered, using the appropriate engine control schedules.

The SPRINT™ Solution at Work

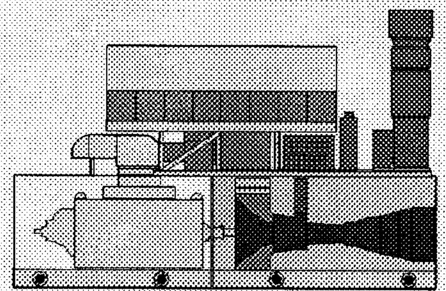
On high-pressure ratio gas turbines such as the LM6000, the compressor discharge temperature is often the criteria that limits power output because compressed air is used to cool the hot section components. By pre-cooling the LM6000 compressor with a mico-mist of water, the compressor inlet temperature and outlet temperature are significantly reduced. Thus, the compressor outlet temperature limitation is reduced allowing the LM6000 to operate on its natural firing temperature control. The result is higher output and better efficiency.





SPRINT 60-Hz Generator Sets

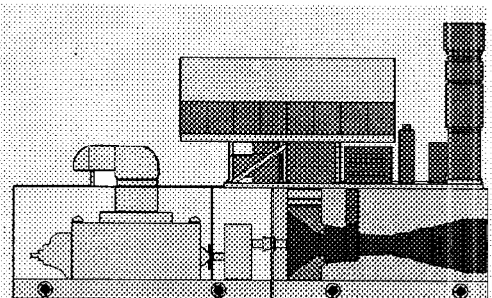
Base Plate Length	56'	6"	(17.22 m)
Base Plate Width	13'	6"	(4.11 m)
Enclosure Height	14'	6"	(4.42 m)
Overall Length	56'	9"	(17.30 m)
Overall Width*	49'	9"	(15.16 m)
Overall Height*	36'	2"	(11.02 m)
Base Plate Foundation Load*	476,000 lb		(214,200 kg)



	Power kW	Heat Rate Btu/kWh LHV	Heat Rate kJ/kWh LHV	No. Shafts	Pressure Ratio	Shaft Speed rpm	Exhaust Flow lb/s	Exhaust Flow kg/s	Exhaust Temp. °F	Exhaust Temp. °C
LM6000PC SPRINT*	50080	8434	8916	2	30.9	3600	295	134	826	441
LM6000PC	43417	8112	8549	2	29.1	3600	281	127	831	444
LM6000PD SPRINT	46824	8235	8688	2	30.7	3600	290	131	837	447
LM6000PD	42336	8308	8765	2	29.3	3600	278	126	846	452
LM6000PD (liquid fuel)	40212	8415	8878	2	28.1	3600	268	122	857	458
LM2500PK	30676	8834	9300	2	23.6	3600	192	87.1	958	514
LM2500PV	30463	8854	9069	2	22.6	6100	186	84.3	931	499
LM2500PH**	27763	8391	8775	2	20.2	3600	167	75.9	926	497
LM2500PE	22719	9311	9789	2	19.1	3600	153	69.4	992	533

SPRINT 50-Hz Generator Sets

Base Plate Length	64'	7"	(19.69 m)
Base Plate Width	13'	6"	(4.11 m)
Enclosure Height	14'	6"	(4.42 m)
Overall Length	64'	10"	(19.76 m)
Overall Width*	49'	3"	(15.01 m)
Overall Height*	37'	11"	(11.56 m)
Base Plate Foundation Load*	522,000 lb		(234,900 kg)



	Power kW	Heat Rate Btu/kWh LHV	Heat Rate kJ/kWh LHV	No. Shafts	Pressure Ratio	Shaft Speed rpm	Exhaust Flow lb/s	Exhaust Flow kg/s	Exhaust Temp. °F	Exhaust Temp. °C
LM6000PC SPRINT*	50041	8461	8961	2	31.0	3627	297	135	821	438
LM6000PC	42890	8173	8617	2	29.1	3627	282	128	825	441
LM6000PD SPRINT	46902	8272	8739	2	30.9	3627	292	133	834	446
LM6000PD	41711	8374	8846	2	29.3	3627	279	127	838	448
LM6000PD (liquid fuel)	40376	8452	8917	2	28.5	3627	272	123	853	456
LM2500PK	29244	9177	9675	2	22.8	3000	193	87.7	967	519
LM2500PV	30349	8577	9069	2	21.5	6100	186	84.3	931	499
LM2500PH**	26463	8673	9080	2	19.4	3000	168	76.2	932	500
LM2500PE	21719	9653	10141	2	18	3000	154	69.8	1000	538

Mechanical-Drive Sets

	Heat Rate Btu/kWh LHV	No. Shafts	Pressure Ratio	Shaft Speed rpm	Exhaust Flow lb/s	Exhaust Flow kg/s	Exhaust Temp. °F	Exhaust Temp. °C
LM6000PC	5941	2	29.1	3600	281.9	127.8	825	440
LM2500PK	6442	2	22.5	3600	192.0	87.1	958	514
LM2500PV	6187	2	21.5	6100	186.0	84.3	931	499
LM2500PE	6773	2	22.8	3600	153.0	69.4	992	533

Note: Performance based on 59° F amb. Temp. 60% RH, sea level, no inlet/exhause losses on gas fuel without NOx media, unless otherwise specified.
*SPRINT 2002 deck is used with water injection to 25ppmvd for power enhancement
**Rating includes use of 50,000 lb/hr steam injection.

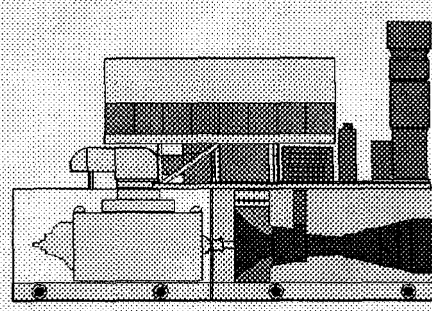
GE Aero Energy Products

A GE Power Systems Business

2707 North Loop West • Houston, TX 77008 • Phone: 713.803.0900 • Fax: 713.803.0362 • www.gepower.com

SPRINT™ 60-Hz Generator Sets

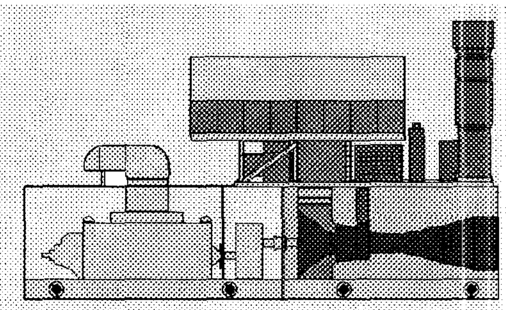
Base Plate Length	56' 6"	(17.22 m)
Base Plate Width	13' 6"	(4.11 m)
Enclosure Height	14' 6"	(4.42 m)
Overall Length	56' 9"	(17.30 m)
Overall Width*	49' 9"	(15.16 m)
Overall Height*	36' 2"	(11.02 m)
Base Plate Foundation Load*	476,000 lb	(214,200 kg)



	Power kW	Heat Rate Btu/kWh LHV	Heat Rate kJ/kWh LHV	No. Shafts	Pressure Ratio	Shaft Speed rpm	Exhaust Flow lb/s	Exhaust Flow kg/s	Exhaust Temp. °F	Exhaust Temp. °C
LM6000PC SPRINT™ *	50080	8434	8916	2	30.9	3600	295	134	826	441
LM6000PC	43417	8112	8549	2	29.1	3600	281	127	831	444
LM6000PD SPRINT™	46824	8235	8688	2	30.7	3600	290	131	837	447
LM6000PD	42336	8308	8765	2	29.3	3600	278	126	846	452
LM6000PD (liquid fuel)	40212	8415	8878	2	28.1	3600	268	122	857	458
LM2500PK	30676	8834	9300	2	23.6	3600	192	87.1	958	514
LM2500PV	30463	8854	9069	2	22.6	6100	186	84.3	931	499
LM2500PH**	27763	8391	8775	2	20.2	3600	167	75.9	926	497
LM2500PE	22719	9311	9789	2	19.1	3600	153	69.4	992	533

SPRINT™ 50-Hz Generator Sets

Base Plate Length	64' 7"	(19.69 m)
Base Plate Width	13' 6"	(4.11 m)
Enclosure Height	14' 6"	(4.42 m)
Overall Length	64' 10"	(19.76 m)
Overall Width*	49' 3"	(15.01 m)
Overall Height*	37' 11"	(11.56 m)
Base Plate Foundation Load*	522,000 lb	(234,900 kg)



	Power kW	Heat Rate Btu/kWh LHV	Heat Rate kJ/kWh LHV	No. Shafts	Pressure Ratio	Shaft Speed rpm	Exhaust Flow lb/s	Exhaust Flow kg/s	Exhaust Temp. °F	Exhaust Temp. °C
LM6000PC SPRINT™ *	50041	8461	8961	2	31.0	3627	297	135	821	438
LM6000PC	42890	8173	8617	2	29.1	3627	282	128	825	441
LM6000PD SPRINT™	46902	8272	8739	2	30.9	3627	292	133	834	446
LM6000PD	41711	8374	8846	2	29.3	3627	279	127	838	448
LM6000PD (liquid fuel)	40376	8452	8917	2	28.5	3627	272	123	853	456
LM2500PK	29244	9177	9675	2	22.8	3000	193	87.7	967	519
LM2500PV	30349	8577	9069	2	21.5	6100	186	84.3	931	499
LM2500PH**	26463	8673	9080	2	19.4	3000	168	76.2	932	500
LM2500PE	21719	9653	10141	2	18	3000	154	69.8	1000	538

Mechanical-Drive Sets

	Heat Rate Btu/kWh LHV	No. Shafts	Pressure Ratio	Shaft Speed rpm	Exhaust Flow lb/s	Exhaust Flow kg/s	Exhaust Temp. °F	Exhaust Temp. °C
LM6000PC	5941	2	29.1	3600	281.9	127.8	825	440
LM2500PK	6442	2	22.5	3600	192.0	87.1	958	514
LM2500PV	6187	2	21.5	6100	186.0	84.3	931	499
LM2500PE	6773	2	22.8	3600	153.0	69.4	992	533

Note: Performance based on 59° F amb. Temp. 60% RH, sea level, no inlet/exhause losses on gas fuel without NOx media, unless otherwise specified.

*SPRINT™ 2002 deck is used with water injection to 25ppmvd for power enhancement

**Rating includes use of 50,000 lb/hr steam injection.

GE Aero Energy Products

A GE Power Systems Business

2707 North Loop West • Houston, TX 77008 • Phone: 713.803.0900 • Fax: 713.803.0362 • www.gepower.com

3/03

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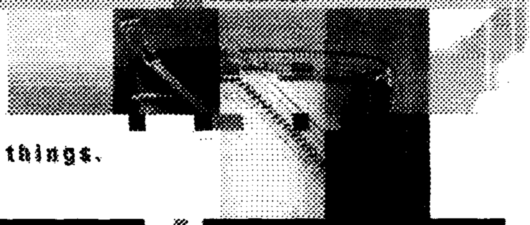

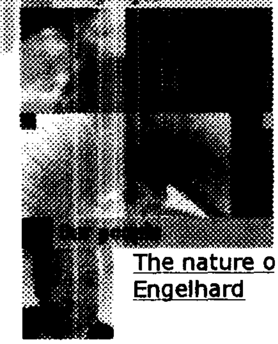

Technologies we create | Markets we serve

Environmental

Environmental Overview | Environmental Technologies | Environmental Market Applications

Environmental

A leader in clean air technology for more than 60 years, Engelhard has unsurpassed expertise in the development of environmental catalysts for a wide range of applications that protect the air we breathe.

Catalyst expertise enabled Engelhard to pioneer the development of the first catalytic converters for automobiles. One of the most important pollution abatement devices ever invented, the catalytic converter reduces tailpipe emissions by up to 97 percent. The catalytic converter is now a key component of every car driven in America.

Engelhard environmental catalysts are also used today to minimize emissions from buses, trucks,motorcycles, and mopeds. Environmental catalysts are also effective in the reducing stack emissions from power plants and factories.

Though not as visible as cars, buses, trucks or giant smokėstacks, small engines are a major source of pollution. Weed wackers, leaf blowers, and lawn mowers are meaningful sources of pollution right in our own backyards. Engelhard environmental catalysts makes these tools and equipment run cleaner.

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Applications expertise

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CORMETECH

Technical Data

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Cormetech has shared its knowledge and experience with the industry through technical papers presented at conferences and symposiums. You can access papers presented by Cormetech's experts here.

- Zero Ammonia Slip Technology for Combined Cycle Gas Turbine Exhaust
- B&W's NOx Reduction Systems and Equipment at Moss Landing Power Plant
- SCR Catalyst Performance Under Severe Operating Conditions
- ICAC Forum '94
  Living With Air Toxics and NOx Emissions Controls
- Implementation of SCR System at TVA Paradise 2
- Optimizing SCR Catalyst Design and Performance for Coal-Fired Boilers
- Catalyst Design Experience for 640 MW Cyclone Boiler Fired with 100% PRB Fuel
- Successful Implementation of Cormetech Catalyst in High Sulfur Coal-Fired SCR Demonstration Project
- Quality Assurance of Catalysts During the Life of SCR Systems Through Periodic Laboratory Performance Testing

Karl Lany

From: andrew.morton@ps.ge.com
Sent: Wednesday, February 18, 2004 5:38 PM
To: rbg@ci.riverside.ca.us; dtateosian@powereng.com
Cc: harry.cotham@ss.ps.ge.com; jimmy.holub@ps.ge.com
Subject: FW: Riverside Air Permit Issue

RIVERSIDE RTUP EMISSION 72 RIVERSIDE RTUP EMISSION 10

Bob, attached are the NOx and CO emissions during the 10-minute start-up for
the 73F and 100F degree days and comments from our SCR supplier. Note that the ATS Express SCR is fitted with an ammonia pre-heater that heats the injection chamber, allowing for injection of NH3 once the unit has reached base load after 10 minutes. Emission levels will be within specified requirements soon after the injection begins.

Begin comments:
"During a cold start, it will take some time before the SCR ammonia injection chamber is hot enough to heat the ammonia for injection and the catalysts are hot enough to react effectively. That being said, it has been our experience that air permits will allow for this during the 10 minute start-up of the CTG, so expected emissions out of the SCR stack during the 10 minute start will be the same as what is coming from the turbine. The SCR includes an electric pre-heater for the ammonia injection chamber, eliminating the need to wait for the ammonia injection chamber to come to temperature. Upon completion of the 10 minute CTG start cycle, the SCR will be ready to inject ammonia and the catalysts will be at an adequate temperature to react with the exhaust. After 10 minutes, the SCR will be fully capable of making the guaranteed emissions levels.

Short answer is during the 10 minute start, the emissions levels are per the attached performance. After 10 minutes, the SCR can meet the guaranteed emissions levels per our guarantee PROVIDED that RPU does not disable/deactivate the ammonia injection grid pre-heater prior to the 10 minute start.

The volumetric air flow of the SCR's tempering air fans is 18,200 CFM. I've attached Excel versions of the expected start-up emissions that included the volumetric air flow from the turbine. Add these together for each case and you have the total volumetric air flow of the system."
End comment.

Notes:
- 10 minute startups assume SCR purge requirements have been satisfied prior to startup
- gas turbine volumetric flow rates are shown in the attached spreadsheet for the stated load conditions.
- Cases shown have no inlet air conditioning during startup

Let me know if you need additional info on this subject or others.

Regards,
Andrew

APPENDIX-I
B03-217 GE Aero – BASE: 12" Backpressure
SCR AND CEMS PACKAGE PROPOSAL FORM

8. Equipment Data Sheets:

DATA SHEET FOR CO AND SCR - BASE			
1.0	**Design and Construction Details**	**CO**	**SCR**
1.1	Catalyst material	Pt. on Alumina	Ti-V-W
1.2	Catalyst manufactured by	Engelhard	Cormetech, Inc.
1.3	Number of catalyst layers	1	1
1.4	Total number of modules	Later	8
1.5	Catalyst Module length x width x height (ft)	Later	31.75"d x 106.125"w x 78.5"h
1.6	Include room for a spare layer	Yes	Yes / No
1.7	Catalyst module cells per sq in.	155	84
1.8	Catalyst space volume {ratio of gas volume (ft^3/hr) and catalyst volume in service (ft^3)}	Nom. 205,000 Max.	15350
1.9	a) Catalyst conversion efficiency %	See Proposal – 95% Min.	90
	b) Catalyst efficiency after 10000 hours of operation	See Proposal – 95% Min.	90
1.10	Catalyst washing requirements	DE-ION Water	N/A
1.11	The maximum temp. catalyst can withstand ^0F	1250	600 °C (cumulative 4 hours)
1.12	Minimum operating catalyst temperature ^0F	500	485
1.13	Over temperature protection for catalyst	Alarm	Alarm
1.14	Differential pressure protection	Alarm	Alarm
1.15	Exhaust gas face velocity through catalyst housing, fps	20 Max.	9.0
1.16	Ammonia Injection Grid (AIG)	N/A	
	Number of headers	N/A	8
	Branches per header	N/A	7
	AIG pipes total	N/A	64
1.17	Ammonia Flow Control Skid	N/A	
	Number of blowers / fans provided	N/A	2 x 100%
	Atomizing air requirements (CFM)	N/A	660
	How is the ammonia injection skid controls interfaced with plant controls?	N/A	Via GE Fanuc PLC
1.18	Catalyst support frame / structure	A387-11 or SS	A387 Grade 11 Chrome Moly
1.19	Number of test elements provided for each layer of catalyst	8	8 test elements plus 3 spare
1.20	List of catalyst poisons and operating conditions that may reduce the life of catalyst.	See Warranty	See catalyst poisons document
1.21	Catalyst life, (operating hours)	25,000	25,000
1.22	Pressure drop, (In of WC)	1.7" wg Max.	4.6
1.23	Lifting equipment and tools	N/R	TBD
1.24	At design operating conditions, estimated ammonia consumption, lb/hr	N/A	76 (19% aqueous)
1.25	Will the catalyst supplier accept spent catalyst for disposal?	Yes	No

PROPOSERS INITIALS____________

1.26	Type of gaskets used	**Zetex Rope**	**Pillow gasket (fiberglass tape around fiberglass blanket)**
2.0	**Ducting, Insulation and Lagging**		
2.1	Duct external material and thickness	**¼" A36**	**¼" A36**
2.2	Duct internal material and thickness	**12 GA 409SS**	**12 GA 409SS**
2.3	Internally Insulated / External insulation	**4" Internal**	**4" Internal**
2.4	Insulation Material and Density	**8# Ceramic Fiber**	**8# Ceramic Fiber**
2.5	Lagging material and thickness	**N/A**	**N/A**
2.6	Stack height and diameter	**80 Ft. 13' – 0" I.D.**	
3.0	List out the flow model studies included in the proposal.	**Nels Physical Model**	
4.0	Total auxiliary power consumption for the SCR and CO system	**176.4 KW @ Operating Guarantee Pt. (per system)**	
5.0	Ammonia consumption rates. (gpm)	**See Gas Turbine Data Sheets**	

DATA SHEET FOR AMMONIA SYSTEM

1.0	**General Information**	
1.1	Equipment Name	Aqua Ammonia Storage Tank
1.2	Purpose of the equipment	To store reactant used in SCR
1.3	Size	1x 12,000 Gal (net capacity)
1.4	Type	Horizontal, ASME Section-VIII construction.
1.5	Fluid	19% aqua ammonia
1.6	Other details	Vessel shall be provided with safety relief and vacuum breaker.
2.0	**Specific Information**	
2.1	Process Connections	Proposer to Provide a P&ID and show connections
2.3	Average operating temperature	70° F
2.4	Maximum operating temperature	100° F
2.6	Normal operating pressure	150 psig
2.7	Maximum operating pressure	225 psig
3.0	**Construction Details**	**Proposer to fill in all the data**
3.1	Design Pressure	250 psig
3.2	Design Temperature	150° F
3.3	Test Pressure	325 psig
3.4	Maximum permissible temperature for the vessel	-20 / 150° F
3.5	Shell / Vessel Internal diameter	96"
3.6	Shell thickness	0.875"
3.7	Corrosion allowance	0.625"
3.8	Saddle Support thickness	0.5"
3.9	Connections (Size/Pressure Class/End Preparation):	
	▪ Truck unloading fill connection	2" / 150# / RF
	▪ Drains outlet	2" / 150# / RF
	▪ Vessel relief valve	2" / 150# / RF
	▪ Vessel vent connection	2" / 150# / RF
	▪ Inspection connection	18" / 150# / RF
	▪ Connection for level gage	4" / 150# / RF
	▪ Connection for pressure gage	½" NPT / 3000 /cplg
	▪ Temperature thermowell	¾" NPT / 3000# / cplg
	▪ Transfer pump suction connection	2" / 150# / RF
	▪ Vapor return connection	2" / 150# / RF
3.10	Code requirements	ASME Section VIII, Div-I
3.11	Type of joints, vessel side	Welded
3.12	Radiography Shell and dish ends	100% FXR
3.13	Magnetic particle inspection	Yes
3.14	Stress relief	Yes
3.15	Surface preparation inside and external	INT–Blast & Corr. Inh./EXT-Blast & Paint
3.16	Insulation clips (for applying 1" thick insulation)	N/A
4.0	**Materials of Construction**	
4.1	Shell	SA 516-70
4.2	Saddle support	A 36
4.3	Connection isolation valves	SS Trim - Ball Valve

APPENDIX-I

B03-217 GE Aero – BASE: 12" Backpressure

SCR AND CEMS PACKAGE PROPOSAL FORM

DATA SHEETS FOR PUMPS

1.0	**Design Parameters**	**Proposer to fill in the data**		
1.1	Name of the pump	Milton Ray		
1.2	Number of Pumps (operating + standby)	(1+1)		
1.3	Fluid Pumped:	19% Aqueous Ammonia		
1.4	Design Flow, gpm	0.35 each (0.7 total)		
1.5	Discharge head (TDH)	200		
1.6	Required total head, with 5% margin:	231		
1.7	Specific Gravity, ref 60°F:	0.929		
1.8	Site Barometric Press; mmHg	740 @ 750' / AMSL		
1.9	Viscosity at Design Temp, cp	0.125		
1.11	Design Temperature °F:	70		
1.12	Range, Min to Max, gpm	0.1 – 0.35		
1.13	Suction Pressure, psig	ATM		
1.14	Available NPSH/ ft Water reference point:	4 (low level to pump cl)		
1.15	Maximum allowable shutoff Head, ft water/psig:	230 ft. / 99.6 psig		
1.16	Vapor Pressure at design Temp, psig	14.7 psig @ 124° F		
1.17	Available cooling water Temperature, °F:	NA		
1.18	Rated HP:	¼		
1.19	Installation, indoors/Outdoors	Outdoors		
2.0	**Construction Details**	**Diaphragm Metering**		
2.1	Impeller Material	Teflon Diaphragm Pump		
2.2	Casing Material	CS		
2.3	Shaft Material	CS		
2.4	Pump Type	Diaphragm		
2.5	Casing Split	[redacted]		
2.6	Drive Arrangement			
2.7	Base Type			
2.8	Mount Arrangement			
2.9	Rotation = Cplg end			
2.10	Pumps Identical			
2.11	Impeller Type			
2.12	***Bearing Detail***			
	Radial	[redacted]		
	Thrust			
	Bearing Lubrication			
	Bearing/ Sealing Cooling			
2.13	***Nozzle Detail***			
	Suction Location	Top	End	Bottom X
	Suction Type	Flanged	Screwed X	
	Discharge Location	Top X	Side	Bottom

APPENDIX-I
B03-217 GE Aero – BASE: 12" Backpressure
SCR AND CEMS PACKAGE PROPOSAL FORM

	Discharge Type	Flanged	Screwed X	
3.0	**Factory Tests**			
3.1	Performance	None X	Non witnessed	Witnessed
3.2	Hydrostatic	None X	Non witnessed	Witnessed
3.3	NPSH	None X	Non witnessed	Witnessed

Note: Proposer shall fill in this data sheet separately for ammonia unloading and transfer pumps

No unloading pumps.

Cooling Tower Data Sheet

GE AEP

Project:	031134-GE AEP Riverside (Alt.)	
Location:	Riverside, California	
Product Type:	AT	Cooling Tower

Evapco, Incorporated
P.O. Box 1300
Westminster, MD, 21158, U.S.A.
410-756-2600 Fax: 410-756-6450

Selection Criteria Date: 12/02/03 Page: 1

Capacity (Tons):	3,130.40
Capacity (MBH):	46,956.000
Fluid:	Water
Flow (GPM):	5590.0
Entering Fluid Temp (F):	96.6
Leaving Fluid Temp (F):	79.8
Wet Bulb (F):	72.0

Exhaust Temp:
Drift Rate:
Fan Guard Height:
Exit Diameter:

Selection

Qty	**AT Model**	**Capacity (Tons)**	**Percent Capacity**
1	314-0772	3,140	100.3

All Weights, Dimensions and Technical Data are Shown per Unit

# Fans:	3	Overall Length :	71' 8.00"
# Fan Motors @ HP:	(3) @ 50.00	Overall Width :	13' 11.25"
		Overall Height :	18' 3.50"
Air Flow (CFM):	613,000 (204,333/cell)	Operating Weight (lbs):	105,720
		Shipping Weight (lbs):	58,170
Inlet Pressure Drop (psi):	0.7	Heaviest Section (lbs):	12,210
Evaporated Water Rate (gpm):	75.1		

Options Selected

Layout Criteria

Recommended Clearances Around Units (Feet)

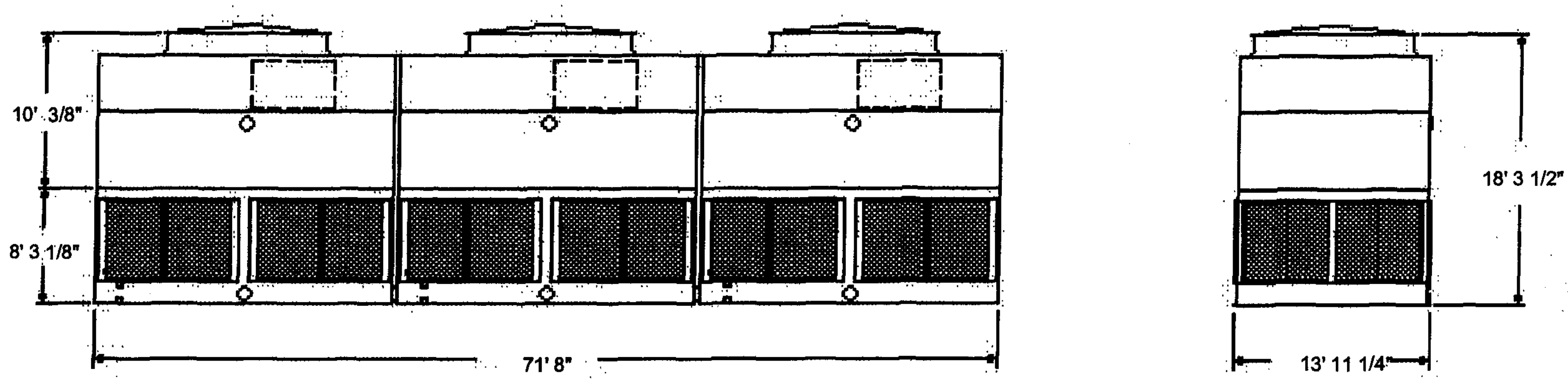
From Unit Ends to Wall:	4	Between Unit Ends:	5
From Sides to Wall:	7	Between Unit Sides:	12

Refer to the Equipment Layout Manual or contact your Sales Representative for more details on layout criteria.

Shipping Data

Description **Section**		***Domestic Skidded Dimensions (in)*** **Length**	**Width**	**Height**	**Cubic Feet**	**Total Cubic Feet**	**Gross Wt (lbs)**	**Total Gross Wt (lbs)**
Basin:	3	294	167	102	2898	8694	7,180	21,540
Casing:	3	303	167	123	3602	10805	12,210	36,630
Totals:	6				6500	19500	19,390	58,170

Shipping Notes: Ships with fan screen loose; Escorted extra wide truck



Notes:

1. Make-up water pressure 20 psi MIN. 50 psi MAX.
2. An adequately sized bleed line must be installed in the cooling tower system to prevent build-up of impurities in the recirculated water.
3. Do not use drawings for certified prints. Dimensions subject to change.
4. Height does not include fan guards. Fan guards ship loose for field mounting.
5. Outlet connection extends 3/8" beyond bottom flange.
6. Adequate spacing must be allowed for access to the cooling tower.
7. Access door swings inside unit.

Connections:

Description	Qty	Size	Type
Inlet:	3	14.0	BFW/Grooved
Outlet:	3	14.0	BFW/Grooved
Make-Up:	3	3.00	Male Pipe Thread
Drain:	3	4.00	Female Pipe Thread
Overflow:	3	4.00	Female Pipe Thread

Qty: 1	Model: **AT 314-0772**	Customer:	Project:

Capacity:

Fluid:	**Water**
Flow (GPM):	**5560.0**
Temp In (F):	**96.6**
Temp Out (F):	**79.8**
Wet Bulb (F):	**72.0**

Fan Motors:

Qty: **3** HP: **50.00**

Type: **TEAO**

Elec: **460/3/60**

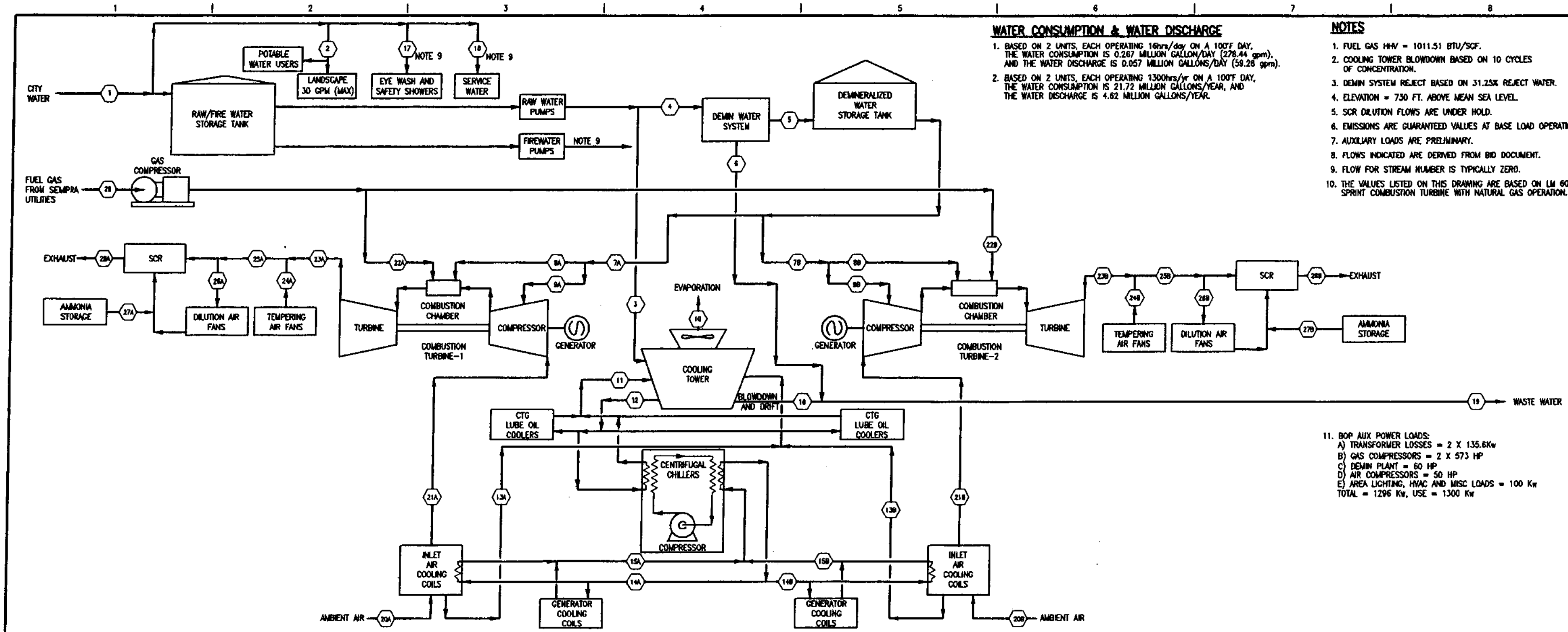
Weights (lbs)

Shipping:	**58170**
Operating:	**105720**
Heaviest:	**12210**
No. Sections:	**6**

Date: **12/01/03**

P.O. Box 1300
Westminster, MD, 21158
Phone 410-756-2600
Fax 410-756-6450

1 | 2 | 3 | 4 | 5 | 6 | 7 | 8



WATER CONSUMPTION & WATER DISCHARGE

1. BASED ON 2 UNITS, EACH OPERATING 16hrs/day ON A 100°F DAY, THE WATER CONSUMPTION IS 0.267 MILLION GALLON/DAY (278.44 gpm), AND THE WATER DISCHARGE IS 0.057 MILLION GALLONS/DAY (59.26 gpm).
2. BASED ON 2 UNITS, EACH OPERATING 1300hrs/yr ON A 100°F DAY, THE WATER CONSUMPTION IS 21.72 MILLION GALLONS/YEAR, AND THE WATER DISCHARGE IS 4.62 MILLION GALLONS/YEAR.

NOTES

1. FUEL GAS HHV = 1011.51 BTU/SCF.
2. COOLING TOWER BLOWDOWN BASED ON 10 CYCLES OF CONCENTRATION.
3. DEMIN SYSTEM REJECT BASED ON 31.25% REJECT WATER.
4. ELEVATION = 730 FT. ABOVE MEAN SEA LEVEL.
5. SCR DILUTION FLOWS ARE UNDER HOLD.
6. EMISSIONS ARE GUARANTEED VALUES AT BASE LOAD OPERATION.
7. AUXILIARY LOADS ARE PRELIMINARY.
8. FLOWS INDICATED ARE DERIVED FROM BID DOCUMENT.
9. FLOW FOR STREAM NUMBER IS TYPICALLY ZERO.
10. THE VALUES LISTED ON THIS DRAWING ARE BASED ON LM 6000 SPRINT COMBUSTION TURBINE WITH NATURAL GAS OPERATION.
11. BOP AUX POWER LOADS:
    A) TRANSFORMER LOSSES = 2 X 135.6Kw
    B) GAS COMPRESSORS = 2 X 573 HP
    C) DEMIN PLANT = 60 HP
    D) AIR COMPRESSORS = 50 HP
    E) AREA LIGHTING, HVAC AND MISC LOADS = 100 Kw
    TOTAL = 1296 Kw, USE = 1300 Kw

STREAM NO.	1				2				3				4				5				6			
CASE	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
FLOW RATE (LB/HR)	139,220	156,535	119,980	71,570	15,000	15,000	15,000	–	43,200	60,515	23,960	1,375	81,020	81,020	81,020	70,195	55,702	55,702	55,702	48,258	25,320	25,320	25,320	21,935
FLOW RATE (GPM)	278.44	313.07	239.96	143.14	30	30	30	–	86.4	121.03	47.92	2.75	162.04	162.04	162.04	140.39	111.40	111.40	111.40	96.52	50.64	50.64	50.64	43.87
TEMP (F)	75	75	63	50	75	75	63	–	75	75	63	50	75	75	63	50	75	75	63	50	75	75	63	50

STREAM NO.	7A/B				8A/B				9A/B				10				11			
CASE	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
FLOW RATE (LB/HR)	27,851	27,851	27,851	24,129	22,960	22,960	22,960	24,129	4,881	4,881	4,881	0	38,880	54,465	21,560	1,240	2,250,000	2,250,000	2,250,000	120,000
FLOW RATE (GPM)	55.70	55.70	55.70	48.26	45.92	45.92	45.92	48.26	9.78	9.78	9.78	0	77.76	108.93	43.12	2.48	4,500	4,500	4,500	240
TEMP (F)	75	75	63	50	75	75	63	50	75	75	63	50	–	–	–	–	96.2	105.3	86.52	60

STREAM NO.	12				13A/B				14A/B				15A/B				16				17			
CASE	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
FLOW RATE (LB/HR)	2,250,000	2,250,000	2,250,000	120,000	980	710	3,700	0	1,312,920	1,624,163	951,479	–	1,312,926	1,624,163	951,479	–	4,320	6,050	2,400	135	0	0	0	0
FLOW RATE (GPM)	4,500	4,500	4,500	240	1.96	1.42	7.4	–	2,626	3,248.3	1,903	–	2626	3,248.3	1903	–	8.64	12.1	4.80	0.27	0	0	0	0
TEMP (F)	80	84	74.8	50	75	75	60	–	36	36	36	–	47	47	47	–	80	84	74.8	50	75	75	63	50

STREAM NO.	18				19				20A/B				21A/B				22A/B			
CASE	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
FLOW RATE (LB/HR)	0	0	0	0	29,640	31,370	27,720	22,070	1,008,767	1,008,767	1,009,131.6	HOLD	1,008,767	1,008,767	1,009,131.6	1,074,475.91	20,117.7	20,118.12	20,118.4	20,069.09
FLOW RATE (GPM)	0	0	0	0	59.28	62.74	55.44	44.14	–	–	–	–	–	–	–	–	–	–	–	–
TEMP (F)	75	75	63	50	75.73	76.74	64.02	50	100	115	72.2	18.0	46	46	46	32	250	250	250	250

STREAM NO.	23A/B				24A/B				25A/B				26A/B			
EMISSIONS / CASE	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
FLOW RATE (LB/HR)	1,056,736	1,056,736	1,057,101	1,118,664	HOLD	HOLD	HOLD	HOLD	HOLD	HOLD	HOLD	HOLD	HOLD	HOLD	HOLD	HOLD
FLOW RATE (GPM)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
TEMP (F)	828.1	828.1	828.1	761.2	HOLD	HOLD	HOLD	HOLD	HOLD	HOLD	HOLD	HOLD	HOLD	HOLD	HOLD	HOLD
NOx, PPMVD, 15% O2	25	25	25	25												
NOx, PPH	42	42	42	42												
CO, PPMVD, 15% O2	40	40	40	60												
CO, PPH	40	40	41	60												
PM 10 PARTICULATES	–	–	–	–												
NH3 SLIP, LB/HR PPMVD 15% O2	–	–	–	–												

STREAM NO.	27A/B				28A/B				29			
EMISSIONS / CASE	I	II	III	IV	I	II	III	IV	I	II	III	IV
FLOW RATE (LB/HR)	99	99	99	99	HOLD	HOLD	HOLD	HOLD	40,235.4	40,236.2	40,236.8	40,118.18
FLOW RATE (GPM)	–	–	–	–	–	–	–	–	–	–	–	–
TEMP (F)	–	–	–	–	HOLD	HOLD	HOLD	HOLD	75	75	75	75
NOx, PPMVD, 15% O2	–	–	–	–	2.5	2.5	2.5	2.5	–	–	–	–
NOx, PPH	–	–	–	–	4.2	4.2	4.2	4.2	–	–	–	–
CO, PPMVD, 15% O2	–	–	–	–	6.0	6.0	6.0	6.0	–	–	–	–
CO, PPH	–	–	–	–	6.1	6.1	6.1	6.0	–	–	–	–
PM 10 PARTICULATES	–	–	–	–	3.0	3.0	3.0	3.0	–	–	–	–
NH3 SLIP, LB/HR PPMVD 15% O2	–	–	–	–	5.0	5.0	5.0	5.0	–	–	–	–

PERFORMANCE SUMMARY

CASE	I	II	III	IV
COMBUSTION TURBINE Kw/UNIT	49,800	49,800	49,800	50,454
NUMBER OF CTG'S	2	2	2	2
TOTAL GROSS OUTPUT, Kw	99,600	99,600	99,600	100,908
CTG AUX POWER/LOSSES, Kw	2,818	3,298	2,250	964
BOP AUX POWER AND GSU TRANSFORMER LOSSES Kw	1,300	1,300	1,300	1,300
NET PLANT, Kw	95,482	95,002	96,050	98,644
FUEL INPUT/UNIT MMBTU/HR (LHV)	425.55	425.559	425.565	424.31
TOTAL FUEL INPUT/MMBTU/HR (LHV)	851.10	851.12	851.13	848.62
NET PLANT HEAT RATE				
BTU/KWH (LHV)	8,913.72	8,958.87	8,861.32	8,602.85
BTU/KWH (HHV)	9,849.66	9,899.66	9,791.76	9,506.15

CASE
I = SUMMER DESIGN, 100°F DBT, 68°F WBT, 19% RH
II = MAX SUMMER, 115°F DBT, 72°F WBT, 12% RH
III = AVERAGE ANNUAL, 72.2°F DBT, 62.8°F WBT, 60% RH
IV = WINTER DESIGN, 18°F DBT, 18°F WBT, 100% RH

INTER-DISCIPLINE REVIEW							
DISC	ARCH	CIVIL	ELECT	HVAC	I&C	MECH	STRUCT
DATE	–	9/5/03	9/5/03	–	9/5/03	9/5/03	9/5/03
INIT	–	WKW	LT	–	MAC	PR	KL

REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD
D	ISSUED FOR BID	2/12/04	JAB	PR	JPB	JPB
C	ISSUED FOR REVIEW	1/26/04	JAB	PR	JPB	JPB
B	ISSUED FOR REVIEW	10/21/03	CEA	PR	JPB	DT
A	ISSUED FOR REVIEW	9/5/03	JAB	PR	JPB	DT

REFERENCE DRAWINGS

DSGN	PR	7/19/02
DRN	JAB	8/29/03
CKD	JPB	9/5/03
SCALE:	NONE	

FOR 22x34 DWG ONLY

POWER ENGINEERS

RIVERSIDE PUBLIC UTILITIES
RIVERSIDE ENERGY RESOURCE CENTER
PROCESS FLOW DIAGRAM

JOB NUMBER: 101414
REV: D
DRAWING NUMBER: M2-1

A | B | C | D

EXHIBITS 3 AND 4
(Provided via CD)