

Message Information

Date 12/10/2009 07:00 PM
From "Van Dalen, Corinne J" <cvandale@tulane.edu>
To LisaP Jackson/DC/USEPA/US@EPA
cc <kmiller@frilot.com>; <hal.leggett@la.gov>
Subject Title V Petition to EPA - Murphy Oil

Message Body

Dear Administrator Jackson,

Attached is a petition that we sent pursuant to Title V of the Clean Air Act to EPA today asking you to object to the Title V permit issued to Murphy Oil USA for its refinery in Louisiana.

Sincerely,



Corinne Van Dalen 12-10-09-Murphy_DFT_EPA_Petition.FINAL.pdf

OEX Processing Information

Processed Date:

Processed By

PO Office

Category:

Message Count

BEFORE THE ADMINISTRATOR
U.S. ENVIRONMENTAL PROTECTION AGENCY

In the Matter of the Title V Air Operating Permit
Modification, Meraux Refinery, Murphy Oil, USA
Meraux, Louisiana

Permit No.: 2500-00001-V5
Activity No.: PER20090002
LDEQ Agency Interest No.: 1238

Issued to Murphy Oil, USA
By the Louisiana Department of Environmental Quality

**PETITION REQUESTING THE ADMINISTRATOR TO OBJECT TO THE
TITLE V OPERATING PERMIT MODIFICATION NO. 2500-00001-V5 FOR MURPHY
OIL, USA , MERAUX REFINERY**

Pursuant to section 505(b) of the Clean Air Act, 42 U.S.C. § 7661d(b)(2) and 40 C.F.R. § 70.8(d), Concerned Citizens Around Murphy¹ petition the Administrator of the U.S. Environmental Protection Agency to object to the Title V Air Operating Permit (No. 2500-00001-V5; "Permit") issued on October 15, 2009 by the Louisiana Department of Environmental Quality ("LDEQ") to Murphy Oil, USA for the Meraux Refinery ("refinery") in Meraux, Louisiana.

Petitioner bases this petition on comments it filed with LDEQ on August 4, 2009 during the public comment period on the draft permit. A qualified engineer, J. Phyllis Fox, PhD, PE, DEE, prepared the technical analysis in these comments. Petitioner incorporates by reference its comments (including a copy of Dr. Fox's C.V.), which it attaches here as Exhibit A.

¹ Concerned Citizens Around Murphy is a non-profit corporation organized under the laws of the State of Louisiana and is a "person" within the meaning of 42 U.S.C. § 7602(e). Its purpose is to protect the health, safety, environment, and quality of life of Meraux and the surrounding communities in St. Bernard Parish. Concerned Citizens Around Murphy has individual members who breathe and are otherwise exposed to air pollutants from the Meraux Refinery.

SUMMARY

The Application that Murphy Oil submitted to LDEQ to obtain the Permit at issue is incomplete. Murphy Oil failed to include support for emissions calculations. Regardless, LDEQ issued the Permit without requiring the needed support. Consequently, LDEQ, EPA, and the public are unable to verify the emissions figures for this permit. For this reason alone, EPA should object to the Permit and require LDEQ to obtain the support for Murphy Oil's emission calculations, which LDEQ had to take at face value when making its permit decision.

In addition, Murphy Oil has incorrectly suggested that the estimated increase in emissions from its proposed modifications to the Meraux Refinery is below Clean Air Act Prevention of Significant Deterioration (PSD) significance thresholds and thus does not trigger New Source Review (NSR). Ap., p. 7 (LDEQ-EDMS Doc. 40169977, p. 14 of 435). LDEQ has adopted Murphy Oil's calculations. However, these calculations exclude significant emission sources and miscalculate sulfur dioxide (SO₂) emissions. As explained in detail below, if Murphy Oil corrects its errors and omissions, the net increase in emissions exceeds PSD significance thresholds for at least volatile organic compounds (VOCs) and SO₂, triggering PSD review for these pollutants. Moreover, Murphy Oil's calculations rely on limits to emissions that are not practically enforceable.

For these reasons, the Administrator should object to the Permit because it violates the Clean Air Act.

BACKGROUND

Factual and Procedural Background

Murphy Oil submitted a Significant Source Modification Application to LDEQ in February 2009 to construct and operate a benzene saturation unit ("BenFree Unit"²) at its Meraux Refinery. Murphy Oil claims this unit will remove benzene from gasoline to satisfy EPA's Mobile Air Sources Toxics rule. In addition to the BenFree Unit, however, the 2/09 Application pp. 2-3 includes the following modifications:

- modifications to several tank emission caps,
- cancellation of rerouting the Oily Water Stripper vent stream to the fuel gas system,
- emissions for the No. 2 Amine Unit turnaround / startup/shutdown omitted from the current permit,
- "reconciliation" of turnaround emissions for other units, changing current one-year startup/shutdown emissions to a yearly estimate based on five-year total emissions.

Additionally, Murphy Oil amended the 2/09 Application in May 2009 to include Boiler B-7. LDEQ had previously permitted Boiler B-7, but Murphy Oil never installed it. Instead, Murphy Oil used a temporary rental boiler to supplement steam production when necessary during planned maintenance activities. Petitioner collectively refers to the 2/09 Application and the 5/09 Addendum as "the Application."

LDEQ transmitted the Permit to the Administrator for review around June 1, 2009, triggering EPA's 45-day review period as required by CAA § 505(b)(2), 42 U.S.C. § 7661d(b)(2). Subsequently, EPA restarted the clock for EPA's 45-day review period so that the period ended October 10, 2009. Petitioner files this petition within sixty days following the end

² BenFree is a trademark process of Axens which reduces benzene from reformate through integrated reactive distillation. The process uses high pressure pumps to withdraw benzene rich light fractions from the splitter to the hydrogenation unit, where benzene is converted to cyclohexane. Available at <http://www.axens.net>.

of EPA's review period as required by CAA § 505(b)(2), 42 U.S.C. § 7661d(b)(2). The Administrator has sixty days to grant or deny this Petition after Petitioner has filed it. The Act provides that "[i]f any permit contains provisions that are determined by the Administrator as not in compliance with the applicable requirements of this chapter, . . . the Administrator shall . . . object to its issuance." 42 U.S.C. § 7661d(b)(1).

Regulatory Background

State and Federal New Source Review regulations aim to protect air quality standards from the impact of new sources of pollution. The Prevention of Significant Deterioration program is a subset of New Source Review designed specifically to protect a geographic area that attains Clean Air Act air quality standards for a regulated air pollutant.³ Any "significant" "net increase" in emissions of an attainment pollutant from the modifications of an existing stationary source triggers PSD requirements.⁴ These requirements include, *inter alia*, air dispersion modeling,⁵ to ensure that an emissions increase does not jeopardize attainment, and the "best available control technology" ("BACT"),⁶ to control emissions of the pollutant of concern.

The process for determining whether a net increase in emissions of a given pollutant will be "significant," and thereby trigger PSD requirements, has two steps.⁷ First, the state permitting authority must determine whether the modification will result in a significant emissions increase. Then, the permitting authority must determine whether a significant *net* emissions increase will

³ See LAC 33:III.509 (included in Louisiana State Implementation Plan ("SIP"), which is a set of Louisiana statutes and regulations implementing the Clean Air Act).

⁴ *Id.*

⁵ LAC 33:III.509.D and K.

⁶ LAC 33:III.509.J; see also *Louisiana Guidance for Air Permitting Actions*, available at <http://www.deq.louisiana.gov/portal/tabid/64/Default.aspx>

⁷ LAC 33:III.509.A.4 ("If the project causes a significant emissions increase, then the project is a major modification only if it also results in a significant net emissions increase.")

occur. As explained below, netting requires an accounting of *all* emissions increases associated with the modification, as well as any plant-wide emissions increases or decreases occurring contemporaneously with the modification. Complete inclusiveness is essential; an omission of any significant emissions source may preclude PSD requirements and thereby jeopardize air quality standards.

To first calculate whether the modification will result in a significant emissions increase, the permitting authority must determine each new and modified unit's "potential to emit" (PTE) for the regulated pollutants of concern.⁸ PTE is the sum of the maximum potential emissions increase from *all* units of the facility affected by the modification.⁹ If the PTE for any pollutant is higher than the "significance threshold" for that pollutant identified in the State Implementation Plan (SIP), then the authority must proceed to the second step of determining whether the facility's net emissions of the pollutant will increase due to the proposed modification.¹⁰

In step two, netting takes into account any other contemporaneous increases or decreases in emissions at the facility. "Contemporaneous" means occurring between 1) the date five years before construction begins on the modifications in question and 2) the date when those modifications result in an increase in emissions.¹¹ If the increase in emissions from the modifications does not "net out;" *i.e.*, go below the significance threshold by sufficient emissions

⁸ For existing emissions units, the Louisiana SIP allows a source to use "projected actual emissions" (defined in LAC 33:III.509.B) rather than PTE. Because Murphy Oil opted to use PTE, see Final Permit p. 9.

⁹ See LAC 33:III.509.B (definition of potential to emit) and 509(A)(4)(d) ("A significant emissions increase of a regulated NSR pollutant is projected to occur if the *sum of the difference between the potential to emit*, as defined in Subsection B of this Section, *from each new emissions unit* following completion of the project and the baseline actual emissions, as defined in Subparagraph B.Baseline Actual Emissions.c of this Section, of these units before the project equals or exceeds the significant amount for that pollutant..." (emphasis added)); LAC 33:III.509.B (defining "emissions unit" broadly as "any part of a stationary source that emits or would have the potential to emit any regulated NSR pollutant.").

¹⁰ LAC 33:III.509.A.4.

¹¹ LAC 33:III.509.B

decreases at the facility as a whole, then the modification triggers PSD requirements.

Conversely, if the netting analysis shows the emissions increase for all pollutants of concern will stay below the significance threshold, then the modification does not trigger PSD requirements.

Furthermore, the Clean Air Act Title V operating permit program charges state permitting authorities with issuing each major stationary source a comprehensive operating permit that will “identify all emission limits for the source,” including “enforceable emissions limitations and standards” and “requirements to assure compliance with the permit terms and conditions.” *Sierra Club v. Environmental Protection Agency*, 536 F.3d 673, 674 (D.C. Cir. 2008), 42 U.S.C. § 7661c (a) and (c). Both the Title V statutory provisions and the implementing regulations require operating permits to contain sufficient conditions to ensure compliance, including compliance with PSD significance thresholds.

SPECIFIC OBJECTIONS

I. LDEQ ISSUED THE PERMIT WITHOUT REQUIRING A COMPLETE APPLICATION: MURPHY OIL FAILED TO PROVIDE SUPPORT FOR ITS EMISSIONS CALCULATIONS.

Title V regulations for revisions to Part 70 operating permits require an applicant to provide in its application in part the following emissions-related information:

(i) All emissions of pollutants for which the source is major, and all emissions of regulated air pollutants. A permit application shall describe all emissions of regulated air pollutants emitted from any emissions unit . . . (iii) Emissions rate in tpy and in such terms as are necessary to establish compliance consistent with the applicable standard reference test method. For emissions units subject to an annual emissions cap, tpy can be reported as part of the aggregate emissions associated with the cap, except where more specific information is needed, including where necessary to determine and/or assure compliance with an applicable requirement. . . [and] (viii) Calculations on which the information in paragraphs (c)(3)(i) through (vii) of this section is based.

40 C.F.R. § 70.5(c); *see also* 42 U.S.C. § 7661b(c). This information must be “sufficient to evaluate the subject source and its application and to determine all applicable requirements.” 40 C.F.R. § 70.5(a)(2). Furthermore, the regulations forbid an application from omitting “information needed to determine the applicability of, or to impose, any applicable requirement.” 40 C.F.R. § 70.5(c). However, Murphy Oil failed to provide all of this information in its application. Therefore, the Administrator must object because the permit application lacks emission information critical for determining applicable requirements and setting appropriate limits and conditions.

Appendix D of the Application contains over 300 pages of emissions calculations, many of which are illegible and supported only by general reference to emails or personal communications between Murphy Oil and its consultant Trinity Consulting. Petitioners asked LDEQ to provide the emails and content of the personal communications on which the emissions calculations rely. However, LDEQ does not have the information, stating that “[t]hese notes were entered by Murphy’s consultant to assist in keeping track of information related to prior modifications and revisions addressed via previously approved permit modifications.” LDEQ Resp. to Cmmts, resp. 20. LDEQ said that the “emails[] and personal communications do not reflect the absence of any essential information needed to review the permit application.” *Id.* However, many of the referenced emails and personal communications provide support for Murphy Oil’s emissions estimates for *this* modification (*i.e.*, emissions from the BenFree Unit), not prior projects—and are essential to verifying such figures.

For instance, Murphy Oil bases the combustion calculations for emissions of NO_x, SO_x, CO, PM, and VOCs from the BenFree Reboiler on “email correspondence between Matt Dobbins (MOUSA) and Cheri Kwast (Trinity) on December 4, 2008 and January 14, 15, and 26.

2009 and personal communication phone conversations on December 17, 2008.” Application, App. D, p. 1, fn 9. Again, Murphy Oil provides the fugitive emissions calculations for the BenFree Unit “[b]ased on Personal Communication emails from Matt Dobbins (MOUSA) to Cheri [last name eligible] (Trinity) on Dec. 4, 2008 and January 8 and 15, 2009.” *Id.* at 12, fn. 8. But where are these emails and what do they say? Petitioners do not know, and presume based on LDEQ’s inability to provide the emails upon request, that LDEQ does not know either. A further example is Murphy Oil’s statement that “[a]n emission factor of 0.275 lbs/MMBtu for CO was used based on a stack test conducted 3/02/04 as described in an email to Ms. Valerie Barth (Trinity) from Mr. Matt Dobbins (Murphy) dated October 1, 2004.” *Id.* at 1, fn. 4.¹² However, not only did Murphy Oil fail to provide the referenced email, it did not provide a copy of the stack test.

EPA should object to the Permit because Murphy Oil did not provide information “sufficient to evaluate the subject source and its application and to determine all applicable requirements.” 40 C.F.R. § 70.5(a)(2).

II. THE NETTING ANALYSIS FAILS TO INCLUDE EMERGENCY FLARING EMISSIONS.

Louisiana air regulations implementing the Clean Air Act require Murphy Oil to include emergency flaring emissions in the netting analysis for all regulated pollutants. Specifically, in the first step of netting, Murphy Oil must calculate the maximum potential emissions increase from *all* units of the facility affected by the modifications,¹³ including flares. A flare is an “emissions unit” in that it has the potential to release emissions both when not operating (pilot

¹² Petitioner could list over 100 additional examples of instances where Murphy Oil failed to provide any support for its assumptions or the underlying data necessary to prove its emissions calculations. Instead, Petitioner refers EPA to Appendix D of the Application.

¹³ See LAC 33:III,509.B (definition of potential to emit) and 509(A)(4)(d); see also, *infra*, Regulatory Background, note 7.

and purge) and while in use (active flaring). At Meraux Refinery, at least one flare will be “affected by the modifications” because, according to the Permit, “in an emergency or during maintenance activities, emissions from the [new BenFree Unit] will be controlled by routing the vent to the existing North Flare.”¹⁴

The problem here is that Murphy Oil’s netting analysis underestimates potential flare emissions by only including routine releases to the North Flare from the new BenFree Unit. These releases occur about five times a year with each incident lasting 30 minutes. *See* Exh. A, Petitioner’s Cmmts, Exh. 2, fn.11. They are part of the normal operation of the BenFree Unit. The netting analysis did not include the emergency emissions for any subject pollutant that are due to malfunctions at the BenFree Unit.

The netting calculations should, however, include those emergency emissions.¹⁵ The primary purpose of a flare is to handle “emergency” releases, which are not planned or anticipated for safety reasons, *e.g.*, to relieve pressure inside vessels to prevent explosions. These emergency releases occur when there are process and other types of malfunctions. The most severe emergency releases usually occur during power outages. In fact, for some facilities, releases from startups, shutdowns, and malfunctions were reportedly *higher* than total annual “routine” emissions for the entire facility for the entire year.¹⁶

¹⁴ *See* Final Permit p. 8.

¹⁵ *See*, for example, the flaring emission data compiled by the Bay Area Air Quality Management District, and published on its website at www.baaqmd.gov/enf/flares/.

¹⁶ Environmental Integrity Project, “Gaming the System – How Off the-Books Industrial Upset Emissions Cheat the Public Out of Clean Air” (Aug. 2004). The report found that more than half of the 37 facilities studied had start-up, shutdown, and malfunction (SSM) emissions of at least one pollutant that were 25% or more of their total reported annual emissions of that pollutant. For ten of the facilities, upset emissions of at least one pollutant actually exceeded the annual emissions that each facility reported to the state for that pollutant. SSM emissions of carbon monoxide (CO) from Exxon Mobil’s Baton Rouge facility were almost three times its reported annual CO emissions.

Nonetheless, LDEQ argues that, “because ‘emergency releases’ are not permitted” in Louisiana, Murphy Oil’s netting analysis need not reflect them.¹⁷ But, there is a difference between saying that emergency releases are “not permitted” and imposing a legally and practically enforceable prohibition on them. Moreover, LAC 33:III.507(J) allows for certain qualifying emergency releases. The next sections describe these regulations and show that the Permit violates the regulations because LDEQ did not, and most likely cannot, impose enforceable prohibitions on emergency flaring releases.

A. Netting analysis must include emergency flare emissions unless they are subject to a legally and practically enforceable limit.

Pursuant to federal and state regulations, the first step of netting requires the calculation of the “Potential to Emit” (PTE), defined as:

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.

LAC 33:III.509.B; 40 C.F.R. 51.166(b)(4) (state and federal provisions are identical). According to this definition, Murphy Oil’s PTE calculation must reflect Meraux Refinery’s maximum capacity to emit a source pollutant. To the extent that Murphy or LDEQ claims maximum capacity to emit is constrained in any way, the constraint must appear in the Permit as an *enforceable* physical or operational limit. The regulation gives examples of such limits, including (1) restrictions on hours of operation, (2) restrictions on the type or amount of fuel used, and (3) pollution control equipment. “Blanket restrictions” on “specific types and amounts of actual emissions” do not qualify as enforceable limits. *United States v. Louisiana Pacific Corp.*, 682 F.

¹⁷ LDEQ Response to Comment no. 9.

Supp. 1122, 1131-33 (D. Colo. 1987). Moreover, nowhere in the regulatory definition of PTE is there an exemption for emergency flaring.

Indeed, EPA determinations and guidance interpreting the controlling federal regulatory definition of PTE make clear that PTE must account for emergency flaring. In recent comments on a permit for stationary source modifications, EPA stated that only a “legally and practically enforceable” prohibition on emissions from startups, shutdown, and malfunctions, could obviate the need to include them in the netting analysis.¹⁸ Likewise, EPA has issued guidance stating:

The consensus is that for the purposes of determining PTE in the New Source Review (NSR) and Title V programs, EPA has no policy that specifically requires exclusion of “emergency” (or malfunction) emissions. Rather, to determine PTE, a source *must* estimate its emissions based on the worst-case scenario taking into account startups, shutdowns and *malfunctions*. [emphasis added]¹⁹

Similarly, the EPA Environmental Appeals Board (EAB), the agency’s supreme adjudicative body,²⁰ has recognized that flares will contribute to the increase in pollutants counted towards triggering PSD requirements.²¹ Given EPA and EAB’s interpretation of the meaning of the controlling federal definition of PTE, and the lack of supportable justification from LDEQ and Murphy Oil for their interpretations as discussed below, emergency flaring must be included in the PTE calculation in Murphy Oil’s netting analysis.

¹⁸ “EPA Order Partially Denying and Partially Granting Petition for Objection to Permit,” in the Matter of BP Products North America, Inc.: Whiting Business Unit, Permit No. 089-25488-00453, Aug. 10, 2009.

¹⁹ Feb. 14, 2006 Letter From Steven C. Riva, U.S. EPA to William O’Sullivan, Division of Air Quality, N.J. Dept. of Environmental Protection) (emphasis added) (“2006 Riva Letter”).

²⁰ The EAB is EPA’s supreme adjudicative body. See 57 Fed. Reg. 5320 (Feb. 13, 1992). EAB decisions represent the position of the EPA Administrator with respect to the matters brought before it. See *Tennessee Valley Auth. v. U.S. E.P.A.*, 278 F.3d 1184, 1198-99 (11th Cir. 2002) (finding EAB decision to be “final agency action”).

²¹ *In re: ConocoPhillips Co.*, PSD Appeal No. 07-02, Order Denying Review in Part and Remanding in Part, at 8-9 (June 2, 2008). The EAB further bolstered the requirement to treat flares as emissions units by its remand of the permit at issue to the state agency for a proper PSD program review of the Best Available Control Technology (“BACT”) for flaring emissions. See *In re: ConocoPhillips*, at 27-36. The EAB’s ruling requiring BACT for flares cannot be reconciled with BP’s attempt to omit active flaring emissions from the consideration as to whether PSD or NNSR should apply in the first instance.

In a state permitting proceeding under the Clean Air Act and Louisiana SIP, deference is due to EPA's interpretations over those of a state permitting agency, such as LDEQ. Moreover, definitions in Louisiana's SIP-approved regulations must be at least as stringent as the parallel federal definitions from which they derive. Indeed, Louisiana copied the definition of PTE verbatim from the federal definition, and EPA approved Louisiana's PSD definitions on the basis that they are consistent with definitions in 40 C.F.C. 51.166(b). 56 Fed. Reg. 20,137 (May 2, 1991). Likewise, EAB decisions interpreting the federal regulations, serve as persuasive authority on the interpretation of the regulatory definition.

B. The Permit Lacks Enforceable Limits on Emergency Flaring Emissions.

Murphy Oil's Permit does not bar emergency flaring emissions. In fact, the Permit states, "in an emergency or during maintenance activities, emissions from the [new BenFree Unit] will be controlled by routing the vent to the existing North Flare."²² Thus, Murphy Oil and LDEQ acknowledged the fact that the North Flare will have the capacity to release emergency emissions because of the modification project. During the public comment period on the draft permit, Petitioners explained that emergency emissions, therefore, must be included in Murphy Oil's netting analysis. In response to comments, LDEQ maintained that emergency emissions may be excluded because they are not permitted and must be reported as deviations, which are subject to enforcement action.²³ But, withholding permission and threatening enforcement do not amount to "legally and practically enforceable" prohibition. EPA should object to Murphy Oil's permit because any actual emissions that are excluded from the PTE calculation must be grounded in enforcement reality.

²² Final Permit p. 8.

²³ LDEQ Response to Comment No. 9.

Here, it is clear that LDEQ has not, and likely cannot, place enforceable limits on emergency flaring for three reasons: 1) blanket restrictions on emergency flaring do not qualify as enforceable limits; 2) Louisiana's PSD regulations exempt certain emergency emissions, and the Permit does not deny the applicability of these exemptions to Murphy's modification project; and 3) by definition, some emergency releases are "unavoidable" and "beyond the control of the owner and operator,"²⁴ which makes it unlikely that any restrictions on such emissions would be practically enforceable. Indeed, Louisiana PSD regulations carve out two exceptions for emergency ("upset") emissions releases. The following are summaries of the two exceptions:

1. Pursuant to the on-line operating adjustments provision, LAC 33:III, 1507(B), Murphy Oil is eligible for a four-hour (continuous) exemption from emission limitations where upsets (i.e., emergencies or malfunctions) have caused excessive emissions and on-line operating changes will eliminate a temporary condition.
2. Pursuant to the upset provision, LAC 33:III.507.j, Murphy Oil may establish an affirmative defense to an action for excessive emissions due to unavoidable (i.e., emergency) events.

The Permit does not deny the applicability of these regulatory exceptions to Murphy Oil's modification project. Instead, the Permit acknowledges that emergency emissions from the new BenFree Unit will be routed to the North Flare without any mention of a prohibition on such emissions or any other justification for why such emissions should be excluded from the PTE calculation. Contrary to LDEQ's suggestion, there is thus no practically and legally enforceable limit on emergency flaring in the Permit. Absent an enforceable limit, the potential to emit calculation in Murphy Oil's netting analysis *must* include emergency flaring releases. Because Murphy Oil and LDEQ unjustifiably excluded emergency flaring from the netting analysis, the Administrator should object to the Permit. Murphy Oil must supplement its Application with

²⁴ LAC 33:III,507.J.2.

emergency release emissions data and republish a draft permit for public comment with the updated information.

III. THE PROJECT TRIGGERS NSR REVIEW FOR SULFUR DIOXIDE AND VOLATILE ORGANIC COMPOUNDS.

A. Murphy Oil Underestimated Sulfur Dioxide Emissions.

Murphy Oil's netting analysis incorrectly concluded that the project would increase emissions of sulfur dioxide ("SO₂") by 26.85 ton/yr, which is less than the PSD significance threshold of 40 ton/yr. Briefing Sheet, p. 9 (LDEQ-EDMS Doc. 41456805, p. 13 of 786). SO₂ emission sources include: (1) the reboiler in the BenFree Unit; (2) the North Flare to which the BenFree Unit vents; and (3) Boiler B-7. Ap., Appx. D. However, Murphy's calculations left out a number of important factors.

Murphy Oil incorrectly based SO₂ emissions calculations solely on the H₂S content of combusted gas. 7/7/09 Quadri Email; Ap., p. 1 (fuel gas monitored by a H₂S CEMS), Appx. D, Emission Calculations, North Flare, footnote 7 (H₂S content is 159 ppmv); Ap., Appx. F, 10/8/08 Bourgeois Letter (requiring only monitoring of H₂S in flare vent gases.). Because H₂S is not the only sulfur compound found in refinery fuel gas, Murphy Oil has significantly underestimated the SO₂ emissions.

Murphy Oil should have calculated the SO₂ emissions from fuel sulfur content based on total sulfur in the fuel, not just H₂S because the combustion process converts essentially 100% of the sulfur in a fuel gas to SO₂. Additional sulfuric compounds include mercaptans and oxidized sulfur compounds, such as thiophenes and carbonyl sulfide. These other compounds make up most of the sulfur that is present in refinery fuel gas,²⁵ generally well over half of the total sulfur.

²⁵ Letter from Jack P. Broadbent, Executive Officer/APCO, Bay Area Air Quality Management District, to EPA Docket Center, Docket EPA-HQ-OAR-2007-0011, August 24, 2007; Garry Lee Ripperger, Process for Removing Sulfur from a Fuel Gas Stream, US Provisions Application No. 60/911,422, April

Thus, assuming that LDEQ is correct as to how Murphy Oil calculated the SO₂ emission factor, the netting analysis has significantly underestimated SO₂ emissions. Nearly all of the SO₂ emissions from the project arise from burning refinery fuel gas in either the reboiler, Boiler B-7, or the North Flare. The unaccounted for sulfur in the refinery fuel gas is at least double the claimed SO₂ emissions. Adding to the analysis pushes the netted SO₂ emissions over the PSD significance threshold and triggers NSR review for SO₂. The reported SO₂ increase is 26.85 ton/yr. Adopting the reasonable and conservative assumption that total sulfur is double LDEQ's calculation based on only H₂S, SO₂ emissions rise to 53.7 ton/yr, which exceeds the 40 ton/yr significance threshold.

LDEQ responded to Petitioner's comments regarding these issues is by saying that the Permit complies with applicable New Source Performance Standards under 40 CFR 60. LDEQ Resp. Cmmts, resp. 13. However, the fact that Murphy Oil must comply with NSPS does not excuse LDEQ's failure to account for the other sulfur compounds in Murphy's refinery fuel gas.

LDEQ also argues that because the refinery does not have a coker, it need not consider non-H₂S sulfur compounds because they would be "a fraction of the concentrations of H₂S." *Id.* (relying on EPA Memo). Regardless of the "fraction" of the sulfur compounds, LDEQ must account for these emissions. According to LDEQ, Murphy Oil "monitors H₂S content in the North Flare gases via gas chromatograph on weekdays." *Id.* Therefore, Murphy Oil has the data since this gas chromatograph measures other sulfur content. Accordingly, EPA should require LDEQ to obtain this data and update SO₂ emission figures for netting purposes by including all sulfur compounds found in the fuel gas.

12, 2007. ("Certain of the refinery fuel gas streams such as a coker unit dry gas or a fluid catalytic cracking unit gas can contain concentrations of carbonyl sulfide (COS) and other sulfur compounds that are difficult to acceptably be removed there from by traditional caustic or absorption scrubbing and other methods to the lower sulfur concentration levels required by the newer regulations.")

LDEQ also defends Murphy Oil's SO₂ emission calculations by stating: "Use of the 160 ppmv factor of H₂S in estimating SO₂ emissions is conservative in Murphy Oil's case as the average H₂S emissions monitored by Murphy Oil have been less than 40 ppmv over the past year." *Id.* However, average emission figures do not provide a baseline for netting purposes. Furthermore, neither Murphy Oil nor LDEQ provide any support for this very low average of 40 ppmv.

B. Netting Analysis Underestimates Volatile Organic Compound Emissions.

The netting analysis concluded that the project would increase emissions of volatile organic compounds ("VOCs") by 37.22 ton/yr, which is just 2.78 ton/yr shy of the PSD significance threshold of 40 ton/yr. Briefing Sheet, p. 9 (LDEQ-EDMS Doc. 41456805, p. 13 of 786). As demonstrated below, the netting analysis underestimated flaring emissions and excluded several sources of VOC emissions.

1. *Routine Flaring Emissions*

The netting analysis includes emissions from routine flaring. Routine flaring emissions include emissions from burning flare pilot gas, flare sweep gas (for purging the flare system), and BenFree vent gases. Murphy Oil calculated the increase in flaring VOC emissions due to the project (0.44 ton/yr) as the difference between projected future flaring emissions (13.860 ton/yr) and baseline flaring emissions (13.420 ton/yr). *See* Exh. A, Petitioner's Cmmts, Exh. 3 (Application, Appendix C, Table 1). . This small increase, 0.44 ton/yr, is a gross underestimate. The estimated increase in routine flaring emissions is incorrect because Murphy calculated its projected future flaring emissions using an emission factor that does not apply to flaring of refinery fuel gases. If LDEQ had required the more accurate Ideal Gas Law to estimate future

flaring emissions, the resulting increase in emission would exceed the PSD significance threshold of 40 ton/yr.

(a) Murphy Oil Used Wrong Emission Factor Used To Calculate Project Future Flaring Emissions.

Murphy Oil based its baseline emissions on permitted emissions since actual emissions exceeded permitted emission limits, *i.e.*, actual emissions violated existing permit limits. See Exh. A, Petitioner's Cmmts, Exh. 3, fn. 3. This is correct – a permit applicant cannot avoid significance levels by claiming credit emissions that violate legal limits. However, Murphy Oil calculated the projected future flaring emissions from an emission factor that does not apply to flares that burn refinery fuel gas streams.

Murphy Oil estimated projected future routine flaring VOC emissions using the AP-42 emission factor for flares of 0.16 lb/MMBtu and an assumed maximum heat input of 20.0 MMBtu/hr. See Exh. A, Petitioner's Cmmts, Exh. 2 (Ap. Appx. D, Emission Calculations, North Flare, fn. 11).²⁶ This emission factor underestimates routine flaring VOC emissions because it does not take into account the specific fuel that Murphy Oil will burn. EPA developed the flare AP-42 emission factor from tests in which a mixture of propylene and propane was burned.²⁷ The gases sent to the North Flare are not similar to this mixture.

The Application indicates that the fuels that Murphy Oil will burn in the North Flare are natural gas (15.2 MMBtu/hr) and vent gases (4.8 MMBtu/hr). Ap., EIQ, North Flare. Natural gas

²⁶ The flare emission calculations in Exhibit 2 contain errors. The stated firing rate, 20.0 MMBtu/hr, times the stated emission factor, 0.16 lb/MMBtu, do not equal the reported emissions of 13.86 ton/yr, or $(20.0 \text{ MMBtu/hr})(8760 \text{ hr/yr})(0.16 \text{ lb/MMBtu})/2000 \text{ lb/ton} = 14.02 \text{ ton/yr}$ compared to 13.86 ton/yr stated in Exhibit 2. This error is not simply a rounding error. Similarly, the SO₂ emission table reports the heat input from the RenFree reboiler vents to the North Flare as 1332.4 MMBtu/hr, which calculations for other pollutants assume 4.8 MMBtu/hr. These are examples of the types of inconsistencies that cannot be resolved without the underlying Excel spreadsheets. These spreadsheets are not in the record and, accordingly, the permit cannot be lawfully issued based on the record before LDEQ.

²⁷ AP-42, Table 13.5-1, note a.

is nearly 100% methane and contains very little propylene and propane. The Application does not disclose the composition of vent gas beyond indicating that it is mostly refinery fuel gas. See Exh. A, Petitioner's Cmnts, Exh. 2 (Ap. Appx. D, Emission Calculations, North Flare). However, composition data for other refinery fuel gases indicates that it also contains very little propylene and propane.²⁸

Thus, the fuel mixture burned by the North Flare is not similar to a mixture of propylene and propane, the mixture assumed by the AP-42 emission factor used in the netting calculations. VOC emissions from burning a fuel gas depend upon the composition of the gas, specifically, the molecular weight of the gas. Thus, the AP-42 emission factor relied on in the Application is not accurate for routine flaring emissions.

(b) Revised Projected Future Flaring Emissions.

A more accurate and direct method of calculating VOC emissions is the Ideal Gas Law. The Ideal Gas Law is a fundamental statement of the relationship among the pressure, temperature, volume, and number of molecules in a mole of gas. It is one of the most commonly used methods to estimate VOC emissions from flares. The Texas Commission on Environmental Quality (TCEQ), for example, has published New Source Review emission calculation procedures to determine VOC emissions from flaring.²⁹ The TCEQ guidance is widely used in the refining industry to calculate VOC emissions from flaring.

Using the Ideal Gas Law consistent with TCEQ's guidance and the preponderance of evidence, VOC emissions are calculated from the molecular weight of the flared gas and the flare

²⁸ Charles K. Baukal, Jr. (Ed.), The John Zink Combustion Handbook, CRC Press, 2001, Table 5.2 (p. 159), Table 5.3 (p. 160), Table 5.6 (p. 163), and Table 14.4 (p. 446).

²⁹ TCEQ, New Source Review (NSR) Emission Calculations.
http://www.tceq.state.tx.us/assets/public/permitting/air/Guidance/NewSourceReview/emiss_calc_flares.pdf

VOC destruction efficiency. The VOC destruction efficiency is the percent of the VOCs in the gases sent to the flare that is burned to CO₂ and water. The standard destruction efficiency used in flaring calculations is 98%. The molecular weight for refinery fuel gases typically ranges from 15 to 30 lb/lb-mol. A molecular weight of 16 corresponds to pure methane and the midpoint of this range corresponds to a typical refinery fuel gas such as that vented to the North Flare.

The resulting calculations indicate that future VOC emissions are 55.11 ton/yr for pilot and purge gases³⁰ and 24.72 ton/yr for vent gases.³¹ The total VOC emissions from projected future flaring are thus 79.83 ton/yr. The resulting increase in VOC emissions due to the modifications, from 13.42 ton/yr (Exh. A, Petitioner's Cmmts, Exh. 1) to 79.83 ton/yr, is 66.4 tons/yr. This increase is sufficient by itself to cause the project net increase in emissions to exceed the PSD significance threshold of 40 ton/yr. Thus, the project triggers NSR review.

The above calculations assume that flare destruction efficiency never goes below 98 percent on average for the lifetime of the project. But this is will not be the result under actual conditions. If flare combustion efficiency drops to 95 percent on average, Murphy Oil will emit 5 percent of VOCs in the flared gases, and VOC emissions will be 2.5 times higher than at 98 percent efficiency. Destruction efficiency will, more likely than not, go far lower, causing VOC emissions to increase drastically.

³⁰ Pilot and purge VOC emissions (for natural gas) assuming molecular weight of 16 lb/lb-mol (methane): $(1-0.98)((15.2 \text{ MMBtu/hr})(10^6 \text{ Btu/MMBtu}/1020 \text{ Btu/scf})(8760 \text{ hr/yr})(16 \text{ lb/lb-mol}))/379 \text{ scf/lb-mol}/2000 \text{ lb/ton} = \mathbf{55.11 \text{ ton/yr}}$.

³¹ Pilot and purge VOC emissions (for vent gas) assuming molecular weight of 16 lb/lb-mol (methane): $(1-0.98)((4.8 \text{ MMBtu/hr})(10^6 \text{ Btu/MMBtu}/1010 \text{ Btu/scf})(8760 \text{ hr/yr})(22.5 \text{ lb/lb-mol}))/379 \text{ scf/lb-mol}/2000 \text{ lb/ton} = \mathbf{24.72 \text{ ton/yr}}$.

For example, the VOC destruction efficiency drops significantly when crosswinds are greater than 5 mph.³² The average annual wind speed in the vicinity of the Meraux Refinery is 8.2 mph.³³ As significant crosswinds, i.e., greater than 5 mph, are usually present in this area, LDEQ must account for these wind effects in estimating flaring emissions. Further, as Murphy Oil reduces the Btu content of the flare gas, it will also reduce its combustion efficiency. Recent studies have suggested that lower Btu flares may have efficiencies as low as 65 percent.³⁴ The Btu content of refinery fuel gases sent to the North Flare can vary widely. This estimate of the increase in emissions from routine flaring is very conservative. Actual emissions could be substantially higher.

LDEQ responds to Petitioner's arguments by stating: "Only a small portion of the VOC increase is due to flaring emissions." LDEQ Resp. to Cmmts, resp. 15. However, this response does not apply here because Murphy Oil used the wrong emission factor to determine these emissions—whatever the fraction. LDEQ goes on to say: "Venting periodic releases to the North Flare would be BACT had PSD review been required"—claiming no harm no foul. *Id.* But, LDEQ cannot summarily conclude what is BACT in this situation without having required

³² Robert E. Levy, Lucy Randel, Meg Healy, and Don Weaver, Reducing Emissions from Plant Flares, Paper 61, Industry Professionals for Clean Air, April 24, 2006; Douglas M. Leahey, Katherine Preston, and Mel Stroscher, Theoretical and Observational Assessments of Flare Efficiencies, *Journal of the Air & Waste Management Association*, v. 51, December 2001, pp. 1610-1616.

³³ See <http://lwf.ncdc.noaa.gov/oa/climate/online/ccd/avgwind.html>

³⁴ Mel T. Stroscher, Characterization of Emissions from Diffusion Flame Systems, *Journal of the Air & Waste Management Association*, v. 50, October 2000, pp. 1723-1733; Robert E. Levy, Lucy Randel, Meg Healy and Don Weaver, Reducing Emissions from Plant Flares, Industry Professionals for Clean Air, 2006; University of Alberta, Flare Research Project, Interim Report, November 1996 - June 2000, December 1, 2000; Douglas M. Leahey, Katherine Preston, and Mel Stroscher, Theoretical and Observational Assessments of Flare Efficiencies, *Journal of the Air & Waste Management Association*, v. 51, December 2001, pp. 1610-1616. ("The mean and standard deviation of observed combustion efficiencies were 68 +/- 7%. Comparable predicted values were 69 +/- 7%"); Industry Professionals for Clean Air, Reducing Flare Emissions from Chemical Plants and Refineries. An Analysis of Industrial Flares' Contribution to the Gulf Coast Region's Air Pollution Problem, May 23, 2005

Murphy Oil to perform an appropriate BACT analysis. Moreover, once NSR is triggered, the entire PSD review is required.

2. *Tank Emissions*

Some of the subject tanks included in the proposed modifications are floating roof tanks. Murphy Oil calculated the VOC emissions from these tanks using the EPA TANKS 4.0 model. This model assumes that the floating tank roof is always floating and thus does not include VOC losses during roof landings. Thus, the netting analysis did not include increases in VOC emissions due to roof landing emissions, which typically occur when the facility takes the tank out of service due to an emergency or malfunction. While LDEQ acknowledged that “[a] roof landing situation may arise in an upset condition or during planned cleaning operations,” it concluded that it need not include emissions resulting from such situations because “LDEQ does not permit upset conditions or malfunctions.” For reasons that Petitioners explain in section II above, LDEQ is wrong. The Clean Air Act and its own regulations require LDEQ to include emergency emissions the netting analysis.

IV. THE NETTING ANALYSIS RELIES ON LIMITATIONS THAT ARE NOT PRACTICALLY ENFORCEABLE.

The netting analysis is flawed; the increase in emissions of at least SO₂ and VOC does exceed emission thresholds for PSD analysis. The Permit must contain sufficient operating limits, emission limits, monitoring, and recordkeeping to assure that Murphy Oil achieves in practice the calculations in the netting analysis. The Permit does not contain these required checks.

The Clean Air Act requires LDEQ to include in each Title V permit “enforceable emission limitations and standards,” 42 U.S.C. § 7661c(a), and “monitoring . . . requirements to assure compliance with the permit terms and conditions.” 42 U.S.C. § 7661c(c). *See also* 40

C.F.R. 70.6(c)(1) (“Consistent with paragraph (a)(3) of this section, compliance certification, testing, monitoring, reporting, and recordkeeping requirements sufficient to assure compliance with the terms and conditions of the permit”); LAC 33:III.507(H) (“Each permit issued to a Part 70 source shall include . . . compliance certification, testing, monitoring, reporting, and recordkeeping requirements sufficient to assure compliance with the terms and conditions of the permit as required by 40 CFR 70.6(a)(3)”); *Sierra Club v. Environmental Protection Agency*, 536 F.3d 673, 677 (D.C. Cir. 2008).³⁵

The Permit, however, fails to provide mechanisms to ensure compliance with the most fundamental requirement: that net emissions remain below significance thresholds. If net emissions are above significance thresholds, then LDEQ must require stringent BACT and/or LAER pollution controls invalidating the less stringent minor source limits currently contained in the Permit. Therefore, it is critical that the Permit contain sufficient enforceable terms and conditions to ensure that Murphy Oil does not exceed those thresholds. Similarly, any limits on the potential to emit assumed in the netting analysis must be enforceable as a practical matter, to ensure that limits on the potential to emit are not illusory.

Specifically, the Permit does not require Murphy Oil to monitor SO₂ from any of the fired sources, nor does it require Murphy Oil to monitor total sulfur in the fuel gas. Thus, the requirement that the project would increase SO₂ emissions by only 26.85 ton/yr is practically unenforceable. Additionally, the Permit does not require any monitoring of flaring VOC

³⁵ Since the *Sierra Club* decision, EPA has illustrated the importance of enforceability concerns by granting citizen petitions to EPA requesting objections to Title V permits issued to petroleum refineries on the ground that they lacked sufficient conditions ensuring enforceability. In both *In re Citgo Refining and Chemicals Company, L.P.*, Petition No. VI-2007-01 and *In re Premcor Refining Group, Inc.*, Petition No. VI-2007-02 (both issued May 28, 2009), EPA cited to the *Sierra Club* decision, and held that the permits at issue lacked sufficient conditions to ensure that all requirements applicable to the refineries were enforceable. In both cases, EPA stated that the permitting agency failed in its responsibility to articulate a specific rationale as to why the terms of the permits were sufficient to ensure compliance with applicable requirements.

emissions eliminating any way of verifying that the subject modifications do not result in a significant increase in VOC emissions. Therefore, the requirements that the project would increase VOC emissions by 37.22 ton/yr are unenforceable as a practical matter.

The general provisions purportedly limiting overall net emissions to below significance thresholds are inadequate, as they do not require actual measurement of emissions, but rather are unenforceable blanket limits and circular calculations. The Permit netting analysis is rife with assumptions regarding facts and circumstances that will supposedly limit project's potential to emit emissions that are either incorrect and/or not based on any permit limits that would ensure their accuracy.

Again, LDEQ responded to Petitioner's comments regarding these issues is by saying that the Permit complies with applicable New Source Performance Standards under 40 CFR 60. LDEQ Resp. Cmmts, resp. 18. However, the fact that Murphy Oil must comply with NSPS has nothing to do with whether the permit contains conditions to ensure that emissions do not exceed the PSD significance level for criteria pollutants.

Moreover, LDEQ's assertion that the Permit's reporting and monitoring requirements meet Clean Air Act requirements is wrong. LDEQ said:

[T]he facility is required to report the BenFree Reboiler emissions under a cap as stated in the proposed permit. This cap, identified as Emission Point CAP-HEATERS, specifically requires Murphy to monitor the heat input to all the boilers, heaters, and reboilers and calculate emissions based on individual heat inputs and combustion unit-specific emission factors. In addition, the cap limits total heat input to 1869.07 MM BTU/hr and overall emissions to 67.75 TPY of PM10, 242.15 TPY of SO2, 893.49 TPY of NOx, 869.37 TPY of CO, and 49.03 TPY of VOC. Records must be kept on site and reported to LDEQ as per the specific condition in the permit.

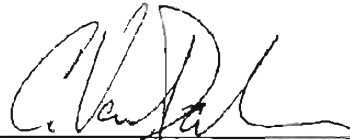
Id.

This monitoring and reporting scheme sets up a self-fulfilling prophecy, not monitoring to assure compliance. It is merely a calculation, and it is based on the same inputs and assumptions that Murphy Oil used to determine PSD significant thresholds. It requires no physical monitoring of emissions to determine what actually comes out of the refinery post-project. The scheme offers no ability to "truth" the assumptions that Murphy Oil made in its emissions estimations.

CONCLUSION

For the reasons set forth above, Petitioner asks that the Administrator deny the Title V Permit # 2500-00001-V5 for Murphy Oil.

Sincerely,

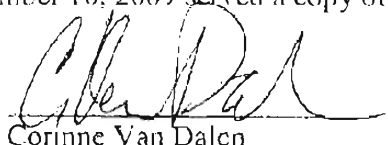


Corinne Van Dalen, Staff Attorney
Tulane Environmental Law Clinic
6329 Freret Street
New Orleans, Louisiana 70118
Phone (504) 865-8814
Fax (504) 862-8721
*On behalf of Concerned Citizens Around
Murphy*

Substantially prepared by:
Shreya Biswas, Law Student
Diana Csank, Law Student
Tulane Environmental Law Clinic

Cc:

I hereby certify that I have this December 10, 2009 served a copy of this Petition to those listed below.


Corinne Van Dalen

Lisa P. Jackson, Administrator
U.S. EPA Headquarters
Ariel Rios Bldg.
Mail Code 1101A
1200 Penn. Ave., NW
Washington, D.C. 20460

Harold Leggett
Secretary
Louisiana Department of Environmental Quality
602 N. Fifth Street
Baton Rouge, LA 70802

Dr. Alfredo Armendariz
Regional Administrator, Region 6
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202
(214) 665-6444

Lynn G. Bourgeois (U.S. Certified Mail)
Plant Manager, Meraux Refinery
Murphy Oil, USA, Inc.
P.O. Box 100
Meraux, LA 70075



TULANE ENVIRONMENTAL LAW CLINIC

August 4, 2009

Via Email and Overnight Mail Delivery

Ms. Soumaya Ghosn
Louisiana Department of Environmental Quality
Public Participation Group
602 N. Fifth Street
Baton Rouge, LA 70821-4313.

Re: Draft Part 70/Title V Permit No. 2500-00001-V5
AI No. 1238
Activity No. PER2009002

Dear Ms. Ghosn,

Concerned Citizens Around Murphy¹ respectfully submit these comments on the draft Part 70/Title V Permit No. 2500-00001-V5 proposed by the Louisiana Department of Environmental Quality ("Department") on May 25, 2009 for Murphy Oil USA, Inc., Meraux Refinery in St. Bernard Parish, Louisiana.

Please note that a qualified engineer, Phyllis Fox, prepared the technical analysis in these comments. A copy of Ms. Fox's C.V. is attached to these comments and incorporated by reference.

Murphy Oil presented netting calculations that suggest incorrectly that the net increase in emissions from these modifications is below Clean Air Act Prevention of Significant Deterioration (PSD) significance thresholds and thus do not trigger New Source Review (NSR). Ap., p. 7 (LDEQ-EDMS Doc. 40169977). LDEQ has proposed to adopt these calculations without modification. Briefing Sheet, p. 9 (LDEQ-EDMS Doc. 41456805, p. 14 of 786). However, the netting analysis excludes significant emission sources and incorrectly calculates sulfur dioxide (SO₂) emissions. As explained in detail below, if Murphy Oil corrects its errors and omissions, the net increase in emissions exceeds PSD significance thresholds for at least volatile organic compounds (VOCs) and SO₂, triggering PSD review for these pollutants. Emissions of other pollutants may also exceed PSD significance thresholds. However, the information in the Application is not adequate to assess all other pollutants.

¹ Concerned Citizens Around Murphy is a non-profit corporation organized under the laws of the State of Louisiana and a "person" within the meaning of 42 U.S.C. § 7602(e). Its purpose is to protect the health, safety, environment, and quality of life of Meraux and the surrounding communities in St. Bernard Parish. Concerned Citizens Around Murphy has individual members who breathe and who are otherwise exposed to air pollutants from Murphy's refinery.

Tulane Environmental Law Clinic

6329 Freret St., Ste 130, New Orleans, LA 70118-6231 tel 504.865.5789 fax 504.862.8721 www.tulane.edu/~telc

BACKGROUND

Murphy Oil submitted a Significant Source Modification Application to LDEQ in February 2009, 2/09 Ap. (LDEQ-EDMS Doc. #s 40169977 (Vol. 1) and 40127062 (Vol. 2)) to construct and operate a benzene saturation unit ("BenFree Unit"²) at its Meraux Refinery. Murphy Oil claims this unit will remove benzene from gasoline to satisfy USEPA's Mobile Air Sources Toxics rule. In addition to the BenFree Unit, however, the 2/09 Application includes the following other modifications:

- modifications to several tank emission caps,
- cancellation of rerouting of the Oily Water Stripper vent stream to the fuel gas system,
- emissions for the No. 2 Amine Unit turnaround / startup/shutdown omitted from the current permit,
- "reconciliation" of turnaround emissions for other units, changing current one-year startup/shutdown emissions to a yearly estimate based on five year emissions total.

2/09 Ap., pp. 2-3.

In addition, Murphy Oil amended the 2/09 Application in May 2009 to include Boiler B-7, 5/09 Addendum (LDEQ-EDMS Doc. # 41151130). LDEQ had previously permitted Boiler B-7, but Murphy Oil never installed it. Instead, Murphy Oil used a temporary rental boiler to supplement steam production when necessary during planned maintenance activities.

Concerned Citizens Around Murphy collectively refers to the 2/09 Application and the 5/09 Addendum as "the Application."

SPECIFIC COMMENTS

1. THE NETTING ANALYSIS FAILS TO INCLUDE THE FOLLOWING EMISSION SOURCES.

A. Emergency Flaring Emissions.

The netting calculations included routine releases to the North Flare from the new BenFree Unit. These vent releases occur about five times a year with each incident lasting 30 minutes. Exh. 2, footnote 11. According to the permit engineer and our understanding of the process, these venting emissions are part of the normal operation of the BenFree Unit. The netting calculations did not include emergency release emissions due to malfunctions at the BenFree Unit for any subject pollutant.

² BenFree is a trademark process of Axens which reduces benzene from reformat through integrated reactive distillation. The process uses high pressure pumps to withdraw benzene rich light fractions from the splitter to the hydrogenation unit, where benzene is converted to cyclohexane. www.axens.net.

Louisiana air regulations require Murphy Oil to include emergency flaring emissions in the netting analysis for all regulated pollutants. The regulations specifically require Murphy Oil to include emergency emissions for calculating both "Baseline Actual Emissions" and "Projected Annual Emissions." See LAC 33:III.111 (definition for "Baseline Actual Emissions" and "Projected Annual Emissions" require inclusion of authorized emissions associated with start-ups, shutdowns, and *malfunctions*) (emphasis added). See also, *id.* (definition of "Malfunction" – "any sudden and unavoidable failure of air pollution control equipment or process equipment or of a process to operate in a normal or usual manner.").

The primary purpose of a flare is to handle "emergency" releases which are not planned or anticipated for safety reasons, e.g., to relieve pressure inside vessels to prevent explosions. These emergency releases occur when there are process and other types of malfunctions. The most severe emergency releases usually occur during power outages. The emissions from these events were not included in the netting analysis.³ LDEQ must require Murphy Oil to supplement its Application with emergency release emissions data and republish the draft permit for public comment with the updated information.

B. Updated Facility-wide Turnaround Emissions and No. 2 Amine Unit Turnaround.

The proposed permit covers the "reconciliation" of turnaround emissions for facility wide turnaround or startup/shutdown emissions, changing current one-year startup/shutdown emissions to a yearly estimate based on five year emissions total. 2/09 Ap., pp. 2-3; Briefing Sheet, p. 9. In addition, the proposed permit includes No. 2 Amine Unit turnaround or startup/shutdown emissions. However, the netting analysis does not include these emissions because "the turnaround and startup/shutdown emissions are not subject to New Source Review as they are existing emissions and no new modification is triggering an increase in the associated emissions. Air Permit Briefing Sheet, pp 9-10, p. 9 note (**). There are three major problems with the treatment of these emissions.

First, the increase in SO₂ emissions due to these reconciliation issues, 40.53 ton/yr, exceeds the PSD significance threshold for SO₂ by themselves. Thus, regardless of how LDEQ classifies them, the resulting increases are a significant PSD modification triggering PSD review.

Second, these emissions are not "existing" as they are projections of future emissions over the term of the Title V permit. A portion of them, for example, include startup, shutdown, and turnaround emissions from the new BenFree Unit.

Third, as discussed above, Louisiana air regulations require Murphy Oil to include startup, shutdown, and turnaround emissions in the potential to emit for purposes of determining NSR applicability. The fact that Murphy Oil has not included these emissions in prior NSR analyses for this facility is contrary to the law.

D. Boiler 7

³ See, e.g., the flaring emission data compiled by the Bay Area Air Quality Management District, and published on its website at www.baaqmd.gov/enf/flares/.

The Applicant submitted an addendum to the 2/09 Application, requesting that emissions from a temporary boiler formerly used during planned maintenance activities be permitted and included in the Title V operating permit as Boiler B-7. As some portion of the increase will service the new BenFree Unit, LDEQ must require the netting analysis to include that portion of these emissions.

E. Hydrogen Generation

The Project includes a new 27,000 BPD BenFree Unit. This unit, licensed technology of Axens, will use hydrogen and a fixed bed catalyst to convert Platformate benzene into cyclohexane. The Application incorrectly suggests that it will use hydrogen as a fuel in the reboiler (Ap., p. 4) and fails to recognize that hydrogen is one of the inputs to the process itself. The netting analysis did include increases in cooling tower emissions from increases in cooling water, another input to the BenFree Unit. Ap., p. 2 and Exh. 3. Hydrogen production generates emissions of NOx, SOx, CO, PM10, and VOC that Murphy Oil did not include in netting analysis. However, Murphy Oil must include emissions that result from the hydrogen production if: 1. the entity that produces the hydrogen shares a boundary with Murphy Oil, 2. shares common control, or 3. if the entity the produces the hydrogen sends more than 50 percent of the hydrogen it produces to Murphy Oil. Concerned Citizens Around Murphy asks LDEQ to investigate all three of these issues and provide answers in its response to comments.

Furthermore, the Application does not contain any of the BenFree process information required to estimate the amount of hydrogen that would be required, or the increase in emissions from this increase in hydrogen production. Concerned Citizens Around Murphy also asks LDEQ to provide determine the amount of hydrogen required and increased emissions from the hydrogen production.

II. THE PROJECT TRIGGERS NSR REVIEW FOR SULFUR DIOXIDE AND VOLITILE ORGANIC COMPOUNDS.

A. Murphy Oil Underestimated Sulfur Dioxide Emissions.

Murphy Oil's netting analysis concluded that the project would increase emissions of sulfur dioxide ("SO2") by 26.85 ton/yr, which is less than the PSD significance threshold of 40 ton/yr. Briefing Sheet, p. 9 (LDEQ-EDMS Doc. 41456805, p. 13 of 786). SO2 emission sources include: (1) the reboiler in the BenFree Unit; (2) the North Flare to which the BenFree Unit vents; and (3) Boiler B-7. Ap., Appx. D.

As a preliminary matter, Murphy Oil improperly excluded emissions from Boiler B-7 in its netting calculations, which we explain in section II below.

In addition, Murphy Oil incorrectly based SO2 emissions calculations solely on the H2S content of combusted gas. 7/7/09 Quadri Email; Ap., p. 1 (fuel gas monitored by a H2S CEMS), Appx. D, Emission Calculations, North Flare, footnote 7 (H2S content is 159 ppmv); Ap., Appx. F, 10/8/08 Bourgeois Letter (requiring only monitoring of H2S in flare vent gases.). Because

H₂S is not the only sulfur compound found in refinery fuel gas, Murphy Oil has significantly underestimated the SO₂ emissions.

The combustion process converts essentially 100% of the sulfur in a fuel gas to SO₂. Thus, Murphy Oil should have calculated the SO₂ emissions from fuel sulfur content based on total sulfur in the fuel, not just H₂S. Additional sulfur compounds include mercaptans and oxidized sulfur compounds, such as thiophenes and carbonyl sulfide. These other compounds make up most of the sulfur that is present in refinery fuel gas,⁴ generally well over half of the total sulfur. Thus, assuming that LDEQ is correct as to how Murphy Oil calculated the SO₂ emission factor, the netting analysis has significantly underestimated SO₂ emissions. Nearly all of the SO₂ emissions from the project arise from burning refinery fuel gas in either the reboiler, Boiler B-7 (erroneously excluded), or the North Flare. The unaccounted for sulfur in the refinery fuel gas is at least double the claimed SO₂ emissions, pushing the project's SO₂ emissions over the PSD significance threshold, thus triggering NSR review for SO₂. The reported SO₂ increase is 26.85 ton/yr. Adopting the reasonable and conservative assumption that total sulfur is double LDEQ's calculation based on only H₂S, SO₂ emissions rise to 53.7 ton/yr, which exceeds the 40 ton/yr significance threshold.

B. Netting Analysis Underestimates Volatile Organic Compound Emissions.

The netting analysis concluded that the project would increase emissions of volatile organic compounds ("VOCs") by 37.22 ton/yr, which is just 2.78 ton/yr shy of the PSD significance threshold of 40 ton/yr. Briefing Sheet, p. 9 (LDEQ-EDMS Doc. 41456805, p. 13 of 786). As demonstrated below, the netting analysis underestimated flaring emissions and excluded several sources of VOC emissions.

1. Routine Flaring Emissions

The netting analysis includes emissions from routine flaring. Routine flaring emissions include emissions from burning flare pilot gas, flare sweep gas (for purging the flare system), and BenFree vent gases. Murphy Oil calculated the increase in flaring VOC emissions due to the project (0.44 ton/yr) as the difference between projected future flaring emissions (13.860 ton/yr) and baseline flaring emissions (13.420 ton/yr). See Application, Appendix C, Table 1, attached here as Exh. 3. This small increase, 0.44 ton/yr, is a gross underestimate. The estimated 1 increase in routine flaring emissions is wrong because Murphy calculated its projected future flaring emissions using an emission factor that does not apply to flaring of refinery fuel gases. When the project future flaring emissions are estimated using the more accurate Ideal Gas Law, the resulting increase in emission is to exceed the PSD significance threshold of 40 ton/yr.

⁴ Letter from Jack P. Broadbent, Executive Officer/APCO, Bay Area Air Quality Management District, to EPA Docket Center, Docket EPA-HQ-OAR-2007-0011, August 24, 2007; Garry Lee Ripperger, Process for Removing Sulfur from a Fuel Gas Stream, US Provisions Application No. 60/911,422, April 12, 2007. ("Certain of the refinery fuel gas streams such as a coker unit dry gas or a fluid catalytic cracking unit gas can contain concentrations of carbonyl sulfide (COS) and other sulfur compounds that are difficult to acceptably be removed there from by traditional caustic or absorption scrubbing and other methods to the lower sulfur concentration levels required by the newer regulations.")

(a) Murphy Oil Used Wrong Emission Factor Used To Calculate Project Future Flaring Emissions.

Murphy Oil based its baseline emissions on permitted emissions, since actual emissions exceeded permitted emission limits, i.e., actual emissions violated existing permit limits. Exh. 3, footnote 3. This is correct – a permit applicant cannot avoid significance levels by claiming credit emissions that violate legal limits. However, Murphy Oil calculated the projected future flaring emissions from an emission factor that does not apply to flares that burn refinery fuel gas streams.

Murphy Oil estimated projected future routine flaring VOC emissions using the AP-42 emission factor for flares of 0.16 lb/Moto and an assumed maximum heat input of 20.0 Moto/hr. Ap. Appx. D, Emission Calculations, North Flare, Footnote 11 (Exh. 2).⁵ This emission factor underestimates routine flaring VOC emissions because it does not take into account the specific fuel that Murphy Oil will burn. EPA developed the flare AP-42 emission factor from tests in which a mixture of propylene and propane was burned.⁶ The gases sent to the North Flare are not similar to this mixture.

The Application indicates that the fuels that Murphy Oil will burn in the North Flare are natural gas (15.2 Moto/hr) and vent gases (4.8 Moto/hr). Ap., ElQ, North Flare. Natural gas is nearly 100% methane and contains very little propylene and propane. The Application does not disclose the composition of vent gas beyond indicating that it is mostly refinery fuel gas. Exh. 2. However, composition data for other refinery fuel gases indicates that it also contains very little propylene and propane.⁷

Thus, the fuel mixture burned by the North Flare are not similar to a mixture of propylene and propane, the mixture assumed by the AP-42 emission factor used in the netting calculations. VOC emissions from burning a fuel gas depend upon the composition of the gas, specifically, the molecular weight of the gas. Thus, the AP-42 emission factor relied on in the Application is not accurate for routine flaring emissions.

(b) Revised Projected Future Flaring Emissions.

A more accurate and direct method of calculating VOC emissions is the Ideal Gas Law. The Ideal Gas Law is a fundamental statement of the relationship among the pressure,

⁵ The flare emission calculations in Exhibit 2 contain errors. The stated firing rate, 20.0 MMBtu/hr, times the stated emission factor, 0.16 lb/MMBtu, do not equal the reported emissions of 13.86 ton/yr, or $(20.0 \text{ MMBtu/hr})(8760 \text{ hr/yr})(0.16 \text{ lb/MMBtu})/2000 \text{ lb/ton} = 14.02 \text{ ton/yr}$ compared to 13.86 ton/yr stated in Exhibit 2. This error is not simply a rounding error. Similarly, the SO₂ emission table reports the heat input from the BenFree reboiler vents to the North Flare as 1332.4 MMBtu/hr, which calculations for other pollutants assume 4.8 MMBtu/hr. These are examples of the types of inconsistencies that cannot be resolved without the underlying Excel spreadsheets. These spreadsheets are not in the record and, accordingly, the permit cannot be lawfully issued based on the record before LDEQ.

⁶ AP-42, Table 13.5-1, note a.

⁷ Charles K. Baukal, Jr. (Ed.), The John Zink Combustion Handbook, CRC Press, 2001, Table 5.2 (p. 159), Table 5.3 (p. 160), Table 5.6 (p. 163), and Table 14.4 (p. 446).

temperature, volume, and number of molecules in a mole of gas. It is one of the most commonly used methods to estimate VOC emissions from flares. The Texas Commission on Environmental Quality (TCEQ), for example, has published New Source Review emission calculation procedures to determine VOC emissions from flaring.⁸ The TCEQ guidance is widely used in the refining industry to calculate VOC emissions from flaring.

Using the Ideal Gas Law consistent with TCEQ's guidance and the preponderance of evidence, VOC emissions are calculated from the molecular weight of the flared gas and the flare VOC destruction efficiency. The VOC destruction efficiency is the percent of the VOCs in the gases sent to the flare that is burned to CO₂ and water. The standard destruction efficiency used in flaring calculations is 98%. The molecular weight for refinery fuel gases typically ranges from 15 to 30 lb/lb-mol. A molecular weight of 16 corresponds to pure methane and the midpoint of this range corresponds to a typical refinery fuel gas such as that vented to the North Flare.

The resulting calculations indicate that future VOC emissions are 55.11 ton/yr for pilot and purge gases⁹ and 24.72 ton/yr for vent gases.¹⁰ The total VOC emissions from projected future flaring are thus 79.83 ton/yr. The resulting increase in VOC emissions due to the modifications, from 13.42 ton/yr (Exh. 1) to 79.83 ton/yr, is **66.4 tons/yr**. This increase is sufficient by itself to cause the project net increase in emissions to exceed the PSD significance threshold of 40 ton/yr. Thus, the project triggers NSR review for VOCs.

The above calculations assume that flare destruction efficiency never goes below 98 percent on average for the lifetime of the project. But this is will not be the result under actual conditions. If flare combustion efficiency drops to 95 percent on average, Murphy Oil will emit 5 percent of VOCs in the flared gases, and VOC emissions will be 2.5 times higher than at 98 percent efficiency. Destruction efficiency will, more likely than not, go far lower, causing VOC emissions to increase drastically.

For example, the VOC destruction efficiency drops significantly when crosswinds are greater than 5 mph.¹¹ The average annual wind speed in the vicinity of the Meraux Refinery is

⁸ TCEQ, New Source Review (NSR) Emission Calculations.

http://www.tceq.state.tx.us/assets/public/permitting/air/Guidance/NewSourceReview/emiss_calc_flares.pdf

⁹ Pilot and purge VOC emissions (for natural gas) assuming molecular weight of 16 lb/lb-mol (methane): $(1-0.98)((15.2 \text{ MMBtu/hr})(10^6 \text{ Btu/MMBtu}/1020 \text{ Btu/scf})(8760 \text{ hr/yr})(16 \text{ lb/lb-mol}))/379 \text{ scf/lb-mol}/2000 \text{ lb/ton} = \mathbf{55.11 \text{ ton/yr}}$.

¹⁰ Pilot and purge VOC emissions (for vent gas) assuming molecular weight of 16 lb/lb-mol (methane): $(1-0.98)((4.8 \text{ MMBtu/hr})(10^6 \text{ Btu/MMBtu}/1010 \text{ Btu/scf})(8760 \text{ hr/yr})(22.5 \text{ lb/lb-mol}))/379 \text{ scf/lb-mol}/2000 \text{ lb/ton} = \mathbf{24.72 \text{ ton/yr}}$.

¹¹ Robert E. Levy, Lucy Randel, Meg Healy, and Don Weaver, Reducing Emissions from Plant Flares, Paper 61, Industry Professionals for Clean Air, April 24, 2006; Douglas M. Leahey, Katherine Preston, and Mel Stroscher, Theoretical and Observational Assessments of Flare Efficiencies, Journal of the Air & Waste Management Association, v. 51, December 2001, pp. 1610-1616.

8.2 mph.¹² As significant crosswinds, i.e., greater than 5 mph, are usually present in this area, LDEQ must account for these wind effects in estimating flaring emissions. Further, as Murphy Oil reduces the Btu content of the flare gas, it will also reduce its combustion efficiency. Recent studies have suggested that lower Btu flares may have efficiencies as low as 65 percent.¹³ The Btu content of refinery fuel gases sent to the North Flare can vary widely. Thus, our estimate of the increase in emissions from routine flaring is very conservative. Actual emissions could be substantially higher.

2. *Tank Emissions*

The Application includes updates to existing permitted Tanks Caps, which Murphy Oil claims will result in a net decrease in VOC emissions. Ap., p. 1; 7/7/09 Murphy Public Comments, p. 4 (claiming a 10% decrease in VOCs). However, the netting analysis includes 11.78 ton/yr of VOC increases from nine tanks. Murphy Oil fails to explain the origin of these increases. Concerned Citizens Around Murphy ask that LDEQ explain this apparent discrepancy, i.e., the claim that Murphy Oil will reduce tank emissions by 10%, while the netting calculations shows an increase. Without an explanation of this inconsistency in the record, LDEQ cannot lawfully issue the permit.

Murphy's supporting calculations have underestimated tank emissions. First, Murphy Oil failed to include tank cleaning emissions. Sludges build up inside of tanks, reducing their working capacity. Therefore, facilities typically clean tanks once every five to ten years, or more frequently to facilitate inspections to fix leaks and address subsurface contamination. These sludges can contain up to 90 percent hydrocarbon (i.e., VOC) and significant amounts of H₂S.¹⁴ The netting analysis did not include increases in VOC emissions due to tank cleaning emissions.

Second, some of the subject tanks included in the proposed modifications are floating roof tanks. Murphy Oil calculated the VOC emissions from these tanks using the EPA TANKS 4.0 model. This model assumes that the floating tank roof is always floating and thus does not include VOC losses during roof landings. Thus, the netting analysis did not include increases in VOC emissions due to roof landing emissions.

¹² See <http://lwf.ncdc.noaa.gov/oa/climate/online/ccd/avgwind.html>

¹³ Mel T. Strosher, Characterization of Emissions from Diffusion Flame Systems, *Journal of the Air & Waste Management Association*, v. 50, October 2000, pp. 1723-1733; Robert E. Levy, Lucy Randel, Meg Healy and Don Weaver, Reducing Emissions from Plant Flares, Industry Professionals for Clean Air, 2006; University of Alberta, Flare Research Project, Interim Report, November 1996 - June 2000, December 1, 2000; Douglas M. Leahey, Katherine Preston, and, Mel Strosher, Theoretical and Observational Assessments of Flare Efficiencies, *Journal of the Air & Waste Management Association*, v. 51, December 2001, pp. 1610-1616. ("The mean and standard deviation of observed combustion efficiencies were 68 +/- 7%. Comparable predicted values were 69 +/- 7%"); Industry Professionals for Clean Air, Reducing Flare Emissions from Chemical Plants and Refineries. An Analysis of Industrial Flares' Contribution to the Gulf Coast Region's Air Pollution Problem, May 23, 2005

¹⁴ Philip E. Myers, *Aboveground Storage Tanks*, 1997, Chapter 15.2 Tank Degassing, Cleaning, and Sludge Reduction Principles.

III. THE NETTING ANALYSIS RELIES ON LIMITATIONS THAT ARE NOT PRACTICALLY ENFORCEABLE.

Our analysis indicates that the netting analysis is flawed and that the increase in emissions of at least SO₂ and VOC do exceed emission thresholds for PSD analysis. Regardless, however, the permit must contain sufficient operating limits, emission limits, monitoring, and recordkeeping to assure that Murphy Oil achieves in practice the calculations in the netting analysis. The draft permit does not contain these required checks.

Title V of the Clean Air Act requires that LDEQ issue a comprehensive operating permit to Murphy Oil that will “identify all emission limits for the source,” and also include “enforceable emission limitations and standards” and “requirements to assure compliance with the permit terms and conditions.” *Sierra Club v. Environmental Protection Agency*, 536 F.3d 673, 674 (D.C. Cir. 2008); 42 U.S.C. § 7661c (a) and (c).¹⁵

Both the Title V statutory provisions and the implementing regulations expressly require that operating permits contain sufficient conditions to ensure compliance. 42 U.S.C. 7661c(c) (“Each permit issued under this subchapter shall set forth inspection, entry, monitoring, compliance certification, and reporting requirements to assure compliance with the permit terms and conditions.”); 40 C.F.R. 70.6(c)(1) (“Consistent with paragraph (a)(3) of this section, compliance certification, testing, monitoring, reporting, and recordkeeping requirements sufficient to assure compliance with the terms and conditions of the permit”); LAC 33:III.507(H) (“Each permit issued to a Part 70 source shall include . . . compliance certification, testing, monitoring, reporting, and recordkeeping requirements sufficient to assure compliance with the terms and conditions of the permit as required by 40 CFR 70.6(a)(3)).

Here, the draft permit fails to provide mechanisms to ensure compliance with the most fundamental requirement: that net emissions remain below significance thresholds.¹⁶ If net emissions are above significance thresholds, then LDEQ must require stringent BACT and/or LAER pollution controls, and the less stringent minor source limits contained in the permits are invalid. Thus, it is critical that the draft permit contain sufficient enforceable terms and conditions to ensure that Murphy Oil does not exceed those thresholds. Similarly, the underlying

¹⁵ Since the *Sierra Club* decision, EPA has illustrated the importance of enforceability concerns by twice granting citizen petitions to EPA requesting objections to Title V permits issued to petroleum refineries on the ground that they lacked sufficient conditions ensuring enforceability.¹⁵ In both *In the Matter of Citgo Refining and Chemicals Company, L.P.*, Petition No. VI-2007-01, and *In the Matter of Premcor Refining Group, Inc.*, Petition No. VI-2007-02 (both issued May 28, 2009), EPA cited to the *Sierra Club* decision, and held that the permits at issue lacked sufficient conditions to ensure that all requirements applicable to the refineries were enforceable. In both cases, EPA stated that the permitting agency failed in its responsibility to articulate a specific rationale as to why the terms of the permits were sufficient to ensure compliance with applicable requirements.

¹⁶ Entergy Order at 2 (“applicable requirements include the requirement to obtain preconstruction permits that comply with applicable new source review requirements”); Exxon Order at 4 (“the applicable requirements include the substantive and procedural requirements of the Louisiana NNSR program”).

requirements governing the netting process specifically require that any limits on the potential to emit assumed in the netting analysis be enforceable as a practical matter, to ensure that limits on the potential to emit are not illusory.

Specifically, the draft permit does not require Murphy Oil to monitor SO₂ from any of the fired sources. Further, the draft permit does not require Murphy Oil to monitor total sulfur in the fuel gas. Thus, the requirement that the project would increase SO₂ emissions by only 26.85 ton/yr is unenforceable as a practical matter. In addition, the draft permit does not require any monitoring of flaring VOC emissions. Thus, there is no way to verify that the subject modifications do not result in a significant increase in VOC emissions. Therefore, the requirements that the project would increase VOC emissions by 37.22 ton/yr is unenforceable as a practical matter.

The general provisions purportedly limiting overall net emissions to below significance thresholds are inadequate, as they do not require actual measurement of emissions, but rather are unenforceable blanket limits and circular calculations. Additionally, the draft permit netting analysis is rife with assumptions regarding facts and circumstances that will supposedly limit project's potential to emit emissions that are either incorrect and/or not based on any permit limits that would ensure their accuracy.

IV. THE PSD NETTING ANALYSIS LACKS ADEQUATE SUPPORT AND CANNOT BE VERIFIED.

As explained in detail below, neither the Application nor the draft permit provide adequate support for Murphy Oil's PSD netting analysis. Therefore, LDEQ should require Murphy Oil to provide data supporting all emission calculations, including the SO₂ emission factor discussed here, and reopen the public comment period so that the public can submit additional comments with the benefit of this information. LDEQ cannot lawfully issue the permit on an inadequate record.

A. Support for SO₂ emissions is Inadequate.

The Application reports SO₂ emissions from the relevant sources in pounds per hour (lb/hr) and tons per year (ton/yr), but does not disclose the emission factor (in lb/Moto) used to calculate these emissions.¹⁷ While the emission factor can be backcalculated from firing rates reported in Appendix D, Murphy Oil did not disclose the backcalculated emission factor beyond references to e-mail correspondence and phone conversations that LDEQ did not produce in response to our request. Ap., Appx. D, Combustion Calculations and Emission Calculations, North Flare. This is true also for VOC, NO_x, PM₁₀, and CO. However, this comment focuses only on SO₂.

For example, it is possible to calculate the SO₂ emission factor for the reboiler from the Combustion Calculations table in Appendix D as: 1.841 lb/hr/70 Moto/hr = 0.0263 lb/Moto.

¹⁷ Emissions from combustion sources are calculated by multiplying an emission factor in pounds of pollutant per unit of production or throughput by the number of units.

Exh. 1.¹⁸ However, Murphy Oil has provided no basis for this factor beyond footnote 9, which states: "Per email correspondence (sic) between Matt Dobbins (Murphy Oil) and Cheri Kwasi (Trinity) on December 4, 2008 and January 14, 15, and 26, 2009 and personal communication phone conversations on December 17, 2008 and January 22, 2009." Neither LDEQ nor Concerned Citizens Around Murphy can evaluate the assumed SO₂ emission factor without the data that explains the basis for factor.

We discussed this matter with LDEQ, who informed us that with respect to the reboiler, that Murphy Oil based the SO₂ emissions on a maximum value of 160 ppm hydrogen sulfide ("H₂S") in the fuel gas. In addition, LDEQ informed us that the reboiler vendor determined this value of 160 ppm H₂S to result in an emission factor of 0.0263 lb/Mto. 7/7/09 Quadri email.¹⁹ However, the record does not contain the calculations supporting this conclusion, nor does it contain the vendor inputs. Thus, we cannot verify the accuracy of the emission factor.

In further discussions, LDEQ informed us that we could figure out the accuracy of the emission factor from the data provided in the Emission Inventory Questionnaire ("EIQ") submitted with the Application.²⁰ However, this information is not correct since we cannot make this calculation without the assumed molecular weight of the refinery fuel gas. Neither the EIQ nor any other available document reports this value. Further, the Application contains no actual measurements of H₂S or any other sulfur compound in the fuel gas at the Meraux Refinery. Thus, there is no adequate support for the SO₂ emissions.

B. Other Missing Emissions Support.

The netting calculations in the Application consist of about 1,000 pages of calculations, many illegible, supported only by footnotes, most of which are emails or personal communications that LDEQ has not provided in response to our records request. Required information includes:

- vendor support for emission factors alleged to be based on vendor information (e.g., a vendor guarantee),
- copies of stack tests that support emission factors based on tests or the use of outdated AP-42 emission factors, and
- a process flow diagram and vendor information describing the proposed BenFree Unit, including quantification of any utilities (steam, hydrogen) required to support the process and the resulting increase in emissions to supply these utilities; and
- copies of the emails, correspondence, notes, and calculations documenting the claimed emissions.

¹⁸ Separate exhibits are attached to these comments for clarity as the Application consists of nearly 1,000 pages of tables, most of which have no unique page or table numbers.

¹⁹ See also Exhibit to Murphy Oil Public Hearing Comments, July 7, 2009 ("The SO₂ emissions factor of 0.0263 #/MMBtu was calculated by the vendor, based on Reboiler design and using a maximum value of 160 ppm H₂S in fuel gas.")

²⁰ Personal communication Phyllis Fox with Syed Quadri, July 8, 2009.

Furthermore, we have not received Excel spreadsheets which we requested which would show the bases for emissions calculations. Other missing

CONCLUSION

For the reasons set forth above, we ask LDEQ to deny the draft permit for Murphy Oil. If you have any questions, or would like any further information, do not hesitate to contact us.

Concerned Citizens Around Murphy reserve the right to supplement these comments and rely on comments submitted by others in this or any future proceeding regarding the proposed permits.

Sincerely,

A handwritten signature in black ink, appearing to read 'C. Van Dalen', written over a horizontal line.

Corinne Van Dalen, Staff Attorney
TULANE ENVIRONMENTAL LAW CLINIC
6329 Freret Street
New Orleans, Louisiana 70118
Phone (504) 865-8814
Fax (504) 862-8721
On behalf of Concerned Citizens Around Murphy

Murphy Oil Co. - Moravia Refinery
Combustion Calculations (lb/hr)

EMISSIONS

EIO No.	Source Name	Header Maximum	DUTY @	NOX			SOX			CO			PARTICULATES			VOCs		
				125	125	Max	125	125	Max	125	125	Max	125	125	Max	125	125	Max
			101.5	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	
13-77A	Coke Hrs A & B	394	355.44	377.81	377.81	39,800	11,170	11,713		34,538	36,221	36,221	3,125	3,277	3,277	2,261	2,372	
14-72	H2 Charge Heater	46.43	37.48	48.16	11,541	11,720	1,368	1,367		4,272	4,268	4,268	0.382	0.388	0.388	0.276	0.281	
15-72	H2 DeC4 Reboiler	44.48	34.53	42.52	6,549	6,850	1,258	1,318		3,880	4,068	4,068	0.352	0.368	0.368	0.255	0.260	
16-72	H2 DeC4 Reboiler	50	41.22	50.00	7,700	7,700	1,479	1,479		4,573	4,573	4,573	0.414	0.414	0.414	0.289	0.298	
17-72a & b	H2 CHG HTR (MAX 1+3)	340	275.92	150.00	12,000	26,800	4,437	10,849		13,720	32,828	32,828	1,241	2,879	2,879	0.886	2,150	
16-72	H2 DeC4 Reboiler	49.74	41.63	48.78	7,683	7,683	1,472	1,472		4,551	4,551	4,551	0.412	0.412	0.412	0.288	0.298	
8-73	H2 Charge Htr	43.41	25.10	30.91	3,366	4,727	0,914	1,284		2,827	3,971	3,971	0.258	0.358	0.358	0.185	0.260	
1-75	Vac Heaters C/F	198.3	64.50	150.00	15,000	19,820	4,437	5,804		41,250	53,955	53,955	1,241	1,824	1,824	0.898	1,175	
1-77	H2 CHG Reboiler	164.34	83.00	102.22	11,185	50,105	3,074	4,861		9,349	15,032	15,032	0.848	1,360	1,360	0.612	0.984	
2-77	FCCU H2	135	90.19	111.07	11,107	13,500	3,285	3,983		187,717	224,000	224,000	28,027	28,730	28,730			
1-80	Reflux Heater	290.64	124.26	151.02	15,302	20,064	4,575	5,935		10,159	12,348	12,348	0.918	1,117	1,117	0.665	0.808	
1-83	H2M CHG Htr		14.24	17.53	3,100	3,100	18,300	18,300		3,653	3,653	3,653	2,055	2,055	2,055	0.600	0.600	
1-89	Hydrocracker Charge Heater	108.24		89.81	6,581	10,824	2,065	3,202		8,385	9,800	9,800	0.578	0.896	0.896	0.418	0.543	
	Hydrocracker Charge Heater	25.65		15.99	1,599	2,353	0,473	0,758		1,483	2,344	2,344	0.132	0,212	0,212	0.088	0.153	
	Fractionator Heater	141.13		90.99	9,098	14,113	2,691	4,175		8,322	12,869	12,869	0.753	1,168	1,168	0.545	0.845	
2-90	Reflux B-5	290	0	125	10,000	20,000	3,697	7,395		11,433	22,867	22,867	1,034	2,069	2,069	0.748	1,487	
3-90	Reflux B-6	290	0	125	10,000	20,000	3,697	7,395		11,433	22,867	22,867	1,034	2,069	2,069	0.749	1,487	
1-97	Reflux B-7	290	0	125	10,000	20,000	3,697	7,395		11,433	22,867	22,867	1,034	2,069	2,069	0.745	1,457	
1-98	Reflux B-8	110	0	100.00	4,000	11,000	2,958	3,254		9,147	10,081	10,081	0.828	0.910	0.910	0.598	0.659	
1-99	Gen-Flex Reboiler	70	54.00	2,160	2,800	2,800	1,597	1,841		4,839	6,403	6,403	0,447	0,579	0,579	0,323	0,418	
	Cap-SRU's			43.83	5.20		45.80			6.06			2.27			0.76		
	Cap-Heaters				203.99		55.78			194.49			15.47			11.19		
	Heater Size																	
S		0.11																
M		0.11																
L		0.30																
		0.10																
		0.08																
		0.04																

Note

- The heater cap includes the following feed sources: 1-76, 1-77, 1-80, 12-72A, 14-72, 15-72, 16-72, 17-72a,b,c, 18-72, 2-92, 5-73, 1-90, 2-90, 3-90, 1-98, 1-97, and 1-99.
- An AP-42 factor from October 1992 is used to perform this calculation for NOx since updated factors produced results that were not representative of actual emissions.
- An emission factor of 0.275 lb/MMBtu for CO was used based on a stack test conducted 3/9/2004 as described in an email to Mr. Valerie Barth (Trinity) from Mr. Matt Dobbins (Murphy) dated October 1, 2004.
- Maximum firing rates for the combined feed heaters (1-90) and Boiler B-5 & 6 were provided by Mr. Matt Dobbins (Murphy) to Mr. Valerie Barth (Trinity) from Mr. Matt Dobbins (Murphy) dated October 1, 2004.
- The SRU cap includes the No. 2 SRU Incinerator (Emission Point No. 1-93), and the No. 3NO. 4 SRU Incinerator (Emission Point No. 5-00).
- The annual emission rates for NOx and SOx are based on an email from Lee Vail (Murphy) to Valerie Barth (Trinity) on February 27, 2007.
- The annual correspondence between Mr. Lee Vail (MOUSA) to Mr. Valerie Barth (Trinity) in a face to face meeting on July 31, 2008.
- Per email correspondence between Matt Dobbins (MOUSA) and Chen Kwasi (Trinity) on December 4, 2008 and January 14, 15, and 28, 2009 and personal communication phone conversations on December 17, 2008 and January 22, 2009.

lb per hour - Combustion calculations 021309.xls - 2/18/2008

Emission Point: North Flare (20-72)

Higher Heating Value of Refinery Fuel Gas (MMBtu/MMscf) = 1009.7
Lower Heating Value of Refinery Fuel Gas (MMBtu/MMscf) = 906.1
Ratio of Higher Heating Value to Lower Heating Value = 1.11

Lower Heating Value of Propane (MMBtu/MMscf) = 2316.1

SO₂ Emissions from Streams Vented to North Flare (20-72)

Unit	Vent Source	Regulatory Applicability Subject to:	Composition	Flow Rate (scfh)	Heating Input (MMBtu/hr)	SO ₂ (lb/hr)	SO ₂ (tpy)	Vent Frequency
ROSE	Hot Oil Surge Drum		Natural Gas	2000	1.8	0.05	0.17	50%
ROSE	LPG Wash Drum		Refinery Fuel Gas	2000	1.8	0.054	0.004	60% (1 day/month)
Truck Rack	LPG Loading		Propane	69.26	0.1	0.027	0.003	1 hour/day
Truck Rack	LPG Loading		Butane	59.26	0.1	0.027	0.003	1 hour/day
Water	Butane Causalic Treater		Butane	254	0.8	0.007	0.0007	1 hour/week
OWS ¹	Feed Surge Drum		Refinery Fuel Gas	25.42	0.0	0.08	0.37	Continuous
OWS ¹	Overhead Receiver		Refinery Fuel Gas	203.5	0.2	4.45	18.48	Continuous
BenFire ¹⁰	BenFire Refactor	NSPS Subpart Jb	Refinery Fuel Gas	145574.05	133.24	0.080	0.0001	2.5 hours/year
Total					4.8	8.77	18.98	

Heat Input from Sweep Gas and Pilot (MMBtu/hr) = 15.9
Heat Input from Vent Gas (MMBtu/hr) = 4.8
Total Heat Input (MMBtu/hr) = 20.0

Emissions from Combustion

Pollutant	Duty (MMBtu/hr)	Emission Factor (lb/MMBtu)	Average Hourly Emissions (lb/hr)	Maximum Hourly Emissions ¹¹ (lb/hr)	Annual Emissions (tpy)
NO _x ¹	20.0	0.028	1.54	102.13	8.73
SO ₂ ²	15.9	0.0285	0.45	0.45	1.98
CO	20.0	0.41	8.38	555.73	39.84
PM-10 ³	20.0	0.0083	0.17	11.19	0.74
VOC ⁴	20.0	0.16	3.16	210.28	13.88

Speciation of VOC Emissions

Pollutant	Wt% of VOC Emissions	Average Hourly Emissions (lb/hr)	Maximum Hourly Emissions ¹¹ (lb/hr)	Annual Emissions (tpy)
Benzene ⁵	4	0.13	8.41	0.55
Toluene ⁶	2	0.08	4.21	0.29
Formaldehyde ⁷	8	0.25	16.82	1.11

Total SO₂ Emissions

EG Point	Average Hourly Emissions (lb/hr)	Maximum Hourly Emissions (lb/hr)	Annual Emissions (tpy)
North Flare (20-72)	5.21	8.21	21.66

References

- AP-42 emission factors were multiplied by the ratio of the higher heating value of refinery fuel gas to the lower heating value of refinery fuel gas.
- Based on Personal Communication, separate interviews between Mr. Vince Vicentini (MOUSA), Mr. Ousey Sellery (MOUSA), and Ms. Valerie Kucharskas Barth (Trinity) on January 23, 2004. Mr. Vicentini stated that the additional vent stream from the Hydrocracker Feed Drum vent (MC-V-431) contains only sweep gas. Mr. Sellery provided the heat input value for the sweep gas.
- Emission factor from AP-42, Section 13-3, Industrial Flares, Table 13.5-1, September 1981.
- SO₂ emission factor based on NSPS standard for fuel gas combustion devices. Since SO₂ emissions from the vent gas streams have already been accounted for, only the heat input from the sweep gas and pilot was used in calculating combustion emissions.
- Emission factor from AP-42, Section 1.4, Natural Gas Combustion, Tables 1.4-1 and 1.4-2. Emission factors were converted from lb/MMBtu to lb/MMBtu by dividing the emission factor by 1020, as per Table 1.4-1, Note A, September 1988.
- VOC speciation from Air Emission Species Manual, Volume 1, Volatile Organic Compound Species, Profile Number 0003 for natural gas combustion, January 1990, EPA-450/2-90-001a.
- Based on phone conversation with Lee Vail (MOUSA) and Valerie Barth (Trinity) on October 12, 2006, the flow rate and frequency of this stream is identical to the spent caustic degassing drum that is routed to the South Flare. The H₂S content of this stream is 159 ppmv.
- The North Flare is used as a dual control device with the Platformer charge heater for the Platformer regeneration vent stream for compliance with NSPS-AP-42 Subpart UU. A maximum vent gas flow rate of 12,000 Bbl/hr from this stream is taken into account in this calculation.
- Based on email from Matt Dobbins (MOUSA) to Cheryl Kweel (Trinity) on December 4, 2008 and on personal communication phone conversation on January 10, 2009, the city water stripper vent will remain routed to the North Flare as calculated in the January 10, 2009 permit application.
- Based on email from Matt Dobbins (MOUSA) to Cheryl Kweel (Trinity) on January 29, 2009 and on personal communication phone conversation on January 27, 2009.
- Per personal communication phone conversation between Matt Dobbins (MOUSA) and Cheryl Kweel (Trinity) on January 27, 2009, the BenFire Refactor will be vented to the North Flare as a relief valve approximately five times a year with each incident lasting thirty minutes. Maximum hourly emissions for this source are based on the BenFire Refactor being vented to the North Flare. Annual and average emissions for this source include the heat input from the BenFire Refactor during the estimated 2.5 hours/year.

**Murphy Oil USA, Inc. - Meraux Refinery
NSR Analysis for 2009 Capital Projects**

**Table 1. Determine Emissions Increases from Proposed Project
and Comparison to PSD de Minimis Levels**

EQ No.	Source Name	EMISSIONS (TPY)						CO		PARTICULATES		VOCs	
		Baseline	125	Baseline	SOx	Baseline	125	Baseline	125	Baseline	125	Baseline	125
1-09	BenFree Reboiler	-	9.461	-	6.986	-	21.634	-	1.957	-	1.416	-	20.360
	Fugitive Emissions (BenFree)	-	0.080	-	-	-	0.460	-	0.001	-	2.700	-	0.100
	BenFree Turnaround Emissions ¹	-	-	-	-	-	-	-	-	-	-	-	2.760
	Fugitive Emissions (Tank Farm)	-	-	-	-	-	-	-	-	-	-	-	2.665
4-00	Cooling Tower ²	-	-	-	-	-	-	-	-	-	-	-	13.860
20-12	North Flare ³	8.520	6.730	2.100	21.950	35.480	36.640	0.710	0.74	1.585	1.840	2.665	13.860
300-4	Tank 300-4	-	-	-	-	-	-	-	-	-	-	-	1.750
300-6A	Tank 300-6A	-	-	-	-	-	-	-	-	-	-	-	2.320
300-3A	Tank 300-3A	-	-	-	-	-	-	-	-	-	-	-	0.530
250-8	Tank 250-8	-	-	-	-	-	-	-	-	-	-	-	0.120
T-5	Tank T-5	-	-	-	-	-	-	-	-	-	-	-	0.782
1-3A	Tank 1-3A	-	-	-	-	-	-	-	-	-	-	-	1.108
80-5A	Tank 80-5A	-	-	-	-	-	-	-	-	-	-	-	1.420
80-9	Tank 80-9 ⁴	-	-	-	-	-	-	-	-	-	-	-	2.000
80-10A	Tank 80-10A	-	-	-	-	-	-	-	-	-	-	-	-

Total:	8.520	16.271	2.100	28.946	35.480	58.734	2.295	4.338	18.085	52.876
Increases Only	8.751		26.846		23.254		2.043			
PSD Threshold	40		40		100		15			
Greater than de minimis levels? (Y/N)	N	N	N	N	N	N	N	N	N	N

¹The BenFree Turnaround emissions have been conservatively based on one turnaround per year. The calculation of BenFree turnaround emissions over five years has been based on the Hydrocracker turnaround emissions, which assumed three turnarounds every five years.

²Baseline emissions based on data used in the preparation of the 2006 and 2007 Emissions Reporting Inventory Center (ERIC) Submittals.

³Emissions from the North Flare (Source ID 20-12) have been adjusted down to the currently permitted emission rate for the North Flare.

J. Phyllis Fox, Ph.D, PE, DEE
Environmental Management

745 White Pine Ave.
Rockledge, FL 32955
321-626-6885
510-593-7576
PhyllisFox@gmail.com

Dr. Fox has over 35 years of experience in the field of environmental engineering, including air pollution control, air quality management, water quality and water supply investigations, hazardous waste investigations, environmental permitting, nuisance investigations, 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.

Post-Graduate:

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.
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, 11/1/06
Cost Estimating and Tricks of the Trade – A Practical Approach, P159, 11/19/06
Process Equipment Cost Estimating by Ratio & Proportion, G127 11/19/06
Power Plant Air Quality Decisions, Power-Gen 11/06
Negotiating Permit Conditions, EEUC, 1/21/06
BACT for Utilities, EEUC, 1/21/06
McIlvaine Hot Topic Hour, Chinese FGD/SCR Program & Impact on World, 2/1/07
McIlvaine Hot Top Hour, Mercury CFMS, 4/12/07
Coal-to-Liquids – A Timely Revival, 9th Electric Power, 4/30/07
Advances in Multi-Pollutant and CO₂ Control Technologies, 9th Electric Power, 4/30/07
McIlvaine Hot Topic Hour, Measurement & Control of PM2.5, 5/16/07
Ethanol 101: Points to Consider When Building an Ethanol Plant, BBI International, 6/26/07

REGISTRATION

Registered Professional Engineer: Arizona (2001-present), California (2002-present), Florida (2001-present), Georgia (2002-present), Washington (2002-present), Wisconsin (2005-present)
Board Certified Environmental Engineer, American Academy of Environmental Engineers,
Certified in Air Pollution Control (DEE #01-20014), 2002-present
Qualified Environmental Professional (QEP), Institute of Professional Environmental Practice (QEP #02-010007), 2001-present
Class I Registered Environmental Assessor, California (REA-00704), 1988-present.
Class II Registered Environmental Assessor, California (REA-20040), 2000-present

PROFESSIONAL HISTORY

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

PROFESSIONAL AFFILIATIONS

American Industrial Hygiene Association (2002-present)
Air and Waste Management Association (1999-present)
American Chemical Society (1981-present)

American Society of Mechanical Engineers (2004-present)
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 refineries; reformulated fuels projects; petroleum distribution terminals; conventional and thermally enhanced oil production; underground storage tanks; pipelines; gasoline stations; landfills; railyards; hazardous waste treatment facilities; nuclear, hydroelectric, geothermal, wood, waste, gas, oil and coal-fired power plants; transmission lines; airports; hydrogen plants; petroleum coke calcining plants; 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; urea plants; food processing plants; almond hulling facilities; composting facilities; grain processing facilities; grain elevators; ethanol production facilities; soy bean oil extraction plant; biodiesel plants; paint formulation plants; wastewater treatment plants; marine terminals and ports; gas processing plants; steel mills; iron nugget production facilities; railcar refinishing facility; battery manufacturing plants; pesticide manufacturing and repackaging facilities; pulp and paper mills; selective catalytic reduction (SCR) 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, nahcolite, coal, molybdenum, gold, zinc, and oil shale.

EXPERT WITNESS/LITIGATION SUPPORT

- For plaintiffs, expert witness 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 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, 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 NO_x and SO₂ 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.
- For plaintiffs, expert witness in contested case hearing on BACT, enforceability, and alternatives analysis for a 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*. Petition for Judicial Review filed by petitioners in Greene County Circuit Court, May 19, 2006.
- 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. 1H-04-21. Petitions for Judicial Review filed by petitioners and respondents in Brown County Circuit Court, May 2006.
- 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.
- 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 NO_x, SO₂, 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.
- 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).

- 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 prepare response. Prepare declaration and present 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. (Los Angeles Superior Court).
- 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).
- 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 SO₂ 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. *Sierra Club et al. v. Georgia Power Company* (Northern District of Georgia). Summary Judgment Order issued December 14, 2004 granting plaintiffs' motion as to opacity violations and startup not defense to violations.

- 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 NO_x, SO₂, 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, NO_x, SO₂, Hg, Be), single source, enforceability, and errors and omissions. Assist counsel draft exceptions. Cabinet Secretary issued Order April 11, 2006 denying Hearing Officer's report, except as to NO_x 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 ft² 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 CO₂ and NH₃, 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 NH₃ and CO₂, 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 30 large combined cycle, simple cycle, and peaker power plants in California, Arizona, Georgia, Florida, Illinois, Missouri, Oklahoma, Oregon, and elsewhere. Prepare analyses of and comments on applications for certification, preliminary and final staff assessments, and permits issued by local agencies. Present written and oral testimony before California Energy Commission and Arizona Power Plant and Transmission

Line Siting Committee 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 CVPLA 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. Currently representing neighbors on technical advisory committee established by port to implement the air quality mitigation program.
- 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, 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 PERMITTING/NEGOTIATIONS

- 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 Central Coast. Negotiated conditions with agencies and secured permits.
- Prepared Authority to Construct Permit for remediation of a former oil field on the 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, 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 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 30 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 streams. 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 outgassing 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, T.P. Rose, and T.L. Sawyer, Isotope Hydrology of a Spring-fed Waterfall in Fractured Volcanic Rock, Submitted to Journal of Hydrology, 2006.

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, 1984.
- 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).
- 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. Giaque, 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.