California Environmental Protection Agency

# Air Resources Board

## PUBLIC MEETING AGENDA

**January 22 & 23,2009**

**LOCATION:**
Air Resources Board
Byron Sher Auditorium, Second Floor
1001 I Street
Sacramento, California 95814

This facility is accessible by public transit. For transit information, call (916) 321-BUSS, website: http://www.sacrt.com
(This facility is accessible to persons with disabilities.)

**TO SUBMIT WRITTEN COMMENTS ON AN AGENDA ITEM IN ADVANCE OF THE MEETING GO TO: http://www.arb.ca.gov/lispub/comm/bclist.php**

## January 22, 2009
## 9:00 a.m.

Agenda Item #

**09-1-7: Report to the Board on the Air Resources Board's Program Priorities for 2009**

*ARB Executive Officer James Goldstene will brief the Board on major program priorities for 2009.*

**09-1-1: Health Update: Potential Health Impacts of Residential Wood Burning**

*The health impacts of exposure to fine particulate matter, such as.increased risk for mortality and asthma exacerbations, are well established. Yet, the components of particulate matter that may be most responsible for these health effects are not known. This month's health update highlights a study of the potential health impacts of exposure to wood smoke in asthmatic children. The study found lung function changes in the exposed children, which may be related to combustion-generated components of ambient particulate matter, including wood burning sources.*

**09-1-2: Public Hearing to Consider the Adoption of a Proposed Regulation for Small Containers of Automotive Refrigerant**

*Air Resources Board (ARB or Board) staff is proposing a Discrete Early Action regulation that would reduce greenhouse gas emissions associated with do-it-yourself recharging of motor vehicle air conditioning systems. This regulation would achieve greenhouse gas emission reductions through the use of a self-sealing valve on the container, improved labeling instructions, a container deposit and return program, reclamation of the refrigerant remaining in the used container, recycling of the container, and an education program that emphasizes best practice techniques for vehicle recharging as well as highlights the environmental risks associated with this product. This regulation would result in an estimated emission reduction of 0.26 million metric tons carbon dioxide equivalent in a cost-effective manner.*

**09-1-3: Public Hearing to Consider Proposed California Evaluation Procedures for Aftermarket Critical Emission Control Parts on Highway Motorcycles**

*The proposed regulations would allow manufacturers to offer for sale aftermarket critical emission control parts for motorcycles within their emissions compliance period. The motorcycle aftermarket parts manufacturers would have to demonstrate compliance to ARB new vehicle emissions standards through a new evaluation procedure for the exemption of motorcycle aftermarket critical emission control parts from the anti-tampering requirements of Vehicle Code section 27156. Examples of such parts include exhaust systems with catalytic converters, oxygen sensors, and hydrocarbon absorbers. The proposal would allow the replacement of stock critical emission control parts with aftermarket parts by non-original manufacturers. The proposed requirements include durability emission testing, emission defects warranty and reporting, exemption labeling, audit testing, and in-use recall.*

**09-1-6: Public Meeting to Report to the Board on the Impacts of the Particulate Matter Performance Standards of the In-Use On-Road Vehicle Regulation in Oxides of Nitrogen Attainment Areas**

*On December 12, 2008, the Board approved for adoption the proposed regulation to reduce emissions of diesel particulate matter (PM), oxides of nitrogen (NOx), and greenhouse gases from in-use on-road diesel vehicles that operate in California (Truck and Bus Regulation). The Board requested that staff report back and provide an update on the impacts of the PM performance standards for vehicles driven exclusively within the designated NOx attainment areas identified in the approved Truck and Bus Regulation.*

**09-1-4: Public Hearing to Consider Proposed Amendments to the Regulation for In-Use Off-Road Diesel-Fueled Fleets and an Update on Status of Implementation of the Regulation**

*The in-use off-road diesel vehicle regulation (off-road regulation) was adopted by the Board on July 26, 2007, as California Code of Regulations, title 13, section 2449. As directed by the Board in Resolution 07-19, ARB staff will present an update on the implementation of the off-road regulation, including an assessment of the technologies currently available for compliance with the off-road regulation. In addition to this update, staff will propose an amendment to the regulation, which would extend the deadline for receiving early credit for the installation of verified diesel emission control strategies.*

**09-1-5: Public Meeting to Consider Approval of California's Regional Haze Plan**

*The Regional Haze Plan charts a path towards visibility improvement through 2018 at 29 of California's national parks and wilderness areas.*

# January 23, 2009
## 8:30 a.m.

**Agenda Item #**

**09-1-8: Public Hearing to Consider Plug-In Hybrid Electric Vehicle Test Procedure Amendments and Aftermarket Parts Certification Requirements Adoption**

*ARB staff has developed modifications to existing exhaust and evaporative test procedures in the passenger car, light-duty truck, and medium-duty classes to address operating characteristics of plug-in hybrid electric vehicles. New certification and installation requirements for aftermarket kits converting hybrid electric vehicles to plug-in hybrid electric vehicles will also be presented for adoption.*

**09-1-9: Public Meeting to Consider Appointment of Members to the Regional Targets Advisory Committee under Senate Bill 375**

*Senate Bill* 375 *(Steinberg, chapter* 728, *statutes* of *2008) requires ARB to provide metropolitan planning organizations with passenger vehicle greenhouse gas reduction targets by September 30, 2010. The bill requires ARB, no later than January* 31, *2009, to appoint* a *Regional Targets Advisory Committee to recommend factors to be considered and methodologies to be used for setting regional greenhouse gas reduction targets. Staff will describe the scope* of *the committee's work and the Board will appoint committee members.*

**CLOSED SESSION - LITIGATION**

*The Board will hold* a *closed session,* as *authorized by Government Code section 11126(e), to confer with, and receive advice from, its legal counsel regarding the following pending litigation:*

*Central Valley Chrysler-Jeep, Inc. et al. v. Goldstene, U.*S. *Court* of *Appeals, Ninth Circuit, No. 08-17378 on appeal from U.S. District Court (E.D. Cal. - Fresno).*

*Fresno Dodge, Inc. et al. v. California Air Resources Board et al., Superior Court* of *California (Fresno County),* Case *No. 04CE* CG03498.

*General Motors Corp. et al. v. California Air Resources Board et al., Superior Court* of *California (Fresno County),* Case *No. 05CE* CG02787.

*State* of *California by and through Arnold Schwarzenegger, the California Air Resources Board, and the Attorney General v. U.*S. *Environmental Protection Agency, and Stephen L. Johnson, Administrator, U.*S. *Court* of *Appeals, District* of *Columbia Circuit,* Case *No. 08-1178.*

*Green Mountain Chrysler-Plymouth-Dodge-Jeep, et al. v. Crombie, 508 F. Supp. 2d 295, U.S. District Court Vermont (2007), appeal to U.S. Court* of *Appeals, Second Circuit, Nos. 07-4342-cv(L) and 07-4360-cv(CON).*

*Tesoro Refining and Marketing Company v. California Air Resources Board, Superior Court* of *California (Sacramento County),* Case *No. 34-2008-80000064.*

OPPORTUNITY FOR MEMBERS OF THE BOARD TO COMMENT ON MATTERS OF INTEREST

*Board members may identify matters they would like to have noticed for consideration at future meetings and comment on topics of interest; no formal action on these topics will be taken without further notice.*

OPEN SESSION TO PROVIDE AN OPPORTUNITY FOR MEMBERS OF THE PUBLIC TO ADDRESS THE BOARD ON SUBJECT MATTERS WITHIN THE JURISDICTION OF THE BOARD

*Although no formal Board action may be taken, the Board is allowing an opportunity to interested members of the public to address the Board on items of interest that are within the Board's jurisdiction, but do not specifically appear on the agenda. Each person will be allowed a maximum of three minutes to ensure that everyone has a chance to speak.*

THE AGENDA ITEMS LISTED ABOVE MAY BE CONSIDERED IN A DIFFERENT ORDER AT THE BOARD MEETING. BOARD ITEMS NOTED ABOVE WHICH ARE NOT COMPLETED ON JANUARY 22, WILL BE HEARD ON JANUARY 23 BEGINNING AT 8:30 A.M.

TO SUBMIT WRITTEN COMMENTS ON AN AGENDA ITEM IN ADVANCE OF THE MEETING GO TO:
http://www.arb.ca.gov/lispub/comm/bclist.php

IF YOU HAVE ANY QUESTIONS, PLEASE CONTACT THE CLERK OF THE BOARD:
OFFICE: (916) 322-5594 or FAX: (916) 322-3928
1001 I Street, Floor 23, Sacramento, California 95814
ARB Homepage: www.arb.ca.gov

To *request special accommodation or language needs, please contact the following:*

- For individuals with sensory disabilities, this document and other related material can be made available in Braille, large print, audiocassette, or computer disk. For assistance, please contact ARB's Reasonable AccommodationlDisability Coordinator at (916) 323-4916 by voice, or through the California Relay Services at 711, to place your request for disability services, or go to http://www.arb.ca.gov/htmllada/ada.htm.

- If you are a person with limited English, and would like to request interpreter services to be available at the Board meeting, please contact ARB's Bilingual Manager at (916) 323-7053.

California Environmental Protection Agency

# Air Resources Board

PUBLIC MEETING AGENDA

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## INDEX

January 22, 2009 at 9:00 a.m.
&
January 23, 2009 at 8:30 a.m.

# TITLE 17. CALIFORNIA AIR RESOURCES BOARD

## NOTICE OF PUBLIC HEARING TO CONSIDER THE ADOPTJON OF A PROPOSED REGULATION FOR SMALL CONTAINERS OF AUTOMOTIVE REFRIGERANT

The Air Resources Board (the Board or ARB) will conduct a public hearing at the time and place noted below to consider the adoption of a proposed regulation for small containers of automotive refrigerant.

DATE: January 22, 2009

TIME: 9:00 a.m.

PLACE: California Environmental protection Agency
Air Resources Board
Byron Sher Auditorium
1001 I Street
Sacramento, CA 95814

This item will be considered at a two-day meeting of the Board, which will commence at 9:00 a.m., January 22,2009, and may continue at 8:30a.m., January 23,2009. This item may not be considered until January 23, 2009. Please consult the agenda for the meeting, which will be available at least ten days before January 22,2009, to determine the day on which this item will be considered.

For individuals with sensory disabilities, this document and other related material can be made available in Braille, large print, audiocassette, or computer disk. For assistance, please contact ARB's Reasonable Accommodations/Disability Coordinator at (916) 323-4916 by voice or through the California Relay Services at 711, to place your request for disability services, or go to http://www.arb.ca.gov/html/ada/ada.htm.

If you are a person with limited English and would like to request interpreter services'to be available at the Board meeting, please contact ARB's Bilingual Manager at (916) 323-7053.

### INFORMATIVE DIGEST OF PROPOSED ACTION AND POLICY STATEMENT OVERVIEW

**Sections Affected:** Proposed adoption of California Code of Regulations, title 17, new Subchapter 10, Article 4, Subarticle 4. Small Containers of Automotive Refrigerant, , sections 95360, 95361, 95362, 95363, 95364, 95365, 95366, 95367, 95368, 95369, and 95370, and the proposed adoption of the incorporated documents: "Certification Procedures for Small Containers of Automotive Refrigerant", "Test Procedure for Leaks from Small Containers of Automotive Refrigerant" (TP-503), and "Balance Protocol for Gravimetric Determination of Sample Weight using a Precision Analytical Balance" (BP-A1).

**Background:**
The California Global Warming Solutions Act of 2006 (Assembly Bill 32, AB 32, Núñez, Ch. 486, Stats. 2006) creates a comprehensive, multi-year program to reduce greenhouse gas (GHG) emissions in California. AB 32 also requires the Air Resources Board (ARB or Board) to identify a list of discrete early action greenhouse gas reduction measures by June 30, 2007, and to adopt regulations to implement listed early action measures. These early action measures must be enforceable no later than January 1, 2010. Early action measures must also achieve the maximum technologically feasible and cost-effective reductions in GHGs from sources or categories of sources.

In 2007, the Board approved an early action measure to reduce GHG emissions resulting from non-professional (i.e., do-it-yourselfer [DIYer]) recharging of motor vehicle air conditioning (MVAC) systems. ARB staff has worked closely with stakeholders and has developed the proposed discrete early action measure to reduce GHG emissions associated with DIY recharging of MVAC systems. The proposed regulation establishes requirements for the small containers of automotive refrigerants and on the sale, use, and disposal of those containers when the refrigerant in them has a global warming potential greater than 150. These new requirements will help reduce GHG emissions generated from current DIY practices.

HFC-134a is ahydrofluorocarbon (HFC) that is, and has been, the predominant refrigerant used in MVAC systems manufactured since 1995. HFC-134a is not an ozone-depleting substance, but is a potent GHG that has a global warming impact 1,300 times greater than carbon dioxide ($CO_2$).. A single 12-ounce container of this refrigerant is equivalent to 1,000 lbs of $CO_2$ or roughly the carbon dioxide emissions emitted from an automobile burning 50 gallons of gasoline. Approximately two million small containers of automotive refrigerant are sold annually in California, and an estimated 810,000 metric tons of carbon dioxide equivalent (MTC02E) are emitted each year as a result of DIY practices.

Currently, most small containers of automotive refrigerant are not equipped with self-sealing valves. Consequently, when a user punctures a container with a dispensing device to recharge a MVAC system, the refrigerant is either transferred into the MVAC system, released to the atmosphere, or remains in the container: The refrigerant remaining in the can, called the can heel, is eventually released to the atmosphere when the can is discarded. Staff estimates that 33 percent of the refrigerant is released to the atmosphere when DIYers recharge MVAC systems.

A DIYer saves money by recharging his or her MVAC system with small containers of refrigerant compared to having a professional service the MVAC, because small containers typically cost $10 per container, compared to over one hundred dollars that professionals may charge to diagnose and recharge a MVAC. However, DIYers may not properly identify or repair repairable leaks because they lack the training and/or equipment possessed by MVAC technicians. Furthermore, DIYers may also unintentionally release more refrigerant than if the recharges were performed by trained and certified MVAC technicians at a licensed auto repair facility. Staff estimates that 1.4 million DIY recharges are performed annually in California.

**DESCRIPTION OF THE PROPOSED REGULATORY ACTION**

The proposed regulation would be effective as of January 1, 2010, and utilizes a multi-pronged approach that is comprised of the following major components:

- A certification program that would require manufacturers to equip small containers of automotive refrigerant with self-sealing valves and to demonstrate compliance with the designed leak rate. These requirements would help reduce losses occurring during DIY servicing, and would help capture can heels in used containers.

- A container deposit and return program to recover and recycle the can heel in used containers. Consumers would pay a $10 deposit at the time of purchase, and would return a used container to the retailer within 90 days of purchase to receive a full refund of the deposit. The disposal or destruction of a container of refrigerant would be prohibited to ensure that used containers would be returned to retailers and manufacturers. Retailers would store and transfer the used cans back to manufacturers, who would then recover and reclaim the refrigerant remaining in the containers. Manufacturers are presently already recovering refrigerant from dented containers using existing container-filling equipment. The regulation establishes an initial ta.rget recycle rate of 90 percent that increases to 95 percent beginning January, 2012. Staff would determine the recycle rate from manufacturer submitted records, and the regulation would allow the Executive Officer to revise the deposit fee if the container return rate falls below the targeted rate.

- Container labeling-and consumer education requirements to promote consumer education of proper MVAC system charging practices, and to inform consumers of the environmental consequences associated with the improper use of refrigerant, and of the container deposit and return program. These requirements would help DIYers reduce refrigerant losses that result from improper servicing techniques.

- Recordkeeping requirements to enable staff to determine the effectiveness of the regulation and to monitor and ensure compliance with the regulation's requirements.

**Environmental and Economic Impacts**

The proposed regulation achieves GHG emissions reductions of about 260,000 MTCOzE per year, at an estimated cost effectiveness of $11/MTCOzE.

Manufacturers are expected to amortize their compliance costs to consumers, which would increase the retail unit cost of a small container of refrigerant by about $1. Consumers would also be required to pay an additional $10 deposit per container, but this amount would be fully refunded if the consumer returned the used container within. 90 days and with a receipt to the place of purchase.

The proposed regulation achieves emission reductions at a minimal cost compared to the regulatory alternative of banning the sale of small containers of automotive refrigerant, and can serve as a model regulatory approach for other states.

**COMPARABLE FEDERAL REGULATIONS**

Although the Federal Clean Air Act (CM) and U.S. Environmental Protection Agency regulations generally regulate certain aspects regarding the usage of non-ozone depleting refrigerants used in MVAC systems, they do not currently restrict or regulate the sales or usage of small containers of non-ozone-depleting automotive refrigerant. Therefore, the proposed regulation would establish more stringent requirements than comparable federal regulations.

Section 609(e) of the federal Clean Air Act (CM) [42 U.S.C. § 7671 h(e)] and Title 40, Code of Federal Regulations (CFR) section 82.34(b) have restricted, as of November 15, 1992, the sale, distribution, or offer for sale or distribution of ozone-depleting refrigerants that are suitable for use in motor vehicle air-conditioning systems and that are in containers with less than 20 pounds of refrigerant, except to those technicians that have been trained and certified pursuant to an EPA-approved course. On March 12, 2004, the U.S. EPA decided not to extend a proposed restriction on the sale of small containers of pure HFC or PFC refrigerants to certified technicians.

Section 608(c)(2) of the CAA [42 U.S.C. § 7671 g(c)(2)] has generally prohibited any person from venting or releasing any substance that is used as a substitute 'for an ozone-depleting refrigerant into the atmosphere since November 15, 1995. In 2004, the U.S. EPA amended its regulations regarding refrigerant recycling to clarify that the section 608(c)(2) venting ban also extends to pure HFC and perfluorocarbon (PFC) refrigerants.

**AVAILABILITY OF DOCUMENTS AND AGENCY CONTACT PERSONS**

The Board staff has prepared a Staff Report: Initial Statement of Reasons (ISOR) for the proposed regulatory action, which includes a summary of the economic and environmental impacts of the proposal. The report is entitled "Initial Statement of Reasons for Rulemaking, Proposed Regulation for Small Containers of Automotive Refrigerant." A Technical Support Document has also been prepared which contains a more detailed presentation of the emissions and economic impact of the proposed regulation.

Copies of the ISOR and the full text of the proposed regulatory language may be accessed on the ARB's web site listed below, or may be obtained from the Public Information Office, Air Resources Board, 1001 I Street, Visitors and Environmental

Services Center, 1st Floor, Sacramento, CA 95814, (916) 322-2990 at least 45 days prior to the scheduled hearing on January 22, 2009.

Upon its completion, the Final Statement of Reasons (FSOR) will be available and copies may be requested from the agency contact persons in this notice, or may be accessed on the ARB's web site listed below.

Inquiries concerning the substance of the proposed regulation may be directed to the designated agency' contact persons, Dr. Tao Huai, Manager of the Climate Change Mitigation and Emissions Research Section, at (916) 324-2981 or Mr. Winston Potts, P.E., Air Resources Engineer, Climate Change Mitigation and Emissions Research Section, (916) 323-2537.

Further, the agency representative and designated back-up contact persons to whom nonsubstantive inquiries concerning the proposed administrative action may be directed are Ms. Lori Andreoni, Manager, Board Administration & Regulatory Coordination Unit, (916) 322-4011, or Ms. Amy Whiting, Regulations Coordinator, (916) 322-6533. The Board has compiled a record for this rulemaking action, which includes all the information upon which the proposal is based. This material is available for inspection upon request to the contact persons.

This notice, the ISOR and all subsequent regulatory documents, including the FSOR, when completed, are available on the ARB Internet site for this rulemaking at www.arb.ca.gov/regact/2009/hfc09/hfc09.htm.

**COSTS TO PUBLIC AGENCIES AND TO BUSINESSES AND PERSONS AFFECTED**

The determinations of the Board's Executive Officer concerning the costs or savings necessarily incurred by public agencies and private persons and businesses in reasonable compliance with the proposed regulations are presented below.

Pursuant to Government Code sections 11346.5(a)(5), the Executive Officer has determined that the proposed regulation would not impose a mandate on local agencies or school districts. The Executive Officer has further determined pursuant to Government Code section 11346.5(a)(6) that the proposed regulation would result in some additional costs to ARB. In addition, the Executive Officer has determined that the proposed regulatory action would not create costs or savings in federal funding to the state, would not create costs or savings to local agencies or school districts that are required to be reimbursed under Part 7 (commencing with section 17500), Division 4, Title 2 of the Government Code, and would not result in other nondiscretionary costs or savings to state or local agencies.

In developing this regulatory proposal, ARB staff evaluated the potential economic impacts on representative private persons or businesses, and has determined that those private persons that purchase small containers of automotive refrigerant to recharge their own MVAC systems (estimated at 1.4 million Californians) would incur additional costs as a result of this regulation. Specifically, the retail cost of a small container of automotive refrigerant would increase by $1 on average. The average retail price of a small container is approximately $10, so this estimated price increase only represents a ten percent increase over current prices. Consumers would also be required to pay an additional $10 deposit per container, but this amount would be fully refunded if the consumer returned the used container within 90 days and with a receipt to the place of purchase.

Manufacturers of small containers of automotive refrigerant would incur additional costs as a result of the proposed regulation, but are expected to amortize these costs into the retail price of small containers. In addition, manufacturers would be able to offset some of these costs with the value of refrigerant that they would recapture under the proposed container recycling component of the proposed regulation.

Both manufacturers and retailers would incur costs associated with the proposed recordkeeping and other administrative components of the proposed regulation, but such costs should be minimal.

The Executive Officer has made an initial determination that the proposed regulatory action would not have a significant statewide adverse economic impact dfrectly affecting businesses, including the ability of California businesses to compete with businesses in other states, or on representative private persons.

In accordance with Government Code section 11346.3, the Executive Officer has determined that the proposed regulatory action could affect the creation or elimination of jobs within the State of California, the creation of new businesses or elimination of existing businesses within the State of California, or the expansion of, businesses currently doing business within the State of California. Jobs are not expected to be lost as a result of the proposed regulatory action, but rather some jobs may be created in order for manufacturers to comply with the proposed container recycling provisions. A detailed assessment of the economic, impacts of the proposed regulatory action can be found in the ISOR.

The Executive Officer has also determined, pursuant to the California Code of Regulations, title 1, section 4, that the proposed regulatory action would affect small businesses. Small retailers such as automotive parts stores would incur increased costs resulting from the proposed administrative requirements for recordkeeping, handling container deposit funds, and storing and returning used cans for recycling, but these cost increases should be minimal because most of these activities are already conducted by retailers as part of their normal daily business. Some retailers that do not predominately sell automotive products may decide to stop selling the product, because their projected profit from selling small containers of refrigerant would not compensate them for incurring the additional costs resulting from the proposed regulation.

Small MVAC service centers that purchase small containers of refrigerant would incur the same increased costs as consumers ($1 per container). These additional costs should be minimal because it is estimated that only 5 percent of small cans are sold to professional MVAC servicing centers, and these service centers would likely pass these additional costs onto their consumers.

In accordance with Government Code sections 11346.3(c) and 11346.5(a)(1·1), the Executive Officer has found that the reporting requirements of the regulation which apply to businesses are necessary for the health, safety, and welfare of the people of the State of California.

Before taking final action on the proposed regulatory action, the Board must determine that no reasonable alternative considered by the Board or that has otherwise been identified and brought to the attention of the Board would be more effective in carrying out the purpose for which the action is proposed or would be as effective and less burdensome to affected private persons than the proposed action.

**SUBMITTAL OF COMMENTS**

Interested members of the public may also present comments orally or in writing at the meeting, and in writing or bye-mail before the meeting. To be considered by the Board, written comments submissions not physically submitted at the meeting must be received **no later than 12:00 noon, January 21,2009,** and addressed to the following:

Postal mail: Clerk of the Board
Air Resources Board
1001 I Street
Sacramento, California 95814

Electronic submittal: http://www.arb.ca.gov/lispub/comm/bclist.php

Facsimile submittal: (916) 322-3928

Please note that under the California Public Records Act (Government Code section 6250 et seq.), your written and oral comments, attachments, and associated *contact* information (e.g., your address, phone, email, etc.) become part of the public record and can be released to the public upon request. Additionally, this information may become available via Google, Yahoo, and any other search engines.

The Board requests but does not require that 30 copies of any written statement be . submitted and that all written statements be'filed at least ten days prior to the hearing so that ARB staff and Board Members have time to fully consider each comment. The Board encourages members of the public to bring to the attention of staff in advance of the hearing any suggestions for modification of the proposed regulatory action.

## STATUTORY AUTHORITY AND REFERENCES

This regulatory action is proposed under that authority granted in Health and Safety Code, sections 38501, 38505, 38510, 38550, 38551, 38560, 38560.5, 38580, 39600, and 39601. This action is proposed to implement, interpret and make specific sections 38501,38505,38510,38550,38551, 38560,38560.5, 39003,39500, 39600, and 39601 of the Health and Safety Code.

## HEARING PROCEDURES

The public hearing will be conducted in accordance with the California Administrative Procedure Act, title 2, division 3, part 1, chapter 3.5 (commencing with section 11340) of the Government Code.

Following the public hearing, the Board may adopt the regulatory language as originally proposed, or with non substantial'or grammatical modifications. The Board may also adopt the proposed regulatory language with other modifications if the text as modified is sufficiently related to the originally proposed text that the public was adequately placed on notice that the regulatory language as modified could result from the proposed regulatory action; in such event the full regulatory text, with the modifications clearly indicated, will be made available to the public, for written comment, at least 15 days before it is adopted.

The public may request a copy of the modified regulatory text from the ARB's Public Information Office, Air Resources Board, 1001 I Street, Visitors and Environmental Services Center, 1st Floor, Sacramento, CA 95814, (916) 322-2990.

CALIFORNIA AIR RESOURCES BOARD

James N. Goldstene
Executive Officer

Date: November 25, 2008

*The energy challenge facing California is real. Every Californian needs to take immediate action to reduce energy consumption. For a list of simple ways you can reduce demand and cut your energy costs see our Web -site at www.arb.ca.gov.*

California Environmental Protection' Agency

# Air Resources Board


## INITIAL STATEMENT OF REASONS FOR PROPOSED REGULATION FOR SMALL CONTAINERS OF AUTOMOTIVE REFRIGERANT

Release Date:
December 5, 2008

State of California
AIR RESOURCES BOARD

# INITIAL STATEMENT OF REASONS FOR PROPOSED RULEMAKING

## Public Hearing to Consider

## ADOPTION OF THE PROPOSED REGULATION FOR SMALL CONTAINERS OF AUTOMOTIVE REFRIGERANT·

To be considered by the California Air Resources Board
On January 22, 2009

at

Cal/EPA Headquarters
1001 I Street
Sacramento, California

Air Resources Board
P.O. Box 2815
Sacramento, CA 95812

State of California
AIR RESOURCES BOARD

# PROPOSED REGULATION FOR SMALL CONTAINERS OF AUTOMOTIVE REFRIGERANT

Prepared by:

Research Division
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December 5, 2008

*Special Consultant to ARB and Retired Professor of Mechanical and Aeronautical Engineering, University of California, Davis.

# ACKNOWLEDGEMENTS

We wish to acknowledge the assistance and cooperation we received from many individuals and organizations. In particular we would like to thank:

Stakeholders from industry including Tom Brown, Cap and Seal Co.; Ken Adams, Technical Chemical Co.; Mitch Bolinsky and Ken Motush, Interdynamics Inc.; Doug Wheeler, Hogan & Hartson LLP; Aaron Lowe, Automotive Aftermarket Industry Association (AAIA); Norm Plotkin, Plotkin Zins & Associates, LLC; Rick Henry, ITW Sexton; Bill Quest, EF Products, LP; Ward Atkinson, SAE International. We thank staff from California Waste Management Board- Howard Levenson, Fernando Berton, Kathy Frevert, Cynthia Dunn, and Jeffrey Lin. We also thank ARB staff members James McCormack, Allison Spreadborough, Judy Lewis, Mark Stover, David Mallory, Jenifer Kiger, Angus Macpherson, Daniel Leon, and Karin Donhowe, for their assistance on this regulation.

# DISCLAIMER

TABLE OF CONTENTS

## TABLE OF APPENDICES

## LIST OF TABLES



## LIST OF FIGURES

# ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| AAIA | Automotive Aftermarket Industry Association |
| AB 1493 | Assembly Bill 1493 |
| AB32 | Assembly Bill 32, California Global Warming Solutions Act of 2006 |
| AC | Air conditioning |
| ACEA | European Automobile Manufacturers Association |
| ARB | Air Resources Board |
| ARI | Air Conditioning and Refrigeration Institute |
| ARPI | Automotive Refrigeration Products Institute |
| BAU | Business-as-usual |
| CAA | Federal Clean Air Act |
| CFC | Chlorofluorocarbon |
| CFR | Code of Federal Regulations |
| CIWMB | California Integrated Waste Management Board |
| CPSC | California Product Stewardship Council |
| $CO_2$ | Carbon dioxide |
| DIY | Do-it-yourself |
| DIYers | Do-it-yourselfers |
| EMFAC | EMission FACtors model |
| EPR | Extended producer responsibility |
| EU | European Union |
| GHG | Greenhouse gas |
| GWP | Global warming potential |
| HFC | Hydrofluorocarbon |
| JAMA | Japan Automobile Manufacturers Association |
| LCCP | Life cycle climate performance |
| MACS | Mobile Air Conditioning Society Worldwide |
| $MMTC0_2E$ | Million metric tons of carbon dioxide equivalents |
| MVAC | Motor vehicle air conditioning |
| ODS | Ozone depleting substance |
| PY | Person years |
| SAE | Society of Automotive Engineers International |
| SKU | Stock Keeping Unit |
| U.S. EPA | U.S. Environmental Protection Agency |

# EXECUTIVE SUMMARY

Staff of the California Air Resources Board (ARB or Board) is proposing a Discrete Early Action regulation as described in the California Global Warming SolLltions Act of 2006 (Assembly Bill 32, AB 32, **Núñez,** 2006) to reduce the greenhouse gas (GHG) emissions associated with dO-it-yourself (DIY) re-charging of auto air conditioners (ARB, 2007a). The automotive refrigerant currently in wide use, HFC-134a, is a potent GHG with a global warming impact 1,300 times greater than carbon dioxide ($C0_2$), A single 12-ounce small can of this refrigerant is equivalent to 1,000 Ibs of $CO_2$ or the emissions from an automobile burning 50 gallons of gasoline. Since adoption of the AB 32 Early Action Plan in October 2007, ARB staff has worked with a broad spectrum of stakeholders, including the affected industry, and has taken input during a series of public workshops and workgroup meetings to develop a proposal that achieves emission reductions in the most cost-effective manner possible.

The recommendation to be considered by the Board in January 2009 is a multi-prong approach developed collaboratively with key stakeholders that will not only reduce emissions in California, but can serve as a national model. The proposed regulation will require:

1. Better container technology - a self-sealing valve on all small containers of automotive refrigerant sold in California to prevent emissions of any content remaining in a used container,
2. Improved labeling instructions for use,
3. Deposit and recycling - a new industry-run container deposit and recycling program to recover and recycle refrigerant remaining in a used can patterned after a recent and successful pilot program by industry in Southern California, and
4. Consumer education - a manufacturer-developed education program so the consumer can use best practice techniques for recharging an air conditioner.

The proposed regulation is estimated to achieve GHG emissions reductions of over 250,000 metric tons of carbon dioxide **equivalents** ($MTC0_2E$) at a cost of about \$11/$MTC0_2E$. The regulation will add about \$1 to the purchase price of a can.

## Authority

AB 32 requires that ARB adopt regulations by January 1, 2010 to achieve the maximum technologically feasible and cost-effective reductions in GHGs. AB 32 creates a comprehensive, multi-year program to reduce GHG emissions in California. The AB 32 program includes an Early Action Plan approved by the Board in 2007. Under the Early Action Plan, ARB staff worked closely with stakeholders and is proposing a Discrete Early Action regulation that would reduce GHG emissions beginning January 1, 2010.

**Scope of Regulation**

The particular source of emiSSions targeted for reduction by the proposed Discrete Early Action measure is associated with DIY recharging of motor vehicle air conditioning (MVAC) systems (ARB, 2007a). DIY practitioners currently use HFC-134a refrigerant sold in small containers holding between 2 ounces and 2 pounds of refrigerant by weight. The proposed regulation imposes requirements on the sale, use, and disposal of small containers of any automotive refrigerant having a GWP greater than 150. These requirements will eliminate or reduce emissions from the DIY practice.

**Current Emissions**

Approximately two million small containers of automotive refrigerant are sold annually to consumers in California. The portion sold to DIY consumers amounts to 0.81 million metric ton carbon dioxide equivalent per year ($MMTC0_2E$/yr). Typically a can is not fully emptied during the recharging process since the air conditioning system may only require a portion of the can, and due to incorrect technique by DIY users. Approximately 11% of the container contents are lost during servicing, approximately 22% remain in the can (can heel), and only about 67% goes into the vehicle AC system. Due to current container design, the can heel is vented almost immediately to the atmosphere. The current automotive refrigerant, HFC-134a, has a global warming potential (GWP) of 1,300, so .preventing the escape of the can contents is important. The global warming impact of a 12-ounce can of this refrigerant is equivalent to the impact of an automobile burning 50 gallons of gasoline.

**Proposed Actions**

This regulation would achieve emission reductions through:

'1. Use of a self-sealing valve on the can.
2. Improved labeling instructions.
3. A deposit and recycling program for small containers.
4. An education program that emphasizes best practices for vehicle recharging as well as highlights the environmental risks associated with this product.

**Parties Affected**

The regulation will affect all manufacturers, packagers, distributors, and retail outlets involved in the production, distribution, and sale of small containers of automotive refrigerant. The regulation would also affect the estimated 1.4 million Californians who annually service their own vehicle AC systems. It would also affect a small number of professional businesses that choose to use the small containers rather than large canisters to recharge vehicle AC systems.

## Description of the Regulation

. Prohibition

It would become illegal to dispose of or destroy any small container containing automotive refrigerant.

Registration Process

Manufacturers would submit an application to ARB to get approval to sell their product in California. This application would include documentation of leak rates for the self-sealing valves used on the cans, documentation for a registered recovery facility that will recover and/or recycle used and partially used cans, information on procedures used to return cans to the recovery facility, labeling language, and educational outreach materials that will be available at the point of sale.

Recycling Program

The recycling program and self-sealing valve are designed to prevent emissions and allow recovery of the can heel, the refrigerant that remains in the can after it has been used to charge a vehicle. Retailers would be required to collect a $10 deposit, approximately equivalent to the price of a 12-ounce can, from consumers when the consumer purchases a can, and the deposit will be refunded by the retailer when the consumer returns the can. The manufacturer will transport cans from the retailer to a recovery facility in order to recover any refrigerant remaining in the can.

Education Program

Consumer practices can be improved through better knowledge of recharge techniques and knowing the importance of preventing emissions of global warming gases. It has been shown that knowledgeable consumers generate minimal emissions during recharge. Manufacturers must develop educational materials suitable for use by purchasers and users of the small containers. The information includes best recharging practices to minimize servicing losses, promotes repair of leaking MVAC systems, and creates an awareness of the impact of refrigerant on climate change.

## Emission Reductions and Costs

The current total annual emissions from small can usage is 0.85 MMTC02E/yr. Ninety-five percent of emissions, or 0.81 MMTC02E/yr, result from DIY recharge, and the rest are due to small can usage by the professional servicing industry. DIY emissions arise from three sources: servicing losses, can heel, and leaking MVAC systems. Implementation of this regulation would reduce emissions from servicing losses and can heel for an emissions reduction of 0.26 MMTC02E/yr.

The remaining emissions (0.55 MMTC02E/yr) are predominantly associated with leaking systems which will be addressed through other approaches, such as . improving professional servicing and identifying and repairing leaky MVAC systems via the smog check program.

The proposed regulation is estimated to cost about $11 in increased consumer costs per MTC02E reduced. The cost of the product (a 12-ounce container of HFC-134a refrigerant costs about $10) will be increased by about $1 to cover the cost of the self-sealing valve, the costs for recycling, and the cost of education programs. The increased cost is also attributed to a percent of customers not returning used cans, thereby losing their deposit (**i.e.,** $10). These costs are about a factor of 15 lower than the cost of the originally proposed can ban.

**Public Process, Stakeholder Interactions**

Staff worked closely with stakeholders throughout the year-long development process of this regulation. Staff held two public workshops and three workgroup meetings in Sacramento. The public process proved valuable as interactions with stakeholders resulted in mitigation options that were not originally under consideration. The recommended regulation is the result of many hours of cooperative work between stakeholders and ARB staff. This regulation has potential to be exported to the rest of the nation.

**Implementation Timeline and Enforcement**

The regulation is recommended for adoption in January, 2009, and would be enforceable beginning January, 2010. The new requirements for small container labeling and educational material would go into effect on January 1, 2010. There would be a one-year sell-through period for cans manufactured before January 1, 2010. The target recycle rate is initially set at 90%, and rises to 95% beginning January 1, 2012.' The Air Resources Board Enforcement Division would be responsible for testing the retailer's compliance with the educational display and recycling requirements. The Monitoring & Laboratory Division would test compliance of the cans for leak rate requirements. Based on reported data, the Research Division would calculate recycle rates and compare them to the targets specified in the regulation.

# I. OVERVIEW AND STAFF RECOMMENDATION

The California Global Warming Solutions Act of 2006 (Assembly Bill 32, AB 32, Núñez, . 2006) creates a comprehensive, multi-year program to reduce greenhouse gas (GHG) emissions in California. The AB 32 program includes an Early Action plan approved by the Board in 2007. Under the Early Action plan, staff of the Air Resources Board (ARB or Board) worked closely with stakeholders and are proposing a Discrete Early Action regulation that would reduce GHG emissions associated with do-it-yourself (DIY) recharging of motor vehicle air conditioning (MVAC) systems (ARB, 2007a). This regulation is not only a Discreet Early Action, it is a part of the overall strategy for reaching the 2020 target as presented in the Draft Scoping Plan.

Automotive refrigerant used by DIY is sold in small containers. This regulation pertains to containers holding between 2 ounces and 2 pounds of any automotive refrigerant by weight having a GWP greater than 150. The containers are small cans and in this document the words containers and cans will be used interchangeably. Large canisters of refrigerant are used for professional servicing and stationary applications. Containers holding less than 2 ounces of refrigerant are used for special purposes such as injecting dye and/or oil, and they have a very low sales volume, thus they are exempt from this regulation. Regulations to address emissions of containers of refrigerant holding 2 pounds or more are under separate development.

The current predominant automotive refrigerant, HFC-134a, has a global warming potential (GWP) of 1,300. Future refrigerants approved by EPA for automotive use would likely have much lower GWPs; the proposed regulation would encourage adoption of automotive refrigerants with a GWP lower than 150. The impact of a 12-ounce container of HFC-134a refrigerant is equivalent to the GHG gas emissions from a typical California automobile burning 50 gallons of gasoline to drive over 1,000 miles. Approximately two million cans are sold annually in California at retail stores that sell automotive parts and products. This regulation would achieve emission reductions through:

1. Use of a self-sealing valve on the can.
2. Improved labeling instructions.
3. A recycling program for used cans.
4. An education program that emphasizes best practices for vehicle recharging as well as highlights the environmental risks associated with this product.

The regulation would annually affect an estimated 1.4 million Californians who service their own vehicle air conditioning systems. It would also affect a small number of professional businesses that choose to use the small cans rather than large canisters to recharge vehicle air conditioning systems. Small can manufacturers, distributors, and retail outlets would be affected as they have responsibilities to implement all components of the regulation.

The regulation, a copy of which is provided in Appendix A, covers many facets needed to achieve the emission reductions. Typically a can is not fully emptied during the recharging process since the air conditioning system only requires part of the can contents. It would become illegal to dispose of or destroy any container containing any amount of refrigerant. Under the regulation, manufacturers would submit an application to ARB to get approval to sell their product in California. This application would include demonstration and documentation that valves used on the cans meet a performance standard, documentation for a registered recovery facility that will recover and/or recycle used and partially used cans, information on procedures used to return cans to the recovery facility, labeling language, and educational outreach materials that will be available at the point of sale.

The intent of the recycling program and self-sealing valve are to recover the can heel, the refrigerant that remains in the can after it has been used to charge a vehicle. Retailers will collect a $10 deposit, approximately equivalent to the price of a 12-ounce can, from consumers when the consumer purchases a can. The current purchase price is approximately $10, so the customer will have an initial outlay that is approximately double the current price. This deposit will be refunded when the consumer returns the can, after use, to the retailer where the can was purchased. The regulation states that the can should be returned within 90 days with a proof of purchase for refund of deposit.

Consumer practices should be improved through better knowledge of recharge practices and global warming issues. Each manufacturer who sells small cans of refrigerant will required to develop educational materials suitable for use by purchasers and users of the cans. The information is designed to promote best recharging practices in order to minimize servicing losses, promote repair of leaking MVAC systems, create an awareness of the impact of refrigerant on climate change, and potential risks to the MVAC system due to lack of professional equipment. This information will be required on can labeling, educational brochures that will be distributed by retailers, and on the internet. It is hoped that the consumer will be motivated to reduce emissions as a result of increased awareness of the issues.

Staff estimates that the current total annual emissions from small can usage is 0.85 MMTC0$_2$E/yr. Ninety-five percent of emissions, or 0.81 MMTC02E/yr, are caused by DIY recharge, and the rest are due to small can usage by the professional servicing industry. These emissions arise from three sources: servicing losses, can heel, and leaking MVAC systems. Implementation of this regulation would reduce emissions ·by 0.26 MMTC0$_2$E/yr. The estimated increased cost of the proposed regulation is about $11 per MTC0$_2$E. The cost of the product will be increased a small amount to cover the cost of the self-sealing valve and industry costs for recycling and education programs. It is anticipated that industry will pass their increased costs to the consumer with an estimated $1 increase in can price. The increased cost is also attributed to some· customers not returning used cans, thereby losing their deposit. Unclaimed deposits that are retained by the manufacturer will be spent on enhanced education and outreach designed to inform consumers of measures to reduce GHG emissions associated with DIY recharging of MVAC systems.

Staff worked closely with. stakeholders including representatives from the Automotive Refrigeration Products Institute (ARPI, industry), the retailers, the California Integrated Waste Management Board (CIWMB), the California Product Stewardship Council (CPSC), the Mobile Air Conditioning Society Worldwide (MACS), the SAE International, and the California Bureau of Automotive Repair (BAR) throughout the year-long development process of this regulation. Staff held two public workshops and three workgroup meetings in Sacramento. The public process proved valuable as interactions with stakeholders resulted in mitigation options that were not originally under consideration. The recommended regulation is the result of many hours of cooperative work between stakeholders and ARB staff.

Staff recommends that the Board adopt this regulation. A significant emission reduction is achieved at a minimal cost compared to alternative proposals considered. The recommended measure is a model that can be copied elsewhere. It focuses directly on the emissions attributable to the small cans and will complement other efforts that focus on the vehicle. The recycle and education programs are a form of public outreach on climate change issues, generating positive behavior and extended producer responsibility.

The following sections include the need for emission reductions, affected industries and stakeholders, a description of the regulation, costs and economic impacts, implementation and enforcement, and alternatives considered. These sections should provide answers to most questions about the regulation.

## II. BACKGROUND

Under normal operation, many vehicles slowly lose refrigerant due to "normal" leakage and permeation. Larger leaks are generally due to compressor leaks, and malfunctioning hoses and connections. When a vehicle's air conditioning system loses about 50% of its design refrigerant charge, cooling effectiveness suffers. Studies indicate that, on average, such a loss may occur for vehicles 6 to 8 years old. The vehicle owner has two choices for servicing the system in an attempt to restore cooling ability, self service and professional repair. Those choosing self service can recharge or "top off" the system using small cans of HFC-134a purchased at retail auto parts stores or other retail outlets. DIYers can purchase small cans of HFC-134a in retail stores for approximately $10 (NPD, 2008). Nominally, two or three 12-ounce cans are sufficient to fully recharge an empty MVAC system of a typical passenger car. Otherwise service should be done at a professional auto·shop certified to perform AC maintenance with a cost to consumers of $100 to $2,000, depending on the severity of the problem.

A vehicle owner saves money by recharging an MVAC system with small cans of refrigerant compared to having a professional perform the recharge. However, the DIY may not properly identify a repairable leak and repair it due to a lack of adequate training and/or equipment. A DIY recharge of an MVAC system may unintentionally release more HFC-134a than a recharge performed by a professionally trained and industry-certified technician at a licensed auto repair facility. There is also increased risk of damage to the system by over- or under-charging the proper amount of refrigerant and lubricant in the system.

### A.IMPACT OF AUTOMOTIVE REFRIGERANT ON GLOBAL WARMING

HFC-134a is a hydrofluorocarbon (HFC) currently used as a refrigerant in most MVAC systems. It replaced the refrigerant R-12, a chlorofluorocarbon (CFC) identified as an ozone depleting substance (ODS) under the Montreal Protocol. HFC-134a is not an ODS, but is a potent GHG with a GWP of 1,300 (IPCC, 2007). The global HFC emissions from MVAC are estimated to be around 86 $MMTC0_2E$ in 2002 and are projected to grow rapidly to around 281 $MMTC0_2E$ in 2015 under business-as-usual (BAU) (Clodic et al., 2004). Nearly all HFC used in MVAC is HFC-134a. High-GWP GHGs constitute about three percent of the total C02 equivalent emissions in California in 2002 to 2004 (ARB, 2008a). The estimate of HFC-134a emissions in California during 2004 is 9 $MMTC0_2E$ (ARB, 2008b). About 4 $MMTC0_2E$ are from MVAC applications, which is based on a nationwide ratio of mobile AC to total HFC-134a emissions as estimated by U.S. Environmental Protection Agency's (U.S. EPA) Vintaging Model, private communication with U.S. EPA staff, and California ratio of MVAC to total GHG emissions from MVAC.

## B. ENVIRONMENTAL IMPACTS

Measurements show that the global average temperature has increased by 1.6 of in the last 100 years, with most of it happening in the last three decades. This warming is linked to increasing atmospheric concentrations of GHGs resulting from human activities. The 10 warmest years of the last century all occurred within the last 15 years. As the average temperature increases, weather is affected, and rainfall patterns may change. We can expect to see worsening air quality, an increase in the number of weather-related deaths, and a possible increase in infectious diseases. Higher temperatures contribute to increased smog, which is damaging to plants and humans. Climate change also affects forests to increase fire hazards and make forests more susceptible to pests and diseases. Forest fires have occurred at unprecedented rates and earlier in the fire season than past years. Agricultural patterns will change as crops and productivity shift along with climate change. Physical changes such as these impact California's public health, economy and ecology.

Climate change affects the high Sierra Nevada snowpack. Throughout the $20^{th}$ century, annual April to July spring runoff has been decreasing, with total water runoff declining by about ten percent over the last 100 years. This observation has direct consequences - less spring runoff for hydroelectric power production, agricultural irrigation, and human consumption.

California has seen a sea level rise of 3 - 8 inches in the last century. This can lead to serious consequences such as flooding of low-lying property, loss of coastal wetlands, erosion of cliffs and beaches, saltwater contamination of drinking water, and damage to roads and bridges (ARB, 2004a).

Greenhouse gases remain in the atmosphere for many years, decades, and even centuries, so the problem cannot be eliminated quickly. As a result, the climate change effect of gases emitted years ago may not yet be fully realized. Emissions in GHGs are needed immediately to reduce future effects. The California legislature realized the urgency for reducing emissions of GHGs and as a result, in the AB 32 specified that ARB develop discrete Early Action measures in order to begin reducing emissions as soon as possible.

# III. REQUIREMENTS OF AS 32

AB 32, The California Global Warming Solutions Act of 2006, creates a comprehensive, multi-year program to reduce GHG emissions in California. AB 32, at Health and. Safety Code section 38560.5, requires that ARB adopt regulations by January 1, 2010 to implement discrete early action GHG emission reduction measures. These measures must "achieve the maximum technologically feasible and cost-effective reductions in greenhouse gas emissions" from the sources identified for early action measures.AB 32 contains additional standards in Health and Safety Code section 38562 that apply to regulations that will be adopted for general emissions reductions consistent with ARB's scoping plan. Among other things, this section requires that reductions must be real, permanent, quantifiable, verifiable, and enforceable. ARB is also required to adopt rules and regulations in an open, public process. While section 38562 does not directly apply to early action measures enacted under section 38560.5, ARB is interested in ensuring that its early action measures, such as the proposed regulatory action meet the broader criteria for the GHG reduction regulations that will follow. For that reason, those criteria are summarized here, with staff's assessment as to why the proposed regulatory action meets them or is not specifically applicable to them.

The proposed regulatory action has been designated as a discrete early action measure and would reduce GHG emissions attributable to small containers of automotive refrigerant by establishing small container certification requirements that will require containers to have self-sealing valves, and requiring the implementation of a small container deposit and return and refrigerant recovery program. Small containers of automotive refrigerant are predominately used by do-it-yourselfers to recharge their MVAC systems. The following discussion explains why staff believes this proposed regulatory action meets the requirements of State law.

1. The State Board shall adopt rules and regulations in an open public process to achieve the maximum technologically feasible and cost-effective greenhouse gas emission reduction from sources or categories of sources.

The proposed regulation was developed in consultation with affected parties in an open, public process. Staff conducted numerous outreach efforts to inform affected parties of the proposal and to obtain stakeholder comments. Outreach efforts included two public workshops and several individual consultation meetings. See Section X of this Staff Report for additional details.

2. Design the regulations, including distribution of emissions allowances where appropriate, in a manner that is equitable, seeks to minimize costs and maximize the total benefits to California, and encourages early action to reduce greenhouse gas emissions.

The multifaceted proposed regulation for small containers of automotive . refrigerant was designed to maximize emission reductions uniformly through out the State, while minimizing costs. All manufacturers of small containers of automotive refrigerant intended for sale in California are required to meet the certification requirements to sell product. No manufacturer or retailer would be allowed to sell non-complying products in California, including internet or catalogue sales, therefore a DIY user anywhere in California will be unable to purchase non-complying products. It will become illegal to dispose of or destroy a small container of automotive refrigerant, except at a recovery facility. As a result, consumers must return used containers so the unused portion of refrigerant can be recovered and recycled. Improved labeling and the education program will assist the DIY in reducing emissions while servicing his/her MVAC. Since DIY pursue this practice throughout the State, reductions would occur throughout the State. Greater reductions will likely occur in population centers or areas with warmer weather that necessitate greater use of MVAC. The cost effectiveness of the proposed regulation is about $11 per $MTC0_2E$.

The estimated reduced emissions represent the maximum technically feasible reduction. Further reductions from this category were determined not to be technologically and commercially feasible, due to the necessity to continue servicing MVAC systems with the refrigerant in common use.

This regulation will become effective in one year, rather than a longer period, to maximize the emission reductions. Product will have a one-year sell-through period, then old product must be removed from store shelves.

3. Ensure that activities undertaken to comply with the regulations do not disproportionately impact low-income communities.

In developing the proposed regulation, staff was especially aware of its potential impacts, and therefore incorporated measures to avoid disproportionately impacting low-income communities. As discussed above, staff decided not to follow an alternative proposal to completely ban the sale of small containers of automotive refrigerant. Such a measure would necessitate the use of professional servicing rather than DIY servicing, at a greatly increased cost. The proposed approach avoids imposing such a disproportionate hardship on low-income communities.

4. Ensure that entities that have voluntarily reduced their greenhouse gas emissions prior to the implementation of this section receive appropriate credit for early voluntary reductions.

This requirement is not applicable to this proposed rulemaking.

5. Ensure that activities undertaken pursuant to the regulations complement, and do not interfere with, efforts to achieve and

maintain federal and state ambient air quality standards and to reduce toxic air contaminant emissions.

GHG emissions are distinct from criteria pollutants and toxic air contaminants that have historically been regulated through federal and state air quality standards. The proposed regulation does not conflict with existing laws or regulations.

6. Consider cost effectiveness of these regulations.

The cost effectiveness of the proposed limit is about $11 per $MTC0_2E$. The cost of the product will be increased a small amount (about $1) to cover the cost of the self-sealing valve, the costs for recycling, and the cost of education programs. Additional increased cost is attributed to a percent of customers not returning used cans (additional $10), thereby losing their deposit. See section IX and Appendix G of Technical Support Document for a more detailed discussion.

7. Consider overall societal benefits, including reductions in other air pollutants, diversification of energy sources, and other benefits to the economy, environment, and public health.

The proposed regulation is not expected to cause any adverse impacts to society or the environment. California would benefit from the reduction of GHG emissions and it is anticipated that the proposed requirement to recycle small containers of refrigerant would reduce the solid waste stream of containers that would likely be discarded in landfills. The number of cans and the packaging used should not increase. See section IX and Appendix G of Technical Support Document for a more detailed discussion.

8. Minimize the administrative burden of implementing and complying with these regulations.

The proposed regulation has several components to achieve GHG emiSSion reductions from small containers of automotive refrigerant. An especially important component would require manufacturers to utilize a self-sealing valve on the containers to prevent refrigerant from venting to the atmosphere. Most containers do not currently incorporate this feature. This proposed requirement does not present an administrative burden.

The proposed regulations would require manufacturers to apply for and receive Executive Orders from ARB before they could sell or offer for sale their products in California. However, once a manufacturer obtains a certification, it does not need to submit a further application for certification unless it significantly changes the design or specifications of a previously certified product.

Under the proposed regulation, manufacturers would bear most of the administrative burdens associated with the recycling component of the regulation, but would also economically benefit from recovering the refrigerant from used containers. Manufacturers would also be required to develop product labels and educational materials to inform DIYers of best practices for using 'their products, although the development of these materials should only be an one-time event.

Finally, the proposed regulations would require both manufacturers and retailers. to record and report data on sales and returned cans, although any administrative burdens should be minimal given the widespread use of computerized technology by both manufacturers and retailers to track sales information.

9. Minimize leakage.

Leakage is not expected to occur as a result of the proposed regulation. Leakage occurs when an emission limit or regulatory requirement set by the State causes business activities to be displaced outside of California. If leakage were to occur, emissions benefits, jobs and other economic benefits to California would be lost. The proposed regulation applies to all manufacturers and retailers of small containers of automotive refrigerant that sell, offer for sale, or manufacture for sale in California those products, regardless of where those manufacturers or retailers are located (although currently, all small containers of automotive refrigerant are manufactured and packaged outside of California.) Therefore, the regulation would not create a situation where a manufacturer or retailer located in California would be placed in a competitive disadvantage compared to manufacturers or retailers out-of-state.

10. Consider the significance of the contribution of each source or category of.sources to statewide emissions of greenhouse gases.

The California GHG emissions inventory suggests that high-GWP GHGs constitute about three percent of the total $CO_2$ equivalent emissions in 2002 to 2004. A preliminary estimate of HFC-134a emissions in Califomia during 2004 is approximately 9 $MMTC0_2E$, of which approximately 4 MMTC02E are attributable to motor vehicle air conditioning applications. The current emissions attributable to the usage of small cans of HFC-134a are estimated to be 0.85 $MMTC0_2E$ per year.

The proposed regulation would achieve emIssIons reductions of about 0.26 $MMTC0_2E$ per year. While this reduction may appear somewhat modest, when it is considered in conjunction with anticipated future GHG reductions from MVAC regulations, the total reductions could become quite significant. When each early action measure related to MVACs is considered alone, it yields relatively small emission reductions, but with regard to GHG emissions the aggregate emissions are more significant. This situation necessitates achieving relatively small reductions from a number of distinct early action measures to achieve significant overall reductions. See section IX and Appendix G of the Technical Support Document for additional details.

11. The greenhouse gas emission reductions achieved are real, permanent, quantifiable, verifiable, and enforceable by the state board.

The emiSSions and emiSSion reductions from small containers of automotive refrigerant were calculated based on data submitted by manufacturers of the affected products and on independent research data commissioned by ARB. Data from the manufacturers were submitted in accordance with State law and were certified by an officer of each company that submitted the data. The GHG emissions and reductions were calculated based on GWP values defined by the Intergovernmental Panel on Climate Change 2007: The Physical Science Basis, IPCC Working Group 1 Fourth Assessment Report, 2007 (IPCC, 2007).

The proposed regulation would require manufacturers of small containers of automotive refrigerant to apply for and receive certification by ARB before they could sell or offer for sale their products in California, specifies the effective date of the regulation and the test methods used to determine if the products comply with the proposed certification requirements, and specifies recordkeeping requirements that would provide enforcement staff with the information needed to enforce the proposed requirements in the field. The proposed regulation also requires that products subject to the certification must display new labeling and be date coded. These identifiers enable enforcement personnel to ascertain if a product is certified for sale in California. Finally, the proposed regulation would enact reporting requirements for manufacturers, distributors, and retailers to allow staff to determine recycle rates and the quantity of refrigerant recycled. Once the regulation is approved by the Office of Administrative Law, the proposed regulation will become State law. Based on the above, upon the effective date of the proposed emission limit, the reductions become real, permanent, quantifiable, verifiable, and enforceable.

12. For regulations the reduction is in addition to any greenhouse gas emission reduction otherwise required by law or regulation, and any other greenhouse gas emission reduction that otherwise would occur.

The proposed regulation is the first GHG emission limitation affecting this product category. No other existing State, federal or other requirements would affect GHG emissions specifically attributable to small containers of automotive refrigerant sold in California. The state of Wisconsin currently prohibits the sale of small containers of automotive refrigerant, but that ban is not applicable to products sold in California.

13. If applicable, the greenhouse gas emission reduction occurs over the same time period and is equivalent in amount to any direct emission reduction required pursuant to this division.

This regulation achieves its emission reductions as direct emissions.

14. The state board shall rely upon the best available economic and scientific information and its assessment of existing and projected technological capabilities when adopting the regulations required by the law.

ARB staff used the best available economic and scientific information available to develop the proposed regulation. The description in this section of the Staff Report documents that the proposal was developed in accordance with AB 32 requirements. Section IX of this Staff Report contains a detailed description of the economic impact of the proposed emission limit. A technological assessment of the feasibility of the proposed regulation is discussed in section V of this Staff Report.

## IV. COMPARABLE FEDERAL LAWS AND REGULATIONS

Although various provisions of the Federal Clean Air Act (CAA) and U.S. Environmental Protection Agency regulations generally regulate many aspects regarding the usage of non-ozone depleting refrigerants used in MVACs, they do not currently restrict or address sales of small containers of non-ozone-depleting automotive refrigerant.

Since November 15, 1995, section 608(c)(2) of the CAA [42 U.S.C. § 7671 g(c)(2)] has generally prohibited any person from venting or releasing any substance that is used as a substitute for an ozone-depleting refrigerant into the atmosphere. In 2004, the U.S. EPA amended its regulations regarding refrigerant recycling to clarify that the section 608(c)(2) venting ban also extends to pure HFC and perfluorocarbon (PFC) refrigerants.

Section 609(e) of the CAA [42. U.S.C. § 7671 h(e)] and Title 40, Code of Federal Regulations (CFR) section 82.34(b) have restricted, as of November 15, 1992, the sale, distribution, or offer for sale or distribution of ozone-depleting refrigerants (class I or class II substances) that are suitable for use in motor vehicle air-conditioning systems and that are in containers with less than 20 pounds of refrigerant, except to those technicians that have been trained and certified pursuant to an EPA-approved course.

On March 12, 2004, the U.S. EPA decided not to extend a proposed restriction on the sale of small containers of pure HFC or PFC refrigerants. to certified technicians. U.S. EPA has provided input to the proposed regulation, but has not announced any plans to adopt a similar provision in the near future.

# V. PROPOSED REGULATORY PROVISIONS

The proposed regulation is included in Appendix A. It is accompanied by new Certification Procedures, which are included in Appendix B.

## A. Applicability and Exemptions

The proposed regulation would take effect on January 1, 2010. Because the proposed regulation does not involve or require a change in formulation, like many consumer product regulations, it may be implemented quickly. Industry is actively engaged in implementing the necessary changes and agrees with this implementation date.

Because most small containers of automotive refrigerant contain less than five pounds of refrigerant (they must be light enough for a DIVer to easily lift with one hand), the proposed regulation only applies to small containers containing between two ounces and two pounds of refrigerant by weight.

The proposed regulation affects only refrigerants with a GWP value greater than 150. ARB recognizes that alternative refrigerants may replace the current refrigerants. If a transition to low GWP refrigerants occurs, this regulation may not be applicable. This cut point is consistent with the EU Directive that allows only automotive refrigerants with a GWP less than 150. It allows for the use of HFC-152a, as well as other potential alternatives, should EPA approve their use in MVAC systems. With all other factors being equal, a switch to a refrigeraht with a GWP of 150 would result in an aa-percent reduction in carbon dioxide-equivalent emissions compared to HFC-134a.

The proposed regulation would also contain a sell-through period that would allow small containers of automotive refrigerant manufactured before January 1, 2010 to be sold until December 31, 2010. Manufacturers would have to recall any containers after the sell-through period expires.

Finally, the proposed regulation would only apply to non-ozone depleting refrigerants because, as discussed above in section IV of this report, federal law currently restricts the sale of any ozone-depleting refrigerants for use in motor vehicle air-conditioning systems and that are in containers with less than 20 pounds of refrigerant to technicians that have been trained and certified pursuant to an EPA-approved course.

## B. Certification Requirements

The proposed regulation would require any manufacturer of small containers of automotive refrigerant to obtain a certification for its product before it could sell, supply, offer for sale, or manufacture for sale its products in California. ARB would only certify those small containers of automotive refrigerant that comply with the following proposed certification requirements:

### 1. Self-sealing Valve and Leakage Rate

Each small container of automotive refrigerant must be equipped with a single self-sealing valve that automatically closes and seals when not dispensing refrigerant. The leak rate from each container must not exceed 3 grams per year when the self-sealing valve is closed, as determined by a new proposed test procedure (Appendices C and D). This leak rate was proposed by industry as a specification they could comply with, and this rate would apply to both new, full containers as well as partially full containers. Technology is currently available to meet this requirement. Self-sealing valves are available from several manufacturers and are routinely used on consumer products, and valves are available that meet the 3 grams per year leakage requirement.

Currently, most small containers of automotive refrigerant are not equipped with self-sealing valves. The user punctures the container with a dispensing device and releases the refrigerant. The stored refrigerant is then either transferred into the MVAC system, released to the atmosphere, or remains in the container. The refrigerant remaining in the can, called the can heel, will be released to the atmosphere with the eventual disposal of the can. However, the proposed self-sealing valve requirement will allow manufacturers to recapture the can heel that is otherwise vented to the atmosphere from current containers.

### 2. Recovery Facilities

Manufacturers would be required to identify and register with ARB each facility that would be used to recover refrigerant from a small container, and to provide information including the location and a description of recovery equipment and operating parameters. Recovery facilities would be required to use best operating procedures to minimize leakage of refrigerant to the atmosphere. Industry representatives have indicated that they are currently recovering refrigerant from damaged containers using existing equipment (the machinery used to fill the cans is simply operated in reverse to recover the can heel from the can).

### 3. Container Labeling Requirements

The proposed regulation would require each container of refrigerant to display, in both English and Spanish, information to promote consumer education of proper charging practices and of the environmental consequences of misuse of refrigerant.

The proposed regulation would require each container to be labeled with the following statement:

> "Contents of this container contribute to Global Warming. It is illegal to destroy or discard this container or its contents. Return for $xx refund."

The dollar amount of the deposit would initially be set at $10, and could be increased, as proposed in the regulation.

Container labels would also be required to state: safety precautions, operating parameters for the vehicle engine, air conditioner and fan; recharging procedures, including identification of low pressure port, container rotation, time required for recharging, and how to disconnect the container; date of manufacture, a California specific code and the words "Approved for use in California" and "$XX refundable deposit, if returned within 90 days of purchase."

### 4. Education Requirements

Manufacturers would be required to develop educational materials for purchasers of small containers of automotive refrigerant that include information regarding: identifying and repairing leaks in the MVAC system, techniques to minimize can heel and servicing loss while transferring refrigerant from the container to the MVAC system, the environmental hazards associated with refrigerant emissions due to improper use and disposal of cans as well as failure to repair leaky MVAC systems, potential risks to the MVAC system due to lack of professional equipment and diagnostic techniques, and components of the container deposit and return program. Examples of container labels and educational materials are provided in Appendix E. Manufacturers currently have a tri-fold brochure and websites with instructions and photos for recharging an MVAC system. This medium will be modified to include additional educational information.

## C. Container Deposit and Return Program

The proposed container deposit and return program would work in conjunction with the self-sealing valve requirement to ensure that refrigerant remaining in used small containers as can heel is returned to and recovered by manufacturers.

Retailers would collect a deposit, at the time of sale, from a consumer of a small container of automotive refrigerant. The deposit amount would initially be $10 but is subject to increases, as described below. After using the refrigerant, the consumer would return the used container to the retailer within 90 days of purchase along with a valid proof of purchase to receive a full refund of the deposit. The retailer is not required to pay a refund for any containers that have been damaged such that its contents have been released to the environment. Finally, the retailer would be required to accumulate and store any used small containers before they are transferred back to the manufacturer.

The manufacturers would be responsible for administering a container recycling program and recovering refrigerant. They would: coordinate the collection of used containers from retailers and designated return agencies, provide collection boxes or bins to retailers, transport the returned containers to recovery/recycle facilities, and recover any refrigerant remaining in the returned cans at a facility registered with the ARB. Unclaimed deposits that are retained by a manufacturer must be spent on enhanced education and outreach programs designed to inform consumers of measures to reduce GHG emissions associated with DIY' recharging of MVAC systems.

Staff calculates that the carbon emissions associated with transporting used cans to a recovery facility will be on the order of 0.02 % of the $CO_2$ equivalent of the refrigerant remaining in used cans.

The proposed regulation provides manufacturers two years to achieve a 90% used container return rate. After two years, the recycling target will increase to 95%. For any two year reporting period in which the return rate does not meet or exceed its target return rate, the Executive Officer may revise the deposit amount by an additional $5. Before increasing the deposit, the Executive Officer could consider any information submitted by manufacturers or retailers that increasing deposit amounts would not increase recycle rates.

**D. Reporting and Recordkeeping Requirements for Deposit and Return Program**

The proposed regulation would require manufacturers, retailers, distributors and recyclers to report sales data, returned can data, the amount of refrigerant recovered, along with the amount of that refrigerant recycled, reclaimed, or disposed of, and/or the amounts of unclaimed deposits retained and how those funds were spent to enhance consumer education. Staff would utilize this data to calculate the annual return rate of used cans of refrigerant.

Suggested reporting forms are provided in Appendix F. A detailed table of the reporting requirements and dates is presented in Table 1. This table has an important role in the evaluation of the return rate, as well as the determination of the amount of the can deposit. All important dates associated with the regulation are given in the table.

Table 1. Proposed Schedule of Recycling and Reporting

| | Small Container Type of Manufacture | Small Container Sale Allowed | Reporting Period & Target Return Rate | Comments |
|---|---|---|---|---|
| Jan.l,2010thru Sept. 30, 2010 | New | Any | #1-90% | Report due Dec. 1,2010 |
| **Oct. 1, 2010 thru Sept. 30, 2011** | New | New | #2 – 90% | Report due Dec. 1, 2011; Evaluation of Return Rate and New Deposit Process |
| Oct. 1, 2011 thru Sept. 30, 2012 | New* | New* | #3 -95% | Report due Dec. 1,2012; 6 months sell-through** |
| **Oct. 1, 2012 thru Sept. 30, 2013** | New* | New* | #4 – 95% | Report due Dec. 1, 2013; Evaluation of Return Rate and New Deposit Process |
| Oct. 1, 2013 thru Sept. 30, 2014 | New* | New* | #5 -95% | Report due Dec. 1,2014 6 months sell-through** |
| **Oct. 1, 2014 thru Sept. 30, 2015** | New* | New* | #6 – 95% | Report due Dec. 1, 2015; Evaluation of Return Rate and New Deposit Process |
| continue | continue | continue | continue | continue |

* The can labels and SKUs must be changed if a new deposit rate is introduced.
** 6 months sell-through for old can labels and SKU if a new deposit rate is introduced.

E. Container Disposal or Destruction Restrictions

Finally, the proposed regulation would prohibit any person from disposing or destroying a small container of automotive refrigerant unless the disposal or destruction is performed in accordance with the procedures specified in the regulation.

Manufacturers or their designated recovery facilities would be required to evacuate small containers of automotive refrigerant to less than atmospheric pressure, unless the containers were previously damaged. All other persons would have to return small containers of refrigerant that contain any quantity of refrigerant to the retailer, the manufacturer, or the manufacturer's designated recovery facility for future refrigerant recovery.

# VI. IMPLEMENTATION AND ENFORCEMENT OF THE PROPOSED REGULATION

## A. Implementation

ARB staff would review and either approve or disapprove applications for certification submitted by manufacturers, including documentation for self-sealing valves, container labeling, and educational documents. Staff would also review documentation that registers refrigerant recovery facilities designated by manufacturers. If a certification application complies with all specified requirements, ARB would issue an Executive Order certifying the small container of automotive refrigerant for sale in California.

The recycling component of the regulation requires recordkeeping and reporting requirements from several participants. ARB staff would review and approve the reports submitted by retailers, distributors, manufacturers, and recyclers. After the first reporting period, staff would calculate and report the annual return rate of containers. However, the can deposit fee would be reviewed and adjusted, if necessary, on a biennial basis.

## B. Enforcement

ARB enforcement staff would ensure that all small containers of refrigerant sold in California comply with the proposed regulation through inspection procedures. Retailers would be inspected to ensure they do not sell uncertified containers, that they comply with the can deposit and return program, and the point-of-sale Consumer information requirements. Specifically, staff would confirm proper handling of returned cans, confirm that a deposit is collected when a can is sold and refunded when the can is returned, and observe the collection, storage and transfer of small containers.

Staff would also inspect manufacturers to confirm they accept and properly handle the used cans when the cans are returned. If an intermediate designee is involved in the return and recycle program, staff would inspect the designee for proper handling and coordination of returns, and proper refunding of deposits.

Staff would also inspect recovery facilities to ensure they are registered for recovery, and to confirm they are recovering refrigerant and reclaiming or destroying it. Finally, if necessary, enforcement staff would initiate enforcement actions against any entity that was violating the provisions of the proposed regulation.

## VII. ISSUES REGARDING THE PROPOSAL

ARPI conducted a brief pilot study in two Southern California cities during the spring of 2008 to determine consumer compliance with a recycling program. This short-term study, with minimal advertising, included a $5 deposit and resulted in a 75% return rate. Implementation of a statewide program with greater financial incentive to return cans should result in higher return rates. The proposed regulation establishes a return rate of 90% for the first two years, and a return rate of 95% after the first two years.

Industry has argued that because future small containers will incorporate self-sealing valves, consumers will be more likely to store partially used containers rather than return them within 90 days of purchase to obtain their can deposit fee, which will reduce the. recycling rate. Staff believes that the proposed $10 per container deposit will provide sufficient .incentive for the vast majority of consumers to return their containers, and has also provided industry flexibility in achieving the proposed return rates by basing the calculation of a return rate over a two-year period. Under current practices, DIY users of small containers of automotive refrigerant are accustomed to using the entire container or lose the remaining can heel rather than attempting to save partially filled cans for subsequent use. This is consistent with an ARB-commissioned study (Clodic et al., 2008) which shows that a noticeable reduction in cooling performance does not occur until the system charge is low by about one can for typical MVAC systems. Moreover, staff believes that a high deposit rate will discourage consumers from purchasing small containers of refrigerant for later use, and would encourage immediate use of such containers as well as avoid problems associated with lost cans or receipts, which results in decreased recycle rates.

## VIII. ENTITIES AFFECTED BY THE PROPOSED REGULATION

The proposed regulation will directly affect individuals who practice DIY recharging of MVAC systems, manufacturers of HFC-134a, companies that package and distribute the small containers of HFC-134a, retailers of small containers of HFC-134a, and potentially professional auto shops that service MVACs.

### A. Manufacturers and Recyclers

According to' the 2006 Consumer Product Survey, there were 7 manufacturers selling small containers of automotive refrigerant in California. All of them are located outside of California. The sales of three of those manufacturers, represented by ARPI, constituted almost 90% of the market. All manufacturers would be responsible for installing self-sealing valves on the containers, administering and operating the container return and refrigerant recycling program, and developing the educational materials. Manufacturers would also be required to obtain certification of their product(s) and to maintain records of sales, returns and refrigerant recovery. Manufacturers are expected to pass the costs of these requirements onto their consumers. The price increase is unlikely to decrease demand due to unavailability of good substitute products. Furthermore, the proposed regulation would apply to any manufacturer that elects to sell its product in California The regulation might also produce a small increase in business for the professional MVAC servicing industry due to these added costs, but this is again not likely given that the proposed regulation would likely only increase the retail price of a small container of automotive refrigerant by $1.

The proposed regulation's can recycling program component would involve transporting used containers to a recovery and recycle facility. Manufacturers would recover any remaining refrigerant at their can filling facilities by operating the machinery in a reverse fashion. Refrigerant recovery machinery is presently available and is currently operated in reverse to recover refrigerant from dented and damaged cans. In general terms, a recovery facility will receive used cans and sort them by content. Used cans will then be fed into equipment that pierces the can while creating a positive seal to prevent venting of refrigerant. A vacuum will be applied to the can interior ensuring complete removal and recovery of the refrigerant heel. The recovered refrigerant is then transferred to a holding tank and prepared for either recycling or reclamation to ARI 700 purity standards. Recovery facilities anticipate reclaiming and using all recovered refrigerant. Empty cans will be collected for recycling.

### B. Retailers

Retailers would collect the $10 deposit from consumers at time the containers were purchased and would return this deposit when they receive the used cans from the consumer. Retailers would provide space to cQllect and store the used cans before they are transported to the manufacturer or distributor and would display and distribute the educational materials provided by manufacturers. .

**C. Consumers (DIVers)**

The U.S. EPA Vintaging Model assumes that a properly functioning system should only need to be recharged after about 6 years, and has an average life of 16 years. This value is consistent with the assessment ARB staff developed in support of implementing AB 1493. For the vehicles 7 years old and older, a fraction will need repair or recharge. Of those vehicles, a fraction will operate without air conditioning, a fraction will receive professional service, and a fraction will be recharged by DIY. There is insufficient data to estimate those fractions, but there is enough data to estimate the total number of DIY recharges occurring per year. As described the Technical Support Document (Appendix G), this number is about 1.4 million recharges per year. Data from three different surveys show that some of the recharges are performed on normally functioning vehicles that only need to be recharged every few years, and others are performed on vehicles that need to be recharged more frequently, for example more than once a year. These different vehicles contribute differently to emissions, generate different costs, and their owners would react differently to major regulatory changes such as a can ban. All three surveys indicate that the average recharge frequency is about equal to one recharge per vehicle per year. To illustrate what that means, consider vehicle A being recharged twice per year, with vehicle B and vehicle C each being recharged every other year. Over two years, six recharges will occur, for an average of one recharge per vehicle per year.

For purpose of analysis, staff made the assumption that every DIY consumer recharges his/her vehicle not at all during the first 7 years, and then once every year for the following 9 years. Although the details of the emission reductions and cost benefit analysis will vary depending on the details of the distribution, the order of magnitude will not. That is because the most important factors driving the analysis are the number of recharge operations and the number of vehicles involved. Given the number of recharge operations, the number of vehicles is determined by the average recharge rate, not the specifics of the distribution.

Consumers would be affected by several aspects of the proposed regulation. They would be required to pay the $10 deposit per container at the time of purchase, and to return the used cans within 90 days of purchase to obtain a refund of that deposit. Consumers should also become better educated regarding the global warming impacts of automotive refrigerant and improve MVAC recharging techniques. Some consumers may elect to have their MVACs repaired and/or recharged by professional technicians based on information in the educational materials.

Based on industry input, staff estimates that the retail price of a small can of refrigerant will increase by about $1. The price increase will *cover* the cost of installing a self-sealing *valve* on each can, administering the container recycling and refrigerant *recovery* program, and preparing and distributing the educational materials. The current retail price of a small container of *automotive* refrigerant is approximately $10, and the deposit amount would initially be $10, so a consumer would *have* an initial outlay that is approximately double the current price. The deposit is refunded when the used container is returned to a facility participating in the program.

Based on household income reported for DIY users (Frost and Sullivan, 2006), approximately 15% of DIYers are considered low-income households. A household is considered to be low-income if its annual household income is less than twice the federal *poverty level* for a household of three. This criterion is similar to that found in the California Health and Safety Code that defines low-income households for the *automotive* repair assistance programs (Health and Safety Code, §44062.1). For context, applying this criterion for 2008 would define a low-income threshold of $35,200.

This proposed regulatory approach will impact the low-income population to a much lesser degree than banning the sale of small containers of *automotive* refrigerant in California, as the original AB 32 Early Action Plan suggested. Banning the sale of small cans would *leave* the low-income population with *very* limited options. They could either forgo repairing their MVACs or *have* the MVACs professionally serviced at much higher costs. Therefore, the proposed regulation represents a sensible approach for obtaining GHG emission reductions in the most cost-effective manner possible.

D. Manufacturer and Retailer Interactions in the Can Recycling Program

The proposed regUlation would require a retailer to pay a deposit on each can to the manufacturer/distributor, and to collect a deposit from a consumer when a small container of refrigerant is sold, and to return that deposit when the consumer returns the used container with a receipt dated within 90 days of purchase. The deposit/refund process starts with the manufacturer. As the can *travels* to distributor, retailer, and consumer, the deposit *travels* the other direction (along with the wholesale price of the can). When the consumer returns the can and gets his deposit, the retailer must return the can to the manufacturer to *retrieve* the $10 deposit that was paid as part of the wholesale cost.

Figure 1 shows a possible flow chart that may occur as a result of the regulation. The solid lines trace the flow of cans from the manufacturer, down the left side to the consumer, and back up the right side to the manufacturer. The broken lines trace the flow of deposit money up the left side of the figure and back down the right side of the figure. The specific details of the deposit program are up to

**manufacturers, distributors and retailers. Figure 1 is only an example, included for the purposes of clarification.**

**The proposed regulation only specifies the amount of** deposit the **consumer must pay. The regulation leaves a manufacturer the flexibility to adjust the deposit at different steps of the process. If a retailer incentive is needed to cover handling costs or promote a higher return rate, a manufacturer may decide to pay a small incentive to retailers when the used cans are collected and returned.**

**The manufacturer will keep the deposit of unreturned containers, but the proposed regulation would require manufacturers to expend any such funds to reduce GHG emissions, primarily through enhanced consumer education and outreach programs. The manufacturer must provide an accounting of how the unreturned deposits are used. Unclaimed deposits will be utilized to benefit the consumer through website support, development of educational materials, and training and outreach to the consumer via the retailer.**

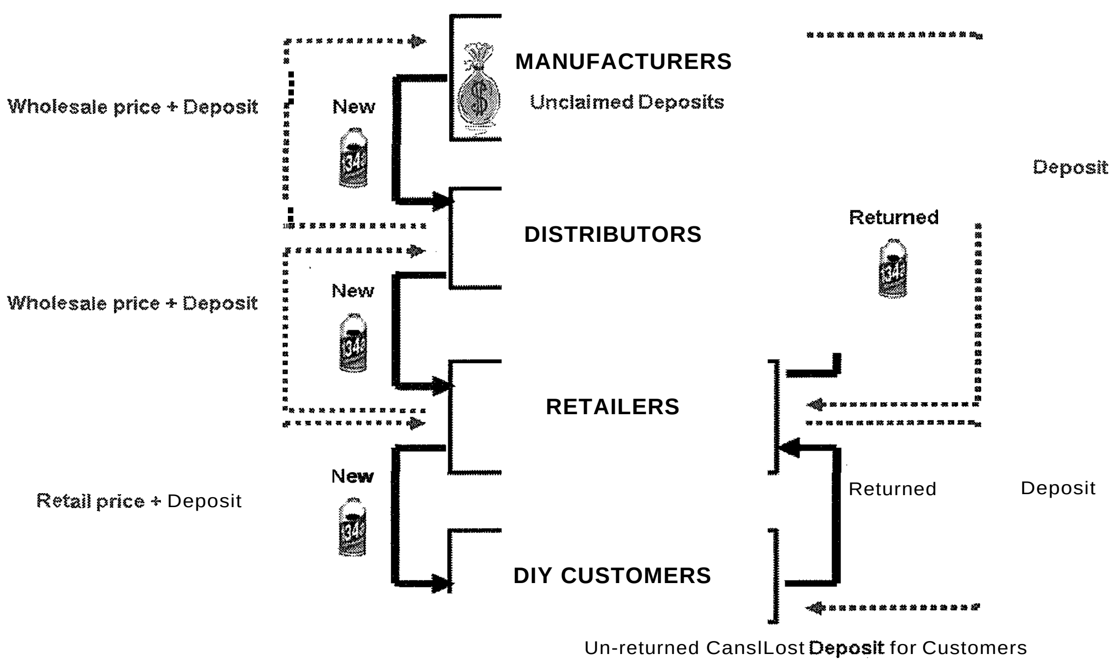


**Figure 1. Chart Showing the Deposit Process between the Affected Entities**

* The solid line traces the flow of cans from manufacturer to the customer (left side) and back to the manufacturer (right side). The broken line traces the deposit money from the customer (left side) to the retailer, and back to the customer (right side). Likewise the deposit money is traced from the retailer to the manufacturer and back.

# IX. AIR QUALITY, ENVIRONMENTAL, AND ECONOMIC IMPACTS

## A. Baseline Emissions

Staff surveyed manufacturers of small containers of HFC-134a to obtain 2006 sales data, and estimates that approximately 2 million small containers of HFC-134a were sold in California in 2006, containing about 654 metric tons of HFC-134a (ARB, 2007b). When factoring in HFC-134a's GWP of 1,300, this amount of refrigerant corresponds to sales of 0.85 $MMTC0_2E$ per year. Based on information from a mobile air conditioning trade association survey and national refrigerant usage apportionment (MACS, 2008; Atkinson, 2008a), an estimated 95% of total small cans sales are being used by DIYers. This corresponds to 0.81 $MMTC0_2E$ per year. The remaining cans are sold to professional shops although m9st professional shops purchase refrigerant in much larger canisters.

A DIYer recharging his or her MVAC system may emit refrigerant through three different mechanisms:

1. Release refrigerant from the MVAC system when the system is breached or from incomplete transfer of the can's content to the MVAC system (some content is vented to the atmosphere),
2. Release refrigerant from disposal of the container which is known to contain some refrigerant following a recharge (can heel), and
3. Failure to repair any repairable leak(s) in the MVAC system.

Based on ARB funded research (Clodic et al., 2008), the above emiSSion processes account'for the following percentages of refrigerant emissions, on average, for DIY practices:

1. *Servicing losses:* 11% is emitted directly to the atmosphere during the charging procedure,
2. *Can heel:* 22% remains in the can as heel. This percentage falls within the range of data observed in a U.S. EPA testing study for disposable container heel (U.S. EPA, 2007). Because most cans do not have sealing valves, most of this is released almost immediately to the atmosphere, and
3. *Delayed emissions:* 67% of initial mass contained in the can is effectively charged into the system (this will eventually leak to the atmosphere if leaks are not repaired).

The immediate emissions due to DIY servicing are therefore approximately 0.27 $MMTC0_2E$ per year (points 1 and 2 above), and the emissions from leaking, unrepaired MVAC systems are approximately 0.54 $MMTC0_2E$ per year (point 3 above). Most of the immediate emissions are due to improper recharging techniques. A small percentage of DIYers (25%) are responsible for 60% of the immediate emissions, which indicates that improved recharging practices are effective in reducing emISSions (Clodic et al., 2008). Figure 2 illustrates the sources of emissions associated with DIY use of small cans.

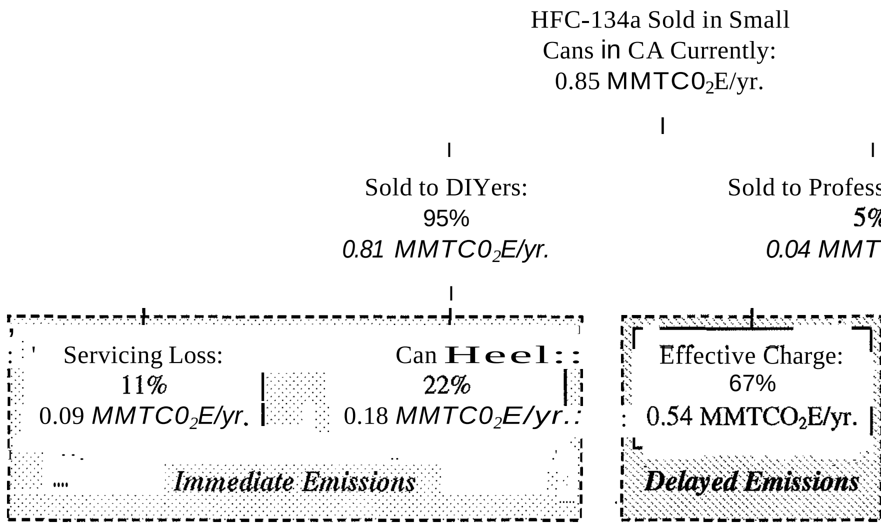


**Figure 2. HFC-134a Emissions Associated with DIY Usage of Small Cans**

Staff estimates that the emissions shown in Figure 2 will remain roughly unchanged through 2020 under business-as-usual (BAU) practices because several competing factors will likely offset each other's impact. First, the increase of passenger vehicle population and better refrigerant containment in newer MVAC will keep the number of leaky vehicles unchanged. The EMFAC Model 2007 estimates that the population of passenger vehicles in California will increase by around 400,000 each year through 2020. But newer MVAC systems have improved designs and improved production controls so that they are tighter and have reduced probability of becoming leaky. The latter cannot be quantified at this point. So a conservative assumption is made that the increased population and decreased probability of leaking produces a steady number of leaky MVAC systems.

Second, the decrease in MVAC nominal refrigerant charge size and improvement of refrigerant containment will keep the recharge frequency unchanged. The average nominal charge size for a new single evaporator MVAC decreases from 26.9 oz in 2000 to 22.3 oz in 2006 (Atkinson, 2008b). This trend will likely continue, but with a reduced pace over years. On the other hand, the improved refrigerant containment will reduce the leak rate of MVACs. In the absence of data to quantify the containment improvement, it is reasonable to assume that these two factors cancel out the effects from each other, leaving the MVAC recharge frequency unchanged. This is consistent with the approach used in the GREEN-MAC-LCCP Model, which does not differentiate recharge frequency for different model year vehicles (Papasawa et al., 2008). In the development of

AB 1493 regulation, ARB staff estimated that California MVACs emit 55 grams per year on average (ARB, 2004b). MVAC refrigerant emissions testing studies conducted by the European Automobile Manufacturers Association (ACEA) and Japan Automobile Manufacturers Association (JAMA) suggest that newer MVACs leak around 10 grams per year and very few MVACs emit significantly more than that (Atkinson, 2008c; Clodic, 2006). This substantial difference in leak rate may be attributed mainly to improved refrigerant containment of newer MVAC models as well as deterioration of containment over time.

Lastly, the amount of refrigerant consumed per recharge will not change. due to the characteristics of DIY recharging. A DIY has no means of knowing the remaining refrigerant level in an MVAC or how to determine the proper amount of refrigerant to be charged. A DIYer terminates charging based on empirical or arbitrary criteria, such as the outflow air temperature, depletion of a can, and pressure gauge reading falling into a range specified in charging kit instructions. None of these criteria presents solid grounds for charging the proper amount of refrigerant (Clodic et al., 2008). On average, a DIYer undercharges MVAC systems. With a decrease in MVAC nominal charges, a DIYer may more accurately charge the system, or overcharge, but the number of small cans used per recharge is not dependent on the nominal charge size.

Based on the factors discussed above, staff estimates that the BAU emissions from DIY recharging are projected to remain roughly constant at 0.81 $MMTC0_2E$ pe(year through 2020. ARPI had projected a 1-2% annual sales growth under BAU, likely based on national sales trend (ARPI, 2006). This projection may not accurately reflect California's unique usage patterns and the various trends discussed above. The uncertainties associated with the assumptions in the staff analysis to support this document may overshadow at most a 1-2% annual change. Therefore, no attempt has been made to empirically adjust the BAU trend to match ARPI's projection.

## B. Estimated Emission Reductions

As outlined above in section V of this Staff Report, the proposed regulation is comprised of four main components:

1. Small cans of automotive refrigerant would be equipped with self-sealing valves to reduce losses during DIY service and to eliminate loss of the can heel after DIY service was completed.
2. Improved instructions on the can would educate DIYers of methods to reduce losses during service and to reduce the size of the can heel.
3. Manufacturers would establish and implement a can recycling program to recover refrigerant that is present in can heels.
4. Manufacturers would be required to develop an educational program with brochures and websites to inform DIYers of methods to reduce losses

during service, to reduce the size of the can heel, and to describe the can recycling program.

The proposed regulation is expected to reduce HFC-134a emissions by 0.26 $MMTCO_2E$ per year. The discussion below provides a general explanation how the proposed regulation would reduce refrigerant losses attributable to servicing losses, can heel and MVAC leaks. The Technical Support Document to this Staff Report (Appendix G) provides a more detailed discussion of the projected emission reductions attributable to the proposed regulation.

1. **Servicing Losses**

Refrigerant losses arising during servicing will be addressed by the combination of the self-sealing valve, the can labeling instructions, and the educational outreach program. These components will likely reduce servicing losses from 11% of can contents to minimal, which corresponds to an emissions reduction from 0.09 $MMTCO_2E$ per year to zero, for a net reduction of 0.09 $MMTCO_2E$.

2. Can **Heel**

Emissions from the can heel will be eliminated by the use of the self-sealing valve, provided the small containers are returned for recycling. A target return rate is set at 90% for the first two years, and 95% for the following years. Staff does not believe that a 100% return rate is achievable, but established these target return rates to achieve the maximum feasible amount of emissions reductions it believes is practical based on results from a brief pilot program recycling study conducted by ARPI during the spring of 2008.

The can heel from recycled cans is assumed to be captured with 100% efficiency under the best engineering practices. All of the can heel from unrecycled cans is assumed to eventually reach the atmosphere. The current emissions from the can heel are estimated to be 0.18 $MMTCO_2E$ per year. At a 90% return rate, this would be reduced to 0.02 $MMTCO_2E$ per year, for a net reduction of 0.16 MMTC02E per year. At a 95% return rate the emissions would be reduced to 0.01 $MMTCO_2E$ per year, for a net reduction of 0.17 $MMTCO_2E$ per year. The U.S. EPA Disposable Container Heel Testing Study suggests that rotating the can while recharging for 10 to 15 minutes would significantly reduce the can heel. The improved instruction on the cans and the education program will reflect these preferred recharging practices and should help reduce the amount of can heel remaining in the containers after use. However, because no available study quantifies the emission reductions attributable to improvements in DIY recharging practices from improved instructions and the proposed education program, this analysis does not account for such reductions.

3. **Emissions from Repairing Leaking MVAC Systems**

In the Early Action report that the Board adopted in 2007, staff proposed a measure to incorporate MVAC testing and repair into the California smog check program. Staff is also considering other approaches for identifying and repairing leaks in MVAC systems that may be more viable than integrating an MVAC check into the smog check program. However, currently no emission reductions can be credited for reducing refrigerant emissions from leaks in MVAC systems associated with current DIY practices. Therefore, the delayed emissions associated with leaking MVAC systems remains at 0.54 MMTC02E per year.

Total annual emissions are thus 0.56 MMTC02E for the first two years and 0.55 MMTC02E for the following years. And the corresponding annual emission reductions are 0.25 MMTC02E and 0:26 MMTC02E, respectively, as shown in Figure 3. Figure 4 illustrates the detailed breakdown of the emissions impacts of the proposed regulation when the final return rate target of 95% is reached.

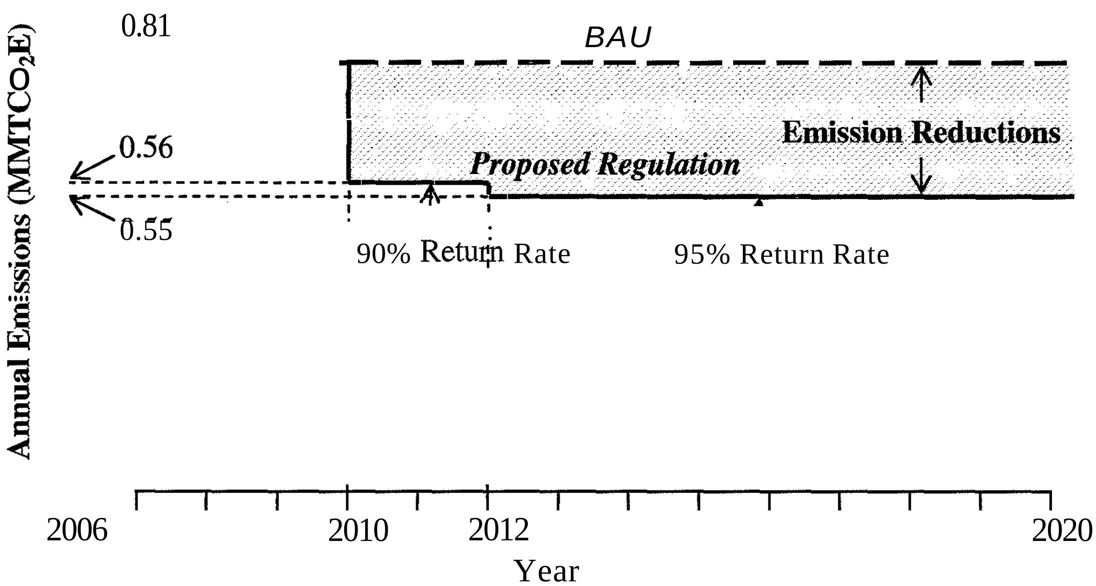


**Figure 3. Emissions Impact of Proposed Regulation**

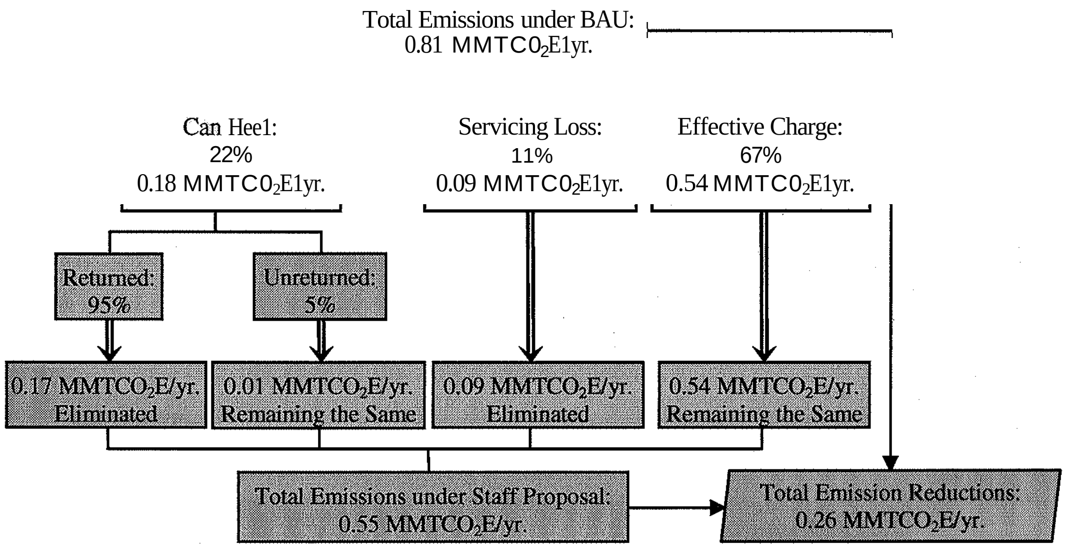


Figure 4. Detailed HFC-134a Emissions Impact under Proposed Regulation (95% Return Rate)

C. Cost-Effectiveness

Staff has estimated the cost-effectivess of the proposed regulation to be $11 per metric ton of $CO_2$ equivalent of emission reductions. The methodology is presented in the Technical Support Document, Appendix G to this Staff Report. This cost is similar to other AB 32 Early Action measures, such as cool paints, landfill emissions, and stationary refrigerant sources.

D. Costs and Economic Impacts

This section provides a general discussion of the proposed regulation's estimated costs and economic impacts. A more detailed analysis of these costs and economic impacts is provided in the Technical Support Document (Appendix G).

1. Costs to Consumers

Staff estimates that the proposed regulation would result in an increased per unit retail cost of $1 per small container of refrigerant. This cost increase would result from the proposed self-sealing valve and recycling and consumer education programs. Because the average retail price of a small can is approximately $10, the estimated price increase represents a ten percent increase over current prices. Consumers would also be required to pay an additional $10 deposit per container, but this amount would be refunded if the consumer returned the used container within 90 days and with a receipt to the place of purchase. .

## 2. Costs to Manufacturers

Manufacturers of srnall containers of *automotive* refrigerant would incur the *vast* portion of the costs associated with the proposed certification, recycling, educational, and recordkeeping components of the proposed regulation, but staff expects that these costs would largely be amortized into the market price of the containers. As discussed *above,* staff estimates that a manufacturer will incur a per unit cost of $1 for installing self-sealing *valves* and for administering the can return and recycling program, but would pass these costs on to the consumer. Manufacturers would be able to offset some of the costs associated with obtaining certification and producing educational materials with the *value* of refrigerant they would recapture under the can recycle program.

Manufacturers would likely incur minimal additional costs to comply with the proposed can recycling requirements. .Industry representatives *have* indicated that they are currently *recovering* refrigerant from damaged containers using existing equipment (the machinery used to fill the cans is simply operated in *reverse* to *recover* the can heel from the can). The exact cost impact of these *recovery* operations is not known at this time but is likely to be minimal.

Similarly, costs associated with the proposed administrative and recordkeeping requirements, such as documenting container sales and returns, amounts of refrigerant *recovered,* and unclaimed deposits should be minimal, because manufacturers already track much, if not all, of this information as part of their normal daily business.

The entire small can industry would experience an additional administrative burden related to administering the recycling program. Employee time will be required to *receive* returned cans, refund the deposit, and maintain records. Time and space will be required to store the cans until they are transported to the recycling facility.

## 3. Impact on Small Businesses

Small auto parts stores may see increased administrative burden for record-keeping, handling the deposit funds, and handling, storing, and returning the cans for recycling, but the economic impacts should be minimal because these activities are part of their normal daily business.

Small MVAC service centers that purchase small cans to recharge MVACs would *have* increased purchase and deposit costs, similar to those of DIY consumers. These additional costs should be minimal because it is estimated that only 5% of small cans are sold to professional MVAC servicing centers, and the service centers would pass the additional costs to their consumers.

### 4. Impact on Retailers

Staff estimates that retailers of small containers of automotive refrigerant would not be adversely impacted by the proposed regulation. Any increased costs are likely to be passed on to the consumers in the form of higher product prices. The price increase is unlikely to decrease demand for these products due to unavajlability of good substitute products. Retailers, thus, are likely to maintain their profit margin on this product and the proposed regulation is not expected to affect them adversely.

The proposed regulation would require retailers to administer the can deposit and recycling program, which would result in increased administrative burdens for record-keeping, handling the deposit funds, and handling, storing, and returning the cans for recycling, but these economic impacts should be minimal because these activities are part of their normal daily business. However, staff expects that some non-dedicated auto parts stores, such as big box stores, supermarkets, drugstores, etc., may decide to stop selling small containers of refrigerant due to the administrative requirements of the regulation. This would reduce the availability of the product to DIYers.

## E. Alternatives Considered

Staff considered several possible regulatory alternatives to the proposed regulation. No alternative would be more effective in carrying out the purpose for which the regulation is proposed, nor would be as effective and less burdensome than the proposed regulation.

### 1. Banning Sale of Small Containers of Automotive Refrigerant

This alternative was initially explored by staff. Under this alternative, sales and usage of small containers of automotive refrigerant would have been banned, which would have required consumers to have their MVAC systems recharged or serviced by MVAC professionals. Both the state of Wisconsin and the European Union currently ban the sale of small containers of automotive refrigerant. The state of Minnesota recently considered, but ultimately decided not to enact a sales ban in its final MVAC refrigeration regulations. The intent of this alternative is to eliminate DIY servicing of MVACs and the associated GHG emissions that result from improper servicing.

This alternative would effectively require that only professional technicians service and repair MVACs, which should reduce refrigerant emissions compared to individual vehicle owners because professionals employ practices that result in somewhat lower emissions and they have access to equipment that DIYers typically do not. Shifting MVAC recharging from DIYers to professional technicians would have several effects that help reduce emissions:

1) Losses during servicing are reduced because professionals release less refrigerant than DIYers during servicing MVACs (Clodic et aL, 2008; Appendix G).
2) Losses due to can heel are smaller because the heel left by professionals in 30-pound cylinders is smaller on a relative basis than the heel left in small cans by DIYers (U.S. EPA, 2007; Clodic et aL, 2008).
3) Likewise, heels left in small cans by professionals are probably smaller than heels left in small cans by DIYers, because professionals are familiar with the correct charging procedure for small cans.
4) Delayed emissions from leaking systems are less because the technicians can identify and repair leaks that the typical DIY can not. (California law requires that professional service technicians must provide a complete diagnostic evaluation to customers before recharging an MVAC system, but does not require that repairs be performed before recharging the MVAC system. Despite the absence of a repair requirement, staff analysis shows that a large portion of customers elect to complete repairs when they are advised repairs are needed [Appendix G]).
5) Finally, the shift to professional servicing moves the handling and use of refrigerant from the general consumer to a much smaller group of technicians, more able to be licensed and monitored.

Although the proposed regulation does not contain any measures intended to address requirements applicable to professional technicians or the handling of heels from 30-pound cylinders, these measures may be addressed in separate regulatory measures.

While increasing overall emission reductions, eliminating small can sales would greatly raise the consumer cost of MVAC servicing. Individuals would no longer be able to top off their system for $10 to $30. Instead they would require professional MVAC servicing. A diagnosis and top off would cost about $100 (Clodic et aL, 2008), and repair of system leaks would cost many hundred dollars (MACS, 2008). Due to increased costs, ARB staff concluded this strategy was not cost effective. Additionally, it could place economic hardship on the low-income sector of the public that would face the greatest difficulty with higher repair bills.

### 2. Consumer Education Program with Certification

This alternative was proposed by a stakeholder who suggested that consumers should be required to complete a training course and obtain a certification before being able to purchase small containers of refrigerant. The advantages of this alternative are that the course would directly address problems associated with DIY recharging. For example, it would promote best practices techniques, inform the consumer of damage that may occur to the MVAC system during recharge, and educate the consumer of the environmental impacts associated with use of refrigerant. Emissions would be reduced if consumers follow the best practice techniques; others may choose to not purchase small cans due to the training requirement. Staff rejected this option because it would be very time consuming for consumers, would be too complex to administer to a million or more individuals, and would likely have relatively small additional emission benefits.

**F. Other Mitigation Strategies Discussed During the Development of the Proposed**

In addition to the regulatory alternatives discussed above in Section IX.E, other mitigation strategies were discussed, but were not considered as alternatives during the development of the proposed regulation. These strategies are discussed below

**1. Mitigation Fee**

The Climate Change Proposed Scoping Plan recommends applying a mitigation fee to high GWP compounds with long lifetimes and high potency, such as automotive refrigerants. High GWp·gases are used in a broad range of applications, including significant usage in stationary and MVAC and refrigeration. High GWP gases are also used in a wide range of other applications, such as foam-blowing agents, electrical transmission, fire suppressants, consumer products, and the semiconductor industry. A mitigation fee would address all high GWP gases in a consistent manner and serve to decrease GHG emissions in several ways. It could change behavior by increasing price (e.g. improve leakage reduction efforts), induce new lower GWP alternative products, or provide fees to mitigate GHG emissions elsewhere within or outside of a given sector. The fee approach would be used to address emissions that are difficult to address via traditional regulatory approaches due to 1) many small uses that would require complicated regulations, 2) new gases and new or evolving usages, and 3) uses with no current alternative and a lack of incentive to either develop an alternative or·reduce leakage beyond regulatory standards. High GWP specific fees are already in place in several other countries including Australia, Norway, and Denmark.

Staff believes that it is best to defer development of a fee approach for this particular use of high-GWP compounds until a more comprehensive rule is developed. If a mitigation fee is applied to high GWP gases in the future, it would be in harmonization with this regulation.

**2. Equipment to Extract Refrigerant for DIVers**

One proponent has indicated he is developing equipment that would allow a DIVer to extract refrigerant from an MVAC system and then to recharge the system only if the system is leak free. This equipment is in the development stage, and it has not undergone field testing by a significant number of consumers nor has it been reviewed or approved by any MVAC system organization. If this or any other similar new technology becomes available for DIY charging and recharging of MVAC systems, it will be considered in the future.

**G. Other Regulations Related to Mitigating Emissions of Automotive Refrigerants**

To provide some perspective, the proposed regulation comprises just one of many existing measures intended to mitigate or eliminate losses of refrigerants. In September 2004, as authorized by Assembly Bill 1493 (AB 1493, Pavley, Ch. 987', Stats. 2002), the Board adopted regulations for new passenger vehicles and light-duty trucks beginning with the 2009 model year (ARB, 2005) which apply credits for the reduction of C02 equivalent emissions from HFCs used in MVACs against the tailpipe C02 emissions level.

The California Bureau of Automotive Repair (BAR) has two regulations that affect the servicing of automotive air conditioning systems. "Equipment Requirements for Automotive Air Conditioning Repair Dealers" (16 CCR 3351.6) requires shops engaged in servicing of automotive air conditioning systems to have the proper equipment available and provides specifications for the equipment including leak detectors, recovery machines, pressure gages, vacuum pump and thermometers. "Automotive Air Conditioning" (16 CCR 3366) requires shops engaged in diagnosis or servicing of automotive air conditioning systems to always completely perform a list of sixteen specific diagnostic steps including visual inspections, performance checks, and leak checks as part of their work.

ARB recently adopted a regulation that requires the Environmental Performance label on all new California vehicles to include information about emissions of global warming gases, including those from the operation of the air conditioner (ARB, 2008c). This information will now allow consumers to compare relative GHG emissions between different vehicles in addition to smog emissions as the original label intended. The new label will be affixed to the window of every new car sold in California beginning with model year 2009.

ARB is also currently developing another early action measure that is based on measures to reduce the solar heat load on vehicles parked outdoors (ARB, 2008d). A cooler vehicle interior would reduce GHG emissions by causing drivers to use less air conditioning. Potential approaches include reformulation of paint to reflect near-infrared sunlight ("cool paints"), parked car ventilation, and solar reflective window glazing. This measure is planned for a Board hearing in March 2009, and would affect 2012 and subsequent model year vehicles.

ARB is also developing a suite of measures to reduce direct and indirect emissions of high GWP refrigerants from stationary sources. One measure would require commercial and public facilities with large stationary air conditioning and refrigeration equipment to minimize emissions of high GWP refrigerants through reporting, leak repair, improved servicing, and end-of-life control (ARB, 2008e). Another measure being developed' in coordination with California Energy Commission proposes new specifications for commercial and industrial refrigeration systems to both reduce emissions of high GWP refrigerant and to increase energy efficiency of the units (ARB, 2008f).

ARB recently adopted a regulation requiring that gases used in the consumer product Pressured Gas Dusters must have a GWP less than 150. This regulation will take effect on December 31,2010 (ARB, 2008g).

Several local air districts in California prohibit the release of refrigerants into the atmosphere and restrict the sale of small cans of refrigerant. However, those local rules only apply to ozone-depleting substances such as CFC refrigerants, and not to non-ozone depleting substances such as HFC-134a.

The state of Wisconsin has regulations prohibiting the sale of refrigerant in small cans, and restricts the sale and use of refrigerant in larger containers to certified, state-registered technicians (ATCP 136). This was enacted in the 1990's as an extension of its R-12 restrictions and without consideration of its cost-effectiveness.

Recently, the State of Minnesota considered, but ultimately did not adopt a restriction on the sale of small cans of refrigerant. Instead, Minnesota will require reporting purchases of high-GWP gases, including automotive refrigerants. Minnesota will also require automobile manufacturers to report the refrigerant leak rates for new vehicles sold in the state, and these reports will be available to the public (Minnesota Senate, 2008).

As previously discussed, the federal Clean Air Act and the U.S. EPA prohibit venting refrigerants, including HFC-134a, to the atmosphere during servicing and repair of MVAC systems and during dismantling at end-of-life. The U.S. EPA also requires MVAC technicians to be certified (40 CFR §82.154).

In the EU, the sale and usage of small cans for recharging MVAC have never been allowed, and large bottles of refrigerant can only be sold to certified air conditi9ning technicians. In addition, the European Parliament has adopted a prohibition of HFC-134a in new vehicle types starting in model year 2011 (European Parliament, 2006). Only refrigerants with GWPs less than 150 will be allowed in the EU. Life cycle climate performance (LCCP) studies are being conducted to determine which refrigerants offer the best LCCP globally and for specific regions such as the United States (Papasawa et al., 2008).

## X. PUBLIC OUTREACH EFFORTS

The proposed regulation was initially proposed as a 'can ban' in the Climate Action Team Report to the Governor released in April, 2006. The can ban concept was presented at an AB 32 workshop in January 2007, then again brought to the attention of the public in June 2007, when the Board identified the can ban as a Discrete Early Action measure.

Since February 2008, staff has been notifying affected industries and other interested parties regarding the development of the proposed regulation. Staff held public workshops on February 5, 2008 and July 31, 2008, and workgroup meetings in February, April, and June of 2008. Interactions with stakeholders resulted in additional mitigation options that had not been previously considered.

Staff also interacted with stakeholders on an individual basis, particularly representatives from Automotive Refrigeration Products Institute (ARPI). ARPI proposed alternate mitigation options and conducted a pilot test on the feasibility and potential success of a consumer-based can recycling program. Other stakeholders also interacted with staff on an individual basis. A partial list of these participants includes representatives from the Mobile Air Conditioning Society Worldwide (MACS) and attendees ofthree SAE International sponsored Alternate Refrigerant Systems Symposiums. Staff also met with representatives from U.S. EPA, the European Commission, and the states of Wisconsin and Minnesota in individual meetings.

To incorporate the principles of Extended Producer Responsibility (EPR), staff collaborated with staff from the California Integrated Waste Management Board (CIWMB) and had repeated contacts with the California Product Stewardship Council (CPSC). CIWMB has established a framework that defines key features of EPR programs and is seeking legislative action that would provide CIWMB the statutory authority to establish EPR programs. Under EPR, producers are required to design and implement a system that eliminates the necessity for government administered programs to handle waste products. The burden of designing and implementing the program is therefore shifted from tax payers and local government to the producer and consumer. EPR places the responsibility of dealing with the waste products on all parties involved in making, distributing, selling, and using the product (CIWMB, 2008). The proposed regulation is designed in conformity with the EPR framework.

Retailers were contacted by both ARB staff and ARPI members. ARB staff specifically contacted the California Retailers Association to establish a working relationship for this proposed regulation. Representatives of the association were already on the list serve e-mail list. The announcement of the second public workshop was forwarded to representatives of WalMart, Target, Sears, K Mart, Orchard Supply, AutoZone, CSK Auto, Les Schwab, and Keystone Automotive.

Pursuant to staff's request, ARPI members notified their top retail and distribution partners of pending regulatory efforts in California. Through the assistance of ARPI, the members of the Automotive Aftermarket Industry Association (AAIA) have been formally notified of the proposed regulation.

Additional contacts were made with California retailers including auto parts stores, major retailers, and drug stores, to seek their comments on the proposed measure. ARB staff provided a brief verbal explanation of the proposed regulation over the telephone to each representative, and then sent a follow-up e-mail with a written summary of the proposed regulation highlighting the retailers' involvement, along with website links where additional information could be obtained. Retailers contacted include NAPA, Kragen, Pep Boys, Carquest, Target, Sears (which owns Orchard Supply Hardware and Kmart), Rite Aid, and Walgreen's. Individual meetings were held between retailers and ARB staff to discuss retailers' concerns.

In 2006 and 2007 ARB staff gave presentations that informed representatives from government, Europe, and the MVAC industry of California's actions and progress on MVAC Early Action measures. The conferences at the Alternate Refrigerant Systems Symposium provide a network for interacting with experts in this MVAC field.

# XI. CONCLUSIONS AND RECOMMENDATIONS

ARB staff proposes a new regulation to address GHG emissions attributable to GHG emissions associated with DIY recharging of MVAC systems as discussed in this staff report. The proposed regulati.on would consist of the following major components:

1. A certification program for small containers of automotive refrigerant that would require manufacturers to equip small containers with self-sealing valves.
2. Establish a container deposit and return program to ensure DIYers return used containers to retailers and that would allow manufacturers to recover any refrigerant remaining in the containers.
3. Establish container labeling and consumer education requirements to promote consumer education of proper charging practices and of the environmental consequences of misuse of refrigerant.
4. Establish recordkeeping requirements to enable staff to determine the effectiveness of the regulation and to monitor and ensure compliance with the regulation's requirements.

The proposed regulation fulfills the requirements applicable to discrete early action GHG emission reduction measures to "achieve the maximum technologically feasible and cost-effective reductions in greenhouse gas emissions" from the sources identified for early action measures. The proposed regulation and associated certification procedure and test procedures are achievable using existing technology and manufacturing processes. The emission reductions are cost-effective compared to other early action GHG measures under consideration by the Board. The proposed regulation is necessary to meet emission reduction goals and reduce climate change impacts.

No alternatives considered by the Board would be more effective in achieving the goals of this proposal, nor would be less burdensome to manufacturers or affected private persons.

Staff recommends that the Board approve its proposal to adopt Sections 95360 through 95370 of Title 17, California Code of Regulations, Certification Procedures for Small Containers of Automotive Refrigerant, Test Procedures TP-503, and Balance Protocol BP-A1 incorporated therein and provided in Appendices A through D of this report.

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# Appendix A

## Proposed Regulatory Language

Division 3. AIR RESOURCES

Chapter 1. AIR RESOURCES BOARD

Subchapter 10. Climate Change

Article 4. Regulations to Achieve Greenhouse Gas Emission Reductions

Subarticle 5. Small Containers of Automotive Refrigerant

# PROPOSED REGULATION ORDER

Adopt new Article 4, Subarticle 5, Small Containers of Automotive Refrigerant, sections 95360 to 95370, title 17, California Code of Regulations, to read as follows:

Note: All of the text below is new language to be added tothe California Code of Regulations (CCR).

## Subchapter 10. Climate Change
## Article 4. Regulations. to Achieve Greenhouse Gas Emission Reductions
## Subarticle 5. Small Containers of Automotive Refrigerant

## Small Containers of Automotive Refrigerant

### § 95360. Applicability

Except as otherwise provided in sections 95363 or 95364, this subarticle applies to any person who uses, sells, supplies, offers for sale, advertises, manufactures for sale, recycles, reclaims, recovers, imports, exports, or introduces into commerce in the State of California any automotive refrigerant in a small container that is used or intended for use to charge motor vehicle air conditioning systems.

Note: Authority cited: Sections 38501,38510,38560,38560.5,38580,39600, and 39601, Health and Safety Code. Reference: Sections 38501, 38505, 38510,38550,38551,38560,38560.5,39003,39500,39600, and 39601, Health and Safety Code.

### § 95361. Definitions

(a) The definitions in section 1900(b), Title 13 of the California Code of Regulations apply with the following additions:

(1) "Automotive Refrigerant" means any substance used, sold for use, or designed or intended for use as a heat transfer fluid and provides ą cooling effect in a Motor Vehicle Air Conditioner (MVAC) that is not either a Class I or a Class II refrigerant as defined in 42 U.S.C. sections 7671 (a) or (b), or that is listed in Title 40, Code of Federal Regulations part 82, subpart A, appendix A, as it existed as of July 1, 2006.

(2) "Automotive Refrigerant in a Small Container" means automotive refrigerant packaged in a container holding more than 2 ounces and less than 2 pounds of automotive refrigerant by weight.

(3) "Breached Container" means any small container that has been structurally compromised so that the container's contents have been released to the environment through an opening other than the self-sealing valve.

(4) "Can Heel" means the quantity of automotive refrigerant remaining in a small container of automotive refrigerant after that small container of automotive refrigerant has been used to charge an MVAC system or systems with refrigerant.

(5) "Consumer" means the first person who in good faith purchases automotive refrigerant in a small container for purposes otherthan resale, including, but not limited to, MVAC maintenance and repair activities or other applications involving this product. A person who purchases automotive refrigerant in a small container for purposes of servicing or repairing another person's MVAC for consideration (e.g., a MVAC technician) is considered a 'consumer' for purposes of this article. Manufacturers, distributors, and retailers are not consumers.

(6) "Dispose" means to discard a small container of automotive refrigerant in any manner, except as permitted in section 95365 of this article.

(7) "Distributor" means any person to whom an automotive refrigerant small container is sold or supplied for the purposes of resale or distribution in commerce, including imports and exports from the United States. Manufacturers, retailers, and consumers are not distributors.

(8) "Executive Officer" means the Executive Officer of the California Air Resources Board (ARB).

(9) "Global Warming Potential" (GWP) means the radiative forcing impact of one mass-based unit of a given greenhouse gas relative to an equivalent unit of carbon dioxide over a given period of time.

(10) "Global Warming Potential Value" or "GWP Value" means, for the purposes of this subarticle, the 100-yr GWP value first published by the IPCC in its Second Assessment Report (SAR) (IPCC, 1995); or if a 100-yr GWP value was not specified in the IPCC SAR, it means the GWP value published by the IPCC in its Fourth Assessment

Report (AR4) OPCC, 2007); or if a 100-yr GWP value was not specified in the IPCC AR4, then the GWP value will be determined by the Executive Officer based on data, studies and/or good engineering or scientific judgment. Both the 1995.IPCC SAR values and the 2007 IPCC AR4 values are published in table 2.14 of the 2007 IPCC AR4. The SAR GWP values are found in column "SAR (1 OO-yr)" of Table 2.14.; the AR4 GWP values are found in column "100 yr" of Table 2.14."

(11) "Label" means any written, printed, or graphic matter affixed to, applied to, attached to, embossed on, or appearing upon any automotive refrigerant small container for purposes of branding, identifying, or giving information with respect to the product or to the contents of the package.

(12) "Manufacturer" means any person who imports, manufactures, assembles, packages, repackages, recovers, recycles, or reclaims automotive refrigerant in a small container, or who re-Iabels such a container of refrigerant.

(13) "Motor Vehicle Air Conditioner" (MVAC) is a system installed in a motor vehicle that uses a refrigerant to cool the driver's or passenger's compartment.

(14) "Person" has the same meaning as defined in Health and Safety . Code section 39047.

(15) "Reclaim" means to process refrigerant to a level equivalent to new product·specifications in accordance with the ARI 700-2006 Standard ("Specifications for Fluorocarbon Refrigerants", Air-conditioning & Refrigeration Institute, Arlington, VA, 2006).

(16) "Recover" means to remove automotive refrigerant, in any condition, from a MVAC system without necessarily testing or processing it in any way.

(17) "Recycle" means to clean automotive refrigerant for reuse by oil separation and by single or multiple passes through moisture-absorption devices, such as replaceable core filter-driers that reduce moisture, acidity, and particulate matter.

(18) "Recovery facility" means a facility that recovers automotive refrigerant that is subject to the provisions of this subarticle.

(19) "Retailer" means any person who owns, leases, operates or controls, or supervises a retail outlet in California. Manufacturers, distributors, and consumers are not retailers.

(20) "Retail Outlet" means any establishment at which automotive refrigerant in a small container is sold, supplied, or offered for sale in California.

(21) "Self-Sealing Valve" means a valve affixed to an automotive refrigerant small container that automatically seals to prevent or minimized inadvertent release of refrigerant when not actively engaged for the purpose of dispensing refrigerant, and meets or exceeds established performance criteria as specified by the Executive Officer.

(22) "SKU" (Stock Keeping Unit) means a unique code identifier for each distinct product or service that can be ordered from a supplier. The SKU system enables the merchant to systematically track their inventory, such as in warehouses and retail outlets.

Note: Authority cited: Sections 38501,38510,38560,38560.5,38580,39600, and 39601, Health and Safety Code. Reference: Sections 38501, 38505, 38510,38550,38551,38560,38560.5,39003,39500,39600, and 39601, Health and Safety Code.

## § 95362. Certification Procedures for Small Containers of Automotive Refrigerant

(a) Except as provided in sections 95363 or 95364, on or after January 1, 2010, no person may sell, supply, offer for sale, or manufacture for sale in California automotive refrigerant in a small container unless that automotive refrigerant in a small container has been certified for use and sale by the Air Resources Board and is covered by an Executive Order issued pursuant to this article.

(b) The criteria for obtaining certification, including. all test procedures for determining compliance with applicable test procedures, are set forth in "Certification Procedures for Small Containers of Automotive Refrigerant", adopted on **[Insert date of Adoption]** which is incorporated by reference herein.

(c) Any modification to the design or specifications of a small container of automotive refrigerant that has been issued an Executive Order pursuant to these procedures must be disclosed to ARB before any modified small container of automotive refrigerant may be sold, supplied, offered for sale, or manufactured for sale in California. The Executive Officer will exercise good engineering judgment to determine if said change(s) constitute a significant difference to the design or specification of a previously certified small container of automotive refrigerant. If the Executive Officer determines that said change(s) constitute a significant difference to the design or specification of a previously certified small container of automotive refrigerant, the manufacturer must then request that the modified small container of automotive refrigerant be issued a new Executive Order pursuant to the provisions of this Article.

Note: Authority cited: Sections 38501,38510,38560,38560.5,38580,39600, and 39601, Health and Safety Code. Reference: Sections 38501,38505, 38510,38550,38551,38560,38560.5,39003,39500,39600, and 39601, Health and Safety Code.

### § 95363. Exemption for Low GWP Value Refrigerants

This subarticle does not apply to automotive refrigerants with a GWP value equal to or less than 150, where GWP value is defined as described in section 95361 (a)(1 0).

Note: Authority cited: Sections 38501, 38510, 38560, 38560.5, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38501, 38505, 38510,38550,38551,38560,38560.5,39003,39500,39600, and 39601, Health and Safety Code.

### § 95364. Sell-Through of Products

(a) Notwithstanding the provisions of section 95362(a), automotive refrigerant in a small container that was packaged or manufactured before January 1, 2010 may be sold, supplied, or offered for sale in California until December 31, 2010.

(b) Notification necessary for products sold during the sell-through period. A person who sells or supplies automotive refrigerant in a small container that does not fully comply with the provisions of section 95362 must notify the purchaser in writing of the date on which the sell-through period will end. This notification must be supplied only if all of the following conditions are met:

(1) The product is being sold or supplied to a distributor or retailer; and

(2) The sell-through period for the product will expire 6 months or less from the date the product is sold or supplied.

(c) Any small container of automotive refrigerant that is not sold by December 31,2010 must be recalled by the manufacturer. A manufacturer must report the total number of small containers of *automotive* refrigerant that are recalled in the reports required by section 95367.

Note: Authority cited: Sections 38501, 38510, 38560, 38560.5, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38501,38505, 38510, 38550, 38551, 38560, 38560.5, 39003, 39500,39600, and 39601, Health and Safety Code.

## § 95365. Container Disposal or Destruction

(a) On or after January 1, 2010, no person shall dispose of or destroy any small container of *automotive* refrigerant that is subject to the requirements of this subarticle unless the disposal or destruction is performed in accordance with the procedures specified in this section.

(b) A manufacturer or its designated *recovery* facility must *evacuate* small containers of *automotive* refrigerant to less than atmospheric pressure, unless the containers are breached or damaged to an extent that precludes *recovery* of the refrigerant. All other persons must return small containers of refrigerant that contain any quantity of refrigerant to the retailer, the manufacturer, or the manufacturer's designated *recovery* facility.

(c) Refrigerant *recovery* facilities must be registered with the ARB as described in "Certification Procedures for Small Containers of *Automotive* Refrigerant" adopted on **[Insert date of Adoption],** which is incorporated by reference herein.

(d) Small containers of *automotive* refrigerant that are breached should not be recycled, since their contents cannot be readily *recovered.* They do not count as recycled cans for the purpose of calculating the recycle rate.

Note: Authority cited: Sections 38501,38510,38560,38560.5,38580,39600, and 39601, Health and Safety Code. Reference: Sections 38501, 38505, 38510,38550,38551,38560,38560.5,39003,39500,39600, and 39601, Health and Safety Code.

## § 95366. Container Deposit and Return Program Requirement

(a) Except for small containers of *automotive* refrigerant exempted under section 95363 or section 95364 of this subarticle, on or after January 1, 2010, and subject to the provisions of section 95367, a retailer of *automotive* refrigerant in a small container that is subject to the requirements of this subarticle must:

(1) Collect a deposit from the consumer or charge the consumer's account for each small container of automotive refrigerant at the time of sale.

(2) The amount of deposit on each small container is initially set at $10, and can be increased in $5 increments as described in section 95367(d).

(3) Return the deposit to the consumer, or credit the consumer's account when the consumer returns a used small container of automotive refrigerant to the retailer, provided that the consumer returns the used container of refrigerant to the retailer where purchased within 90 days of purchase, and submits proof of purchase (e.g., cash register receipt). A retailer may return the deposit at its discretion if more than 90 days have elapsed, the consumer does not have a receipt, or if the consumer returns the container to a location other than the place of purchase. A retailer must not return the deposit and must not accept any small containers of automotive refrigerant that have been breached or .structurally compromised.

(4) All deposits not returned to customers in exchange for used small containers of automotive refrigerant will accrue to the benefit of the manufacturer.

(5) Accumulate and store any used small container of automotive refrigerant for transfer to the manufacturer or its designee. The manufacturer will, along with each participating retailer/distributor, identify or provide collection bins, totes or boxes that work in a complementary fashion within each retailer/distributors' current established distribution best practice for like merchandise. Likewise, it will be the manufacturer's responsibility to identify each retailer/ distributor's most complimentary manner of transport and return of returned small containers of automotive refrigerant to the recovery/recycle facilities.

(b) Except for small containers of automotive refrigerant exempted under section 95363 or section 95364 of this subarticle, on or after January 1, 2010, and subject to the provisions of section 95367, a manufacturer or its designated return agency must:

(1) Collect a deposit on each small container of automotive refrigerant at the time of sale to a distributor or retailer.

(2) Accept from a retailer or distributor used small containers of refrigerant certified under section 95362.

(3) Maintain a log of returned used containers by SKU, retailer, and return date.

(4) Refund to the retailer or distributor the full amount of the deposits colleoted under section 95366(b)(1) for all used small containers of automotive refrigerant certified under section 95362 that were returned. A manufacturer or designated return agency must not pay a refund for and must not accept any small containers of automotive refrigerant that have been breached or structurally compromised.

(5) Separately account for any funds attributable to unclaimed deposits, expend those funds only on enhanced educational programs that are designed to inform consumers of measures to reduce GHG emissions associated with do-it-yourself recharging of MVAC systems, and provide to ARB an accounting of the collection and expenditures of these funds as described in section 95367(a)(5). Examples of enhanced education programs include, but are not limited to: improved Internet website **support,** development of additional educational materials, training and outreach to the consumer via retailers, and development and usage of videos and other means of demonstrations at retail sites.

(c) A manufacturer may designate an additional facility to receive and store returned used small containers of automotive refrigerant and to pay consumer refunds specified in section 95366(a) and (b) at the time a container is returned. Such a facility may be either a retail store or an entity that is not affiliated with a retail store.

(d) A manufacturer or its designee must coordinate the collection of used small containers of automotive refrigerant from retailers and any designated return agencies. To reduce the burden on the retailer, the manufacturer shall, along with each participating retailer/distributor, identify or provide,collection bins, totes or boxes that work in a complementary fashion within each retailer/distributors' current established distribution best practice for like merchandise. Likewise, it shall be the manufacturer's responsibility to identify each retailer/ distributor's most complementary manner of transporting returned small containers of automotive refrigerant to the recovery/recycle facilities.

(e) A manufacturer or its designee must recover any refrigerant remaining in the returned cans at a facility registered with the ARB as described in "Certification Procedures for Small Containers of Automotive Refrigerant" adopted on [Insert **date of Adoption],** which is incorporated by reference herein. The facility must employ good engineering practices to avoid loss of refrigerant to the atmosphere. The recovered refrigerant must be recovered, recycled, reclaimed, or removed to a licensed waste disposal facility.

Note: Authority cited: Sections 38501, 38510, 38560, 38560.5, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38501,38505, 38510,38550,38551,38560,38560.5,39003,39500,39600, and 39601, Health and Safety Code.

## § 95367. Recycling Reporting Requirements

(a) Reports to the Executive Officer will cover an initial 9 month period starting January 1, 2010, and extending through September 30, 2010. The next and continuing reporting periods are 12-month periods covering October 1 through September 30 of each calendar year, with a summary report for the entire year due by December 1 of each calendar year. Reports must be submitted as follows:

(1) Upon request from ARB, each retailer must report sales data of the number of small containers of automotive refrigerant sold and the number of used small containers of automotive refrigerant returned by consumers. The sales data and returned can data must be reported for each SKU, for each manufacturer, distributor, for each month, and as totals for each reporting period. The data must be reported separately for the following categories: recalled/returned unused, returned for recycle, returned damaged.

(2) Each distributor must report sales data of small containers of automotive refrigerant. The sales data must be reported for each SKU for each retailer, manufacturer, and for each month.

(3) Each manufacturer must report sales data of the number of small containers of automotive refrigerant sold to each retailer or distributor within the State and the number of small containers of automotive refrigerant returned for recycling by each retailer or distributor within the State. The sales data must be reported for each SKU, for each distributor, retailer, or other outlet, for each month and as totals for each reporting period.

(4) Each manufacturer or recycler of small containers of automotive refrigerant must report the number of small containers received for recycling. The returned container data must be reported for each SKU, for each retailer or other source of return, for each month, and as totals for each reporting period. The data must be segregated according to reason for the can return: .

recalled/returned unused, returned for recycle, returned damaged. The refrigerant amount recovered must be reported for each manufacturer, and for each month.

(5) Each manufacturer of small containers of automotive refrigerant must report the amounts of unclaimed deposits retained, and an accounting and description of how those funds were spent to enhance consumer education. The report must highlight each component of an educational program and funds spent for that component.

(6) Each recycler of refrigerant from small containers of automotive refrigerant must report the amount of refrigerant recovered, along with the amount of that refrigerant recycled, reclaimed, or disposed of. The refrigerant amounts must be reported for each manufacturer, and for each month.

(b) The ARB will calculate and publish the annual return rate for containers of refrigerant subject to the requirements of this subarticle based on reports submitted to ARB by the manufacturers, distributors, and the retailers. The return rate of containers will be calculated as the number of containers of refrigerant returned divided by the number of containers sold to consumers during the period under consideration.

(c) Between January 1, 2010 and September 30, 2011, the target return rate for containers is 90%. For the two year period beginning October 1, 2011, the target return rate for containers is 95%.

(d) For each two year reporting period in which the return rate does not meet or exceed its target return rate, the Executive Officer or his or her designee may revise the deposit amount of section 95366(a) by an additional $5. Before increasing the deposit amount under this provision, the Executive Officer or his or her designee may consider any information submitted by manufacturers or retailers received by December 1 of that calendar year.

(e) The effective date and sell-through period for older cans with a different deposit amount will be six months from January 1 of the year following the change of the deposit rate. All new cans with a different deposit rate must have new labels and SKUs, which reflect the new deposit rate.

Note: Authority cited: Sections 38501,38510,38560,38560.5,38580,39600, and 39601, Health and Safety Code. Reference: Sections 38501, 38505, 38510,38550,38551,38560,38560.5,39003,39500,39600, and 39601, Health and Safety Code.

## § 95368. Enforcement

(a) If the Executive Officer finds any manufacturer, distributor, or retailer manufacturing for sale, advertising for sale, selling, acquiring, or offering for sale in the State of California small containers of automotive refrigerant that do not comply with the requirements of this subarticle, he or she may enjoin said manufacturer, distributor, or retailer from any further manufacture, advertisement, sales, offers for sale, or distribution of noncompliant small containers automotive refrigerant pursuant to section 41513 of the Health and Safety Code. The Executive Officer may also assess penalties to the extent permissible under Chapter 1.5 of Part 5, Division 26 of the Health and Safety Code commencing with section 42400 and/or revoke any Executive Order(s) issued for the noncompliant automotive refrigeration small container.

(b) Testing to determine that small containers of automotive refrigerant are in compliance with the leakage rate requirement specified in "Certification Procedures for Small Containers of Automotive Refrigerant" adopted on **[Insert date of Adoption],** which is incorporated by reference herein, shall be performed using Test Procedure (TP-503), Test Procedure for Leaks from Small Containers of Automotive Refrigerant, adopted **[Insert date of Adoption],** which is incorporated herein by reference.

(c) Before seeking remedial action against any manufacturer, distributor, or retailer, the Executive Officer will consider any information provided by the manufacturer, distributor, or retailer.

Note: Authority cited: Sections 38501,38510,38560,38560.5,38580,39600, and 39601, Health and Safety Code. Reference: Sections 38501, 38505, 38510,38550,38551,38560,38560.5,39003,39500,39600, and 39601, Health and Safety Code.

## § 95369. Recordkeeping Requirements.

(a) Each manufacturer, distributor, and retailer of small containers of automotive refrigerant must retain invoices for a period not less than 5 years that show the manufacturer, distributor, or retailer name, business name, physical address, contact name, telephone number, fax number, e-mail address, web site address, sale date, and the quantity of small containers of automotive refrigerant purchased or sold.

(b) Each recovery facility must maintain records for a period not less than 5 years that show the number of small containers received, and from whom they were received.

(c) Each recovery facility must maintain records for a period not less than 5 years that show the quantity of automotive refrigerant recovered, along with the quantity of that recovered refrigerant that was recycled, reclaimed, or disposed of.

(d) Each manufacturer must maintain records for a period not less than 5 years that show expenditures for educational programs that it funded from unclaimed deposits.

(e) Records include copies of all invoices, books, correspondence, electronic data, or other pertinent documents in the possession or under the control of a manufacturer, distributor or retailer that is necessary to prove compliance with the requirements of this subarticle.

(f) The records specified in this section may be stored in paper, electronic, or other usable formats.

(g) The records specified in this section must be provided to ARB upon request by the Executive Officer or his or her designee.

Note: Authority cited: Sections 38501, 38510, 38560, 38560.5, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38501,38505, 38510,38550,38551,38560,38560.5,39003,39500,39600, and 39601, Health and Safety Code.

**§ 95370. Severability**

Each part of this article is severable, and in the event that any provision of this article is held to be invalid, the remainder of this article shall continue in full force and effect.

Note: Authority cited: Sections 38501,38510,38560,38560.5,38580,39600, and 39601, Health and Safety Code. Reference: Sections 38501,38505, 38510,38550,38551,38560,38560.5,39003,39500,39600, and 39601, Health and Safety Code.

# Appendix B

# Proposed Certification Procedures

## Certification Procedures for Small Containers of Automotive Refrigerant

**NOTE:** This is a new Certification Procedure. For clarity the proposed text is shown in normal type.

California Environmental Protection Agency

# Air Resources Board

## Certification Procedures for Small Containers of Automotive Refrigerant

Adoption Date: [To be determined]

# TABLE OF CONTENTS

California Environmental Protection Agency
Air Resources Board

# Certification Procedures For Small Containers of Automotive Refrigerant

The definitions in Section 95361, Title 17 of the California Code of Regulations (CCR) apply to this Certificat!on Procedure. For purposes of these Procedures, the term "ARB" refers to the California Air Resources Board.

## 1. GENERAL INFORMATION AND APPLICABILITY

This document specifies the criteria and procedures used by ARB to evaluate and certify small containers of automotive refrigerant that are manufactured for sale, advertised for sale, sold, or offered for sale in California, or that are introduced, delivered or imported into California for introduction into commerce. An Executive Order will only be issued for a small container of automotive refrigerant that demonstrates compliance with all applicable certification requirements.

Compliance with the standards specified in these procedures does not exempt small containers of automotive refrigerant from compliance with other applicable federal or state statutes or regulations such as safety codes and other safety regulations, nor will the ARB test for or determine compliance with such other statutes or regulations.

## 2. CERTIFICATION REQUIREMENTS

A manufacturer seeking an Executive Order for small containers of automotive refrigerant that are subject to the requirements set forth in title 17, CCR sections 95360 *et seq.* must submit information demonstrating that the small containers of automotive refrigerant comply with each of the requirements set forth below.

### 2.1 Self-sealing Valve and Leakage Rate

(A) Each container of refrigerant must be equipped with a single self-sealing valve that automatically closes and seals when not dispensing refrigerant.

(B) The leakage rate from each container must not exceed 3.0 grams per year when the self-sealing valve is closed. This leakage rate applies to new, full containers as well as containers that may be partially full.

(C) The leakage rate specified in 2.1 (B) of these procedures will be determined by TP-503, Test Procedure for Leaks from Small Containers of Automotive Refrigerant, adopted which is incorporated herein by reference.

(D) All testing to demonstrate compliance with sections 2.1 (B) and (C) of these procedures must be conducted by an independent test laboratory in the United States. For purposes of this requirement, an independent test laboratory is one that is not owned, operated or affiliated with the applicant seeking an Executive Order.

(E) Test procedures other than those specified in this Certification Procedure may be used only if prior written approval is obtained from the Executive Officer. A request for approval to use an alternative test procedure must describe the proposed alternative test procedure, including equipment specifications and personnel skill requirements necessary to conduct the test. If training is required to properly perform a test, a proposed training program must be included. The Executive Officer will utilize good engineering judgment to determine if an alternative test procedure will produce data that is as accurate and precise as the data generated from the specified test procedures.

If the Executive Officer approves a request to utilize an alternative test procedure, he or she may condition the approval upon conditions including, but not limited to, the manufacturer's acknowledgement and agreement that notwithstanding the approval, ARB will determine the leakage rate for a small container of automotive refrigerant by using test procedure TP-503, Test Procedure for Leaks from Small Containers of Automotive Refrigerant, adopted **[BARCU will insert date],** which is incorporated herein by reference, and will base decisions whether to initiate enforcement actions for non-compliant small containers of automotive refrigerant on the results obtained from TP -503.

(F) Test procedures referred to in this Article can be obtained from the California Air Resources Board.

2.2 Recovery Facilities

(A) Each manufacturer seeking an Executive Order for small containers of refrigerant must identify and register with ARB each facility that will be used to recover refrigerant from a small container. Registration includes providing location, contact information, a description of recovery equipment including operating parameters such as vacuum to be used and operational capacity, and description of any processing and ultimate fate of the recovered refrigerant. Any recovery facility must use best operating procedures to minimize leakage of refrigerant to the atmosphere.

## 2.3 Container Labeling Requirements

(A) Each container of refrigerant must clearly display instructions for proper use in both English and Spanish. The instructional language must be approved by ARB and must include the following:

(1) General safety precautions with the following statements required:

(a) "Wear protective (rubber) gloves and safety glasses".

(b) "Contents under pressure".

(c) "Do not exposure to temperatures above 120°F".

(d) "Store in a cool place".

*(e)* "Do not puncture or incinerate".

(f) "Keep out of reach of children".

(2) Vehicle operating parameters for the performance of a typical DIY air conditioning recharge, phrases to be included are:

(a) "Start engine..."

(b) "... Set air conditioner on maximum cooling".

(c) "...fan on highest setting (high)".

(3) Procedures for recharging with the following phrases included as a minimum requirement:

(a) "Check hoses and ports for leaks and repair before recharging".

(b) "Follow instructions on recharge hose." - or similar instruction.

(c) "Hold can upright to charge. While charging, rotate can between 12 o'clock and 3 o'clock, continually agitating (sweeping) can back and forth." - or similar instruction.

(d) "Continue process until can is empty (5 to 15 minutes) or until correct amount of refrigerant is charged into system". - or similar instruction.

*(e)* An instructional phrase such as "Check AlC system nameplate for maximum volume", or "Check AlC system pressure", followed by the instruction: "Do not overcharge".

(f) "Visit www.staycoolcalifornia.com.. with one of the following: "for best practices", "for more info", "to learn more", "for project instructions".

(8) Each small container must clearly display the following items:

(1) The following statement in English and Spanish in a font size of at least 6 point unless otherwise specified "Contents of this container contribute to Global Warming. It is illegal to destroy or discard this container or its contents. Return for $XX refund." Refer to 17 CCR section 95360 *et seq.* for actual dollar amount.

(2) The following statement in English and Spanish in a font size of at least 9 point for English and 8 point for Spanish: "Approved for use in California".

(3) The following statement in English and Spanish: "$XX refundable deposit, if returned within 90 days of purchase". "$10" must be in the lead position and at least 15 point font. "Refundable Deposit" must be at least 10 point font for English and 7 point font for Spanish. "If returned within 90 days of purchase" must be at least 7 point font for English and 6 point font for Spanish. Refer to 17 CCR section 95360 *et seq.* for actual dollar amount.

(4) A product SKU code that is uniquely identifiable to this program by dedicated markings, UPC coding, and program identification markings, language or icons that serve to reasonably differentiate this product as approved for use in California.

(C) Each manufacturer must display on each small container of refrigerant offered for sale in California a legible date or coded data of manufacture and file an explanation of such date code with the Executive Officer no later than three months after the effective date of this article or within three months of production, and within three months of any change in coding.

(D) Each manufacturer must supply to the Executive Officer a list of California specific SKU codes and non-California SKU codes with their application no later than three months after the effective date of this article or within three months of production, and within three months of any change in coding.

## 2.4 Education Requirement

(A) Each manufacturer seeking an Executive Order for small containers of refrigerant must develop educational materials suitable for use by ultimate purchasers of *automotive* refrigerant in small containers. The format and content of the educational materials must be approved by the Executive Officer and must include the following:

(1) Advice to identify and repair leaks in the MVAC system;

(2) Proper techniques to minimize can heel and servicing loss while transferring refrigerant from the container. to the MVAC system;

(3) Information on environmental hazards associated with refrigerant;

(4) Information on risks -and consequences of overcharging or undercharging the MVAC due to lack of professional diagnostic techniques.

(5) Components of the container deposit and return program.

(6) Web pages containing the information in items 1 through 5 *above* that are suitable for browsing by do-it-yourself consumers of *automotive* refrigerant in small containers

(7) Brochures containing the information in items 1 through 5 *above* that are suitable for distribution to do-it-yourself consumers of *automotive* refrigerant in small containers

(B) Any manufacturer who sells small containers of *automotive* refrigerant that are subject to Title 17, CCR section 95360 *et seq.* must make available to consumers an Internet web site containing the educational course materials described in 2.4 (A)(6) of these certification procedures.

(C). Any retailer who sells small containers of *automotive* refrigerant that are subject to Title 17, CCR section 95360 *et seq.* must display material as described in 2.4 (A)(7) of these certification procedures to customers.

(0) On or after January 1, 2010, any retailer selling small containers of *automotive* refrigerant must display a placard next to the display of small containers of *automotive* refrigerant. This placard must be at least 8 ½ inches by 11 inches and describe environmental hazards associated with

release of HFC-134a, references for proper recharge techniques, and a description of the deposit and recycle program. The language must be in English and Spanish and must be approved by ARB.

3. SUBMITTING AN APPLICATION

An applicant must submit the following information in an application for certification:

3.1 Model number(s), size(s), and SKU(s) of the small containers of automotive refrigerant for which certification is requested. The applicant must supply test data that demonstrates the small cans of automotive refrigerant comply with each of the requirements specified in Section 2.1 of these Procedures.

3.2 Engineering drawings of the small containers of automotive refrigerant that detail the dimensions specific to each component.

3.3 A sample of the small container of automotive refrigerant.

3.4 Test data from each of the test procedures specified in Section 2.1 of these procedures.

3.5 Any other test data that supports the requirements in 3.4 above and that would assist in the determination of certification.

3.6 The language and documentation required by Sections 2.2 through 2.4 of these procedures.

4. APPLICATION REVIEW

4.1 If an application for certification contains all of the information required by these procedures, it will be deemed to be complete, and will be processed for certification. The application will not be deemed complete unless an applicant has supplied all of the information required by section 3 of these procedures.

4.2 The Executive Officer may find it necessary to request additional information from the applicant in order to fully evaluate the application.

4.3 Applications will be processed in accordance with the procedures and time periods set forth in 17 CCR section 60030 *et seq.* The time periods may be extended by the Executive Officer for good cause.

4.4 An application must be signed by the applicant or their authorized delegate.

# Appendix C

# Test Procedure for Leaks from Small Containers of Automotive Refrigerant

# TP-503

**NOTE:** This is a new Certification Procedure. For clarity the proposed text is shown in normal type.

California Environmental Protection Agency

Air Resources Board

**Test Procedure for Leaks from**
**Small Containers of Automotive Refrigerant**

**TP-503**

Adoption Date: [To be determined]

# TABLE OF CONTENTS

# California Environmental Protection Agency
# Air Resources Board

## TP-503

## Test Procedure for Leaks from Small Containers of Automotive Refrigerant

The definitions in Section 95361 of Title 17, California Code of Regulations (CCR) apply to this test procedure.

In these procedures, the term "ARB" refers to the California Air Resources Board, and the term "Executive Officer" refers to the ARB Executive Officer or his or her authorized representative.

### 1. APPLICABILITY

This test procedure is used by manufacturers of small containers of automotive refrigerant and ARB to determine the leakage rate of small containers of automotive refrigerant that are subject to the requirements of Title 17,CCR section 95360 *et seq*. Specifically, this test procedure will specify the equipment, procedures, and calculations to determine if a small container of automotive refrigerant complies with the leakage rate specified in section 2.1 (B) of the Certification Procedures for Small Containers of Automotive Refrigerant, adopted [BARCU will insert].

**Requirement to Comply with All Other Applicable Codes and Regulations**

Approval of a small container of automotive refrigerant by the Executive Officer does not exempt the container from compliance or with other applicable codes and regulations such as local, State or federal safety codes and regulations.

**Safety**

This test procedure involves the use of materials under pressure, and operations and should only be used by or under the supervision of those familiar and experienced in the use of such materials and operations. Appropriate safety precautions should be observed at all times while performing this test procedure.

### 2. PRINCIPLE AND SUMMARY OF TEST PROCEDURE

This procedure is used to determine the leakage rate of small containers of automotive refrigerant (small cans). Testing will involve subjecting both full and partially empty cans in both upright and *inverted* positions at two temperatures: 73 of and 130 of.

Thirty cans are tested under each condition for a total of 240 cans tested. Cans are brought to temperature stability, weighed, then stored for 30 days under specified conditions of temperature, orientation, and state of fill, then re-weighed. Leakage rate (grams/year) is estimated by (weight loss in grams) *365/ (days duration). The leakage rate is then compared to a standard of 3 grams/year to determine if a *given* small can complies with the leakage rate specified in section 2.1 (8) of the Certification Procedures for Small Containers of Automotive Refrigerant, adopted

## 3. BIASES AND INTERFERENCES

3.1. Contaminants on the operator's hands can affect the weight of the can and the ability of the can to absorb moisture. To *avoid* contamination of the can, the balance operator should wear *gloves* while handling the small cans.

3.2. Weight determinations can be interfered with by moisture condensing on the can and by thermal currents generated by temperature differences between the can and the room temperature. The small cans cool during discharge and could cause condensation. For these reasons, cans must be equilibrated to balance room temperature for at least four hours before weighing.

3.3. Variations in the temperature, pressure, and humidity of the ambient air will cause variations in the buoyancy of the small can. These variations should typically be less than 25 mg for a small can. If the can is not leaking at all, then the uncorrected weight changes will be within the range of 0 +/- 25 mg, which is about ten percent of the 247 mg loss expected after thirty days for a can leaking at 3 g/yr. In that case buoyancy corrections can be omitted. If the absolute value of the uncorrected weight change exceeds 25 mg, then all calculations must be made using weights corrected for buoyancy based on the temperature, pressure, and humidity of the weighing room.

3.4. Some electronic balances are sensitive to the effects of small static charges. The small can should be placed directly on the balance pan, ensuring metal to metal contact. If the balance pan is not grounded, the can and balance pan should be statically discharged before weighing.

## 4. SENSITIVITY AND RANGE

The mass of a full can could range from roughly 50 to 1000 grams depending on the container capacity. A top loading balance, capable of a maximum weight measurement of not less than 1,000 grams and having a minimum readability of 0.001 gram, reproducibility and linearity of ± 0.002 grams, must be used to perform mass measurements (examples: Sartorius LA1200S, Mettler XS1 003S, etc).

## 5. EQUIPMENT

5.1. A top loading balance that meets the requirements of Section 4 above.

5.2. A NIST traceable working standard mass for balance calibration. A NIST traceable working standard mass for a balance linearity check. A reference mass to serve as a "blank" can.

5.3. A enclosure capable of controlling the internal air temperature from 73 OF +/- 5 OF and an enclosure capable of controlling the internal air temperature to 130 OF, +/- 5 OF.

5.4. A temperature instrument capable of measuring the internal temperature of the temperature conditioning enclosures and the balance room with a sensitivity of +/- 2 OF.

5.5. A barometric pressure instrument capable of measuring atmospheric pressure at the location of the balance to within +/- 0.02 inches of mercury.

5.6. A relative humidity measuring instrument capable of measuring the relative humidity (RH) at the location of the balance with a sensitivity of +/-2% RH.

5.7. A hose with appropriate fitting for dispensing refrigerant from the small can to a recovery machine.

5.a. A refrigerant recovery machine to collect the discharged refrigerant from cans being tested.

## 6. CALIBRATION PROCEDURES

Calibrations are applied to the balance and to the support equipment such as temperature, humidity, and pressure monitoring equipment. Procedures for calibration are not spelled out here. General calibration principals for the support equipment and the balance are described in Section 11, Quality Assurance / Quality Control. Detailed calibration procedures for measurement made using the balance are contained in Balance Protocol (BP-A1) "Balance Protocol for Gravimetric Determination of Sample Weights using a Precision Balance" adopted [BARCU will insert], which is incorporated by reference herein.

## 7. CAN PREPARATION

7.1. Receive a batch of 240 cans of one design to be tested. These may include several SKUs from different manufacturers if the container and valve combination are the same.

7.2. Clean cans with Alkanox solution or equivalent and dry with lint free towel.

7.3. Confirm that the sample 10 sticker on the can matches the sample 10 on the chain of custody forms.

7.4. Select a reference mass similar to the weight of a full can. If multiple sets of similar sized cans are being tested, only one reference mass is needed; it can be used with all sets. Store the reference mass in the balance area.

7.5. Discharge the contents of one half of the cans (120 cans) into the refrigerant recovery machine using normal DIY dispensing procedures until each small can is approximately half full.

7.6. Select a reference mass similar the weight the half full small can. If multiple sets of similar size cans are being tested, only one reference mass is needed; it can be used with all sets. Store the reference mass in the balance area.

## 8. CAN WEIGHING

Weighing cans on the balance is done in accordance with Balance Protocol (BP-A1) adopted **[BARCU will insert],** which is incorporated by reference herein. The Balance Protocol describes how to conduct weight determinations including appropriate calibration and QC data. This section, Can Weighing, describes the overall process, not the details of how to use the balance.

### Initial Weights

8.1. Put on gloves. Check the cans for contamination.

8.2. Place the 240 cans into a location where they can equilibrate to balance room temperature. Record the can test IDs and the equilibration start time on the Small Can Test Data Forms (Form TP-503-01) in sets of thirty, one form for each of the eight each test conditions.

8.3. Let cans equilibrate for at least four hours.

8.4. Weigh the set of 240 cans and the reference weights using the Balance Protocol (BP-A1) "Balance Protocol for Gravimetric Determination of Sample Weights using a Precision Balance" adopted [BARCU will insert], which is incorporated by reference herein, and log the results to the Balance Weighing Log Form (Form TP-503-02) attached to this test procedure.

8.5. Transfer data from the Balance Weighing Log Form to the Small Can Test Data Forms in sets of 30, one set for each of the eight conditions to be tested.

**Thirty-Day Soak**

8.6. Place each set of 30 cans into the appropriate orientation and temperature for soaking:

30 full cans - 73 of, upright

30 full cans - 73 of, inverted

30 full cans - 130 of, upright

30 full cans - 130 of, inverted

30 half-full cans - 73 of, upright

30 half-full cans - 73 of, inverted

30 half-full cans - 130 °F,upright

30 half-full cans - 130 of, inverted

8.7. Soak the cans for 30 days undisturbed.

**Final Weighing**

8.8. Place the 240 cans into a location where they can equilibrate to balance room temperature.

8.9. Let the cans equilibrate for at least four hours.

8.10. Weigh the set of 240 cans, the reference weights, and any additional sets of cans using the Balance Protocol (BP-A1) "Balance Protocol for Gravimetric Determination of Sample Weights using a Precision Balance" adopted [BARCU will insert], which is incorporated by reference herein.

8.11. Transfer data from the Balance Weighing Log Form to the corresponding Small Can Test Data Forms.

**Can Storage (only applicable to ARB)**

8.12. If the cans can pass the leak rate criteria, the cans may be recycled. (Return the cans to the place of purchase for recycling).

8.13. If the cans do not pass the leak rate criteria, then mark the set with the message "Hold until released by Enforcement Division". Transfer the entire set of cans to safe storage location.

## 9. CALCULATIONS

### Corrections for Buoyancy

The calculations in this section are described in terms of "weight." Mass is a property of the can, whereas weight is a force due to the effects of buoyancy and gravity. Procedures for correcting the effect of buoyancy are given in Attachment A of this procedure. Ignoring buoyancy, Le. using weight data uncorrected for buoyancy effects, is acceptable for a thirty day test if the absolute magnitude of the weight change is less than 25 mg. If the uncorrected weight change exceeds 25 mg for any can, then correct all can weights for buoyancy using the procedures in Attachment A before performing the calculations described below.

### Calculation of Leak Rate

The emission rate in grams/day for each can is calculated by subtracting the final weight from the initial weight and then dividing the weight difference by the time difference measured in days to the nearest hour (nearest 1/24 of a day). The emission rate in g/day is multiplied by 365 to determine emission rate in grams/yr. If the annual emission rate for any can exceeds the entire can contents, then the annual emission rate for that can is adjusted to equal the entire can contents/year (e.g., about 350 g/yrfor a 12 ounce can). The annual emission rate for the purpose of the test is calculated by averaging the 240 individual adjusted annual emission rates and rounding to 2 decimal places. The cans fail the test if the adjusted annual emission rate averaged over 240 cans is greater than 3.00 grams/yr. The calculations are described below.

Loss rate for each can

$$E_{i\,daily} = (W_{i\,final} - W_{i\,initial}) / (D_{i\,final} - D_{i\,initial}), \quad \text{grams/day}$$
$$E_{i\,annual} = 365 * E_{i\,daily} \quad \text{grams/year}$$
$$E_{i\,adjusted} = \text{Minimum of } (E_{i\,adjusted}, C_i/year) \quad \text{grams/yr}$$

Where,

$E_i$ = emission rate
$W_{i\,final}$ = weight of can $i$ after soaking (grams)
$W_{i\,initial}$ = weight of can I before soaking (grams)
$D_{i\,final}$ = date/time of final weight measurements (days)
$D_{i\,initial}$ = date/time of initial weight measurements (days)
$C_i$ = original factory mass of refrigerant in can $i$

Note Date/Times are measured in days. Microsoft Excel stores dates and times in days, and the calculations can be made directly in Excel. If calculations are made manually, calculate serial days to the nearest hour for each date and time as follows:

$D = Julday + Hour/24$

Where,

Julday = serial day of the year: Jan 1 = 1, Jan 31 = 31, Feb 1 = 32, etc.
Hour = hour of day using 24-hour clock, 0 to 23

Calculate the average loss rate for the 240 cans as follows:

$E_{mean}$ = [Sum(Eadjusted/), *i=1* to 240 ] /240

## 10. RECORDING AND REPORTING DATA

During can weighing, record the can weights and date/times on the Balance Weighing Log Form. After each weighing session, transfer the measured weights and date/times from the Balance Weighing Log Form to the Small Can Test Data Form.

At the end of the test, complete the calculations described in Section 9, Calculations, and record the results on the Small Can Test Data Forms.

At the end of the test, transmit a copy of the Small Can Test Data Forms to the Project Engineer.

## 11. QUALITY ASSURANCE / QUALITY CONTROL

11.1. All temperature, pressure, and humidity instruments should be calibrated at least annually against NIST traceable laboratory standards. The main purpose of the NIST traceable calibration is to establish the absolute accuracy of the device. The instruments should also be checked periodically such as weekly, monthly, or quarterly against intermediate standards or against independent instruments. For example, a thermocouple can be checked weekly against a wall thermometer. A barometer or pressure gauge can be checked weekly by adjusting to sea level and comparing with local airport data. The main purpose of the frequent checks is to verify that the device has not failed in some way. This is especially important for electronic devices such as a digital thermometer, but even a liquid filled thermometer can develop a problem such as a bubble.

11.2. The balance should be serviced and calibrated at least annually by an independent balance service company or agency using NIST traceable reference masses. Servicing verifies accuracy and linearity, and the maintenance performed helps ensure that a malfunction does not develop.

11.3. The balance must also be calibrated and its linearity checked with working standards before and after each weighing session, or before and after each group of 24 cans if more than 24 cans are weighed in a session. Procedures for calibrating and using the balance, as well as recording balance data, are described in the accompanying balance weighing protocol. These procedures include zero checks, calibration checks, and reference mass checks. Procedures for calculating quality control data from those checks are described in the balance protocol.

11.4. The small containers are cleaned then handled using gloves to prevent contamination. All equilibration and soaking must be done in a dust free area.

## Form TP-50a-01: Small Can Test Data Form

Enforcement Lot 10 | Full: ☐ Half full: ☐ | Upright: ☐ Inverted: ☐ | T=73 F: ☐ T= 130 F: ☐

| Date: | | Date: | | | | | Adjusted |
|---|---|---|---|---|---|---|---|
| Can 10 | Initial time (hour) | Initial weight (g) | Final Time (hour) | Final Weight (g) | Delta Days | Delta Weight (g) | Annual Rate (a!vr) |

Number of Samples:
Technician:

Average Loss Rate:
Standard Deviation:

Comments:

## Form TP-503-o2: Balance Data Log Form

| Rec# | Date | Time | Proj. | Prot. | Tech. | QC Code | Can Type | Can ID# | Recorded grams | Comment |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | |
| 2 | | | | | | | | | | |
| 3 | | | | | | | | | | |
| 4 | | | | | | | | | | |
| 5 | | | | | | | | | | |
| 6 | | | | | | | | | | |
| 7 | | | | | | | | | | |
| 8 | | | | | | | | | | |
| 9 | | | | | | | | | | |
| 10 | | | | | | | | | | |
| 11 | | | | | | | | | | |
| 12 | | | | | | | | | | |
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| 20 | | | | | | | | | | |
| 21 | | | | | | | | | | |
| 22 | | | | | | | | | | |
| 23 | | | | | | | | | | |
| 24 | | | | | | | | | | |
| 25 | | | | | | | | | | |

## Attachment A

## Compensation of Weight Data for Buoyancy and Gravity Effects

### Gravity

Variations in gravity are important only when weighing objects under different gravitational fields, Le. at different locations or at different heights. Since the balance procedures calibrate the balance against a known mass (the calibration "weight") at the same location where sample objects are weighed, there is no need to correct for location. Although both the sample and the calibration weight are used at the same location, there will be a difference in the height of the center of gravity of the sample object (small can) and the center of gravity of the reference mass (calibration weight). However, this difference in height is maintained during both the initial weights and final weights, affecting the initial and final weights by the same amount, and affecting the scale of the weight difference by only a few ppm. In any event, the magnitude of this correction is on the order of 0.3 ug per kg per mm of height difference. A difference on the order of 100 mm would thus yield a weight difference of about 0.03 mg, which is insignificant compared to our balance resolution which is 0.001 g or 1 mg.

Based on the discussion above, no corrections for gravity are necessary when determining weight changes in small cans.

### Buoyancy

Within a weighing session, the difference in density between the sample object and the calibration weight will cause the sample object weight value to differ from its mass value due to buoyancy. For a 1-liter object in air at 20°C and at 1 atm, the buoyant force is about 1.2 grams. The volume of a 1 kg object with a density of 8 g/cm3 (e.g. a calibration weight), is about 0.125 liters, and the buoyancy force is about 0.15 g. Variations in air density will affect both of these values in proportion. The net value being affected by variations in air density is thus on the order of 1.2 - 0.15 = 1.05 g. Air density can vary up or down by 2% or more due to variations in barometric pressure, temperature, and humidity. The buoyancy force will then vary up or down by 0.02 g, or 20 mg. This is significant compared to the weight change expected after one week for a can leaking at 3 grams per year, which is 57 mg.

Based on the discussion above, buoyancy corrections must be made.

### Variables measured or calculated:

$V_{can}$ = volume of can ($cm^3$). Estimate to within 10% by measuring the can dimensions or by water displacement. Error in the can volume will cause an error in the absolute amount of the buoyancy force, but will have only a small effect on the change in buoyancy force from day to day.

Wean = nominal weight of a can (g), used to calculate the nominal density of the can

Pean = nominal density of a small can (g/cm$^3$). The nominal values can be applied to corrections for all cans. It is not necessary to calculate a more exact density for each can. Calculate once for a full can and once for a half full can as follows:

$$Pean = Wean / V_{can}$$

T = Temperature in balance chamber (degrees Celsius)

RH = Relative humidity in balance chamber (expressed a number between 0 and 100)

$P_{baro}$ = Barometric pressure in balance chamber (millibar). Use actual pressure, NOT pressure adjusted to sea level.

Pair = density of air in the balance chamber (g/cm$^3$). Calculate using the following approximation

$$Pair = [0.348444*P_{baro} - (RH / 100)*(0.252*T - 2.0582)] / (T + 273.15)$$

Pref = the reference density of the calibration weight (g/cm3)' Should be 8.0 g/cm$^3$.

## Equation to correct for buoyancy

$$Wcorrected = Wreading * (1 - Pair / Pref) / (1 - Pair / Pean)$$

# Appendix D

## Balance Protocol for Gravimetric Determination of Sample Weights using a Precision Balance

BP-A1

California Environ-mental Protection Agency

# Air Resources Board

**Balance Protocol for Gravimetric Determination of Sample Weight Using a Precision Analytical Balance**

**BP-A1**

'NOTE: This is a new Test Protocol. For clarity the proposed text is shown in normal type.

Adoption Date: [To be determined]

# Table of Contents

## 1. SCOPE AND APPLICATION

This Protocol summarizes a set of procedures and tolerances for weighing objects in the range of 0 to 1000g with a resolution of 0.001 g. This protocol only addresses balance operations, it does not address project requirements for equilibration, sample hold time limits, sample collection etc.

## 2. SUMMARY OF METHOD

The balance is zeroed and calibrated using procedures defined herein. Object weight determinations are conducted along with control object weight determinations, zero checks, calibration checks, sensitivity checks, and replicate weightings in a defined sequence designed to control and quantitatively characterize precision and accuracy.

## 3. DEFINITIONS

N/A.

## 4. INTERFERENCES

Object weights can be affected by temperature and relative humidity of their environment, air currents, static electricity, gain and loss of water vapor, gain or loss of and loss of volatile compounds directly from the sample or from contaminants such as finger prints, marker ink, and adhesive tape.

Contamination, transfer of material to or from the samples, is controlled by conducting operations inside a clean area dedicated to the purpose and having a filtered laminar air flow where possible; by wearing gloves while handling all samples and related balance equipment; by using forceps to handle small objects, and by keeping the balance and all related equipment inside the clean area.

Air currents are controlled by conducting weighing operations inside a closed chamber or glove box and by allowing the substrates to reach temperature and relative humidity equilibrium. The chamber is maintained at 40% relative humidity and 25°C by a continuous humidity and temperature control system. The temperature and RH conditions are recorded at least once per weighing sessions. Equilibration times for samples that are particularly sensitive to humidity or to loss of semi-volatiles species are specified by project requirements.

Static electric charges on the walls of the balance and the weighed objects, including samples, controls, and calibration weights, can significantly affect balance readings. Static is avoided by the operator ground himself and test objects as described in the balance manual.

## 5. PERSONNEL HEALTH AND SAFETY

N/A

## 6. EQUIPMENT AND SUPPLIES

- Filtered, temperature and humidity controlled weighing chamber.
- Precision Balance
- Plastic forceps
- Nylon fabric gloves.
- Working calibration weights: ANSI Class 2, 1000g and 500 g
- Working sensitivity weight: 50 mg
- Reference objects: references are one or more objects that are typical of the objects to be weighed during a project, but that are stored permanently inside the balance glove box. Reference objects are labeled Test1, Test2, Test3, etc.

## 7. REAGENTS AND **STANDARDS**

N/A

## 8. SAMPLE COLLECTION, PRESERVATION, AND STORAGE

N/A. See relevant project requirements and SOPs.

## 9. QUALITY CONTROL

Data quality is controlled by specifying frequencies and tolerances for Zero, Calibration, Linearity, and Sensitivity checks. If checks do not meet tolerance criteria, then samples must be re-weighed. In addition, the procedures specify frequencies for Control Object Checks.

Data quality is quantitatively characterized using Zero Check, Calibration Check, and Control Check data. These data are summarized monthly in statistics and QC charts.

See Section 11 for procedures, frequencies, and tolerances.

## 10. CALIBRATION AND STANDARDIZATION

The absolute accuracy of the balance is established by calibration against an ANSI Class 2, stainless steel working weight: 1000.000 g +/- 0.0025 g. Linearity is established checking the midpoint against an ANSI Class 2 stainless steel working weight: 500.000 +/- 0.0012 g. Sensitivity is established using and ANSI Class 2 stainless steel or aluminum working weight: 50 mg. Precision is checked by periodically checking zero, calibration, and reference object weights.

See Section 11 for procedure.

## 11. PROCEDURE

### 11.1 Overview of Weighing Sequence

Weighing a series of substrates consists of performing the following procedures in sequence, while observing the procedures for handling and the procedures for reading the balance:

1. Initial Adjustment
2. Weigh 8 samples
3. Zero Check
4. Weigh 8 samples
5. Zero Check
6. Weigh 8 samples
7. Calibration Check
8. Return to step 2.
9. If less than 24 cans are weighed, perform a final Calibration Check at the end of weighing.

This sequence is interrupted and samples are reweighed if QC check tolerances are not met. Each of these procedures along with procedures for handling and reading the balance are described below. The QC tolerances referred to in these procedures are listed in Table 1. The QC codes described in these procedures are summarized in Table 2. The data are recorded in the Precision Balance Data Log, a sample is shown in Table 3.

### 11.2 Handling

1. Never touch samples, weights, balance pans, etc. with bare hands. Wear powder free gloves to handle the weights, controls, and samples.

### 11.3 Reading the Balance

1. Close the door. Wait for the balance stabilization light to come on, and' note the reading.

2. Watch the balance reading for 30 sec (use a clock). If the reading has not changed by more than 0.001 g from the reading noted in step 1, then record the reading observed at the end of the 30 sec period.
3. If the reading has drifted more than 0.001 g note the new balance reading and go to step 2.
4. If the balance reading is flickering back and forth between two consecutive values choose the value that is displayed more often than the other.
5. If the balance reading is flickering equally back and forth between two consecutive values choose the higher value.

### 11.4 Initial Adjustment

1. Empty the sample pan Close the door. Select Range 1000 g
2. Wait for a stable reading
3. Record the reading with QC code IZC (initial zero check)
4. Press the Tare button
5. Record the reading in the logbook with QC code IZA (initial zero adjust)
6. Place the 1000 g working calibration weight on the balance pan
7. Wait for a stable reading.
8. Record the reading with QC code ICC (initial cal check)
9. Press the Calibrate button
10. Record the reading withQC code ICA (initial cal adjust)
11. Remove the calibration weight.
12. Wait for a stable reading.
13. Record the reading with QC code IZC.
14. If the zero reading exceeds +/- 0.002 g, go to step 4.
15. Place the 500 g calibration weight on the balance pan
16. After a stable reading, record the reading with QC code C500. Do not adjust the balance.
17. Add the 0.050 g weight to 500 g weight on the balance pan.
18. After a stable reading, record the reading with QC code CO.05. Do not adjust the balance.
19. Weigh reference object TEST1, record reading with QC code T1.
20. Weigh the reference object TEST2, TEST3, etc. that is similar in weight to the samples that you will be weighing. Record with QC code T2, T3, etc.

### 11.5 Zero Check

1. Empty the sample pan. Close the door.
2. Wait for a stable reading
3. Record the reading with QC code ZC

4. If the ZC reading is less than or equal to the zero adjustment tolerance shown in Table 1, return to weighing and do not adjust the zero.

   If the ZC reading exceeded the zero adjustment tolerance, proceed with steps 5 through 7.
5. Press the Tare button
6. Record the reading in the logbook with QC code ZA.
7. If the ZC reading exceeded the zero re-weigh tolerance, change the QC code recorded in step 3 from ZC to FZC. Then enter a QC code of FZ into the QC code column of all samples weights obtained after the last valid zero check. Re-weigh all of those samples, recording new data in new rows of the logbook.

## 11.6 Calibration Check

1. First, follow procedures for Zero Check. If the ZC was within tolerance, tare the balance anyway (Le. follow steps 5 and 6 of the Zero Check method)
2. Place the 1000 g working calibration weight on the sample pan, wait for a stable reading.
3. Record the reading with QC code C1 000
4. If the C1000 reading is less than or equal to the calibration adjustment tolerances, skip steps 5 through 8 and proceed to step 9. Do not adjust the calibration.
5. If the C100 reading exceeded the calibration adjust tolerance, press the Calibrate button.
6. Record the reading in the logbook with QC code CA
7. Perform a Zero Check (follow the Zero Check method)
8. If the C1 000 reading exceeded the calibration re-weigh tolerance, change the code recorded in step 3 from C1 000 to FC1000. Enter FC into the QC column for all sample weights obtained after the last valid calibration check. Re-weigh all of those samples, recording new data in new rows of the logbook.

## 11.7 Replicate Weighing Check

1. This protocol does not include reweigh samples to obtain replicates. The projects for which this protocol is intended already include procedures multiple weightings of each sample.

**Table 1. QC Tolerances and Frequencies for Balance Protocol A1**

**Reading tolerance:**

0.001 g, stable for 30 sec

**Adjustment Tolerances:**

| | | |
|---|---|---|
| Zero: | - 0.003 to | +0.003 g. |
| Calibration: | 999.997 to | 1000.003 9 |
| Controls: | none | |
| Replicates: | none | |

**Re-weigh Tolerances:**

| | | |
|---|---|---|
| Zero: | - 0.005 to | +0.005 g. |
| Calibration: | 999.995 to | 1000.005 9 |
| Controls: | none | |
| Replicates: | none | |

**Reference Objects:**

Test 1 - A reference object weighing about 400 9
Test 2 - A refernce object weighing about 200 9
Test 3 - A reference object weighin about 700 g.

**QC Frequencies:**

| | |
|---|---|
| Zero Checks: | once per 8 samples |
| Calibration Checks: | once per 24 samples |
| Repeat weighings: | none (test method includes replicate determinations) |
| Control objects: | once per weighing session |

**Table 2. QC Codes For Balance Protocol A1**

| | |
|---|---|
| IZG | Initial Zero Check |
| IZA | Initial Zero Adjust |
| ICC | Initial Calibration Check |
| ICA | Initial Calibration Adjust |
| ZC | Zero Check |
| ZA | Zero Adjust |
| CC | Calibration Check |
| CA | Calibration Adjust |
| R | Replicate Filter Weighing |
| FZ | Sample Failed Zero Check |
| FC | Sample Failed Calibration Check |
| T1 | Test Object 1: empty can of automotive refrigerant |
| T2 | Test Object 2: |
| T3 | Test Object 3: |

## 12. DATA ANALYSIS AND CALCULATIONS

For Zero Checks, let Z equal the recorded Zero Check value. For control checks let T1 , T2, etc. equal the recorded value for control object Test 1, Test 2, etc. For Calibration Checks, let C1000 equal C1000 reading minus 1000, M= C500 - 500, S = .C.050 - . C500 - .050. For Replicate Checks, let D equal the loss that occurred between the first and second measurements. In summary:

T1 = T1
T2= T2
T3= T3
Z = ZC - 0
C = C1000 - 1000
M = C500-500
G = C.050 - C500 - .050

Tabulate the mean and standard deviation for each of the following: Z, C, M, G. T1, T2, T3. Depending on the number of operators using the balance and the number of protocols in use, analyze the data by subcategories to determine the effects of balance operator and protocol. Each of these standard deviations, Sz, Sc, etc. is an estimate of the precision of single weight measurement. .

For Z, C, M, and G, check the mean value for statistical difference from 0. If the means are statistically different than zero, troubleshooting to eliminate bias may be called for. For Z, C, M, G, T1, T2, T3, check that the standard deviations are all comparable. If there are systematic differences, then troubleshooting to eliminate the problem may be called for.

Note that the precision of a weight *gain,* involves two weight determinations, and therefore is larger than S by a factor of sqrt(2). On the other hand replicates weighings improves the precision of the determinations by a factor of sqrt(N). If N= 2, Le. duplicates, then the factors cancel each other.

To estimate the overall uncertainty in a weight determination, a conservative estimate might be to combine the imprecision contributed by the zero with the imprecision contributed by the calibration.

$$U. = \mathrm{sqrt}( S_Z^2 + Sc^2 )$$

The uncertainty in a weight *gain* from N replicates is then given by:

$$U_{gain.} = \mathrm{sqrt}(2) * \mathrm{sqrt}( S_Z^2 + Sc^2 ) / \mathrm{Sqrt}(N)$$

But due to the balance adjustment and reweigh tolerances, we expect Sz to approximately equal Sc, to approximately equal SM, etc. tolerances, so that the equation above becomes:

$$U_{gain.} = 2 * S / \mathrm{Sqrt}(N)$$

Where S is any individual standard deviation; or better, a pooled standard deviation.

## 13. METHOD PERFORMANCE

The data necessary to characterize the accuracy and precision of this method are still being collected. The method is used primarily to weigh objects before and after a period of soaking to determine weight loss by subtraction. Given the reweigh tolerances, we expect the that the precision of weight gain determinations will be on the order of 0.006 g at the 1-sigma level. Bias in the weight gain determination, due to inaccuracy of the calibration weight and to fixed non-linearity of the balance response is on the order 0.005% of the gain.

## 14. POLLUTION PREVENTION

When discharging half the can contents during can preparation, do not vent the contents to f the small can to the atmosphere. Use an automotive recovery machine to transfer small can contest to a recovery cylinder.

## 15. WASTE MANAGEMENT

Return full and half full cans to the place of purchase for a refund of the purchase deposit. Dispose of the contents of the recycle cylinder through a service that consolidates waste for shipment to EPA certified facilities for reclaiming or destruction.

## 16. REFERENCES

Precision Balance Instruction Manual. Company, City, State

## Table 3. Precision Balance Data Log

| Rec# | Date | Time | Proj. | Prot. | Tech. | QC Code | Can Type | Can ID# | Recorded grams | Comment |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | |
| 2 | | | | | | | | | | |
| 3 | | | | | | | | | | |
| 4 | | | | | | | | | | |
| 5 | | | | | | | | | | |
| 6 | | | | | | | | | | |
| 7 | | | | | | | | | | |
| 8 | | | | | | | | | | |
| 9 | | | | | | | | | | |
| 10 | | | | | | | | | | |
| 11 | | | | | | | | | | |
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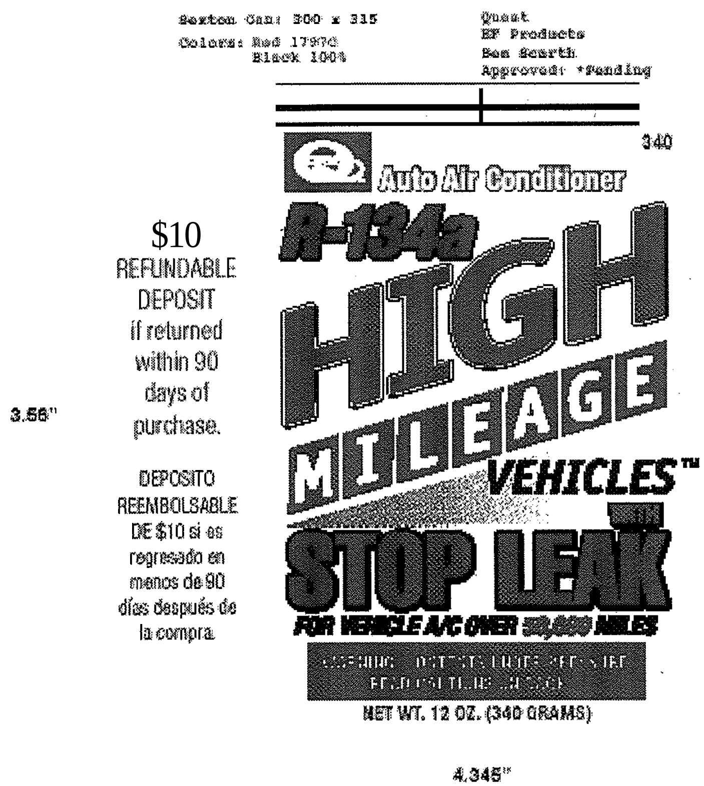
# Appendix E

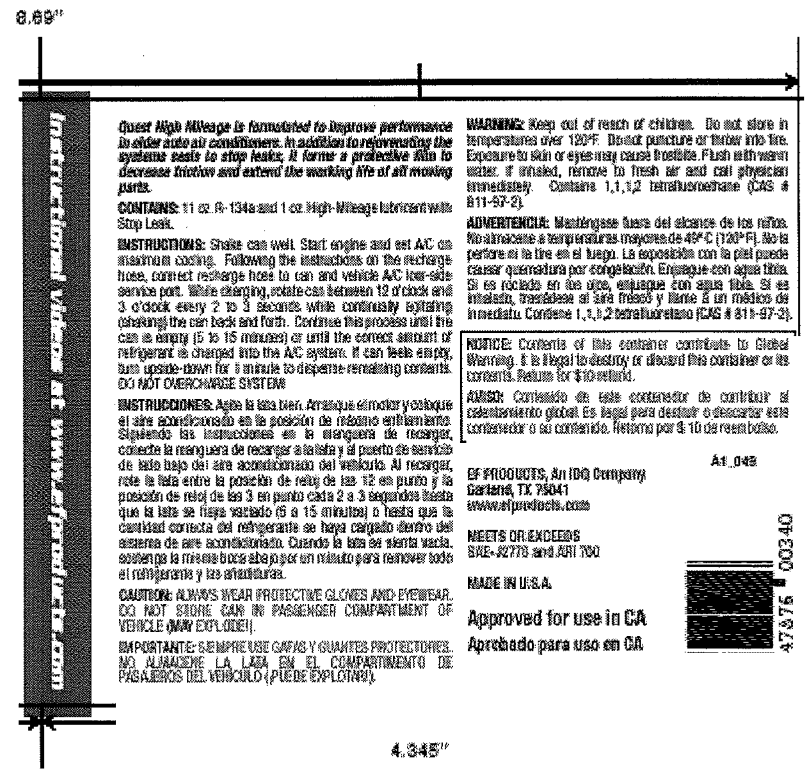
## Examples of Labeling and Education Materials

# 1. Example of a New Label on Small Container

EF Products SKU # 340: Quest 134a High Mileage Refrigerant w/Stop Leak

(not printed to correct dimensional scale)




BACK PANEL COPY:
Header (Description) -
Font Face: Helvetica Neue LT 57 Condensed
Font Face Style(s): Bold Oblique
Font Size: 6.5 point (at 90% width, 100% height)

BACK PANEL COPY:
Instructions -
Font Face: Helvetica Neue LT 57 Condensed
Font Face Style(s): Regular, Bold
Font Size: 6.5 point (at 90% width, 100% height)

## 2. Example of Educational Brochure Content

*Side 1/ Left Panel (folds inside)*

Be AWARE... < Stylized / icicles >
and...
Follow these simple steps:

The State of California has determined that R-134a, the refrigerant used in your car's A/C system, causes Global Warming.

Effective January 1, 2010, California law requires all purchasers of small containers of refrigerant marked for deposit and return to pay a $10.00 per container deposit at time of retail purchase and **return all purchased, used containers for recycling within 90 days** to the retailer where purchased for a $10.00 per container refund with valid proof of purchase.

It is illegal to destroy or discard used or unused small refrigerant containers under Section 95360 of the California Code of Regulations.

*A/C Recharging is fast & easy!*
*Helpful tips while recharging:*

- **Check for and repair leaks before recharging.**
- **Using a gauge ensures proper fill levels**
- **Don't overfill/overcharge the system...too much refrigerant can damage your A/C system**
- **Check vent temperatures while charging. Cooler air should result as you're adding refrigerant.**
- **If you have added a can of refrigerant and are not getting cooler air...STOP...see a professional! You may have leaks requiring repairs to the system.**

*Side 1/Center Panel (outside back cover)*

Be COOL.. < Stylized / icicles >
but...
**Be RESPONSIBLE!**

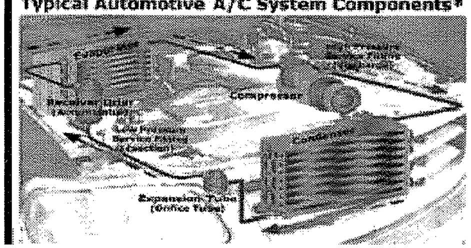
DID YOU KNOW?

- **Not long ago, R-134a was designated as a greenhouse gas, meaning it contributes to global warming if released to the atmosphere.**

YOU SHOULD KNOW...

- **The mobile *Ale* industry is working on long-term replacements for R-134a.** Until then, we join the State of California in the following measures to ensure proper, responsible use:
  - Effective January 1, 2010, on appropriately marked containers an instant $10 California deposit and return program will begin.
  - Returned, used containers will be recycled to recover remaining refrigerant.
  - In California, it is illega1to destroy or discard used refrigerant cans or their contents.
  - A new, self sealing valve on cans of R-134a will help you avoid accidental discharges of this global warming gas.
  - Better product instructions and education resources will help you do the job properly.
  - An informational website is available for you at www.staycoolcalifornia.com.

**Typical Automotive A/C System Components***




*Side 1/Right Panel (outside front cover)*

< Background graphic: Green fields / open road >

The Do-it-Yourself Guide to
Proper *Ale* System Recharging

| *Side 2 / Left Panel (inside left)* | *Side 2 / Center Panel (inside center)* | *Side 2 / Right Panel (outside right)* |
|---|---|---|
| *DO-IT-YOURSELF* | *STEP-BY-STEP GUIDE FOR A/C RECHARGE* | *DO-IT-RIGHT* |

1. **ALWAYS WEAR INSULATED GLOVES & SAFETY GLASSES.**
2. **IF SYSTEM REQUIRES RECHARGE MORE THAN ONCE A YEAR,** diagnose and repair leaks before adding refrigerant.
3. **READ THE LABEL** and prepare by understanding the instructions.
4. **PREPARE YOUR TOOLS,** as specified on the product label. Lay out the proper charging hose, gauge, safety gear and hand tools in an accessible place.
5. **IF NOT PREASSEMBLED, ATTACH CHARGING HOSE TO REFRIGERANT CAN,** following hose or can instructions.
6. **LOCATE A/C SYSTEM NAMEPLATE** in the engine compartment. **NOTE THE COMPLETE SYSTEM CHARGE** VOLUME. For optimal cooling, NEVER EXCEED MAX CHARGE.
7. **LOCATE YOUR VEHICLE'S LOW SIDE A/C SERVICE PORT** and remove the blue or black protective cap. It's a "SNAP"; the charging hose will only fit on the low-side port.

8. **START THE ENGINE,** turn on the A/C to maximum cooling, the fan switch to high and the temperature dial to full blue. Set the engine to approximately 1500 RPM.
9. **ATTACH QUICK CONNECTOR TO LOW-SIDE PORT** by pulling back connecting ring or snapping into place. Check to assure it is securely locked.
10. **DIAGNOSE A/C SYSTEM BEFORE ADDING REFRIGERANT** using a charging hose with a gauge, an electronic meter or manifold gauge set. Compare gauge reading to the chart below. If pressure reading is below chart range, you may add refrigerant.

    **NOTE:** Pressure can only be taken when compressor is running. Determine by looking at the center of compressor pulley:
    - If rotating, it's on.
    - If it will not engage, add a can of R-134a.
    - If compressor still won't cycle on, seek professional service advice.

**Air Conditioner needs to be set on MAX COOL and compressor must be engaged (cycled on - clutch turning) in order to take an accurate pressure reading with the gauge.**

11. **ADD REFRIGERANT** by opening dispensing valve or pulling the trigger, as shown in the charging device's instructions.
12. **WHILE CHARGING, HOLD CAN UPRIGHT, AGITATING FREQUENTLY USING A "12 O'CLOCK TO 3 O'CLOCK MOTION".** It takes 5 to 15 minutes to dispense a can of refrigerant. Check pressure gauge every minute, per instructions. Agitate the can!
13. **REPEAT STEPS 11 & 12 AS NEEDED,** until correct pressure is reached or can is empty. **NOTE:** When can feels empty, turn upside down for 1-minute to remove entire contents.
14. **A PROPERLY CHARGED A/C SYSTEM** will not only read at the correct gauge pressure but air exiting all interior vents should be the same approximate cooled temperature. For optimal cooling, DO NOT OVERCHARGE!

**Ambient temperature** refers to the outside air temperature surrounding the vehicle. The chart shows the desired range for the low-pressure side of the A/C system at each 5° increment. If the pressure is outside of the range (over or under), service may be required.

| If Ambient Temperature is: (Temperatura de Ambiente) | Low Side Gauge Should Read: (Manometro de Lado Inferior) |
|---|---|
| 65°F (18°C) | 25-35 psi (172-241 kPa) |
| 70°F (21°C) | 35-40 psi (241-276 kPa) |
| 75°F (24°C) | 35-45 psi (241-310 kPa) |
| 80°F (27°C) | 40-50 psi (276-345 kPa) |
| 85°F (29°C) | 45-55 psi (310-379 kPa) |
| 90°F (32°C) | 45-55 psi (310-379 kPa) |
| 95°F (35°C) | 50-55 psi (345-379 kPa) |
| 100°F (38°C) | 50-55 psi (345-379 kPa) |
| 105°F (41°C) | 50-55 psi (345-379 kPa) |
| 110°F (43°C) | 50-55 psi (345-379 kPa) |

15. **REMOVE QUICK CONNECT FROM LOW-SIDE PORT** by pulling connector ring back and straight up from service port. Replace protective cap on Low-Side Port.
16. **REMOVE EMPTY CAN FROM CHARGING HOSE** unless permanently attached.
17. **RETURN ALL USED CONTAINERS TO THE PLACE OF PURCHASE FOR RECYCLING & REFUND OF YOUR DEPOSIT** •

## 3. Example of Information Placard

# NOTICE

Contents of this container, R-134a, contribute to Global Warming.

It is your responsibility to understand proper re-charging techniques before servicing your vehicle's air conditioner. Resources available to you include:

- Product Label Instructions
- Your Store Sales Associate
- liThe Do-it-Yourself Guide to Proper *Ale* System Recharging" brochure
- On the Web: www.staycoolcalifornia.com

Effective January 1, 2010, California law requires all purchasers of small containers of refrigerant marked for deposit and return to pay a $10.00 per container deposit at time of retail purchase and **return all purchased, used containers for recycling within 90 days** to the retailer where purchased for a $10.00 per container refund with valid proof of purchase.

It is illegal to destroy or discard used or unused small refrigerant containers under Section 95360 of the California Code of Regulations.

# NOTICIA (en Espanal)

# Appendix F

# Reporting Forms

# AppendixFl

# Manufacturers Application

Submit by Email Print Form

California Environmental Protection Agency
AIR RESOURCES BOAR

# Application Form for the Sale and Certification of Manufacturers of Small Containers of Automotive Refrigerant in California

**Mail or E-mail Completed Application to:**

California Air Resources Board
Research Division
ATTN: Winston Potts - Application Review Coordinator
1001 I street
Sacramento, CA 95812
Phone 916-323-2537

**Pre-Application Meeting:** 0 I request a pre-application meeting. Please complete the section below and return this form to the email or address shown above.

**Application:** O Please complete all sections of the form below and return this form to the email or address shown above.

## Company Information

Date:

| | |
|---|---|
| Company Name | |
| Company Mailing Address | |
| Company Web Site | |
| Company Contact Person and Title | |
| Phone No., FAX No., and E-mail | |
| Preparer Name | |
| Preparer Address | |
| Prepare Phone and E-mail | |

## Instructions for Completion of This Applications:

An applicant must submit the following information in an application for certification:

1. Model number(s), size(s), and SKU(s) of the small containers of automotive refrigerant for which certification is requested. Please give this information in the space allotted below.

2. The applicant must supply test data that demonstrates the small cans of automotive refrigerant comply with each of the requirements specified in Section 2.1 of the Certification Procedures.

3. Engineering drawings of the small containers of automotive refrigerant that detail the dimensions specific to each component.

4. A sample of the small container of automotive refrigerant.

5. Test data from each of the test procedures specified in Section 2.1 of the Certification Procedures.

6. Any other test data that supports the requirements in section 3.4 of the Certification Procedures and that would assist in the determination of certification.

7. The language and documentation required by Sections 2.2 through 2.4 of the Certification Procedures.

8. Each manufacturer seeking an Executive Order for small containers of refrigerant must identify and register with ARB each facility that will be used to recover refrigerant from a small container. Registration includes providing location, contact information, a description of recovery equipment including operating parameters such as vacuum to be used and operational capacity, and description of any processing and ultimate fate of the recovered refrigerant. Any recovery facility must use best operating procedures to minimize leakage of refrigerant to the atmosphere.

Accept for part 1 above, all of the other sections must be prepared by the manufacturer and submitted with the application. The complete package can be sent by E-mail or conventional mail.

### Product Identification Information

| | |
|---|---|
| Model Number | |
| Size of Can | |
| SKUs | |
| Model Number | |
| Size of Can | |
| SKUs | |

# Certification

Company Name:

I, I ], hereby certify that the information and data submitted in this application are true and as accurate as possible, to the best of my knowledge, professional expertise, and experience.

Signature Date

Printed Name Title

# Appendix F2

# Application Recycler

Submit by Email Print Form

California Environmental Protection Agency

AIR RESOURCES BOARD

# Application Form for Registration of a Facility to Recover, Reclaim,or Recycle Refrigerant from a Small Container

**Mail or E-Mail Completed Application to:**

California Air Resources Board
Research Division
ATIN: Winston Potts - Application ReView Coordinator
1001 I Street
Sacramento, CA 95812
Phone 916-323-2537

**Pre-Application Meeting:** 0 I request a pre-application meeting. Please complete the section below and return this form to the email or address shown above.

**Application:** O Please complete all sections of the form below and return this form to the email or address shown above.

## Company Information

Date:

Company Name

Company Mailing Address

Company Web Site

Company Contact Person and Title

Phone No., FAX No., and E-mail

Preparer Name

Preparer Address

Prepare Phone and E-mail

# Instructions for Completion of This Applications:

## Information:

The following definitions have been added to this document to help the applicant in completing the form.

"Recover" means to remove refrigerant, in any condition, from a system without necessarily testing or processing it in any way.
"Recycle" means to clean refrigerant for reuse by oil separation and by single or multiple passes through moisture-absorption devices, such as replaceable core filter-driers that reduce moisture, acidity, and particulate matter.
"Reclaim" means to process refrigerant to a level equivalent to new product specifications in accordance with the ARI 700 Standard ("Specifications for Fluorocarbon Refrigerants", Air-conditioning & Refrigeration Institute, Arlington, VA, 2006).

An applicant must submit the following information in an application for Registration

### Facility Information

Part 1. Facility Contact Information

Facility Name

Facility Location

Facility Address

Contact Person

Contact Information

Part 2. Facility Description

a. Please describe all recovery equipment that will be used to recover, reclaim, recycle, or dispose of refrigerant. Include all operating parameters, such as vacuum to be used. Any facility must use best operating proceduresto minimize leakage of refrigerant to the atmosphere.

b. Specify the operating capacity of the facility for all aspects of the recovery operation.

c. The ultimate fate of the refrigerant should be described for each specific operation of the facility.

# Certification

Company Name:

I, ____________________, hereby certify that the information and data submitted in this application are true and as accurate as possible, to the best of my knowledge, professional expertise, and

Signature

Date

Printed Name

Title

# Appendix F3

# Small Containers of Automotive Refrigerant Reporting Forms

Submit by Email | Print Form

California Environmental Protection Agency
# AIR RIESOURCES BOAR.D

## Reporting of Sales and Recycling of Small Containers of Automotive Refrigerant

**Mail or E-mail Completed Form to:**

California Air Resources Board
Research Division
AnN: Winston Potts - Report Coordinator
1001 I Street
Sacramento, CA 95812
Phone 916-323-2537

**Reporting Period** October 1, to September 30, 1 :1

Due: December 1 , 1

**Instructions**
**Retailers: Please fill in sections A, 81, 82, and G**
**Distributors: Please fill in Sections A, C, and G**
**Manufacturers: Please fill in Sections A, D, E, and G**
**Recyclers: Please fill in Sections A, E, F, and G**
**Note: Please print out extra pages if necessary!**

**Section A: Information and Identification of Retailer, Distributor, Manufacturer, Recycler, or Other**

Please identify your type of facility

O Retailer O Distributor O Manufacturer O Recycler O Other

Company Name

Mailing Address

Street Address

Contact Person

Contact Telephone

**Section 81: Sales Data for Retailers**

Sales by Manufacturer or Distributor: Please Insert Monthly Can Amounts

| Manufacturer or Distributer | SKU | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
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## Section 82: Return Data for Retailers

Return Data by Manufacturer or Distributor: Please Insert Monthly Can Amounts

| Manufacturer or Distributer | SKU | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
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## Section C: Sales Data for Distributors

### Sales Data for Distributor: Please Insert Monthly Can Amounts

| Retailer | SKU | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

## Section D: Sales Data for Manufacturers

### Manufacturer Sales: Please Insert Monthly Can Amounts

| Retailer or Distributer | SKU | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

## Section E: Return Data for Manufacturers

Manufacturer or Recycler Returns: Please Insert Monthly Can Amounts

| Distributer | Retailer | SKU | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
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## Section F: Recovery Data for Recyclers

Recycler Amounts Recovered, Recycled, Reclaimed, and Disposed: Please Insert Monthly Mass Amounts

| Manufacturer | SKU | Operation Performed | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Recovered** | | | | | | | | | | | | |
| | | **Recycled** | | | | | | | | | | | | |
| | | **Reclaimed** | | | | | | | | | | | | |
| | | Disposed | | | | | | | | | | | | |
| | | Totals | | | | | | | | | | | | |

**Section G: Authorization - THIS SECTION TO BE COMPLETED BY PERSON AUTHORIZED TO PREPARE REPORT.**

Certification:
I certify to the best of my knowledge that the submitted information is true, accurate, and complete

Print/Type Name    Title

Signature    Date

# Appendix G

## Technical Support Document

## Staff Analysis on Emissions and Economic Impact of Proposed Regulation for Small Containers of Automotive Refrigerant

Table of Contents

## List of Tables



## List of Figures

# Staff Analysis on Emissions and Economic Impact of Proposed Regulation for Small Containers of Automotive Refrigerant

## 1. INTRODUCTION

As required by AB 32, the California Air Resources Bo'ard (the ARB, the Board) has developed a list of early action measures (ARB, 2007a). Six of these early action measures are related to Motor Vehicle Air Conditioning (MVAC). According to the U.S. EPA Vintaging Model, MVAC systems are the dominant user of HFC-134a (Thundiyil, 2005). One of the early action measures, reduction of HFC-134a emissions from do-it-yourself (DIY) servicing of MVAC systems, has been identified as a Discrete Early Action. DIY servicing involves recharging the AC system using small containers (small cans) of refrigerant typically containing about 12 ounces of refrigerant in weight, but ranging from 2 ounces to 2 pounds in weight. The initial proposal contemplated a ban on the sale and use of small cans. A small can industry association, Automotive Refrigeration Products Association (ARPI), proposed an alternative plan that they claim would achieve similar emission reductions at lower cost. Their proposal included self-sealing valve installed on the can, charging a refundable deposit upon sales of the cans, and setting up a can return and recycling program. Concerns about a ban were also expressed by the AB 32 Environmental Justice Advisory Committee (EJAC). The EJAC recommended removing the proposed can ban measure from the Early Action list because the committee believed that the measure seemed unlikely to achieve the goal of detection and repair of leaking auto air conditioning systems, and because it would place a large burden on low-income people (EJAC, 2007).

ARB staff explored the impact of adding firm recycling rate targets and a DIY education program to the industry proposal, and is proposing this approach as the Discrete Early Action. This document compares emission reductions and costs associated with the staff proposal and the alternative proposal of can ban. The reductions in emissions are calculated in terms of changes from business-as-usual (BAU). The following discussions will first provide an overview of the method to calculate emissions and costs, key data, key assumptions, and results. It will be followed by the details of the assumptions and calculation.

# 2. METHODS

## 2.1 Business-as-usual (BAU)

### 2.1.1 Practices

DIY practice involves puncturing a one-way can of refrigerant with a low cost apparatus consisting of a valve and hose, connecting the apparatus to the low pressure (suction) side of the AC system, and transferring refrigerant from one or more small cans to the AC system over the course of many minutes. There are two immediate sources of emissions resulting from this process. First, some refrigerant escapes from the can and apparatus during the servicing process, which is called servicing losses. Second, some of the refrigerant typically remains in the small can after the refilling process has been completed. This remainder is called the can heel. Because most cans do not include a means to close themselves, the entire can heel is emitted to the atmosphere shortly after the can is disconnected from the recharge apparatus.

In addition to the immediate emissions there are also delayed emissions that can be associated with DIY practice. The AC system that receives charge from the DIY small can has leaked, hence the need for recharge. Not all DIY service operations are necessarily on systems that leak more than properly functioning systems, but some DIY operators recharge their systems every few months. The information needed to determine the distribution of leak rates from DIY vehicles is not readily available. But because in most instances the DIY operator is not repairing the AC system, but simply re-filling the leaking system, the leak rate is very likely to be higher than properly repaired systems. The U.S. EPA Vintaging Model assumes that a properly functioning system should only need to be recharged after about 6 years (Thundiyil, 2008a). The difference in leak rates between DIY serviced and professionally serviced systems is an emission that can be attributed to DIY practice. Professional service technicians are required to fully diagnose the AC system before repairing or recharging it. A large fraction of customers choose to make repairs, even though some choose to simply recharge or top off, and some choose to reject repairs and forgo air conditioning (see 4.5.3).

### 2.1.2 Emissions

ARB's Survey of Consumer Products for 2006 estimates that California sales of HFC-134a in small containers are 654 metric tons in about 2 million cans (ARB, 2007b). Using a global warming potential (GWP) of 1300 for HFC-134a (IPCC, 2007), the annual sales correspond to 0.85 million metric ton $CO_2$ equivalent ($MMTC0_2E$) per year. Based on information from a MVAC trade association (Atkinson, 2008a; MACS, 2008), it is estimated that only 5% of small cans sales, or 0.04 $MMTC0_2E$ per year of HFC-134a, are made to automotive repair shops, suggesting that 95%, or 0.81 $MMTC0_2E$ per year of HFC-134a are used by DIY.

This analysis only considers small can operations performed by individual consumers as DIY emissions. We do not include emissions associated with small can use by professionals, nor do we include reductions of these emissions by the proposed mitigation measures.

The fraction of DIY can use apportioned to servicing losses, can heels, and system charge is estimated to be 11%, 22%, and 67%, respectively. These figures are based on research commissioned by ARB (Clodic et al., 2008). The immediate emissions are thus approximately 0.23 MMTC0$_2$E per year and the delayed emissions are approximately 0.48 MMTC0$_2$E per year. The following figure illustrates the emissions associated with DIY practice.

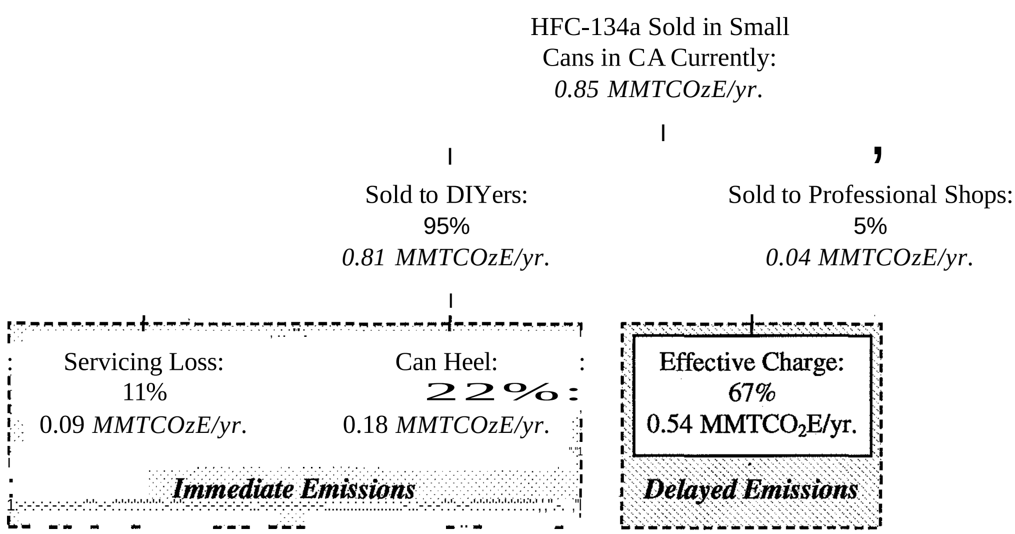


Figure 1. HFC-134a Emissions Associated with DIY Small Can Usage in 2006

In order to project BAU into the future, several major factors are analyzed. First, the increase of passenger vehicle population and better refrigerant containment would likely keep the number of leaky vehicles unchanged. Second, the decrease in AC nominal charge size and better refrigerant containment may keep the recharge frequency unchanged. Furthermore, the amount of refrigerant consumed per recharge will not change due to the characteristics of DIY recharging. Therefore, the annual emissions from DIY recharging of MVAC are projected to remain roughly constant (at 0.81 MMTC0$_2$E per year) through 2020 under BAU. A detailed analysis is presented in 4.3.1.

2.1.3 Costs

The annual consumer costs associated with BAU are estimated based on the average retail cost per can. Based on the NPD Automotive Aftermarket Industry Monitor Data from the total U.S. auto parts chain retailers sales records (NPD, 2008), the cost average out to about $13 per can, including the cost of the transfer apparatus.

To estimate lifetime costs and costs per consumer, it is necessary to estimate vehicle life and the rate at which the vehicle needs service. Based on a study carried out by ARB staff in support of the AB 1493 regulation development (Vincent et al., 2004), the average vehicle lifetime in California is 16 years. Based on the I-MAC study (I-MAC Team, 2007), the average time for which a new vehicle will not need AC service is about 7 years. This is also consistent with ARB's study (Vincent et al., 2004). The estimated portion of time for which an average vehicle needs servicing is then 9 years. For vehicles receiving DIY servicing, it is assumed that the leaks are not repaired, and it is estimated that the vehicle is recharged about once per year, primarily during summer, based on various data sources. This generates 9 DIY servicing over the 9 years of service need.

To estimate costs per consumer, it is necessary to estimate the number of vehicles needing service. The ARB study data indicates that the average number of cans used per service is 1.3 (Clodic et al., 2008). Given that 1.8 million cans per year are used by DIY operators, about 1.4 million DIY service operations occur each year. Given a DIY service rate of once per year per vehicle, the total number of vehicles that have ever been DIY serviced in the whole in-use fleet is 1.4 million. They are referred to as "DIY vehicles" hereafter in this document. It should be noted that these vehicles have a spectrum of leakage rate. Some of them function normally and only need recharge every several years. Some of them have leaking problem and need frequent recharge, likely more than once per year. So the number of vehicles that actually get recharged in any year should be significantly less than 1.4 million. At 1.3 cans per service and about $13 per can, the average costs of one DIY service are about $17. The costs per vehicle per year are then about $17. The annual costs to consumers for 1.8 million cans at about $13 each are about $24 million per year. The costs of 9 DIY service operations over the life of the vehicle are about $152.

## 2.2 Staff Proposal

### 2.2.1 Practices

ARB staff is now proposing a comprehensive approach as the Discrete Early Action measure to reduce emissions associated with DIY servicing of MVAC using small cans. The emission reductions would be achieved through the use of a self-sealing valve on the can, improved labeling instructions, a recycling program for used cans, and an education program that emphasizes best practice techniques for vehicle recharging as well as highlights the environmental risks associated with this product. A mandatory return rate target will be set at 90% for the first two years of the regulation, and 95% for the following years. As an incentive to promote return of the cans, a deposit of $10 (approximately equivalent to the price of a 12-ounce can) will be collected at time of the sales and will be refunded when the consumer returns the cans. If the return rate target is not met by the end of the first two years, the deposit will be increased by $5. This process would continue until the target recycle rate is achieved.

Improved usage instructions on the small cans and DIY education program will better inform consumers of the potential risk to their AC and damage to the climate system from DIY recharging, thus discourage some of them continuing DIY recharging. However, this cannot be quantified at this point. In this analysis, it is assumed that no consumer would change DIY behavior due to this regulation.

2.2.2 Emissions

We expect that the consumer education program would increase the number of DIY users motivated to find and repair leaks. However, no data are available to quantify this change in consumer behavior. For purpose of analysis the delayed emissions of 0.54 $MMTC0_2E$ per year are assumed to remain the same and will be addressed through other regulatory approaches, such as improving professional servicing and identifying and repairing leaky MVAC systems via the smog check program.

The emissions due to can heels were 0.18 $MMTC0_2E$ per year under BAU. With the self-sealing valve, the heel will be contained in the can. If the target return rate of 90% is met for the first two years, these emissions will be reduced to 0.02 $MMTC0_2E$ per year. If the 95% return rate target is met for the years to follow, the can heel emissions will be reduced to 0.01 $MMTC0_2E$ per year.

It is anticipated that with self-sealing valve, improved can instructions, and DIY education program, the servicing losses would be reduced to minimal. Thus, the 0.09 $MMTC0_2E$ of annual emissions due to servicing are eliminated.

Therefore, the annual emissions under this proposal would be 0.56 $MMTC0_2E$ for the first two years, achieving annual emission reductions of 0.25 $MMTC0_2E$. For the following years, the emissions would be 0.55 $MMTC0_2E$ per year and emission reductions are thus 0.26 $MMTC0_2E$ per year (Figure 2). Figure 3 illustrates the detailed breakdown of the emissions impacts of the proposed regulation when the final return rate target of 95% is reached.

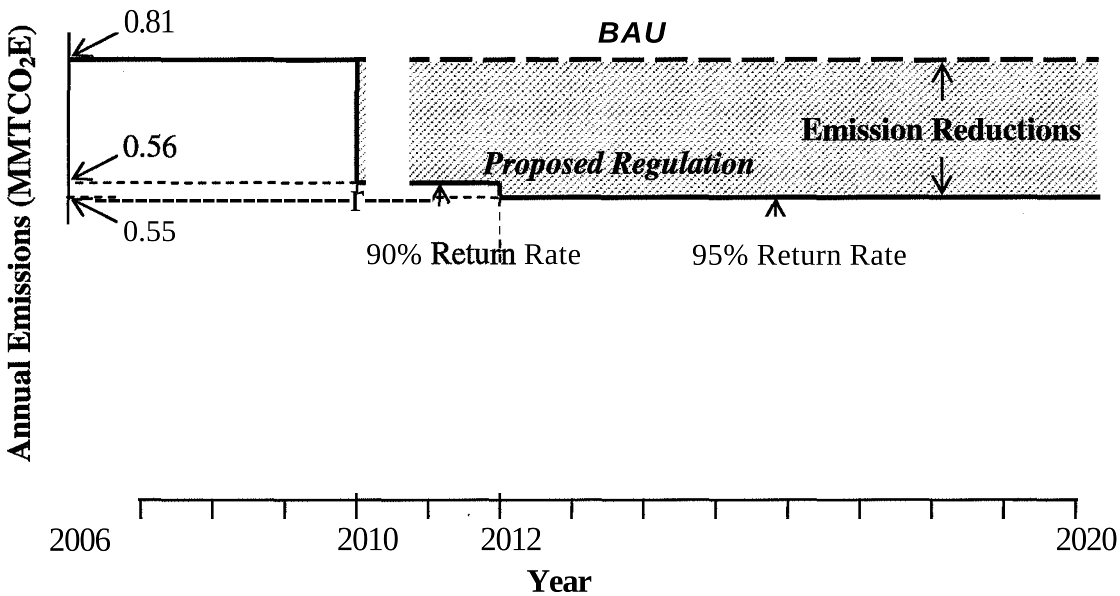


**Figure 2. Emissions Impact of Proposed Regulation**

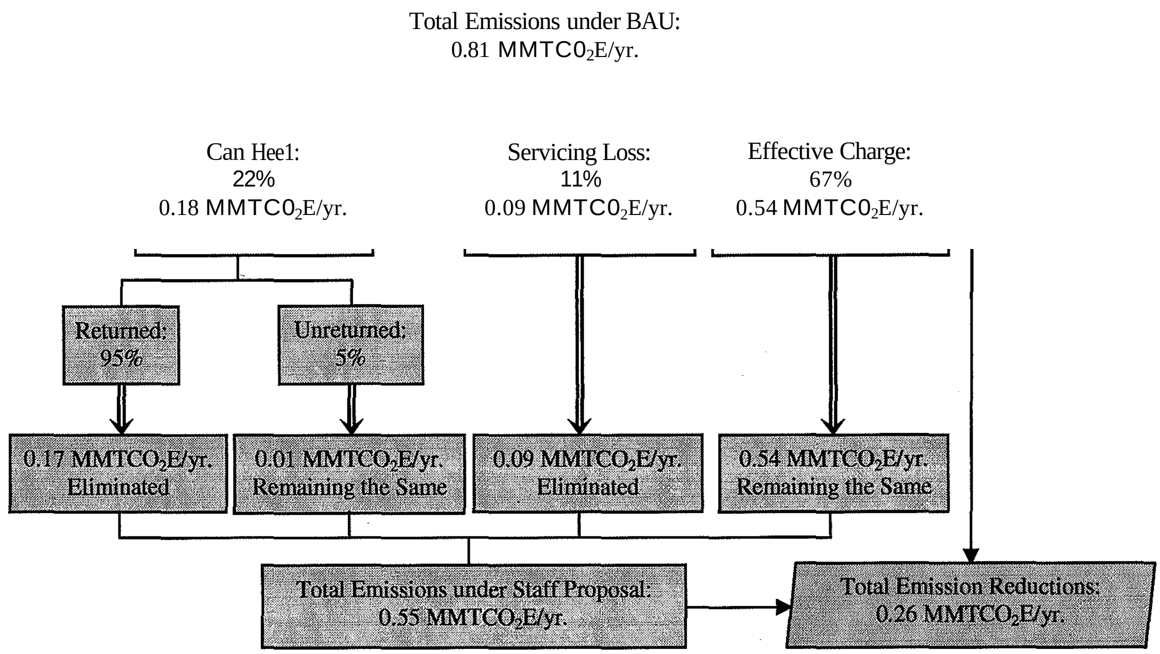


**Figure 3. Detailed Emissions Impact under Proposed Regulation (95% Return Rate)**

2.2.3 Costs

The extra cost of $1 per can due to the self-sealing valve and recycling program would be passed on to the consumer in the increased price of the can. At 1.8 million cans per year the increased consumer costs are $1.8 million. The extra costs include about $0.25 per can for the valve, and about $0.75 per can to cover the costs of return shipping for the cans, extracting and recycling the can contents, and reporting to ARB.

Given a 95% can return rate and a $10 deposit per can, the 5% of unclaimed deposits come to $0.9 million per year and will be additional costs to the consumers.

Total increased costs to the consumer are thus $2.7 million per year.

2.2.4 Cost-Effectiveness

Under this proposal, about 0.26 $MMTC0_2E$ of emissions would be reduced per year at an increased cost of $2.7 million per year. The cost-effectiveness is then about $11IMTC0$_2$E.

2.3 Can Ban (Original Proposal in AB 32 Early Action Report 2007)

2.3.1 Practices

The can ban remains as an alternative proposal. Ideally, there would no longer be any DIY servicing if a can ban is in place. All servicing would be done by professional shops. Some consumers would forgo air conditioning and some would take their vehicle to the professional shops. In practice, some DIY will evade the regulations and acquire HFC-134a for DIY operations. Professional shops in California are required by the California Bureau of Automotive Repair (BAR) to conduct complete diagnostics prior to recharging an auto AC system. Based on trade association survey data a large fraction of vehicles brought to a professional shop are repaired before being released in a recharged state. The repairs conducted by professional shops are expected to last 6 years (Thundiyil, 2008a), thus reducing the emission rate for former DIY vehicles to one sixth of its pre-repair value. During professional repair and recharge, a certain amount of refrigerant will be emitted due to servicing losses and cylinder heel emissions. There will also be some professionally serviced vehicles that may need repairs but receive a recharge only or a top' off. There will also be professional serviced vehicles for which repairs are not effective. For purpose of analysis these vehicles are considered part of the group of vehicles that receive a professional recharge service or top off without repair.

2.3.2 Emissions

Under the ban, the treatment of the delayed emissions of 0.54 MMTC0₂E per year from leaking vehicles is divided into categories based on consumer choices. The emission reductions are different for each category. Based on an ARPI commissioned survey (Frost and Sullivan, 2006), A MACS survey (Atkinson, 2008b), and an IMR survey (ARPI, 2008a), it is estimated that 32% of the original DIY consumers would pay for professional repair and recharge, 23% of them would have professional technicians recharge their AC without repair, 7% would choose topping off at professional servicing, 19% would continue DIY recharging using small cans obtained from alternative ways, and the remaining 19% would forgo AC.

The 32% of vehicles that receive professional repair are assumed to have their original recharge frequency of once per year reduced to once charge per 6 years. On the other hand, it is estimated that every professional recharge uses 1.6 times as much as the fresh refrigerant used in DIY recharge. Therefore, the delayed emissions of 0.17 $MMTC0_2E$ per year become 0.27 $MMTC0_2E$ per 6 years, or 0.045 MMTC02E per year. A U.S. EPA testing study on the heel from disposable containers (U.S. EPA, 2007) suggests the average cylinder heels are about 2%. So the heel emissions are about 0.001 MMTC02E per year. It is assumed there is no fresh refrigerant lost in the form of servicing losses during professional recharging.

The 23% of vehicles that receive professional recharge without repair would then leak at their pre-servicing rate. Nonetheless, the professional technicians have the equipment and skills to charge AC to their nominal charge. The next recharge will not take place until the AC loses 50% of the nominal charge again. In contrast, DIY on average undercharge their AC. It is estimated that a professionally recharged AC has 1.4 times as much refrigerant to lose as that of a DIY recharged· AC. Therefore, a professionally recharged AC has longer interval between two recharges, 1.4 times as long as that of a DIY recharged AC. On the other hand, the average professional recharge uses 1.6 times as much as the refrigerant used by DIY. Therefore, the delayed emissions of 0.12 $MMTC0_2E$ per year are changed to 0.2 $MMTC0_2E$ per 1.4 years, or 0.14 MMTC02E per year. The heel emissions work out to be about 0.003 $MMTC0_2E$ per year. No fresh refrigerant will be lost as servicing losses.

The 7% of vehicles that are topped off at professional servicing will emit at their original rate. Therefore, the delayed emissions of 0.04 $MMTC0_2E$ per year emitted by these vehicles remain the same. In addition, topping off would incur 0.013 $MMTC0_2E$ per year in heel emissions and 0.006 $MMTC0_2E$ per year in servicing losses.

The 19% that remain DIY recharging using small cans obtained from alternative ways will also emit at their original rate. Therefore, the delayed emissions of 0.1

**$MMTCO_2E$ per year emitted by these vehicles remain the same. Another 0.033 $MMTCO_2E$ per year in heel emissions and 0.016 $MMTCO_2E$ per year in servicing losses would occur.**

**The rest 19% of vehicles would forgo AC, thus no longer emit refrigerant. Therefore 0.1 $MMTCO_2E$ of delayed emissions per year are reduced to zero. Apparently, there are no immediate emissions associated with this group of vehicles. Forgoing MVAC has potential consequences for indirect emissions because consumers without AC would likely drive with windows rolled down for a large share of vehicle-miles-traveled (VMT).** The increased **load due to increased drag force must be balanced against the reduced load due to non-operation of the AC compressor. At high speed, indirect emissions might be increased. At low speed, indirect emissions will be reduced. On average, the change in indirect emissions due to non-operation of the MVAC is expected to be a net reduction** (Le., forgoing **AC would probably reduce indirect emissions). Changes in indirect emissions have not been included in this analysis.**

**The total annual emissions under can ban are thus 0.4 $MMTCO_2E$. The annual emission reductions are 0.41 MMTC02E. Figure 4 shows the emissions impact of the can ban approach.**

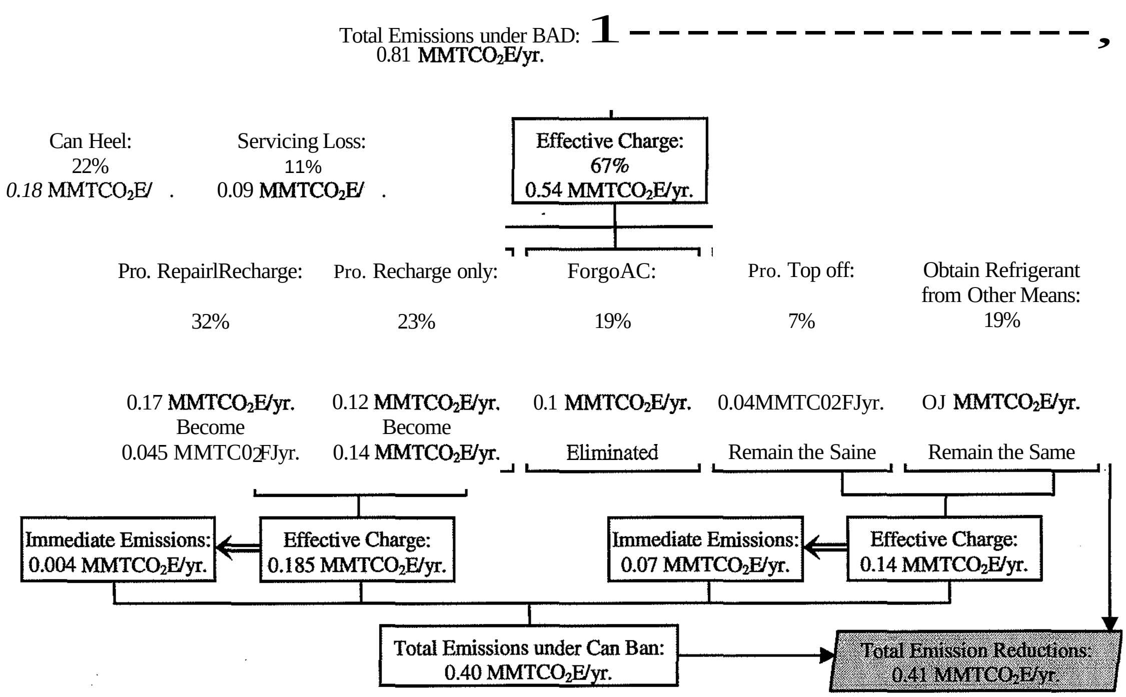


**Figure 4. Detailed Emissions Impact under Can Ban**

2.3.3 Costs

Under the can ban, consumer costs would be affected mainly by the difference between the cost of professional repairs and the cost of DIY recharges. DIY recharges were estimated to occur at a rate of once per year, at cost of about $17 per year. Professional diagnosis/repairs/recharges are estimated to cost about $650. This is based on the 2003 MACS Survey which shows that a professional repair costs $508 on average in 2003 (MACS, 2008), which is about $580 in 2007 dollars. We then add a $70 recharge charge on top of that. Professional repair/recharge is assumed to occur every 6 years on average for a cost of $108 per year for the 32% of consumers choosing professional repair. Professional recharge without repair is estimated to cost about $100 (Clodic et al., 2008) and is assumed to occur every 1.4 years for a cost of $71 per year for the 23% of consumers choosing professional recharge. Professional topping off is estimated to cost about the same as professional recharge, $100 (Clodic et al., 2008), and to occur once a year on average for a cost of $100 per year for the 7% of consumers choosing to have their system topped off. About 19% of consumers would still DIY recharge their vehicles once a year using refrigerant that they obtain from alternative ways, at a cost assumed to be 50% hig.her than under SAU, or about $25 per year. For the approximately 1.4 million vehicles involved, the total consumer costs increase from $24 million to $88 million, an increase of $65 million annually. For individual owners, the vehicle lifetime costs increase from $152 for 9 DIY recharges to $975 for 1.5 professional repair and recharge services, to $643 for 6.4 professional .recharges, to $900 for 9 top offs at professional servicing, or to $228 for 9 DIY recharges using HFC-134a obtained by alternative means. In addition, about 19% of consumers do not pay the increased cost, and therefore have no air conditioning in their vehicles.

There would be no costs or charges imposed on the small can industry to comply with the ban, but there would be complete loss of revenue from the small can business in California. Annual can sales to DIY owners are about 1.8 million at an average retail price of about $13 including cost of transfer apparatus. The 0.1 million cans sold to professional AC shops are also assumed to be at $13 per can for purpose of analysis. Therefore, industry would lose annual revenues of about $25 million due to the can ban.

Under the can ban, the professional MVAC repair industry would see a revenue increase equal to the amount paid by former DIY operators to obtain professional repairs. This amount is estimated to be $82 million per year.

2.3.4 Cost-Effectiveness

The emissions reduction under the can ban is 0.41 MMTC02E per year. The increase in consumer costs is $65 million per year. The cost per metric ton of reduction borne by the consumer is then about $159/MTC02E.

## 3. SUMMARY OF RESULTS

DIY recharging of MVAC systems with HFC-134a generates emissions of about 0.81 $MMTC0_2E$ per year.

ARB staff proposes a comprehensive measure that could achieve emiSSion reductions of 0.26 $MMTC0_2E$ per year even if no DIY consumers change their behavior. The cost-effectiveness works out to be \$11/$MTC0_2E$ and industry would likely see no revenue losses.

The alternative can ban approach would eliminate approximately 0.41 $MMTC0_2E$ per year of HFC-134a emissions from DIY recharging of MVAC using small cans at a cost of about \$159/$MTC0_2E$ to the consumer plus \$25 million per year in lost revenues to industry.

Table 1: Emissions and Economic Impact Of Regulatory Proposals

| Scenario | Emissions $MMTC0_2E$/yr. | Emission Reductions $MMTC0_2E$/yr. | Cost-Effectiveness Dollars/$MTC0_2E$ | Lost Revenue Million Dollars/yr. |
|---|---|---|---|---|
| BAU | 0.81 | NA | NA | NA |
| Staff Proposal* | 0.55 | 0.26 | 11 | 0 |
| Can Ban | 0.4 | 0.41 | 159 | 25 |

* Calculation based on a can return rate target of 95%.

# 4. DETAILS OF ASSUMPTIONS AND CALCULATION

## 4.1 Independent Parameters

**Table 2: Independent Parameters**

| Notation | Definition | Estimate | References |
|---|---|---|---|
| $S_{tot}$ | Number of small cans sold annually in CA | 2 million | ARB,2007b |
| $E_{tot}$ | Amount of HFC-134a sold in small cans annually in CA | 0.85 $MMTCO_2E$ | Same as the above |
| $Y$ | Vehicle's average lifetime | 16 years | Vincent et aL, 2004 |
| $Y_0$ | Average time after which a leaky vehicle's AC needs its first recharge | 7 years | I-MAC Team, 2007 |
| $Y_1$ | Average time that a leaky MVAC recharged without repair lasts before it needs another recharge | 1year | ARB staff estimate (see 4.5.1) |
| $Y_2$ | Average time that a leaky MVAC repaired and recharged by a professional shop lasts before it needs another repair and recharge | 6 years | Thundiyil, 2008a |
| $N_C$ | Average number of small cans needed for a DIY recharging event | 1.3 cans | Clodic et aL, 2008 |
| $P_0$ | Percentage of HFC-134a in small cans sold to DIY in CA | 95% | ARB staff estimate (see 4.5.2) |
| $P_{11}$ | Average percentage of can heels during DIY recharging | 22% | Clodic et aL, 2008 |
| $P_{12}$ | Average percentage of servicing leaks during DIY recharging | 11% | Same as the above |
| $P_2$ | Percentage of DIY that return the used cans (under hybrid approach) | 90%,95% | Targeted return rates in the mandatory small can return / recycling program |
| $P_{31}$ | Percentage of original DIY (under BAU) that would pay for professional diagnosis, repair and recharge in case of a can ban | 32% | ARB staff estimate (see 4.5.3) |
| $P_{32}$ | Percentage of original DIY (under BAU) that would choose to evacuate and recharge at professional shops in case of a can ban | 23% | Same as the above |
| $P_{33}$ | Percentage of original DIY (under BAU) that would choose to top off with small cans at professional shops in case of a can ban | 7% | Same as the above |
| $P_{34}$ | Percentage of original DIY (under BAU) that would choose to continue DIY recharging AC using small cans obtained through alternative ways in case of a can ban | 19% | Same as the above |
| $P_{35}$ | Average percentage of fresh refrigerant lost due to can heels during professional recharge (in relation with total fresh refrigerant usage) | 2% | U.S. EPA, 2007 |
| $P_{3G}$ | Average percentage of fresh refrigerant lost due to servicing losses during professional recharge (in relation with total fresh refrigerant usage) | 0% | Most conservative scenario based on Clodic et aL, 2008 |

| | | | |
|---|---|---|---|
| $P_{37}$ | Percentage of increase in DIY cost for people seeking alternative ways to obtain small cans in case of a can ban | 50% | ARB staff estimate |
| $R_1$ | Average retail price for a small can | $13 | NPD,2008 |
| $R_{21}$ | Price increment for a small can under staff proposal | $1 | ARPI,2008b |
| $R_{22}$ | Deposit for a small can under staff proposal | $10 | Specified value to ensure high incentive for return of cans |
| $R_{31}$ | Average price for a professional diagnosis, repair and recharge of a leaky MVAC | $650 | ARB staff estimate based on 2003 MACS Survey (MACS, 2008) |
| $R_{32}$ | Average price for a professional recharge of a leaky MVAC | $100 | Clodic et al., 2008 |
| $F_1$ | Ratio of effective charge to be leaked out before next servicing from professionally recharged MVAC to that from DIY recharged MVAC | 1.4 | ARB staff estimate (see 4.5.4) |
| $F_2$ | Ratio of effective charge during professional recharging to that during DIY recharging | 1.6 | Same as the above |

### 4.2 Key Assumptions

1. The refrigerant charged into a MVAC during the last recharge in its useful lifetime is emitted in the same way and amount as the previous recharges. I.e. the effect of end-of-life emissions is not taken into account.

2. The owner of a DIY vehicle maintains his / her repair / recharge preferences unless there are regulatory changes. This may not always be the case in reality. For example, a consumer could DIY recharge the MVAC this year but have professional repair it the next year. Another example is when vehicle ownership changes, the new owner may make different decisions on the maintenance of the vehicle. But that would make the situation too complicated for the analysis to be feasible.

3. Each DIY consumer (household) owns one and only one DIY vehicle.

4. MVAC is used throughout a vehicle's lifetime.

5. A MVAC has to lose 50% of its refrigerant before a recharge takes place. This is based on findings from an ARB sponsored study (Clodic et al., 2008) and is consistent with an assumption made in the U.S. EPA Vintaging Model.

6. Under the staff proposal, no DIY consumer would change his behavior (switching to professional servicing, etc.). This is because the increased financial burden is mild as long as a consumer returns the used cans for a refund of the deposit. The potential risk of DIY recharging MVAC conveyed by the education

materials might discourage some consumers to continue DIY recharging. However, this effect cannot be quantified at this point.

7. Under the staff proposal, the effective charge is the same as under BAU. Having self-sealing valve and improved usage instructions would likely change the percentage. But no data are available to quantify this effect.

8. Under the staff proposal, servicing leaks can be reduced down to minimal due to better usage instructions to the DIY and having self-sealing valves on the can.

9. Under the staff proposal, the heel in the returned cans would be completely recovered, thus causing no emissions.

10. Under the staff proposal, unreturned cans would end up being disposed of and the heel would be emitted to the atmosphere eventually.

11. Under the staff proposal, the can heel percentage is the same as under BAU. Having self-sealing valve and improved usage instructions would likely change the percentage. But no data are available to quantify this effect.

12. The DIY education components of the staff proposal incur no additional costs to the consumers. In reality, having the education components might add some costs to the industry, which would probably pass the costs on to consumers. However, this cannot be quantified.

13. On average, DIY recharging under the staff proposal uses the same number of cans per recharge as under BAU. Having self-sealing valve and improved usage instructions would likely reduce the number of cans used per recharge. However, no data are available to quantify this effect.

14. In case of can ban, the behavior changes (switching to professional servicing, etc.) of the original DIY consumers are independent of the working conditions of the MVAC. The implication is that every new group of vehicles formed by the behavior changes of their owners will have the same average leak rate.

15. Topping off of a MVAC by a professional technician resembles DIY recharging at all aspects. It is reasonable to speculate that professional topping off using small cans or cylinder and manifold produces less immediate emissions and more effectively charges refrigerant into AC than DIY operation. However, no data are available to justify it.

16. In case of can ban, the revenue lost by the small can industry cannot be offset by the potential internet or out-of-state sales. Although part of the sales may generate revenue to the industry, the sales may depend on a lot of factors which are difficult to quantify.

## 4.3 Analysis

### 4.3.1 BAU

According to the ARB Consumer Products Survey for 2006 (ARB, 2007b), the small cans of HFC-134a sold in California in 2006 amounted to

$S_{tot} = 2 \text{ million cans}$, and $E_{tot} = 0.85 \text{MMTCO}_2\text{E}$.

It is estimated (see 4.5.2) that $P_0 = 95\%$ of the cans are sold to DIY and the rest to professional servicing for topping off purposes. Thus, cans used by DIY constitute

$$E_{BAU} = P_0 . E_{tot}$$
$$= 95\% \times 0.85 = 0.808 \text{ (MMTCO}_2\text{E)} \quad (4.3.1)$$

Per Assumption 1, this equals the annual emissions caused by DIY recharging. For purpose of analysis, we convert the emissions to the nominal number of cans by assuming 12 oz / can:

$$S_{BAU} = \frac{E_{BAU}}{12 oz \times 0.02835 \frac{kg}{oz} \times 10^{-9} \frac{MMT}{kg} \times 1300 \frac{MMTCO_2E}{MMT}} = 2.261 \times 10^6 . E_{BAU} \quad (4.3.2)$$
$$= 2.261 \times 10^6 \times 0.808 = 1.826 \text{ (million cans)}$$

This number is used hereafter wherever the number of cans sold to DIY is needed.

The number of unique DIY vehicles is

$$N_V = \frac{Y_1 \cdot S_{BAU}}{N_C}, \quad (4.3.3)$$
$$= \frac{1 \times 1.826}{1.3} = 1.404 \text{ (million vehicles)}$$

where $Y_1$ is the interval between two consecutive recharges, and $N_C$ is the number of cans used in each recharge. Note that a vehicle that gets multiple recharges during its lifetime is counted as one unique DIY vehicle. According to Assumption 2, these vehicles will be DIY recharged during their lifetime unless a regulation such as can ban takes effect. Based on Assumption 3, this is also the number of unique DIY consumers (households). It is worth noted that quite often a vehicle changes ownership. So the group of DIY vehicle owners changes over time.

It is assumed a MVAC does not need recharging until after $Y_0 = 7$ years in its lifetime. So the adjusted lifetime (referred to hereafter as 'lifetime') during which recharging happens is

$$\begin{aligned} Y_{adj} &= Y - Y_0 \\ &= 16 - 7 = 9 \text{ (years)}, \end{aligned} \tag{4.3.4}$$

where $Y = 16$ years is vehicle's lifetime and also the lifetime of MVAC (Assumption 4) in California.

The number of recharges in a DIY vehicle's lifetime is

$$\begin{aligned} N_{R,BAU} &= \frac{Y_{adj}}{Y_1} \\ &= \frac{9}{1} = 9 \text{ (times)} \end{aligned} \tag{4.3.5}$$

The emissions under BAU can also be expressed by a bottom-up approach. Under BAU, a DIY recharges the AC when its refrigerant level drops to 50% of the nominal charge (Assumption 5). Define MDIY (in $MMTCO_2E$) as the amount of refrigerant effectively charged into AC. This equals the amount of refrigerant that the AC needs to lose before another recharge becomes necessary. Then over $Y_1$ years the AC leaks until its charge drops to 50% again. Thus each year the AC leaks by the amount of $M_{DIY}/Y_1$. However, these gradual leaks (delayed emissions) are not the only source of emissions caused by DIY. Losses during servicing and due to can heels also need to be taken, into account. Thus the total annual emissions are

$$E_{BAU} = \frac{N_V \cdot M_{DIY} / Y_1}{1 - P_{11} - P_{12}}, \tag{4.3.6}$$

where $P_{11}$ and $P_{12}$ are the fractions of refrigerant lost due to can heel and during servicing, respectively, during DIY recharging.

The annual costs for a DIY vehicle are

$$\begin{aligned} C_{BAU} &= \frac{N_C \cdot R_1}{Y_1}, \\ &= \frac{1.3 \times 13}{1} = 16.90 \text{ (dollars)} \end{aligned} \tag{4.3.7}$$

where $R_1$ is the retail price of a can of HFC-134a.

Therefore the annual costs for all DIY vehicles are

$$\begin{aligned} C_{all,BAU} &= N_V \cdot C_{BAU} = S_{BAU} \cdot R_l \\ &= 1.826 \times 13 = 23.73 \text{ (million dollars)} \end{aligned} \quad (4.3.8)$$

The lifetime costs for a DIY vehicle are

$$\begin{aligned} C_{L,BAU} &= f_{adj} \cdot C_{BAU} \\ &= 9 \times 16.90 = 152.10 \text{ (dollars)} \end{aligned} \quad (4.3.9)$$

In order to project BAU into the future, several major factors need to be taken into account. First, the increase of passenger vehicle population and better refrigerant containment in newer MVAC will keep the number of leaky vehicles unchanged. The EMFAC Model 2007 estimates that the population of passenger vehicles in California will increase by around 400,000 each year through 2020. But newer MVAC systems have improved designs and improved production controls so that they are tighter and have reduced probability of becoming leaky. The latter cannot be quantified at this point. So a conservative assumption is made that the increased population and decreased probability produces a steady multiplication, Le. the number of leaky MVAC.

Second, the decrease in MVAC nominal charge size and improvement of refrigerant containment will keep the recharge frequency unchanged. The average nominal charge size for a new single evaporator MVAC decreases from 26.9 oz in 2000 to 22.3 oz in 2006 (Atkinson, 2008b). The trend will· likely continue, but with reduced pace over years. On the other hand, the improved refrigerant containment will reduce the leak rate of a leaky AC. In the absence of data to quantify the containment improvement, it is reasonable to assume that these two factors cancel out the effects from each other, making the recharge frequency unchanged. This is consistent with the approach used in the GREEN-MAC-LCCP Model, which does not differentiate recharge frequency for different model year vehicles (Papasawa et al., 2008). As a side note, in the development of AB 1493 regulation, ARB staff estimated that California's MVAC emits 55 grams per year on average (ARB, 2004). The MVAC refrigerant emissions testing studies conducted by the European Automobile Manufacturers Association (ACEA) and Japan Automobile Manufacturers Association (JAMA) suggest that newer vehicles leak around 10 grams per year and very few vehicles emit significantly more than that (Atkinson, 2008c; Clodic, 2006). This substantial difference in leak rate may be attributed mainly to improved refrigerant containment of newer AC models as well as deterioration of containment over time.

Lastly, the amount of refrigerant consumed per recharge will not change due to the characteristics of DIY recharging. A DIY has no means to know the remaining refrigerant level in an MVAC or to determine the proper amount of refrigerant to be charged. A DIY terminates charging based on empirical or arbitrary criteria, such as the outflow air temperature, depletion of a can, and pressure gauge reading falling into a range specified in charging kit instructions. None of these criteria presents solid ground for charging the proper amount of refrigerant (Clodic et al., 2008). DIY on average undercharge the current MVAC systems. With AC nominal charge decreased, DIY may charge close to the correct amount or overcharge. But the number of small cans used per recharge is not dependent on the nominal charge size.

Therefore, the BAU emissions from DIY recharging are projected to remain roughly constant at 0.81 $MMTC0_2E$ per year through 2020. ARPI had projected a 1-2% annual sales growth under BAU, likely based on national sales trend (ARPI,2006). It may not reflect with precision California's unique usage patterns and the various trends discussed above. The uncertainties carried with the assumptions in the staff analysis to support this document may overshadow a 1-2% annual change. Therefore, no attempt has been made to empirically adjust the BAU trend to match ARPI's projection.

Note that this BAU projection does not account for the potential climate impact from other Early Action measures, such as "Addition of AC leak test and repair requirement to smog check", "Requirement of low-GWP refrigerants for new MVAC", and "Reductions of HFC-134a emissions from professional servicing of MVAC".

4.3.2 Staff Proposal

ARB staff now proposes a comprehensive approach to reducing the emissions from DIY recharging of MVAC. This approach incorporates some of the key elements that were proposed by the small can industry association, ARPI, and also reflects staff's modifications.

Per Assumption 6, all the original DIY consumers would continue DIY recharging their MVAC. They would charge the same amount of refrigerant as under BAU (Assumption 7). Based on Assumption 8, there are no servicing losses due to improved usage instructions and effects of self-sealing valves. Because of the mandatory return requirement for the cans and the deposit / refund mechanism, most of the DIY consumers *(Pa)* are anticipated to return the used cans, thus causing no emissions from can heels (Assumption 9). Those who do not return the can will incur heel emissions (Assumption 10) at the same percentage as under BAU (Assumption 11). Since the effective charge and leak rate are the same as under BAU, the recharging frequency is still once every $Y1$ years. The annual emissions are then

$$E_{\text{prop}} = P_2 \cdot N_{\text{V}} \cdot \frac{M_{\text{DIY}}}{Y_1} + \frac{(1-P_2) \cdot N_{\text{V}} \cdot \frac{M_{\text{DIY}}}{Y_1}}{1-P_{11}} \qquad (4.3.10)$$

Thus,

$$E_{prop} = (P_2 + \frac{1-P_2}{1-P_{11}}) \cdot (1 - P_{11} - P_{12}) \cdot E_{BAU}$$
$$= (95\% + \frac{1-95\%}{1-22\%}) \times (1 - 22\% - 11\%) \times 0.808 = 0.549 \text{ (MMTC0}_2\text{E)} \quad (4.3.11)$$

The annual emission reductions are

$$ER_{prop} = E_{BAU} - E_{prop}$$
$$= 0.808 - 0.549 = 0.259 \text{ (MMTC0}_2\text{E)} \quad (4.3.12)$$

Having self-sealing valve installed on the cans, managing the can return / recycling, and handling the deposit would cause additional costs, which would most probably be passed on to consumers in the form of price increase of $R_{31}$ per can. Those who do not return the cans would lose the deposit of $R_{32}$ per can. Per Assumption 12, no additional costs to the consumers would occur as a result of the education components.

The number of DIY recharging is the same as under BAU $(N_{R,BAU})$'

$$N_{R,prop} = \frac{Y_{adj}}{Y_1}$$
$$= \frac{9}{1} = 9 \text{ (times)} \quad (4.3.13)$$

The annual costs for a vehicle whose owner returns the used cans are

$$C_{1,prop} = \frac{N_C \cdot (R_1 + R_{21})}{Y_1}$$
$$= \frac{1.3 \times (13+1)}{1} = 18.20 \text{ (dollars)} \quad (4.3.14)$$

Note that every recharge uses the same number of cans as under BAU (Assumption 13).

The lifetime costs for such a vehicle are

$$C_{1,L,prop} = Y_{adj} \cdot c_{1,prop}$$
$$= 9 \times 18.20 = 163.80 \text{ (dollars)} \quad (4.3.15)$$

**The annual costs for a vehicle whose owner does not return the used cans are**

$$C_{Z,prop} = \frac{N_C \cdot (R_1 + R_{Z1} + R_{Z2})}{Y_1} \tag{4.3.16}$$

$$= \frac{1.3 \times (13 + 1 + 10)}{1} = 31.20 \text{ (dollars)}$$

**The lifetime costs for such a vehicle are**

$$C_{Z,L,prop} = Y_{adj} \cdot C_{Z,prop} \tag{4.3.17}$$

$$= 9 \times 31.20 = 280.80 \text{ (dollars)}$$

**Then the annual costs for all DIY vehicles are**

$$C_{all,prop} = P_Z \cdot N_y \cdot C_{1,prop} + (1 - P_Z) \cdot N_y \cdot C_{Z,prop} \tag{4.3.18}$$

$$= 95\% \times 1.404 \times 18.20 + (1 - 95\%) \times 1.404 \times 31.20 = 26.47 \text{ (million dollars)}$$

**The annual extra costs for all DIY vehicles are**

$$EC_{all,prop} = C_{all,prop} - C_{all,BAU} \tag{4.3.19}$$

$$= 26.47 - 23.73 = 2.74 \text{ (million dollars)}$$

**The cost-effectiveness to consumers is**

$$CE_{cons,prop} = \frac{EC_{all,prop}}{ER_{prop}} \tag{4.3.20}$$

$$= \frac{2.74}{0.259} = 10.58 \text{ (dollars/MTCO}_2\text{E)}$$

**The annual revenue losses by small can industry are**

$$RL_{prop} = 0. \tag{4.3.21}$$

4.3.3 Can Ban

If a can ban is in place, a portion of the original DIY consumers would change their behavior based on costs, convenience and other personal preferences, but not the MVAC's working conditions (Assumption 14). A fraction ($P_{31}$) of the same leaky vehicles would be brought into professional shops for diagnosis, repair and recharge by $M_{pro}$ (in MMTC0$_2$E) of fresh refrigerant. They originally would lose 50% of their nominal charge over $Y_1$ years (Assumption 14) if DIY recharged. But now they would leak at reduced rates during $Y_2$ years until they lose 50% of their nominal charge again. A second part ($P_{32}$) of the leaky vehicles would be taken to professional shops for recharge without repair. The serviced AC will then leak at the same rate as DIY (Assumption 14), but during a modified (prolonged) period. This is because DIY generally undercharge AC due to lack of equipment and skills to know the proper amount of effective charge. On the contrary, professional technician can charge AC to its nominal level. Defining $F_1$ as the ratio of charge to be leaked out before next servicing from a professionally recharged AC to that from a DIY recharged AC, a professionally recharged AC needs another recharging after a period of $F_1 \cdot Y_1 \cdot$ Another fraction ($P_{33}$) of the leaky vehicles would be taken to professional shops for topping off using small cans or cylinder and manifold. According to Assumption 15, they will be charged by $M_{DIY}$ and the charge will leak out during $Y_1$ years, essentially the same as DIY. A fourth portion ($P_{34}$) of the vehicles would still be DIY recharged with refrigerant obtained from alternative ways, resulting in exactly the same emissions as under BAU (Assumption 14). The rest of the leaky vehicles would not get repair and recharge and hence would eventually go without AC, generating no refrigerant emissions. The total annual emissions should include not only the amount of fresh refrigerant effectively charged into the AC, but also the fresh refrigerant lost during servicing (DIY or professional) and due to container (can or cylinder) heels.

$$E_{ban} = \frac{P_{31} \cdot N_V \cdot \frac{M_{Pro}}{Y_2} + P_{32} \cdot N_V \cdot \frac{M_{Pro}}{F_1 \cdot Y_1}}{1 - P_{35} - P_{36}} + \frac{P_{33} \cdot N_V \cdot \frac{M_{DIY}}{Y_1} + P_{34} \cdot N_V \cdot \frac{M_{DIY}}{Y_1}}{1 - P_{11} - P_{12}} \qquad (4.3.22)$$

where $P_{35}$ and $P_{36}$ are the fractions of fresh refrigerant lost due to can heel and during servicing, respectively, during professional recharging. Note that $P_{36}$ is assumed to be negligible in this analysis.

Define

$$\frac{M_{Pro}}{M_{DIY}} = F_2 \cdot$$

Then

$$E_{ban} = [\frac{1 - P_{11} - P_{12}}{1 - P_{35} - P_{36}} \cdot F_2 \cdot (\frac{Y_1}{Y_2} \cdot P_{31} + \frac{P_{32}}{F_1}) + P_{33} + P_{34})] \cdot E_{BAU}$$
$$= [\frac{1-22\%-11\%}{1-2\%-0\%} \times 1.6 \times (\frac{1}{6} \times 32\% + \frac{23\%}{1.4}) + 7\% + 19\%)] \times 0.808 = 0.402 \text{ (MMTCO}_2\text{E)} \quad (4.3.23)$$

The derivation of $P_{31}$, $P_{32}$, $P_{33}$, $P_{34}$, $F_1$, and $F_2$ can be found in 4.5.3 and 4.5.4.

The annual emission reductions are

$$ER_{ban} = E_{BAU} - E_{ban}$$
$$= 0.808 - 0.402 = 0.405 \text{ (MMTCO}_2\text{E)} \quad (4.3.24)$$

The number of professional servicing that involves repair in a vehicle's lifetime is

$$N_{R,rep} = \frac{Y_{adj}}{Y_2}$$
$$= \frac{9}{6} = 1.5 \text{ (times)} \quad (4.3.25)$$

The annual costs for such a vehicle are

$$C_{1,ban} = \frac{R_{31}}{Y_2}$$
$$= \frac{650}{6} = 108.33 \text{ (dollars)} \quad (4.3.26)$$

The lifetime costs for such a vehicle are

$$C_{1,L,ban} = Y_{adj} \cdot C_{1,ban}$$
$$= 9 \times 108.33 = 975 \text{ (dollars)} \quad (4.3.27)$$

The number of professional recharging that does not involves repairs in a vehicle's lifetime is

$$N_{R,rec} = \frac{Y_{adj}}{F_1 \cdot Y_1}$$
$$= \frac{9}{1.4 \times 1} = 6.4 \text{ (times)} \quad (4.3.28)$$

**The annual costs for such a vehicle are**

$$C_{2,ban} = \frac{R_{32}}{1.4 Y_1} = \frac{100}{1.4 \times 1} = 71.43 \text{ (dollars)} \tag{4.3.29}$$

**The lifetime costs for such a vehicle are**

$$C_{2,L,ban} = Y_{adj} \cdot C_{2,ban} = 9 \times 71.43 = 642.86 \text{ (dollars)} \tag{4.3.30}$$

**The number of professional topping off in a vehicle's lifetime is the same as under BAU** (NR,BAU).

$$N_{R,top} = \frac{Y_{adj}}{Y_1} = \frac{9}{1} = 9 \text{ (times)} \tag{4.3.31}$$

**The annual costs for such a vehicle are**

$$C_{3,ban} = \frac{R_{32}}{Y_1} = \frac{100}{1} = 100 \text{ (dollars)} \tag{4.3.32}$$

**The lifetime costs for such a vehicle are**

$$C_{3,L,ban} = Y_{adj} \cdot C_{3,ban} = 9 \times 100 = 900 \text{ (dollars)} \tag{4.3.33}$$

**The number of DIY recharging using refrigerant obtained through alternative ways is the same as under BAU** (NR,BAU).

$$N_{R,ait} = \frac{Y_{adj}}{Y_1} = \frac{9}{1} = 9 \text{ (times)} \tag{4.3.34}$$

**The annual costs for such a vehicle are**

$$C_{4,ban} = \frac{N_C \cdot (1+P_{37}) \cdot R_1}{Y_1} = \frac{1.3 \times (1+50\%) \times 13}{1} = 25.35 \text{(dollars)} , \quad \textbf{(4.3.35)}$$

**where** $P_{37}$ **is the percentage of cost increase for those who seek alternative ways of obtaining refrigerant.**

**The lifetime costs for such a vehicle are**

$$C_{4,L,ban} = Y_{adj} \cdot C_{4,ban} = 9 \times 25.35 = 228.15 \text{ (dollars)} \quad \textbf{(4.3.36)}$$

**Note that the owners for the rest of the original DIY vehicles would choose to forgo AC under can ban, thus incur no costs.**
**The annual costs for all original DIY vehicles are**

$$C_{all,ban} = P_{31} \cdot N_y \cdot C_{1,ban} + P_{32} \cdot N_y \cdot C_{2,ban} + P_{33} \cdot N_y \cdot C_{3,ban} + P_{34} \cdot N_y \cdot C_{4,ban}$$
$$= N_y \cdot (P_{31} \cdot C_{1,ban} + P_{32} \cdot C_{2,ban} + P_{33} \cdot C_{3,ban} + P_{34} \cdot C_{4,ban}) \quad \textbf{.(4.3.37)}$$
$$= 1.404 \times (32\% \times 108.33 + 23\% \times 71.43 + 7\% \times 100 + 19\% \times 25.35) = 88.36 \text{ (million dollars)}$$

**The annual extra costs for all original DIY vehicles are**

$$EC_{all,ban} = C_{all,ban} - C_{all,BAU} = 88.33 - 23.73 = 64.62 \text{ (million dollars)} \quad \textbf{(4.3.38)}$$

**The cost-effectiveness to consumers is**

$$CE_{cons,ban} = \frac{EC_{all,ban}}{ER_{ban}} = \frac{64.62}{0.405} = 157.85 \text{ (dollars/MTCO}_2\text{E)} \quad \textbf{(4.3.39)}$$

**The annual revenue losses by small can industry are**

$$RL_{ban} = \frac{S_{BAU}}{P_0} \cdot R_1 = \frac{1.826}{95\%} \times 13 = 24.98 \text{ (million dollars)} \quad \textbf{(4.3.40)}$$

**Note that the above equation accounts for the revenue from the can sales to professional servicing that would be lost in case of can ban. Also note that the**

potential revenue increase through sales via internet or from out-of-state is not included per Assumption 16.

### 4.4 Detailed Summary of Results

**Table 3: Detailed Emissions and Economic Impact of Regulatory Proposals**

| | BAU | Staff Proposal* | Can Ban |
|---|---|---|---|
| Annual Can Sales to DIY (million cans) | 1.8 | 1.8 | NA |
| Annual Emissions (MMTC$0_2$E) | 0.81 | 0.55 | 0.40 |
| Annual Emission Reductions (MMTC$0_2$E) | NA | 0.26 | 0.41 |
| Annual Costs for All Original DIY Vehicles (million dollars) | 23.73 | 26.47 | 88.36 |
| Annual Extra Costs for All Original DIY Vehicles (million dollars) | NA | 2.7 | "64.6 |
| Cost-effectiveness to Consumers (dollars/MTC$0_2$E) | NA | 11 | 159 |
| Annual Revenue Loss (million dollars) | NA | 0 | 25 |

* Calculation based on a can return rate target of 95%

## 4.5 Derivation of Key Independent Parameters

### 4.5.1 $Y_1$

Definition

The average interval between two DIY recharging is estimated by several approaches and data sources in this document. In most cases, it is calculated based on responses from surveyed individuals about their recharge intervals. It needs to be noted that the average recharge interval should not be defined as the straight mean of the recharge intervals from all the samples because this does not make physical sense. Rather, it should be defined as the reciprocal of the average leak rate and the average leak rate is the mean of the leak rate for all responses. In other words, it is the harmonic mean of the recharge intervals of all the samples:

$$\frac{1}{\bar{Y}} = \frac{1}{N}\sum_{i=1}^{N}\frac{1}{Y_i}. \qquad (4.5.1)$$

This is because, by definition, the average delayed emissions per vehicle are the arithmetic mean of the delayed emissions of all the vehicles under consideration:

$$\bar{E} = \frac{1}{N}\sum_{i=1}^{N} E_i , \qquad (4.5.2)$$

where

$$E_i = \frac{M}{Y_i} , \qquad (4.5.3)$$

and

$$\bar{E} = \frac{M}{\bar{Y}} , \qquad (5.5.4)$$

where $M$ is the effective charge that is to be emitted over the period of $Y_i$, which will incur the next recharge. Equations (4.5.2) through (4.5.4) lead to Equation (4.5.1).

In case the intervals are accompanied with percentages of DIY, the mean becomes weighted mean:

$$\frac{1}{\bar{Y}} = \sum_{i=1}^{N} P_i \left(\frac{1}{Y_i}\right). \qquad (4.5.5)$$

ARB El Monte Survey

During the ongoing study on non-professional servicing of MVAC sponsored by ARB, Denis Clodic's team interviewed 16 people who participated in the study. 10 out of them provided relevant responses. Out of these 10, 3 responded with an ambiguous answer, "long time ago". The vintage of their vehicles was as early as 1996 and as late as 2003. These 3 responses are hence deemed invalid and excluded from the analysis. The valid responses are compiled in Table 4.

Table 4: Recharge Interval in ARB El Monte Survey

| Vintage | Time of last recharge | Recharge interval (months) |
|---|---|---|
| 1999 | 5 months ago | 5 |
| 1994 | 4 months ago | 4 |
| 1997 | 10 years ago | 120 |
| 1994 | 1994 | 156 |
| 2001 | 4 years ago | 48 |
| 2004 | 3 years ago | 36 |
| 1997 | 1 year ago | 12 |

Using Equation (4.5.1), the average recharge interval is 11.7 months.

2008 ARPI DIY Survey

ARPI conducted a survey in May, 2008 in California to characterize DIY consumer profiles. 200 survey were handed out in participating Autozone stores in Southern California and 20 responses were received (ARPI, 2008c). Two of the questions are related to estimating recharge intervals. The relevant results are compiled in Table 5.

Table 5: Recharge Interval in 2008 ARPI DIY Survey

| Time of last recharge | Recharge interval (months) | Percentage | Combined Percentage | Normalized Percentage |
|---|---|---|---|---|
| < 3 months | 3 | 5% | 5% | 5.4% |
| 3 months to 1 year | 7.5 | 20% | 20% | 21.6% |
| 1 to 2 years | 18 | 30% | 30% | 32.4% |
| >2 years | 72 | 15% | 37.5% | 40.5% |
| never | | 30% | | |

| Time of owning the vehicle | Percentage | Percentage: never recharged |
|---|---|---|
| <1 yr. | 25% | 7.5% |
| 1 to 2 yrs. | 35% | 10.5% |
| 2 to 3 yrs. | 15% | 4.5% |
| 3 to 4 yrs. | 5% | 1.5% |
| > 4 yrs. | 20% | 6.0% |
| Own for >1yr.; never recharged | | 22.5% |

Although 30% of the respondents said that they never recharged their AC before, it is noticeable that most of the survey participants have not own their cars for very long. As the second part of the table shows, 80% of these people have their cars for less than 4 years. Therefore, having never charged does not necessarily mean the recharge interval would be very long (longer than 4 years). Assuming the vehicle ownership profile holds true for those who never charged their AC, 7.5% own their vehicle for less than one year and never charged the AC, and 22.5% own their vehicle for more than one year and never charged the AC. To be conservative, add the 22.5% to the 15% that had their last recharge more than 2 years ago, and assign a 6-year recharge interval for the total 37.5%. Exclude the 7.5% that have owned their vehicle for less than a year and never recharged the AC, and normalize the rest of the population. Using Equation (4.5.5), the average recharge interval is 14.2 months.

Frost and Sullivan Study

Commissioned by the ARPI, the Frost and Sullivan Co. conducted an online survey to investigate consumer purchase and usage behavior of small cans (Fn?st and Sullivan, 2006). Its California sample includes 400 respondents. The questionnaire did not explicitly ask about the recharging intervals. However, this information can be derived from the response to some other questions when making a few assumptions.

According to the study, out of the 400 respondents, 38% or 152 of them generally would not use the full can of HFC-134a. Since whether a full can is used is a natural outcome of the recharging process, instead of an arbitrary decision, any other aspects of the can usage of these 152 people should be representative of the California respondents as a whole. So we only need analyze these 152 samples. Among them, 62% or 95 would store the partial can, and the rest 38% or 57 would dispose of it. Of the 95 people that stored the partial cans, 22% of them said that they had not tried to re-use them. This can be conservatively interpreted as the fraction of people that had only recharged once.

The study provides the storage period for those who would store the partial cans. This information is included in the first and third columns of Table 6. Each storage period range is assigned a storage period as the middle value of the range in the second column, where storage period of longer than 18 months is conservatively assigned the value of 72 months. Some of them are first time DIY and we need to exclude them when estimating the recharge intervals. However, 12% of the people stored the cans for over a year and they are certainly not the first time DIY. This is because the survey respondents all had recharged AC in the past 12 months. If they are the first time users, the recharge events happening within the 12 months were their only experience and their storage periods are definitely less than 12 months. We have shown that 22% of the people had only charged once. This translates into 25% out of the 88% whose storage periods were less than a year (25% = 22% ÷ 88%). Evenly allocating

25% to all these 88% people, we get the percentage of the first time DIY in column 4, totaling 22% as expected. Only the rest 78% are the non-first time DIY, which is tabulated in column 5 and normalized in column 6. Finally, we use 62% to adjust the normalized percentages since 62% of all DIY consumers would store the cans.

Table 6: Storage Period for People Who would Store Partial Cans

| Storage Period Range | Storage Period (months) | Percent of DIY | First Time DIY | Non-first Time DIY | Normalized Non-first Time DIY | Non-first Time DIY Multiplied by 62% |
|---|---|---|---|---|---|---|
| 0-3 man | 3 | 27% | 7% | 20% | 26.0% | 12.6% |
| 3-6 man | 4.5 | 19% | 5% | 14% | 18.3% | 8.8% |
| 6-9 man | 7.5 | 25% | 6% | 19% | 24.0% | 11.6% |
| 9-12 man | 10.5 | 17% | 4% | 13% | 16.4% | 7.9% |
| 12-18 man | 15 | 6% | 0% | 6% | 7.7% | 3.7% |
| >18 man | 72 | 6% | 0% | 6% | 7.7% | 3.7% |
| | Total of First 4 Lines | 88% | 22% | | | |
| | Total of First 4 Lines Divided by 22% | 25% | | | | |

On the other hand, of all the California respondents (348 valid responses), 42% had only recharged their present and past vehicles once. As an approximation, we assume all the recharges happen to their present vehicles. This percentage should hold true for the 152 people that would not use up the full cans. Therefore,

$$22\% \times 62\% + P_{disp} \times 38\% = 42\%,$$

where $P_{disp}$ is the percentage of the first time DIY out of those who would dispose of the can. And

$$P_{disp} = 75\%.$$

It indicates that most people disposing of partial cans are first time users. This is consistent with intuition since experienced consumers would know that once the vehicle starts needing recharge, it is likely that it has some leaking problem and may need repeated recharge within a certain time frame.

Assuming disposing of or store partial cans is more related to personal preference than recharging practices, we can apply the same apportionment as in Table 6 for those who choose to dispose of partial cans by "virtual storage period". This is the period that they would store cans should they choose to store the cans. This is shown in Table 7.

Table 7: Virtual Storage Period for Those Who would Dispose of Partial Cans

| Storage Period Range | Storage Period (months) | Percent of DIY | First Time DIY | Non-first Time DIY | Normalized Non-first Time DIY | Non-first Time DIY Multiplied by 38% |
|---|---|---|---|---|---|---|
| 0-3 man | 3 | 27% | 23% | 4% | 16.0% | 1.5% |
| 3-6 man | 4.5 | 19% | 16% | 3% | 11.2% | 1.1% |
| 6-9 man | 7.5 | 25% | 21% | 4% | 14.8% | 1.4% |
| 9-12 man | 10.5 | 17% | 14% | 3% | 10.0% | 1.0% |
| 12-18 man | 15 | 6% | 0% | 6% | 24.0% | 2.3% |
| >18 man | 72 | 6% | 0% | 6% | 24.0% | 2.3% |
| | Total of First 4 Lines | 88% | 75% | | | |
| | Total of First 4 Lines Divided by 75% | 85% | | | | |

Adding the last columns of the above two tables, we obtain the storage period for the overall California samples (Table 8). It is important to note that this study restrict the survey panel to those who had charged their MVAC during the last 12 months. Thus, the survey panel members with recharge intervals of less than 12 months are not filtered. But for those with recharge intervals of more than 12 months, only a fraction will be able to participate in the survey. For example, for the group that has recharge intervals of 6 years, approximately 1/6 of them would have performed recharging during the last 12 months and would have been captured by the survey. Their percentages in the following table should then be multiplied by 6 to account for that. This is also true for the group with recharge interval of 15 months. After this adjustment and then normalization, around half of the samples have a recharge interval of more than a year. Using Equation (4.5.5), the average recharge interval is 8.5 months.

Table 8: Overall Storage Period

| Storage Period Range | Storage Period (months) | Combined Non-first Time DIY | Adjusted Combined Non-first Time DIY | Normalized Non-first Time DIY |
|---|---|---|---|---|
| 0-3 man | 3 | 14.1% | 14.1% | 15.8% |
| 3-6 man | 4.5 | 9.9% | 9.9% | 11.1% |
| 6-9 man | 7.5 | 13.0% | 13.0% | 14.6% |
| 9-12 man | 10.5 | 8.9% | 8.9% | 9.9% |
| 12-18 man | 15 | 6.0% | 7.5% | 8.4% |
| >18 man | 72 | 6.0% | 36.0% | 40.3% |

NPD Sales Data

The NPD Automotive Aftermarket Industry Monitor provides cashier transaction information from the U.S. auto parts chain retailers (NPD, 2008). The data come from nine participants including Advance, AutoZone, CSKlMurrays, PepBoys, O'Reilly's, CarQuest, NAPA, Strauss Auto and Parts Alliance. As shown in Table 9, in 2006 and 2007, average annual sales of HFC-134a units without charging kits were 14 million. Given that every recharging uses about 1.3 cans on average, this suggests 11 million DIY recharging operations each year. The Average annual sales of charging kits were·just over 1 million. Assuming a vehicle's "effective lifetime" during which it needs recharging is 9 years and every DIY user only purchase one charging kit and use it throughout his vehicle's lifetime, the number of DIY vehicles should be equal to the total sales of charging kits in 9 years, which is about 10 million. Thus, on average, a DIY vehicle gets 1.1 recharging per year and the recharge interval is 10.8 months.

Table 9: NPD Data on HFC-134a Units Sold in the U.S.

| | 2006 & 2007 Total |
|---|---|
| Total HFC-134a Units without Charging Kits | 14,079,386 |
| AC Charging Kits | 1,086,872 |
| DIY Recharge Operations per Year | 10,830,297 |
| AC Charging Kits Sold in 9 Years | 9,781,848 |
| DIY Vehicles | 9,781,848 |
| Recharges per Vehicle per Year | 1.1 |

Summary

The recharge interval estimates range from less than three quarters to slightly over 14 months (Table 10). Therefore, it is reasonable to assume a recharge interval $Y_1 = 1$ year.

Table 10: Summary of Recharge Interval Estimates

| Data Source(s) | Sample Size | Recharge Interval Estimate (months) |
|---|---|---|
| ARB El Monte Survey | 7 | 11.7 |
| 2008 ARPI DIY Survey | 20 | 14.2 |
| Frost and Sullivan Study | 152 | 8.5 |
| NPD Survey | | 10.8 |

4.5.2 Po

SAE supplied data that indicate that of all the HFC-134a used in MVAC nationwide in 2003, factory fill, 30-lb cylinders and small cans share 30%, 39% and 31%, respectively (Atkinson, 2008a). 30-lb cylinders are apparently exclusively used by professional servicing. But some professional technicians also use small cans, which is about 3.5% of the total usage by professional shops (MACS, 2008). Thus, out of all the HFC-134a used in MVAC, the percentage of HFC-134a in small cans used by professional shops is

$$\frac{3.5\%}{1-3.5\%} \times 39\% = 1.4\% .$$

!

So the percentage of small cans used by professional servicing in relation with the total small can usage is

$$\frac{1.4\%}{31\%} = 4.6\%.$$

Therefore, 96.4% of small cans are sold to DIY. Rounding it off, we have $P_0$ = 95%.

4.5.3 $P_{31}$, $P_{32}$, $P_{33}$, and $P_{34}$

A study of small can consumers commissioned by the ARPI estimates that 12% of former DIY owners would opt to have no air conditioning rather than go to a professional shop, 49% would go to the professional shop, and 39% would look for other options of obtaining refrigerant (Frost and Sullivan, 2006). The 39% of consumers seeking alternative options will contribute to illegal internet or out of state sales, but given the inconvenience of doing that, it is unlikely that all of them will have the perseverance to circumvent the can ban. The true rate of DIY circumventing the ban will probably be somewhere between 0% and 39%. In the absence of further data on which to assign a fraction, we take the midpoint of this range, or 19%, to maximize the probability of being close to reality. We assume that the remainder of those looking for alternative sources of HFC-134a will choose one of the legitimate options which are: obtain professional repairs, obtain professional recharge without repair, obtain professional top off, forgo air conditioning, or go to professional servicing without deciding on actions. We assign the rest half (20% of total) of the former DIY equally among those five legitimate options: 4% forgo air conditioning; 4% go to the shop for repair and recharge; 4% go to the shop for recharge without repair; 4% go to the shop for topping off; and 4% go to the shop undecidedly. The percentages in each category become: forgo air conditioning 12% + 4% = 16%; go to the shop undecidedly 49% + 4% =53%; go to the shop with the specific objective of repair 4%; go to the shop specifically for recharge without repair 4%; go to the shop specifically for topping off 4%; and obtain HFC-134a by alternative means 19%.

A 2005 MACS study showed the choices of customers who currently visit professional shops for diagnosis and repair (Atkinson, 2008b). The study surveyed 7 service facilities located in Pennsylvania, Ohio, Arizona, California and Florida and included over 1,400 repair orders. In that study, among those with refrigeration circuit problems, 88% chose to have their system repaired or recharged, 7% chose to simply be topped off, and the other 5% choose to reject recharges and forgo air conditioning. The first two categories, adding up to 95%, represent all the operations that involve adding refrigerant. An IMR Continuing Consumer Auto Maintenance Survey (CCAMS) data supplied by ARPI (ARPI, 2008a) suggest that of all professional servicing that involve adding refrigerant, only 56% involves repair. This translates into 53% in context of the 95%, whereas the other 42% of the 95% are either topping off (7%) or recharge without repair (42% - 7% =35%).

Assuming the 53% of consumers described in the first paragraph who go to professional shops without deciding on actions would behave the same way as normal customers at professional shops, they are reapportioned into categories as described in the preceding paragraph: 28% of former DIY consumers have AC repaired; 19% get recharge without repair; 3% receive topping off; and another 3% forgo AC. Recombining them with those who already have specific goals, $P_{31}$ = 32% get professional repair, $P_{32}$ = 23% receive professional recharge, $P_{33}$ = 7% top off at professional servicing, $P_{34}$ = 19% continue DIY recharging AC using refrigerant obtained through alternative means, and the other 19% forgo AC. The figure below shows how the various fractions were apportioned and combined, with the final values on the right.

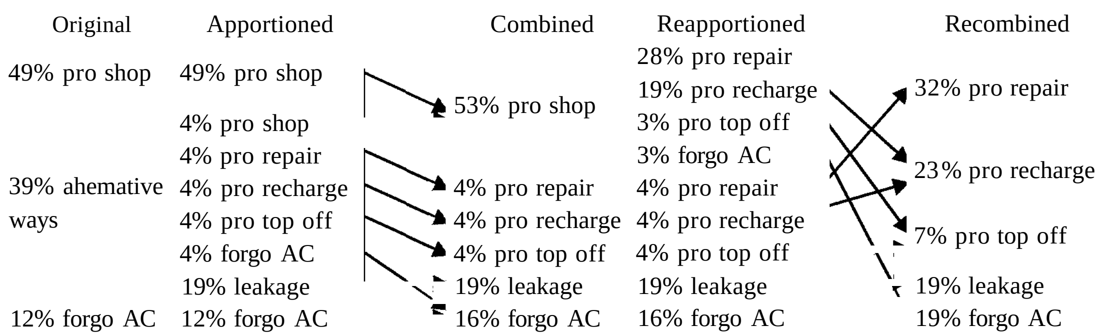


**Figure 5. DIY Behavior Change under Can Ban**

### 4.5.4 $F_1$ *and* $F_2$

The average nominal charge size of passenger vehicles in the U.S. is 824 grams (Thundiyil, 2008b). It assumed the AC average to 50% empty when brought in to the professional servicing facility for recharge (Assumption 5), which indicates that 412 grams of refrigerant remains in the AC.

Every DIY recharge uses 445 grams of refrigerant (all fresh), with 98 grams (22%), 49 grams (11%), and 298 grams (67%) as can heel, servicing loss, and effective charge, respectively. Apparently DIY on average recharge AC at 86% (412 grams remaining refrigerant + 298 grams fresh refrigerant) of nominal level. A DIY recharged AC has 298 grams of refrigerant to lose before the next recharge is needed.

In comparison, a professional technician has the equipment and skills to restore AC charge to its nominal level, rendering more refrigerant (412 grams) in the systems to be emitted before the next servicing is needed. When no repair is conducted, the recharged AC will leak at the same rate as a DIY recharged AC, but at a prolonged period. The recharge interval for a professionally recharged AC to that for a DIY recharged AC is

$$F_1 = \frac{412}{298} = 1.4.$$

It should be noted that during professional servicing (with or without repair), the amount of fresh refrigerant effectively charged into AC is not 412 grams because the remaining refrigerant needs first to be recovered and stored in a cylinder. Then it will be recharged back into the AC. These operations will incur losses due to servicing losses and cylinder heels. The refrigerant lost during incomplete recovery is by far the main source of servicing losses. For purpose of analysis, we assume the refrigerant recovery rate by professional servicing using the current prevailing equipment and practices is 85%. Thus, 62 grams (15% of 412 grams) will be lost due to incomplete recovery. A new SAE standard for refrigerant recovery and recharge, J2788, has taken into effect, to replace the old SAE J2210 standard. Using the equipment and practices compliant with the new standard, the recovery rate will be increased to at least 95% (about 21 grams of servicing loss). However, there is no requirement for the professional servicing to replace their current recovery machines, and the phase-in of the new machines will likely be slow. The recovered 350 grams will be stored in cylinder for future use. Not all of them will be effectively charged into AC during the next servicing due to cylinder heels. The U.S. EPA Disposable Container Heel Testing Study found that the cylinder heel in professional servicing is about 1.8% (U.S. EPA, 2007). This translates into about 7 grams loss in cylinder heel out of the recovered 350 grams. The rest of 343 grams will be effectively charged into AC during the next recharge. To add up to the nominal charge of 824 grams, another 481 grams of fresh refrigerant needs to be effectively charged into the AC, which will cause another 10 grams of losses in cylinder heel. Therefore, the ratio of fresh refrigerant effectively charged into AC during professional recharging to thatduring DIY recharging is

$$F_2 = \frac{481}{298} = 1.6.$$

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State of California
AIR RESOURCES BOARD

# NOTICE OF POSTPONEMENT

## NOTICE OF PUBLIC HEARING TO CONSIDER PROPOSED CALIFORNIA EVALUATION PROCEDURES FOR AFTERMARKET CRITICAL EMISSION CONTROL PARTS ON HIGHWAY MOTORCYCLES

BY NOTICE dated October 14, 2008, and published in the October 24, 2008, California Notice Register, Register 2008, No. 43-Z, the Air Resources Board (the Board or ARB) announced it would conduct a public hearing consider the adoption of new California evaluation procedures for aftermarket critical emission control parts on highway motorcycles. The hearing was scheduled for December 11, 2008, at 9:00 a.m.

PLEASE BE ADVISED that the hearing has been postponed to the following date:

DATE: January 22, 2009

TIME: 9:00 a.m.

PLACE: California Environmental Protection Agency
Byron Sher Auditorium, Second Floor
1001 I Street
Sacramento, California 95814

This item will be considered at a two-day meeting of the Board, which will commence at 9:00 a.m., January 22, 2009, and may continue at 8:30 a.m., January 23, 2009. This item may not be considered until January 23, 2009. Please consult the agenda for the meeting, which will be available at least ten days before January 22, 2009, to determine the day on which this item will be considered.

For individuals with sensory disabilities, this document and other related material can be made available in Braille, large print, audiocassette, or computer disk. For assistance, please contact ARB's Reasonable Accommodations/Disability Coordinator at (916) 323-4916 by voice, or through the California Relay Services at 711, to place your request for disability services, or go to http://www.arb.ca.gov/html/ada/ada.htm

If you are a person with limited English and would like to request interpreter services to be available at the Board meeting, please contact ARB's Bilingual Manager at (916) 323-7053.

CALIFORNIA AIR RESOURCES BOARD

James N. Goldstene
Executive Officer

Date: November 7, 2008

# TITLE 13. CALIFORNIA AIR RESOURCES BOARD

## NOTICE OF PUBLIC HEARING TO CONSIDER PROPOSED CALIFORNIA EVALUATION PROCEDURES FOR AFTERMARKET CRITICAL EMISSION CONTROL PARTS ON HIGHWAY MOTORCYCLES

The Air Resources Board (the Board or ARB) will conduct a public hearing at the time and place noted below to consider the adoption of new California evaluation procedures for aftermarket critical emission control parts on highway motorcycles.

DATE: December 11, 2008

TIME: 9:00 a.m.

PLACE: California Environmental Protection Agency<br>Air Resources Board<br>Byron Sher Auditorium<br>1001 I Street<br>Sacramento, California 95814

This item will be considered at a two-day meeting of the Board, which will commence at 9:00 a.m., December 11, 2008, and may continue at 8:30 a.m., December 12, 2008. This item may not be considered until December 12, 2008. Please consult the agenda for the meeting, which will be available at least ten days before December 11,2008, to determine the day on which this item will be considered.

For individuals with sensory disabilities, this document and other related material can be made available in Braille, large print, audiecassette, or computer 'disk. For assistance, please contact ARB's Reasonable Accommodations/Disability Coordinator at 916-323-4916 by voice or through the California Relay Services at 711, to place your request for disability services, or go to http://www.arb.ca.gov/html/ada/ada.htm.

If you are a person with limited English and would like to request interpreter services to be available at the Board meeting, please contact ARB's Bilingual Manager at 916-323-7053.

## INFORMATIVE DIGEST OF PROPOSED ACTION AND POLICY STATEMENT OVERVIEW

Sections Affected:

Proposed adoption to California Code of Regulations, title 13, new subsection 2222(j), Add-On Parts and Modified Parts, and proposed adoption of the incorporated document, "California Evaluation Procedures for Aftermarket Critical Emission Control Parts on Highway Motorcycles."

**Background:**

ARB has been regulating emissions from highway motorcycles since 1978. Beginning with the 2004 model year, ARB's highway motorcycle emission standards became more stringent (an exhaust emission standard of 1.4 grams/kilometer for hydrocarbons-plus oxides of nitrogen, the first major reduction since the 1988 model year.) The standard applicable to 2008 and subsequent model year motorcycles was further increased in stringency compared to the 2004 standard (0.8 grams/kilometer for_hydrocarbons plus oxides of nitrogen). Motorcycle manufacturers have been able to comply with these increasingly more stringent standards by using cost-effective technologies in engine design, fuel injection, closed-loop control systems, and catalytic converters. Generally,- this has meant the increased integration of critical emission control parts, such as oxygen sensors and catalytic converters for exhaust emissions compliance, and hydrocarbon adsorbers for evaporative emissions cor;npliance, into motorcycle exhaust systems. Certificatiqn sales data indicates that the use of catalytic converters alone in highway motorcycles increased by almost five times percentage-wise between the 1996 and 2008 model years (from-18 to 87 percent.)

Health and Safety Code section 43100 et seq. -requires that new motor vehicles comply with emission standards. Manufacturers, through new vehicle certification, must demonstrate that their vehicles will comply with applicable emission standards throughout the vehicle's useful life. Modifying a certified vehicle may be considered tampering and could result in excess emissions.

California Vehicle Code sections 27156 and 38391 prohibit the sale, offer for sale, advertisement, or installation of any device that alters the design or performance of any required motor vehicle pollution control device or system. ARB has the statutory authority to exempt add-on and modified parts from this prohibition if it finds that such modifications will not reduce the effectiveness of any required pollution control device or will not cause vehicle emissions to exceed applicable standards. Pursuant to this authority, ARB has adopted regulations applicable to aftermarket parts, and has recently adopted provisions specifically applicable to aftermarket catalytic converters. However, ARB's aftermarket converter regulations were developed to address issues raised in the context of passenger cars and light-duty and medium-duty vehicles; catalytic converters to control motorcycle emissions have not been previously addressed. Consequently, ARB's existing aftermarket converter provisions are not directly applicable to non-original equipment manufacturer aftermarket catalytic . converters for highway motorcycles. These parts are considered aftermarket critical emission control parts (defined as parts that are primarily designed to reduce emissions and are necessary for vehicles to comply with emission standards). - Other examples of aftermarket critical emission control parts for highway motorcycles include oxygen sensors and hydrocarbon adsorbers.

In the past, submitted applications for exemption of motorcycle aftermarket parts in general have been low. Part of the reason for this has been the lack of consistent enforcement at the dealerlretailer level to ensure that legal aftermarket parts were being sold. ARB has increased these efforts in recent years, and is actively assessing monetary penalties on manufacturers and dealers for noncompliance. Still, ARB inspections do not confirm that motorcycle owners are indeed installing legal aftermarket parts. Ultimately, it is anticipated that an Inspection and Maintenance program (Le., Smog Check) will proviqe necessary oversight of ARB's aftermarket parts program.

Unlike cars whose exhaust systems are rarely modified until a repair is needed, a recent survey by ARB staff showed that 85 percent of motorcycle owners modify their motorcycles while relatively new. A frequent modification is to replace the original exhaust system, which may likely include a catalytic converter, with an aftermarket exhaust system that does not. This type of modification increases emissions and is illegal under state law. Unfortunately, it is a widespread practice.

As ARB staff investigated this practice, manufacturers of motorcycle aftermarket exhaust systems suggested that ARB develop an aftermarket exhaust system approval process that would result in the legal sale of aftermarket exhaust systems that did not degrade emissions given the high rate of modifications occurring. Staff agreed and' developed the proposed regulation.

The proposed regulatory procedures were developed after considering the issues unique to highway motorcycles, and the procedures therefore allow exempted·parts to replace fully functional original equipment manufacturer (OEM) emission control systems within the original emission warranty period. The procedures also incorporate safeguards to ensure that any exempted parts do not reduce the effectiveness of any required pollution control device or cause motorcycles to exceed applicable emission standards, as required by Vehicle Code sections 27156 and 38391. Such safeguards essentially mirror the requirements applicable to OEM motorcycle manufacturers.

The absence of exemption procedures for aftermarket critical emission control parts for highway motqrcycles may cause motorcycle owners to use aftermarket parts that have not received ARB's approval and are therefore likely to cause increased emissions. ARB's current emissions inventory includes the emissions contribution of catalyst, non-catalyst, fuel injected, carbureted, tampered and non-tampered motorcycles. As part of the 1998 motorcycle rulemaking, staff estimated the impact of tampering on motorcycles. Although the impact of tampering on the benefits of the rulemaking was estimated to be small overall, the impact on an individual motorcycle may be significant. As an example, a 2008 motorcycle with fuel injection and a catalytic converter that has been tampered will emit approximately ten times the hydrocarbon emissions of a non-tampered motorcycle.[1] Establishing a process for evaluating and approving. aftermarket critical emission control parts will help reduce the effects of tampering by allowing emission compliant aftermarket parts to be sold and installed on highway motorcycles in California.

1 EMFAC2007, Techn!cal Support Document Section 4.11 On-road Motorcycle Activity, Technology Groups, and Emission Rates, http://www.arb.ca.gov/msei/onroad/doctabletest.htm
Appendix 4.11-0, comparing FTP Bag 1 HC emission zero mile emission rates.

## PROPOSED REGULATORY ACTION

Staff is proposing new evaluation procedures that would establish criteria for aftermarket critical emission control parts on highway motorcycles in California. Because these parts will likely be installed on relatively new highway motorcycles that are still within the coverage of the original manufacturer's warranty, the proposed procedures incorporate many certification provisions applicable to new highway motorcycles to help ensure that exempted parts will be as reliable and durable as the original emission controls in certified highway motorcycles.

The proposed procedures would require manufacturers to demonstrate that their aftermarket critical emission control parts, when installed and aged on a designated test vehicle, would not cause the vehicle to exceed applicable exhaust or evaporative emission standards over the useful life of the motorcycle.

The procedures would also require manufacturers to warrant their aftermarket critical emission control parts are free from defects for up to the full useful life of the highway motorcycle if the part is installed within four years of the date that the motorcycle is first acquired by an ultimate purchaser. Shorter warranty periods apply if parts are installed on older motorcycles. Manufacturers or installers would also be required to provide an installation warranty for two years or 7,456 miles, whichever occurs first.

The proposed procedures also establish warranty reporting requirements, labeling requirements, and audit reporting and testing and recall procedures that essentially mirror requirements applicable to manufacturers of new motorcycles.

## COMPARABLE FEDERAL REGULATIONS

The United States Environmental Protection Agency (U.S. EPA) has adopted regulations applicable to aftermarket parts in Code of Federal Regulations, title 40, part 85. However, these regulations only establish a voluntary self-certification program. In contrast, ARB's aftermarket parts regulations require aftermarket part manufacturers to receive and obtain an exemption before they can sell parts in California.

Aftermarket catalytic converters are legal for sale federally under an enforcement policy established by U.S. EPA in 1986, but the policy does not constitute a regulation. Moreover, U.S. EPA's policy was established to address issues regarding aftermarket converters for light-duty vehicles and light-duty trucks, not highway motorcycles. Since issuing its enforcement policy, U.S. EPA has thus far decided not to issue regulations specific to aftermarket converters, and has not announced any plans to do so in the near future.

## AVAILABILITY OF DOCUMENTS AND AGENCY CONTACT PERSONS

ARB staff has prepared a Staff Report: Initial Statement of Reasons (ISOR) for the proposed regulatory action, which includes a summary of the economic and

. environmental impacts of the proposal. The report is entitled: "Public Hearing to Consider Proposed California Evaluation Procedures for Aftermarket Critical Emission Control Parts on Highway Motorcycles." _

Copies of the ISOR and the full text of the proposed regulatory language, in underline and strikeout format to allow for comparison with the existing regulations, may be accessed on the ARB's website listed below, or may be obtained from the Public Information Office, Air Resources Board, 1001 IStreef,-Visitors and Environmental Services Center, First Floor, Sacramento, California95814, (916) 322-2990, at least 45 days prior to the scheduled hearing on December 11, 2008.

Upon its completion, the Final Statement of Reasons (FSOR) will be available and copies may be requested from the agency contact persons in this notice, or may be accessed on the ARB's website listed below.

Inquiries concerning the substance of the proposed regulation may be directed to the designated agency contact persons, Mr. Dean Hermano, Staff Air Pollution Specialist, at (626) 459-4487 or ehermano@arb.ca.gov, or Ms. Rose Castro, Manager, Aftermarket Parts Section, at (626) 575-6848 or rcastro@arb.ca.gov.

Further, the agency representative and designated back-up contact persons, to who nonsubstantive inquiries concerning the proposed adm.inistrative action may be directed, are Lori Andreoni, Manager, Board Administration & Regulatory Coordination Unit, (916) 322-4011, or Amy Whiting, Regulations Coordinator, (916) 322-6533. The Board has compiled a record for this rulemaking action, which includes all the information upon which the proposal is based. This material is available for inspection upon request to the contact persons.

This notice, the ISOR and all SUbsequent regulatory documents, including the FSOR, when completed, are available on the ARB website for this rulemaking at www.arb.ca.gov/regact/2008/amhmc08/amhmc08.htm.

**COSTS TO PUBLIC AGENCIES AND TO BUSINESSES AND PERSONS AFFECTED**

The determinations of the Board's Executive Officer concerning the costs or savings necessarily incurred by public agencies and private persons and businesses in reasonable compliance with the proposed regulations are presented below.

Pursuant to Government Code sections 11346.5(a)(5), the Executive Officer has determined that the proposed amendments would not impose a mandate on local agencies or school districts. The Executive Officer has further determined pursuant to Government Code section 11346.5(a)(6) that the proposed regulatory action would' result in some additional costs to ARB to implement and enforce the proposed regulatory action. In addition, the Executive Officer has determined that the proposed regulatory action would not create costs or savings in federal funding to the State, will not create costs or savings to local agencies or school districts that are required to be reimbursed under the Government Code, title 2, division 4, part 7 (commencing with section 17500), and will not result in other nondiscretionary savings to State or locar agencies.

In developing this regulatory proposal, the ARB staff evaluated the potential economic impacts on representative private persons or businesses. Manufacturers of aftermarket critical emission control parts for highway motorcycles would incur additional costs resulting from this regulation only if they choose to enter the existing California market for those parts. Therefore, costs that a part manufacturer may pay related to the regulation"s specific provisions for durability emission testing, warranty, audit testing, and'recall, are not accounted for since they are considered normal costs that any part manufacturer would be required to pay in order to legally sell aftermarket critical emission control parts in the State. Part manufacturers voluntarily make a decision to comply with the regulation based on their ability to generate satisfactory profits and to compete with motorcycle OEMs that may already be selling similar, compliant parts in California. The only applicable costs then attributable to the regulation would be those associated with the pre'paration and submittal of exemption applications that demonstrate compliance with the provisions. ARB, staff estimates that this cost would be approximately $100 per application. Over a five year regulatory life, the 60 potentially affected part manufacturers could be expected to spend up to $58,000 for those applications. The proposal is not expected to affect the ability of California part manufacturers to compete with part manufacturers in other states since it applies to all manufacturers that choose to sell parts in California.

The Executive Officer has made an initial determination that the proposed regulatory action would not have a significant statewide adverse economic impact directly affecting businesses, including the ability of California businesses to compete with businesses in other states, or on representative private persons.

In accordance with Government Code section 11346.3, the Executive Officer has determined that the proposed regulatory action could affect the creation or elimination of jobs within the State of California, the creation of new businesses or elimination of existing businesses within the State of California, or the expansion of businesses currently doing business within the State of California. Jobs are not expected to be lost as a result of the proposed regulatory action, but rather some jobs may be created in order to perform the exemption provisions. A detailed assessment of the economic impacts of the proposed regulatory action can be found in the ISOR.

The Executive Officer has also determined, pursuant to the California Code of Regulations, title 1, section 4, that the proposed regulatory action would affect small businesses. Recordkeeping costs would be borne by retailers and installers to document their sales of aftermarket critical emission control parts for highway motorcycles., Proposed recordkeeping would 'require maintenance of basic information about each sold part and its purchaser for a period of five years at a cost of about $60 per year per retailer or installer. Over that five year period, the overall cost to the 1,000+ part retailers and installers in California to comply with this requirement is estimated to be $300,000.

In accordance with Government Code sections 11346.3(c)and 11346.5(a)(11), the Executive Officer has found that the reporting requirements ofthe regulation which apply to businesses are necessary for the health, safety, and welfare of the people of the State of California.

Before taking final action on the proposed regulatory action, the Board must determine that no reasonable alternative considered by the Board, or that has otherwise been identified and brought to the attention of the Board, would be more effective in carrying out the purpose for which the action is proposed, or would be as effective and less burdensome to affected private persons than the proposed action.

SUBMITTAL OF COMMENTS

Interested members of the public may also present comments orally orin writing at the meeting, and in writing or bye-mail before the meeting. To be considered by the Board, written comments submissions not physically submitted at the meeting must be received no later than 12:00 noon, December 10, 2008, and addressed to the following:

Postal mail: Clerk of the Board, Air Resources Board
1001 I Street, Sacramento, California 95814

Electronic submittal: http://www.arb.ca.gov/lispub/comm/bclist.php

Facsimile submittal: (916) 322-3928

Please note that under the California Public Records Act (Gov. Code, § 6250 et seq.), your written and oral comments, attachments, and associated contact information (e.g., your address, phone, email, etc.) become part of the public record and can be released to the public upon request. Additionally, this information may become available via Google, Yahoo, and any other search engines.

The Board requests, but does not require, that 30 copies of any written statement be submitted and that all written statements be filed at least ten days prior to the hearing so that ARB staff and Board Members have time to fully consider each comment. The board encourages members of the public to bring to the attention of staff in advance of the hearing any suggestions for modification of the proposed regulatory action.

STATUTORY AUTHORITY AND REFERENCES

This regulatory action is proposed under that authority granted in Health and Safety Code sections 39600,39601,43000,43000.5,43011, and 43107, and Vehicle Code sections 27156, 38391, and 38395. This action is proposed to implement, interpret and make specific sections in Health and Safety Code sections 39002,39003,39500, 43000,43000.5,43009.5,43011,43107,43204, 43205, 43205.5, and 43644, and Vehicle Code sections 27156,38391, and 38395.

**HEARING PROCEDURES**

The public hearing will be conducted in accordance with the California Administrative Procedure Act, Government Code, title 2, division 3, part 1,-chapter 3.5 (commencing with section 11340).

Following the public hearing, the Board inay adopt the regulatory language as originally proposed, or with non substantial or grammatical modifications. The Board may also adopt the proposed regulatory language with other modifications if the text as modified is sufficiently related to the originally proposed text that the public was adequately placed on notice and that the regulatory language as modified could result from the proposed regulatory action; in such event, the Jull regulatory text, with the modifications clearly indicated, will be made available to the public, for written comment, at least 15 days before it is adopted.

The public may request a.copy of the modified regulatory text from ARB's Public Information Office, Air Resources Board, 1001 I Street, Visitors and Environmental Services Center, First Floor, Sacramento, California 95814, (916) 322-2990.

CALIFORNIA AIR RESOURCES BOARD.

James N. Goldstene
Executive Officer

Date: October 14, 2008

*The energy challenge facing Califomia is real. Every Califomian needs to take immediate action to reduce energy consumption. For* a *list* of *simple* ways *you can reduce demand and cut your energy* costs see *our website at www.arb.ca.gov.*

State of California
AIR RESOURCES BOARD

STAFF REPORT: INITIAL STATEMENT OF REASONS
FOR PROPOSED RULEMAKING

# PUBLIC. HEARING TO CONSIDER PROPOSED CALIFORNIA EVALUATION PROCEDURES FOR AFTERMARKET CRITICAL EMISSION CONTROL PARTS ON HIGHWAY MOTORCYCLES

Date of Release: October 24, 2008
Scheduled for Consideration: December 11, 2008

# TABLE OF CONTENTS

# EXECUTIVE SUMMARY

The Air Resources Board (ARB) has been regulating emissions from highway motorcycles since 1978. Beginning with the 2004 model year, ARB's highway motorcycle emission standards became more stringent, and this standard was further increased in stringency beginning with the 2008 model year. Motorcycle manufacturers have been able to comply with these increasingly more stringent standards by using cost-effective technologies in engine design, fuel injection, closed-loop control systems, and more recently, catalytic converters. Eighty-seven (87) percent of new 2008 model year highway motorcycles certified in California are equipped with catalytic converters incorporated in their original exhaust systems.

Highway motorcycle owners have commonly customized their motorcycles as a way of expressing their individuality and lifestyle. One of the more popular modifications today is replacement of the original exhaust system with aftermarket exhaust systems and parts. A 2003 Motorcycle Industry Council survey revealed that 38 percent of all highway motorcycles had modified exhaust systems. According to a recent ARB survey of 2003 to 2007 model year highway motorcycles, 85 percent of newer motorcycles in Southern California have had some type of exhaust modification before the original emission warranty had expired. Aftermarket exhaust systems on highway motorcycles can range from straight pipes without any catalysts to systems with catalysts that have not demonstrated durability and/or the ability to effectively control emissions.

California Vehicle Code sections 27156 and 38391 prohibit the sale, offer for sale, advertisement, or installation of any device that alters the design or performance of any required motor vehicle pollution control device or system unless that device has been exempted by ARB. In the past, most highway motorcycle aftermarket parts have not been considered to affect emissions, but that is no longer the case for aftermarket parts for newer highway motorcycles that are equipped with catalysts.

Highway motorcycle aftermarket part manufacturers and retailers have a significant presence in California. Approximately 30 of the 60 aftermarket parts manufacturers and more than 1,000 part retailers are located in California. These companies are primarily small businesses, and have a long history of providing exhaust systems to their customers. In the past, these manufacturers were able to provide unique exhaust systems that served as replacements to original manufacturer systems because they did not affectemissions. However, with the introduction of exhaust catalytic converters and related emission control components, the sale and installation of replacement exhaust systems not equivalent in performance to the original exhaust system is considered tampering and result in non-compliant motorcycles. Manufacturers of aftermarket parts for highway motorcycles have requested that ARB establish exemption procedures that would allow them to legally sell aftermarket exhaust systems by demonstrating that the aftermarket exhausts do not increase emissions.

ARB's present aftermarket parts regulation contain provisions applicable to aftermarket catalytic converters, but these were developed to address issues raised in the context of passenger cars and light- and medium-duty vehicles; there are no regulations addressing aftermarket catalytic converters and exhaust systems for highway motorcycles. These parts are considered aftermarket critical emission control parts (defined as parts that are primarily designed to reduce emissions and are necessary for vehicles to comply with emission standards). Other examples of aftermarket critical emission control parts for highway motorcycles include oxygen sensors and hydrocarbon adsorbers.

To help maintain the emission benefits of certified highway motorcycles, while also providing aftermarket part manufacturers a means to sell legally exempted aftermarket parts, staff is proposing the adoption of new exemption procedures for evaluating and exempting aftermarket critical emission control parts on highway motorcycles in California. The proposed procedures contain requirements that are similar to those applicable to the certification of new highway motorcycles. These include durability demonstration and emission testing, emission defects warranty and recordkeeping, audit testing, warranty defects reporting, and recall procedures. The proposed procedures would require that an exempted aftermarket critical emission control part demonstrate equivalent durability, functionality, and emissions compliance characteristics as the original emission control part it replaces.

Part manufacturers are estimated to only incur costs if they choose to voluntarily comply with the regulation. The proposed procedures are intended to allow them to legally enter into an existing sales market if they believe profits can be generated. Therefore, the only associated costs required by the procedures would be $100 for the preparation and submittal of each exemption application. However, due to associated development costs, motorcycle owners would likely see the price of an average aftermarket exhaust system increase by $100 to $150. Non-compliant aftermarket exhaust systems currently sell for $500 and up. Dealers and retailers that sell aftermarket critical emission control parts would also incur annual costs of $60 per year to document the sale of aftermarket critical emission control parts. The total statewide dollar costs to businesses and individuals as a result of the proposal would be $358,000 over a five year period.

If the proposed provisions are not adopted, motorcycle owners may continue to purchase and install non-exempted aftermarket parts that result in higher emissions. For example, a 2008 model motorcycle with fuel injection and catalytic converter that has been tampered will emit approximately 10 times more emissions than a non-tampered motorcycle.[1]

1 EMFAC2007, Technical Support Document section 4.11 On-road Motorcycle Activity, Technology Groups, and Emission Rates, http://www.arb.ca.gov/msei/onroad/doctabletest.htm Appendix 4.11-0, comparing FTP Bag 1 HC emission zero mile emission rates.

# I. Introduction

California Vehicle Code sections 27156 and 38391 prohibit the sale, offer for sale, advertisement or installation of any device that alters the design or performance of any required motor vehicle pollution control device or system. Air Resources Board (ARB) is authorized to exempt non-original equipment components from this prohibition if it finds that such components will not reduce the effectiveness of any required pollution control device or will not cause vehicle emissions to exceed applicable standards. Pursuant to this authority, ARB has adopted regulations that establish criteria for exempting add-on and modified parts such as fuel injection systems, superchargers, and controllers from the anti-tampering prohibitions, so they can be sold and used in California.

ARB first adopted regulations applicable to aftermarket parts in 1977. In 1989, ARB adopted regulations for aftermarket catalytic converters, to address issues regarding durability, lifetime and effectiveness that were specific to aftermarket converters. The aftermarket converter regulations were driven by the fact that converters had become (and continue to be) the single most important technology for controlling emissions from motor vehicles. ARB recently amended the aftermarket converter Jegulations in 2007 to address increases in vehicle emission contrQt durability, more stringent emission standards, and the implementation of on-board 'diagnostic systems in vehicles. However, both the 1989 and 2007 regulatio.ns were developed to address converters used on passenger cars and light- and medium-duty vehicles, and are not applicable to catalytic converter-equipped exhaust systems used on motorcycles.

Consequently, no exemption procedures currently exist for non-OEM aftermarket catalytic converters for highway motorcycles. These parts are considered to be aftermarket critical emission control parts. Other examples of aftermarket critical emission control parts for highway motorcycles include oxygen sensors and hydrocarbon adsorbers. These parts are primarily designed to reduce emissions and are necessary for vehicles to comply with emission' standards.

Manufacturers have requested ARB to adopt provisions allowing the sale and installation of aftermarket critical emission control parts on highway motorcycles. They have also asked ARB to allow sale of exempted aftermarket parts within the motorcycle's emission warranty period, which is not allowed for aftermarket catalysts used on passenger cars and trucks. They cite the current practice and high rate of exhaust system replacement while the motorcycle is relatively new as a reason to allow exempted exhaust systems and related emission control parts to be sold within the warranty period. The absence of an exemption process for aftermarket critical emission control parts would result in the continued illegal use and sale of aftermarket exhaust systems that do not contain catalytic converters, while also preventing part manufacturers who wish to develop aftermarket exhaust systems that do not degrade emissions from doing so.

## II. Background

Owners of highway motorcycles have historically engaged in customizing their motorcycles. In American popular culture, motorcycle ownership is synonymous with personal freedom, individual expression, and sometimes a rebellious attitude. Motorcycle owners are usually very passionate about their lifestyle, and this passion is expressed not only in the technological choices they make for their bikes, but is also reflected in the comfort and aesthetic' aspects related to them. Motorcycle modifications visibly reflect this enhanced attitude of becoming "one with the road," and many motorcycle owners therefore desire aftermarket parts that are lighter, better performing, and better looking than the originals. Owners want this connection from the start, and therefore perform part modifications while their motorcycles are brand new, or at least relatively new.

The Motorcycle Industry Council (MIC), an association representing various motorcycle original manufacturers (OEMs), part manufacturers, and distributors, conducted a motorcycle owner survey in 2003 that revealed that exhaust and/or muffler modifications alone existed in 38 percent of all highway motorcycles.[2] Broken down by specific motorcycle type, these modifications occurred most in sport bikes (50 percent) and cruisers.(44 percent). To determine the rate at which these modifications were occurring in newer motorcycles that are typically equipped at the time of sale with a catalytic exhaust system, staff conducted its own informal survey in Southern California of 79 owners of 2003-2007 model year highway motorcycles (primarily Harley-Davidson models). Staff's survey revealed that 85 percent of those motorcycles had at least some type of exhaust or engine modification.

Historically, exemption requests for aftermarket parts for highway motorcycles have not been common because such parts were not expected to affect emissions. Many aftermarket parts such as saddlebags, handlebars, foot pegs, and mirrors are purchased solely for utility or cosmetic reasons and have no emissions impact. ARB first adopted emission standards and associated test procedures applicable to 1978 and subsequent model year on-road motorcycles in 1975, and has amended these standards in 1984. Highway motorcycles could certify to the earlier emission standards through the use of relatively simple controls, such as engine modifications to carbureted fuel systems and ignition timing for exhaust emissions and carbon canisters for evaporative emissions compliance. Most aftermarket parts were not expected to affect the emission control-related parts of the motorcycle. Customized exhaust systems were, for the most part, considered replacement parts because most were slip-on type or replacement of existing exhaust pipes that did not contain catalytic converters in them.

Beginning with the 2004 model year, ARB's motorcycle emission standards became more stringent (an exhaust emission standard of 1.4 grams/kilometer for hydrocarbons plus oxides of nitrogen, the first major reduction since the 1988 model

2 "MIC 2003 Motorcycle/ATV Owner Survey," Table 144-1, Motorcycle Industry Council, 2004.

year). The emission standard for 2008 and subsequent model year motorcycles was lowered to 0.8 grams/kilometer for hydrocarbons plus oxides of nitrogen. Motorcycle manufacturers have been able to comply with these more stringent standards through changes in engine design, and use of fuel injection, closed-loop control systems, and catalytic converters. Generally, this has meant the increased integration of critical emission control parts, such as oxygen sensors and catalytic converters for exhaust emissions compliance into motorcycle exhaust systems, and hydrocarbon adsorbers for evaporative emissions compliance into air intake systems. Certification sales data (Table 1 below) indicates that the use of catalytic converters alone in highway motorcycles increased by almost five times percentage-wise between the 1996 and 2008 model years (from 18 to 87 percent).

Table 1 - Projected Sales of Catalyst-Equipped Highway Motorcycles in California*
(1996-2008 Model Years)

| Model Year | Total Number of Highway Motorcycles Sold | Catalyst-Equipped | Non-Catalyst-Equipped | %of Highway Motorcycles with Catalysts |
|---|---|---|---|---|
| 1996 | 38,558 | 6,821 | 31,737 | 17.7% |
| 1997 | 42,107 | 8,479 | 33,628 | 20.1% |
| 1998 | 42,553 | 10,751 | 31,802 | 25.3% |
| 1999 | 59,346 | 14,148 | 45,198 | 23.8% |
| 2000 | 44,238 | 15,561 | 28,677 | 35.2% |
| 2001 | 48,156 | 16,369 | 31,787 | 34.0% |
| 2002' | 66,141 | 26,789 | 39,352 | 40.5% |
| 2003 | 84,842 | 31,312 | 53,530 | 36.9% |
| 2004 | 80,399 | 52,941 | 27,458 | 65.8% |
| 2005 | 79,166 | 54,395 | 24,771 | 68.7% |
| 2006 | 117,844 | 76,996 | 40,848 | 65.3% |
| 2007 | 199,943 | ,130,297 | 69,646 | 65.2% |
| 2008 | 106,309 | 92,503 | 13,806 | 87.0% |

* Based on ARB new vehicle certification data.

Despite the increased usage of critical emission control parts on highway motorcycles, only limited numbers of aftermarket parts for highway motorcycles have been exempted by ARB. This was partly because enforcement of the emission standards in-use was not Widespread due to a lack of an Inspection and Maintenance program, Le., "Smog Check," for motorcycles. Also, there was little or no visual inspection of motorcycle aftermarket parts by ARB staff at either the dealer or owner levels to verify that the parts had been exempted. In recent years, ARB has increased its inspections of dealers and retailers selling motorcycle aftermarket parts. These activities have resulted in more part manufacturers requesting aftermarket exemptions for their products.

The increasing usage of more complex emission control systems, combined with the increased presence of ARB enforcement actions, has led manufactu'rers of motorcycle aftermarket parts to request that ARB develop a suitable evaluation process that would allow them to legally sell aftermarket exhaust systems that contain critical emission control parts such as aftermarket catalytic converters. ARB's current evaluation procedures are not well suited to evaluate the effectiveness ofhighway motorcycle catalytic converters.

ARB has exemption procedures for aftermarket catalytic converters used on light and medium-duty vehicles, but those procedures only allow aftermarket converters to be installed in vehicles that are beyond the coverage of the OEM catalyst warranty period (typically after 70,000 miles of operation) and where a legitimate need for the replacement converter has been established and documented, such as a defective or missing converter (which is usuaHy detected through a Smog Check test failure.) Aftermarket catalytic converters for light-duty vehicles are typically approved for vehicles four model years old and older.

To address the need for an exemption procedure for aftermarket exhaust systems and related emission control parts for highway motorcycles, ARB is proposing new evaluation procedures. These procedures were developed after considering the issues unique to aftermarket part sales for highway motorcycles, and the procedures therefore allow exempted parts to replace fully functional OEM emission control systems within the original emission warranty period. The procedures also incorporate safeguards to ensure that any exempted parts do not reduce the effectiveness of any required pollution control device or cause motorcycles to exceed applicable emission standards, as required' by Vehicle Code sections 27156 and 38391. Such safeguards essentially mirror the certification requirements applicable to OEM motorcycle manufacturers.

## Ill. Comparable Federal Regulations

The United States Environmental Protection Agency (U.S. EPA) has adopted regulations applicable to aftermarket parts in Title 40, Code of Federal Regulations Part 85. However, these regulations only establish a voluntary self-certification program. In contrast, California law and ARB's program require aftermarket part manufacturers to receive and obtain an exemption before they can sell parts in California.

Aftermarket catalytic converters are legal for sale federally under an enforcement policy established by U.S. EPA in 1986, but the policy does not constitute a regulation. Moreover, U.S. EPA's policy was established to address issues regarding aftermarket converters for light-duty vehicles and light-duty trucks, not highway motorcycles. To date, U.S. EPA has not issued regulations specific to aftermarket catalytic converters, and has not announced any plans to do so in the future.

## IV. Proposed Regulatory Provisions

### A. Applicability

The proposed procedures would establish exemption criteria applicable to aftermarket critical emission control parts for use on highway motorcycles in California. An aftermarket critical emission control part is anyadd-on or modified part that is intended to modify or replace any original part designed and used primarily for the reduction of emissions. Examples of such parts are catalytic converters, oxygen sensors, and hydrocarbon adsorbers. The proposed procedures would not apply to non-critical aftermarket add-on and modified parts, such as superchargers, fuel injectors, controllers, etc. as these parts will continue to be considered for exemption under ARB's existing exemption procedures for aftermarket parts.[3]

### B. Emissions Testing & Durability Requirements

The proposed procedures establish emissions testing and durability requirements that are very similar to those in the new highway motorcycle certification requirements. An aftermarket parts manufacturer would be required to identify each highway motorcycle engine family that may use its aftermarket critical emission control part. The manufacturer would then install its part in a "worst case" motorcycle, and accumulate mileage in accordance with the service accumulation requirements applicable to new motorcycle certification to demonstrate durability and generate deterioration factors from the emission test results. To be eligible for an exemption, the modified motorcycle's exhaust emissions, with the deterioration factors applied, would have to meet the applicable useful life emission standards. Both exhaust and evaporative emission testing would be required, but the evaporative emission requirement may be waived if the manufacturer can provide technical Justification that the part does not affect evaporative emissions. No issues were raised by parts manufacturers during the two public workshops held by ARB on April 9, 2008, and August 20,2008, respectively, or in individual meetings regarding these testing requirements.

The proposed procedures would allow ARB to conduct confirmatory tests within 30 days of the submittal of the emission data. To reduce testing burdens, the procedures would also allow carry-over and carry-across of emissions data to other similar applications, subject to an advance approval by the Executive Officer.

### C. Emissions Defect Warranty & Recordkeeping

Aftermarket critical emission control part manufacturers would be required to warrant that their parts are designed and manufactured to comply with the requirements of the proposed procedures, and are free from defects in materials and workmanship

[3] "Procedures for Exemption of Add-On and Modified Parts," Air Resources Board, adopted November 4, 1977, and as amended on June 1, 1990.

which cause the part to fail to conform with the requirements of these procedures or to cause damage to any original part on the highway. motorcycle. This warranty is similar to the emissions defect warranty that new highway motorcycle manufacturers are required to provide in title 13, CCR section 2036(c).

The proposed emission defects warranty for an aftermarket part installed on a highway motorcycle within four years of its original purchase would extend to a maximum of five years ororiginal warranty period mileage specific to the motorcycle class in question, whichever occurs first. For a class I motorcycle, the·warranty period mileage is 12,000 kilometers (km) (7,456 miles), class II is 18,000 km (11,185 miles), and class III is 30,000 km (18,641 miles). The emission defects warranty for an aftermarket part installed on a highway motorcycle more than four years from its date of original purchase would extend to three years or half the original warranty period mileage, whichever occurs first.

The proposed procedures would also require installers of aftermarket critical emission control parts to warrant that they have installed the part according to the part manufacturer's specified instructions and that the installation will not cause the part to fail to conform with the requirements of the procedures or to cause damage to any original part on the highway motorcycle. The installationwarranty would extend two years or 12,000 km (7,456 miles) whichever occurs first. This coverage was reduced from staff's original proposal after industry pointed out that installation defects are usually detected shortly after an aftermarket part is installed.

Finally, the proposed procedures would require manufacturers to supply a warranty registration card with each aftermarket critical emission control part. The registration card would include the general terms and conditions of applicable emission warranties, and request information from the purchaser that is needed to notify the purchaser in the event of a warranty claim or a recall action. Manufacturers would be responsible for ensuring that at least 50 percent of registration cards are returned by customers,and would be required to implement measures, such as offering product incentives and inserting various tags or labels with the aftermarket critical emission control part reminding purchasers to complete their cards, to increase the return rates. Staff proposed the 50 percent warranty card return requirement in response to industry comments that part manufacturers only se!1 their products to distributors and because parts manufacturers do not directly deal with parts purchasers, they would not be able to trace and locate purchasers in the event of a recall action. Manufacturers would also be allowed to alternatively comply with the 50 percent return rate requirement if they could demonstrate they could accurately locate 50 percent of the part purchasers irrespective of the number of warranty cards returned.

Manufacturers and installers would be required to retain records of sales and/or installation of aftermarket critical emission control parts for a minimum of five years after sale or installation of the part.

Issues related to the 50 percent warranty card return and recordkeeping requirements were raised at ARB's second public workshop, and are discussed in section V. of this report.

D. Exemption Labeling

The proper labeling of an aftermarket critical emission control part is essential to facilitate identification that a part is legal for use in California. The proposed procedures would require part manufacturers to stamp or emboss the following information on the part: the part manufacturer's name, the device name and model number, and the Executive Order number. All information must be visible and readable. If the part is too small for the required information to be stamped or embossed, the manufacturer would be required to supply a legible identification plate or label with instructions on the location on which the label will be permanently affixed.

E. Application Submittal

Manufacturers initiate ARB approval process for aftermarket critical emission control parts by submitting an application ·for exemption. The proposed procedures specifically list the information and data that must be included in the application. An exemption Executive Order will be issued after the submitted test data and information have been reviewed and determined to comply with all the requirements in the procedures. Once a manufacturer is issued an Executive Order for an aftermarket critical emission control part that is designed or intended for installation on specified motorcycle models, that manu.facturer can sell and install that part until and unless it needs to update the Executive *Order* to incorporate changes in part design that could affect emissions or to add other motorcycle models. Although the proposed procedures do not require them to do so, part manufacturers are encouraged to submit a "Letter of Intent" to the Executive Officer before submitting an application for exemption and before conducting any emissions testing or service accumulation. The letter should list the names and types of aftermarket critical emission control parts that the manufacturer intends to seek exemptions for, the applicable motorcycle engine families, and the recommended test vehicle selections. This advance notification will allow staff to provide feedback whether the test vehicles are properly selected and whether the test plan is consistent with the requirements in the procedures, and could therefore prevent manufacturers from unnecessarily accruing test expenses. Advance notification will also allow ARB to allocate adequate staff resources to review the forthcoming applications ina timely manner.

F. Audit Reporting and Testing

Manufacturers would be required to submit quarterly reports that provide the total .number of exempted parts produced, and the total number of parts sold or installed in California with the corresponding vehicle identification numbers as determined by warranty registration cards or other satisfactory methods. ARB could then use these reports to determine if and when audit testing of an aftermarket critical emission control part should be conducted.

Audit testing would be ARB's primary means of ensuring that production parts are identical in all material respects to an exempted part, and that production parts comply with applicable emission standards. The proposed procedures would allow staff to select up to five production parts per part manufacturer per year for audit testing. These limits were set in recognition that the majority of manufacturers are small businesses and have limited economic resources. Further, to minimize the cost impacts to manufacturers ARB would conduct audit tests at its own laboratory or at contracted facilities, and would bear all audit-testing related expenses, including motorcycle procurement and maintenance, if the part complies with all applicable emission standards. If a part fails to meet applicable emission standards, the part manufacturer would be required to compensate ARB for the audit test costs.

To ensure that the audit testing results accurately reflect the emissions performance of the aftermarket critical emission control part being tested, all highway motorcycles selected for testing would be baseline tested in stock, emission-certified configuration and have baseline emissions that are typical for that make, model and year of highway motorcycle before the motorcycle can be selected for testing. Manufacturers would be invited to observe any audit testing performed by ARB.

G. Warranty Reporting and Recall/Corrective Action

The proposed procedures establish warranty claims reporting requirements that.are analogous to those applicable to new highway motorcycle OEMs. The warranty reporting requirements require manufacturers to review all emission-related warranty claims on a regular basis to determine the number of repairs or replacements made for each component. When an emission control component's reporting rate becomes excessive, the defect is considered to be systemic in nature and additional activity is required of the manufacturer. Reporting of warranty claims is only required when unscreened claims reach four percent or 10 highway motorcycles, whichever is greater. Once unscreened claims reach ten percent or 20 highway motorcycles, whichever is greater, the part manufacturer would have to submit a supplemental report. The supplemental report would require screening of non-valid emission claims. Non-valid claims would include claims related to cosmetic defects, improper maintenance, neglect, and abuse. If the number of valid claims reaches or exceeds four percent or 10 motorcycles, whichever is greater, then a recall action would be triggered.

The proposed procedures would also establish in-use recall provisions that are again analogous to those applicable to new highway motorcycle OEMs. However, the proposed recall provisions contain provisions to accommodate those manufacturers that do not have a dealer network to perform replacement or repair of defective aftermarket critical emission control parts. First, because owner installation of motorcycle aftermarket parts is common (many parts utilize simple "screw-in" or "bolt-on" type of assemblies that typically require little technical expertise), the recall provisions allow a manufacturer to supply free replacement parts to motorcycle owners and to have the owners perform the replacement of the part themselves. Second, in light of the fact that there is currently no Smog Check program requirement applicable to highway motorcycles, and that it is therefore difficult to verify that motorcycle owners have properly performed required replacements, manufacturers that elect to and are approved to utilize this type of corrective action would have to provide ARB with plans on how they intend to ensure that owners will perform the replacement within a designated time (such as providing incentives and requiring the return of the defective parts.) .

## V. Issues Regarding the Proposal

The following issues were raised at ARB's second public workshop held on August 20, 2008. Issues raised during the first public workshop on April 9, 2008, were generally resolved through discussions with the affected aftermarket parts industry and by presenting subsequent modifications to the proposal at the second workshop.

### A. Warranty Registration Card Returns

Although many manufacturers did not express concerns regarding the proposed . requirement for manufacturers to ensure a 50 percent return rate of warranty cards (as described in section IV.C. of this staff report), some manufacturers were concerned that this return rate could bedifficult to meet, especially in an industry where a 10 percent return rate is currently considered a success. MIC expressed that even if a 50 percent return rate was achievable, the information on the cards would be ineffective to locate owners in the event that an owner moved or sold the modified motorcycle to a subsequent owner. Several part manufacturers remarked that including motorcycles in the Smog Check program would be a more effective means of identifying and locating motorcycles and owners, and of verifying the presence and proper installation of aftermarket parts during a visual inspection. However, Smog Check currently does not extend to motorcycles and moreover, is not responsible for identifying or locating owners for manufacturers.

A 50 percent warranty return rate is already a significant reduction from the 100 percent return rate presently required for new aftermarket catalytic converters for cars and trucks. Notwithstanding this, ARB solicited suggestions from the affected industry regarding alternatives for effectively meeting the proposed return rate. MIC suggested language that would allow a manufacturer to alternatively comply with the return rate requirement if it demonstrates it can accurately and effectively locate 50 percent of its purchasers irrespective of the number of warranty cards received. MIC's proposal would allow a manufacturer to avoid incurring expenses and expending resources on ensuring the return of warranty cards for aftermarket critical emission control parts that may never be recalled. Instead, by concentrating on the parts that are indeed recalled, a manufacturer would be able to prioritize its spending efforts on contacting those specific owners affected by the recall rather than diluting its costs upfront by trying to collect warranty cards in advance of an anticipated recall that may never occur.

MIG's proposal relies heavily on the cooperation of part dealers and retailers. However, manufacturers have consistently stated they have almost no direct contact with or influence over such dealers and retailers. MIG's proposal essentially shifts the burden of collecting purchaser information from manufacturers to dealers and retailers. Although dealers and retailers are already subject to accurate recordkeeping regarding their purchasers (which itself presents an issue as described in section V.B. below), MIG's proposal would require dealers and retailers to essentially provide part manufacturers with all information regarding the aftermarket critical emission control parts sold. In contrast, part manufacturers would only be required to request information from dealers and retailers for parts that are actually recalled. Since the burden of collecting purchaser information does not appear to be reduced for dealers and retailers, staff believes that MIG's proposal provides no advantage because manufacturers would still need to provide dealers . and retailers with incentives to collect the requested purchaser information for all of their offered aftermarket critical emission· control parts due to the fact that any part could potentially be subject to recall. Attempting to collect this information during an actual recall would be very difficult if a manufacturer did not provide a concerted effort to collect it at the time of the part's sale through the use of a warranty registration card. Additionally; staff intends to use the warranty card reports from-manufacturers to assist in selecting appropriate parts for audit testing.

Despite these concerns, staff is still willing to provide flexibility in complying with the proposed return rate, and has added provisions in the warranty requirements that would allow part manufacturers to propose effective methods in place of the 50 percent warranty return rate. These recommendations would be submitted to the Executive Officer for review at the time the exemption application is submitted.

B. Recordkeeping Requirements

Another issue raised during ARB's second public workshop concerned the ability of dealers and retailers to effectively document sales of aftermarket critical emission control parts. MIG claimed that parts manufacturers do not have the same type of business agreements with their dealers and retailers as motorcycle OEMs generally have, and that most shops do not have standardized recordkeeping forms or even keep records· if a purchase is made in cash.

However, parts dealers and retailers are presently required under title 13 GGR section 2222(f) to maintain records for the sale or installation of non-exempted parts:

> "Each person engaged in the business of retail sale or installation of an add-on or modified part which has not been exempted from Vehicle Code· section 27156 shall maintain records of such activity which indicate date of sale, purchaser name and address, vehicle model and work performed if applicable. Such records shall be open for reasonable inspection by the Executive Officer or his/her representative. All such records shall be maintained for four years from the date of sale or installation."

Staff therefore believes it is not unreasonable for dealers and retailers to also document and maintain similar information regarding the sale of legally exempted aftermarket critical emission control parts for highway motorcycles.

## VI. Air Quality, Environmental, and Economic Impacts

### A. Air Quality and Environmental Impacts

The proposed regulatory action will have a positive impact on air quality by ensuring that the emission benefits attributable to California's emission standards for highway motorcycles are realized and not diminished by exhaust system tampering.

As previously discussed, recent surveys from MIC and staff indicate that tampering occurs on approximately 38 percentto 85 percent of highway motorcycles, and that many owners perform part modifications while their motorcycles are at low mileages and are still covered under the motorcycle OEM's emission control warranty period. Because the proposed regulatory action would establish exemption procedures that are specifically developed to encourage the development of emission compliant aftermarket critical emission control parts for on highway motorcycles, the use of non-complying exhaust systems will decline and the excess emissions due to tampering will decrease.

The current inventory including the adopted emission standards shows that highway motorcycles contribute approximately 53 tons per day of hydrocarbons plus oxides of nitrogen (HC+NOx) emissions statewide in 2010[4] and 2020. The true extent of the replacement of original catalyst exhaust systems with non-catalyst exhausts, and when during the life of the motorcycle this occurs, is not accurately known. The impact of removal of a catalyst exhaust, however, can increase the exhaust emissions by up to ten times. To illustrate the potential impact, if we assume typical annual sales of 2008 model year, fuel-injected, catalyst-equipped motorcycles are 90,000, and one-third operate throughout their life with a replacement, non-catalyst exhaust system, HC+NOx emissions will increase by about 2.6 tons per day for the one model year alone over a five year useful life. If exhaust tampering of these motorcycles were to rise to 85 percent, the HC+NOx increase would then jump to 6.8 tons per day. Implementation of the proposed regulation would be expected to

4 ARB Almanac, Air Resources Board website, http://www.arb.ca.gov/app/emsitw/emssumcat.php. September 26,2008.

reduce a substantial fraction of these excess emissions resulting from illegal tampering..

B. Environmental Justice

State law defines environmental justice as the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies (Senate Bill 115, Solis; Stats 1999, Ch. 690; Government Code § 65040.12(c». The Board has established a framework for incorporating environmental justice into ARB's programs consistent with the directives of State law. The policies developed apply to all communities in California, but recognize that environmental justice issues have been raised more in the context of ,low income and minority communities, which sometimes experience higher exposures to some pollutants as a result of the cumulative impacts of air pollution from multiple mobile, commercial, industrial, areawide, and other sources.

The proposed procedures apply to aftermarket critical emission control parts installed in highway motorcycles that operate throughout the State. This proposal would greatly assist in reducing the sale of non-exempted parts because it establishes, for the first time, procedures for evaluating aftermarket parts on highway motorcycles that a're primarily designed to reduce emissions and are necessary for motorcycles to remain in compliance with emission standards. To the extent that highway motorcycle operation is higher near certain communities, those' communities would receive greater emission benefits due to those motorcycles being equipped with aftermarket critical emission control parts that are emission compliant and as durable as the stock components that they replace.

C. Economic Impacts

1. Costs to State Agencies

The only costs to state agencies would be those incurred by ARB to implement and enforce the proposed regulation. Staff has estimated that these costs could be as much as $340,000 over the first three years of the regulation's implementation (based on one additional ARB staff). Related duties include reviewing submitted exemption applications, and overseeing audit testing or any ordered recall actions. The proposal is not expected to create additional costs to any other state agency, local district, or school district, including any federally funded state agency or program.

2. Costs to Part Manufacturers

Manufacturers of aftermarket critical emission control parts for highway motorcycles would incur additional costs resulting from this regulation only if they choose to enter the existing California market for those parts. Therefore, costs that a part manufacturer may pay related to the regulation's specific provisions for durability emission testing, warranty, audit testing, and recall are not accounted for since they are considered normal costs that any part manufacturer would ,be required to pay in order to legally sell aftermarket critical emission control parts in the state. Part manufacturers voluntarily make a decision to comply with the regulation based on their ability to generate satisfactory profits and to compete with motorcycle OEMs that may already be selling similar, compliant parts in California. The. only applicable costs then attributable to the regulation would be those associated with the preparation and submittal of exemption applications that demonstrate compliance with the provisions. ARB staff estimates that this cost would be approximately $100 per application. Over a five yearregulatory life, the 60 potentially affected part manufacturers could be expected to spend up to $58,000 for those applications. The proposal is not expected to affect the·ability of California part manufacturers to compete with part manufacturers in other states since it applies to all manufacturers that choose to sell parts in·California.

3. Costs to Consumers

Part manufacturers may increase the purchase price of a typical exhaust system to cover the cost of developing an emission-compliant part. While actual price increases will be dependent on specific development costs and the typical market forces affecting part sales, MIC and several affected part manufacturers have estimated that they would likely range between $100 and $150. It is important to note that the choice to purchase an aftermarketcritical emission control part is most often influenced by a motorcycle owner's desire for customization, and not because the stock component is failing emissions.

4. Potential Impacts on Other Businesses

The other portion of the costs attributable to the proposal would be incurred by the approximately 1,000 dealers and retailers that sell aftermarket critical emission control parts in the state. The proposed recordkeeping requirements associated with each part purchased are estimated to cost each retailer about $60 dollars annually, assuming that each dealer or retailer sells an average of 30 aftermarket critical emission control parts per year. Over five years, costs would total $300,000.

It is also possible for a retailer's profits from part sales to be negatively impacted if the incremental cost associated with each aftermarket critical emission control part would cause consumers to purchase fewer of them. However, this is impossible to determine at this time.

Motorcycle OEMs may experience some loss of business as manufacturers of aftermarket critical.emission control parts enter the market and competition subsequently increases. However,this effect is to be expected as consumers look for aftermarket parts from competing companies that are not only less expensive, but also better looking and potentially more efficient than the original parts.

5. Potential Impacts on Business Competitiveness

The proposal is not expected to have a net effect on the ability of California businesses to compete with businesses in other states. Of about 60 affected part manufacturers, 30 are located in California. However, the proposal would apply to all aftermarket critical emission control parts sold, offered for sale, installed, or advertised in California, irrespective of where they are produced.

6. Potential Impacts on Employment

Staff does not estimate that the regulatory proposal would result in the loss of jobs. Some jobs may be created in California, based on the need for part manufacturers to develop new aftermarket critical emission control parts and also to comply with the provisions in the proposal. To the extent that motorcycle OEMs more extensively use critical emission control parts, such as catalyst mufflers, to meet ARB's new vehicle certification requirements, the sale of aftermarket critical emission control parts as replacements may also accordingly increase, possibly resulting in part manufacturers hiring additional staff to handle the demand.

Staff also believes that some new laboratory businesses may be created in the state because the proposed testing requirements in the regulation would increase the overall need by part manufacturers for emission testing services. Most of these part manufacturers do not possess in-house emission testing capabilities.

D. Regulatory Alternatives

ARB currently does not have evaluation procedures that are directly applicable to the exemption and sale of aftermarket-critical emission control parts for highway motorcycles. Given the absence of such procedures, staff only considered two alternatives.

1. Require Certification as a New Motorcycle

The first alternative would require an aftermarket parts manufacturer to essentially recertify highway motorcycles with their aftermarket critical emission control part installed, and to be issued a new highway motorcycle Executive Order for the combination of the highway motorcycle and the aftermarket part. Under this alternative, part manufacturers would have to purchase highway motorcycles and then fully emissions test that motorcycle with any aftermarket critical emission control part(s) installed. This would subject part manufacturers to all of ARB's current new motorcycle certification provisions and applicable certification fees paid to the state. Part manufacturers would also be required to warrant the entire motorcycle instead of only their critical emission control part(s). Although this alternative would have resolved the durability and emission-related concerns resulting from early replacement of original critical emission control parts, and would have 'allowed manufacturers to sell their critical emission control parts as replacement parts rather than add-on or modified parts, it would also have imposed very significant costs that essentially made it infeasible. Certifying highway motorcycles on an annual basis would greatly increase a part manufacturer's initial expenses and would exceed most part manufacturer's financial and other resources. Many part manufacturers could likely go out of business in California or would have to scale back their product offerings drastically. This alternative is not viable because of its high costs compared to the' proposal, which provides much more compliance flexibility for the affected aftermarket industry.

2. Leave Existing Aftermarket Part Requirements Unchang.ed

The second alternative was to leave California's requirements for new aftermarket parts unchanged. This alternative was also rejected because the sale Of illegal aftermarket critical emission control parts would likely still occur, and would result in increased emissions from illegally modified highway motorcycles. Inaction would also prevent part manufacturers from legally selling products that have been designed to ensure that highway motorcycles can comply with emission standards and that demonstrate durability comparable to OEM parts.

Staff has therefore determined that no feasible alternative considered would be more effective in carrying out the purpose of the proposed regulation. No other alternative would be as effective or less burdensome to affected businesses and private persons than the proposed regulatory action.

VII. Summary and Staff Recommendation

The proposed regulatory action would establish exemption procedures applicable to aftermarket critical emission control parts on highway motorcycles. These procedures were developed after considering the issues unique to highway motorcycles, and the procedures therefore allow exempted parts to replace fully functional OEM emission control systems within the original emission warranty period. The procedures also incorporate safeguards to ensure that any exempted parts do not reduce the effectiveness of any required pollution control device or cause motorcycles to exceed applicable emission standards, as required by Vehicle Code sections 27156 and 38391. Such safeguards essentially mirror the requirements applicable to OEM motorcycle manufacturers and help ensure that the emissions benefits of California's motorcycle standards are fully safeguarded.

Staff believes the proposal carefully accounts for the concerns of the affected part manufacturers, dealers, and retailers that would be subjected to it. The proposal would also allowARB to continue to fully implement the anti-tampering requirements of Vehicle Code sections 27156 and 38391 in a manner consistent with the customization practices related to the use of aftermarket parts for highway motorcycles. Therefore, staff recommends that the Board adopt the proposed regulatory action. -

## VIII. References

1. Mail-Out #93-45, Air Resources Board, September 28, 1993.

2. "MIC 2003 Motorcycle/ATV Owner Survey," Table 144-1, Motorcycle Industry Council, 2004.

3. Staff Report: Initial Statement of Reasons, "Proposed Amendments to the California On-Road Motorcycle Regulation," Air Resources Board, October 28,1998.

4. ARB Almanac, Air Resources Board website, http://www.arb.ca.gov/app/emsinv/emssumcat.php. September 26, 2008.

# TITLE 13. CALIFORNIA AIR RESOURCES BOARD

## NOTICE OF PUBLIC HEARING TO CONSIDER PROPOSED AMENDMENTS TO THE REGULATION FOR IN-USE OFF-ROAD DIESEL-FUELED FLEETS AND AN UPDATE ON STATUS OF IMPLEMENTATION OF THE REGULATION

The Air Resources Board (the Board or ARB) will conduct a public hearing at the time and place noted below to consider adopting amendments to its regulation for In-Use Off-Road Diesel-Fueled Fleets. This notice summarizes the specific amendments being proposed. At the hearing, the Board will also receive an update from staff on the status of implementation of the regulation, which will include a technology update report regarding diesel emission control strategies that have been verified by ARB. The staff report (initial Statement of Reasons) presents the proposed amendments and information supporting the adoption of the amendments in greater detail, as well as the update.

DATE: January 22, 2009

TIME: 9:00 a.m.

PLACE: California Environmental Protection Agency
Air Resources Board
Byron Sher Auditorium
1001 I Street
Sacramento, California 95814

This item will be considered at a two-day meeting of the Board, which will commence at 9:00 a.m., January 22, 2009, and may continue at 8:30 a.m., January 23,2009. This item may not be considered until January 23, 2009. Please consult the agenda for the meeting, which will be available at least 10 days before January 22, 2009, to determine the day on which this item will be considered.

For individuals with sensory disabilities, this document and other related material can be made available in Braille, large print, audiocassette, .or computer disk. For assistance, please contact ARB's Reasonable Accommodations/Disability Coordinator at 916-323-4916 by voice or through the California Relay Services at 711, to place your request for disability services, or go to http://www.arb.ca.gov/htmllada/ada.htm.

If you are a person with limited English and would like to request interpreter services to be available at the Board meeting, please contact ARB's Bilingual Manager at 916-323-7053.

## INFORMATIVE DIGEST OF PROPOSED ACTION AND POLICY STATEMENT OVERVIEW

**Sections Affected:** Proposed amendments to California Code of Regulations, title 13, sections 2449(d)(4)(A), 2449(g)(1)(D), 2449(h)(8), 2449.1 (a)(2)(A)5., and 2449.2(a)(2)(A)2.a.L, the regulation for In-Use Off-Road Diesel Vehicles.

**Background:**

At its July 26,2007, public hearing, the Air Resources Board (Board or ARB) approved the regulation for In-Use Off-Road Diesel-Fueled Fleets (the in-use off-road regwlation or regulation) with the adoption of California Code of Regulations, title 13, sections 2449 through 2449.3. The regulation is intended to reduce emissions of diesel particulate matter (diesel PM) and oxides of nitrogen (NOx) from in-use off-road diesel vehicles that operate in California. The regulation will significantly reduce diesel PM and NOx emissions from the nearly 180,000 off-road diesel vehicles that operate in California, which is necessary to meet state and federal air quality standards. The regulation requires fleet owners to accelerate turnover to cleaner engines and install exhaust retrofits. The regulation also supports the Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles, which was adopted by the Board on September 30,2000.

On October 24, 2008, the Board released public notice that it would consider at its December, 2008 hearing two minor change,s to the regulation as part of the regulatory package for'the Proposed Regulation for In-Use On-Road Diesel Vehicles. As part of the regulatory package for the Proposed Regulation for In-Use On-Road Diesel Vehicles,' staff has proposed to make two minor changes to the regulation: (1) clarify the low-use provisions, and (2) add all two engine cranes to the off-road regulation. The Board will still consider these changes at the December, 2008 hearing.

*Applicability*

The fleet re'quirementsof the in-use off-road regulation apply to any person, business, or government agency who owns or operates within California any diesel-fueled or alternative diesel fueled off-road compression ignition vehicle engine with maximum power of 25 horsepower (hp) or greater that is used to provide motive power ina workover rig or to provide motive power in any other motor vehicle that (1) cannot be registered and driven safely on-road orwas not designed to be driven on-road, and (2) is not an implement of husbandry or recreational off-highway vehicle. The regulation only addresses engines that drive self-propelled vehicles (Le., it does not apply to stationary equipment or portable equipment like generators).

*Fleet Requirements*

In general, the regulation requires owners to modernize their fleets by replacing engines with newer, cleaner ones (repowering), replacing vehicles with newer vehicles equipped with cleaner engines, retiring older vehicles,operating higher emitting vehicles less often (designating them as low-use vehicles) or by applying exhaust retrofits that capture and destroy pollutants before they are emitted into the atmosphere. The regulation determines the date of compliance and the actions required based on the size of the fleet, splitting fleets into three categories: large fleets with over 5,000 horsepower, medium fleets with 2,501 to 5,000 horsepower, and small fleets with 2,500 horsepower or less.

*Retrofits*

To meet the diesel PM emission reduction requirements of the in-use off-road regulation, fleets have the option of meeting fleet average emissions targets, or installing the highest level verified dieselemissi.on control strategy (VDECS or retrofit) on 20 percent of their maximum horsepowerin each year of compliance. To assist fleets spread out the cost of compliance during the early years of the regulation and to encourage retrofits prior to implementation of the regulation, fleets were granted double credit for all retrofits installed by March 1, 2009.

**Description of Proposed Regulatory Action**

*Early Double Credit for Retrofits*

Staff proposes to amend section 2449.2(a)(2)(A)2.a.i. to extend the deadline for double retrofit credit for fleets that have installed the highest level VDECS by 10 months from March 1, 2009 to January 1, 2010. The change would also provide double credits for VDECS ordered by September 1, 2009 even if manufacturer or installer delays cause their installation to be delayed beyond January 1, 2010. Staff recommends this extension because exhaust retrofits have become verified slower than anticipated since the July 2007 Board Hearing, leaving many fleets unable to take full advantage of the early credit provisions. The ability of fleetsto take advantage of the double retrofit credit provision was important during the Board's consideration and approval of the regulation, as it provides an important mechanism for fleets to use to reduce their costs during the initial years of the regulation. The change would provide additional time for manufacturers of diesel emission control strategies to submit and verify new off-road retrofit applications, as well as additional fleets to purchase and install VDECS that have been recently verified.

*Fleet Size Changes*

Staff proposes to amend section 2449(d)(4)(A) to remove the provision that requires a small fleet that becomes a medium or large fleet, and then subsequently becomes a small fleet again, to continue meeting the medium or large fleet requirements for the next two reporting years after returning to small fleet status. This provision was initially developed to prevent fleets from potentially circumventing the regulation by growing and shrinking their fleet and remaining subject to only the small fleet requirements. However, staff has determined that, in practice, application of the provision is too complex and potentially confusing for affected fleets, especially in those situations where a fleet's size may change frequently over time. Staff believes that such complexity and potential confusion far outweighs the potential for fleets to abuse the changing fleet size provisions.

*Recordkeeping Requirements for Disclosure of Applicability*

Staff also proposes that section 2449(h)(8) be amended to clarify that the section applies to both sellers and dealers of off-road vehicles, and that both sellers and dealers must maintain records of the disclosure of regulation applicability. The record retention requirements currently require that only dealers must maintain records of the disclosure of the regulation applicability: However, since section 2449(j) applies to any person in California selling a vehicle with an engine subject to the regulation and that the seller is required to include a disclosure of applicability, staff believes it is necessary to clarify that the record retention requirements of disclosure apply to any person that sells a vehicle, and not just to dealers.

*Turnover Delay for Tier 1*

Staff is proposing to amend section 2449.1 (a)(2)(A)5. to clarify the turnover exemption for Tier 1 or higher engines. The original intent of this provision was to exempt Tier 1 vehicles from the turnover requirements only through March 1, 2012, and that these vehicles would have to meet the March 1, 2013 compliance deadline -- that is a fleet may have to turn over their Tier 1 vehicles between March 1,2012 and February 28, 2013, provided that all Tier 0 vehicles in the fleet owner's fleet not qualifying for exemption have already been turned over. Staff is proposing to clarify this language by stating that all vehicles with a Tier 1 or higher engine are exempt from the turnover requirement until the compliance year ending March 1, 2013 (i.e., the first turnover of Tier 1 or h"igher engines would be required between March 2, 2012 and March 1,2013).

*VDECS Reporting*

Staff is proposing to amend section 2449(g)(1)(0) to require reporting of the VDECS family name and serial number, rather than the VDECS model. During development of the reporting system for the regulation, staff determined that just the VDECS model does not provide specific enough information to determine if a device was verified for a particular engine at the time of installation. Instead, the VDECS family name is necessary for this purpose. The VDECS serial number is also important to enable ARB enforcement to track a particular device should there be some question regarding the proper functioning of that device. Including VDECS serial number data in DOORS will also facilitate transfer of that information to the buyer should a vehicle with a VDECS be sold.

## COMPARABLE FEDERAL REGULATIONS

The United States Environmental Protection Agency (U.S. EPA) has promulgated federal emission standards for new non-road engines. However, no federal standards have been promulgated addressing emission reductions from in-use diesel vehicle engines.

Under section 209(e)(2), California may adopt and enforce emission standards and other requirements for off-road engines and equipment not expressly subject to federal preemption, so long as California applies for and receives authorization from the Administrator of U.S. EPA. California's request for authorization was submitted on August 12, 2008, and on October 27,2008, the U.S. EPA conducted a hearing regarding California's request for authorization for the in-use off-road regulation; the request is presently pending.

## AVAILABILITY OF DOCUMENTS AND AGENCY CONTACT PERSONS

The Board staff has prepared a Staff Report: Initial Statement of Reasons (IS0R) for the proposed regulatory action, which includes a summary of the economic and environmental impacts of the proposal. The report is entitled: "Proposed Amendments to the Regulation for In-Use Off-Road Diesel Vehicles and Implementation Update."

Copies of the ISOR and the full text of the proposed regulatory language, in underline and strikeout format to allow for comparison with the existing regulations, may be accessed on the ARB's web site listed below, or may be obtained from the Public Information Office, Air Resources Board, 1001 I Street, Visitors and Environmental Services Center, 1st Floor, Sacramento, CA 95814, (916) 322-2990 at least 45 days prior to the scheduled hearing on January 22, 2009.

Upon its completion, the Final Statement of Reasons (FSOR) will be available and copies may be requested from the agency contact persons in this notice, or may be accessed on the ARB's web site listed below.

Inquiries concerning the substance ofthe proposed regulation may be directed to Ms. Kim Heroy-Rogalski, Manager of the Off-road Implementation Section at (916) 327-2200, or Ms. Elizabeth Yura, Air Resources Engineer, at (916) 323-2397.

Further, the agency representative and designated back-up contact persons to whom nonsubstantive inquiries concerning the proposed administrative action may be directed are Lori Andreoni, Manager, Board Administration & Regulatory Coordination Unit, (916) 322-4011, or Amy Whiting, Regulations Coordinator, (916) 322-6533. The Board has compiled a record for this rulemaking action, which includes all the information upon which the proposal is based. This material is available for inspection upon request to the contact persons.

This notice, the ISOR and all subsequent regulatory documents, including the FSOR, when completed, are available on the ARB Internet site for this rulemaking at www.arb.ca.gov/regact/2009/ordiesI09/ordiesI09.htm.

**COSTS TO** PUBLIC AGENCIES **AND TO BUSINESSES AND PERSONS AFFECTED**

*Costs to State Government and Local Agencies*

Pursuant to Government Code sections 11346.5(a)(5) and 11346.5(a)(6), the Executive Officer has prepared an estimate in accordance with instructions adopted by the Department of Finance, and determined that the proposed regulatory action would not create overall costs or savings to any state agency or in federal funding to the state, costs or mandate to any local agency or school district whether or not reimbursable by the state pursuant to part 7 (commencing with section 17500), division 4, title 2 of the Government Code, or other nondiscretionary cost or savings to state or local agencies.

The proposed modification to extend early double credit would provide fleets additional time to install early VDECS, and thereby the opportunity to accumulate additional credits and spread out their compliance *costs* over several years, without increasing or decreasing the total cost of the regulation. The ability to spread out initial compliance costs will benefit the state, federal, and larger municipal fleets whose first compliance date is March 1, 2010, more than local municipalities that are small or medium fleets, because their earlier first compliance dates mean their need for early credit is more urgent.

*Effect on Private Persons and Businesses*

Pursuant to Government Code section 11346.5(a)(9), ARB has evaluated the potential economic impacts on representative private persons or businesses and the Executive Officer has determined that a representative private person and business would incur minimal, if any, cost impacts because of the proposed amendments. The only amendment that would potentially result in additional costs is including all sellers in the disclosure retention provision. However, the cost of retaining such records is expected to be negligible. In addition, it was staff's original intent to include all sellers in the disclosure requirements, and thus any additional cost of maintaining these records was accounted for in the statewide cost analysis for the in-use off-road regulation when it was originally adopted.

As discussed previously, the proposed modification to extend early double credit is not expected to result in any additional costs or savings on businesses overall. Instead, it will provide a benefit to them by enabling fleets additional time to install early VDECS, and thereby accumulate credit that will enable them to spread out their compliance costs in later years.

The Executive Officer has also determined, pursuant to CCR, title 1, section 4, that the proposed regulatory action may affect small businesses.

*Effect on State Economy*

Pursuant to Government Code section 11346.5(a)(8), the Executive Officer has made an initial determination that the proposed regulatory action would not have a significant statewide adverse economic impact directly affecting businesses, including the ability of California businesses to compete with businesses in other states, oron representative private persons.

In accordance with Government Code sections 11346.5(a)(10) and 11346.3(b), the Executive Officer has further determined that the proposed regulatory action would not affect the creation or elimination of jobs within the State of California, the creation of new businesses or elimination of existing businesses within the State of California, or the expansion of businesses currently doing business within the State of California. A detailed assessment of the economic impacts of the proposed regulatory action and its effect on California businesses can be found in the ISOR.

*Consideration* of *Alternatives*

Before taking final action on the proposed regulatory action, the Board must determine that no reasonable alternative considered by the board or that has otherwise been identified and brought to the attention of the board would be more effective in carrying out the purpose for which the action is proposed or would be as effective and less burdensome to affected private persons than the prop'osed action.

**SUBMITTAL OF COMMENTS REGARDING PROPOSED REGULATORY ACTION**

The public may present comments relating to the proposed amendments orally or in writing at the hearing, and in writing or bye-mail before the hearing. To be considered by the Board, written submissions not physically submitted at the hearing must be received **no later than 12:00 noon, January 21, 2009,** and addressed to the following:

Postal mail: Clerk of the Board
Air Resources Board
1001 I Street
Sacramento, California 95814

Electronic submittal: http://www:arb.ca.gov/lispub/comm/bclist.php
The list name is: **ordiesl09**

**{NOTE: Comments submitted here should be for the regulatory action ONLY}**

Facsimile submittal: (916) 322-3928

Please note that under the California Public Records Act (Government Code section 6250 et seq.), your written and oral comments, attachments, and associated contact information (e.g., your address, phone, email, etc.) become part of the public record andean be released to the public upon request. Additionally, this information may become available via Google, Yahoo, and any other search engines.

The Board requests but does *nqt* require that 30 copies of any written statement be submitted and that all written statements be filed at least ten days prior to the hearing so that ARB staff and Board Members have time to fully consider each comment. The board encourages members of the public to bring to the attention of staff in advance of the hearing any suggestions for modification of the proposed regulatory action.

For comments to the update on status of implementation of regulation for in-use off-road diesel vehicles please the last page of this notice. Comments submitted to the link above should be for the proposed regulatory action only.

## STATUTORY AUTHORITY AND REFERENCES

This regulatory action is proposed under that authority granted in Health and Safety Code sections 39600,39601,39602.5,39667,43013, and 43018. This action is proposed to implement, interpret and make specific California Code of Regulations, . title 13, sections 2449, 2449.1, and 2449.2.

## HEARING PROCEDURES

The public hearing will be conducted in accordance with the California Administrative Procedure Act, title 2, division 3, part 1, chapter 3.5 (commencing with section 11340) of the Government Code.

Following the public hearing, the Board may adopt the regulatory amendments as originally proposed, or with non substantial or grammatical modifications. The Board may also adopt the proposed regulatory language with other modifications if the text as modified is sufficiently related to the originally proposed text that the public was adequately placed on notice that the regulatory language as modified could result from the proposed regulatory action; in such event the full regulatory text, with the modifications clearly indicated, will be made available to the public, for written comment, at least 15 days before it is adopted.

The public may request a copy of the modified regulatory text from the ARB's Public Information Office, Air Resources Board, 1001 I Street, Visitors and Environmental Services Center, 1st Floor, Sacramento, CA 95814, (916) 322-2990.

**NON-REGULATORY UPDATE ON STATUS OF** IMPLEMENTATION OF **REGULATION FOR IN-USE OFF-ROAD DIESEL VEHICLES AND SUBMITTAL OF COMMENTS**

At the hearing, the Board will also receive a status update on implementation of the' regulation. The update is described in the aforementioned staff report describing the proposed regulatory.amendments. The public may present comments orally or in writing at the hearing, and in writing or bye-mail before the hearing. To be considered by the Board, written submissions not physically submitted at the hearing must be received **no later than 12:00 noon, January 21, 2009,** and addressed to the following.

Postal mail: Clerk of the Board
Air Resources Board
1001 I Street
Sacramento, California 95814

Electronic submittal: http://www.arb.ca.gov/lispub/comm/bclist.php
List name: **ordieslnr**

**{NOTE: Comments submitted here, should be for the non-regulatory status update ONLY}**

Facsimile submittal: (916) 322-3928

At the Board meeting, the Board may direct staff to develop additional modifications to the regulation to be considered at a later Board hearing. If directed to do so, ARB will prepare a separate notice of proposed rulemaking that will be published not less than 45 days before the scheduled hearing date..

CALIFORNIA AIR RESOURCES BOARD

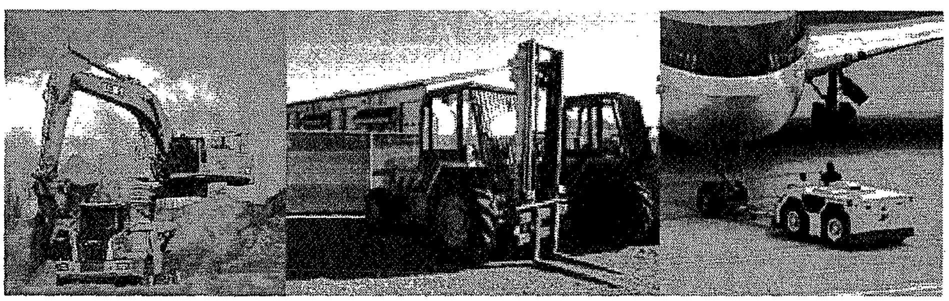
James N. Goldstene
Executive Officer

Date: November 25, 2008

California Environmental Protection Agency
AIR RESOURCES BOARD

**STAFF REPORT: INITIAL STATEMENT OF REASONS FOR PROPOSED RULEMAKING**

# PROPOSED AMENDMENTS TO THE REGULATION FOR IN-USE OFF-ROAD DIESEL-FUELED FLEETS AND IMPLEMENTATION UPDATE



Mobile Source Control Division
Heavy Duty Diesel In-Use Strategies Branch

December 2008

State of California
AIR RESOURCES BOARD

# STAFF REPORT: INITIAL STATEMENT OF REASONS

Public Hearing to Consider

# PROPOSED MODIFICATIONS TO THE REGULATION FOR IN-USE OFF-ROAD DIESEL-FUELED FLEETS AND IMPLEMENTATION UPDATE

To be considered by the Air Resources Board at a meeting of the Board that will commence on January 22,2009, and may continue to January 23,2009, at

California Environmental Protection Agency
Air Resources Board
Byron Sher Auditorium
1001 I Street
Sacramento, California 95814

Mobile Source Control Division:
Robert Cross, Chief

Heavy-Duty Diesel In-Use Strategies Branch:
Erik White, Chief

Off-Road Implementation Section:
Kim Heroy-Rogalski, Manager

State of California
AIR RESOURCES BOARD

# PROPOSED MODIFICATIONS TO THE REGULATION FOR IN-USE OFF-ROAD DIESEL-FUELED FLEETS AND IMPLEMENTATION UPDATE

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Supporting Divisions

Mobile Source Operations Division
Planning and Technical Support Division
Research Division
Stationary Source Division

Acknowledgements

This report was prepared with the assistance and support from the other divisions and offices of the Air Resources Board. In addition, we would like to acknowledge the assistance and cooperation that we have received from many individuals and organizations.

TABLE OF CONTENTS

# APPENDICES

LIST OF TABLES

LIST OF FIGURES

# EXECUTIVE SUMMARY

## What is the purpose of this report?

This report serves several purposes. First, it describes proposed changes to the regulation for in-use off-road diesel fueled-fleets (the regulation). These amendments are limited and include extending the deadline for double credit for early particulate· matter (PM) retrofits and several additional minor modifications that clarify the regulation.

Second, when the Air Resources Board (ARB or Board) approved the regulation on July 26,2007, the Board directed staff to provide the Board a technology update report by January 2009 (ARB, 2007d). This report serves as that technology update.

Finally, this report updates the Board on how implementation of the regulation has proceeded in the year and a half since the regulation was approved by the Board. It summarizes the public outreach and reporting work that staff has done, and provides a status report on the Surplus Off-road Opt-in for NOx (SOON) program.

## What modifications to the regulation is staff proposing?

To provide additional flexibility and clarity to the regulation, staff is proposing the following changes to the regulation:

- Extend the deadline for double credit for early PM retrofits by 10 months, from March 1,2009, to January 1,2010. This will also mean that fleets that ordered verified diesel emission control systems (VDECS) by September 1, 2009, would receive double credit even if their installation is delayed beyond January 1, 2010.
- Modify the changing fleet size requirements to not penalize fleets that change their designation from small fleets to larger fleets, and then subsequently become a small fleet again;
- Clarify that all sellers, not just dealers, of off-road vehicles must maintain records of the disclosure of regulation applicability;
- Clarify that the provision providing a delay for the turnover of Tier 1 and newer vehicles from the turnover requirements of the regulation applies only through the March 1, 2012 compliance deadline. This is consistent with staff's original intent for this provision; and
- Clarify the reporting requirements for VDECS.

## Why should the deadline for early double PM credit be extended?

In originally providing this double credit in the regulation, staff intended to provide an incentive for fleets to take early action and achieve early PM reductions. The double credit provisions were also intended to help fleets spread out their costs by reducing the annual number of retrofits they would need to perform in the regulation's first compliance years. However, because it has taken longer than anticipated for additional diesel particulate filters (DPFs), especially passive DPFs, to become verified, many fleets *have* been unable totake full *advantage* of the early credit provisions.

### Why should the other modifications be made?

Since the regulation was adopted, in talking with affected fleets and stakeholders, ARB staff has determined that several sections of the regulation require clarification.

### What are the emissions impacts of the proposed modifications?

Staff expects there to be little to no overall *adverse* impact on emissions from the proposed modifications. While the proposed change to extend the deadline for early double PM credit may also *have* a small disbenefit as many fleets take *advantage* of the extended double credit provisions (thereby decreasing the total number of retrofits completed by March 1, 2010), *evidence* from a number of sources indicates that many of the industries affected by the regulation (primarily the residential construction, rental, and airline industries) *have* reduced their activity since the regulation was adopted due to the current economic downturn, thereby potentially offsetting this impact. Available fuel use data supports this, showing total off-road diesel fuel consumption from all sources (off-road vehicles, locomotives, marine, etc.) down *over* 10 percent from year 2007 levels (BOE, 2008). However, staff cannot precisely quantify at this time the extent of the decline in emissions from off-road vehicles subject to the regulation due to the poor economy. To better understand the impact of current economic conditions on fleets affected by the regulation and their emissions, ARB staff is evaluating available data on vehicle activity, as well as attempting to evaluate whether fleets may *have* changed their turnover practices due to the poor economy. Staff will present their findings at the January 2009, Board meeting.

Overall, staff believes the proposed modifications may result in a slight positive effect on health, Le., result in reduced health impact from poor air quality, because extending the early credit deadline so that it is usable by more fleets may encourage fleets of all sizes to retrofit earlier than they otherwise would, thereby achieving more immediate reductions in diesel PM. The earlier diesel PM is reduced, the more health benefits are achieved.

### What will the cost impact of the proposed modifications be?

The proposed modification to extend the early double credit provision for PM VDECS should result in no adverse economic impacts, and instead should ease the burden of the regulation on affected fleets. This is because the proposed extension would help fleets spread out the costs of the regulation, without increasing the overall cost of the regulation. The proposed modification is expected to lower costs in 2010, the year of maximum expected annual regulation costs (ARB, 2007a). The other proposed modifications will not increase compliance costs for the regulation.

### What did the Board direct staff to report back on by January, 2009?

In Resolution 07-19, the Board directed staff to, by January 2009, provide a technology update report on the status of VDECS that are available for installation to comply with the March 1, 2010 compliance date of the regulation (ARB, 2007d). The Board also directed staff to include an update on the number of devices that have been verified, the cost of those devices, and information on the ARB/South Coast Air Quality Management District/Mobile Source Air Pollution Reduction Review Committee Off-Road Diesel Retrofit Showcase (Showcase).

This is the first of four updates the Board directed staff to provide. Resolution 07-19 also directed staff to:

- By December, 2010, provide a status report on compliance with and enforcement of the March 1, 2010, compliance date for large fleets, including an analysis of the regulation's flexibility provisions and its economic impacts; and
- By December, 2013 and December, 2017, provide updates on compliance and enforcement for the periods March 1, 2010 through March 1, 2013, and March 1, 2013 through March 1,2017, respectively, and updates on the progress of engine technology needed to comply with the regulation.

**What diesel emission control strategies have been verified to date?**

ARB's verification program[1] is intended to ensure that a device achieves the advertised emission reductions and meets minimum durability requirements. To receive ARB verification, the device manufacturer must submit data showing the device is effective and durable and warrant the VDECS and the engine against any"damage caused by the device. ARB's verification procedure is a multi-level verification program consisting of PM reduction levels (Levels 1, 2, and 3) and optional oxides of nitrogen (NOx) reduction levels.

There are two main types of DPFs - passive and active. Passive DPFs use· a catalyst to lower the PM ignition temperature, so no outside source of energy is required for regeneration. Unlike a passive DPF, an active DPF uses an external source of heat to burn off the accumulated PM. The most common sources of heat are (1) plugging in to pass a current through the filter medium, and (2) injecting and burning additional fuel. Nearly all vehicles can be retrofitted with an active DPF, although for many off-road applications DPFs that require plugging in are not feasible, so fuel-burner active DPFs like the HUSS Umwelttechnik FS_MK are the most broadly applicable. However, for many reasons including cost and ease of operation, many fleets find passive systems to be more desirable.

When the regulation was approved in July 2007, there were only three Level 3 DPFs verified for off-road use (all active DPFs). Of the types of systems verified by ARB, Level 3 systems are the most effective, reducing diesel PM by at least 85 percent. Since the adoption of the regulation, three additional systems have now been verified and are available:

- Caterpillar DPF,

1 Title 13, California Code of Regulations (CCR), sections 2700-2710.

- DCI International Inc. DPF, and
- Engine Control Systems' Purifilter DPF.

**What is the potential penetration of passive DPFs in the off-road fleet?**

Until mid-October 2008, passive DPF systems were available to less than five percent of off-road vehicles and 11 percent of off-road vehicle horsepower (hp) covered by the regulation. However, in late October, ARB issued additional verifications, which significantly expanded the availability of passive off-road DPFs. Staff now estimates that up to 24 percent of all off-road vehicles and up to 60 percent of the horsepower of affected off-road vehicles could have passive DPFs installed.[2]

**What is the cost of DPFs available today?**

The vast majority of VDECS that have been installed in California so far are active systems. Current active VDECS costs range from below $14,000 for a less than 50 hp engine to nearly $50,000 for an engine over 500 hp. Very few passive DPFs have been installed so far, but the average cost for these passive installations on engines of 230 to 300 hp was about $21,000.

The current costs for DPFs are about 30 percent higher than the overall average cost over the life of the regulation for DPFs assumed in the initial staff report for the regulation (ARB, 2007a)3. However, the cost analysis in the initial staff report was based on estimates of the average prices for DPFs over the course of regulation (through year 2030). As the market for DPFs expands, staff expects the volume of sales, coupled with the increased number of DPF options fleets may choose from, to reduce retrofit costs relative to today's prices. In addition, staff also expects the expanded availability of passive DPFs in additional horsepower ranges to provide less costly retrofit solutions relative to today. Overall, staff expects these retrofit costs will lower over time, bring them in line with the estimated VDECS costs presented in the initial staff report.

**What is the status of the Showcase?**

Since 2007, staff in conjunction with the South Coast Air Quality Management District (SCAQMD) and the Mobile Source Air Pollution Reduction Review Committee' (MSRC) has engaged in developing the Showcase program. This program is providing valuable experience to staff, fleets, and retrofit manufacturers on the challenges of retrofitting off-road vehicles, and is facilitating an increase in the number of available VDECS. To date, the Showcase has been funded at $4.9 million, including $3.7 million from the

2 The percentages are upper-bounds in that they do not account for several factors, including the fact that some engines do not attain sufficient exhaust temperatures to be retrofit with passive DPFs.

3 This estimate weights current active DPF costs by 70 percent and current passive DPF costs by 30 percent, which is the original distribution of active versus passive DPFs assumed in the staff report.

MSRC, and $1.2 million from the SCAQMD. As of early November 2008, 18 fleets with 202 vehicles have applied and been accepted to participate in the Showcase. Of the eighteen participating fleets, thirteen are privately-owned, and five are public. In addition, 14 emission control manufacturers with 26 systems are participating in the Showcase. The 26 systems include 11 active DPFs and 15 passive DPFs. Seven of these systems reduce NOx as well as PM, and six of the systems include fuel borne catalysts. The vehicles participating in the Showcase include off-road engines with a full range of emission standard tier levels, from the highest emitting uncertified Tier 0 engines to the cleanest new Tier 3 engines. Also, there are systems included in the Showcase that are seeking verification for engines of all certification tiers.

To date, over 60 vehicles have been datalogged, and 9 vehicles have been retrofit, which is slower than originally anticipated. A variety of circumstances - including contracts taking longer than expected, participating vehicles having reduced usage or being pulled from service or retired, and installation designs being more complicated than anticipated - have pushed back the timeline from what was originally anticipated. However, staff estimates that all the vehicles participating in the Showcase will be retrofit by mid-2009.

In addition to the Showcase, ARB staff is participating in another off-road demonstration project with the United States Environmental Protection Agency (U.S. EPA) known as the Supplemental Environmental Project (SEP). Its goals are identical to the Showcase, and it is funded with $700,000 in settlement funds from two U.S. EPA enforcement cases. Thus far, 22 vehicles have been retrofit through the SEP and an additional 16 are expected to be retrofit in the next three months. In both the Showcase and SEP programs, fleets have been satisfied with the operation and reliability of the DECS.

**What major milestones in implementation of the regulation have been achieved?**

First, staff conducted 13 free training seminars throughout the state including at the following locations:

- San Luis Obispo
- Bakersfield
- Redding
- Nevada City
- Fresno
- Riverside
- San Diego
- El Monte
- Sacramento
- San Jose
- Ventura
- Oakland
- South Lake Tahoe

More than 12,000 flyers were distributed to publicize the seminars, and about 1,300 stakeholders attended.

Staff has also made presentations to over 15 groups, such as the National Association of Demolition Contractors and California Golf Course Superintendents Association. In addition, staff has met individually with dozens of individual stakeholders and fleets, and attended nine conferences and workshops to distribute information regarding the regulation.

ARB also formed an advisory group, called the off-road implementation advisory group (ORIAG), in March 2008, to assist staff with outreach and implementation. ORIAG has had three general meetings and has formed the following subcommittees:

- Safety,
- Diesel emission control strategies (DECS),
- Fleets,
- Outreach, and
- Diesel Off-road On-line Reporting System (DOORS).

ORIAG has also created a guidance document review group, which reviews guidance documents and answers to frequently asked questions before ARB releases them to the public. The input from the ORIAG members and subcommittees has proved invaluable in implementing the regulation.

Staff is also currently working with the Contractors State License Board (CSLB) to have information about the off-road regulation inserted into their contractor renewal letters. Staff expects to be able to reach approximately 15,000 contractors each month through CSLB renewal letters.

Finally, staff has built an electronic reporting system called DOORS to enable fleet owners to report their fleet information to the ARB. Staff has been strongly encouraging fleets to voluntarily report early. As of November 17, 2008,64 fleets have reported information for over 7,100 vehicles, and a number of fleets have begun labeling their vehicles with Equipment Identification Numbers.

**What is the status of obtaining authorization from U.S. EPA to enforce the regulation?**

Two provisions in the regulation became enforceable as soon as the regulation became effective on June 15, 2008: a five minute limit on unnecessary idling for off-road diesel vehicles, and the requirement for sellers located in California to disclose in writing that the vehicle sold may be subject to the regulation. ARB enforcement staff has begun auditing vehicle dealerships and auction sites and performing unannounced construction site inspections to enforce these two provisions.

However, to fully enforce the regulation's performance and recordkeeping requires, under section 209(e) of the federal Clean Air Act (CAA), ARB needs to obtain formal authorization from U.S. EPA. ARB submitted a request for authorization from U.S. EPA on August 12, 2008. On October 7,2008, U.S. EPA published notice of its intent to consider California's request in the Federal Register (U.S. EPA, 2008) at a hearing in Washington DC on October 27,2008. Staff attended the hearing and gave a presentation explaining why U.S. EPA should issue such authorization. The comment period for U.S. EPA's consideration of the authorization request was originally scheduled to end November 28, 2008, but has now been extended until December 19, 2008 (U.S. EPA, 2008a; U.S.EPA, 2008b).

# I. INTRODUCTION

The purpose of this report is to update the Air Resources Board (ARB or Board) on the status of retrofit technology available to fleets to comply with the Regulation for In-Use Off-Road Diesel-Fueled Fleets (the regulation). This report also discusses the efforts taken by staff to implement the regulation. Finally, this report describes a number of minor modifications and clarifications to the regulation that are being proposed by staff.

## A. Background

The regulation was approved by the Board on July 26, 2007, and when implemented will reduce emissions of diesel particulate matter (PM) and oxides of nitrogen (NOx) from in-use off-road diesel vehicles that operate in California. The regulation is codified at California Code of Regulations (CCR), title 13, sections 2449 through 2449.3. The regulation will significantly reduce the public's exposure to diesel PM and NOx emissions from the nearly 180,000 off-road diesel vehicles that operate in California by requiring fleet owners to accelerate turnover to cleaner engines and install exhaust retrofits (ARB, 2007a). The regulation supports the Diesel Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles, which was adopted by the Board on September 30, 2000 and the 2007 State Implementation Plans for the South Coast and San Joaquin Valley air basins (ARB, 2000; ARB, 2007c).

The scope of the regulation is far reaching; affecting vehicles of dozens of types used in over 8,000 fleets, in industries as diverse as construction, air travel, manufacturing, landscaping, and ski resorts, as well as public agencies. The regulation will affect, among others, the warehouse with one diesel forklift, the landscaper with a fleet of a dozen diesel mowers, the county that maintains rural roads, the landfill with a fleet of dozers, as well as the large construction firm or government fleet with hundreds of diesel loaders, graders, scrapers, and rollers.

The regulation's requirements vary depending on the size of the fleet and on the vintage of its vehicles. Fleets are defined in the regulation as small, medium, or large based on their total statewide horsepower. The regulation requires that the largest fleets, which have the most significant emissions and are most able to rapidly understand and absorb the costs of compliance, are required to meet the most stringent requirements. The smallest fleets, and local municipal fleets located in low-population counties, are required to meet the least stringent provisions.

## B. Report Overview .

In approving the regulation, the Board directed staff in Resolution 07-19 to provide the Board, by January 2009, with a technology update on the status of diesel emission control strategies that have been verified by ARB and are available for installation to comply with the March 1,2010, compliance date of the regulation (ARB, 2007d). Additionally, the Board directed that the update include information on the number of devices that have been verified, the cost of those devices, and the status of the ARB/South Coast Air Quality Management District/Mobile Source Air Pollution

Reduction Review Committee Off-Road Diesel Retrofit Showcase (Showcase). This report also includes an update on the status of implementation of the regulation, including information on public outreach, reporting, enforcement, the status on the Surplus Off-Road Opt-In for NOx (SOON) program, and the activities of the Off-Road Implementation Advisory Group (ORIAG). Additionally, as part of this update staff is proposing to modify the regulation by extending the double credit deadline for the early installation of Verified Diesel Emission Control Strategies (VDECS) from March 1, 2009, to January 1,2010. Staff is also proposing a few additional modifications to the regulation to clarify certain provisions of the regulation. A full description of these proposed changes is provided in Chapter IV, and the proposed regulatory language is provided in Appendix A.

# II. TECHNOLOGY UPDATE

This chapter discusses ARB's verification program for diesel emission control systems (DECS), the status of current off-road verifications, ongoing off-road demonstration programs, the number of VDECS that have been installed to date,. the cost of available VDECS, and VDECS safety.

## A. ARB's Verification Program

The regulation only requires the installation of a retrofit device that has been verified under ARB's verification program. ARB's verification program, previously adopted by the Board and codified at title 13, CCR, sections 2700 through 2710, is intended to ensure that a device achieves the advertised emission reductions and meets minimum durability requirements. Also, to receive ARB verification, the device manufacturer is required to warrant the VDECS and the engine against any damage caused by the device. ARB's verification procedure is a multi-level verification program consisting of three PM reduction levels and optional NOx reduction levels. The regulation gives credit for level 2 and level 3 PM devices, which achieve at least 50 percent and 85 percent PM reductions, respectively.

## B. Status of Current Off-Road Verifications

### *1. Off-road verifications*

There are several types of diesel particulate filter (DPF) technologies that are available to meet the requirements of the regulation. DPF technology that uses a catalyst to lower the PM ignition temperature is termed a passive DPF, because no outside source of energy is required for regeneration. Unlike a passive DPF, an active DPF system uses an external source of heat to oxidize the accumulated PM. The most common methods of generating additional heat for oxidation involve electrical regeneration by passing a current through the filter medium (Le., a plug-in system), injecting and burning additional fuel to provide additional heat for particle oxidation, or adding a fuel-borne catalyst or other reagent to initiate regeneration. Some active systems collect and store diesel PM over the course of a full shift and are regenerated at the end of the shift with the vehicle or equipment shut off.

Currently, there are six level 3 DPFs verified for off-road use. Table 1 below lists all the current VDECS for off-road vehicles. All of the VDECS shown in Table 1 are level 3 DPFs. Three of these -- the Caterpillar diesel particulate filter (DPF), the DCI International Inc. DPF, and Engine Control Systems' Purifilter DPF - have recently been verified and entered the market after the off-road regulation was adopted in July 2007. The Caterpillar DPF's verification was also recently expanded to include track-type vehicles.

Table 1: Currently Verified Level 3 Off-Road DPFs

| Product | Type (Active or Passive) | Applicability | Max Allowable PM Certification Level of Engine |
|---|---|---|---|
| Caterpillar DPF | Passive | Verified for some 1996-2008, 175-600 hp, non-exhaust gas recirculation EGR | Less than or equal to 0.2 grams per brake-horsepower hour Ibh -hr |
| Cleaire Horizon | Active; Plug-In | Conditionally verified for many 2007 and older, non-EGR, less than" 15 liters | less than or equal to 0.4 g/bhp-hr |
| DCI MINE-X Sootfilter | Passive | Conditionally verified for some 1996-2008, 175-300 hp, non-EGR, rubber tired | less than or equal to 0.15 g/bhp-hr |
| Engine Control System Combifilter | Active; Plug-In | Verified for many 2007 and older, 25-300 hp (certain conditions) or 175-300 hp, non-EGR, rubber-tired | less than or equal to 0.45 g/bhp-hr |
| Engine Control Systems' Purifilter | Passive | Conditionally verified for some 1996-2008, 50-750 hp, non-EGR | 0.01 to 0.2 g/bhp-hr |
| HUSS Umwelttechnik FS MK | Active; Fuel Burner | Verified for most off-road diesel engines through 2008, most hp, non-EGR | No restrictions |

In addition to the Level 3 DPFs listed above, there is one level 2 off-road VDECS[4]. It consists of a diesel oxidation catalyst (DOC) used with an emulsified diesel fuel.

Although the availability of off-road VDECS is increasing, VDECS have become available at a slower pace than staff anticipated. This lack of off-road verifications is due to a number of reasons, including:

- It is challenging to find the proper vehicles and engines for off-road demonstration programs to ensure the broadest verification possible for each system (discussed in further detail later in this Chapter);
- It is difficult to accrue the number of hours necessary for datalogging due to lower equipment activity related to the current economy;
- Some manufacturers have limited the resources they have invested in off-road verifications, focusing more on the verification of on-road systems; and

4 Although this device is still listed on ARB's verification website, the manufacturer of this product withdrew it from the market several years ago.

- The Showcase has had a slower start than anticipated (discussed later in this Chapter).

While it is difficult to predict with certainty, ARB staff anticipates that more off-road VDECS will become available in the near future. There are over 30 systems currently in the verification process for off-road applications, with several systems in the final stages of verification. Nearly all are Level 3 systems. Approximately five systems will reduce NOx, either alone or in concert with PM reductions. In addition, some manufacturers with current off-road VDECS are working to expand the scope of their verifications.

### *2. Scope of off-road verifications*

As part of their assessment, staff has estimated the scope of applicability of the current off-road VDECS. To do this, staff conducted an analysis using the statewide off-road inventory to estimate the fraction of vehicles in the statewide fleet that could potentially be retrofit with currently verified off-road retrofits (ARB, 2006). Although a device may be verified for a specific engine, it may not always be verified or appropriate for the application in which the vehicle is used. Because of this, staff considers this analysis as an upper bound estimate of the number of off-road vehicles in the statewide fleet that could be retrofit with currently available off-road VDECS.

To develop this estimate, staff used the following information:

- The verification letters (also referred to as Executive Orders) for each off-road VDECS. The Executive Orders specify the horsepower, model year, emissions levels, and whether the device can be used with engines equipped with EGR.
- Letters from VDECS manufacturers exempting certain vehicle types or models from retrofitting under the Carl Moyer program (Bruenke, 2007a; Bruenke, 2007b; Bruenke, 2008a; Bruenke, 2008b; Bruenke, 2008c; Bruenke, 2008d; Luksik, 2008). Staff's analysis assumes that such exempted vehicle types or models cannot be retrofit.

Appendix B of this report contains further detail about how staff estimated the current extent of verifications.

Of the six Level 3 verifications, the Huss active fuel burner system verification has the broadest application. It is verified for most off-road diesel engines through 2008, as long as the engine does not come equipped with EGR and is not in one of the high horsepower applications for which Huss has indicated its system is not feasible. These high horsepower applications include several models of scrapers and dozers, but affect only about 1.5 percent of the total statewide fleet (see Appendix B). While from a technical perspective nearly all vehicles could be retrofit with the Huss or other active systems, as discussed below, fleets have expressed operational concerns regarding the use of active, systems.

For a number of reasons, many fleets find active systems to be undesirable; the reasons for this include the need for external power, the requirement to shut a vehicle down for filter regeneration, and cost. The use of plug-in active systems, such as the

Cleaire Horizon and ECS Combifilter, that require access to high voltage electrical power are challenging for vehicles that may be used away from a power source. For example, if a loader is operating at a remote construction site, and does not return to a central facility each night, it may not be feasible for that fleet to install a plug-in DPF on that loader because there is no on-site access to electricity for filter regeneration. On the other hand, fuel burner systems, such as Huss's active DPF fuel burner system, avoid this issue since they do not require an external source of power. However, despite this, such systems are also not desired by many fleets, especially ones with older, lower tier vehicles, because the vehicles have to be turned off so the filter can be regenerated. Sometimes this filter regeneration interval can be frequent enough, in some cases approaching every few hours, to make use of the vehicle inconvenient or impractical (Porcher, 2008). In addition, as described later, active systems are generally more expensive than passive systems. However, active systems are still appropriate in many applications, and represent a majority of the systems currently installed on off-road vehicles.

Until recently, less than five percent of the vehicles and 11 percent of off-road vehicle horsepower covered by the regulation had passive DPF systems available.[5] In late October 2008, a new ECS system was verified, and the verification for the Caterpillar passive VDECS was significantly expanded; staff now estimates that up to 24 percent of the vehicles and up to 60 percent of the horsepower of affected off-road vehicles are capable of having a passive VDECS installed.[5,6] However, due to the late date of verifications, fleets, as presently adopted, had less than two weeks? to order these systems, which are now available for a wider variety of vehicles, and secure guaranteed double PM VDECS credit under the regulation. As is discussed later, this is the primary rationale for staff's proposal to extend the early PM credit provisions of the regulation.

## C. Status of Current Off-road Demonstration Programs

ARB staff is actively involved with three DECS demonstration programs: the Showcase, a United States Environmental Protection Agency (U.S. EPA) Supplemental Environmental Project (SEP), and a snowcat demonstration project. These programs are providing valuable experience to staff, fleets, and retrofit manufacturers on the challenges of retrofitting off-road vehicles, and are facilitating an increase in the number of verified off-road DECS.

5 The percentages estimated are the maximum possible percent of vehicles and engines that could be retrofit. They do not account for factors such as that some engines do not attain sufficient temperature to be retrofit with passive VDECS. Also, they do not fully account for the fact that one passive VDECS, the Caterpillar DPF, was verified only for rubber tired applications. ARB's inventory data do not allow staff to subtract out tracked vehicles for vehicle types such as loaders that can be either tracked or rubber tired (ARB, 2006).

6 It is estimated that in 2010, approximately 35,000 or 18 percent of the vehicles in the statewide fleet will need VDECS to comply with the regulation; by 2011, approximately 60,000 or 30 percent of the statewide fleet will need VDECS·(ARB, 2007b).

? Less than two weeks from the date of the verifications.

### 1. *Showcase*

#### a) *Overview*

In anticipation" of the need for additional verified DECS for off-road equipment, ARB, in conjunction with the South Coast Air Quality Management District (SCAQMD) and the Mobile Source Air Pollution Reduction Review Committee (MSRC), is administering the Showcase. Stakeholders in the Showcase include retrofit device manufacturers, fleet operators, other local air pollution control districts in California, and U.S. EPA.

The goals of the Showcase project are to:

- Demonstrate the effectiveness and durability of DECS on off-road vehicles;
- Increase the number of VDECS for off-road applications;
- Support the regulation through increased availability of VDECS;
- Introduce DECS to off-road fleets;
- Provide early reductions of emissions from off-road vehicles; and
- Gain additional experience with the installation and use of DECS on off-road vehicles.

The Showcase has been funded for $4.9 million, including $3.7 million from the MSRC, and $1.2 million for devices which control NOx from the SCAQMD. Additional information about the Showcase, including background, current status, vehicle data, photos, and datalogging results are available at the web site http://www.arb.ca.gov/diesel/showcase/showcase.htm.

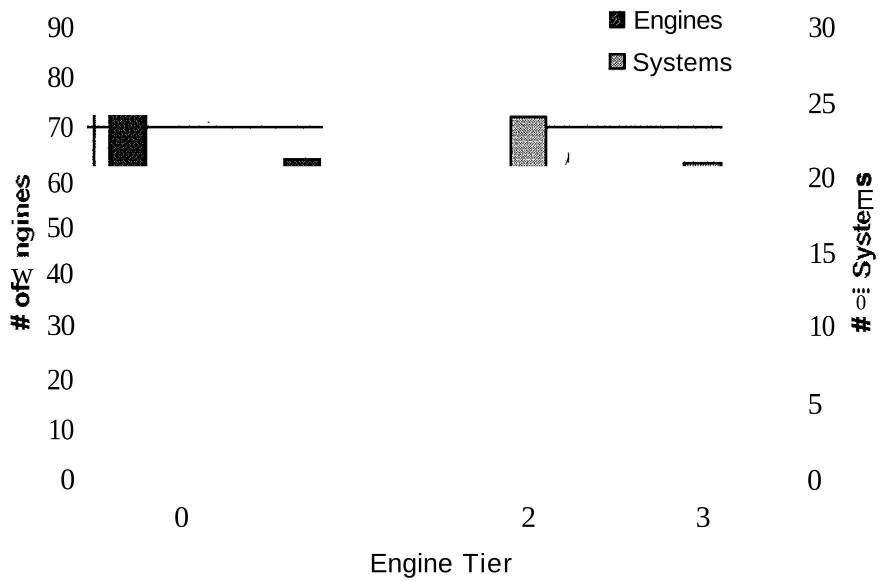
#### b) *Current Status*

The Showcase covers a diverse combination of devices and vehicles in an effort to demonstrate and verify as many devices as possible covering a broad array of vehicles and applications. Vehicles were selected to represent a full range of vehicle types affected by the off-road regulation, as well as a full range of engine sizes. Additional information is provided in Tables 1 and 2 of Appendix C. As of early November 2008, 18 fleets with 202 vehiCles have applied and been accepted to participate in the Showcase. Thirteen of the fleets are privately-owned, and five are public. The participating fleets are listed in Table 3 of Appendix C.

Participation in the Showcase by fleet owners provides them with a number of benefits. First, fleet owners are able to gain valuable experience with DECS with little or no capital outlay on their part. In addition, fleet participants are able to accumulate early double PM retrofit credits to be used to offset future fleet retrofit requirements.

Fourteen emission control manufacturers with 26 systems are participating in the Showcase. The 26 systems include 11 active DPFs and 15 passive DPFs. Seven of the systems reduce NOx as well as PM, and six of the systems include fuel borne catalysts. As shown in Figure 1 below, the vehicles participating in the Showcase include off-road engines with a full range of engine tier levels, from the highest emitting uncertified Tier 0 engines to the newest, cleanest Tier 3 engines. Some of the systems included in the Showcase are seeking verification for engines of all tiers, while others are limited to newer engines. The list of participating emission control manufacturers is located in Table 4 of Appendix C.

**Figure 1: Showcase Installations of OECS**




As of November 2008, over 60 engines have been datalogged, as described below, and .9 engines have been retrofitted through the Showcase. Tables 1 and 2 of Appendix C include a list of the vehicle types and engines that have been retrofit so far, and a list of vehicle types and engines that are remaining to be retrofitted. It will be several more months until all vehicles are retrofitted.

In the initial stages of the Showcase, staff anticipated that all vehicles would have been datalogged, installation designs completed, and most retrofits installed by November 2008. However, a variety of circumstances have pushed back this timeline. The primary reasons for the delay are:

- Contracts took much longer to execute than expected;
- Economic effects (vehicles had reduced usage or were pulled from service or retired);
- Fleets requested a change of vehicles;
- Installation designs were more complicated than anticipated, in some cases increasing the price;
- The exhaust temperatures required an active device when initially a passive device had been planned; and
- A few devices were removed prior to installation as the manufacturers felt they needed further development.

However, the data gathered thus far has provided a significant increase in knowledge regarding the applications of DECS on off-road vehicles. For example, during the development of the regulation, staff estimated that most off-road engines (approximately 70 percent) would require an active, rather than passive, DPF (ARB, 2007b). However, datalogging of engine temperature and backpressure through the Showcase program indicates that over three-quarters of datalogged engines produce sufficiently high exhaust temperatures that would support the use of a passive DPF. This is encouraging because passive devices tend to be significantly less expensive than active DPFs and - as discussed above - are typically more desirable to fleets. Individual datalogging results are available on the Showcase website listed above; one example is included in AppendixC (Figure 1 and Figure 2).

### 2. *U.S. EPA's Supplemental Environmental Project*

Three refineries in Northern and Southern California, in collaboration with the U.S. EPA and the ARB, have agreed to provide funding for retrofitting off-road vehicles with DECS. The refineries are providing the funding through the U.S. EPA SEP program, under which a violator offsets excess pollution by funding emission reductions projects in the immediate vicinity of the violation.

The goals of the SEP are similar to the Showcase. The SEP will complement the Showcase by filling gaps in the test vehicle matrix that were unable to be addressed in the Showcase (see Appendix C, Table 10 for the matrix of vehicles).

The SEP project is divided into three stages - SEP I through SEP III - with total funding of $700,000. The funding for each SEP stage and the scope and status of each is shown in Table 2.

Table 2: SEP Funding and Number of Engines Retrofitted

| SEP | Funding | # of Fleets | # of Engines | Status as of Early Nov |
|---|---|---|---|---|
| | $300,000 | 3 | 15 | DECS Installed |
| II | $200,000 | 3 | 11 | DECS Installed |
| III | $200,000 | 4 | 12 | Datalogging vehicle exhaust tem eratures |

Tables 5 and 6 of Appendix C include a list of the vehicle types and engine sizes that have been retrofit so far in SEP I and SEP II; a list of vehicle types and engine sizes that are proposed to be retrofit in SEP III is also included in Table 7 of Appendix C.

Similar to the Showcase, fleet owners are able to gain valuable experience with DECS with little or no capital outlay on their part. In addition, fleet participants are able to accumulate early PM retrofit credits to be used to offset future fleet retrofit requirements. However, the SEP - unlike the Showcase - offers only single, not double, retrofit credit.[8]

8 The U.S. EPA specified that fleets should only receive single credit for DECS installations funded through the SEP, because the funding was intended to offset emissions violations at the three refineries.

SEP information including vehicle data, photos and datalogging results are available at the web site http://www.arb.ca.gov/diesel/showcase/showcase.htm. Tables 8 and 9 of Appendix C list the fleets and emissions controls manufacturers participating, in the SEP, respectively.

### 3. *Snowcat demonstration project*

A typical off-road engine in California operates at low elevations and in mild temperatures. The DECS verification procedures do not require testing at high elevations or in low ambient air temperatures. During the development of the regulation, some stakeholders raised concerns that under these conditions, DECS would not perform well. To evaluate these concerns, during the winter of *2007/2008,* twelve snowcats used for snow grooming operations were datalogged at the three northern California ski resorts shown in Table 3.

Table 3: Snowcat Project Locations and Number of Vehicles

| Ski Resort | Number of Vehicles Datalogged |
|---|---|
| Su ar Bowl | 2 |
| North Star | 5 |
| Mammoth | 5 |

Snowcat engines operate a majority of the time under medium to heavy load. Many ski resorts have some slopes so steep thatthe snowcats must winch themselves up and down those slopes because the treads alone do not provide sufficient traction. Based on staff's evaluation of datalogged information, staff determined that despite the high elevation and low ambient air temperature that snowcats are typically subject to, their engine exhaust temperatures are high enough that passive DPFs can be used. In fact, one resort has already installed passive DPFs on some of their snowcats.

Snowcat demonstration project information including vehicle data, photos and datalogging results are available at the web site *http://www.arb.ca.gov/diesel/showcase/showcase.htm.*

### 4. *Overall findings* of *the demonstration programs*

The most significant finding of the Showcase, SEP, and Snowcat demonstration programs to date has been that more vehicles than expected have sufficiently high exhaust gas temperatures to be retrofit with passive devices. Every engine in every vehicle' participating in these retrofit demonstration programs has or will be datalogged for 5 to 7 days. The datalogging tracks the characteristics of the exhaust by recording temperature and backpressure. Analysis of the over 110 vehicles datalogged to date demonstrates that over three-quarters of these engines produce sufficiently high exhaust temperatures to support the use of a passive DPF.[9] Passive devices tend to be significantly less expensive than active DPFs and less complicated, therefore they are often more desirable to fleets.

The Showcase and SEP programs have also demonstrated that off-road retrofits are durable and can function well while effectively reducing diesel PM pollution on a wide variety of vehicle types. Thirty devices have been installed on a wide diversity of vehicle types including tractors, graders, loaders, backhoes, excavators, and scrapers, and all the retrofit devices are working well. In addition, these demonstration programs have highlighted the need to ensure proper installation, as there were a limited number of installation issues, such as exhaust leaks, encountered during installation; however, these issues have been or are in the process of being resolved.[10] Despite these issues, the overwhelming reaction of fleets participating in these demonstration programs to retrofits has been extremely positive.

Over the next 6 to 12 months in the Showcase and SEP programs, staff plans to complete the following tasks:

- Install devices onto the remaining off-road vehicles;
- Continue datalogging to gather exhaust temperature data;
- Monitor the performance of the devices;
- Measure emissions during vehicle operation with an on-board portable emissions measurement system (PEMS); and
- Survey the fleet owners and operators regarding their opinions concerning operation of the retrofits.

Staff is continuing to work with retrofit manufacturers participating in these demonstration programs to develop the data necessary to demonstrate the durability and performance of their products in support of verification. Staff is also optimistic that the information and lessons learned through these demonstration programs regarding the installation and operation of off-road retrofits can be used broadly by affected fleets and retrofit installers to assist them during the implementation of the regulation.

## O. Total Number of VOECS installations

To date, staff estimates that about 430 off-road vehicles have been retrofit in California with a Level 3 off-road VDECS, including dozers, loaders, excavators, backhoes, graders, and tractors. Because there is as yet no requirement for fleets or VDECS installers to report each VDECS installation to ARB, staff does not have details on each installation or an exact count of how many VDECS have been installed. However, staff has interviewed VDECS manufacturers to obtain an estimate of how many retrofits are already in place, and will have a better sense of the actual number of installations once

9 The Showcase and SEP did not capture smaller horsepower engines, and smaller horsepower engines will likely require active DPFs.

10 At the time of this report's writing, thirty devices were installed and one device which encountered difficulties during installation was awaiting final installation.

fleets begin reporting in the spring of 2009 (Halloran, 2008; Jerman, 2008; Brown, 2008; *Swenson,* 2008; Surma, 2008).

## E. Cost of Verified Diesel Emission Control Strategies

Table 4 below shows the current average costs[11] for purchase and installation of active VDECS based on data from three VDECS installers (Cox, 2008; Ostrander, 2008; Cram, 2008), and the Carl Moyer program database (CARL, 2008). The data shown in Table 4 is for 194 of the estimated 430 VDECS installations that have occurred to date on off-road vehicles in California. .

Table 4: Summary of Active VDECS Costs in 2008

| Engine Horsepower Range | Active VDECS Cost in 2008 |
|---|---|
| < 50 | $13,800 |
| 50-120 | $15,500 |
| 121-175 | $19,300 |
| 176-250 | $19,100 |
| 251-400 | $44,600 |
| 401-500 | $44,800 |
| 500+ | $48,400 |

The data indicates that the cost to apply an active VDECS to a vehicle shows a distinct jump at around 250 horsepower. This substantial increase in cost is largely due to the necessity of using multiple canisters or larger filter sizes for engines above 250 horsepower.

Very few passive VDECS have been sold in California because they were verified only recently. Therefore, there are insufficient data to determine the average costs over a full range of engine horsepowers. Staff has cost data on a handful of installations of passive VDECS that have been installed on engines of approximately 230 to 300 horsepower! and the average cost for these passive installations was about $21,000. ARB staff will continue to collect information on VDECS costs, as more passive systems are purchased and installed.

The current costs for installed VDECS[12] are, on average, about 30 percent higher than initially estimated by staff during the development of the regulation (ARB, 2007b). However, staff's initial cost analysis was based on estimates of the average prices for VDECS over the entire course of the regulation. As the market for VDECS expands, staff expects the volume of sales, as well as the increased number of VDECS options fleets may choose from, to lower overall retrofit costs. Staff also expects the availability of passive VDECS in additional horsepower ranges to provide less costly solutions where the application supports the use of a passive system. Staff expects these lower

. 11 Cost of VDECS unit plus installation.

12 Assuming a distribution of 30 percent passive DFPs and 70 percent active DPFs.

cost solutions will lower the overall costs of DPFs over time, bringing them in line with the estimated VDECS costs presented in the initial staff report.

## F. VDECS Safety

During the development of the regulation, staff recognized that some VDECS installations could present potential safety hazards and that in some cases it would not be possible to install a VDECS safely. Potential safety issues include significant visibility impairment, thermal hazards, and compromising the structural integrity or center of gravity of the vehicle, with visibility impairment likely to be the most common issue. Recognizing these potential safety hazards, the regulation includes provisions to exempt a vehicle from the VDECS requirements if one can not be installed safely. Under the regulation, a fleet owner may request that the Executive Officer review and determine whether a VDECS should not be considered the highest level VDECS available because of potential conflict with other safety and health requirements. As part of these provisions, there is also an appeals process for any party whose request has been denied.

Staff is currently working with staff from the California Occupational Safety and Health Administration (Cal\OSHA), the Mining Safety and Health Administration (MSHA), and organized labor to develop the protocol for evaluating claims of unsafe installation of VDECS. Cal\OSHA and MSHA staff have been helpful in assisting staff in compiling a summary of all relevant safety regulations. Cal\OSHA staff has attended Off-road Implementation Advisory Group (ORIAG, described in Chapter III) safety committee meetings. Cal\OSHA and MSHA staff have also agreed to work with ARB as part of a group that will review safety appeals. Staff also anticipates working with this group to develop amendments necessary to Cal\OSHA regulations to establish more objective criteria for determining whether a specific VDECS installation presents an unsafe condition.

# III. IMPLEMENTATION UPDATE

This chapter describes staff's ongoing efforts to implement the regulation.

## A. Public Outreach

Since the regulation was approved in July 2007, staff has been working with affected industry stakeholders and other interested parties on its implementation.

### *1. Training seminars*

Since July 2008, staff conducted thirteen free training seminars throughout the state including in:

- San Luis Obispo,
- Bakersfield,
- Redding,
- Nevada City,
- Fresno,
- Riverside,
- San Diego,
- El Monte,
- Sacramento,
- San Jose,
- Ventura,
- Oakland, and
- South Lake Tahoe.

More than 12,000 flyers were distributed to publicize the seminars, local newspapers helped publicize the trainings, and approximately 1,300 stakeholders attended the training sessions. The Sacramento training seminar was also webcast so interested parties could participate remotely via computer. Each seminar lasted approximately three hours and provided a detailed explanation of the regulation and assistance on how fleets should address the regulation's reporting requirements. The seminars also provided interested fleets with the opportunity to speak with representatives from companies who manufacture or install off-road VDECS. A list of the seminar locations and attendance is included in Table 1 of Appendix D.

ARB staff distributed feedback forms at each of the twelve training sessions. On a scale of 1 to 5, with five being the highest, participants ranked the training as a 4.6 when asked if they thought it was worthwhile and worth their time to attend. Staff has another three training sessions currently scheduled and expected to be completed by the end of 2008 in Fortuna, Victorville and Sacramento, and plans to conduct additional training sessions in 2009.

### *2. Other outreach and assistance*

Since the regulation was approved, staff has been making every effort to reach and inform interested parties about the regulation. Over the past year and a half, staff has conducted approximately 28 meetings with individual fleets and dealerships in a one-on-one setting. In these meetings, staff provided an overview of the regulation, in addition to providing reporting and' compliance planning assistance. In addition, staff has not waited to be invited to relevant events; staff researched the meeting and conference schedules for a number of relevant trade associations and called and offered to speak at and attend these meetings. In total, staff has spoken to 17 groups at industry trade association meetings and events. During thistime, staff also attended nine conferences and workshops to give presentations regarding the regulation or to provide fact sheets or other information to interested stakeholders. Additionally, some of these events were held out-of-state; this enabled staff to more widely outreach to those individuals or companies who frequently bring equipment into California from surrounding states. A list of the organizations to which staff has made presentations with since approval of the regulation is included in Table 2 of Appendix D. Table 3 of Appendix D lists individual fleets and stakeholders with which staff has met, and Table 4 in Appendix D describes the conferences that off-road implementation staff has attended to talk about the regulation.

Staff has also done multiple mailings to individuals potentially affected by the regulation and notified them about upcoming training sessions and outreach opportunities. The industry groups and associations that received notification of this information included off-road equipment manufactures, off-road engine manufactures, California county board of supervisors, county public works departments, auction houses, theme parks, and general construction contractors.

In addition to traditional mailings, ARB has sent out multiple e-mail notifications through its Off-road list serve, which contains over 3,700 individual e-mail addresses. Staff is also currently working with the Department of Motor Vehicles (DMV) and the Contractors State License Board (CSLB) to get information about the off-road regulation inserted into the agency's respective registration and license renewal documents. Additionally, ARB staff expects to be able to reach approximately 15,000 contractors each month through CSLB renewal letters.

Staff is also producing a series of training videos to simply and clearly illustrate how to choose, install, and maintain VDECS. The goal for these videos is to help fleets gain the necessary understanding to more readily implement rules such as the off-road regulation that require installation of VDECS. These videos will include information such as:

- What are VDECS and how do they work;
- How to comply with regulatory VDECS requirements;
- Who to turn to for technical advice on VDECS;
- How to select a VDECS; and
- How to properly install and maintain VDECS.

Outreach efforts will continue in the future. ARB staff has designed a poster that will be placed in dealerships throughout the state where off-road equipment is sold, as well as in public works offices and other places where owners of affected vehicles may frequent. Staff is also pursuing other avenues for getting the word out regarding the regulation, including the use of free public service announcements on radio stations.

## B. Off-road Implementation Advisory Group

At the suggestion of several industry stakeholders, ARB formed an advisory group in March 2008 to assist staff with outreach and implementation. The group, called the off-road implementation advisory group (ORIAG), is an informal committee made up of approximately 50 members selected to represent a cross-section of fleets, engine manufacturers, retrofit manufacturers and installers, equipment dealers and manufacturers, trade groups, and others. Thus far, ORIAG has had three general meetings, in May, June, and September of 2008, all of which were webcast. ORIAG has also formed subcommittees on safety, DECS, fleets, outreach, and the Diesel Off-road On-line Reporting System (DOORS), as well as a guidance document review group.

Every general meeting has been attended by most of the ORIAG members. In addition, as the meetings are open to the public, many additional interested members of the public have attended and participated. Through the subcommittees and during general meetings, ORIAG members have provided excellent suggestions and feedback regarding, for example, the content of the training seminars, safe installation of retrofit devices, guidance documents (e.g., advisories and answers to frequently asked questions), and improving DOORS (the reporting system developed for the regulation). The feedback from ORIAG members has helped make ARB staff more aware of the needs and opinions of affected stakeholders and more able to effectively implement the regulation. Staff plans to continue to meet regularly with ORIAG in the future as implementation of the regulation progresses.

## C. SOON Program Status

The Surplus Off-Road Opt-In for NOx (SOON) program was established by section 2449.3 of the regulation. It is intended to allow local air districts to fund projects for off-road diesel vehicles operating inside their district to achieve additional NOx emission reductions beyond those expected from the base regulation. Funding may come from any available funding source; however, staff expects that most of the SOON program funding will come from the Carl Moyer incentive program. The SOON program was implemented, in part, to assist the South Coast and San Joaquin Valley air districts in meeting federal air quality standards for ozone and fine particulate matter. In order for the SOON program to take effect, the participating district must develop administrative guidelines for the program and have those guidelines approved by ARB. Section 2449.3 allows the South Coast Air Quality Management District (SCAQMD) and San Joaquin Valley Air Pollution Control District (SJVAPCD) to make the SOON program mandatory for fleets beginning in 2009.

While any air district may opt into the SOON program, to date only the SCAQMD has officially elected to do so. The SJVAPCD is presently in the process of opting into the SOON program. Further details on the status of SOON in the SCAQMD and SJVAPCD are provided below.

### *1. South Coast Air Quality Management District*

The SCAQMD submitted draft SOON guidelines to staff on March 20, 2008, and May 12, 2008. The SCAQMD's governing Board formally opted into SOON on May 2, 2008, and ARB approved the SCAQMD SOON guidelines on June 6, 2008. The SCAQMD released the first solicitation for SOON projects with a submittal deadline of November 7,2008 (SCAQMD, 2008).

Based on the first round of solicitations, the SCAQMD has funded 125 off-road diesel vehicle repower projects from 21 private companies and one government agency at a cost of $16.6 million.[13] SCAQMD has committed to provide $30 million of Carl Moyer monies annually for the first four years of their SOON Program and will make another $13 million available with another round of solicitations after the November 7,2008, deadline.

### *2. San Joaquin Valley Air Pollution Control District*

The SJVAPCD submitted draft SOON guidelines for review and assessment to ARB staff on August 25, 2008, and September 19, 2008. However, staff's comments were not addressed in the most recent version of the proposed guidelines, and staff disapproved the proposed guidelines on October 15, 2008 (White, 2008). Staff is continuing to work with the staff of the SJVAPCD to develop guidelines that are consistent with the SOON program. The current SJVAPCD implementation plan calls for the investment of five million dollars from Carl Moyer monies annually to fund SOON projects (Gamez, 2008).

## D. **DOORS**

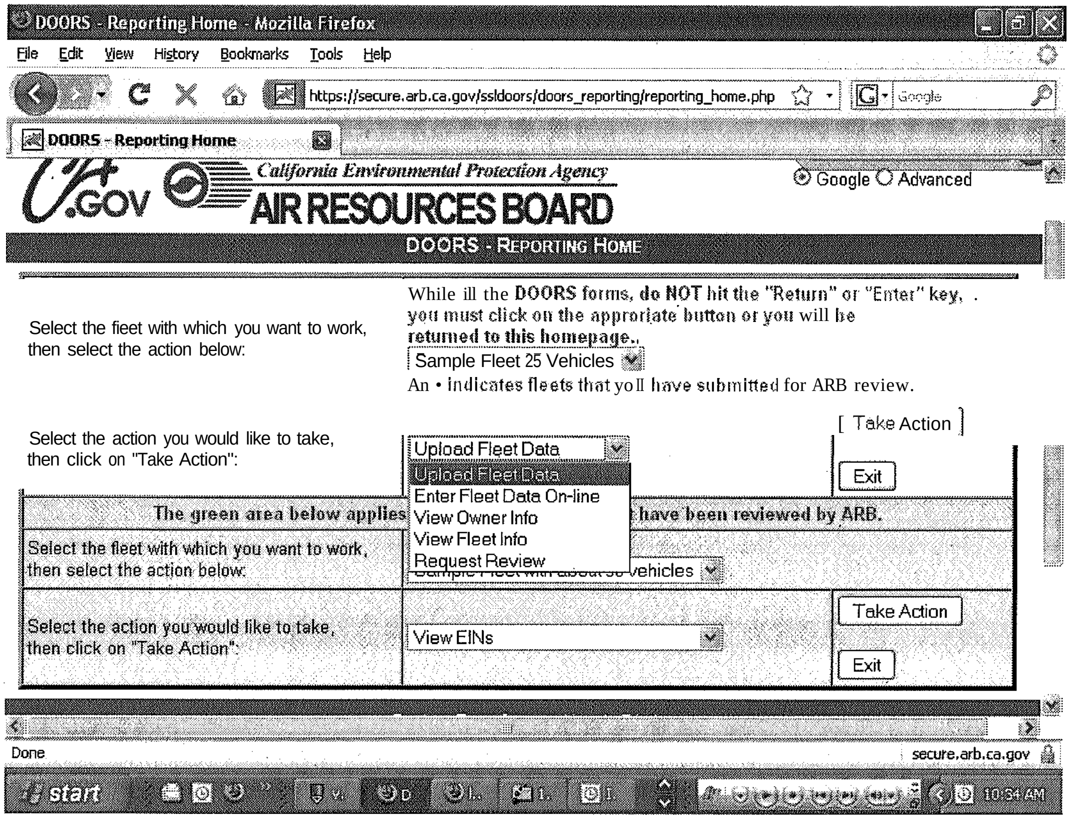
Staff has developed the DOORS system to enable fleet owners to report their fleet information to ARB as required by the regulation. DOORS is a web-based application using a database to store fleet data. Fleet owners, vehicle dealers, consultants and other members of the -DOORS ORIAG subcommittee have provided input on the design and function of DOORS and are assisting in developing the compliance planning features and other enhancements as needed.

As shown in Figure 2, DOORS provides fleet owners a number of ways to provide their information to ARB, as well as providing many other features. As currently structured, DOORS allows fleet owners to:

- Enter their fleet information directly in on-line entry screens or by uploading information from a spreadsheet;
- View and edit their information; and
- Request ARB review of their information.

13 Carl Moyer monies were used.

**Figure 2: DOORS Screenshot**




**Staff has assisted fleets when they have had questions regarding DOORS reporting and has prepared an on-line user-guide (which** is included **in Appendix E) to assist fleet owners. Staff also provided comprehensive training on DOORS in the first round of statewide training sessJons. Building on this, staff is offering half-hour one-on-one training sessions to assist interested fleets in using DOORS during the second round of training in November and December of 2008.**

**The deadlines for initial reporting are rapidly approaching - April 1, 2009, for large fleets, June 1,2009, for medium fleets, and August 1,2009, for small fleets. In total, staff expects that approximately 8,000 fleets with about 180,000 vehicles will be required to report their vehicles to DOORS. Staff has been strongly encouraging fleets to report early so that they will be able to become familiar with the process and be able to fully take advantage of the customer support being provided by staff. As of November 17, 2008, 64 fleets have reported information on over 7,100 vehicles. By reporting early, these fleets have provided themselves with extra time to label their vehicles with Equipment Identification Numbers (EINs) as required by the regulation and shown in Figure 3.**

**Figure 3: Vehicle Labeled with EIN**

## E. Enforcement Actions and Fines Issued

Two provisions in the regulation became enforceable when the regulation became effective on June 15, 2008: a fiveniinute limit on unnecessary idling for off-road diesel vehicles, and the requirement that California-based sellers of off-road vehicles provide written disclosure to purchasers that the regulation may be applicable to the off-road diesel vehicles sold and operated in California.

Enforcement of the idling restrictions began in October, 2008, when ARB enforcement staff visited 15 construction sites in Southern California, and issued two citations for unnecessary idling and identified a dealer that had failedto include disclosure with off-road diesel vehicle sales. Based on the information provided by the dealer, enforcement staff identified 18 violations. Enforcement staff is continuing to perform inspections of construction sites and audit dealerships and auction houses, and are preparing to enforce the fleet reporting requirements beginning next spring.

## F. Waiver Status

The federal Clean Air Act (CM) section 209(e)(2) permits California to adopt emission standards and requirements related to emission control for in-use nonroad engines, so long as it obtains authorization from the Administrator of the U.S. EPA prior to the regulation becoming effective. As part of the authorization process, in Resolution 07-19, the Board made the requisite protectiveness finding required under CM section 209(e)(2) that the adopted regulations will be, in the aggregate, at least as protective of public health and welfare as the applicable Federal standards, that California needs its nonroad emission standards to meet compelling and extraordinary conditions, and that the standards and accompanying enforcement procedures approved therein are consistent with CM section 209.

ARB submitted the request for authorization to U.S. EPA on August 12, 2008. On October 7,2008, U.S. EPA published notice that it would consider California's request (U.S. EPA, 2008) at a public hearing on October 27,2008. Staff attended the hearing in Washington D.C. and gave a presentation in support of its request. The comment period for U.S. EPA's consideration of the authorization request was originally scheduled to end November 28, 2008, but has now been extended until December 19, 2008 (U.S. EPA, 2008a; U.S.EPA, 2008b).

# IV. PROPOSED MODIFICATIONS TO THE REGULATION FOR IN-USE OFF-ROAD DIESEL-FUELED FLEETS

This chapter discusses staff's proposed modifications to the regulation.

## A. Regulatory Authority

ARB has authority under California law to adopt the proposed regulation modifications. California Health and Safety Code (HSC) sections 43000,43000.5, 43013(b) and 43018 provide broad authority for ARB to adopt emission standards and other regulations to reduce emissions from new and in-use vehicular and other mobile sources. Under HSC sections 43013(b) and 43018, ARB is directly authorized to adopt emission standards for off-road vehicular sources, as expeditiously as possible, to meet state ambient air quality standards. ARB is further mandated by California law under HSC section 39667 to adopt Air Toxic Control Measures (ATCMs) for new and in-use vehicular sources, including off-road diesel vehicles, for identified TACs, such as diesel PM.

Under federal and California law, ARB is the primary agency in California responsible for making certain that all regions of the State attain and maintain NMOS. To achieve this, California must adopt all feasible measures to obtain the necessary emission reductions, including measures from mobile sources. The federal CM preempts states, including California, from adopting requirements for new off-road engines less than 175 horsepower used in farm or construction equipment. However, California may adopt emission standards for in-use off-road engines (federal CM section 209(e)(2)). Because the proposed regulation addresses in-use rather than new off-road engines, it is permitted by the federal Clean Air Act. For example, turnover of a vehicle is not required until a vehicle is older than 10 years. California must obtain authorization from the Administrator of the U.S. EPA before the in-use emission standards of this proposed regulation become enforceable. Since the proposed regulation is not within the scope of any existing U.S. EPA authorizations, California must obtain a new authorization from U.S. EPA prior to the regulation becoming effective (ARB, 2007a).

## B. Public Process

Staff is planning to hold a public workshop on December 19, 2008, in Sacramento, California, to solicit public input on the proposed modifications to the regulation. However, since the regulation was adopted, staff has met and spoken with numerous affected fleets and industry representatives who have expressed significant concerns regarding the limited availability of off-road VDECS, and the need for extending the early credit provision.

In addition to the individual meetings, at the September 26, 2008 ORIAG meeting, staff solicited input from the ORIAG on the possibility of extending the early credit deadline. Staff has considered all comments and recommendations received from various stakeholders, and has crafted the proposed amendments to the regulation to help address the specific concerns that were expressed.

## C. Need for Modifications

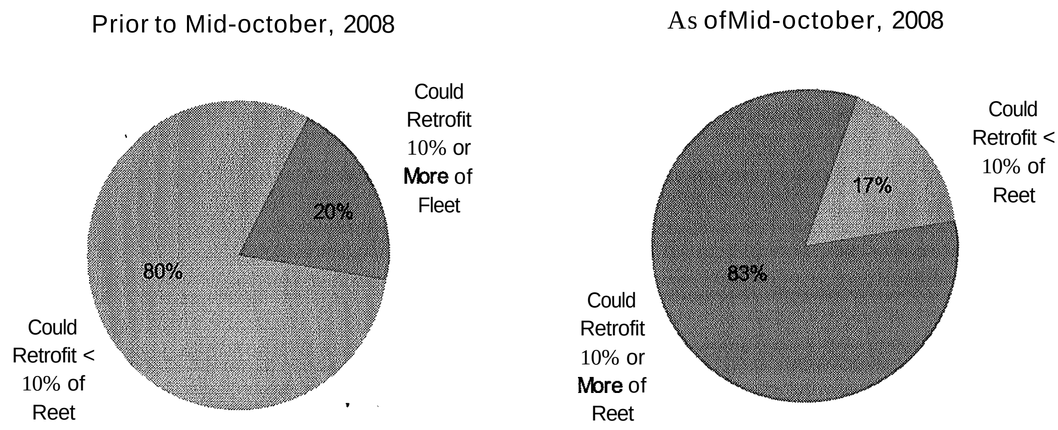
The early credit provision in the regulation currently provides double credit for VDECS installed by March 1, 2009. When a highest level VDECS is installed on an engine before March 1, 2009, that fleet will get double credit, meaning that the fleet will receive *carryover* retrofit credit equal to double the horsepower of the engine on which the highest level VDECS is installed[14]. If there are manufacturing or installer delays that prevent a VDECS from being installed until after March 1, 2009, a fleet will still get double credit as long as the VDECS was ordered by *November* 1, 2008.

Although the availability of off-road VDECS is increasing, as discussed in Chapter II, VDECS *have* become *available* at a slower pace than staff initially anticipated and *have* not allowed fleets to take full *advantage* of this early credit provision. When the regulation was initially adopted, staff anticipated there would be many additional off-road exhaust retrofits verified well before the early credit deadline of March 1, 2009 (ARB,2007a). In proposing the regulation to the Board, staff noted that the early credit provisions for both PM and NOx would be important in making the regulation affordable for some fleets (ARB, 2007e; ARB, 2008a). Early double PM credit was intended to *give* fleets the opportunity to spread out their annual compliance costs in the early years of the regulation *over several* years and to reduce otherwise potentially high initial compliance costs (ARB, 2007e; ARB, 2008a). If the double early credit deadline for PM VDECS is not extended, the forecasted economic benefits of the provision would not be as great.

As shown in Figure 4 below, prior to mid-October, 2008, staff estimates that only 20 percent of fleets affected by the regulation could retrofit 10 percent or more of their vehicle horsepower with available passive verified DECS. Thus, most fleets with a need. or strong preference for passive systems could not take full *advantage* of the early credit provisions. *Even* if they had wanted to purchase retrofits for all of the vehicles in their fleet that could utilize retrofits, they would *have* been unable to accumulate *even* one year's worth of retrofit credit in time to meet the *November* 1, 2008, date for guaranteed double credit.

14 Consider, for example, a large fleet with total horsepower of 10,000 hp that applies highest level VDECS to 1,000 hp of its engines before March 1, 2009. Such a fleet can bank 2,000 hp (1,000 hp times 2), in carryover retrofit credit. Then, on March 1, 2010, if the fleet does not meet the 2010 fleet average target for PM, it may choose not to meet the BACT requirements to retrofit 20 percent of 10,000 hp (Le., 2,000 hp). Instead, the fleet may use its 2,000 hp of banked carryover retrofit credit and postpone any required retrofitting to the following year.

Figure 4: Breadth of Passive Level 3 Verifications by Fleet Hp 2008[15]




However, as can also be seen in Figure 4, now that several more verified systems have recently become available, staff estimates that 83 percent of fleets affected by the regulation can currently retrofit more than 10 percent of their vehicle horsepower with passive VDECS. Thus, many more fleets can now take full advantage of double credit.

Since the regulation was adopted, based on feedback and comments from affected fleets and other stakeholders, staff has also identified a number ofother provisions of the regulation that require clarification or simplification. Specifically, staff is proposing to clarify the duration of the Tier 1 vehicle turnover exemption, the recordkeeping requirements for the disclosure of the regulation's applicability, and the reporting requirements for VDECS. Staff is also proposing to simplify a minor provision in the changing of fleet size requirements. These clarifications are necessary for successful implementation of the regulation.

## D. Proposed Modifications

Staff is proposing the following modifications to the regulation:

- Extend the double creditfor early PM retrofits deadline by 10 months from March 1, 2009 to January 1, 2010;
- Modify the changing fleet size requirements to not penalize fleets that change from small fleets to larger fleets, and then subsequently become a small fleet again;
- Clarify that all sellers, and not just dealers, of off-road vehicles must maintain records of the disclosure of regulation applicability;
- Clarify that the provision for ,delay of Tier 1 turnover exempts Tier 1 vehicles from turnover only until the March 1,2012, compliance deadline; and

15 The pie chart on the left shows the estimated percent of fleets that could have retrofit 10 percent of more of their fleet hp with VDECS verified before mid-October 2008. The pie chart on the right shows the percent of fleets that could do so with VDECS verified as of mid-October 2008.

- Clarify the reporting requirements for VDECS.

In addition to the aforementioned modifications, two minor changes to the off-road regulation were proposed as part of the regulatory package for Proposed Regulation for ,In-Use On-Road Diesel Vehicles: (1) the clarification to the low-use provisions, and (2) the addition of all two engine cranes to the off-road regulation. These changes are scheduled to be considered by the Board at the December 11, 2008, Board hearing. For more information regarding these proposed changes, please see Chapter V. of the Staff Report for the Proposed Regulation for In-Use On-Road Diesel Vehicles (ARB, 2008c).

A more detailed discussion of the modifications staff is proposing is provided below.

*1. Change early double credit deadline*

This change would extend the deadline for earning double PM BACT credit in section 2449.2(a)(2)(A)2.a.i. from March 1,2009, to January 1,2010. The change would also mean that VDECS ordered by September 1, 2009, would receive double credit even if manufacturer or installer delays cause installation of the VDECS to be delayed beyond January 1, 2010. Additionally, this change would allow fleets more time to accumulate early PM credit and take greater advantage of recently verified DECS. Utilizing early PM credit would provide fleets with more time to more effectively spread out the initially compliance costs of the regulation. Also, adding 10 months to the early double PM credit deadline would allow more time for additional off-road verifications to be completed.

*2. Requirements for fleet size changes*

Staff proposes to remove the provision in section 2449(d)(4)(A) that requires a small fleet that becomes a medium or large fleet, and then subsequently reverts to a small fleet, to keep meeting the medium or large fleet requirements for two years after its reduced total maximum horsepower once again reclassifies it as a small fleet. This provision was initially developed to prevent fleets from taking advantage of a potential loophole under the regulation by deliberately growing and shrinking a fleet's size and being subject only to the small fleet requirements. However, after further review of this requirement, staff has determined that the possible complexity of this provision in practice, especially in situations where a fleet's size changes frequently over time, far outweighs the potential for fleets to abuse the changing fleet size provisions.

*3. Recordkeeping requirements for disclosure of applicability*

The record retention requirements in section 2449(h)(8) currently provide that only dealers must maintain records of the disclosure of the regulation applicability required by section 2449(j). In contrast, section 2449(j) requires any person selling a vehicle with an engine subject to the regulation to include a disclosure that the vehicle sold might be subject to the regulation. The intent of section 2449(h)(8) was to parallel section 2449(j) and require the records of the disclosure to be retained by anyone required to issue a disclosure of regulation applicability. As such, staff proposes that the language in 2449(h)(8) be changed to clarify that all sellers, not just dealers, must maintain the records of the disclosure of regulation applicability.

### *4. Tier* **1** *delay*

Section 2449.1 (a)(2)(A)5. states that all vehicles with a Tier 1 or higher engine are exempt from the turnover requirement until March 1, 2013, provided that all Tier 0 vehicles in the fleet owner's fleet that do not qualify for exemption under section 2449.1 (a)(2)(A)4. have been turned over. The intent of this provision is to exempt Tier 1 vehicles from the turnover requirements of the regulation until the fleet must meet their March 1, 2013, com'pliance deadline; that is a fleet may have to begin turning over their Tier 1 vehicles after March 1,2012, to meet the fleet's March 1,2013, compliance requirements. Staff is proposing to clarify this language by stating that all vehicles with a Tier 1 or higher engine are exempt from the turnover requirement until March 1,2012 (instead of March 1, 2013), provided that all Tier 0 vehicles in the fleet owner's fleet that do not qualify for exemption under section 2449.1 (a)(2)(A)4. have been turned over.

### *5. VDECS reporting*

The reporting requirements in section 2449(g)(1 )(0) specify the information regarding VDECS that must be reported to ARB. Section 2449(g)(1 )(0)2. requires reporting of the VDECS model. After further review of this requirement during development of the DOORS system, staff has determined that reporting of just the VDECS model does not provide specific enough information to determine if the device was verified for a particular engine at the time of installation. Instead, it was determined that reporting of the VDECSfamily name is necessary for this purpose. It was also determined that reporting of the VDECS serial number is also important so that ARB enforcement will be able to track a particular device should there be questions regarding the proper functioning of the device. Reporting of the VDECS serial number data in DOORS would also facilitate transferring of information to a buyer should a vehicle with a VDECS be sold. Therefore, staff is proposing to remove the requirement to report the VDECS model and replace it with a requirement to report the VDECS family name and serial number. The DOORS system has been built to request the VDECS family name and serial number, so this change in the regulation will not require any rework for fleets that have reported early.

## E. Staff Recommendation

Staff recommends that the Board adopt the proposed amendments to title 13, CCR, sections 2449 through 2449.3, as set forth in Appendix A.

# V. ECONOMIC IMPACTS

This chapter describes the potential economic impacts of staff's proposal, and specifically the provision to extend the deadline for fleets to accrue early double PM credit for the installation of VDECS from March 1, 2009, to January 1, 2010. Staff's other proposed modifications are clarifications to the regulation, and will not affect the compliance costs for the regulation.

## A. Legal Requirements

Sections 11346.3 and 11346.5 of the Government Code require state agencies to assess the potential for adverse economic impacts on California business enterprises and individuals when proposing to adopt or amend any administrative regulation. The assessment shall' include a consideration of the impact of the proposed regulation on California jobs, business expansion, elimination, or creation, and the ability of California businesses to compete.

State agencies are also required to estimate the cost or savings to any state or local agency and school districts in accordance with instruction adopted by the Department of Finance. This estimate is to include any nondiscretionary costs or savings to local agencies and the costs or savings in federal funding to the state. .

## B. Methodology

To examine the potential economic impacts of the proposed regulation modifications, staff evaluated the impact of the proposed changes on individual fleets, as well as on the total statewide cost of the· regulation.

### *1. Individual fleet analysis*

To estimate the compliance costs for fleets under the proposed modifications, staff reevaluated a previous analysis of an actual rental company fleet that shared its fleet information with staff during the development of the original rulemaking. Staff used average costs for repowers, vehicle replacements, and retrofits as outlined in that Staff Report and the TSD (ARB, 2007a; ARB 2007b). The results of this analysis are provided in Section C below.

### *2. Statewide cost analysis*

To estimate the average statewide costs of the proposed modifications, staff used the ARB Off-Road Compliance Model (the model) previously used to estimate the statewide costs of the regulation. This model is described in detail in Chapter XI and Appendix H of the TSD (ARB, 2007b). As a bounding exercise, staff used the model to calculate the statewide costs of a scenario in which all large fleets took advantage of the proposed extended early PM VDECS credit. The results were then compared to the costs of a scenario where no early PM VDECS credit was utilized. The results of this analysis are provided in Section C below.

## C. Economic Impacts of Proposed Modifications

### *1. Individual fleet analysis results*

In the Final Statement of Reasons (FSOR) prepared for the initial adoption of the regulation, and the 2007 Board Hearing presentation, staff stated that the installation of early PM VDECS and the receipt of credits would help fleets spread out early compliance costs (ARB, 2007e; ARB, 2008a). However, because there were fewer VDECS available than staff anticipated at that time, fleets have not been able to fully utilize this credit, making the regulation less affordable for many fleets.

For example, for the rental fJeet modeled, staff found that they could reduce their PM compliance requirements significantly in the beginning years of the regulation by taking early actions, and receiving early double PM credit (ARB, 2007e). In modeling the fleet's costs, staff assumed that one advantageous compliance path that the fleet could take would be to repower seven percent of its horsepower with engines meeting the Tier 1 standard and have these vehicles retrofitted with VDECS prior to March 1, 2009. Following this compliance path with early retrofits would enable this fleet to build up early retrofit credits and be able to limit the number of retrofits itwould be required to do in subsequent years. If the fleet did not do early retrofits, it would otherwise have to retrofit 20 percent of its horsepower in each of the first three years after compliance becomes mandatory (2010-2012). On the other hand, taking advantage of the early credit provisions the fleet would have been able to reduce its compliance costs by over $110,000, or by about seven percent, in the year when the maximum compliance costs occurred[16], when compared to the scenario where it did not utilize the early credit provisions. Additionally, this fleet was able to reduce its 2010 compliance costs by approximately $1,400,000, or 80 percent, by utilizing the early credit provisions.

If the deadline for double early credit is not extended and this fleet cannot utilize the early credit provisions as initially envisioned by staff, it could experience up to seven percent higher maximum annual compliance costs as well as significantly higher compliance costs in 2010, and could find the regulation less affordable than staff estimated in the Staff Report and TSD (ARB, 2007a, ARB, 2007b). Staff believes that many fleets are in a situation similar to that faced by the modeled fleet. Although these fleets would have liked to utilize the early credit provisions to spread out their compliance costs and lower their maximum annual compliance costs, they have been unable to do so because of a lack of verified devices. Overall, the proposal to extend early credit for PM VDECS would allow compliance to be more affordable for such fleets, and would not increase individual fleet costs above the costs estimated in the initial 2007 TSD (ARB, 2007b).

### *2. Statewide cost analysis*

The statewide cost analysis indicates that the proposed modification should help fleets spread out the initial costs of the regulation, without increasing the total cost of the

16 For most fleets that do not utilize early credit, the maximum compliance costs will occur in 2010. However, if early credits are utilized, the maximum compliance costs will occur later during a fleet's compliance period.

regulation, or the costs in any given year. Staff anticipates that the proposed change would lower compliance costs in 2010, the year maximum annual regulation costs are expected to occur (ARB, 2007a).

The results of staff's analysis are as follows:

- If all large fleets (those fleets with a March 1,2010, compliance date) utilized the early credit provisions and installed retrofits in time to get double PM credit, the statewide costs in 2010 would be approximately 40 percent less than if no fleets performed early retrofitting; and
- The total cost of the regulation over the period 2009 to 2030 would be approximately the same in both scenarios (all large fleets doing early retrofitting versus none doing early retrofitting).

## D. Impacts on California Economy

The proposed modification to extend early double PM credit will not impose additional impacts of the regulation on the economy, nor is it expected to adversely impact employment. The modification is intended to allow fleets to spread out their compliance costs, which is expected to make the regulation more affordable. If in turn, that leads fewer fleets to reduce employment as a result of the regulation, the modification could benefit total California employment.

## E. Potential Impacts on Small Businesses

The proposed modification to extend early double credit will not impose any additional costs on small businesses. Instead, it will provide a benefit to them by providing fleets additional time to install early VDECS, and thereby accumulate PM credit that will enable them to spread out their compliance costs in later years. While staff believes most small businesses are small or medium fleets, which have a first compliance date in 2015 or 2013, respectively, a few small businesses meet the regulation's definition of large fleet, which have their first compliance date in 2010. The proposed modification will benefit large fleets, and in particular small businesses that are large fleets, the most because their initial compliance date means their need for early PM credit is more urgent.

## F. Potential Impacts on Public Agencies

The proposed modification to extend early double PM credit will not impose any additional costs on public agencies. Instead, it will provide a benefit to them by enabling fleets additional time to install VDECS early, and thereby accumulate PM credit that will enable them to spread out their compliance costs in later years.

The proposed modification will benefit the State, Federal, and larger municipal fleets whose first compliance date is March 1, 2010, more than local municipalities that are small or medium fleets, because their earlier first compliance dates mean their need for early PM credit is potentially more urgent.

# VI. ENVIRONMENTAL IMPACTS

This chapter describes the potential environmental impacts of extending early double credit for PM VDECS to January 1, 2010. The other proposed modifications are clarifications only, and will not decrease the estimated emissions benefits of the regulation. Therefore, they were not included as part of the analysis.

## A. Legal Requirements

The legal requirements applicable to the environmental impact analysis are the same as those presented in the original off-road TSD (ARB, 2007b). Please see Chapter IX.A. of the off-road TSD for a description of these requirements.

The results of the environmental impact analysis for the proposed regulation modifications are discussed in the sections below. Alternatives to the proposed changes to the regulation are discussed in Chapter VII of this report.

## B. Air Quality Impacts of Proposed Modifications

The proposed amendments will have no effect on the anticipated emission reductions of NOx, because the provisions of the regulation that will provide NOx reductions (through engine and vehicle turnover) are not proposed to be amended. Any potential change in the emission benefits of the regulation will be limited to PM. Because it is not possible to know exactly how many or which fleets will choose to take advantage of the proposed extension of the early credit provisions, it is impossible to estimate precisely the change in anticipated PM reductions. However, staff expects there to be little to no overall adverse impact on air quality. To the extent that the proposed change could cause some increased emissions, overriding considerations exist for ARB to adopt the proposed changes.

If the proposed amendments cause significant numbers of fleets to perform PM VDECS installations earlier than they otherwise would have, the proposed amendments may have a positive effect (Le., result in reduced health impact from PM emissions) because extending the early credit deadline so that it is usable by more fleets should encourage fleets of all sizes to retrofit earlier than they otherwise would, thereby achieving immediate reductions in diesel PM. The earlier diesel PM is reduced, the more health benefits are achieved.

On the other hand, the change could also have a negative effect (slightly increase emissions) because if many large fleets take advantage of the double PM credit provisions, this could reduce the total number of retrofits that would otherwise be completed by March 1, 2010.

This possible increase in emissions is tempered by the fact that activity and total vehicle horsepower, and therefore emissions, from off-road vehicles have likely been reduced to some extent due to the current economic slowdown. To date, staff has analyzed California off-road (non-taxable) diesel fuel consumption data for 2007 and 2008 from the California Board of Equalization (BOE). As shown in Figure 5, overall off-road diesel fuel consumption in California has dropped in 2008[17] from 2006 and 2007 consumption levels (BOE, 2008). While off-road diesel fuel consumption can provide a useful surrogate for off-road vehicle activity when combined with other data, this data alone does not provide a complete perspective, as it also includes diesel fuel consumption from other off-road uses such as rail, stationary, marine, and agricultural (which are not subject to the regulation).

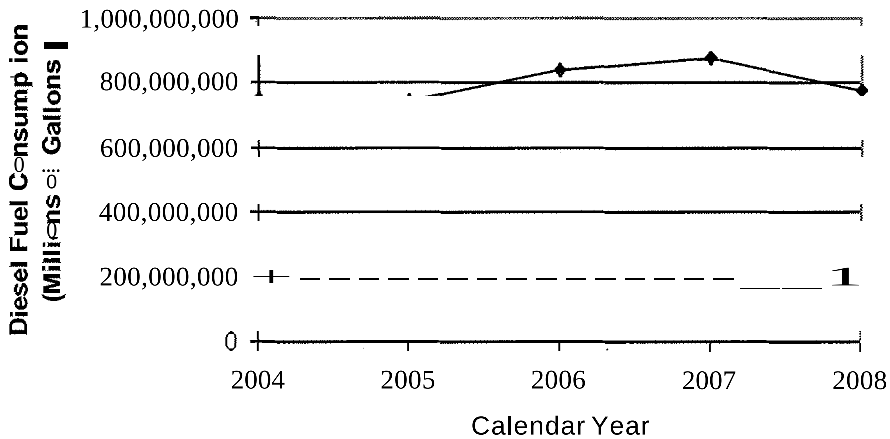



Figure 5: California Off-Road Diesel Vehicle Fuel Consumption

While this data shows a decrease in overall diesel fuel consumption from all off-road sources, and is likely reflective of general trends from all users of off-road diesel fuel, the specific changes in fuel use by fleets affected by the regulation (for example, the construction industry) cannot be derived from this data.

## C. Future Evaluation of Current Economic Conditions on Emissions

It is well understood that the United States economy is currently in an economic downturn (Regalia, 2008; La Monica, 2008). In response to this, staff has been investigating the effect of this downturn on the industries affected by the regulation, and in particular the effect of this on emissions from off-road vehicles subject to the regulation. As part of this analysis, staff is evaluating available data on vehicle activity, as well as attempting to evaluate whether fleets may have changed their turnover practices due to the poor economy or their inability to obtain financing to comply with the regulation or take early compliance actions. Staff will present its findings at the January 2009, Board meeting.

## D. Other Environmental Impacts

Staff does not believe there will be any additional environmental impacts from the proposed modifications to the regulation.

17 The 2008 fuel consumption total is an estimate based on the extrapolation of off-road fuel consumption data for the first three quarters of 2008.

## VII. ALTERNATIVES CONSIDERED

This chapter discusses the alternatives to the proposed 10-month extension of the early double credit that staff considered and why they were rejected in favor of the proposal. Because the proposed modifications to the other minor provisions are clarifications, staff did not perform an alternatives analysis for them.

### A. Extend Early Credit Deadline, but for Less Time

First, staff considered a shorter extension of the early PM VDECS credit. Staff, however, determined that providing a shorter extension (only a couple of months) to the early credit deadline would not adequately address the need of fleets for additional time to purchase and install newly verified DECS. The longer the early credit deadline can be extended, the more time fleets will have to locate theresQurces they need (such as access to credit) to buy retrofits. Finally, many construction vehicles covered by the regulation are used heavily in the summer mo.nths, and not as much during the rainy winter months. The optimal period for fleets to datalog their vehicles is over the summer, with orders for retrofits placed before the fall. Therefore, staff believes the proposal to extend the double credit deadline to January 1, 2010 and the double credit guarantee date to September 1, 2009-, is preferable to other alternatives that would extend the deadlines by only a few months.

### B. Extend Early Credit Deadline by a Full Year

Staff considered extending the early double credit for VDECS by a full year to March 1, 2010, but did not propose that option for two reasons. First, extending the deadline by a full year could result in a loss in emissions benefits. If the deadline were extended to March 1, 2010, this would effectively be the same as cutting the PM BACT retrofit requirement for that year down from 20 percent to 10 percent[18]. If the requirement for PM BACT were changed to 10 percent per year for the 2010 compliance date only, the number of VDECS installed would effectively be cut in half.[19] Second, extending the deadline a full year could disrupt the business plans of retrofit manufacturers that have invested significantly so that they may provide VDECS to fleets. If these manufacturers fail or pull out of the California market because of a delay, that could jeopardize the regulation's future PM benefits. For these reasons, staff did not propose extending the early credit deadline beyond January 1, 2010.

### C. Give More or Less than Double Credit before March 1, 2010

Staff also considered providing more than double PM credit for VDECS installed before March 1,2009, or to give between single and double credit for VDECS installations completed between March 1, 2009, and March 1, 2010 (for example, to give one and a

18 If all large fleets received double credit for early PM VDECS, they could potentially fulfill the PM BACT requirements in 2010 by only retrofitting half of the vehicles they would otherwise have; essentially cutting the retrofitting requirements from 20 percent to 10 percent.

19 This emission benefit loss could be mitigated somewhat, but not completely, by the decreased off-road vehicle activity due to the current economic downturn.

half credit). Staff believes such an approach would add significant additional recordkeeping and compliance complexity to the regulation, while providing no additional relief to fleets relative to staff's proposal.

## D. No Change

Staff also considered making no changes to the regulation. However, as discussed in this report, staff believes it is necessary to provide fleets with additional time to purchase and install VDECS to receive early PM BACT credit. As such, making no change to this provision would not address this issue.

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APPENDIX A: PROPOSED REGULATION ORDER FOR IN-USE OFF-ROAD DIESEL-FUELED FLEETS

Note: Proposed modifications are shown in underline to indicate additions and strikeout to indicate deletions, compared to the preexisting regulatory language. The symbol "*****,, indicates that regulatory language not being amended is not shown.

Amend sections 2449, 2449.1, and 2449.2, title 13, California Code of Regulation to read as follows.

§ 2449 General Requirements for In-Use Off-Road Diesel-Fueled Fleets

*****

(d) Performance Requirements -

*****

*(4) Changing Fleet Size -*

(A) Small fleets that become medium or large fleets must meet the medium or large fleet requirements, respectively, on the reporting date two years subsequent to the year they became a medium or large fleet. If such fleets become small again, they must keep meeting the medium or large fleet requirements for two years after becoming a small fleet.

(B) Large fleets that become medium fleets may meet either the medium or large fleet requirements on the next reporting date. Large fleets that become small fleets may meet either the small or large fleet requirements on the next reporting date.

(C) Medium fleets that become small fleets may meet either the small or medium fleet requirements on the next reporting date. Medium fleets that become large fleets must meet the large fleet requirements on the reporting date two years subsequent to the year they became a large fleet.

*****

*(g) Reporting -*

Reporting is required for each and every fleet. Large and medium fleets may report separately for different divisions or subsidiaries of a given company or agency. Fleet owners may submit reporting information using forms (paper or electronic) approved by the Executive Officer.

*(1) Initial reporting* - All fleet owners must submit the information in section 2449(g)(1 )(A) through (G) to ARB by their initial reporting date. In the initial reporting, fleet owners must report information regarding each vehicle subject to this regulation that was in their fleet on March 1, 2009. Systems or non-diesel

fueled vehicles that are used in place of a vehicle that would be subject to this regulation must also be reported. The initial reporting date for large fleets is April 1, 2009. The initial reporting date for medium fleets is June 1, 2009. The initial reporting date for small fleets is August 1, 2009. Reports must include the following information:

*****

**(D) Verified Diesel Emission Control Strategies** - For each VDECS that is installed on an engine listed per section 2449(g)(1 )(C) report the following information.

1. VDECS Manufacturer;
2. VDECS ModelFamily;
3. Verification level;
4. Verified percent NOx reduction (if any);
5. Date installed;
6. VDECS Serial Number.

*****

***(h) Record keeping*** -

Fleet owners must maintain copies of the information reported under section 2449(g), as well as the records described in section 2449(h) below, and provide them to an agent or employee of the ARB within five business days upon request. Records must be kept at a location within the State of California.

*****

***(8) Record Retention*** - Each fleet owner shall maintain the records for each vehicle subject to the regulation until it is retired and for the overall fleet as long as the owner has a fleet or March 1, 2030, whichever is earlier. If vehicle ownership is transferred, the seller shall convey the vehicle records including vehicle data per section 2449(g)(1 )(B), engine data per section 2449(g)(1 )(C), and VDECS data per section 2449(g)(1 )(D) to the buyer. If fleet ownership is transferred, the seller shall convey the fleet records including fleet data per sections 2449(g)(1 )(A) through (G) to the buyer. Dealers Any person selling a vehicle with an engine subject to this regulation in California must maintain records of the disclosure of regulation applicability required by Section 2449(j) for three years after the sale.

*****

Note: Authority cited: Sections 39002,39515,39516,39600,39601,39602,39650, 39656,39658,39659,39665,39667,39674,39675,40000,41511,42400,42400.1, 42400.2, 42400.3.5, 42402, 42402.1, 42402.2, 42402.4, 42403, 43000, 43000.5, 43013, 43016, and 43018, Health and Safety Code. Reference: Sections 39002,39515,39516, 39600,39601,39602,39650,39656,39657,39658,39659,39665,39667,39674, 39675, 40000, 41511, 42400, 42400.1, 42400.2, 42402.2, 43000, 43000.5, 43013, 43016, and 43018, Health and Safety Code.

**§ 2449.1 NOx Performance Requirements**

***(a) Performance Requirements***

*****

***(2) BACT Requirements***

*****

**(A) Turnover Requirements for Fleets Not Meeting NOx Target Rate -** A fleet may meet the turnover requirements by retiring a vehicle, designating a vehicle as a low-use vehicle, repowering a vehicle, rebuilding the engine to a more stringent emissions configuration, or applying a VDECS verified to achieve NOx reductions. If repowering a vehicle or rebuilding the engine to a more stringent emissions configuration, the new engine must be Tier 2 or higher and must be a higher tier than the engine replaced or rebuilt. The method for counting VDECS verified to achieve NOx reductions is specified in section 2449.1 (a)(2)(A)8. .

*****

5. **Delay Tier 1 turnover** - All vehicles with a Tier 1 or higher engine are exempt from the turnover requirement until the compliance year ending March 1, 2013 (Le.! the first turnover of Tier 1 or higher engines would be required between March 2, 2012 and March 1! 2013), provided that all Tier Ovehicles in the fleet owner's fleet that do not qualify for an exemption under section 2449.1 (a)(2)(A)4. have been turned over.

*****

Note: Authority cited: Sections 39002,39515,39516,39600,39601,39602,43000, 43000.5,43013,43016, and 43018, Health and Safety Code. Reference: Sections 39002,39515,39516,39600,39601,39602,39650,39656,39657,39658,39659, 39665,39667,43000,43000.5,43013,43016, and 43018, Health and Safety Code.

**§ 2449.2 PM Performance Requirements**

*****

***(a) Performance Requirements***

*****

***(2) BACT Requirements***

*****

**(A) PM Retrofit Requirements for Fleets Not Meeting Diesel PM Target Rate**

*****

2. **Carryover PM retrofit credit -**
   a. **Beginning** - All fleets other than those meeting the criteria in (i) or (ii) below for vehicles remaining in their fleets begin with zero carryover retrofit credit on March 1,2009.
      i. **Double Credit for Early PM Retrofits -** Fleets that have installed the highest level VDECS on their vehicles before January 1, 2010 March 1, 2009 begin with a carryover retrofit credit equal to: 2

multiplied by total maximum power of engines on which highest level VDECS was installed before January 1! 2010 March 1, 2009, unless the contract for funding the VDECS stipulates single credit for installation of the VDECS.

ii. **Single Credit for Other PM Retrofits Before Initial Compliance Date -** Medium fleets that install highest level VDECS on their vehicles between January 1! 2010 Marsh 1, 2009 and February 29,2012 accumulate carryover retrofit credit equal to total maximum power of engines on which highest level VDECS was installed. Small fleets that install highest level VDECS on their vehicles between January 1! 2010 March 1, 2009 and February 28,2014 accumulate carryover retrofit credit equal to total maximum power of engines on which highest level VDECS was installed.

b. **Accumulating carryover PM retrofit credit -** Beginning March 1, 2011 ~~2010~~ for large fleets, March 1, 2013 for medium fleets, and March 1, 2015 for small fleets, a fleet accumulates carryover retrofit credit each year it retrofits more than 20 percent of its maximum power. The amount accumulated is the percent of maximum power retrofit in excess of 20 percent in the past 12 months prior to March 1. A large fleet also accumulates carryover retrofit credit on March 1! 2010 if the sum of the double retrofit credit earned from March 1! 2009 to January 1! 2010 plus the single retrofit credit earned from January 1! 2010 to March 1! 2010 exceeds 20 percent of its maximum horsepower. The amount accumulated is the sum of double credit retrofit credit earned from March 1! 2009 to January 1! 2010 plus the single credit earned from January 1! 2010 to March 1! 2010 in excess of 20 percent of fleet's maximum horsepower in the past 12 months.

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Note: Authority cited: Sections 39002, 39515, 39516, 39600, 39601, 39602, 39650, 39656,39658,39659,39665,39667,39674,39675, 40000, 41511, 42400, 42400.1, 42400.2, 42400.3.5, 42402, 42402.1, 42402.2, 42402.4, 42403, 43000, 43000.5, 43013, 43016, and 43018, Health and Safety Code. Reference: Sections 39002, 39515, 39516, 39600,39601,39602,39650,39656,39657,39658,39659,39665,39667,39674, 39675, 40000, 41511, 42400, 42400.1, 42400.2, 42402.2, 43000, 43000.5, 43013, 43016, and 43018, Health and Safety Code.

## APPENDIX B: ASSUMPTIONS FOR STATEWIDE FLEET RETROFITTING ANALYSIS

This appendix provides the assumptions and methodologies used to estimate Verified Diesel Emission Control System (VDECS) applicability.

ARB estimated the in-use off-road diesel vehicle population that could have VDECS installed for three specific cases; (1) the percentage of vehicles that could have any of the current verified devices installed, (2) the percentage of vehicles that could have passively regenerated VDECS installed today, and (3) the percentage of vehicles that could have had passively regenerated VDECS installed more than two weeks prior to the deadline for guaranteed double retrofit credit as of mid-October 2008.

To develop this estimate, staff used the following information:

- The verification letters (also referred to as Executive Orders) for each off-road VDECS. The Executive Orders specify the horsepower, model year, emissions levels, and whether the device can be used with engines equipped with exhaust gas recirculation (EGR).
- Letters from VDECS manufacturers exempting certain vehicle types or models from retrofitting under the Carl Moyer program (Bruenke, 2007a; Bruenke, 2007b; Bruenke, 2008a; Bruenke, 2008b; Bruenke, 2008c; Bruenke, 2008d; Luksik, 2008). Staff's analysis assumes that such exempted vehicle types or models cannot be retrofit.

Staff based the estimate of VDECS applicability on horsepower (hp), particulate matter (PM) emissions limit, and engine model years. Staff chose these parameters because these are the most important factors limiting verifications and because this data is available in the ARB emissions inventory model (the OFFROAD model). Each VDECS has a number of other requirements which would prevent it from being applied to'a particular engine/vehicle combination, including but not limited to:

- specific exemptions or inclusions by engine family name,
- use of fuel additives,
- poor engine conditions with excessive emissions,
- insufficient exhaust pressure for the device,
- no appropriate or safe means of installing the device on the vehicle infrastructure,
- exclusion due to the use tracks instead of rubber tires,
- lack of available electrical power for actively regenerated VDECS, and
- inadequate exhaust temperature for passive VDECS.

These factors would need to be considered for each engine not initially ruled out based on hp, PM emissions, and model year. The factors listed above are not included in the ARB emissions inventory model (the OFFROAD model), nor does staff have access to other vehicle or engine population data that would allow the factors above to be factored into an overall estimate of VDECS applicability. An estimation on the effect of these factors on the breadth of VDECS applicability is unlikely to be accurate without an in-depth inspection, including data logging, of a sizeable portion of California's inventory of off-road equipment. Therefore, it is important to note that the estimations of VDECS applicability below refer only to the engines which are not initially ruled out by the age, PM emissions, and size of the engine. The estimates should be considered upper .bounds on the fraction of vehicle horsepower to which retrofits could be applied.

*Passive and Active Retrofits*

To determine the percentage of vehicles which could have any currently verified or conditionally verified device installed, staff reviewed the breadth of the VDECS verifications for all verified devices. Staff concluded that the HUSS Umwelttechnik GmbHFS-MK Series Diesel Particulate Filter (Huss DPF), which is a level 3 actively regenerated device, is the device with the widest applicability. In fact, the Huss device is verified for virtually any engine, regardless of age, horsepower or emission levels, with the exception of engines using exhaust gas recirculation and vehicles exempted specifically from retrofitting under the Carl Moyer program. The engines specifically exempted from the Huss verification can in most cases be retrofit by an alternative device, hence the only engines which can be entirely ruled out from receiving any of the currently verified retrofit devices are those using exhaust gas recirculation.

Based on staff's analysis, the only manufacturer with a substantive market share of the applicable engines in California using exhaust gas recirculation in all or most of their equipment in any given year was Volvo, in 2006 and later model year engines. Although other manufacturers have used exhaust gas recirculation, they did not do so in quantities which would justify removing all of their engine lines from the engines which could be retrofit.

The market share of Volvo in off-road construction application was determined by industry reports from the Yengst Associates (yengst, 2005). The model years for Volvo engines using EGR were accounted for based on the estimated useful life of the equipment types using Volvo engines (ARB, 2007b).

Staff estimate that exhaust gas recirculation engines comprise 0.4 percent of the off-road diesel inventory, and are the only category that can be absolutely excluded when considering any of the available retrofits. ARB staff acknowledges that many other vehicles and engines are not suited to be retrofit, however as stated above, most the additional exemptions would need to be identified on a case by case basis.

*Passively Regenerated Retrofits*

To determine the *percentage* of vehicles which could have one of the passively regenerated VDECS installed, staff considered the Caterpillar DPF, DCI MINE-X Sootfilter, and the ECS Purifilter verifications on November 1, 2008 (ARB, 2008d; Cross, 2008a; Cross, 2008b). The restrictions on engine applicability are listed in Table 1 below.

**Table 1: Passively Regenerated Retrofit Requirements**

| | Caterpillar DPF | DCL MINE-X Sootfilter | ECS Purifilter |
|---|---|---|---|
| Horsepower Range | 175 - 600 hp | 175 - 300 hp | 50 - 750 hp |
| PM Emissions Limit | 0.2 g/bhp-hr | 0.15 g/bhp-hr | 0.2 g/bhp-hr |
| Engine Model Years | 1996 - 2008 | 1996 - 2008 | 1996 - 2008 |

The PM emissions limits are applied to the engine's certification level, not the certification standard. Although the standards did not require engines to meet a limit of 0.2 g/bhp-hr for PM until 2001 at the earliest, many engines tested at or below 0.2 g/bhp-hr as early as 1996 (ARB, 2008e), and could have one of the passive devices list above installed. Although many engines testabove these standards, no specific model year of 1996 or later, or horsepower category, can be excluded, as each category has at least a few engines which meet the standard.

Comparing the applicability requirements, staff filtered the off-road inventory (ARB, 2006) for all vehicles between 50 and 750 horsepower, for Tier 1 or newer engine models. Engines using exhaust gas recirculation were also discounted, using the method described previously for active and passive retrofits.

Staff estimate that 41 percent of the off-road diesel horsepower covered by the regulation could not have a passive device installed currently due to restriction on hp, model year and emissions. As stated previously, of the remaining 59 percent of California's horsepower, staff expect that the factors such as engine condition, installation issues, and duty cycle would further reduce the amount of vehicles that could be retrofit with a passive device, however the engine would need to be evaluated on an individual basis.

*Passively Regenerated Retrofits Available Mid-October 2008 for Double Retrofit Credit*

Staff also wanted to determine the percentage of vehicles that could have had a passively regenerated retrofit installed at least two weeks prior to the deadline to guarantee double retrofit credit, November 1, 2008. This entailed removing the ECS Purifilter which was verified on October 20, 2008 and the extension of the Caterpillar DPF, which had the verification expanded on October 24,2008. Table 2 below shows the applicability requirements for the Caterpillar DPF and DCl MINE-X Sootfilter prior to the expansion of verification (Cross, 2008a; Cross, 2008c).

**Table 2: Limited Caterpillar DPF and DCI Sootfilter Requirements**

| | Caterpillar DPF | DCL MINE-X Sootfilter |
|---|---|---|
| Horsepower Range | 175 - 300 hp | 175 - 300 hp |
| PM Emissions Limit | 0.2 g/bhp-hr | 0.15 g/bhp-hr |
| Engine Model Years | 1996 - 2008 | 1996 - 2008 |

Additionally, both retrofits were only verified for rubber-tired applications. Although many vehicle categories are comprised of both rubber tired and track vehicles, only the crawler tractor category can be assumed to be comprised solely of track vehicles and can be completely ruled out.

Comparing the applicability requirements, staff filtered the off-road inventory (ARB, 2006) for all vehicles between 175 'and 300 horsepower, for Tier 1 or newer engines, and excluded crawler tractors. Engines that used exhaust gas recirculation were also discounted, using the method described above for active and passive retrofits.

Staff estimate that 89 percent of the off-road diesel horsepower covered by the regulation could not be retrofit with one of the passively regenerated devices installed prior to mid-October, 2008, based on horsepower, model year, and emissions. As with the previous analysis, the remaining 11 percent would need to be evaluated on individual basis.

*HUSS Exemptions by Vehicle Model*

The effect of HUSS exemptions (Bruenke, 2007a; Bruenke, 2007b; Bruenke, 2008a; Bruenke, 2008b; Bruenke, 2008c; Bruenke, 2008d; Luksik, 2008) on the statewide fleet was estimated using information from the Machinery Trader auction site (www.machinervtrader.com). The market share of applicable engine models was estimated by comparing the number of specific vehicle models for sale against the total number of vehicles for sale in that vehicle category (for exampl,e, Cat 769 off-road trucks were 3.5 percent of the total off-road trucks for sale on Machinery Trader on November 24, 2008. These market share estimates were applied to the total vehicle type populations in ARB's off-road inventory (ARB, 2007) to estimate the number of vehicles and horsepower currently used in California that would fall under the HUSS exemptions. The total horsepower of exempted vehicles was compared against the total statewide horsepower (ARB, 2006) to determine the percent of statewide horsepower affected by the HUSS exemptions.

**References**

All references for this appendix can be found in Chapter VIII.

APPENDIX C: SHOWCASE AND SEP

Table 1: Showcase Retrofits Installed as of November 2008

| Year | HP | Tier | Vehicle Type | Installed Device | Type of Device |
|---|---|---|---|---|---|
| 1995 | 275 | 0 | Rubber Tired loader | CAT - EUG/DPF | Passive |
| 2003 | 255 | 2 | Crawler Tractor | DCI MINE-X | Passive |
| 1997 | 400 | 1 | Scraper | DCI MINE-X | Passive |
| 1997 | 559 | 1 | Scraper | DCI MINE-X | Passive |
| 1997 | 400 | 1 | Scraper | DCI MINE-X | Passive |
| 1997 | 559 | 1 | Scraper | DCI MINE-X | Passive |
| 2004 | 95 | 2 | Tractor/loader/Backhoe | JM-CRT | Passive |
| 1994 | 168 | 0 | Excavator | Sud Chemie ENVICAT | Passive |
| 1999 | 222 | 1 | Excavator | Sud Chemie ENVICAT | Passive |

Table 2: Showcase Retrofits Planned for Installation

| Year | HP | Tier | Vehicle Type | Installed Device | Type of Device |
|---|---|---|---|---|---|
| 2006 | 405 | 3 | Crawler Tractor | COT Permit-FBC | Passive FBC |
| 1997 | 67 | 0 | Tractor/loader/Backhoe | Dinex DiNox | Passive+NOx Control |
| 2002 | 73 | 1 | Tractor/loader/Backhoe | Dinex-Dipex | Passive |
| 1992 | 134 | 0 | Rubber Tired loader | Dinex DiNox | Passive+NOx Control |
| 2001 | 62 | 1 | Rubber Tired loader | Dinex-Dipex | Passive |
| 1992 | 375 | 0 | Rubber Tired loader | Mann Hummel FBC | Passive FBC |
| 2001 | 107 | 1 | Rough Terrain Forklift | Nett Tech-Active SCR | Active+NOx Control |
| 2001 | 109 | 1 | Rough Terrain Forklift | Nett Tech-Active SCR | Active+NOx Control |
| 2002 | 123 | 1 | Rough Terrain Forklift | Nett Tech-Active SCR | Active+NOx Control |
| 1998 | 312 | 1 | Excavator | Nett Tech-Passive SCR | Passive+NOx Control |
| 1990 | 270 | 0 | Wheel loader | NettTech - Active SCR | Active+NOx Control |
| 2000 | 178 | 1 | Excavator | Nett Tech-Active SCR | Active+NOx Control |
| 2000 | 222 | 1 | Excavator | Nett Tech-Passive SCR | Passive+NOx Control |

| Year | HP | Tier | Vehicle Type | Installed Device | Type of Device |
|---|---|---|---|---|---|
| 1991 | 375 | 0 | Excavator | Extengine AOECII | Active+NOx Control |
| 1991 | 250 | 0 | Excavator | Recat-ESW OC-100 | Active+FBC |
| 1984 | 350 | 0 | Excavator | Sud Chemie ENVICAT | Passive |
| 2002 | 692 | 1 | Excavator | Sud Chemie ENVICAT | Passive |
| 1986 | 552 | 0 | Rubber Tired Dozer | Extengine AOECII | Active+NOx Control |
| 1997 | 400 | 1 | Scraper, Rear | Extengine AOECII | Active+NOx Control |
| 1986 | 400 | 0 | Scraper, Rear | Extengine AOECII | Active+NOx Control |
| 1997 | 552 | 1 | Scraper, Front | Extengine AOECII | Active+NOx Control |
| 1986 | 596 | 0 | Scraper, Front | Extengine AOECII | Active+NOx Control |
| 1997 | 275 | 1 | Motor Grader | Nett Tech-Passive SCR | Passive+NOx Control |
| 1996 | 177 | 1 | Crawler Tractor | COT FBC-OPF | Passive+FBC |
| 1998 | 75 | 1 | Off-Highway Tractors | COT FBC-OPF | Passive+FBC |
| 1998 | 75 | 1 | Off-Highway Tractors | COT FBC-OPF | Passive+FBC |
| 2006 | 120 | 2 | Off-Highway Tractors | COT FBC-OPF | Passive+FBC |
| 1997 | 120 | 1 | Off-Highway Tractors | COT FBC-OPF | Passive+FBC |
| 1996 | 177 | 1 | Crawler Tractor | COT Permit-FBC | Passive+FBC |
| 1997 | 95 | 0 | Off-Highway Tractors | COT Permit-FBC | Passive+FBC |
| 1993 | 136 | 0 | Rubber Tired Loader | COT Permit-FBC | Passive+FBC |
| 1996 | 170 | 0 | Rubber Tired Loader | COT Permit-FBC | Passive+FBC |
| 2006 | 91 | 2 | Tractor/Loader/Backhoes | COT Permit-FBC | Passive+FBC |
| 1998 | 75 | 1 | Off-Highway Tractors | COT Platinum Plus Purifilter Filter | Passive+FBC |
| 1998 | 75 | 1 | Off-Highway Tractors | COT Platinum | Passive+FBC |

| Year | HP | Tier | Vehicle Type | Installed Device | Type of Device |
|---|---|---|---|---|---|
| | | | | Plus Purifilter Filter | |
| 1999 | 109 | 1 | Off-Highway Tractors | CDT Platinum Plus Purifilter Filter | Passive+FBC |
| 1996 | 145 | 0 | Rubber Tired loader | CDT Platinum Plus Purifilter Filter | Passive+FBC |
| 1993 | 120 | 0 | Off-Hi hwa Tractors | DCI Mine-X | Passive |
| 1995 | 120 | 0 | Off-Hi hwa Tractors | DCI Mine-X | Passive |
| 1993 | 136 | 0 | Rubber Tired loader | DCI Mine-X | Passive |
| 1992 | 136 | 0 | Rubber Tired loader | DCI Mine-X | Passive |
| 1995 | 190 | 0 | Rubber Tired loader | DCI Mine-X | Passive |
| 2006 | 75 | 2 | Tractor/loader/Backhoe | DCI Mine-X | Passive |
| 2006 | 75 | 2 | Tractor/loader/Backhoe | DCI Mine-X | Passive |
| 1992 | 170 | 0 | Rubber Tired loader | Dinex-Dipex | Passive |
| 2001 | 108 | 1 | Off-Highway Tractors | Donaldson Passive DPF | Passive |
| 2001 | 110 | 1 | Off-Highway Tractors | Donaldson Passive DPF | Passive |
| 2004 | 129 | 2 | Rubber Tired loader | Donaldson Passive DPF | Passive |
| 2004 | 170 | 2 | Rubber Tired loader | Donaldson Passive DPF | Passive |
| 1995 | 120 | 0 | Paver | ECS Assisted Purifilter | Active+Electric |
| 1993 | 81 | 0 | Rubber Tired loader | ECS Assisted Purifilter | Active+Electric |
| 1993 | 136 | 0 | Rubber Tired loader | ECS Assisted Purifilter | Active+Electric |
| 1992 | 136 | 0 | Rubber Tired loader | ECS Assisted Purifilter | Active+Electric |
| 1993 | 75 | 0 | Tractor/loader/Backhoe | ECS Assisted Purifilter | Active+Electric |
| 1999 | 89 | 1 | Off-Hi Tractors | ECS Purifilter | Passive |
| 1999 | 89 | 1 | Off-Hi Tractors | ECS Purifilter | Passive |
| 1995 | 120 | 0 | Off-Hi Tractors | ECS Purifi/ter | Passive |
| 1995 | 120 | 0 | Off-Hi hwa Tractors | ECS Purifilter | Passive |
| 1992 | 136 | 0 | Rubber Tired loader | ECS Purifilter | Passive |
| 2004 | 173 | 2 | Rubber Tired loader | ECS Purifilter | Passive |
| 2003 | 205 | 2 | Rubber Tired loader | ECS Purifilter | Passive |
| 1993 | 75 | 0 | Tractor/loader/Backhoe | ECS Purifilter | Passive |
| 1995 | 105 | 0 | Crawler Tractor | Huss FS-MD | Active |
| 2002 | 75 | 1 | Off-Hi hwa Tractors | Huss FS-MD | Active |

| Year | HP | Tier | Vehicle Type | Installed Device | Type of Device |
|---|---|---|---|---|---|
| 1995 | 76 | 0 | Other Mobile Off-Road Vehicle | Huss FS-MD | Active |
| 1992 | 136 | 0 | Rubber Tired Loader | Huss FS-MD | Active |
| 1993 | 190 | 0 | Rubber Tired Loader | Mann-Hummel FBC | Passive+FBC |
| 2006 | 75 | 2 | Off-Highway Tractors | Mann-Hummel SMF-AR | Active+FBC+ Electric |
| 1998 | 83 | 1 | Off-Highway Tractors | Mann-Hummel SMF-AR | Active+FBC+ Electric |
| 1999 | 95 | 1 | Off-Highway Tractors. | Mann-Hummel SMF-AR | Active+FBC+ Electric |
| 2001 | 75 | 1 | Tractor/Loader/Backhoe | Mann-Hummel SMF-AR | Active+FBC+ Electric |
| 1993 | 120 | 0 | Off-Highway Tractors | Mann-Hummel SMF-AR | Active+FBC+ Electric |
| 1998 | 75 | 1 | Off-Highway Tractors | Nett Tech- Active SCR | Active+NOx Control |
| 2000 | 105 | 1 | Off-Highway Tractors | Nett Tech- Active SCR | Active+NOx Control |
| 1996 | 150 | 0 | Rubber Tired Loader | Nett Tech- Active SCR | Active+NOx Control |
| 2004 | 194 | 2 | Rubber Tired Loader | Nett Tech- Active SCR | Active+NOx Control |
| 2004 | 194 | 2 | Rubber Tired Loader | Nett Tech-. Active SCR | Active+NOx Control |
| 1997 | 120 | 1 | Off-Highway Tractors | Nett Tech- Passive SCR | Passive+NOx Control |
| 1996 | 150 | 0 | Rubber Tired Loader | Nett Tech- Passive SCR | Passive+NOx Control |
| 1999 | 109 | 1 | Off-Highway Tractors | Rypos HDPF/C | Active+Electric |
| 2003 | 116 | 2 | Off-Highway Tractors | Rypos HDPF/C | Active+Electric |
| 1999 | 89 | 1 | Off-Highway Tractors | Sud Chemie ENVICAT | Passive |
| 1999 | 89 | 1 | Off-Highway Tractors | Sud Chemie ENVICAT | Passive |
| 1992 | 136 | 0 | Rubber Tired Loader | Sud Chemie ENVICAT | Passive |
| 2004 | 128 | 2 | Rubber Tired Loader | Sud Chemie ENVICAT | Passive |
| 1993 | 136 | 0 | Rubber Tired Loader | Sud Chemie ENVICAT | Passive |
| 1996 | 170 | 0 | Wheel Loader | ECS Assisted | Active+Electric |

| Year | HP | Tier | Vehicle Type | Installed Device | Type of Device |
|---|---|---|---|---|---|
| | | | | Purifilter | |
| 1993 | 220 | 0 | Rubber Tired Loader | DCL Mine-X | Passive |
| 2006 | 211 | 3 | Rubber Tired Loader | CAT - DPF | Passive |
| 2000 | 114 | 1 | Rubber Tired Loader | Nett Tech- Active SCR | Active+NOx Control |
| 2004 | 170 | 2 | Rubber Tired Loader | COT FBC- DPF | Passive+FBC |
| 2005 | 260 | 2 | Rubber Tired Loader | COT Permit- FBC | Passive+FBC |
| 2001 | 145 | 1 | Tractor Wheel Loader | DCL MINE-X | Passive |
| 2004 | 170 | 2 | Rubber Tired Loader | Donaldson Passive DPF | Passive |
| 2006 | 160 | 2 | Tractor Wheel Loader | Extengine ADECII | Active+NOx Control |
| 2004 | 90 | 2 | Tractor Wheel Loader | Huss FS-MD | Active |
| 2005 | 98 | 2 | Tractor | Recat- ESW DC-100 | Active+FBC |
| 2002 | 188 | 1 | Excavator | COT Permit- FBC | Passive+FBC |
| 2001 | 315 | 2 | Rubber Tired Loader | Dinex DiNox | Passive+NOx Control |
| 1998 | 240 | 1 | Excavator | Donaldson Active DPF | Active+Electric |
| 1999 | 235 | 1 | Rubber Tired Loader | Donaldson Active DPF | Active+Electric |
| 2003 | 66 | 1 | Rou h Terrain Forklift | ECS Purifilter | Passive |
| 1994 | 200 | 0 | Rubber Tired Loader | Extengine ADECII | Active+NOx Control |
| 1994 | 200 | 0 | Rubber Tired Loader | Extengine ADECII | Active+NOx Control |
| 1994 | 128 | 0 | Excavator | Extengine ADECII | Active+NOx Control |
| 1997 | 54 | 0 | Excavator | Huss FS-MD | Active |
| 1994 | 168 | 0 | Excavator | .Mann-Hummel GMBH CRT | Passive |
| 2003 | 66 | 1 | Rough Terrain Forklift | Mann-Hummel SMF-AR | ACtive+FBC+ Electric |
| 2003 | 247 | 2 | Excavator | Nett Tech- Passive SCR | Passive+NOx Control |
| 1992 | 256 | 0 | Rubber Tired Loader | Nett Tech- Passive SCR | Passive+NOx Control |
| 1994 | 200 | 0 | Rubber Tired Loader | Sud Chemie ENVICAT | Passive |
| 2006 | 418 | 3 | Scra er, Rear | CAT - DPF | Passive |

| Year | HP | Tier | Vehicle Type | Installed Device | Type of Device |
|---|---|---|---|---|---|
| 2006 | 577 | 3 | Scraper, Front | CAT - DPF | Passive |
| 1996 | 285 | 1 | Motor Grader | CDT Permit-FBC | Passive+FBC |
| 2006 | 418 | 3 | Scraper, Rear | CDT Permit-FBC | Passive+FBC |
| . 2006 | 577 | 3 | Scraper, Front | CDT Permit-FBC | Passive+FBC |
| 2006 | 418 | 3 | Scraper, Rear | CDT Platinum Plus Purifilter Filter | Passive+FBC |
| 2006 | 577 | 3 | Scraper, Front | CDT Platinum Plus Purifilter Filter | Passive+FBC |
| 2007 | 405 | 3 | Crawler Tractor | DCI MINE-X | Passive |
| 1998 | 514 | 1 | Excavator | Recat-ESW DC-100 | Active+FBC |
| 2007 | 405 | 3 | Crawler Tractor | Sud Chemie ENVICAT | Passive |
| 2007 | 405 | 3 | Crawler Tractor | Sud Chemie ENVICAT | Passive |
| 2006 | 405 | 3 | Crawler Tractor | Sud Chemie ENVICAT | Passive |
| 1989 | 375 | 0 | Rubber Tired loader | Rypos HDPF/C | Active+Electric |
| 1995 | 400 | 'O | Rubber Tired loader | Sud Chemie ENVICAT | Passive |
| 1996- | 400 | 0 | Rubber Tired loader | Sud Chemie ENVICAT | Passive |
| 1997 | 290 | 1 | Excavator | CAT-DPF | Passive |
| 1990 | 310 | 0 | Rubber Tired Dozer | CAT-EUG/DPF | Passive+NOx Control |
| 2002 | 128 | 1 | Excavator | CDT Permit-FBC | Passive+FBC |
| 1998 | 305 | 1 | Crawler Tractor | DCI Mine-X | Passive |
| 1997 | 168 | 1 | Excavator | ECS Assisted Purifilter | Active+Electric |
| 1995 | 365 | 0 | S . | ECS Assisted Purifilter | Active+Electric |
| 1997 | 358 | 1 | | ECS Purifilter | Passive |
| 1997 | 305 | 1 | Crawler Tractor | Nett Tech-Active SCR | Active+NOx Control |
| 1997 | 165 | 1 | Grader | Recat-ESW DC-100 | Active+FBC |
| 2004 | 185 | 2 | Grader | CAT - DPF | Passive |

| Year | HP | Tier | Vehicle Type | Installed Device | Type of Device |
|---|---|---|---|---|---|
| 2005 | 185 | 2 | Grader | CAT - DPF | Passive |
| 2001 | 201 | 1 | Rubber Tired Loader | Donaldson DPF-SCR | Passive+NOx Control |
| 1998 | 165 | 1 | Grader | ECS Assisted Purifilter | Active+Electric |
| 2001 | 102 | 1 | Tractpr/Loader/Backhoe | ECS Assisted Purifilter | Active+Electric |
| 1999 | 106 | 1 | Rou h Terrain Forklift | ECS Purifilter | Passive |
| 2006 | 111 | 2 | Tractor/Loader/Backhoe | Huss FS-MD | Active |
| 1995 | 170 | 0 | Rubber Tired Loader | Mann-Hummel FBC | Passive+FBC |
| 2007 | 440 | 3 | Scraper | Donaldson Passive DPF | Passive |
| 2006 | 404 | 3 | Excavator | Dinex DiNox | Passive+NOx Control |
| 2006 | 120 | 2 | Mobile Jumbo Screen Plant | Dinex DiNox | Passive+NOx Control |
| 2007 | 385 | 3 | Retek Startrack Mobile Recycling Plant (Impact) | Extengine ADECII | Active+NOx Control |
| 2006 | 343 | 3 | Rubber Tired Loader | Extengine ADECII | Active+NOx Control |
| 2007 | 440 | 3 | Retek Startrack Mobile Recycling Plant (Cone) | Nett Tech-Passive SCR | Passive+NOx Control |
| 1996 | 310 | 1 | Crawler Tractor | ECS Assisted Purifilter | Active+Electric |
| 1997 | 62 | 0 | Tractor/Loader/Backhoe | ECS Assisted Purifilter | Active+Electric |
| 1994 | 220 | 0 | Rubber Tired Loader | Extengine ADECII | Active+NOx Control |
| 1999 | 175 | 1 | Rubber Tired Loader | Extengine ADECII | Active+NOx Control |
| 1981 | 255 | 0 | Rubber Tired Dozer | Huss FS-MD | Active |
| 1997 | 215 | 1 | Grader | Huss FS-MD | Active |
| 1989 | 450 | 0 | Rubber Tired Dozer | Huss FS-MD | Active |
| 1994 | 175 | 0 | Scra er | Huss FS-MD | Active |
| 2003 | 73 | 1 | Tractor/Loader/Backhoe | Huss FS-MD | Active |
| 1982 | 255 | 0 | Rubber Tired Dozer | Mann-Hummel GMBH CRT | Passive |
| 1979 | 330 | 0 | Scraper | Mann-Hummel GMBH CRT· | Passive |
| 2004 | 115 | 2 | Crawler Tractor | Nett Tech-Active SCR | Active+NOx Control |
| 1995 | 335 | 0 | Crawler Tractor | Nett Tech-Active SCR | Active+NOx Control |

| Year | HP | Tier | Vehicle Type | Installed Device | Type of Device |
|---|---|---|---|---|---|
| 2002 | 110 | 1 | Rubber Tired Loader | Nett Tech-Passive SCR | Passive+NOx Control |
| 2004 | 230 | 2 | Rubber Tired Loader | Nett Tech-Passive SCR | Passive+NOx Control |
| 1980 | 310 | 0 | Rubber Tired Dozer | Recat-ESW DC-100 | Active+FBC |
| 1984 | 330 | 0 | Scraper | Recat-ESW DC-101 | Active+FBC |
| 2003 | 150 | 2 | Crawler Tractor | Sud Chemie ENVICAT | Passive |
| 1993 | 275 | 0 | Rubber Tire Loader | CAT-EUG/DPF | Passive+NOx Control |
| 2004 | 247 | 2 | Excavator | Mann-Hummel FBC | Passive+FBC |
| 2002 | 116 | 1 | Rough Terrain Forklift | Nett Tech-Active SCR | Active+NOx Control |
| 2005 | 371 | 2 | Excavator | CAT-DPF | Passive |
| 2006 | 469 | 3 | Articulated Truck | CAT-DPF | Passive |
| 2005 | 433 | 2 | Excavator | CAT-DPF | Passive |
| 1990 | 525 | 0 | Crawler Tractor | Extengine ADECII | Active+NOx Control |
| 1984 | 315 | 0 | Rubber Tired Dozer | Extengine ADECII | Active+NOx Control |
| 1988 | 550 | 0 | Waterpull | Extengine ADECII | Active+NOx Control |
| 2006 | 187 | 3 | Rubber Tire Loader | CAT - DPF | Passive |
| 1985 | 45 | 0 | Off-Hi hwa Tractors | Dinex-Di ex | Passive |
| 2004 | 75 | 2 | Tractor/Loader/Backhoe | Donaldson Passive DPF | Passive |
| 1985 | 45 | 0 | Off-Hi hwa Tractors | ECS Purifilter | Passive |
| 1985 | 188 | 0 | Scra er | ECS Purifilter | Passive |
| 2006 | 73 | 2 | Rubber Tire Loader | ECS Purifilter | Passive |
| 2003 | 17 | 1 | Tractor/Loader/Backhoes | Huss FS-MD | Active |
| 2006 | 24 | 2 | Tractor/Loader/Backhoe | Huss FS-MD | Active |
| 1987 | .45 | 0 | Off-Hi hwa Tractors | Huss FS-MD | Active |
| 2000 | 62 | 1 | Rubber Tire Loader | Huss FS-MD | Active |
| 2006 | 95 | 2 | Tractor/Loader/Backhoe | Huss FS-MD | Active |
| 1985 | 188 | 0 | Scraper | Mann-Hummel FBC | Passive+FBC |
| 1975 | 125 | 0 | Off-Highway Tractors | Mann-Hummel SMF-AR | Active+FBC+ Electric |
| 1987 | 153 | 0 | Off-Highway Tractors | Sud Chemie ENVICAT | Passive |

| Year | HP | Tier | Vehicle Type | Installed Device | Type of Device |
|---|---|---|---|---|---|
| 1993 | 134 | 0 | Rubber Tire loader | Sud Chemie ENVICAT | Passive |
| 1996 | 166 | 0 | Rubber Tire loader | Sud Chemie ENVICAT | Passive |
| 1996 | 166 | 0 | Rubber Tire loader | Sud Chemie ENVICAT | Passive |

**Table 3: Private and Public Fleets in Showcase**

| Private Fleet | Public Fleet |
|---|---|
| Community Recycling & Resource Recove Inc. | CALTRANS Division of Equipment (Invited) |
| Albert W. Davies, Inc. | City of Burbank Public Works De artment |
| Recycled Materials Company of CA | City of los Angeles, General Services De artment |
| Dan Copp Crushing | Count Sanitation Districts of L.A. Count |
| ECCO Equipment Corp. | City of Culver City Transportation Department |
| Griffith Company | |
| PEED E uipment Company | |
| Altfillisch Contractors, Inc. | |
| Reed Thomas Com an , Inc. | |
| Shimmick Construction Co. | |
| Skanska USA Civil West California District Inc. | |
| Tiger 4 Equipment leasin | |
| Sukut Equipment Inc | |

**Table 4: List of Manufacturers Participating in Showcase**

| Participating Manufacturers | |
|---|---|
| Aaqius | Huss |
| Caterpillar | Johnson Matthe |
| COT | Mann-Hummel |
| DCI | Nett Tech |
| Dinex | Purem |
| Donaldson | Recat-ESWIETI |
| ECS | R os |
| Exten ine | Sud Chemie |

**Figure 1: Example of Data Logging Results (Vehicle # W93518, City of Los Angeles)**

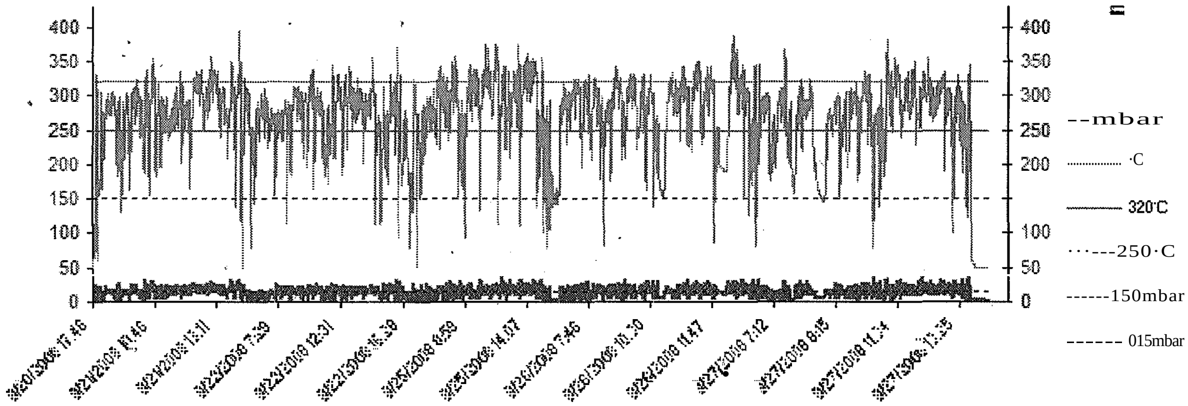
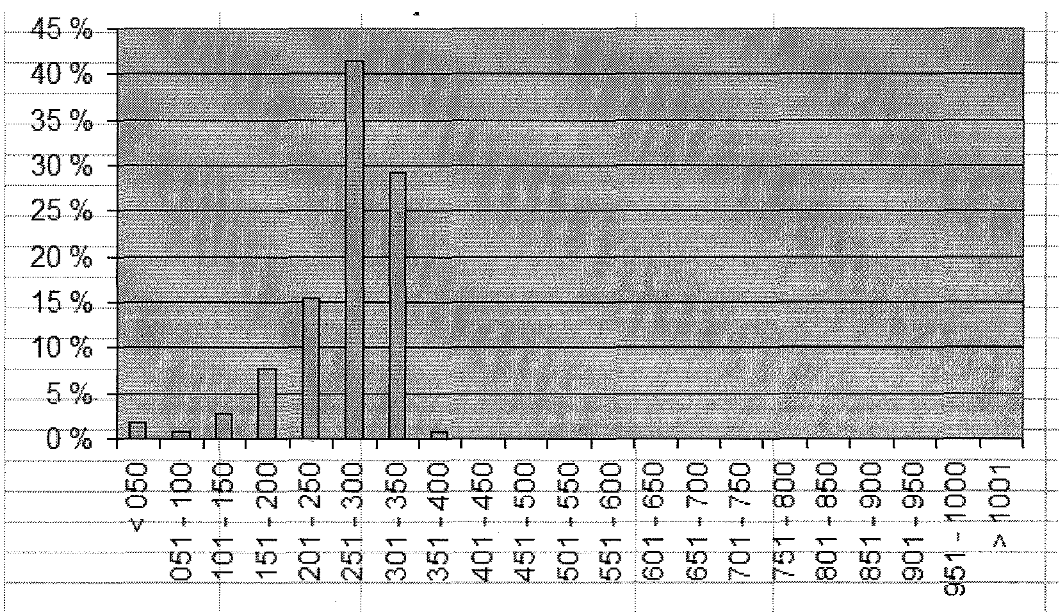



**Figure 2: Example of Data Logging Results (Vehicle # W93518, City of Los Angeles)**




| | |
|---|---|
| Average Temperature . | 266°C |
| Maximum Temperature | 394 °C |
| Percentage >250 °C | 71.5 % |
| Longest duration >320 °C | 0:03:40 hh:mm:ss |
| Frequency of 120 seconds above 320°C | 4 times |

**Table 5: SEP I Retrofits Installed**

| Year | HP | Tier | Vehicle Type | Installed Device | Passive/ Active/NOx Control |
|---|---|---|---|---|---|
| 2000 | 315 | 1 | Wheel loader | Extengine ADECI/ | Active! Nox |
| 1999 | 230 | 1 | Excavator | Rypos HDP | Active |
| 2003 | 550<br>400 | 2 | 2-Engine<br>Scraper | DCI MineX | Passive |
| 1998 | 105 | 1 | Wheel loader | Nett Tech | Passive! Nox |
| 2007 | 125 | 3 | John Deere | ECS Assisted | Active |
| 2007 | 125 | 3 | John Deere | ECS Assisted | Active |
| 2000 | 185 | 1 | Motorgrader | Recat- ESW DC | Active |
| 2006 | 125 | 2 | Tractor | Sud Chemie | Passive |
| 2006 | 125 | 2 | Tractor | Recat ESW | Active |
| 2000 | 89 | 1 | Wheel loader | Mann Hummel | Active |
| 1999 | 80 | 1 | Wheel loader | Mann Hummel· | Active |
| 1995 | 105 | 0 | Wheel loader | Huss FS-MD | Active |
| 2007 | 125 | 3 | John Deere Tractor | Sud Chemie | Passive |
| 2007 | 125 | 3 | John Deere Tractor | Sud Chemie | Passive |

**Table 6: SEP II Retrofits**

| Year | HP | Tier | Vehicle Type | Installed or Proposed Device | Passive/ Active/NOx Control |
|---|---|---|---|---|---|
| 2000 | 86 | 1 | Backhoe | Mann Hummel | Active |
| 2007 | 150 | 3 | Tractor | | Passive |
| 2007 | 150 | 3 | Tractor | | Passive |
| 2005 | 224 | 2 | Wheel loader | | Passive |
| 2007 | 150 | 3 | Tractor | | Passive |
| 2002 | 180 | 0 | Wheel loader | | Active |
| 2000 | 108 | 1 | Wheel loader | | Passive |
| 2004 | 95 | 2 | Wheel loader | | Passive |
| 2002 | 439 | 2 | Excavator | | Passive |
| 2005 | 142 | 2 | Fork Lift Truck | | Active |
| 1999 | 185 | 1 | Side Handler 6 Hi h | (Proposed) | Active/Nox |

**Table 7: SEP III Retrofits Proposed to be Installed**

| Year | HP | Tier | Vehicle Type | Proposed Device | Passive/ Active/NOx Control |
|---|---|---|---|---|---|
| 2006 | 80 | 2 | Broom | COT | Passive |
| 2004 | 119 | 2 | Wheel loader | COT | Passive |
| 1999 | 240 | 1 | Excavator | CAT | Passive |
| 2005 | 55 | 2 | Tractor | ECS | Passive |
| 2005 | 81 | 2 | Mower | ECS | Passive |
| 2004 | 82 | 2 | Mower | Mann Hummel | Passive |
| 2001 | 95 | 1 | Backhoe | Mann Hummel | Active |
| 2006 | 75 | 2 | Tractor loader | HUSS | Active |
| 1998 | 75 | 1 | Wheelloader | Nett Tech | Active |
| 1997 | | 1 | Motor Grader | Nett Tech | Active |
| 1999 | 225 | 1 | Motor Grader | OCI | Passive |
| 2004 | 113 | 2 | Mower | HUSS | Active |

Table 8: Fleets in Participating in SEP

| SEP | Fleet |
|---|---|
| SEPI | LA County Sanitation District |
| | LA County Dept of Beaches and Harbors |
| | City of Burbank Dept of Public Works |
| SEP" | City of Long Beach |
| | City of Los Angeles |
| | Fast Lane (private company) |
| SEP '" | City of Benicia |
| | Alameda County |
| | Contra Costa County |
| | Solano County |

Table 9: Manufacturers Participating in SEP

| Participating Manufacturers | |
|---|---|
| Caterpillar | Mann-Hummel |
| COT | Nett Tech |
| DCl | Recat |
| ECS | R pos |
| Econix | Sud Chemie |
| Exten ine | Teha |
| HUSS | |

**Table 10: Number of Vehicles in Showcase and SEP by Vehicle Type and Horsepower**

| Vehicle Type | <175 HP | 175<HP>500 | >500 HP |
|---|---|---|---|
| Bore/Drill Ri s | 0 | 0 | 0 |
| Cranes | 0 | 0 | 0 |
| Crawler Tractor | 3 | 12 | 1 |
| Excavator | 6 | 19 | 1 |
| Graders | 2 | 7 | 0 |
| Off-Hi hwa Tractor | 35 | 1 | 0 |
| Off-Hi hwa Truck | 1 | 2 | 0 |
| Other Mobile Off-road | 5 | 1 | 1 |
| Paver | 2 | 0 | 0 |
| Roller | 0 | 0 | 0 |
| Rou h Terrain Forklift | 7 | 0 | 0 |
| Rubber Tired Dozer | 0 | 6 | 1 |
| Rubber Tired Loader | 31 | 25 | 0 |
| Scra er | 0 | 16 | 8 |
| Skid Steer Loader | 0 | 0 | 0 |
| Tractor/Loader/Backhoe | 42 | 5 | 0 |
| Trencher | 0 | 0 | 0 |

## APPENDIX D: OUTREACH SUMMARY

### Table 1: ARB Training Sessions

| Date | Location | # of people in attendance |
|---|---|---|
| 7/31/2008 | San Luis Obispo, CA | 92 |
| 8/5/2008 | Bakersfield, CA | 77 |
| 8/7/2008 | Redding, CA | 77 |
| 8/11/2008 | Nevada City,CA | 65 |
| 8/14/2008 | Fresno, CA | 81 |
| 8/19/2008 | Riverside, CA | 142 |
| 8/20/2008 | San Die o, CA | 123 |
| 8/27/2008 | El Monte, CA | 142 |
| 8/29/2008 | Sacramento, CA | 190 |
| 9/3/2008 | San Jose, CA | 83 |
| 9/9/2008 | Ventura, CA | 75 |
| 9/12/2008 | Oakland, CA | 126 |
| 11/19/08 | South Lake Tahoe, CA | 27 |

### Table 2: Presentations to Groups

| Date | Meeting/Group | City | # of people in attendance |
|---|---|---|---|
| 10/16-17/2007 | Clean Vehicle Expo | Ontario, CA | 50 |
| 11/1/2007 | San Luis'Obispo County Builders Exchan e | San Luis Obisbo, CA | 50 |
| 11/7/2007 | National Association of Demolition Contractors | Anaheim, CA | 70 |
| 12/6/2007 | CalCIMA (represents Construction Aggregate and Industrial Mineral producers statewide | Sacramento, CA | 50 |
| 12/13/2007 | Municipal Employees Maintenance Association MEMA | Irvine, CA | 20 |
| 2/21/2008 | Presentation for Quinn Company customers | Santa Maria, CA | 40 |

| Date | Meeting/Group | City | # of people in attendance |
|---|---|---|---|
| *5/22/2008* | Solid Waste Association of North America (SWANA | Seaside, CA | 25 |
| *6/25/2008* | The Air and Waste Management Association (AWMA) Annual Conference and Exhibition | Portland, OR | 12 |
| *8/21/2008* | Building Industry Association of Central California | Modesto, CA | 20 |
| *8/27/2008* | Maintenance Superintendents Association | Rohnert Park, CA | 40 |
| *9/10/2008* | TEC Equipment & AGC (American General Contractors *Event* | Oakland, CA | 40 |
| *10/3/2008* | Tractoberfest | Newark, CA | 150 |
| *10/13/2008* | South Coast AQMD Clean Vehicle Ex 0 | Ontario, CA | 13 |
| *10/14/2008* | CMCA (Concrete Modification Contractor's Assoc. | *Livermore,* CA | 15 |
| *10/21/2008* | Industrial Environmental Association | San Diego, CA | 75 |
| *10/23/2008* | DGS fleet asset m mt unit | Sacramento, CA | 25 |
| *11/10/2008* | CA Golf Course Superintendents Assoc | Cabazon, CA | 150 |

**Table 3: Meetings with Individual Fleets or Stakeholders**

| Date | up | City |
|---|---|---|
| *11/27/2007* | ARB Implementation· Seminarltraining for Sequoia equipment com an CASE dealer | Fresno, CA |
| *·12/10/2007* | Municipal Fleet of Yolo Count | Woodland, CA |
| *12/13/2007* | Cattrac | Fontana, CA |
| *1/4/2007* | Iron Man | Corona, CA |
| *1/7/2007* | CASE Tractor Equipment Sales | Hayward, CA |
| *3/26-28/2008* | Quinn com an | ,CA |
| *3/27/2008* | Stevens Creek Quarry, Inc. | Sacramento, CA |
| *4/712008* | Monterey Regional Waste Management District | Sacramento, CA |
| *4/9/2008* | CASE Tractor Equipment Sales | Hayward, CA |
| *4/10/2008* | Mountain Cascade Inc | Livermore, CA |
| *4/16/2008·* | Tutor Saliba Cor . | Sacramento, CA |
| *4/21/2008* | C & C Construction | Sacramento, CA |
| *5/612008* | Pape Machinery (John Deere | Sacramento, CA |
| *5/14/2008* | Neff Rentals | Sacramento, CA |
| *5/21/2008* | Nissan | Sacramento, CA |
| *5/28/2008* | Pape Materials Handling Grou | Sacramento, CA |
| *5/29/2008* | Western Power and E ui ment | Sacramento, CA |
| *6/12/2008* | CAT dealershi | San Die o, CA |
| *6/17/2008* | Johnson-LiftlHYSTER dealershi | City of Industry, CA |
| *6/20/2008* | NMCO Materials Handling Group (Yale division | Sacramento, CA |
| *6/20/2008* | NMCO Materials Handling Group HYSTER division | Sacramento, CA |
| *7/8/2008* | Su ar Bowl | Sacramento, CA |
| *7/22/2008* | Diamond D Engineering and Associates | Sacramento, CA |
| *8/28/2008* | Tahoe Truckee Sierra Dis osal | Sacramento, CA |
| *9/10/2008* | Rush Enter rises | Fontana, CA |

| Date | Meeting/Group | City |
|---|---|---|
| *10/10/2008* | Western Stabilization | Sacramento, CA |
| *10/27/2008* | Appian Engineering | Mil itas, CA |
| *11/512008* | PAR Electrical Contractors | Sacramento, CA |

**Table 4: Attendance at Conferences and Workshops**

| Date | Meeting/Group | Location |
|---|---|---|
| *10/16-17/2007* | Clean Vehicle Expo | Ontario, CA |
| *9/17/2008* | Public Works Event - AGC | Emeryville, CA |
| 9/25-26/2008 | League of California Cities 2008 Annual Conference & Ex 0 | Long Beach, CA |
| *10/3/2008* | Tractoberfest | Newark, CA |
| *10/13/2008* | South Coast AQMD Clean Vehicle Ex 0 | Ontario CA |
| *10/21-22/2008* | Industrial Environmental Association | San Diego, CA |
| *10/23/2008* | DGS fleet asset mgmt unit | Sacramento, CA |
| *10/29/2008* | AGC Southern California Construction Technology Event | San Diego, CA |
| *11/13-11/14/2008* | Far West Equipment Deaters Association Annual Conference | Phoenix, AZ |

## APPENDIX E: DOORS ON-LINE USER-GUIDES

The Diesel Off-road On-line Reporting System (DOORS) is available for fleets which choose to report early. Staff have been assisting fleet representatives personally, arid have also created a number of user guides and explanations of the reporting information required by the regulation. These guides are available from the reporting homepage (https://secure.arb.ca.gov/ssldoors/doors_reporting/reporting.php) and are listed below in Table 1.

**Table 1: DOORS User Guides**

| General DOORS Guides |
|---|
| Reporting Using Online Screens |
| Reporting Using Excel Spreadsheets |
| How to Report with Missing Information |
| How to Report Duplicate Serial Numbers |
| Reporting Multiple Fleets or Subfleets |
| Importing Data to Excel Spreadsheets |
| **Definitions and Explanations** |
| Owner Information |
| Vehicle Information |
| En ine Information |
| VDECS Information |

The "Reporting Using Online Screens" guide is presented on the following pages as an example of the method and format used in the DOORS guides.

# Online Forms for Initial Reporting

## Introduction

The Diesel Off-Road On-Line Reporting System (DOORS) is an online tool designed to help fleet owners report their off-road diesel vehicle inventories and actions taken to reduce vehicle emissions to the Air Resources Board (ARB), as required by the In-Use Off-Road Diesel Regulation.

Both the DOORS reporting tool and the DOORS User manual were created to help fleet owners comply with the regulation, but they are not a substitute for reading and comprehending the regulation. Many portions of the DOORS system will require fleet owners to understand terms and conditions defined in regulation, and to know which portions of the regulations apply to their vehicles, and where they are eligible for full or partial exemptions. It is strongly recommended that, prior to using the DOORS system, fleet owners determine how the regulation applies to their fleets.

The regulation, fact sheets, additional user guides, and compliance examples can be found at:

http://www.arb.ca.gov/msprog/ordiesel/ordiesel.htm

## User Guide - Online Forms for Initial Reporting

This guide was created to assist fleet owners using Online Screens to report fleet information during the initial reporting period. The guide contains instructions on how to create an online account with ARB in DOORS, navigate to the online screens, enter the data, receive a review from ARB and receive Equipment Identification Numbers (EINs).

### Steps to Report Fleet Data Using Online Forms

This guide provides detailed instructions on how to complete the folloWing steps to report you fleet using our online forms:

A. Create a DOORS account with ARB
B. Determine applicable vehicles
C. Log in to DOORS, and open the online forms
D. Complete the owner information form
E. Enter the vehicle information
F. Enter the engine information, and if necessary, the VDECS information
G. Review the data, and make changes if necessary
H. Request a review from A,RB and receive EINs

A. Create a DOORS Account with ARB

- Go to https://secure.arb.ca.gov/ssldoors/doors_reporting/reporting.php
- Request an account

If you do not have an account, you will be asked to create one, and the account information will be sent to an email address you supply within a few minutes. If you do not see the email, check your "Spam" or "Trash" folders to ensure the email was not blocked by your email server. If you do not receive your email within 15 minutes, re-apply for one on the DOORS homepage. If this does not work, contact ARB for assistance by emailing doors@arb.ca.gov.

B. Determine applicable vehicles

Prior to reporting vehicle information to ARB, fleet owners will need to determine which of their off-road diesel vehicles are covered by the regulation. Some vehicles will likely be fully subject to the regulation, however some vehicles will be exempt from all requirements except labeling and reporting, and some will be fully exempt from the regulation.

- Create a complete list of vehicles subject to the regulation, including those which are only required to be reported and labeled

Early Credit: If you wish to claim early credit, report each vehicle that was included in the fleet from March 1, 2006, to the present, including vehicles you have retired or sold. You will be able to designate which vehicles you have retired or replaced to receive credit in the on-line screens after future updates.

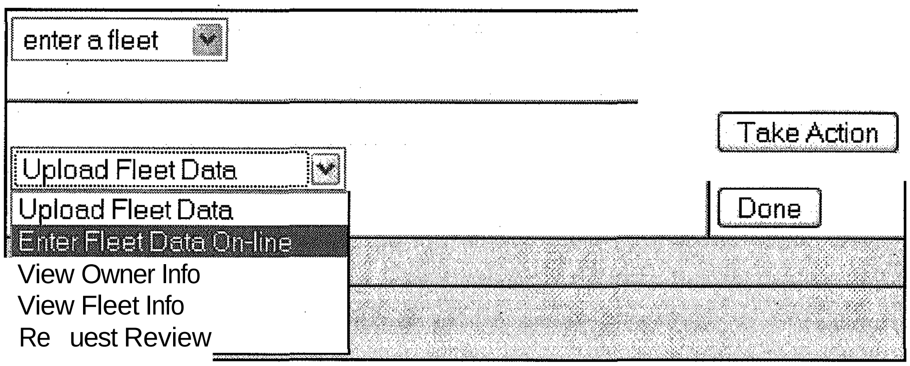
Non-diesel or electric: You will be able to report vehicles using alternative fuels or electric vehicles that have replaced diesel vehicles in your fleet in the on-line screens after updates, for now please include information on the diesel vehicle that was replaced.

C. Log in to DOORS, open the online forms

- Return to the DOORS login screen, and log in to the system using the login name and password emailed to you

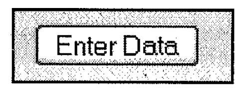
Do not hit "Enter"; you must click on the Login button directly. If DOORS does not accept your password, copy the password from the email, and paste it into the DOORS login screen.

- Once you have logged in to DOORS, go the first dropdown, and select "enter a fleet". In the second dropdown, select "Enter Fleet Data On-Line" and then click on the [Take Action] button to the right.




**D. Complete the owner Information form**

- The first screen you will be taken to is the Owner Information screen. Complete this form, and then select [Enter Data].



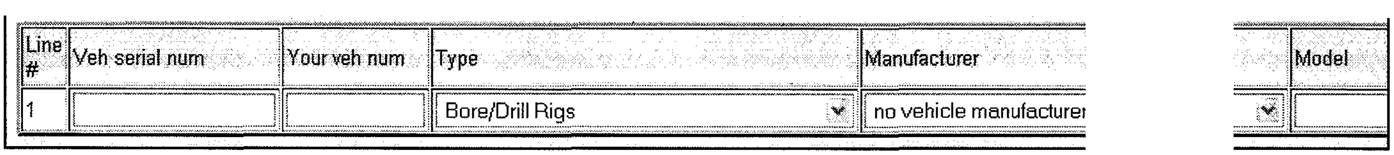

If you have questions about what information is requested, please refer to our explanation for each spreadsheet, available on the reporting page https://secure.arb.ca.gov/ssldoors/doors_reporting/reporting.php under the User Guide menus. For the Owner information, select "Owner Information Dictionary".

- If DOORS rejects any of your information, it will supply an error message and reason at the top of the screen. Attempt to fix the cause of the error, and resubmit the data.

**E. Enter vehicle information**

- Once your owner information has been successfully entered, select the option to [Add / Edit Vehicle] at the top or the bottom of the screen.


- This will take you to the screen where you may add, delete or edit vehicle information.

- Enter the vehicle information required, then select [Enter Data]

If you have questions about what information is requested, please refer to our explanation for each spreadsheet, available on the reporting page https://secure.arb.ca.gov/ssldoors/doors reporting/reporting.php under the Explanation of Terms.

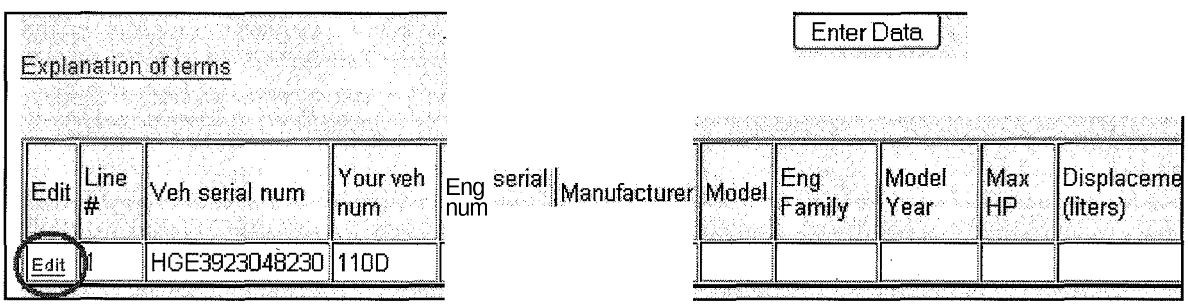
For missing or partial information, refer to the attachment on the last page of the guide.

- After the information on the previous vehicle is entered into a table, continue to use the form to add additional vehicles until your entire inventory is reported. For each successive vehicle, enter the vehicle information required, then select [Enter Data]

## F. Enter engine information, and if necessary, VDECS information

- After entering information on all of the vehicles you wish to report, select the option to [Add / Edit Engine] at the top or the bottom of the screen.

- For each vehicle you have entered, select "Edit" at the left side of the screen, and input the engine information. Then select [Enter Data]. You will only be able to add engine information to vehicles you have already added, and you will only be able to add VDECS information if you have already entered the engine information.

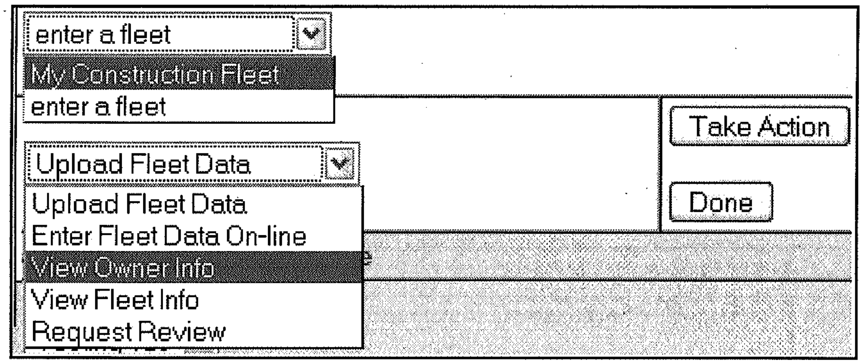



| Edit | Line # | Veh serial num | Your veh num | Eng serial num | Manufacturer | Model | Eng Family | Model Year | Max HP | Displaceme (liters) |
|---|---|---|---|---|---|---|---|---|---|---|
| Edit | 1 | HGE3923048230 | 110D | | | | | | | |

- Complete the same steps to enter VDECS information, if you have any VDECS installed on your vehicles.

## G. Review the data, and make changes if necessary

Before continuing, it is recommended that you review the data you have entered. On the Reporting Home page (the first page in DOORS), the following options are available for fleets you have entered into the system:




- Select the fleet you have entered and wish to review

- Select "View Owner" and click on "Take Action". DOORS will display the fleet owner information you have uploaded. Ensure the data shown is correct, and then return to the Reporting Home page.
  - If it is not correct, return to the reporting homepage, select the fleet, and the choose "Enter Fleet Data On-line". You will be able to edit, delete, and add owner, vehicle, engine, and vdecs information.

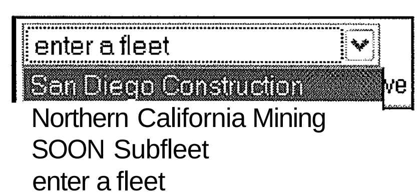
- Select "View Fleet" and click on "Take Action". DOORS will display the vehicle, engine, and VDECS information you have uploaded. Ensure the data shown is correct, and then return to the Reporting Home page.
  - If it is not correct, return to the reporting homepage, select the fleet, and the choose "Enter Fleet Data On-line".

**H. Request a review from ARB and receive EINs**

The information you have entered so far will be saved, and you can access it again and make changes at a later time before submitting it to ARB for review. After ARB reviews the information you will be able to edit and add to your vehicle inventory, and will receive your ARB-designated Equipment Identification Numbers, which must be displayed on your vehicles. The information will not be reviewed by ARB staff, or assigned EINs, until you choose to submit it to ARB for review. To access the fleet information you have entered at a later date, log back in to the DOORS system.

Where you previously selected "Enter a fleet", the fleet (or fleets) you have entered will now be available.

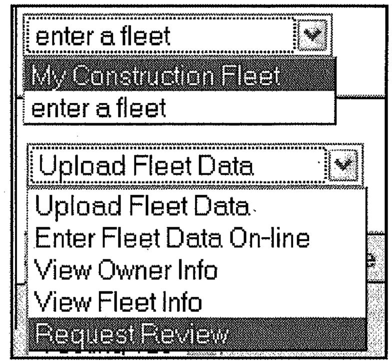
To edit a fleet, select it, and then choose "Upload Fleet Data" and the press the "Take Action" button. You may resubmit the appropriate .prn files and view your updated information.



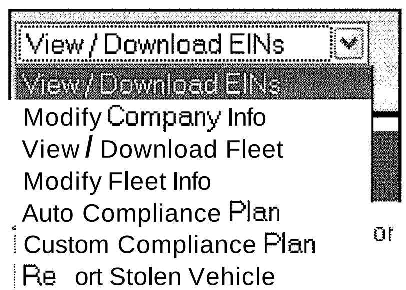
Once you are satisfied with the information and are prepared to send it to ARB for review and receive EIN assignments for your vehicles, return to the.Reporting Home page in the DOORS system.

- Select the Fleet you wish to submit to ARB in the drop down menu

- Select "Request Review" from the drop down menu below, and click on "Take Action"




After the fleet information has been approved by ARB, the fleet will be available for further review and modification, using the following menu on the bottom of the Reporting Home page of the DOORS system after you log in. Not all features will be available when DOORS first comes online in July, 2008.




For more information on reporting with missing or partial information, or how to report multiple f1e.ets or subfleets, refer to our guides, which are available from our reporting homepage at:

https://secure.arb.ca.gov/ssldoors/doors reporting/reporting.php

If you require additional assistance or information, please email us at:

doors@arb.ca.gov

## APPENDIX F: LIST OF ACRONYMS

ARB --- Air Resources Board

BACT --- Best Available Control Technology

BOE --- California Board of Equalization

CM --- Clean Air Act

Cal/OSHA --- California Occupational Safety and Health Administration

CCR --- California Code of Regulations

CSLB --- Contractors State License Board

DECS --- Diesel Emission Control Strategies

DOCs --- Diesel Oxidation Catalysts

DOF --- Department of Finance

DOORS --- Diesel Off-Road On-Line Reporting System

DMV --- Department of Motor Vehicles

DPF --- Diesel Particulate Filter

EIN --- Equipment Identification Number

EGR --- Exhaust Gas Recirculation

G/BHP-HR --- Grams per Brake-Horsepower Hour

HP --- Horsepower

MSHA --- Mining Safety and Health Administration

MSRC --- Mobile Source Air Pollution Reduction Review Committee

NOx --- Oxides of Nitrogen

ORIAG --- Off-Road Implementation Advisory Group

PM --- Particulate Matter

SCAQMD --- South Coast Air Quality Management District

SEP --- Supplemental Environmental Project

SJVAPCD --- San Joaquin Valley Air Pollution Control District

SOON--- Surplus Off-Road Opt-In for NOx

TSD --- Technical Support Document

U.S. EPA --- United States Environmental Protection Agency

VDECS --- Verified Diesel Emission Control System

# CALIFORNIA AIR RESOURCES BOARD

## NOTICE OF PUBLIC HEARING TO CONSIDER THE APPROVAL OF CALIFORNIA'S REGIONAL HAZE PLAN

The Air Resources Board (ARB or the Board) will conduct a public hearing at the time and place noted below to consider the approval of the California Regional Haze Plan (Plan). At the public hearing, the Board will consider this initial Plan to set goals for improving visibility by 2018 at 29 "Class 1 Areas" in California. If approved, ARB will transmit the Plan to the United States Environmental Protection Agency (U.S. EPA) for approval.

DATE: January 22,2009

TIME: 9:00 a.m. (Pacific Standard Time)

PLACE: California Environmental Protection Agency
Air Resources Board
Byron Sher Auditorium
1001 I Street
Sacramento, California 95814

This item will be considered at a two-day meeting of the Board, which will commence at 9:00 a.m., January 22, 2009, and may continue at 8:30 a.m. on January 23, 2009. This item may not be considered until January 23, 2009. Please consult the agenda for the meeting, which will be available at least 10 days before January 22,2009, to determine the day on which this item will be considered.

For individuals with sensory disabilities, this document and other related material can be made available in Braille, large print, audiocassette, or computer disk. For assistance, please contact ARB's Reasonable Accommodations/Disability Coordinator at (916) 323-4916 by voice, or through the California Relay Services at 711, to place your request for disability services, or go to http://www.arb.ca.gov/html/ada/ada.htm

If you are a person with limited English, and would like to request interpreter services to be available at the Board meeting, please contact ARB's Bilingual Manager at (916) 323-7053 within 7-10 business days prior of the meeting date.

**BACKGROUND**

The federal Clean Air Act sets a national policy of achieving visibility comparable to natural conditions for the most treasured national lands and scenic areas of the country. In 1999, the U.S. EPA adopted the Regional Haze Rule to guide this process in each state. The Regional Haze Rule sets out a long-term path towards attaining improved visibility, with the goal of achieving visibility that reflects natural conditions by 2064 at

156 of the national parks and wilderness areas across the United States, deemed "Class 1 Areas." The Regional Haze Rule requires states to establish a series of interim goals to ensure continued ·progress. This Plan addresses the first interim goal period of 2018 for the 29 "Class 1 Areas" in California.

The Plan sets forth California's visibility goals and represents California's element of a multi-state western regional effort to assess the visibility improvement that is expected to occur through 2018. By 2018, visibility is projected to improve in all areas of the West, with the greatest improvements in California due to the extensive nature of California's air pollution control programs. To document the benefits of these programs for visibility, and to meet the requirements of the Regional Haze Rule, ARB has prepared this Plan for California.

This Plan covers all "Class 1 Areas" statewide and includes the following key elements:

- Baseline and natural visibility conditions
- Base and future' year emission inventories
- Long-term control strategy based on already adopted measures
- Best available retrofit technology (BART) analysis
- Consultation with affected states, tribes, and federal land managers
- Reasonable progress goals for 2018
- Future monitoring strategy to assure progress

One of the key elements, the BART analysis, directs the State to evaluate large, older sources from 26 categories to determine whether emission controls should be installed to improve visibility at "Class 1 Areas." In summary, only one facility was identified as contributing to visibility impairment atone nearby "Class 1 Area," and needed to install BART-level controls on certain units at the facility pursuant to the Regional Haze Rule.

**PROPOSED ACTION**

The Plan meets applicable federal requirements. Staff is recommending that the Board approve the Plan, as well as the emission inventory, long-term strategy, reasonable progress goals, and BART analysis, and direct staff to forwardthe Plan to U.S. EPA.

In compliance with the California Environmental Quality Act (CEQA), an environmental impact analysis has been prepared and is provided as chapter 10 of the Plan. This document is being circulated through the State Clearinghouse for agency review and comment. The Board will consider approval of the Plan and adoption of the environmental document concurrently.

**PUBLIC PROCESS AND AVAILABILITY OF DOCUMENTS**

ARB staff will present a summary of the Plan in an oral presentation at the meeting. Copies of the Plan may be obtained from the Board's Public Information Office, 1001 "I" Street, First Floor, Environmental Services Center, Sacramento, California

95814, (916) 322-2990. The Plan may also be obtained from ARB's internet site at http://www.arb.ca.gov/planning/reghaze/reghaze.htm.

Interested members of the public may also present comments orally or in writing at the meeting, and in writing or bye-mail before the meeting. To be considered by the Board, written comments, not physically submitted at the meeting, must be received **no** later than 12:00 noon, January 21, 2009, the day before the meeting begins, and addressed to the following:

Postal mail: Clerk of the Board, Air Resources Board
1001 I Street, Sacramento, California 95814

Electronic submittal: http://www.arb.ca.gov/lispub/comm/bclist.php

Facsimile submittal: (916) 322-3928

Please note that under the California Public Records Act (Gov. Code, § 6250 et seq.), your written and oral comments, attachments, and associated contact information (e.g., your address, phone, email, etc.) become part of the public record and can be released to the public upon request. Additionally, this information may become available via Google, Yahoo, and any other search engines.

The Board requests, but does not require 30 copies of any written submission. Also, ARB requests that written and e-mail statements commenting on the Plan be filed at least 10 days prior to the meeting so that ARB staff and Board members have time to fully consider each comment. Further inquiries regarding this matter should be directed to Tina Suarez-Murias, Air Pollution Specialist, at (916) 323-1495, or by email to csuarezm@arb.ca.gov.

CALIFORNIA AIR RESOURCES BOARD'

Michael N. Scheible

for James N. Goldstene
Executive Officer

Date: December 5, 2008

# CALIFORNIA REGIONAL HAZE. PLAN









California Environmental Protection Agency

Air Resources Board

DRAFT

Release Date:
December 5, 2008

This document has been drafted by the staff of the California Air Resources Board for public review and comment in partial satisfaction of the requirements of the federal Regional Haze Rule, 40 CFR 51.300 et seq.

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Acknowledgements.

The supporting technical information within this draft Plan and the Appendices were assembled with the assistance of the Western Regional Air Partnership member states and their consultants.. Special thanks and appreciation to Tom Moore, Lee Alter, Lee Gribovicz, and Pat Cummins, past and present staff of the Western Governors Association, and to Bob Lebens and Don Arkell at the Western States Air Resources Council (WESTAR). Assistance from the permit. engineers and staff of the air districts in California was invaluable in conducting the extensive review of facility controls, with special recognition to Brenda Cabral at the Bay Area Air Quality Management District. All who contributed to the development of this document made the interactive effort worthwhile.

TABLE OF CONTENTS

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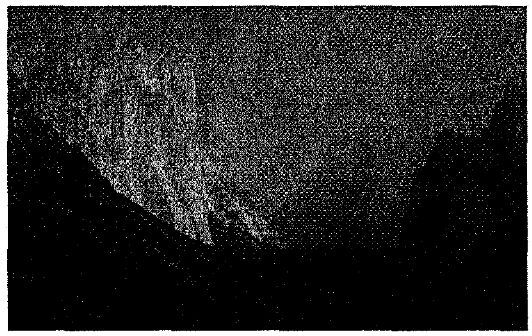
## EXECUTIVE SUMMARY

Good visibility is essential to the enjoyment of national parks and scenic areas throughout the United States. Pollution in the atmosphere, from both natural and human-caused sources, can degrade visibility resulting in what is known as regional haze. As its name implies, this haze can impact broad regional areas and significantly impair the scenic vistas that are so integral to the wilderness experience. A graphic example of the impacts of impaired visibility is provided in the figure below comparing the view of Half Dome in Yosemite National Park on both good and poor visibility days.



To protect visibility in these national parks and scenic areas, the United States Environmental Protection Agency (U.S. EPA) adopted the Regional Haze Rule in 1999. The Rule lays out specific requirements to ensure improvements in the human-caused components of Visibility at 156 of the largest national parks and wilderness areas across the United States. The vast majority of these areas are in the West (118), with 29 in California, including such national treasures as Yosemite and Sequoia National Parks. The Rule sets out a long-term path towards attaining improved visibility, with the goal of achieving visibility which reflects natural conditions by 2064. Unlike State Implementation Plans which require specific targets and attainment dates; the Regional Haze Rule requires States to provide for a series of interim goals to ensure continued progress. This Regional Haze Plan (Plan) addresses the first interim goal period of 2018.

California has a long history of pollution control efforts to address both national and State air quality standards. Due to the unique challenges faced in California, our pollution control programs have gone far beyond what has been achieved on a national level. As a result, California has made tremendous progress in reducing emissions and iinproving air quality. Most recently, California has also embarked on a landmark program to address climate change. Visibility improvement is an additional aspect of environmental protection in California that is benefiting from California's stringent air pollution control efforts addressing a broad spectrum of program areas.

This Plan sets forth California's Visibility goals and represents California's element of a broader western regional effort to assess the visibility improvement that is expected to occur through 2018. Due to the .regional nature of haze, multi-state planning organizations were established to provide for coordinated technical planning and consultation. The Western Regional Air Partnership (WRAP) serves this function in the west. The WRAP membership includes 15 western states, federal land management agencies, tribes, and U.S. EPA. California has worked extensively with the WRAP over the last five years in preparing this Plan. Technical tool development, emission inventories, and air quality modeling have been conducted on a regional basis by the WRAP to support the efforts of all of the western states. This has ensured that there is a common basis for the building blocks of planning efforts both now and in the future. The WRAP has also provided a forum for consultation amongst member states and with federal land managers that has fostered the cooperative, approach for defining future visibility goals.

The technical analysis conducted by the WRAP has shown that by 2018 visibility will improve in all areas of the West. However, the greatest improvements will occur in California. This enhanced rate of progress can be attributed to California's unique and technology-forcing control programs for ozone and particulate matter that are reflected in California's strategy for achieving the 2018 visibility goals. While continuing progress will occur, work conducted by the WRAP has also highlighted that there are impediments to achieving greater rates of progress in the West, including many locations in California. The WRAP analysis has shown that natural sources contribute significantly to visibility impairment. These sources include wildfires that have become more prevalent in the West, as well as natural plant-based biogenic emissions. In addition, analysis has shown that sources outside of the western region, such as from international shipping, and emissions from Mexico and Asia can provide substantial contributions to Visibility impairment. These factors, as well as assessing the cost and feasibility of controls from a regional and national perspective, must be considered in setting appropriate reasonable progress goals.

Nevertheless, California's long-standing emissions control program is providing extensive reductions which establish a reasonable level of progress within this context. For example, California has significantly tightened emission standards for on-road and off-road mobile sources and the fuels that power them. As a result, California's emission control program for on-road motor vehicles is the strongest in the world. Compared to uncontrolled vehicles, passenger cars are now 99 percent cleaner. By 2010, new trucks will be 98 percent cleaner than new pre-1988 models. California has also adopted fuel standards that are more stringent than national reqUirements including California Reformulated Gasoline, and California Clean Diesel fuel. Ourrequirements for consumer products have led to significant improvements in the formulation of products ranging from paints to automotive cleaners to personal care products. California has also pioneered programs to provide incentive funding to expedite the replacement of older equipment such as the Carl Moyer program, school bus retrofits, and the goods movement bond program. In addition, California's stationary sources are subject to stringent control requirements and their emission levels are generally far lower than equivalent sources elsewhere in th,e nation.

Finally, while California's current control measures are the basis for this first set of interim goals and will contribute measurably to visibility improvement by 2018, we are embarking on even more aggressive control programs over the coming years to 'address further air quality standard requirements. Notably, in 2007 the Air Resources Board adopted a comprehensive Statewide strategy to provide for attainment of the federal 8-hour ozone and PM2.5 standards through a combination of far-reaching technologically feasible and cost-effective measures. Meeting the federal standards in 'the South Coast and the San Joaquin Valley, the two regions with the most severe air quality problems, will require a 75 percent reduction in NOx emissions from today's levels. The Statewide strategy targets clean-up of in-use heavy dl:lty trucks, off-road sources, and goods movement sources. In addition, California has established air quality standards which are more stringent than the 'federal standards. The State standards also have long-term planning requirements to ensure they are attained as expeditiously as possible. The scope of these ongoing challenges will ensure that California will continue to be at the forefront of pursuing clean technologies and stringent control approaches far into the future and thus provide ongoing improvements in visibility.

It is also important to note that this Plan is the first of many as we proceed towards 2064. Each state isrequired to submit a five year progress report, as well as a revised Plan every ten years. These mid-course reviews allow states to evaluate interim progress towards their goals. During development of this Plan, the western states have identified a number of areas that require further evaluation to better inform the goal setting process. As noted previously, natural emissions from wildfires and biogenic sources have been found to playa significant role in visibility impairment in the west. Current estimates of natural conditions appear to underestimate the contributions from these sources. An improved understanding of the role of these sources is therefore needed to more appropriately define the level of future natural Visibility that can realistically be achieved. In addition, the western states must continue to work with the federal government and international organizations to reduce the contributions to visibility impairment that come from sources under federal and international control. Updated information on these issues, as well as assessing the additional benefits of new control programs will all be incorporated into future Plan updates.

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# 1. INTRODUCTION TO THE REGIONAL HAZE RULE REQUIREMENTS

## 1.1. Purpose of the Plan

To protect visibil·ity in national parks and scenic areas, the United States Environmental Protection Agency (U.S. EPA) adopted the Regional Haze Rule in 1999. The Rule lays out specific requirements to ensure iinprovements in the anthropogenic components of visibility at 156 of the largest national parks and wilderness areas across the United States. The vast majority of. these areas are in the West (118), with 29 in California, including such national treasures as Yosemite and Sequoia National Parks. The Rule sets out a long-term path towards attaining improved visibility, with the goal of achieving visibility which reflects natural conditions by 2064. Unlike State Implementation Plans which require specific targets and attainment dates, the Regional Haze Rule requires states to establish a series of interim goals to ensure continued progress. This Regional Haze Plan (Plan) addresses the first interim goal period of 2018.

This Plan sets forth Califomia's visibility goals and represents California's element of a multi-state western regional effort to assess the visibility improvement that is expected to occur through 2018. Due to the regional nature of haze, multi-state planning organizations were established to provide for coordinated technical planning and consultation.. The Western Regional Air Partnership (WRAP) serves this function in the West. California has worked extensively with the WRAP over the last five years in preparing this Plan. Technical tool development, emission inventories, and air quality modeling have been conducted on a regional basis by the WRAP to support the efforts of all of the western states.

The technical analysis conducted by the WRAP has shown that by 2018 visibility will improve in all areas of the West. However, the greatest improveinents will occur in California due to the extensive nature of our control programs to achieve ambient air quality standards which have gone far beyond what has been achieved on a national level. To document the co-benefits of these programs for visibility, and to meet the reqUirements. of the Regional Haze Rule, the Air Resources Board (ARB) has prepared this first Plan for California. The Plan evaluates the nature of the visibility problem at each Class 1 Area in the State, demonstrates the progress that will be achieved in each area by 2018, and describes how this progress is occurring within the framework of California's comprehensive control programs.

## 1.2. Overview of Visibility and Regional Haze'

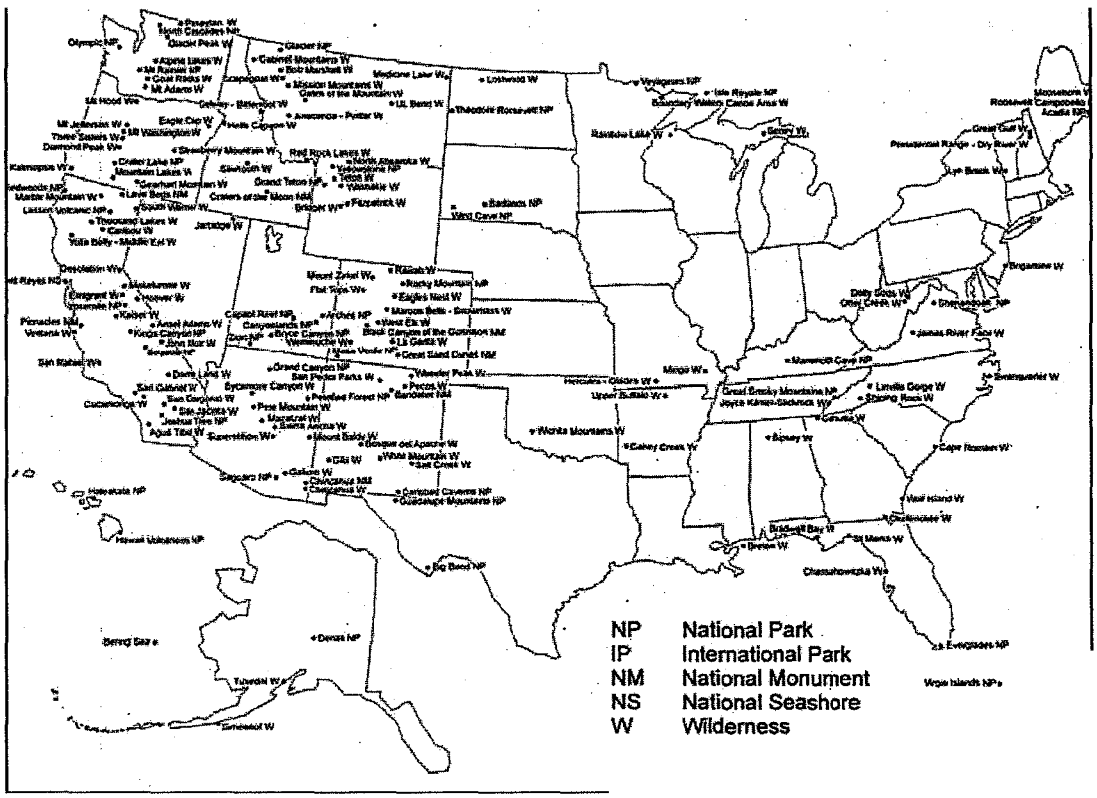
Good visibility is essential to the enjoyment of national parks and scenic areas. Across the United States, regional haze has decreased the visual range in these pristine areas from 140 miles to 35-90 miles in the West, and from 90 miles to

15-25 miles in the East. This haze is composed of small particles that absorb and scatter light, affecting the clarity and color of what humans see in a vista. The pollutants (also called *haze species)* that create haze are measurable as sulfates, nitrates, organic carbon, elemental carbon, fine soil, sea salt, and coarSe mass. Anthropogenic sources of haze include industry, motor vehicles, agricultural and forestry burning, and dust from soils disturbed by human activities. Pollutants from these sources, in concentrations much lower than those which affect public health, can impair visibility anywhere. Natural forest fires, biological emissions, sea salt and other natural events also contribute to haze species concentrations. Visibility-reducing particles can be transported long distances from where they are generated, thereby producing regional haze. But when they are transported to and occur in national parks and wilderness areas, the reduced visibility- impairs the quality and the value of the wilderness experience.

The national visibility goal set forth in section 169A of the federal Clean Air Act is to remedy existing degraded visibility and prevent future visibility impairment in national parks and wilderness areas. U.S. EPA first promulgated visibility rules in 1980. In July 1999, EPA adopted the Regional Haze Rule to complement and add to the visibility rules. These rules apply to 156 national parks and wilderness areas designated by Congress as "mandatory federal Class 1 Areas" (referred to herein as Class 1 Areas). Figure 1.1 shows that most of these are located in the western states, with 29 Class 1 Areas in California as illustrated in Figure 1.2. California Class 1 Areas span all regions of the State, from Joshua Tree National Park in the south, to Yosemite National Park in the Sierras, and Redwoods National Park on the northern coast.

The Regional Haze Rule sets forth the goal of achieving natural visibility conditiOns by 2064 in all Class 1 Areas. Along that path, states must establish a series of interim goals to ensure continued progress. The first planning period specifies setting reasonable progress goals for improving visibility in Class 1 Areas by the year 2018. Specifically, the interim goals must provide for improved visibility on the 20 percent of days with the worst visibility, and ensure that there is no further degradation on the 20 percent of days with the best visibility. The intent is to focus on reducing anthropogenic emissions, while achieving a better understanding and quantification of the natural causes of haze.

**Figure 1-1 Nationwide Class 1 Areas**

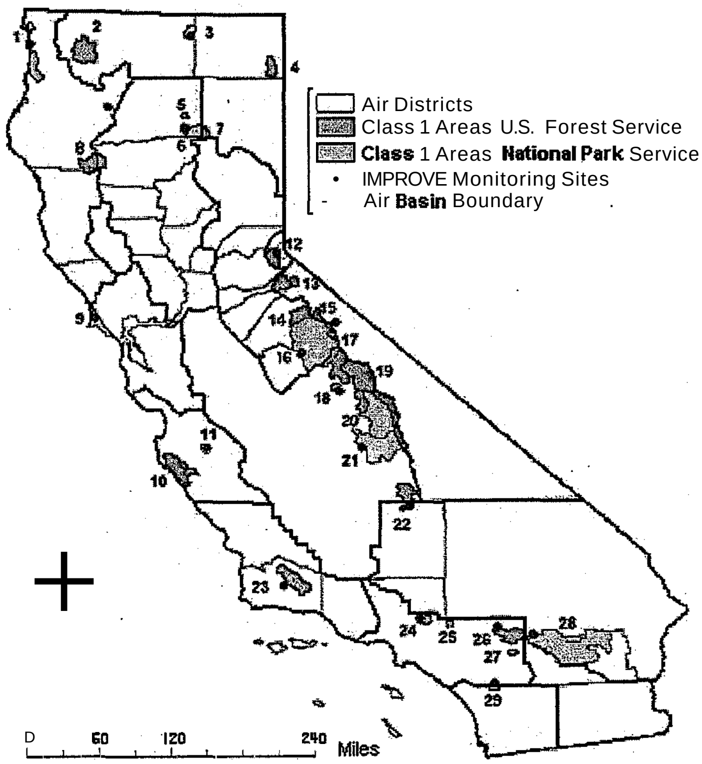



## 1.3. California and the Federal Regional Haze Rule

California has a long history of pollution control efforts to meet the health-based air quality standards. The numerous federal nonattainment areas within the State, as well as requirements to address more stringent State air quality standards have kept California at the forefront of pollution control. Due to the unique challenges faced in California, our pollution control programs have gone far beyond what has been achieved on a national level. California has also pioneered programs to address issues such as health risk from diesel exhaust, mitigating the impacts from good movement within the State, and most recently climate change. As a result, California has made tremendous progress in reducing emissions and improving air quality.

Visibility improvement reflects an additional aspect of environmental protection in California that benefits from the broad spectrum of programs already underway. Examination of visibility data from a number of sites with long-term monitoring demonstrates that California's control programs are providing visibility benefits. For example, at the San Gorgonio.Class 1 Area, a wilderness area just downwind of the South Coast Air Basin, visibility has improved approximately 15 percent between 1990 and 2004, while at Pinnacles·National Monument on the Central Coast, visibility has shown an approximately 18 percent improvement . over the same time period.

**Figure 1-2 California's Class 1 Areas and IMPROVE Monitoring Network**




1. Redwood. National Park
2. Marble Mountain Wilderness
3. Lava Beds National Monument
4. South Warner Wilderness
5. Thousand Lakes Wilderness
6. Lassen Volcanic National Park
7. Caribou Wilderness
8. Yolla Bolly Middle Eel Wilderness*
9. Point Reyes National Seashore
10. Ventana Wilderness
11. Pinnacles National Monument
12. Desolation Wilderness
13. Mokelumne Wilderness
14. Emigrant Wilderness
15. Hoover Wilderness
16. Yosemite National Park
17. Ansel Adams Wilderness
18. Kaiser Wilderness
19. John Muir Wilderness
20. Kings Canyon National Park
21. Sequoia National Park
22. Dome Land Wilderness*
23. San Rafael Wilderness
24. San Gabriel Wilderness
25. Cucamonga Wilderness
26. San Gorgonio Wilderness
27. San Jacinto Wilderness
28. Joshua Tree National Park
29. Agua Tibia

**also includes land managed by the U.S. Bureau of Land Management*

As noted earlier, this Plan represents California's element of a broader regional effort to improve visibility throughout the West through our participation in the WRAP. The WRAP facilitates the regional planning process and interstate consultation for the western states of Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New'MeXico, North Dakota, Oregon, South Dakota, Utah, Washington, and Wyoming. The WRAP established stakeholder-based technical and policy oversight committees to assist in managing the development of regional haze work products. Working' groups and forums were also established that included states, tribal representatives, federal agencies, environmental groups, and industry stakeholders. ARB staff actively participated in the research, data analyses, interstate and tribal coordination, and discussions which led to regionally consistent emissions and air quality modeling approaches for addressing regional haze amongst all the western states.

The Regional Haze Rule contains many technical and informational elements which must be included in the Plan. These key elements include:

- Determining baseline and natural visibility conditions,
- Presenting base and future year emission inventories,
- Setting reasonable progress goals for 2018,
- Documenting the strategy to attain these goals,
- Determination of best available retrofit technologies,
- Consultation with states, tribes, a'nd federal land managers',
- Committing to a monitoring strategy, and
- Specifying a timeline for future Plan revisions.

These elements are briefly explained in this Chapter and then detailed in subsequent Chapters of this document. Appendix J outlines the location of all of the elements that must be included in the Plan.

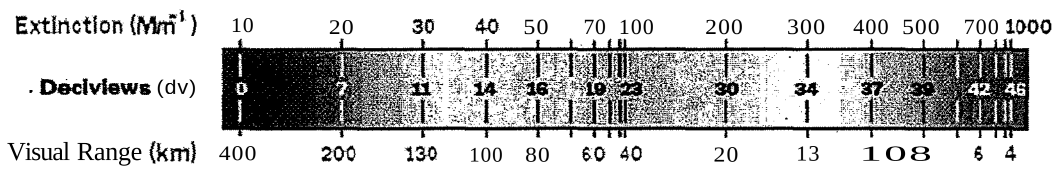
### 1.3.1. *Determining Baseline and Natural Visibility Conditions*

For each Class 1 Area in California, the state must describe existing (current) visibility conditions, on the suite of days with the best and worst visibility, for the baseline years of 2000-2004. The state must also establish what the best and the worst visibility would be like under natural conditions during the baseline period, on days when only natural sources affect visibility, without any anthropogenic impairment. Achieving natural conditions for visibility on worst. days by 2064 is the overall goal of the Regional Haze Program;

Establishing the link between haze species and visibility impairment is the key to understanding regional haze. The haze species reflect (scatter) and absorb light in the atmosphere, thereby extinguishing light. The amount of light extinction affects visibility or the clarity of objects viewed at a distance by the human eye. The amount and type of haze species in the air can be measured, and the amount of light extinction caused by each one can be calculated, for any location or day, as visibility conditions change from good to poor throughout the year. The specific visibility measurement unit, the deciview (dv), is the natural logarithm of light extinction. The deciview is used in the Regional Haze Rule to track visibility conditions. While the deciview value describes overall visibility levels, light extinction describes the contribution of.particular haze species to measured visibility.

The relationship between units of light extinction ($Mm^{-1}$), haze index (dv), and visual range (km) are indicated by the scale below. Visual range is the distance at which a given object can be seen with the unaided eye. The deciview scale is zero for pristine conditions and increases as visibility degrades. Each deciview change represents a perceptible change in visual.air quality to the average person. Generally, a one deciview change in the haze index is likely perceptible by a human regardless of background visibility conditions. This is approximately a 10 percent change in the light extinction reading.

**Figure 1-3 Visibility Measurement Scale**




As the scale indicates, the deciview value gets higher as the amount of light extinction increases. The ultimate goal of the regional haze program is to reduce the amount of light extinction caused by haze species from anthropogenic emissions,until the deciview level for natural conditions is reached. That would be the deciview level corresponding to emission levels from natural sources only. The haze species concentrations are measured as part of the IMPROVE (Interagency Monitoring of Protected Visual Environments) monitoring. network deployed throughout the United States. Seventeen sites are operated in California.

***Baseline or current visibility*** includes haze pollutant contributions from anthropogenic sources as well as those from natural sources using the actual pollutant concentrations measured at the IMPROVE monitors every three days during the period of 2000-2004. The 20 percent highest deciview days (roughly corresponding to the 24 days having the worst visibility) are averaged each year. These five yearly values are then averaged to determine the worst days visibility in deciviews for the 2000-2004 baseline period. The same process is used to get the best day baseline visibility value in deciviews from the annual 20 percent best days over the baseline years.

***Natural visibility*** conditions represent the long-term degree of visibility estimated to exist, in the absence of anthropogenic impairment. Natural events such as wind storms, wildfires, volcanic activity, biogenic emissions from natural plant processes, and even sea salt from sea breezes introduce particles from natural sources that contribute to haze in the atmosphere. Therefore, individual natural. events can lead to high short-term concentrations of visibility-impairing pollutants. Establishing the best and worst days under natural conditions represents a statistical normalization of these episodic events over time.

The U.S EPA initially calculated default natural visibility conditions for all Class 1 monitors but allowed states to develop more refined calculations. The Regional· Planning Organizations nationwide funded research to refine the methods used to calculate visibility, the results of which were used to calculate the deciview values presented in this Plan. However, a great deal of additional research is underway to continue to better define natural visibility conditions in th.e western United States. New research is emerging on the increasing prevalence of wildfires in the western United States. The frequency of dust storms and their impact on areas disturbed by human-caused vs. wildlife activities is being investigated, as well as global transport of dust from natural desert storms in Africa and Asia. There is also increased awareness of the biogenic contributions to haze. As research into long-range transport, biogenic emissions, and wildfire cycles continues, we believe that natural condition visibility levels will be adjusted upwards.

Chapter 2 of this Plan describes current visibility conditions in each Class 1 Area as well as the nature of the pollutant species that contribute to the observed levels. Chapter 6 provides further information on the role of natural versus anthropogenic contributions and how that affects the progress that can be expected by 2018.

### 1.3.2. *Statewide Emissions Inventory of Haze-causing Pollutants*

As with any air quality analysis, a good understanding of the sources of haze pollutants is critical. The Plan includes emissions for the base year 2002, which represents the midpoint of the 2000-2004 baseline planning period, as well as future projected emissions to the year 2018. This emissions inventory was developed by the WRAP with input from California in order to provide a regionally cQnsistent inventory. Chapter 3 provides information on emissions within California, induding both natural and anthropogenic source categories.

### 1.3.3. *2018 Progress Strategy*

The Plan also describes the strategy that provides the necessary emission reductions to achieve the reasonable progress goals established for each Class 1 Area within California,as well as for each Class 1 Area located outside California which may be affected by California emissions. The Regional Haze

Rule requires that the strategy consider ongoing air pollution control programs, measures to mitigate the impacts of construction activities, and smoke management programs. Emissions limitations, control measures, compliance schedules, replacement and retirement schedules, including their enforceability, must also be considered. Given California's need to attain both federal and State standards for pollutants affecting public health, we have a multi-faceted combination of aggressive programs that have been reducing criteria pollutant emissions for many years. California's strategy provides an ambitious and comprehensive basis for setting reasonable progress goals for the purpose of regional haze planning. Chapter 4 describes the measures included in California's 2018 Progress Strategy.

### *1.3.4.* ***Best Available Retrofit Technology (BART) Requirement***

The Best Available Retrofit Technology (BART) requirement implements a federal mandate to retrofit certain very old sources that pre-date the 1977 amendments to the Clean Air Act up to 15 years. The Plan must identify facilities that fall into one of 26 specific source categories, with emission units from the 1962-1977 time period having the potential to emit more than 250 tons per year of any haze pollutant. These emission units are known as BART-eligible sources. If it is demonstrated that the emissions from these sources cause or contribute to visibility impairment in any Class 1 Area, then the best available retrofit technology must be installed.

The determination of BART must take into consideration the costs of compliance, the energy and non-air quality environmental impacts of compliance, any existing pollution control technology in use at the source, the remaining useful life of the source, and the degree of improvement in visibility which may reasonably be anticipated to result from the use of such technology. In California, there are a number of facilities that fit the initial BART-eligible criteria. However, because local air districts have adopted stringent measures to reduce criteria pollutants, the vast majority of the older emission units have already been retrofit or suitably controlled. The systematic BART analysis carried out by ARB and the local air districts are detailed in Chapter 5.

### *1.3.5.* ***Reasonable Progress Goals for 2018***

Reasonable progress goals are established by each state for each Class 1 Area as a deciview level to be achieved by 2018, the end of the first planning period. The reasonable progress goals must assure that the worst haze days get less hazy and that visibility does not deteriorate on the best days, when compared with the baseline period. WRAP regional air quality modeling was used by the western states to assess future visibility and therefore, provide the context for states to establish reasonable progress goals for their Class 1 Areas.

States must also compare their reasonable progress goals to the level of visibility improvement that would be achieved if perfectly linear progress between the current period and expected natural conditions in 2064 were to occur. This linear rate of progress is known as the uniform glide path. The uniform glide path is not a fixed standard that must be met; instead it simply provides a basis for evaluating the selected 2018 goals. Many factors play into whether the uniform glide path can be achieved in the initial progress period including the cost and feasibility" of controls as well as the appropriateness of the level set for natural conditions in 2064. Chapter 4 contains the analysis of control measures leading to California's selection of reasonable progress goals which are described in Chapter 7. Chapter 6 provides information on the WRAP modeling efforts and discussion of natural versus human-caused source contributions.

### *1.3.6.* ***Required Consultation***

Preparation of the Plan and selection of reasonable progress goals requires consultation between states, FederalLandManagers (FLMs), and affected tribes since haze pollutants can be transported across state lines, as well as international and tribal borders. In California, Class 1 Areas are managed primarily by the National Park Service (NPS) and the U.S. Forest Service (USFS.) The ARB has longstanding cooperative relationships with the NPS and the USFS, as well as with other Federal Land Managers within the State. During the preparation of this Plan, ARB formed a Ste.ering Committee with the NPS, the USFS, and the U.S. EPA to discuss the components of the Plan. The draft Plan must be available to the Federal Land Managers at least 60 days before the public hearing on the final Plan. ihis allows time to identify and address any comments from the Federal Land Managers in the final Plan in advance of the Board hearing.

Participation in"the WRAP has fostered a regionally consistent approach to haze planning in the western states and provided a sound mechanism for consultation., Through this process, the western states have agreed upon the overall goals being seHor 2018 and the appropriateness of the strategies to achieve these goals for all Class 1 Areas in the region. The consultation process is explained in detail in Chapter 8. .

### *1.3.7.* ***Monitoring Strategy***

The Plan also includes a monitoring strategy for measuring, Characterizing, and reporting visibility impairment that is representative of all Class 1 Areas within the " " State. California uses the seventeen IMPROVE monitors whose locations are shown on Figure 1.2. Although there are twenty-nine Class 1 Areas in California, the IMPROVE monitors are located to give a reasonable indication of visibility in the respective regions where some of the Class 1 Areas are close to each other and share a monitor. Chapter 9 explains how California will continue to provide monitoring information for visibility analysis, as well as emissions inventories, as required, to the U.S. EPA.

### *1.3.8.* ***Mid-Course Review of Progress, Revisions, and Timelines***

Following submittal of the initial Plan, and every ten years after that, a revised Plan must be submitted for the following ten year period. In the interim, each state is required to sublTiit a 5-year progress report to the U.S. EPA. Inventory and monitoring data updates, as well as a progress report on emission reductions are prepared for the mid-course review. As in this initial Plan, at the mid-coiJrse reView, California will also work and consult with other states through a regional planning process.

The mid-course review also allows each state to assess progress towards its reasonable progress goals. As explained in Chapter 4, California's strategy for improving visibility is related to ongoing activities to reduce emissions of criteria pollutants. While the current control measures and incentive programs for stationary, area, and mobile sources contribute measurably to reductions in haze, California is embarking on ever more stringent, far-reaching, and technology-forcing control efforts in the upcoming years to meet further national and State air quality standard requirements. The first mid-course review, anticipated to occur in 2012, will provide an opportunity to reassess progress in light of these continuing programs.

# 2. VISIBILITY CONDITIONS AT CALIFORNIA CLASS 1 AREAS

## 2.1 Monitoring Data and Measuring Visibility Conditions

As discussed in Chapter 1, the Regional Haze Rule requires tracking visibility conditions at all Class 1 Areas in deciviews (dv). Deciview levels are not measured directly; they are derived from direct measuremen't of the haze pollutant species that impair visibility. The measurements are made at 17 IMPROVE monitors in California, assigned to the 29 Class 1 Areas shown in Figure 1-2 in Chapter 1. California used only"this monitoring data to determine visibility conditions, so the baseline and current visibility will be the same for Class 1 Areas sharing an IMPROVE monitor. For this first Plan submittal, the 2000-2004 baseline conditions are the reference point against which visibility improvement is tracked. For sUbsequent Plan updates (in the year 2018 and every 10 years thereafter), these baseline conditions will be used to calculate progress from the beginning of the regional haze program.

Describing the average "Best Days" and "Worst Days" for Natural Conditions (background visibility in the absence of anthropogenic source visibility impairment) and Baseline Conditions (visibility considering all pollution sources) shows the typical range in visibility for each Class 1 Area during the baseline period. The Plan can be understood as a way to continually shrink the gap between worst days of the baseline period and worst days under Natural Conditions by reducing anthropogenic source visibility impairment. Table 2-1 shows the deciview values for the baseline best and worst days at each IMPROVE monitor and describes the hurdle to overcome in bringing the current worst visibility days to that of Natural Conditions at each Class 1 Area. In the future, the best days for the Baseline Conditions must be maintained or constantly bettered in subsequent planning periods.

The Class 1 Areas with the highest baseline deciview levels and therefore the biggest hurdles to overcome to reach Natural Conditions are Agua Tibia Wilderness Area (68 percent reduction), Kings Canyon and Sequoia National Parks (70 percent reduction), and San Gorgonio and San Jacinto Wilderness Areas (67 percent reduction). These Class 1 Areas are all situated at or near the edge of air basins with high density populations, many different land uses, and large interstate transportation corridors.

The Class 1 Areas with the least change needed in deciview level by 2064 are Redwoods National Park (25 percent reduction) and Point Reyes National Park (31 percent"reduction). Because these two areas are located within 10 km of the coastline, they are exposed to large concentrations of sea salt, a natural cause of haze that will remain constant into the future. Therefore, the expected Natural Conditions at these two sites are much higher than for sites located further inland and hence the reductions needed to meet natural levels are much less.

Class 1 Areas at higher elevations in the Sierra Nevada such as Desolation Wilderness, Mokelumne Wilderness, and Hoover Wilderness, as well as those in the far northeastern corner of California such as Lava Beds National Monument and the South Warner Wilderness have the lowest deciview levels because these sites tend to be the furthest removed from the most highly urbanized portions of the State. These include the Caribou Wilderness and Thousand Lakes Wilderness in the northern, rural,' high terrain areas close to Lassen Volcanic National Park. These sites need an approximately 50 percent reduction from current visibility levels, as measured by deciviews, to achieve Natural Conditions.

The terrain, ecology, land use, and weather patterns around each IMPROVE monitor in California are unique. Emission sources producing haze species or their precursors can have .seasonal fluctuations that vary from one area to another. Additionally, after pollutants are emitted from the various sources, their transformation and transport in ambient air is affected by weather patterns. Detailed examination of the resultant ambient air monitoring data does show similarities within defi'nable intra-State regions. These sub-regions are different from each other based on physiographic features, as well as land use patterns. Therefore California has grouped its Class 1 Areas by geographic sub-region, as . shown in Table 2-1. This facilitates comparison of different landscapes, meteorological conditions, and the impacts of local and regional emissions. The map in Figure 2-1 illustrates these SUb-regions.

## Table 2-1 IMPROVE monitors and Visibility at California Class 1Areas

| California Class 1 Areas (Visibility Calculated In Deciviews) | | | Current Conditions (2000-20()4 Baseline) | | Future Natural Conditions (2064 Goals) | | |
|---|---|---|---|---|---|---|---|
| IMPROVE Monitor (name and elevation In meters) | | CLASS 1 AREA(s) | Worst Days | Best Days (maintain In future years) | Natural Worst Days | Declview Hurdle (baseline to 2064 | Improvement from Current VIsibility on WorstDa s |
| **NORTHERN CALIFORNIA** | | | | | | | |
| **TRIN** *(1014 m.)* | **Trinity** | Marble Mountain Wildemess<br>Yolla Bolly-Middle Eel lIderness | **17.4** | **3.4** | **7.9** | **9.5** | **55%** |
| LABE *(1460* m.) | Lava Beds | Lava Beds National Monument<br>South Warner Wilderness | 15.1 | 3.2 | 7.9 | 7.2 | 48% |
| LAVO 1733 m.) | | Lassen Volcanic National Park<br>Caribou Wilderness<br>Thousand Lakes Wilderness | 14.1 | 2.7 | 7.3 | 6.8 | 48% |
| **SIERRA CALIFORNI** | | | | | | | |
| **BLIS** *(2131 m.)* | **Bliss** | Desolation Wilderness<br>Mokelumne Wilderness | **12.6** | **2.5** | **6.1** | **6.5** | **52%** |
| **HOOV** *(2561m.)* | **Hoover** | Hoover Wilderness | 12.9 | 1.4 | 7.7 | 5.2 | 40% |
| **YOSE** *(1603 m.)* | **Yosemite** | Yosemite National Park<br>Emigrant Wilderness | 17.6 | 3.4 | 7.6 | 10.0 | 57% |
| **KAIS** *(2598 m.)* | Kaiser | Ansel Adams Wilderness<br>Kaiser Wilderness<br>John Muir Wilderness | 15.5 | 2.3 | 7.1 | 8.4 | 54% |
| **SEQU** *(519 m.)* | Sequoia | Sequoia National Park<br>Kings Canyon National Park | 25.4 | 8.8 | 7.7 | 17.7 | 70% |
| **DOME** *(927 m.)* | **Dome Lands** | Dome Lands Wilderness | 19.4 | 5.1 | 7.5 | 11.9 | 61% |
| **COASTAL CALIFORNIA** | | | | | | | |
| **REDW *** *(244 m.)* | **Redwood** | **Redwood National Park** | **18.5** | **6.1** | **13.9** | **4.6** | **25%** |
| **PORE** *(97 m.)* | **Point Reyes** | Point Reyes National Seashore | 22.8 | 10.5 | 15.8 | 7.0 | 31% |
| **PINN** *(302 m.)* | **Pinnacles** | Pinnacles Wilderness<br>Ventana Wilderness | 18.5 | 8.9 | 8 | 10.5 | 57% |
| **RAFA** *(957 m.)* | **San Rafael** | San Rafael Wilderness | 18.8 | 6.4 | 7.6 | 11.2 | 60% |
| **SOUTHERN CALIFORNIA** | | | | | | | |
| **SAGA *** *(1791 m.)* | **San Gabriel** | San Gabriel Wilderness<br>Cucamonga Wilderness | **19.9** | **4.8** | **7.0** | **12.9** | **65%** |
| **SAGO** (1726m.) | **San Gorgonio** | San Gorgonio Wilderness<br>San Jacinto Wilderness | 22.2 | 5.4 | 7.3 | 14.9 | 67% |
| **AGTI *** *(508 m.)* | **Agua Tibia** | Agua Tibia | 23.5 | 9.6 | 7.6 | 15.9 | 68% |
| JOSH 1235m.) | **Joshua** Tree | Joshua Tree National Park | 19.6 | 6.1 | 7.2 | 12.4 | 63% |

* *REDW is influenced by transport* from *the* same *regions* as *the Northem Califomia sites,* **which are** *different* from *the regions influencing the* **other** *monitors close* to *the coast. However,* sea *salt is* a *major component* of *haze* at *Redwoods National Park, characteristic* of *coastal sites. Also,* a *sparsely populated coastal mountain range, cresting around 7000 feet, separates REDW from many inland source influences. Therefore REDW* is *aligned with Coastal sites for analysis purposes.*

SAGA *and AGTI are closer* to *the Pacific Ocean than the other Southem Califomia sites. However, commercial marine* **shipping**, *port activities, sources in the Los Angeles Basin, and transport* from *Mexico impact all the southem sites. Also,* sea **salt's** *contribution* to *haze on worst days* at *all the southern sites is* <*0.1%. All the Southem sites are separated from the other sites by transverse mountain ranges and the Antelope Valley, hence their grouping for analysis purposes.*

## 2.2 Haze Species Contributions to Light Extinction

The deciview level describes the visibility, or relative clarity of view, for every day that haze species are measured at a particular IMPROVE monitor. The deciview value for a given day is the natural logarithm of the total light extinction on that day. As air pollution is reduced, light extinction lessens, visibility improves, and the deciview value gets lower. Although the deciview number does not distinguish how much there is of each haze species or where it came from, the fundamental monitoring data which is used to derive deciview levels reveals what causes haze at each monitor. Differences in the key species which contribute to light extinction in different areas of California provide important insights into the sources of haze.

The IMPROVE monitors measure the concentration of six particulate haze species in the PM2.5 size fraction: nitrates, sulfates, organic carbon (OC), elemental carbon (EC), soil, sea salt. The total amount of mass in the PM10-2.5 size fraction is also measured and denoted as coarse mass. Most importantly, each haze species has a different capability to absorb and scatter light, so the measured pollutant concentration must be converted to light extinction to get the true impact or contribution of each haze species to visibility impairment each measured day. The relationship between haze species concentrations and light extinction is described below.

Haze Species Concentration: These are the particulate matter species concentrations that are measured in micrograms per cubic meter ($ug/m^3$) every three days at each IMPROVE monitor. Since each species does not have the same capability to extinguish light, sometimes a low concentration of one species can have the same effect as a high concentration of another species. For this reason; California has focused on the contribution to light extinction of each species to describe what causes haze at each IMPROVE monitor.

Light Extinction: This is calculated by the Haze Algorithm II equation (see Appendix A) which gives different weight to the concentrations of the various haze species according to their ability to absorb or scatter light and expresses total extinction at the monitor for that day in inverse megameters ($Mm^{-1}$). Humidity and temperature affect the light extinction strength of some of species. The Haze Algorithm II incorporates these factors into the light extinction calculation, on each day of measurement, as the cold/wet and hot/dry seasons change in California, according to the location of the monitor. The Haze Algorithm II also accounts for Rayleigh scattering by natural gases which contribute a relatively small, constant amount to light extinction at each monitor. For the purpose of determining which haze species drive poor visibility on worst days, the "reconstructed" light extinction for the seven major haze species is used as an analysis tool rather than total extinction. That is because these haze species are the aerosol particles that need to be reduced to improve visibility.

Graphing light extinction for the haze species on the best and worst days shows which species have the most influence on impaired visibility at each monitor.

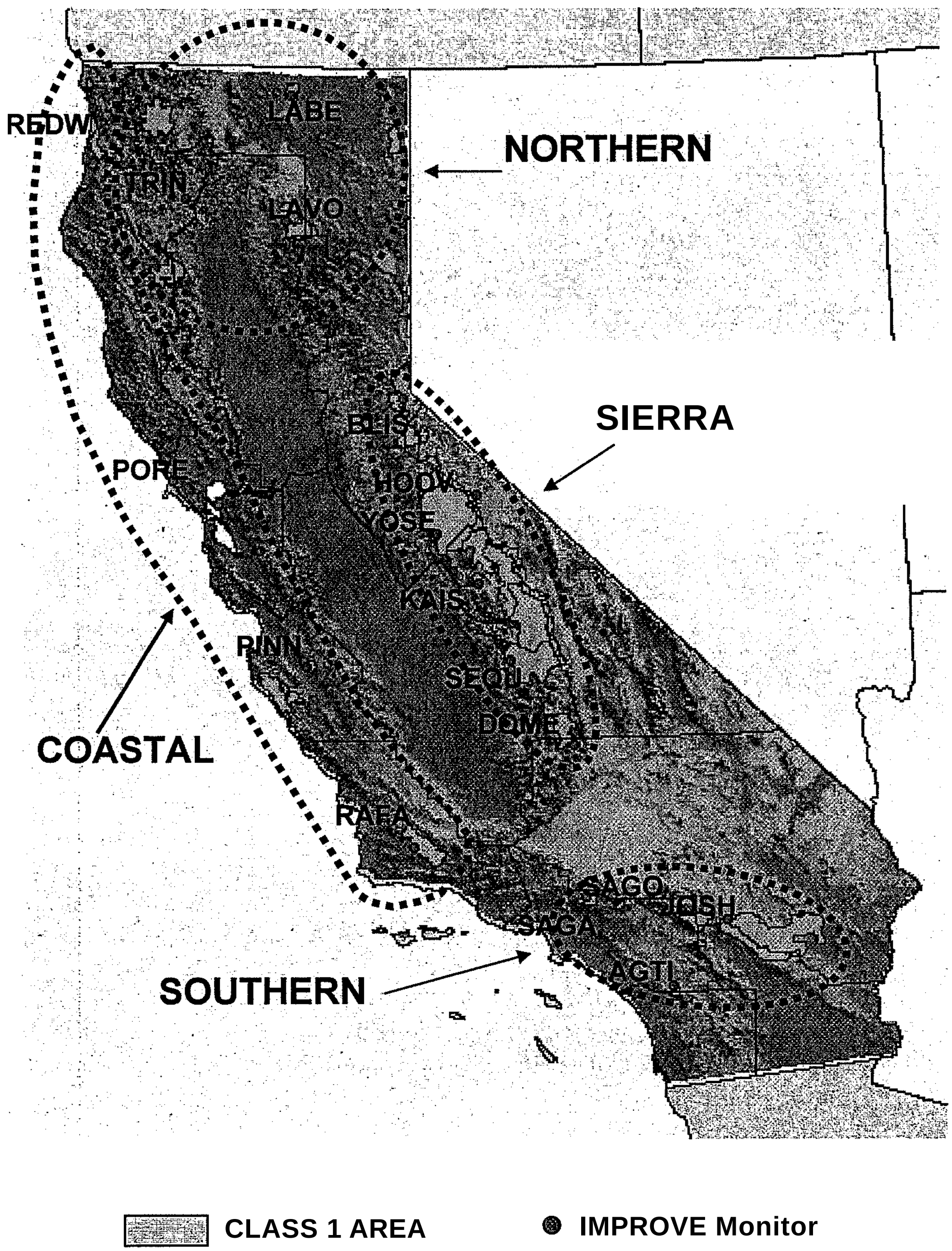
## 2.3 California's Geographic Sub-regions

California has 15 air basins bounded by physical features, such as topography, that impact local weather patterns and affect inter-basin transport of air pollutants. The four sub-regions for analysis of haze in California reflect consideration of these intra-State air basins as well as the jurisdiction of the thirty-five air districts with regulatory control over stationary sources within them. The haze species that serve as the main drivers of haze on worst days are generally the same for each sub-region because the topography and natural resources of each sub-region affect the way the surrounding areas developed. Factors such a"s urbanization level and interstate transportation corridors also play into the types of sources within each sub-region. Finally climate, humidity, vegetative cover, and precipitation patterns also influence which haze species predominate during the year. Therefore, the groupings are based on factors beyond simple geographic proximity.

In California, there are four collective geographic areas or sub-regions of the State with similar natural features, land uses, and population densities. Although data from each monitor is fully scrutinized in this Plan, and visibility conditions and Reasonable Progress Goals are determined for each Class 1 Area, using these sub-regions to compare and contrast characteristics reveals a coherent picture of the causes of haze in California. Through understanding the terrain and meteorology of the sub-regions; the impacts of local emissions can begin to be differentiated from long-range transport of emissions. Figure 2-1 represents the four different geographic sub-regions in CA, the Class 1 Areas that fit within them, and their corresponding IMPROVE monitor locations.

Even within the sub-regions there are variations on visibility conditions and what causes haze. However, for the most part, the main "driver" of haze, the species with the greatest contribution to light extinction on worst days, is the same. The relative abundance of these key drivers, as well as their seasonal variability, provides indications of the sources of haze in each SUb-region as discussed in this Chapter. In addition, Chapter 6 provides further-information through source apportionment analyses linking observed haze levels to specific source regions and source categories. The following sections describe the sub-regions. Summary data of reconstructed light extinction for the baseline worst days for the haze species at the IMPROVE monitors, broken down by geographic "areas, are also provided. More detailed information about each Class 1 Area can.be found in Appendix B.

**Figure 2-1 California's Geographic Sub-Regions**



### 2.3.1 Northern California

The Northern California' sub-region encompasses most of the Northeast Plateau Air Basin, the northeastern portion of the North Coast Air Basin, and the northern part of the Sacramento Valley Air Basin. The IMPROVE monitors in this sub-region are LABE (Lava Beds and South Warner Wilderness), LAVO (Lassen Volcanic National Park, Caribou Wilderness, and Thousand Lakes Wilderness), and TRIN (Marble Mountain Wilderness and Yolla Bolly-Middle Eel Wilderness). Emission sources are primarily from rural land uses as there are few small cities and towns. However, the 1-5 corridor has considerable traffic, particularly truck traffic. Major rail freight corridors also pass through the region.

Figure 2-2 depicts the average haze species makeup on the worst days during the 2000-2004 baseline period at each IMPROVE site in the Northern California region. The baseline days with the worst air quality are dominated by organic aerosols. Figure 2-3 illustrates the seasonal nature of the species that contribute to haze at Lassen Volcanic National Park in 2002. Organic aerosols peak during the summer months. Evaluation of this data has shown a strong correlation with the incidence of wildfires. For example, in 2002, the Biscuit Fire burned nearly 500,000 acres in the Siskiyou National Forest in the states of Oregon and California. Figure 2-4 provides a satellite image of the Biscuit Fire in 2002 highlighting the broad regional extent of smoke from this fire which impacted Class 1 Areas throughout much of Northern California. Smoke from the smaller Umpqua Complex Area Fires northwest of Crater Lake in Oregon also impaired visibility in both states. In addition to wildfires, natural biogenic emissions from plants play an important role in contributing to elevated organic aerosol levels observed during'the spring and summer months.

Figure 2-2 Baseline Conditions for 20 Percent Worst Days: Northern California

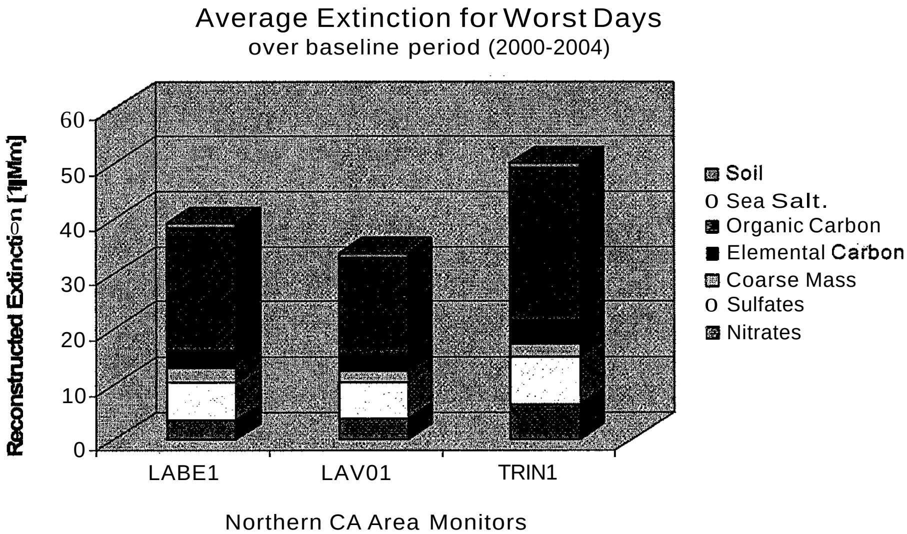



Figure 2-3 Seasonal Variation in Haze Species at Lassen Volcanic NP in 2002

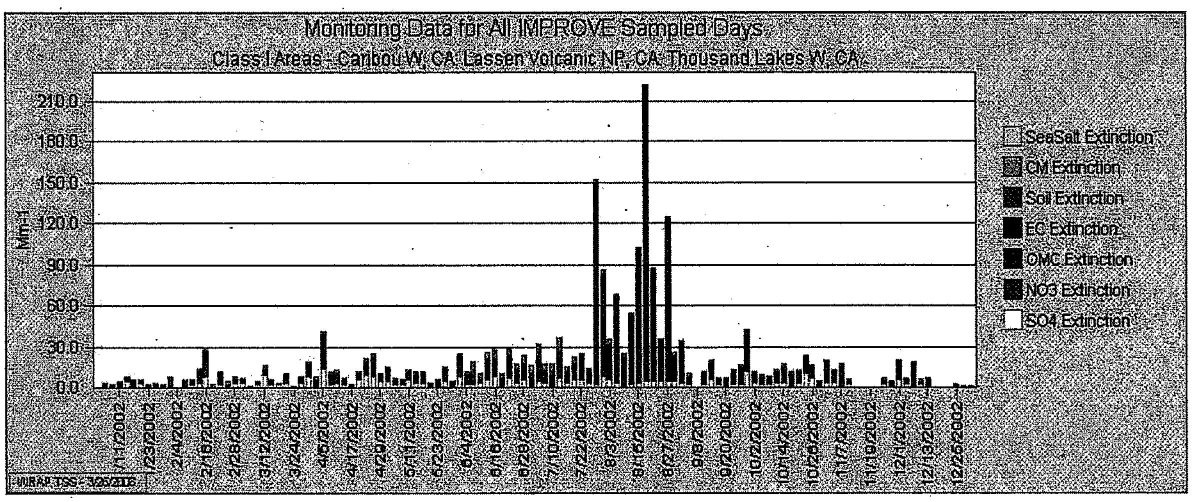
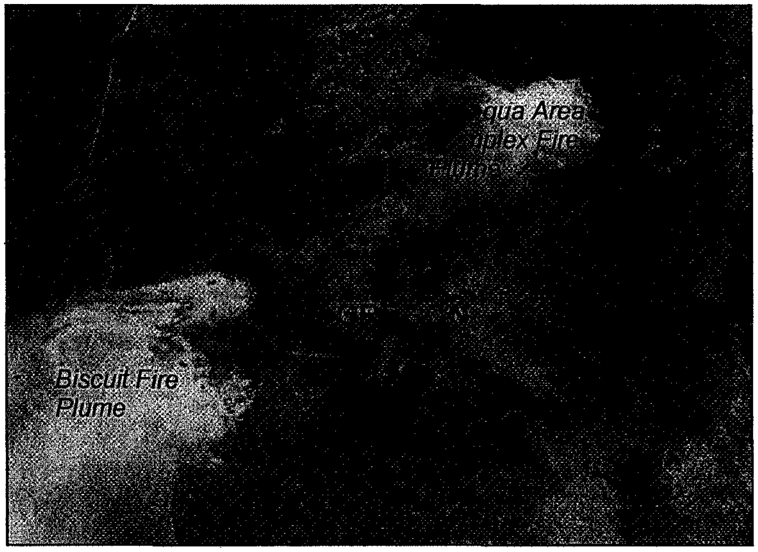


Figure **2-4** **Smoke Impacts from the 2002 Biscuit Fire in Siskiyou National Forest**




### *2.3.2* ***Sierra California***

The Sierra sub-region of California encompasses the Sierra Nevada Mountains and foothills, from the Mountain Counties Air Basin, the Lake Tahoe Air Basin, the northern portion of the Great Basin Valleys, and the eastern part of the San Joaquin Valley Air Basin. The IMPROVE monitors representing the Sierra Nevada region are BUS (Desolation Wilderness and Mokelumne Wilderness) , HOOV (Hoover Wilderness), YOSE (Yosemite National Park and Emigrant Wilderness), KAIS (Ansel Adams Wilderness, Kaiser Wilderness, and John Muir Wilderness), SEQU (Sequoia National Park and Kings Canyon National Park), and DOME(Dome Lands Wilderness). Emissions are primarily from forest biogenic sources, wildfires, transport from the Central Valley, and from the highway and major rail transportation corridors through the mountains.

Figure 2-5 depicts the average haze species makeup on the worst days during the 2000-2004 baseline period at each IMPROVE site in the Sierra sub-region. As with the far Northern California region, the baseline days with the worst air quality are dominated by organic aerosols, with the majority coming from wildfire smoke and biogenic forest emissions. Sulfates and nitrates are also high on the worst case days in the Sierra sub-region, particularly at the SEQU monitor. Figure 2-6 illustrates the seasonal variations in the species that contribute to haze at Sequoia National Park. Nitrate peaks in the winter months, similar to the seasonal variability observed within the San Joaquin Valley. Because the SEQU monitor is at 519 meters, it is exposed to urban, agricUlture, and transportation corridor emissions from the San Joaquin Valley to the west of the Park. As a result, the SEQU monitor represents the highest aerosol concentrations and most severe visibility impacts with.in the Glass 1 Areas. Other sites in the Sierra sub-region are at a higher elevation and therefore experience more limited impacts from the San Joaquin Valley, and corresponding greater impacts from wildfires and biogenic emissions, which peak during the summer months.

Figure 2-5 Baseline Conditions for 20 Percent Worst Days: Sierra California

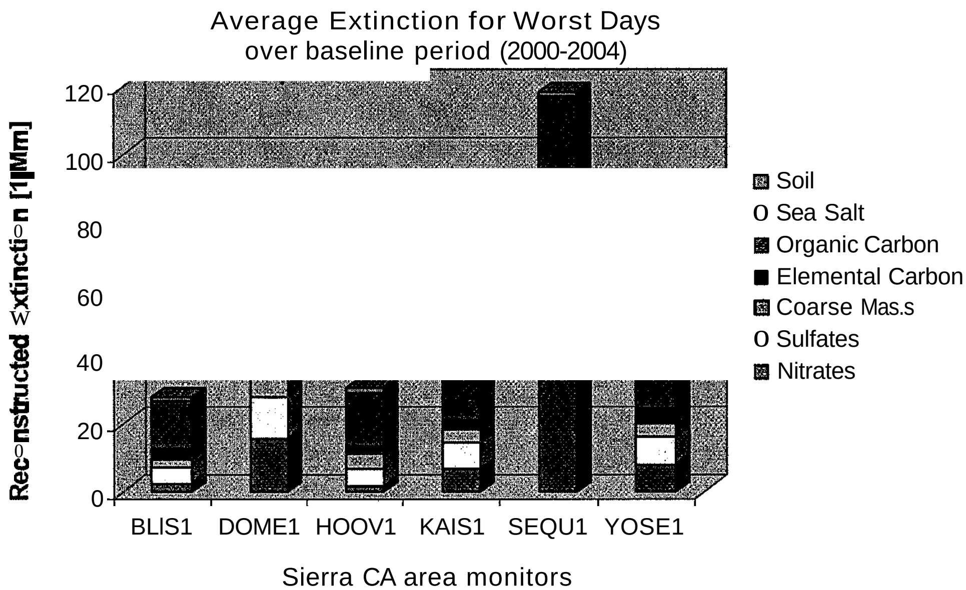
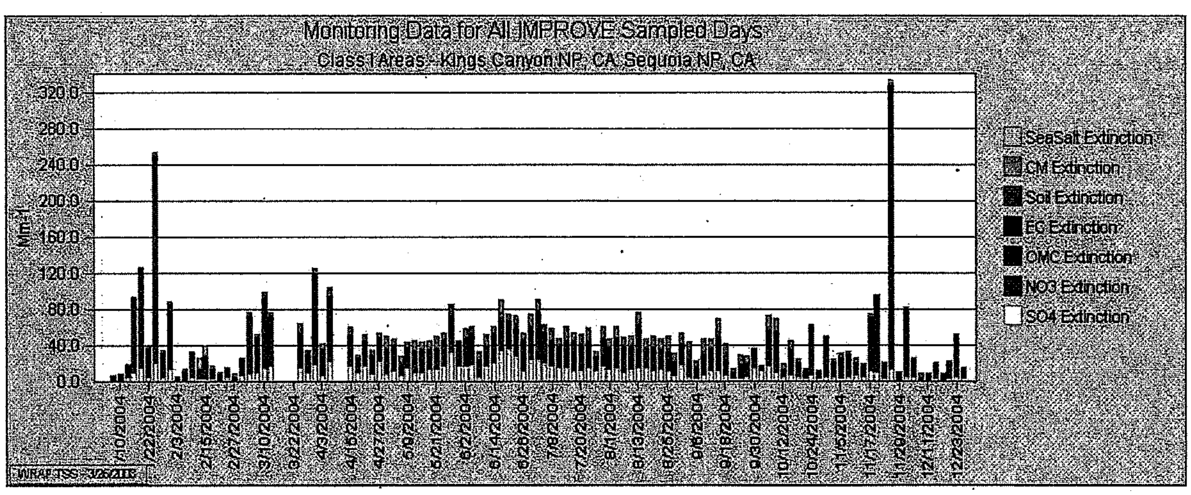



Figure.2-6 Seasonal Variation in Haze Species at Sequoia 2004



### 2.3.3. *Southern California*

The Southern California sub-region includes the South Coast Air Basin, the northern portion' of the Salton Sea Air Basin, and the central and western portions of the Mojave Desert Air Basin. The IMPROVE monitors representing the Southern California sUb-region are AGTI (Agua Tibia), SAGA (San Gabriel ,Wilderness and Cucamonga Wildemess), JOSH (Joshua Tree National Park), and SAGO (San Gorgonio Wilderness and San Jacinto Wilderness). These areas are located generally downwind of the South Coast Air Basin and therefore, upwind urban emissions are key sources of haze. Emissions from offshore shipping and international transport are also important. '

Figure 2-7 depicts the average haze species makeup on the worst days during the 2000-2004 baseline period at each IMPROVE site in the Southern California sub-region. The sites in Southern California have some of the most impaired visibility in the'State, with the largest contribution to haze coming from nitrate. Sulfates and organic carbon are also contributors. Due to their proximity to the urban areas of southern California and general transport patterns, urban sources are a major contributor to haze at all of these sites. ,Elevated sulfate contributions at Agua Tibia in part reflect the fact that this site is closer to the coast, with corresponding impacts from both offshore shipping emissions, as well as natural marine sources of sulfate. It is also the Class 1 Area closest to Mexico and tracer analysis show that AGTI receives the largest impact from Mexican stationary and area source SOx emissions of all the IMPROVE monitors in California. Figure 2-8 depicts the seasonal variation in haze species at San Gorgonio Wilderness. Unlike other areas of the State, there is less of a pronounced seasonal pattern to individual haze species contributions, with high nitrate concentrations occurring throughout the year. Sulfate,contributions are slightly higher during the summer months due to greater photochemical' production during this time of year. Organic carbon contributions are also slightly higher during the summer, likely reflecting some impacts from wildfires and biogenic sources.

Figure 2-7 Baseline Conditions for 20 Percent Worst Days: Southern California

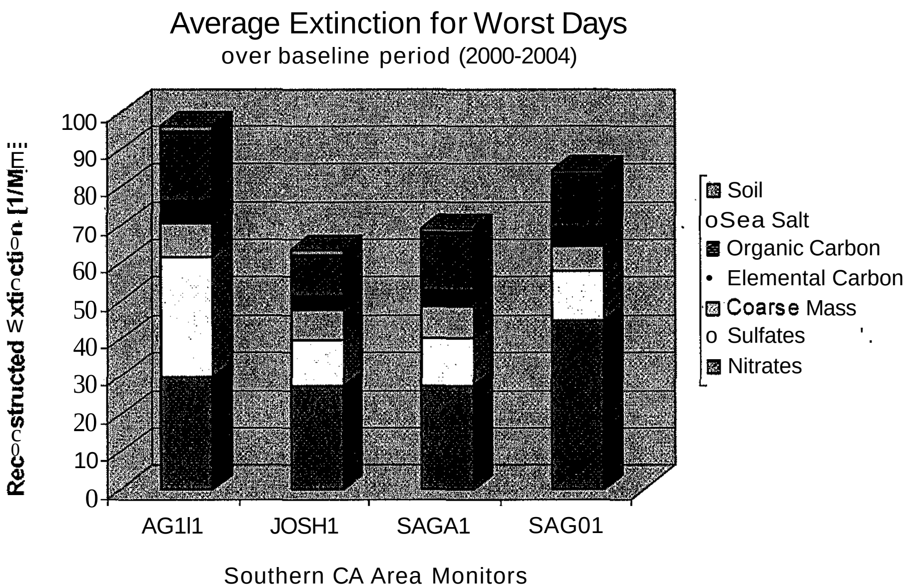
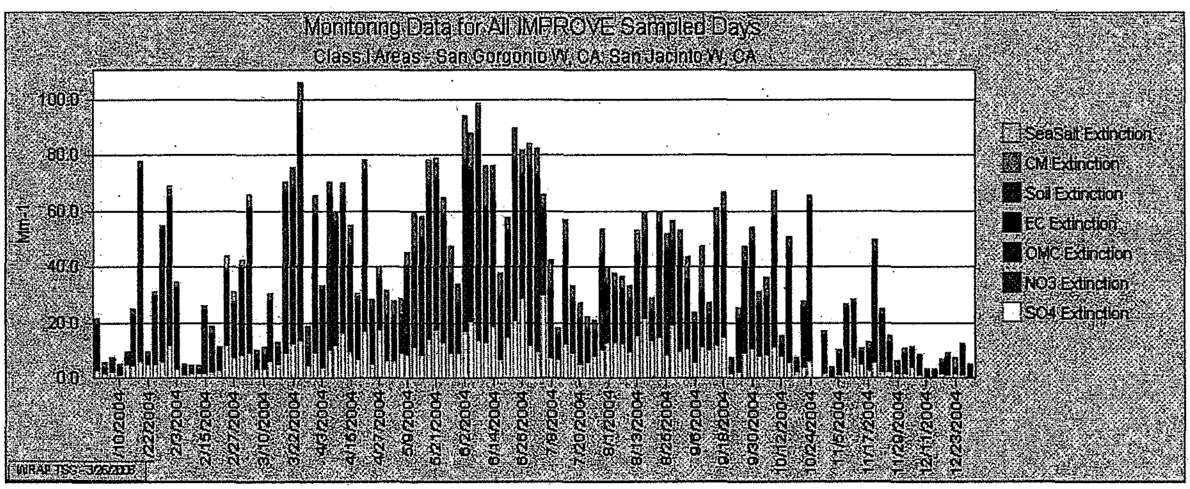



Figure 2-8 Seasonal Variation in Haze Species at San Gorgonio 2004'

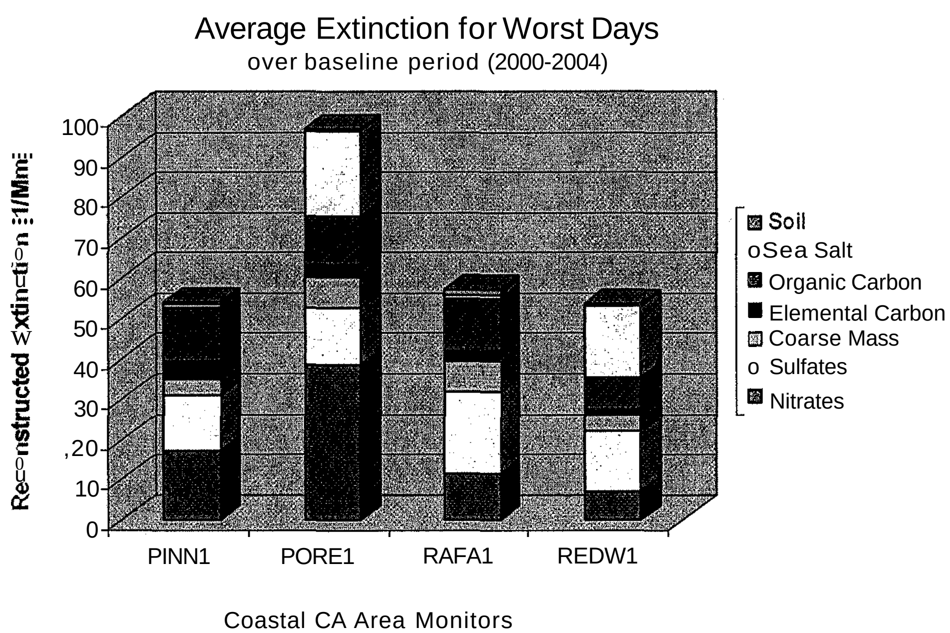


### *2.3.4 Coastal California*

The Coastal.sub":region is represented by the IMPROVE monitors close to the Pacific Ocean coastline. Based on population density and climate, there are actually several sub-areas in this California sub-region. The northern tip encompasses the coastal regions of the North Coast Air Basin, effectively separated from far northern inland California by the Trinity Alps. The San Francisco Bay Area Air Basin around Point Reyes, and the Central Coast Air Basins from Monterey to Ventura include Class 1 Areas with similar exposure to emissions species from oceanic and coastal sources, both offshore, and from urban and agricultural uses along the coast. In general, the IMPROVE monitors representing the Coastal California region are REDW (Redwoods National Park), PORE (Point Reyes National Seashore), PINN (Pinnacles Wilderness and Ventana Wilderness), and RAFA (San Rafael Wilderness).

Figure 2-9 depicts the average haze species makeup on the worst days during the 2000-2004 baseline period at each IMPROVE site in the Coastal sub-region. Contributions on the worst days come from sulfates, nitrates, and sea salt. Point Reyes has higher nitrate concentrations as compared to the other coastal monitors. This is partly because of its location close to a significant metropolitan area, immediately southeast of the IMPROVE monitor and because the monitor is downwind, and within a few nautical miles, of a major commercial shipping lane. The sea salt contribution is especially pronounced at REDW and PORE because these two sites are located within 10 km of the coastline, at elevations close to sea level. In contrast, both PINN and RAFA are located further inland, with a lesser influence from sea salt on worst days than on best days. Sea salt is a natural contributor to haze, and as explained earlier in this section will remain constant in the future, resulting in higher natural conditions at these sites as compared to sites further inland.

Figure2..g Baseline Conditions for 20 Percent Worst Days: Coastal California'




The pattern of sulfate concentration measured at the monitors throughout the year is similar at all the IMPROVE monitors in California. It increases slightly mid-year compared with slightly lower levels during the winter months. Compared with the other sub-regions, the contribution to light extinction from sulfates is generally higher at the coastal sites. Sulfates are the key driver of haze on worst days at the coastal monitors, except on winter worst days at Point Reyes when' nitrates predominate.

Figure 2-10 is an example of the seasonal variation of haze species at Redwoods National Park. High sea salt contributions can occur throughout the year. Sulfate, as in other areas, tends to peak during the summer months. Figure 2-11 depicts the seasonal variation in haze species at Point Reyes for comparison purposes as this site displays a distinctly different pattern. Sulfate contributions are fairly similar across the year. Sea salt contributions also show little variability, consistent with the prevailing onshore wind patterns. However, nitrate contributions exhibit a strong wintertime peak. During the winter months, nitrate concentrations build up in the Bay Area under offshore wind patterns, likely leading to the higher observed nitrate contributions at Point Reyes.

**Figure 2-10 Seasonal Variation in Haze Species at Redwoods in 2004**

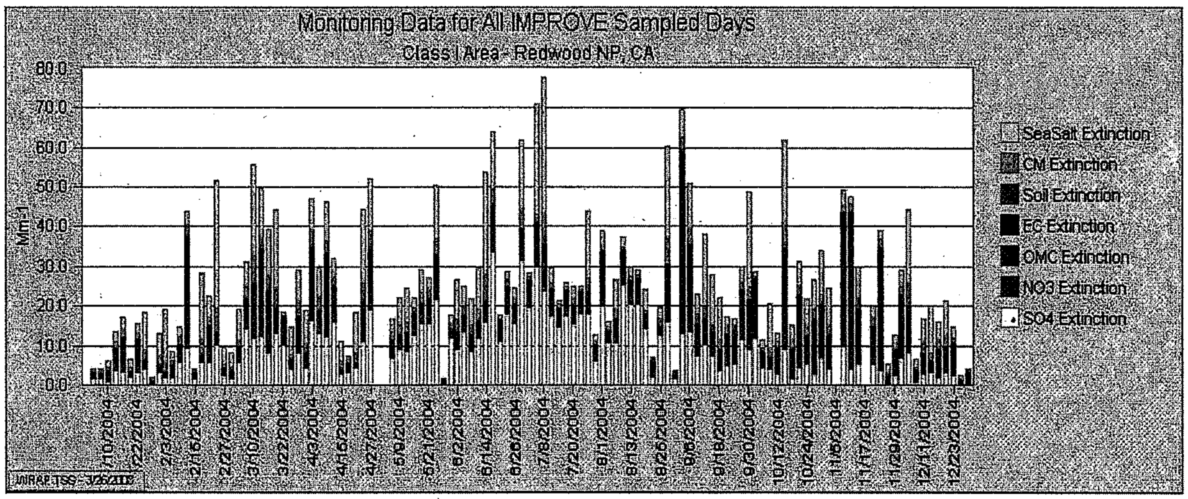
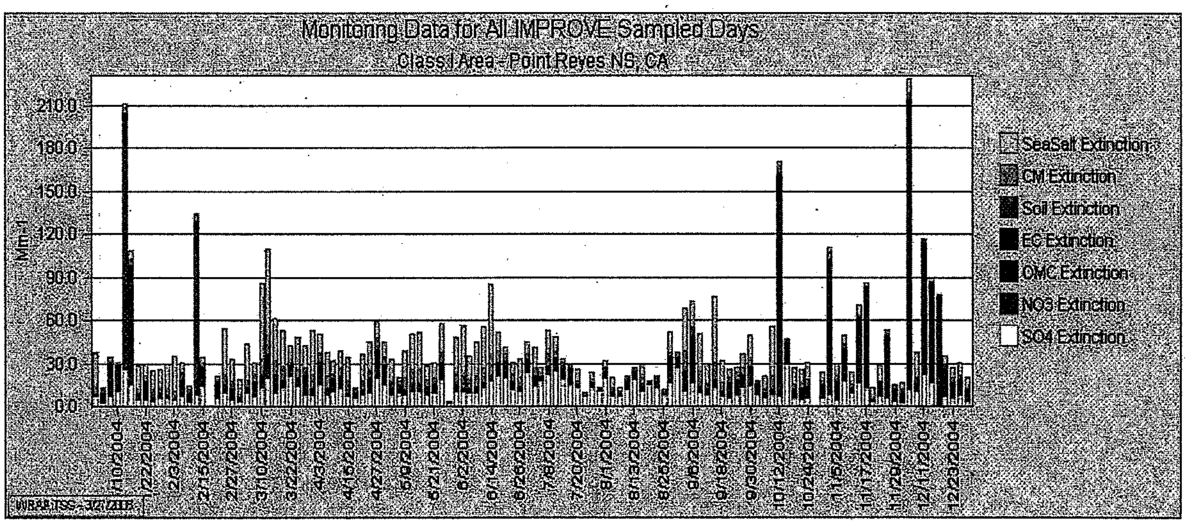



**Figure 2-11 Seasonal Variation in Haze Species at Point Reyes in 2004**



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# 3. EMISSIONS INVENTORY

## 3.1 Background

The ARB, in conjunction with local air districts, develops and maintains a Statewide inventory of emission sources. Because a regional modeling effort was conducted for the Plan, the Western Regional Air Partnership (WRAP), in coordination with the fifteen western states, developed a multi-state emissions inventory to support this work. This inventory was developed for 2002, reflecting' the mid;.point of the 2000-2004 baseline period. The WRAP 2002 planning inventory includes ARB's submission to the National Emission Inventory (2002 NEI), which reflects rules adopted through 2004. This inventory was then projected to 2018 using information on the growth and control of source categories. For regional continuity on a number of source categories which are primarily of natural origin, and which occur similarly throughout the region, WRAP developed new estimates for sources such as biogenic (plant) emissions, wildfires, and windblown dust.

The WRAP inventory is therefore slightly different from ARB's and does not include several recent updates that the ARB has made since the 2002 NEI submittal. Specifically, ARB recently updated California's mobile source inventory to reflect the impacts of new control measures, new vehicle emission factors, and updated vehicle activity estimates. Nevertheless, the WRAP inventory provides an appropriate regionally consistent basis for this Plan, and ARB updates will be incorporated in subsequent Plan revisions. Information on the WRAP inventory can be found at http://www.wrapedms.org.

## 3.2 Pollutants Addressed

The emissions inventory used for the Plan begins with the same inventory of criteria pollutants Qr health-impacting pollutants that is used in planning efforts to meet the National Ambient Air Quality Standards (NMQS). The sources can be from both natural and anthropogenic activities.

Emissions that contribute to impairing visibility include sulfur oxides (SOx), nitrogen oxides (NOx), particulate matter (PM), both PM10 and PM2.5, volatile organic compounds (VOC), and .ammonia (NH3). Not all of these contribute directly to the development of haze, but may undergo chemical reactions in the atmosphere to become haze components. The most pertinent of these species are noted below:·

Oxides of Nitrogen (NOx). Fuel combustion is the primary source of nitrogen oxide emissions in the atmosphere. The vast majority of Statewide NOx emissions come from mobile sources. Combustion processes from stationary industrial sources, such as manufacturing, food processing, electric utilities, and petroleum refining, also contribute, with smaller contributions from area-wide sources, such as waste burning and residential fuel consumption. Natural sources; primarily from wildfires, are not a major source of emissions. Nitrate particles, formed when nitrogen oxides react in the atmosphere, particularly with ammonia, are very effective at scattering light and contributing to haze formation.

Oxides of Sulfur (SOx). The mobile source categories of ships and commercial boats are the primary sources of sulfur oxide emissions along the coastline of California. These sources are not included in the California emission totals, but rather are included in a separate Pacific Offshore category developed by the WRAP. Other significant sources include petroleum refining, locomotives, mining, and cement manufacturing. Wildfire emissions, while a source of SOx, are not significant. Sulfate particles are generally formed when sulfur oxides interact with ammonia in the atmosphere. Similar to nitrate, sulfate particles are effective as scattering light and contributing to haze.

Particulate Matter (PM). PM10, also known as Respirable Particulate Matter, is comprised of both Coarse and Fine PM. PM Coarse, the fraction of PM10 larger than 2.5 and smaller than 10 micrometers in diameter, is primarily emitted from activities that suspend dust in the atmosphere, such as traffic on paved and unpaved roads, farming, and construction, as well as windblown dust.

Fine particulate matter, PM2.5 or PM Fine, is directly emitted into the atmosphere in the form of smoke, soot, and dust particles. These particles come from sources as diverse as mobile sources, managed and agricultural burning and residential fireplaces. Natural sources of PM include wildfires and biogenics (plant and animal matter). Sub-categories of Fine PM include Organic (OC) and elemental (EC) carbon particles, both directly emitted into the atmosphere, primarily through combustion processes. The remaining Fine PM comes primarily from dust and other non-combustion activities.

Volatile Organic Compounds (VQe). Incomplete fuel combustion and the evaporation of chemical solvents and fuels contribute to the presence of volatile organic compounds in the atmosphere. These gases are also emitted from natural, biogenic, sources such as plants and trees. VOCs can react and condense in the atmosphere to form organic aerosols which can then contribute to visibility impairment.

Ammonia (NH3). Mobile sources contribute only a small amount of the ammonia in the atmosphere. Most emissions are from livestock operations and fertilizer applications. Natural biogenic sources such as soil and vegetation contribute almost as much ammonia to the atmosphere as livestock operations (about 40 percent). Ammonia can combine with oxides of sulfur and nitrogen in the atmosphere to form ammonium sulfates and ammonium nitrates.

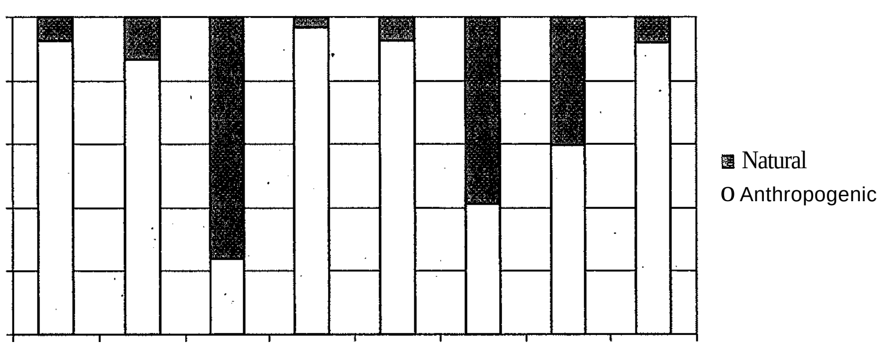
## ·3.3 Statewide Inventorv

The overall emissions inventory for the State of California for the 2002 base year is shown in Table 3·1 and Figure 3-1. Statewide, natural, biogenic sources account for a large portion of the emissions for several pollutants such as VOCs, Fine PM, OC, and EC. Biogenics are the largest contributor to natural VOe emissions, while wildfires account for the majority of Fine OC and EC natural emissions. As will be discussed in subsequent chapters, understanding the contributions from natural versus anthropogenic emissions will be important in assessing the level of improvement in future visibility that can be expected to occur. More detailed emissions inventory on a sub-regional basis can be found in Appendix I.

Table 3-1 Overall Emission Source Inventory (Anthropogenic versus Natural Sources)

| | Source· Plan 02c (tonslyear) | |
|---|---|---|
| Species | Anthropogenic | Natural |
| NOx | 1,127,359 | 93,043 |
| S02 | 62,954 | 9,840 |
| VOC | 908,151 | 2,890,198 |
| NH3 | 225,157 | 7,595 |
| PM Coarse | 279,148 | 23,124 |
| OC Fine PM | 64,491 | 92,097 |
| EC Fine PM | 28,397 | 19,078 |
| Other PM'Fine | 67,667 | 5,880 |

Figure 3-1 2002 Magnitude ofAnthropo.genic versus Natural Sources



## 3.4 Emissions Categories

The WRAP inventory for California includes both natural and anthropogenic sources. Anthropogenic sources are composed of the three major categories below:

- Stationary Sources - sources which can be identified by name and location, such as general industrial facilities.
  - Stationary sources in the WRAP inventory are noted as Point Sources.
- Area-wide Sources - sources that cannot be tied to a single location, such as consumer products and dust from unpaved roads, or small individual sources, such as residential fireplaces.
  - Area sources in the WRAP inventory include the following categories: Area, Road Dust, Fugitive Dust, Wind Blown Dust, and Anthropogenic Fire.
- Mobile Sources - sources that use roads to move from one location to another, such as on-road cars, trucks, buses, etc. Off-road mobile sources are those that move from one location to another, but not necessarily via roads, such as boats and ships, off-road recreational vehicles, aircraft, trains, portable industrial and construction equipment, farm equipment, and other easily moved equipment.
  - WRAP mobile source categories include: On-Road Mobile and Off-Road Mobile. Offshore California emissions are reported as part of a separate Pacific Offshore emissions category and are, therefore, not included here.

In addition, a fourth category addresses natural' emission sources:

- Natural·Sources - sources that are not directly human-caused (not anthropogenic) such as biological and geogenic sources, and wildfires.
  - WRAP natural source categories include: Natural Fire and Biogenics (plant emissions).

Table 3-2 provides a breakdown of the emissions of each pollutant into these key categories.

Table 3-2 Individual Pollutants and Source Categories

| | Stationary (tpy) | | Area (tpy) | | Mobile (tpy) | | Natural (tpy) | |
|---|---|---|---|---|---|---|---|---|
| Species | 2002 | 2018 | 2002· | 2018 | 2002 | 2018 | 2002 | 2018 |
| NOx | 104,991 | 109,514 | 112,988 | 112,789 | 909,380 | 370,385 | 93,043 | 93,043 |
| 802 | 42,227 | 49,632 | 9,139 | 10,134 | 11,588 | 3,800 | 9,840 | 9,840 |
| vac | 54,632 | 54,631 | 335,114 | 594,843 | 518,405 | 232,839 | 2,890,198 | 2,890,198 |
| NH3 | 433 | 0 | 202,045 | 193,486 | 22,679 | 30,430 | 7,595 | 7,595 |
| PM Coarse | 10,172 | 13,700 | 263,902 | 291,429 | 5,075 | 6,389 | 23,124 | 23,124 |
| Fine PMOC | 5,515 | 3,696 | 44,986 | 36,777 | 13,991 | 15,834 | 92,097 | 92,097 |
| Fine PM EC | 933 | 835 | 5,887 | 5,503 | 21,577 | 12,589 | 19,078 | 19,078 |
| Other PM Fine | 10,537 | 12,317 | 55,005 | 54,016 | 2,125 | 2,929 | 5,880 | 5,880 |

Mobile sources, both on-road and off-road, account for the majority of NOx emissions, approximately 70 percent, with almost 50 percent from on-road and over 20 percent from off-road sources. The mobile source contribution, however, decreases significantly by 2018 with overall NOx emissions dropping by nearly 44 percent. Natural sources contribute less than 10 percent.

Sulfur Dioxide, the most common form of the sulfur oxides, is primarily from , anthropogenic stationary/point sources; this is expected to increase slightly by 2018. A little over 10 percent is contributed by biogenic sources. Stringent motor vehicle emissions' regulations will decrease the contribution·from mobile sources significantly, almost 70 percent by 2018, particularly in the off-road category.

Biogenic sources, consisting of plants, crops; and trees, account for 80 percent of Volatile Organic Compound emissions. This natural emission source is expected to remain constant. Total emissions from anthropogenic sources is' expected to decrease, due primarily to mobile source controls.

Ammonia is dominated by area sources,. primarily livestock operations, with very little contribution from natural sources.. Area' sources of ammonia are expected to decrease 4 percent by 2018.

The sources of coarse PM (PM larger than PM2.5 and smaller than PM10) are dominated by fugitive dust sources such as windblown dust and emissions from paved and unpaved roads. Natural contributions are slight and are expected to remain constant. Coarse PM emissions are expected to increase in most other source categories due to popUlation growth.

Fine PM (PM2.5) can be further broken into sub-categories including OC and EC. OC and EC are emitted directly into the atmosphere from combustion sources such as wood burning, mobile sources, and commercial cooking.· The primary source of OC and EC are natural fires and these are expected to remain relatively constant. However, mobile source EC decreases significantly in 2018 due to the effects of California's diesel control program. The remaining portion of Fine PM, or Other Fine PM, is primarily derived from area sources, particularly fugitive dust source categories.

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# 4. CALIFORNIA 2018 PROGRESS STRATEGY·

## 4.1. Introduction

The Regional Haze Rule requires states to submit a long-term strategy that addresses regional haze visibility impairment for the Class 1 Areas impacted by the emissions from that state. This 2018 Progress Strategy reflects the measures which are included in setting California's reasonable progress goals for the first progress period. .The Rule requires that a state's strategy consider emission reductions from on-going control programs as well as specifically consider construction activity mitigation, source retirement.and replacement, and smoke management techniques. Due to the severity of our air quality problems, California has long-standing programs to reduce emissions that comprehensively address all of these aspects. While the driver for California's control efforts has been to meet national and State air quality standards and protect public health, the emission reductions achieved also provide significant benefits for visibility. It is within the context of these broader air quality efforts that California is setting our Visibility Progress Strategy for the first progress period ending in 2018.

California's 2018 Progress Strategy includes ARB, local air district, and U.S. EPA adopted control measures. Based on a recently updated inventory, between 2002 and 2018, NOx emissions and mobile source PM2.5 go down over· 40 percent and 37 percent, respectively, Statewide. These reductions come primarily from ARB's mobile source control program. ARB's aggressive and innovative control measures, which go far beyond federal requirements, define a 'comprehensive and long-term basis for setting the reasonable progress goals. These measures address the main constituents of California's visibility problem, NOx, SOx, and directly emitted particulate matter emissions, and will have a very significant impact on improving visibility between now and 2018 in all Class 1 Areas throughout the State, as well as areas outside the State that may be impacted by California emissions.

. ARB is responsible for controlling emissions from mobile sources (except where federal law preempts ARB's authority) and consumer products, developing fuel specifications, establishing gasoline vapor recovery standards and certifying vapor recovery systems, providing technical support to the districts, and overseeing local district compliance with State and federal law. The Department .of Pesticide Regulation is responsible for control of agricultural, commercial and structural pesticides, while the Bureau of Automotive Repair runs the State's .Smog Check programs to identify and repair polluting cars'on a regular basis.

Local air districts are primarily responsible for controlling emissions from stationary and areawide sources (with the exception of consumer products) through rules and permitting programs. Examples include industrial sources like. factories, refineries, and power plants; commercial sources like gas stations, dry cleaners, and paint spray booth operations; residential sources like fireplaces, water heaters, and house paints; and miscellaneous non-mobile sources like emergency generators. Districts also inspect and test fuel vapor recovery systems to check that such systems are operating as certified.

U.S. EPA has the authority to control emissions from mobile sources, including sources all or partly under exclusive federal jurisdiction (like interstate trucks, some farm and construction equipment, aircraft, marine vessels, and locomotives based in this country). U.S. EPA also has oversight authority for State air programs as they relate to the federal Clean Air Act. International organizations develop standards for aircraft and marine vessels that operate outside the U.S. Federal agencies have the lead role in representing the U.S. in the process of developing international standards. The following sections describe the comprehensive suite of measures that comprise the 2018 Progress Strategy for California.

## 4.2 ARB Control Programs in 2018 Progress Strategy

Statewide, motor vehicle emissions contribute significantly to visibility impairment. For over four decades, ARB has been regulating automotive emissions. Due the severity of the ajr quality problem in California, ARB has some of the strictest control strategies in the nation. Adopted SIP measures have been developed over the years through the combined efforts of air pollution regulators - with a foundation of ARB's mobile source and fuels programs. ARB has adopted 46 emission-reducing control measures since the approval of the 1994 1-hour ozone Sip. The key focus areas of ARB's control measures are described below.

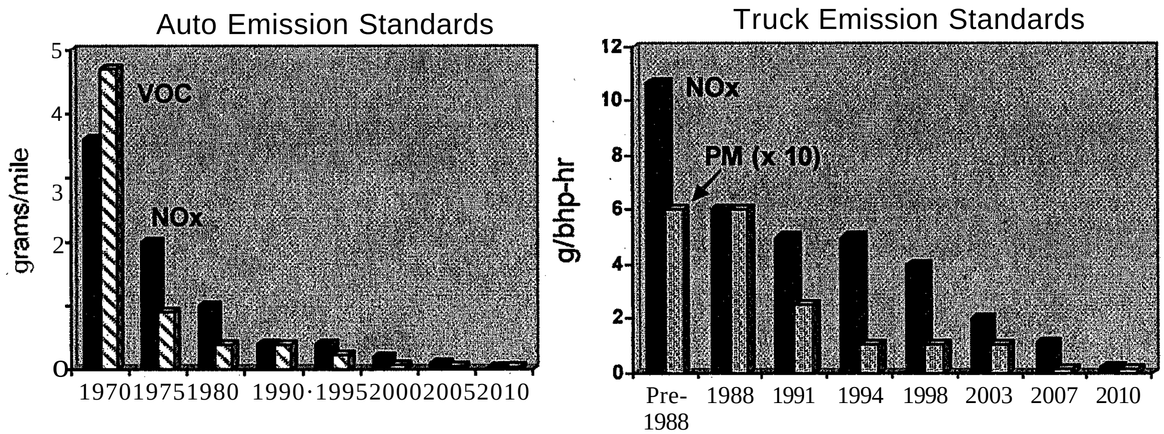
### *4.2.1 Mobile Sources*

#### Cleaner Engines and Fuels

More than any other pollution control effort, ARB's mobile source program has moved the State's nonattainment areas closer to meeting federal air quality standards. California's ability to adopt vehicle emission standards that are more stringent than national standards has been fundamental to this success. The mobile sector continues to be the heart of the attainment effort with a new focus on vehicles and equipment already in use - the "legacy" or in-use fleet. California has dramatically tightened emission standards for on-road and off-road mobile sources and the fuels that power them. Figure 4-1 and Table 4-1, on the next page, show how dramatically the adopted measures have controlled emissions from new engines for the major categories of mobile sources.

California has led the way in adopting stringent regulations for passenger vehicles. Compared to uncontrolled vehicles, cars are now 99 percent cleaner. A new 1965 car produced about 2,000 pounds of ozone-forming VOC emissions during 100,000 miles of driving. In addition, to controlling vehicles, California has also led the way in reducing smog forming emissions from gasoline. Reformulated gasoline has reduced smog-forming emissions by 15 percent and toxic air emissions by 40 percent. Overall, California's low-emission standards, coupled with reformulated gasol.ine, have cut that to less than 50 pounds for the average new car today. By 2010, California's standards will further reduce VOC emissions from the average new 2010 car to approximately 10 pounds.

Figure 4-1 California Emission Standards




ARB's first diesel engine regulations went into effect in 1988. Significant gains began with the introduction of California Clean Diesel fuel in 1993. Clean Diesel Fuel significantly reduced PM and sax. U.S. EPA and ARB worked together to develop and adopt the next phases of on-road diesel engine control, with cleaner fue.l in 2006 and even cleaner engines in 2007 that will reduce per-truck particulate matter emissions by another 90 percent. By 201 0, new trucks will be 98 percent cleaner than new pre-1988 models, providing needed NOx reductions.

**Table 4-1 Impact of Existing Standards and Emission Limits**

| Source | Controlled Since | Level of Control* |
|---|---|---|
| **ON-ROAD** | | |
| *Passenger Cars* | 1966 | **99% in 2006 (VOC + NOx)** |
| *Trucks and Buses* | 1988 | **90% by 2007, 98% by 2010 (NOx) 98% by 2007 (PM)** |
| *Motorcycles* | 1975 | **88% by 2008 (VOC + NOx)** |
| **GOODS MOVEMENT** | | |
| *Ship Auxiliary Engines (fuel)* | 2000 | **96% (SOx), 83% (PM) by 2010** |
| *Locomotives* | 1973 | **60% in 2005 (VOC+NOx)** |
| *Harbor Craft* | | **50% in 2004 (NOx)** |
| *Cargo Handling Equipment* | | **95% by 2011-2012 (VOC+NOx, PM)** |
| **OFF-ROAD SOURCES** | | |
| *Large Off-Road Equipment* | 1996 | **98% by 2015 (VOC + NOx)** |
| *Personal Water Craft* | 1990 | **88% by 2010 (VOC)** |
| *Recreational Boats* | 1990 | **89% by 2010 (VOC)** |
| *Lawn & Garden Equipment* | 1990 | **82-90% by 2010 (VOC)** |
| **AREAWIDE SOURCES** | | |
| *Consumer Products* | 1989 | **50 categories controlled 50% (VOC)** |

* Level of emissions control compared to uncontrolled source.

Working in concert with the U.S. EPA, standards for goods movement sources have also been cut dramatica'lly. By requiring low-sulfur fuel, SOx emissions from ship auxiliary engines will be cut 96 percent by 2010. New locomotive engines are now 50-60 percent cleaner. Harbor craft emission standards were cut roughly in half. And new cargo handling equipment will be 95 percent cleaner by 2011.

California has also drastically lowered standards for off-road sources, from lawn and garden equipment, to recreational vehicles and boats, to construction equipment and other large off-road sources. From 2010 through 2014, these new off-road sources will be manufactured with 80-98 percent fewer emissions than their uncontrolled counterparts:

ARB. has worked closely with U.S. EPA to regulate large diesel, gasoline and liquid petroleum gas equipment – where authority is split between California and the federal government – and by 2014, new large off-road equipment will be 98 percent cleaner. ARB has 'also made great strides in reducing emissions from the smaller engines under State control, from lawn and garden eqUipment, to recreational vehicles and boats. From 2010 to 2015, these new off-road sources' will be manufactured with 82-90 percent fewer emissions than their uncontrolled counterparts.

Figure 4-2 Mobile Source Emissions in California

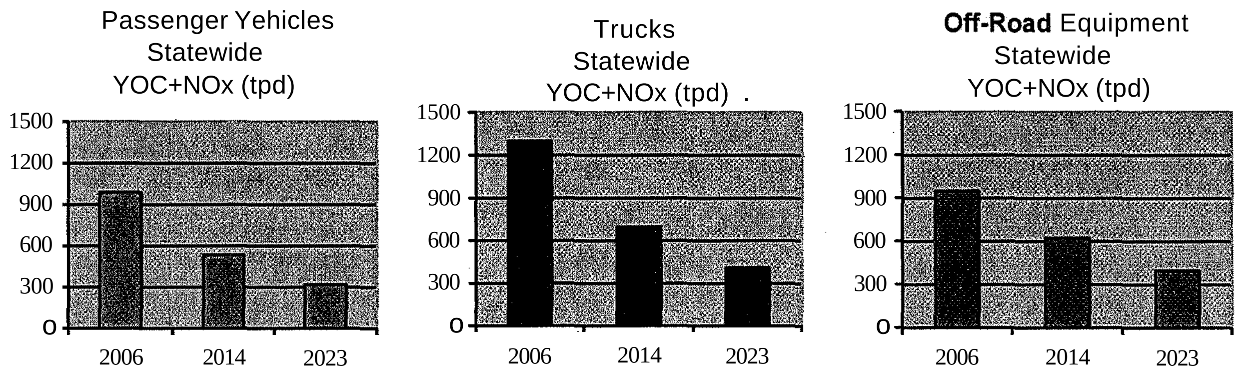
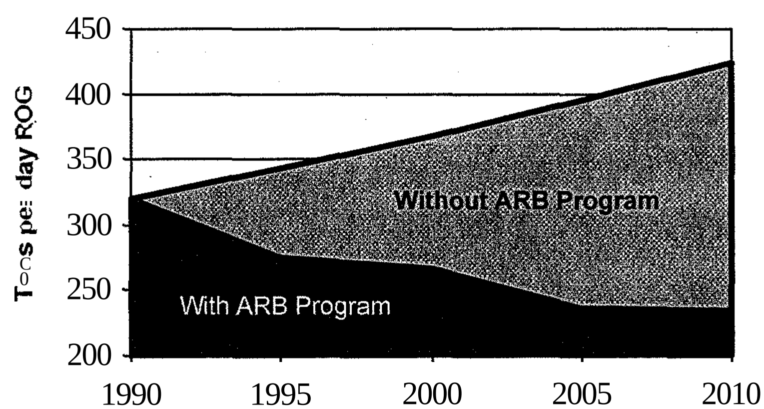



Figure 4-2 above clearly illustrates the benefits of adopted measures to reduce emissions from mobile sources despite significant population growth. The progress has been dramatic.

### *4.2.2 Consumer Products*

ARB has adopted standards to limit emissions from nearly 50 consumer product categories (such as hair sprays, deodorants, and cleaning compounds), as well as over 35 architectural coatings and aerosol paints categories. The Board has adopted and implemented voluntary provisions to offer greater compliance flexibility to consumer product manufacturers while retaining the air quality benefits. Without these actions, VOC emissions from these products would be roughly 60 percent greater in 2010.

Figure 4-3 Consumer Product Emissions in California



### *4.2.3 ARB Diesel Risk Reduction Plan*

An important source of directly emitted PM2.5 is diesel exhaust. The particulate matter from diesel-fueled engines (diesel PM) has been singled out as a particularly harmful pollutant and identified as a toxic air contaminant by ARB in 1998. Nearly 70 percent of the known cancer risk caused by air toxics is attributed to diesel PM. In 2000, ARB adopted a plan to reduce diesel PM emissions 85 percent by 2020, and has since adopted a number of regulatory measures to reduce diesel PM emissions Statewide. Additional measures are under development. Diesel PM control measures in the plan are reducing both direct diesel PM and NOx emissions through a combination of engine retrofits and replacements.

### *4.2.4 California Incentive Programs*

In recent years, regulatory programs have been supplemented with financial incentives to accelerate voluntary emission reductions. Incentive programs like the Carl Moyer Program are both popular and effective. They also help to demonstrate emerging technologies that then can be used to set a tougher emissions benchmark for regulatory requirements. Most of the existing incentive programs are designed to pay for the incremental cost between what is required by regulation and advanced technology that exceeds that level. The incentive programs are publicly funded through fees paid by California vehicle owners as part of their annual registrations, smog inspections or new tire purchases. California is currently investing up to $170 million per year to clean up older, higher emission sources.

The support for clean air incentive funding from Governor Schwarzenegger, the Legislature, and California's voting public is reflected in the passage on November 7, 2006, of the Highway Safety, Traffic Reduction, Air Quality, and Port Security Bond Act of 2006. The Bond Act includes $1 billion to accelerate the cleanup of air pollution caused by goods movement activities in California. Recently, ARB appropriated this money to fund emission reductions from activities related to the movement of freight along California's trade corridors. As with Carl Moyer, projects funded under this program must achieve emissions reductions not required by law or regulation.

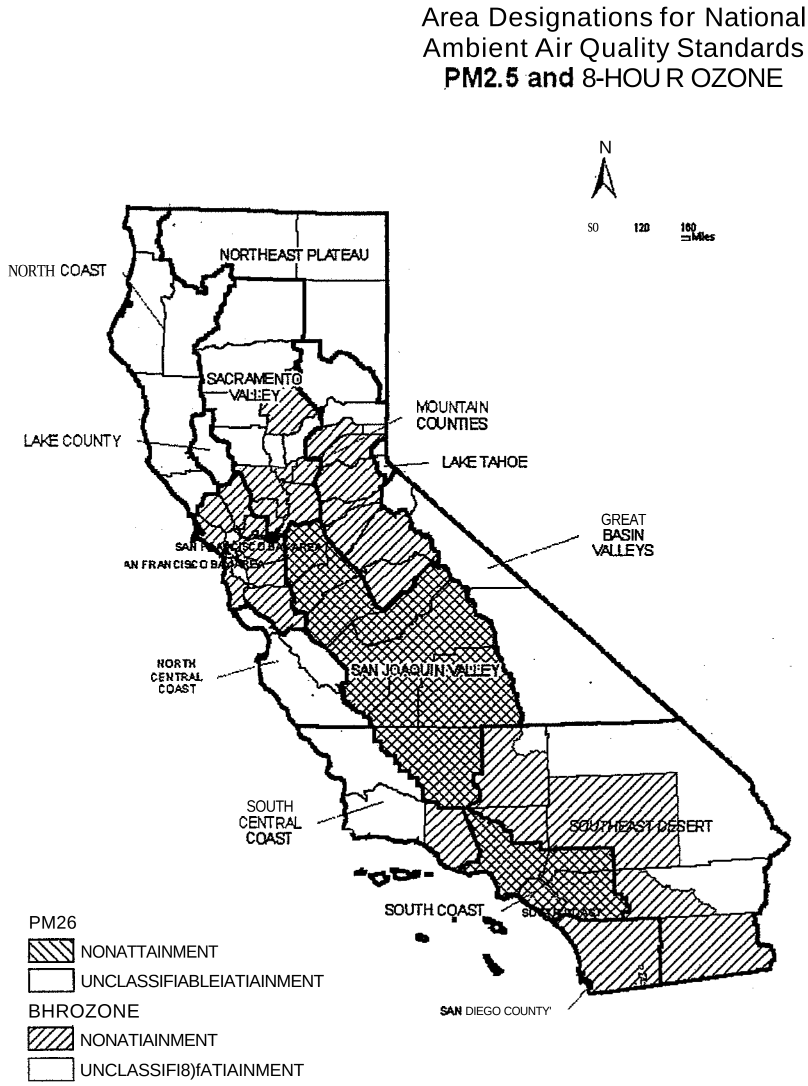
## 4.3 Local Air District Control Programs in 2018 Progress Strategy

Businesses in California are subject to the most stringent air quality rules in the country. In California, local air districts are responsible for controlling stationary source emissions. Limits on emissions from new sources are addressed through the New Source Review (NSR) program. Our stationary sources are subject to stringent NSR requirements because of ongoing needs to meet federal air quality standards. Local air districts have also adopted a number of innovative rules and programs over the years to help reduce emissions from existing stationary sources. Both the South Coast and the San Joaquin Valley set the benchmark for stationary source controls. For example, South Coast's innovative program, RECLAIM,' provides market incentives for companies to use the cleanest possible technologies. In addition, the San Joaquin Valley has adopted a first-of-its-kind indirect source rule that ensures that new developments bear their fair share of the pollution burden. Finally, ARB has over 50 suggested control strategies for stationary sources that many local air districts have adopted.

The reason California has such stringent controls is due to the vast amount of the State that is currently nonattainment for national ambient air quality standards. As $hown'in Figure 4-4, existing nonattainment areas cover most of the large urban areas in the State. In addition, the State is currently in the process of designating nonattainment areas for the new 8-hourozone and PM2.5 standards. These new areas potentially include portions of the South Central Coast, Sacramento Valley, and Great Basin Valleys for 8-hour ozone and the San Francisco Bay Area and portions of the Sacramento Valley for PM2.5. Taken together, California's federal nonattainment areas comprise a substantial portion of the State and corresponding Statewide emissions.

In context to the rest of the nation, California reviewed the top 10 facilities in the State for NOx and SOx emissions. For NOx, the facilities are located in the Mojave Desert, Kern County, and the San Francisco Bay Area. On a national level comparison, California's highest emitting NOx-emitting facilities are well controlled with our largest facility ranking 385 nationally. These facilities are all located in federal 8-hour ozone nonattainment areas which are required to have reasonably available control technologies (RACT) on all large facilities. For SOx, the facilities are located in the San Francisco Bay Area, South Coast region, Kern County, San Luis Obispo County, and Santa Barbara County. On a national level, California's largest SOx facility is ranked 469 and is located in the San Francisco Bay Area, a future PM2.5 nonattainment area which will be subject to RACT requirements. Thus, on a national basis, California facilities are lower emitting and are subject to multiple federal requirements ensuring their emissions are well controlled.

**Figure** 4-4 Ozone and PM2.5 Nonattainment Areas in California




Finally, in addition to federal requirements, California has State ozone and particulate matter standards that are more stringent than the federal standards. As shown in Figure 4-5, 27 local air districts are designated nonattainment for the State ozone standard. Triennially,. local air districts that exceed the ozone standard must develop a' plan demonstrating that they are making progress towards the standard. These plans are required to include an all feasible measure analysis if they do not show a 5 percent reduction in emissions per year. Each time the all feasible measure analysis is done, the air district must evaluate new rules that have been adopted. In addition, as shown in Figure 4-6, nearly the entire State is designated nonattainment for the State PM10 standards. In 2003, the Legislature passed Senate Bill 656 to initiate a planning process for meeting the State PM10 and PM2.5 standards. This legislation required ARB, in consultation with local air districts, to adopt a list of the most readily available, feasible, and cost-effective control measures that could be implemented by air districts to reduce PM1 0 and PM2.5. In turn, local air districts were required to adopt implementation schedules of appropriate rules based upon the nature and severity of their PM problem. As a result of all of the ozone and PM requirements, stationary sources in California have some of the strictest controls in the nation.

Figure 4-5 2006 State Ozone Designations

2006
Area Designations for State
Ambient Air Quality Standards
OZONE

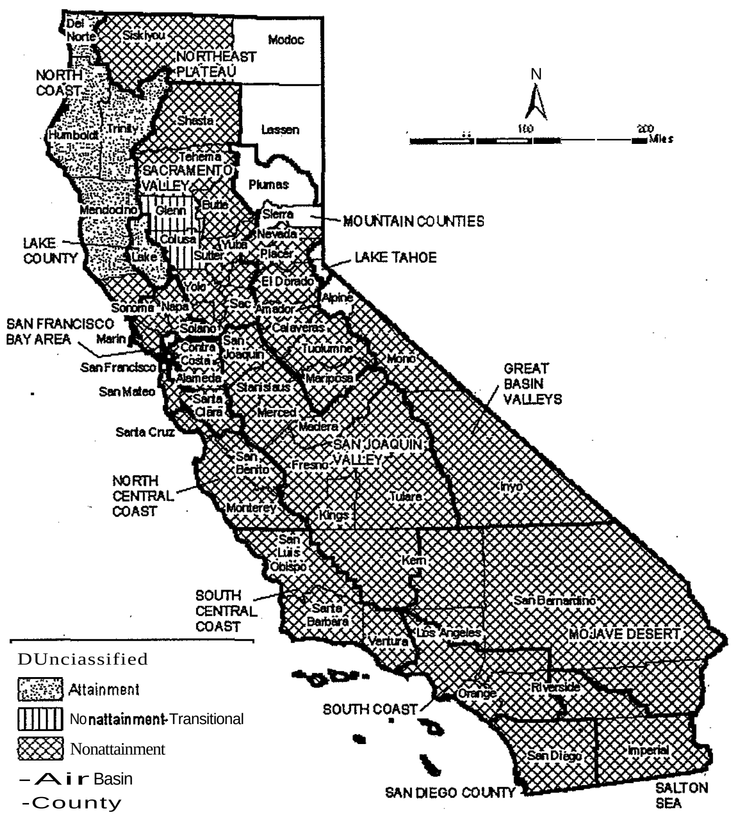


Figure 4-6 2006 State PM10 Designations

. 2006
Area Designations for State
Ambient Air Quality·Standards
PM10


## 4.4 PSD/NSR Permit Programs

In California, new and modified major stationary sources are analyzed under the federal Prevention of Significant Deterioration (PSD) or NSR permitting programs. The PSD permit program applies to polh,ltants that do not exceed the NAAOS. Among other things, the PSD permit program is designed to protect air quality and visibility in Class 1 Areas by requiring best available control technology (BACT) and involving the public in permitdecisions. In California, the responsibility to administer the federal PSD permit requirements is shared by U.S. EPA Region 9 and local air districts. However, U.S. EPA is in the process of re-delegating authority to air districts attaining the federal standards.

For areas with pollutants that do not meet the NAAQS, the NSR permit program administered by the local air dJstricts is applicable. California's NSR program is designed to achieve no net increase in nonattainment pollutants or their precursor emissions for all new or modified major stationary sources. These same pollutants and precursor emissions impact visibility in California. Sources are required to install BACT. Dependent upon their air quality problem, sources are required to mitigate their emission increases after the installation of BACT. Finally, California law does not allow an air district to weaken their NSR program. As stated earlier, California has one of the most stringent NSR programs in the country.

Therefore, California's currentPSD and NSR programs ensure that visibility at Class 1 Areas will not be impacted by growth in stationary sources.· Figure 4.4 and 4.5 above show the areas of the State violating the federal PM2.5 and ozone standards and provide context for areas subject to NSR or PSD programs. The majority of California Class 1 Areas are located in current or future nonattainment areas.

## 4.5 Additional Regional Haze Rule Source Considerations

When developing the 2018 Progress Strategy, the Regional Haze Rule requires states to consider in addition to' emission reductions from on-going programs, specific measures to mitigate construction activities, source retirement schedules, and smoke management techniques. The 2018 Progress Strategy described above considers all of these. Details regarding construction activity mitigation, source retirement, and smoke management techniques are discussed below.

### *4.5.1 Construction Activity Mitigation*

Due to population growth, construction is an on-going activity"throughout the State. In July 2007, ARB adopted a pioneering regulation aimed at reducing diesel and NOx emissions from the State's estimated 180,000 off-road vehicles used in construction, mining, airport ground support and other industries. By 2020, ARB estimates that particulate matter will be reduced by 74 percent and NOx will be reduced by 32 percent compared to current levels. In addition, many air districts have adopted stringent rules to control fugitive dust emissions from construction activities.

### *4.5.2 Source Retirement*

New stationary sources and vehicles are very clean compared to older existing sources and vehicles. However, older sources make up the majority of mobile emissions. In California, mobile sources make up the majority of haze polluting emissions. Therefore, a key focus of California's source retirement strategy is on mobile sources. Several programs are aimed at mobile source retirement. California's Smog Check Breathe Easier Campaign pays motorists $1,000 to permanently retire their high-polluting vehicles rather than repair the vehicle due to smog check inspection failure. These vehicles are taken to one of the State's authorized dismantlers where they are crushed. In addition, local air districts have vehicle retirement programs in which they pay motorists to retire an older vehicle, that although it may pass the smog check inspection, may have higher emissions than a newer vehicle.

California has also pursued the retirement of engines used in a variety of activities through the use of incentive funding. These incentive programs have worked hand-in-hand with in-use regulations, providing added emissions benefits. California is currently investing up to $170 million per year to clean up older, higher-emitting sources through the Carl Moyer Program. The $170 million will clean up to 7500 engines with 24 tons per day of surplus NOx emissions achieved.

Finally, as stated previously, California air districts have some of the most stringent stationary source rules in the country. The stringency of these rules results in sources considering the costs of control in comparison to the useful life of the source in determining whether to retire a source.

### *4.5.3 ARB's Smoke Management Program*

California's Smoke Management Program is an important element of the Regional Haze 2018 Progress Strategy. The Program is designed to provide for best management practices for agricultural and prescribed burning and thereby minimize the potential for harmful smoke impacts. The legal basis of the Program is found in ARB's Smoke Management Guidelines for Agricultural and Prescribed burning which was amended in 2000. In 2003, U.S. EPA accepted ARB's certification that the Guidelines met U.S. EPA's Enhanced Smoke Management requirements.

The ARB and the State's 35 local air pollution control districts are responsible for jointly administering the Guidelines. The ARB is responsible for general oversight of the program and also makes daily burn/no burn day decisions for each of the 15 air basins in the State. Air districts are required to adopt comprehensive smoke management programs and regulations to implement and enforce, the Guidelines. These smoke management programs contain requirements for:

- Permits for all agricultural and prescribed burns
- Daily burn authorization systems
- Annual reporting of all agricultural and prescribed burning
- Annual or seasonal burn registration for prescribed burns
- Smoke management plans for prescribed burns

Basic information on burn location, types and amounts of material to be burned, and the location of smoke sensitive receptors are required for all burns greater than 10 acres in size. More comprehensive plans are required for the largest burns (greater than 100 acres) including projections of where smoke is expected to travel and contingency actions such as fire suppression or containment to be taken if weather changes or unexpected smoke impacts occur. Class 1 Are.as are specifically considered as sensitive receptors in these smoke management . plans. .

## 4.6 Four-factor Analysis

The Regional Haze Rule requires the 2018 Progress Strategy to consider four factors in assessing the appropriateness of the strategy for setting reasonable progress goals: the cost of compliance; the time necessary for compliance; the energy and non-air quality environmental impacts of compliance; and the remaining useful life of potential sources. As described below, California's emission reduction program analysis considers the Regional Haze Rule's four-factor analysis. The 2018 Progress Strategy reflects benefits of these analyses for mobile, stationary, and area source reductions.

As shown earlier in Figure 4-4, California has two PM2.5 and fifteen 8-hour ozone nonattainment areas that cover a vast majority of the State. Due to these federal nonattainment areas plus the State ozone and PM planning requirements discussed earlier, the four-factor analysis process has been embodied in California emission reduction strategies for decades. Later on in this chapter, California will discuss the four-factor analysis on asub:"regional basis. Each of the sub-regions includes·a combination of both State and federal nonattainment areas ensuring the four factors are' considered and emissions will continue to decrease.

### *4.6.1 Cost of Compliance*

Currently, the cost of compliance can be measured by the cost-effectiveness threshold per ton of pollutant reduced throughout the State, up to *$24,5001ton* and *$20,200Iton* for NOx and VOC, respectively, for stationary source rules adopted by local air districts. The local air districts calculate this based on local economies and all feasible control measures. Periodically, local air districts update these values based on their needs to meet air quality standards. For mobile source diesel PM, ARB has adopted regulations with cost-effectiveness' up'to *$86,OOOlton* PM. In addition, ARB's Carl Moyer incentive program sets a maximum cost effectiveness of $16,OOOlton for air quality improvement projects.

The magnitude of these cost-effectiveness thresholds reflects both the length of time that California has been pursuing emission reductions and the severity of California's air quality problems. This has led to the need to pursue ever more aggressive controls at greater costs in order to meet State and federal air quality standards. These cost-effectiveness thresholds therefore set a very stringent bar for assessing reasonable controls and stationary sources in California are already required to reduce emissions at a higher cost than elsewhere in the United States.

### *4.6.2 Time Necessary for Compliance*

During the rule development process, both ARB and local air districts consider the time needed to comply with the rule. In general, for new vehicle regulations, ARB considers the time it takes to develop the new technology, ensure the technology is durable, and implement the regulations within the time constraints of new vehicle certification to maximize the emission benefits. Local air districts also allow for time considerations in their rulemaking process to allow for the availability of new technology. Many ARB and air district rules are already considered technology forcing. ARB's 2018 Progress Strategy has taken these factors into consideration in specifying the suite of measures to be included in the Strategy.

### *4.6.3 Energy and Non-Air Quality Environmental Impacts*

The California Environmental Quality Act requires a documented public review of all environmental and energy impacts for all rulemaking actions of State and local agencies in California. This ensures that all projects are assessed for their environmental impacts. These projects range from air quality plans to local construction projects. This. review requires a determination of environmental factors that have a potentially significant impact and impacts that are potentially significant unless mitigated. The environmental factors that need to be reviewed are aesthetics, biological resources, hazards and hazardous materials, mineral resources, public services, utilities/service systems, agriculture resources, cultural resources, hydrology/water quality, noise, recreation, mandatory fmdings of significance, air quality, geology/soils, land use/planning, population/housing, and transportation/traffic.

### *4.6.4 Remaining Useful Life* of *any Potentially Affected Sources*

When developing regulations, ARB and local air districts consider the useful life of potentially affected sources. The stringency of air district rules results in sources considering the costs of control in comparison to the useful life of the source in determining whether to retire a source or implement new control requirements.

ARB's long-term mobile source strategy has two distinct components - more stringent standards for new engines and clean-up of existing fleets. ARB's Low Emission Vehicle Program, which is a key element in the 2018 Progress Strategy, is ensuring that new vehicles entering the fleet are exceptionally clean. To address existing fleets, ARB has adopted 20 in-use regulations in the last five years to provide for the clean-up of eXisting fleets. These include requiring use of cleaner fuels, limitations on truck idling, and diesel engine retrofit technologies. The California Legislature has also enabled funding programs to incentivize early retirement of equipment and replace them with lower emissions units. In aggregate, these measures provide a comprehensive basis for supporting California's reasonable progress goals for Regional Haze.

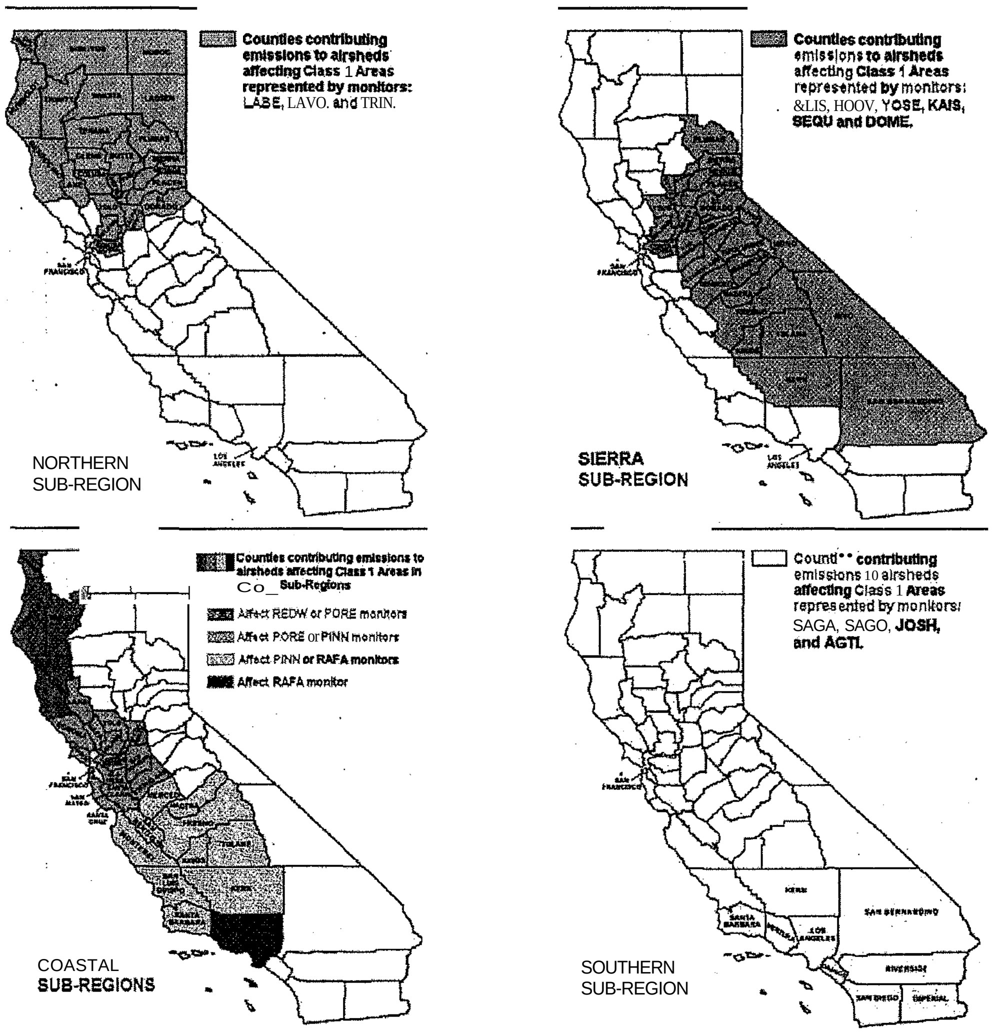
### 4.7 Regional Analysis of Source Categories

California has 15 air basins bounded by physical features, such as topography, that impact local weather patterns and affect inter-basin transport of air pollutants. The four sub,..regions for analysis of haze in California reflect consideration of these intra-State air basins as well as the jurisdiction of the thirty-five air districts with regulatory control over stationary sources within them. The haze species that serve as the main drivers of haze' on worst days are generally the same for each sub-region because the topography and natural resources of each sub-region affect the way the surrounding areas developed. Factors such as urbanization level and interstate transportation corridors also play into the types of sources within each sub-region. Finally climate, humidity, vegetative cover, and precipitation patterns also influence which haze species predominate during the year. Therefore, the groupings are based on factors beyond simple geographic proximity.

In developing the 2018 Progress Strategy, California analyzed each sub-region in the State to determine the types of sources affecting visibility in each sub-region and their current level of control, considering the four. factors discussed above in section 4.6. The analysis focused on the significant pollutant species driving haze on worst days and source categories that California is able to control, specifically in-State and anthropogenic sources. The analysis reflects the results of existing controls to reduce emissions of ozone and partiCUlate matter precursors that are necessary to meet federal and State health standards in the nonattainment areas of California since all of the State's Class 1 Areas are in one or more of these zones. These reductions demonstrate that the four-factor analysis embedded in California rulemaking is effective in improving visibility.

As discussed in Chapter 2, Class 1 Areas in California are clustered in four sub-regions. The counties whose sources are most likely to impact the Class 1 Areas in the sub-regjons are shown in Figure 4-7.

Figure 4-7 Source Regions by Counties in California

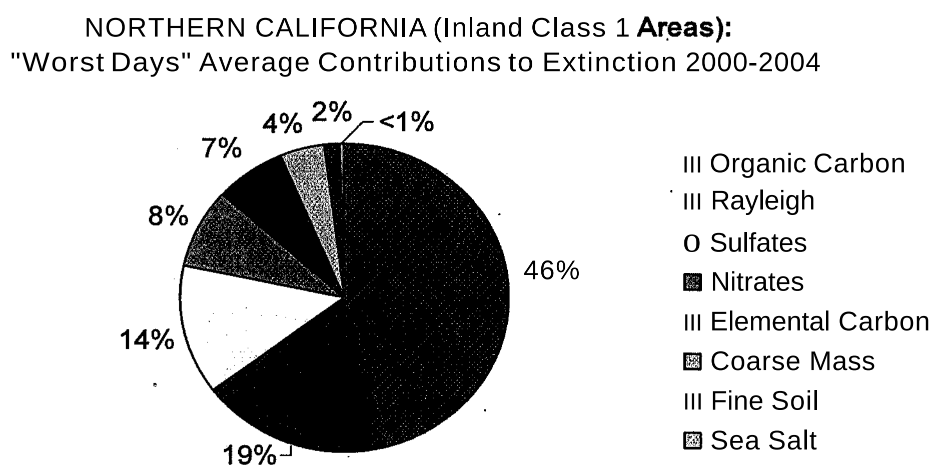



For each sub-region, at least part of each shaded county is in an airshed or air basin where topography and meteorological patterns indicate that the county's emissions influence visibility at the Class 1 Areas in the sub-region. The"other " counties are in air basins where separating mountain ranges and prevailing winds significantly reduce the influence of their emissions on Class 1 Areas in another sUb-region. The emission inventories from the corresponding counties were reviewed, in conjunction with the results of the WRAP's NOx, SOx, and organic aerosol tracer tools, to identify the primary influences on worst day haze from California source categories in each sub-region of the State.

### *4.7.1 Northern California*

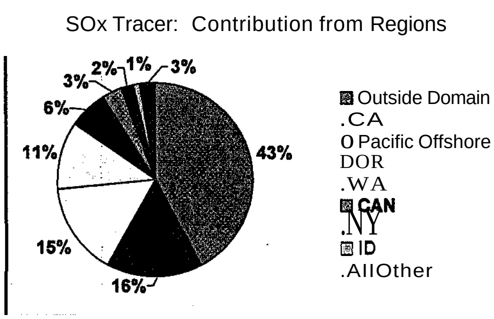
Northern California includes these inland Class 1 Areas: Lava Beds National Park, South Warner Wilderness Area, Lassen Volcanic National Park, Caribou Wilderness Area, Thousand Lakes Wilderness Area, Marble Mountain Wilderness Area, and Yolla Bolly-Middle Eel Wilderness Area. On worst days, organic aerosols drive haze in Northern California, dwarfing the contributions from sulfates and nitrates as shown in Figure 4-8. Rayleigh gas scattering is a natural phenomenon that contributes to haze and is considered "uncontrollable."

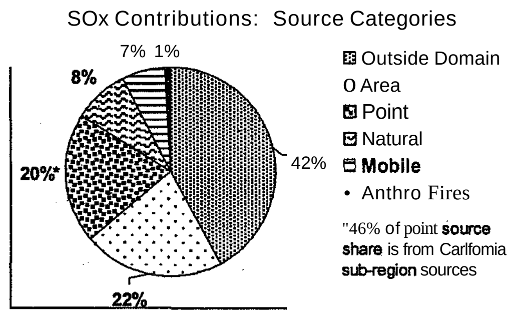
Figure4-8 Species Contributions to Worst Days (Northern Class 1 Areas)




Source apportionment shows that natural wildfires and biogenic emissions contribute 70 to 80 percent of the organic aerosols on worst days. The balance is primarily from area sources and anthropogenic fires. Existing Statewide measures to reduce area source emissions of organic aerosols have already been discussed earlier. Area sources such as residential wood combustion are being controlled at various levels by air districts in Northern California. California has an EPA-certified enhanced Smoke Management Program, which is the best possible means of controlling anthropogenic smoke. In California, all open burning, including agricultural burning and other prescribed burning, is under shared State and air district jurisdiction. The Northern Region will also see a very slight reduction in anthropogenic emissions of precursor volatile organics from planned mobile source emissions reductions.

Figure 4-9 Worst Days SOx Source Attribution (Northern Class 1 Areas)

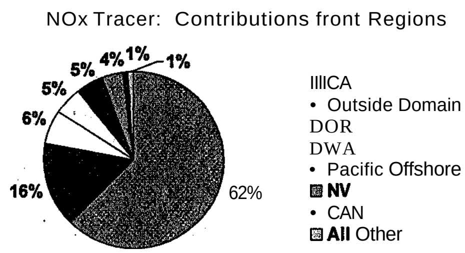


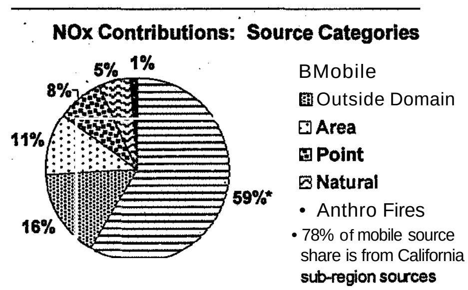




Sulfates are the third largest contributor to light extinction (haze) on worst days in Northern California. Sub-regional sources of SOx were analyzed with respect to their contribution to visibility impairment and existing level of control. The major contributors to sulfates impacting northern inland California Class 1 Areas are sources outside the modeling domain, California sources, and Pacific offshore sources, presumably marine commercial shipping and natural marine emissions. California has already reduced the sulfur content of fuels, which limits SOx emissions from all source categories. The SOx tracer analysis shows that only 16 percent of the sulfates causing worst days haze at Northern California Class 1 Areas come from California sources. Of that, California point sources lead with about 9 percent of the total contribution to light extinction by sulfates. When that amount is converted to visibility impact, the sub-regional California point sources contribute about 1.3 percent of total light extinction on worst days, on average, at Northern California IMPROVE monitors. By comparison, California mobile sources and area sources contribute about 0.4 percent each to total light extinction.

A review of the top 100 SOx-emitting stationary sources in the counties included in the sub-region shows that only eight facilities emitted more than 100 tons per year of SOx in 2006 due to existing controls. The closest source is a BART-eligible facility in Solano County, over 200 kilometers from the nearest Northern California Class 1 Area, Yolla Bolly - Middle Eel Wilderness Area. The facility will be implementing stringent controls to reduce its SOx emissions by more than 90 percent by 2013, which is equivalent to 24 percent of all current point source SOx emissions from the sub-region. The other seven large point sources are in Contra Costa County, even farther south. Existing State and air district rules controlling point sources were developed taking into consideration the cost of compliance, the time necessary for compliance, energy and non-air quality environmental impacts, and the remaining useful life of the source.

Figure4-10 Worst Days NOx Source Attribution (Northern Class 1 Areas)



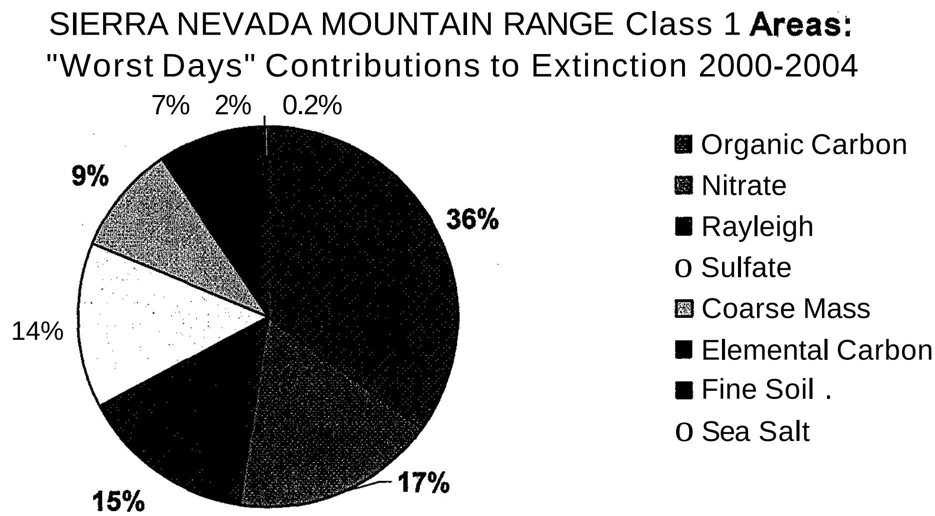




Nitrates are-the fourth highest contributor to haze on worst days at Class 1 Areas in the Northern California sub-region. California sources are responsible for 62 percent of the nitrates with the bulk of these from in-State mobile sources. Mobile source NOx emissions from all regions contribute a 59 percent share of the nitrate light extinction in this sub-region. However, on average at all the Northern California monitors, only 3.6 percent of the'total light extinction on worst days is due to NOx emissions from California's mobile sources. Moreover, only 0.6 percent and 0.4 percent of the total light extinction on worst days comes from California area and point sources, respectively, according to the WRAP's NOx tracer tool. California anticipates a 40 percent reduction in mobile source emissions by 2018. This reduction, along with those achieved by eXisting controls in other source categories, delivers more than a 20 percent reduction in nitrate extinction by 2018 at the Northern Class 1 Area monitors. Therefore, progress beyond a uniform 20 percent NOx reduction increment is achieved for the first of five planning periods before 2064.

### *4.7.2 Sierra California*

There are eleven Class 1 Areas in the Sierra Nevada Mountain Range in California: Desolation Wilderness, Mokelumne Wilderness, Hoover Wilderness; Emigrant Wilderness, Yosemite National Park, Kaiser Wilderness, Ansel Adams Wilderness, John Muir Wilderness, Sequoia NationaJ Park, King's Canyon National Park and Domelands Wilderness. The air masses moving overthe Sierra are similar in content and origin. The slight variations in light extinction at each IMPROVE monitor are influenced by elevation, latitude, vegetative cover, proximity to populated areas and transportation corridors, and position on the windward or leeward side of the crest line. Figure 4-11 shows the average contributions of haze species to light extinction in the baseline years at the six monitoring sites representing the Sierra Class 1 Areas.

Figure 4-11 Species Contributions to Worst Days (Sierra Class 1 Areas)

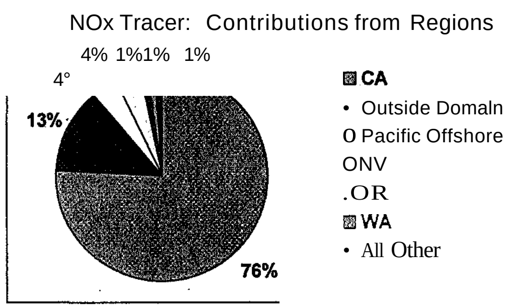


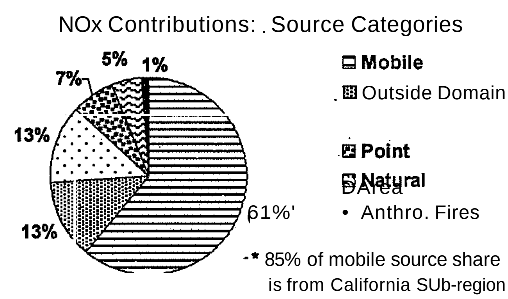

On average. organic aerosols are the predominant cause of haze on worst days, with slight variations in species strength at the representative monitoring sites. The contributions from sulfates and nitrates are stronger at Class 1 Areas closest to urbanized areas and transportation corridors. The influence of coarse mass increases on windy days in the drier. higher Class 1 Areas on the lee side of the Sierra crest. The contribution of elemental carbon increases on days when there are nearby wildfires in the heaVily forested areas. Rayleigh scattering exerts more influence at higher elevations when the monitors are located above the mixing layers associated with adjacent populated valleys to the west and dry valleys and desert to the east. Fine soil and sea salt consistently have little impact on visibility throughout the Sierra.

Source apportionment shows that natural wildfires and biogenic emissions contribute more than half to 90 percent of the organic aerosols on worst days in, the Sierra Class 1 Areas. with wildfire contributions also coming from out-of-State. The balance of the organic aerosols is from area sources, anthropogenic fire, mobile sources. and point sources. If only the California sources in the four "controllable" categories are considered. their combined share of organic aerosol extinction rarely exceeds 15 percent, primarily from area sources. As in the inland Northern California sub-region, area sources such as residential wood smoke and consumer products are controlled by existing State and local measures. Both local'agricultural interests in the Central Valley, immediately west of the Sierra Nevada Range, and State and federal land management agencies. who oversee most of the land in the Sierra and east to the Nevada state line, actively practice smoke management. All open burning. whether by public or private entities, falls' under coordinated State and local regulatory control of California's Smoke Management Program.

Currently, organic aerosols from mobile sources and point sources in California contribute about 1percent apiece to total light extinction in the Sierra Class 1 Areas. There will be reductions in mobile source organic aerosol emissions by 2018 under current controls. Although organic aerosols from point sources have marginal impact on visibility, the nonattainment status for both ozone and particulate matter in the Central Valley and the Mountain Counties means that existing controls are constantly evaluated and upgraded for stringency, taking into account the cost of compliance, time necessary for compliance, energy and non-air quality environmental impacts, and remaining useful life of the source. For example, the San JoaqUin Valley Air Pollution Control District has been nonattainment for both Federal and State ozone and particulate matter health standards. The air district has already implemented control measures that reduce organic matter aerosol precursors from both area and point sources in the key upwind air basin for the Sierra Class 1 Areas.

Figure 4-12 Worst Days NOx Source Attribution (Sierra Class 1 Areas)

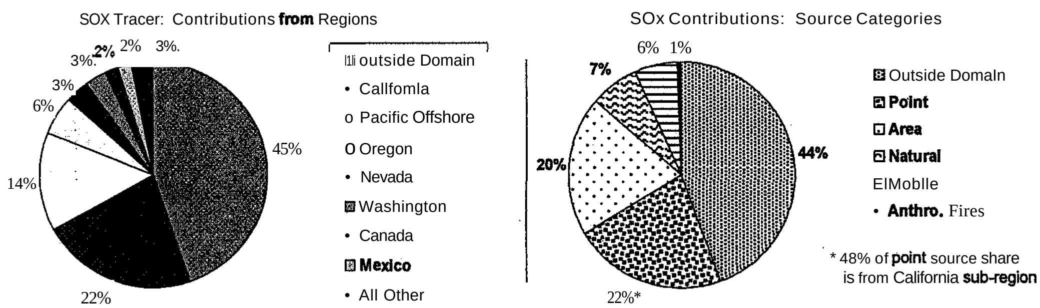



After organic aerosols, nitrates are the next highest driver of haze on worst days in the Sierra, closely followed by Rayleigh scattering and sulfates. Mobile source NOx emissions from all regions contribute an overwhelming 61 percent share of the nitrate light extinction on worst days in this sub-region. California mobile sources contribute 85 percent of the mobile source category, which equates to about 9 percent of the total extinction on worst days in the Sierra. California anticipates a 60 percent reduction in mobile source NOx emissions in the Sierra sub-region by 2018. Currently, California's area and point sources shares. of total light extinction at Sierra Class 1 Areas are minor, about 2 percent and 1 percent," respectively.

Despite predicted population growth in the regional air basins in which the Sierra Class 1 Areas are located, the contribution to nitrates from all categories will decrease by 43 percent by 2018 with existing State and air district controls in place. As noted previOUSly, all air quality rulemaking in California must consider the four factors; cost of compliance, time necessary for compliance, energy and non-air quality environmental impacts, and remaining useful life of the source, to assure that the most stringent and feasible controls are applied to new and eXisting sources. Future controls, now in development to attain the new ozone and PM2.5 standards, will further reduce NOx emissions within the planning period. These controls and their potential benefits to visibility will be evaluated during the mid-course review;

Figure 4-13 Worst Days SOx Source Attribution (Sierra Class 1 Areas)




Sulfates are the fourth highest contributor to worst day haze, after natural Rayleigh gas scattering. Major contributors to sulfates impacting Sierra Class.1 Areas are. sourceS outside the modeling domain, as well as from the Pacific Off-Shore region, with a combined contribution of 59 percent. California sources are responsible for about 22 percent of the sulfates reaching the Sierra Class· 1 Areas from all regions. Of California's share of sulfates; 48 percent (about half of 22 percent) is from California point sources and about 20 percent (one fifth of 20 percent) from area sources. When converted to visibility impact, the sub-regional California point sources contribute, on average, about 1.5 percent to total light extinction on worst days in the Sierra. California area sources contribute only 0.6 percent to total light extinction on worst days.

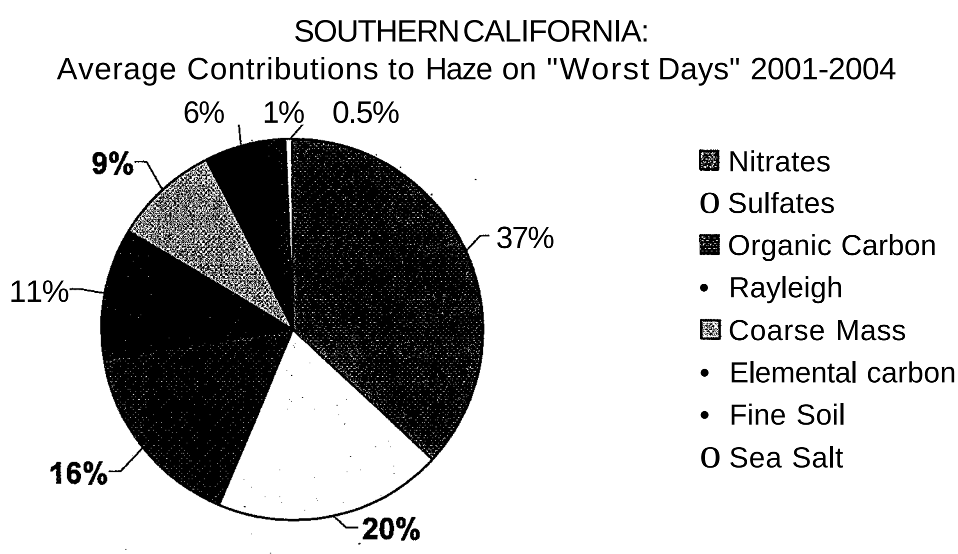
A review of the top 100 SOx-emitting stationary sources in the counties included in the Sierra sub-region shows that 21 facilities emitted more than 100 tons per year of SOx in 2006. All of the sources in the San Joaquin Valley were required to have BACT when they went through New Source Review, because the Valley was nonattainment for PM10. The other sources are in State nonattainment areas for PM and already have considered all feasible measures to improve air quality to benefit health taking into consideration cost of compliance, time necessary for compliance, energy and non-air quality environmental impacts, and remaining useful life of the source. The air districts also require that low-sulfur fuels be used for combustion in stationary sources. State mobile source measures will continue to reduce SOx emissions from traffic on interstate corridors running through and adjacent to the Sierra Class 1 Areas. All of these reductions also benefit visibility.

### *4.7.3 Southern California*

There are six Class 1 Areas in Southern California: San Gabriel Wilderness, Cucamonga Wilderness, San Gorgonio Wilderness, San Jacinto Wilderness, Joshua Tree National Park, and Agua Tibia Wilderness. The Wilderness Areas are located in the mountains ringing the very densely populated Los Angeles Basin. The Route 10 corridor through the mountains funnels air from the Los Angeles Basin into the Coachella Valley and the sparsely populated Mojave Desert that surround Joshua Tree National Park. While airflows from the Basin distribute anthropogenic pollutants across all these Class 1 Areas, natural haze pollutants from geologic and biogenic sources are driven oceanward across the same Class 1 Areas during high velocity Santa Ana wind events. Unique to this part of the State, the hot, dry Santa Ana winds initiate seasonally in the desert every year. They can ignite and fan extensive wildfires throughout the Southern California sub-region spreading smoke throughout Class 1 Areas and nearby urban environments. All Southern Class 1 Areas are also located within 250 kilometers of the Pacific Ocean and Mexico, thereby exposed to transported offshore shipping emissions and international emissions.

Figure 4-14 shows the average contributions of haze species to light extinction in the baseline years at the four monitoring sites representing the Class 1 Areas in the Southern sub-region.

Figure 4-14 Species Contributions to **Worst** Days (Southern Class 1 Areas)

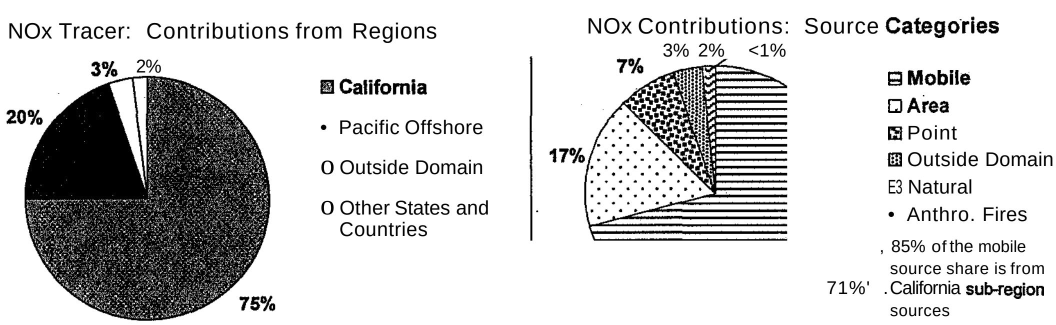



The four-factor analysis targets only the "controllable" sources in this complex mix of anthropogenic and natural emissions in the Southern sub-region. At least 17 million people live within a 50 kilometer radius of this cluster of six Class 1 Areas, with a 40 percent increase in population expected by 2018.

Nevertheless, considerable progress has been made in reducing haze pollutants because all six of the Class 1 Areas are wholly or partially within a federal nonattainment area for ozone or particulate matter, and have been for many years. This area is also hQnattainment for the State standards and as such requirements for rulemaking to address these standards have considered on an ongoing basis the cost of compliance, time necessary for compliance, energy and non-air quality environmental impacts, and remaining useful life of the source. Therefore, visibility will continue to improve. at the Southern Class 1 Areas, because existing stringent .controls require offsets for growth from new sources and continual reductions from existing sources.

On average, nitrates are the predominant cause of haze on the worst days in this sub-region. As shown in Figure 4-15, a small portion ofthe NOx emissions leading to nitrate formation in the Southern sub-region come from natural sources and from anthropogenic sources not within California's jurisdiction.

**Figure 4-15 Worst Days NOx Source Attribution (Southern Class 1 Areas)**

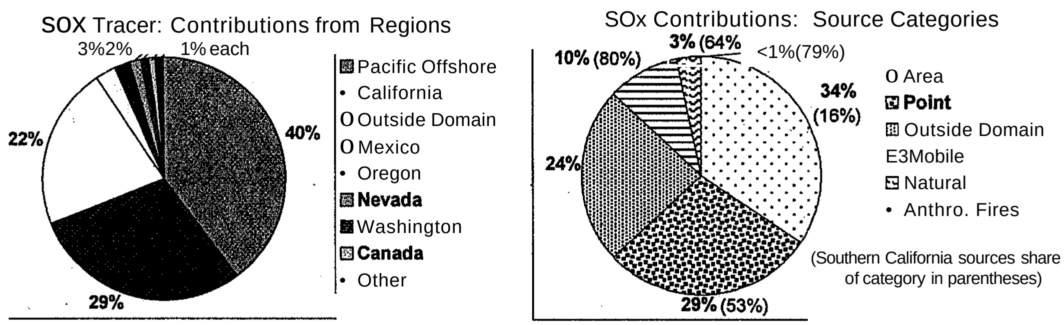



NOx emissions from all the California source categories, taken together, account for about 75 percent of the nitrates. This amounts to about 28 percent of the total light extinction in the Southern Class 1 Areas. Mobile sources, including emissions from commercial marine shipping offshore in the Pacific Ocean, account for the bulk of NOx emissi·ons. NOx emissions from Southern California area and point sources have a lesser role in causing haze, about 3 percent and 2 percent of total light extinction, respectively.

All feasible measures to reduce NOx emissions from stationary sources are required by State law in Southern California. These existing controls which consider cost of compliance, time necessary for compliance, energy and non-air quality environmental impacts, and remaining useful life of the source in the rule development process include an aggressive local program for continuous, quantifiable reductions at facilities emitting more than four new tons of NOx or SOx per year.' The same program' requires an analysis of visibility impacts at the six Southern California Class 1 Areas. Area sources are also subject to rigorous prohibitory rules for industrial, commercial,institutional, and residential uses, to limit even minor emissions from each of the very large number of small units and equipment in the densely populated area. While existing air district regulations keep new and existing stationary sources in check, State programs for reducing mobile source NOx emissions from all on-road and off-road mobile source categories, including portable equipment, provide the biggest benefit to visibility.

By 2018, California anticipates a 40 to 50 percent reduction in nitrate-caused light extinction using existing control measures. This calculation takes into account expected growth in area sources, vehicle miles traveled, and point source expansion, which must be offset. Future controls to attain new federal air quality standards to protect health, are anticipated. They will be addressed during the mid-course review.

**Figure 4-16 Worst Days SOx Source Attribution (Southern Class 1 Areas)**




Sulfates are the second highest cause of light extinction at the Southern California sub-region, when averaged. They are the primary influence at Agua Tibia, and are third highest in the forested'mountains of the San Gabriel, Cucamonga, San Gorgonio, ahd San Jacinto Wilderness Areas where organic matter influence is slightly higher than sulfates on an annual basis. Sulfates increase slightly in hot, dry months at all the monitors, as do organic matter aerosols. The Agua Tibia IMPROVE monitor is at the lowest elevation, directly exposed to air masses containing the marine layer and urban pollution. The other IMPROVE monitors (SAGA, SAGO, and JOSH) are at elevations two to three times higher, above or outside the mixing zone of the urbanized Los Angeles Basin. Nevertheless, the six Class 1 Areas are close enough to be impacted by regional sulfate levels, no matter the location of the initial SOx emissions, because the sulfates subsequently-formed are persistent in the atmosphere.

The tracer analysis shows that SOx emissions come primarily from Pacific offshore sources, largely beyond State or local control. They also come from area, point, and mobile sources in California. These include port activities, interstate freight movements, military bases, and airports with shared federal, State, and local jurisdiction. A review of the top 100 SOx-emitting stationary sources in the Southern sub-region shows that only 19 facilities emitted more than 100 tons per. year of SOx in 2006. All must operate at RACT or BACT level, in accordance with the respective air district federal nonattainment status or maintenance plan.

California has already implemented low sulfur fuel requirements for gasoline, diesel, natural gas, and coal used in combustion at stationary and mobile sources through existing State and air district programs. Fuel oil is restricted to emergency use and natural gas is required for routine use in many existing stationary source permits administered by Southern sub-region air districts. Fuel sulfur restrictions apply to area sources via existing prohibitory rules for residential heaters, small boilers, and internal combustion engines.

Anthropogenic SOx emissions originating in California contribute about 6 percent to regional worst day light extinction and are all subject to existing controls. That estimate does not count near-shore marine commercial emissions grouped with all Pacific Offshore sources in the SOx tracer analysis. Projections to 2018 for California mobile, point, and area sources show that sulfate concentrations will decrease from each source category. California will also continue existing.efforts to work with Mexico in cooperative agreements to reduce the use of high-emitting vehicles entering the United States with commercial.goods.

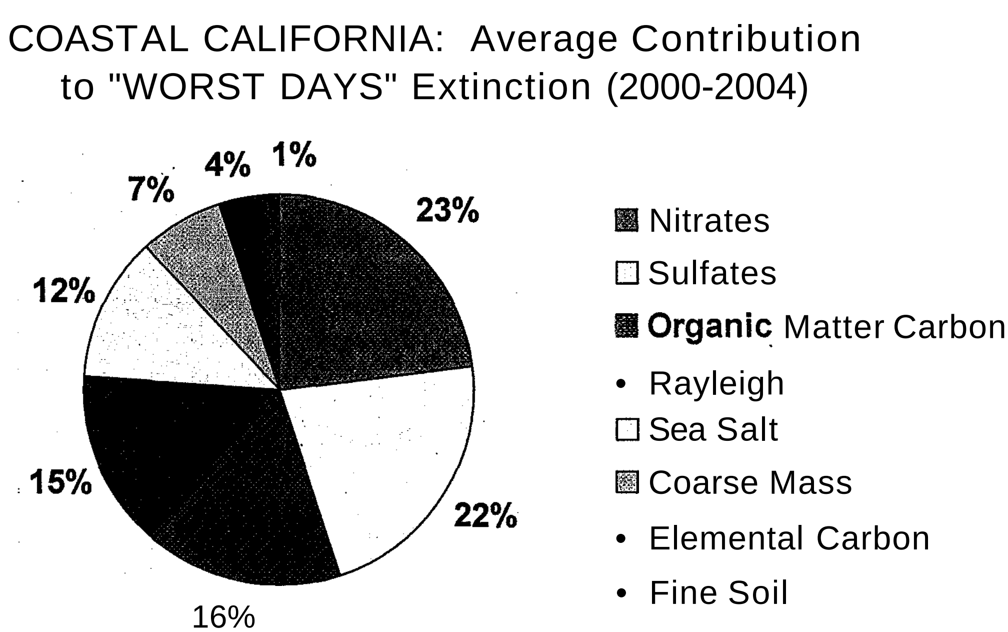
After sulfates, organic aerosols are the next highest driver of haze on worst days in Southern California, on average. In large part, these are due to sustained peaks of organic aerosol during large wildfires that ravaged forests weakened by drought and bark beetle infestations during the baseline years. The year-round growing season in Southern California also delivers plant-emitted carbon compounds that subsequently combine to form organic aerosols, especially in the forested Wilderness Areas. Neither wildfires nor biogenic emissions can be controlled. However, California's Smoke Management Program limits the impacts of anthropogenic fires, with controls and permits for prescribed burning by private and public land managers. Open burning for residential or commercial purposes is already bannedin most of Southern California. Agricultural burning is diminishing, as farmlands and pasture are converted to non-agricultural uses.

Existing stringent State and air district controls of reactive organic gas emissions from consumer products and mobile, stationary, and area sources, to reduce ozone formation, have the benefit of also reducing organic aer.osol formation. These controls are continuously updated, considering the cost of compliance, time necessary for compliance, energy and non-air quality environmental impacts, and remaining useful life of the source. As a reSUlt, anthropogenic emissions of organic aerosols will decrease at least 20 percent across the Southern sUb-region by 2018. Despite the inability to control the predominately natural causes of organic aerosols, modeled projections indicate that organic aerosols from all sources will still decrease approximately 11 percent across the Southern sub-region by 2018.

*4.7.4 Coastal California*

There are five Class 1 Areas on or relatively close to the California coast of the Pacific Ocean: Redwoods National Park, Point Reyes National Park, Pinnacles National Monument, Ventana Wilderness, and the San Rafael Wilderness. These are grouped as the Coastal sub-region because prevailing winds from the ocean affect them directly. Four contiguous air basins comprise the sub-region: the North Coast, San Francisco. Bay Area, North Central Coast, and South Central Coast Air Basins, encompassing the 900 kilometer distance from northernmost to southernmost Class 1 Areas. Three of the Class 1 Areas include Pacific shoreline as well'as higher elevations in the mountain ranges along the California Coast Ranges. Pinnacles and San Rafael are farther inland along the crestline of the inner coastal mountain ranges, at 1,000 to 2,000 meters. These two Class 1 Areas are exposed more often to reverse flows of "inland" air masses that drain .oceanward through passes and river valleys. Figure 4-17 shows the average contributions of haze species to worst day light extinction in the baseline years at the four IMPROVE monitors representing the Class 1 Areas, of the C.oastal sub-region.

Figure 4-17 Species Contributions to Worst Days (Southern Class 1 Areas)

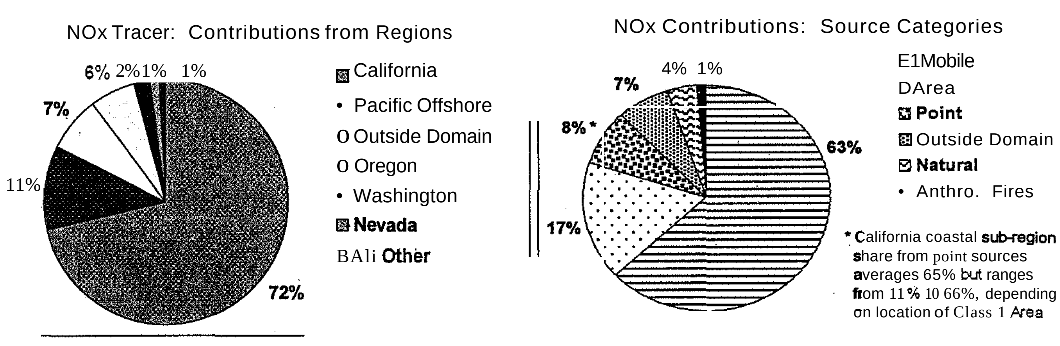



The causes of haze in each Class 1. Area of this sub-region do vary slightly from the . averages depicted in Figure 4-17. The relative influence of nitrates, sulfates, organic matter, Rayleigh and sea salt vary in influence considerably more than coarse mass, elemental carbon, and fine soil due to factors such as latitude, elevation, relative humidity, distance from the shoreline and prevailing offshore winds, and exposure to air masses flowing from inland valleys with different land uses.

Natural contributions from Rayleigh and sea salt show dramatic differences, depending on the elevation of the Class 1 Area and its distance inland from the 'coast, but these "causes" of haze are not "controllable." The contributions of fine soil, elemental carbon, and coarse mass to light extinction are at or below 15 percent at all of the Coastal Class 1 Areas. These pollutants are also largely the result of "uncontrollable" natural events, such as wildfires or local wind events in uninhabited forests and bare-soil areas. Therefore, the four-factor analysis again focuses on the anthropogenic source categories contributing nitrates, sulfates, and organic matter carbon. At each Class 1 Area, these three species are predominant haze drivers on worst days during the year.

The relative prevalence of on-shore and off-shore winds, and the variability of population density and land use near each Class 1 Area, affects the strength of each of the three major drivers of haze. Prevailing winds from off-shore bring in a mix of natural marine sulfates, anthropogenic marine commercial shipping emissions, out-of-State and international industrial pollutants, and transported wildfire smoke that can overwhelm emissions from "on-land"' sources. California is addressing commercial marine shipping emissions, including in-port activities, through long-term programs. The results of these efforts will not be available until the mid-course review. Landside emissions have been addressed through existing programs to reduce ozone and particulate matter to attain State and federal health standards. The following analysis explains the significant existing controls of sources closest to the respective Class 1 Areas.

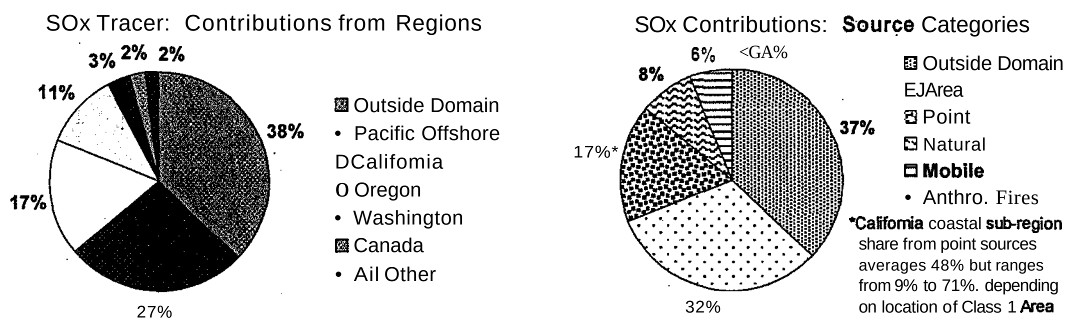
Figure;4-18 Worst Days NOx Source Attribution (Coastal Class 1 Areas)




On average, nitrates causes the most light extinction on worst days in the Coastal SUb-region, although sulfates exert more influence at Redwoods National Park and at the San Rafael Wilderness, as explained in the discussion of sulfates. Taken together, NOx emissions in California from all the source categories account for about 72 percent of the nitrates. This amounts to less than 20 percent of the total light extinction at every Coastal Class 1 Area. Mobile sources, including emissions from commercial marine shipping offshore in the Pacific Ocean, account for the bulk of NOx emissions. Reductions in on-land mobile source NOx should decrease about 60 percent from 2002 to 2018.

The air districts in the three contributing air basins (San Francisco Bay Area, North Central Coast, and South. Central Coast) have all enacted source controls considering the cost of compliance, time necessary for compliance, energy and non-air quality environmental impacts, and remaining useful.life of the source beyond federal requirements because they are all nonattainment for stricter State health standards for ozone or particulate matter. They have also adopted all feasible measures to reduce NOx as required by State law'to mitigate the impact of their emissions on the ozone attainment status of downwind air basins in the Central Valley. While there is a slight increase in stationary source NOx influence on the Coastal Class 1 Areas by 2018, it is more than offset by the overall mobile source reductions near every CoastaJ Class 1 Area. Overall, existing controls in the Coastal sub-region achieve a 40 to 55 percent reduction in nitrate extinction by 2018 at the Coastal Class 1 Area IMPROVE monitors. This will all occur while'the population in the Coastal sub-region increases 16 percent (about 1.6 million more people) from 2002 to 2018.

Figure 4-19 Worst Days SOx Source Attribution (Coastal Class 1 Areas)




Overall, sulfates are the second highest cause ofwbrst days haze in the California coastal SUb-region. Sulfates in the Coastal sub-region originate largely from SOx emissions outside California. SOx contributions from the Pacific Offshore region alone exceed those from California. Marine commercial shipping emissions in shipping lanes along the entire coast account for a measurable share. of the SOx inventory at Coastal Class 1 Areas because prevailing offshore winds blow these emissions inland. These sources, along with natural sources of sulfates are not fully "controllable". As discussed below, landside SOx sources in California's local air basins influence visibility largely when prevailing winds come from inland, or on stagnant days. The analysis belowassesses the success of eXisting measures to reduce sulfate impacts from "controUable" sources.

In the North Coast Air Basin, the "controllable" (in-State, non-natural) sources have been held to 22 percent of the Basin's total emissions inventory for SOx, using existing control measures to meet State health standards for ozone and particulate matter. Most of the anthropogenic sources are usually downwind of Redwoods. As a result, each of the local fire, mobile, area, and point sources categories contribute less than 10 percent of the sulfates contributed by all regions to Redwoods, according to the SOx tracer analysis. The sub-regional share of total extinction at Redwoods National Park is less than 0.5 percent from local SOx sources, considering the four factors, cost of compl!ance, time necessary for compliance, energy and non-air quality environmental impacts, and remaining useful life.

The percentage of sulfates attributed to sources in the San Francisco Bay Area, North Central Coast, and South Central Coast Air Basins is higher than in the North Coast Air Basin because the population is much higher and the land uses more diverse. Area source contributions are higher, in part because the' emissions inventory surrogates are linked to population and density. Nevertheless, combustion emissions of SOx from anthropogenic sources are already limited, since California already requires reduced sulfur in all commercially available fuels (coal, natural gas, gasoline and fuel oil.) Also, internal combustion engines used in portable construction equipment and stationary engines and pumps are already regulated, even in agricultural uses. By 2018, the SOx tracer tool shows that existing controls of Coastal sub-region area sources will reduce their contribution to the overall California share of sulfates by 14 percent. Likewise, existing mobile source controls can achieve an 11 percent reduction in that category's contribution to Coastal sub-region sulfates.

A review of the top 100 SOx-emitting stationary sources in the Coastal sub-region shows that 35 facilities emitted more than 100 tons per year of SOx in 2006. The facility with the highest SOx emissions Statewide, 6353 TPY of SOx in 2006, is a BART-eligible refinery in the San Francisco Bay Area Air Basin. The BART determination for this facility is discussed in Chapter 5; significant emissions reductions will be implemented by 2013. Only seven other facilities emit more than 1000 TPY of SOx in the counties whose emissions could affect the Coastal sub-region. Four are refineries in the San Francisco Bay Area Air Basin whose BART-eligible units went through sUbject-to.:..BART modeling and did not show an impact greater than 0.5 dv above the threshold. One facility in the South Central Coast Air Basin permanently shut down its high SOx-emitting kiln at the end of 2007 to reduce greenhouse gas emissions. One cement plant in the Mojave Desert Air Basin is usually downwind of the nearest Coastal Class 1 Area, 160 kilometers away, and went through New Source Review for a modern kiln design in 1982. Another refinery in the Los Angeles Air Basin is under the RECLAIM program for continuous reductions of emissions. No further changes were identified for these facilities, when considering the cost of compliance, time necessary for compliance, energy and non-air quality environmental impacts, and remaining useful life of the source.

In summary, the point source category shows a slight increase in the contribution to sulfates in the Coastal sub-region, but that growth is limited to 5 percent due to existing controls of particulate matter necessary to maintain the current attainment status for Federal particulate matter standards. As mentioned previously, the Coastal Class 1 Areas are all in nonattainment areas for State health standards for particulate matter. The affected air districts have adopted all feasible stationary. source measures on a path to reduce emissions, as required by State law. California expects that additional measures will also be adopted and implemented in the future, to keep the Coastal sUb-region in attainment of new federal particulate matter standards. These will be discussed in the mid-course review. Despite the anticipated 16 percent increase in population in the Coastal sub-region by 2018 from 2002 levels, the sub-region's share of sulfate extinction will decrease 3 percent on average on worst days, with existing controls in effect.

Along with sulfates, nitrates, sea salt and Rayleigh gas scattering, organic aerosols are significant drivers of worst days haze in Coastal California. In large part, these days are associated with sustained peaks of organic aerosol during large wildfires. The smoke containing the organic mater aerosols can be local or transported with minimal dispersion over long distances by ocean air masses. Biogenic emissions also contribute organic aerosols during the growing season, in direct relation to the types of vegetative covering at the respective Class 1 Areas. Neither wildfires nor biogenic emissions can be controlled. However, California's Smoke Management Program is used to limit the impacts of anthropogenic fires. Despite population growth, anthropogenic emissions of organic aerosols are .decreasing. They will be lower than current levels by.2018 due to existing stringent State and air district controls of reactive organic gas emissions from consumer products and other source categories, to reduce ozone formation. These controls are continuously updated, considering the four factors, cost of compliance, time necessary for compliance, energy and non-air quality' environmental impacts, and remaining useful life of the source. Future refinements will be reported in the mid-course review.

## 4.8 Consultation

California consulted with nearby states regarding the 2018 Progress Strategy by actively participating in the WRAP regional planning organization. Via many WRAP meetings, California conveyed to the WRAP states California's 2018 Progress Strategy and the benefits it provides in improving visibility at all Class 1 Areas impacted by California emissions. In addition, California contacted neighboring states directly. Through this c.onsultation process, the WRAP states concurred that California's 2018 Progress Strategy was appropriate for setting reasonable progress goals for both within State and out-of-State Class 1 Areas within the context of a western regional planning perspective.'

## 4.9 Conclusion

In general, California has reduced emissions at a faster pace than anywhere in the world over the last forty years by introducing cleaner technotogies. We evaluated our 2018 Progress Strategy from a western regional perspective in light of the four factors and have determined that the 2018 Progress Strategy provides a cost-effective, far-reaching, and comprehensive basis for setting our reasonable progress goals for the purpose of Regional Haze planning. However, due to the severity of California's air quality problems and the need to meet State and federal air quality standards, ARB will continue to develop additional strategies for years to come. Notably, in 2007 the Air Resources Board adopted a comprehensive Statewide strategy to provide for attainment of the federal 8-hour ozone and PM2.5 standaOrds that outlines a plan for the development of a combination of far-reaching measures. ARB controls and benefits from future strategies will co"ntinue to reduce emissions through the 2018 time and improve visibility at all Class 1 Areas impacted by California emissions. California will evaluate the benefits of the 2018 Progress Strategy as well as new measures adopted in upcoming years during the mid-course review.

# 5. REGIONAL HAZE BART REQUIREMENT

## 5.1 Overview of Federal BART Requirement

In addition to development of the broader 2018 Progress Strategy, the Best Available Retrofit Technology (BART) requirement of the Regional Haze Rule involves a specific review of existing, older stationary sources that pre-dated the 1977 Clean Air Act Amendments and therefore, were not subject to New Source Performance Standards (NSPS.) The purpose is to identify older emission sources that contribute to haze at Class 1 Areas and can be retrofit to reduce emissions.

The BART requirement applies to all emission units that fit all three of these criteria:

1. came into existence between August 7, 1962 and August 7, 1977, referred to as "BART-era" in this Plan;
2. are at facilities in the 26 NSPS categories listed below in Table 5-1; and
3. have a total potential to emit (PTE) of at least 250 tons per year (TPY) of NOx, sax, PM10, VOC, or ammonia, from all BART-era emission units at the same facility.'

Emission units which meet all three of these criteria are termed BART-eligible. If the emissions of all the BART-era units at a single facility exceed anyone of the pollutant thresholds, then all the BART-era units are considered potentially "BART-eligible", no matter what their emissions level of the other pollutants. If an emission unit (source) has not been retrofit or sufficiently controlled, and has a visibility impact, then it becomes "subject-to-BART". A detailed analysis called. the "BART determination" decides which retrofit or control option for the source is necessary to improve visibility.

**Table 5-1 BART Categories (New Source Performance Standards categories)**

1. Fossil-fuel fired stearn electric plants with >250M BTUlhr heat input
2. Coal cleaning plants (thermal dryers)
3. Kraft pulp mills
4. Portland cement plants
5. Primary zinc smelters
6. Iron and steel mill plants
7. Primary aluminum ote reduction plants
8. Primary copper smelters
9. Municipal incinerators capable of charging >250 tons of refuse daily
10. Hydrofluoric, sulfuric, and nitric acid plants
11. Petroleum' refineries
12. Lime plants
13. Phosphate rock processina plants
14. Coke oven batteries
15. Sulfur recovery plants
16. Carbon black plants (furnace process)
17. Primary lead smelters'
18. Fuel conversion plants
19. Sintering plants
20. Secondary metal production facilities
21. Chemical process plants
22. Fossil-fuel boilers with >250 MBTU per hour heat input
23. Petroleum storage andtransfer facilities with a capacity exceeding 300,000.barrels
24. Taconite ore processing facilities
25. Glass fiber processing plants
26. Charcoal production facilities

Basically, the Regional Haze Rule requires the Plan to provide:

1. A list of all BART-eligible sources within the state; and
2. A determination of BART for each BART-eligible source in the state that emits any air pollutant which may reasonably be anticipated to cause or contribute to any impairment of visibility in any Class I area.

Summary lists of BART-eligible units and those needing BART determinations are included later in this chapter.

## 5.2 Stationary Source Control in California

California has a long history of controlling emissions from stationary sources. Thirty-five local air districts have regulatory authority over stationary sources in the State. California was able to simplify the BART process somewhat because it has had a Best Available Retrofit Control Technology (BARCT) requirement since 1988. BARCT is:

> "an emission limitation that is based on the maximum degree of reduction achievable, taking into account environmental, energy, and economic impacts by each class or category of source."

The requirement to meet BARCT for exi"sting sources applies to all air districts not attaining the California standards for ozone as well as to those upwind districts whose emissions contribute to air quality in a downwind non-attainment district.

Further, all air districts not attaining the State standards must consider all feasible measures to reduce air pollution and adopt and implement measures to attain the State standards as soon as possible. Except for one of the smaller rural air districts in the State, which has no BART-eligible sources, all the other air districts do not attain at least one State standard. The California Air Quality Standards are more stringent than the federal standards. Therefore, the air districts already have adopted and implemented BARCT rules or stringent control measures for sources. Every few years, the California Association of Air Pollution Control Officers Association, in conjunction with ARB, conducts a Statewide evaluation of source category controls used by the air districts to determine all feasible measures.

## 5.3 The BART Process in California

Many BART-eligible sources have already been retrofit or controlled, by air district permit or prohibitory rule, to a BART equivalent or better level. To list those sources and then to select the ones which could be retrofit, ARB began with facilities potentially having BART-eligible sources. The WRAP contractor· Eastern Research Group, Incorporated (ERG) prepared a short list of all facilities in California permitted under Title V of the Clean Air Act that fall into the 26 BART categories. Title V requires permits for facilities that emit the targeted pollutants above a threshold ranging from 100 TPY to 250 TPY, depending on the attainment status in different parts of California.

While NOx, SOx, and PM emissions must be evaluated for BART-eligibility, the Regional Haze Rule gives states the discretion to excuse facilities solely exceeding the threshold for VOC or ammonia provided that those pollutants do not contribute to impaired visibility at Class 1 Areas. In California, ammonia emissions from area, mobile, and natural sources exceed those from stationary sources. Also, since secondary organic aerosols formed from anthropogenic VOC emissions are not significant .contributors to haze on worst days in California, the State chose not to include sources that exceed the threshold for VOCs. When worst days in California are driven by organic aerosols, they appearto be the result of seasonally high biogenic emissions from plants or from wildfire events. Therefore, California's BART-eligible list includes only BART-era units with total emissions of NOx, SOx, or PM above the BART threshold at a single facility.

As stated in our July 2, 2004 letter to U.S. EPA commenting on the BART Regulation, California believes that air districts have generally already adopted and implemented rules requiring the best available retrofit control technology (BARCT) as part of the planning requirements to meet both federal and California air quality standards. (The letter is included in Appendix H.) These BARCT level rules meet the BART-level requirements of the Regional Haze Rule on a source category basis. Give the large number of BART-eligible sources in California, this rule-based approach provides a more efficient process, while still.ensuring-that the Regional Haze Rule BART control requirements are met. California believes this rule-based approach meets the intent of Regional Haze requirements and achieves the same results as a case-by-case BART determination.

ARB worked with the air districts' staffs to create the required summary lists for the Plan. Air district staff provided information regarding control level and age of units. Figure 5-1 illustrates the stepwise winnowing process for confirming which listed BART-eligible sources already meet BART levels and for finding the few remaining sources that might have been grandfathered from stringent controls and therefore, may need a BART determination.

Figure 5-1 California's BART-eligible Source Review Process

Are **BART-era** units at a BART category facility at BART level of emissions control?

YES

Use applicable District rule or federally enforceable permit limits to explain why no **further** review or retrofit is reauired.

**Are** total emissions from BART-era sources at a single BART category facility **low** enough to pass the QID test?

YES →

Use model facility example in the Regional Haze Rule preamble to explain no further review or retrofit is required.

Using "Subject-to-BART" mOdeling, does each BART-era emissions unit cause or contribute less than the deciview threshold of visibility impairment at the nearest Class 1 **area?**

YES

No or minimal impact to visibility means no further action or retrofit **required.**

Conduct BART determination using different retrofit control technology levels balanced against regulatory factors including visibility **impact.** Is retrofit or other control required?

YES

Amend permit or rule to require emissions reductions by installation of retrofit control technology or equivalent permit limits within five (5) years. Optimally, emission reductions from BART level controls must be in place by 2013.

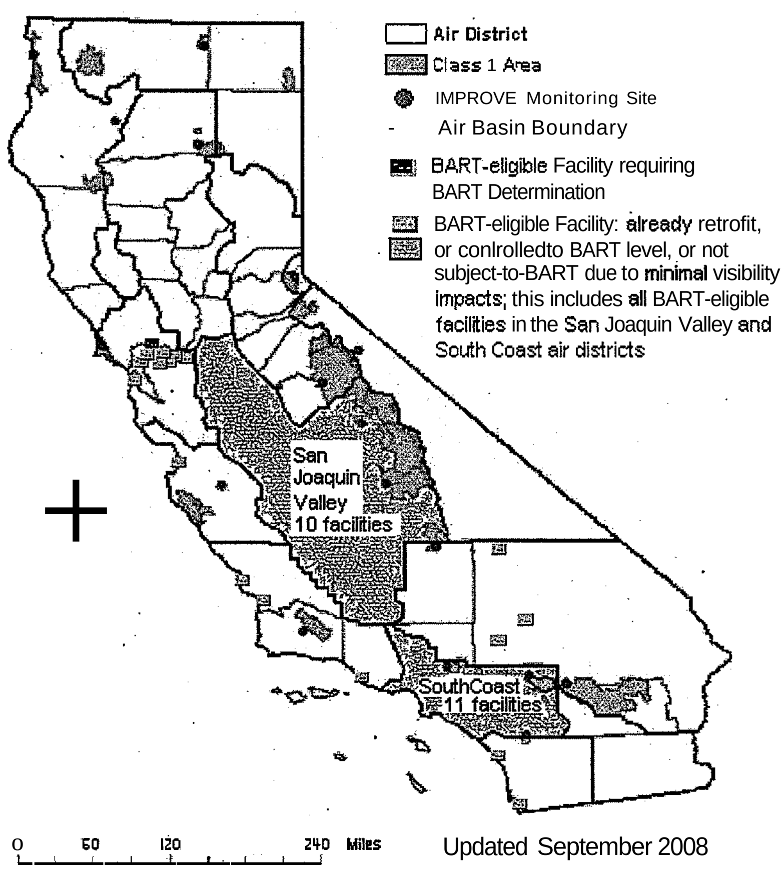
**NO** ↓

No further retrofit or action required.

## 5.4 Locating BART-eligible Source Facilities

The locations of facilities with BART-eligible sources are mapped in Figure 5-2, showing their proximity to Class 1 Areas. Most of the BART-eligible sources are found along the coast, in the San Joaquin Valley, in the South Coast Air Basin and in the Mojave Desert. In California, the types of sources are predominately power plants, refineries, industrial boilers, cement plants, and manufacturing plants. Although there are numerous BART-eligible sources, many are excused from a BART determination because they are already controlled to a BART equivalent level. Some BART-eligible sources active during the Plan baseline period (2000-2004) have been shut down permanently since then. Those sources already scheduled for replacement before 2013, were not put through a BART determination because the facility is required to go through New Source Review and replace the old units with Best Available Control Technology (BACT).

Figure 5-2 Location of Facilities with BART-eligible Sources



## 5.5 Listing BART-eligible Sources

The Regional Haze Rule requires listing of all BART-eligible sources at a facility. Table 5-2 is the list of BART-eligible sources in California. Air districts provided the information on which sources are compliant with the respective prohibitory rule establishing operational emission limits or the permit conditions that are equivalent to the most stringent technology feasible in their area for the source category. When an air district adopts a rule, California air quality and environmental laws require that the air district's staff report contains an analysis of cost-effectiveness, energy and environmental impact, best available technology including equipment lifetime, and local economic impact, among other things. The air districts' rulemaking process takes into consideration the factors also required for a BART determination. Therefore, California did not proceed to the sUbject-to-BART modeling or BART determination phase when the source was already equipped with the most stringent technology, or, is at the level of control deemed cost-effective by the air district for that source category.

## 5.6 Visibility Impact Analysis

The BART rule allows a "subject-to-BART" screening prior to a BART determination that excuses sources from further review if the impact does not cause or contribute to visibility impairment. A one deciview increment is the amount of change in clarity that a human eye can detect when viewing an object on the horizon. Therefore, in the BART rule, the U.S. EPA set the contribution increment of 0.5 deciviews above the baseline threshold as the indicator of *contributing* to visibility impact and allowed states the discretion to set a lower impact threshold. Forsubject-to-BART visibility impact screening, the baseline threshold in California was set at the Statewide average deciview level at Baseline Conditions.

The U.S. EPA also allows all the BART-eligible sources at a facility to be excused from further review if the ratio of their cumulative potential to emit (0) in tons per year of NOx and SOx divided by the distance in kilometers (D) to the nearest Class 1 Area, is less than 10. This rule of thumb *(010* <10) applies only when no other facilities with BART-eligible sources are close to the surrounding Class 1 Areas, so as to avoid cumulative impacts. U.S. EPAused modeled scenarios to demonstrate that a maximum impact of 0.5 deciview impact above the threshold of the baseline best day average for the nearest Class 1 Area was not exceeded, when *010* <10. Several of California's facilities with BART-eligible sources are within 25 kilometers of a Class 1 Area and therefore their BART-eligible emission units could not be excused via a *010* calculation.

It is possible that several BART-eligible emission units, cumulatiyely, might cause or contribute to impaired Visibility because they are clustered very close to a Class 1 Area, even though they individually have less than the maximum

0.5 deciview impact above the allowed threshold. In California, if the modeled Visibility impact of the sum of the pertinent facility emissions exceeded the threshold by 0.5 deciviews, then BART determinations were required for each individual BART-eligible emissions unit at the facility.

The CalPuff modeling protocol used to determine visibility impacts is described in Appendix C. California conducted this "subject-to-BART' visibility modeling only on sources not sufficiently controlled by the air district rules. The BART reqUirement also allows the exclusion of pollutants below a de minimus emissions level from subject-to-BART visibility modeling when evaluating an entire facility for visibility impact if:

1. a PTE <15TPY for PM emissions, or
2. a PTE <40 TPY of SOx emissions, or
3. a PTE <40 TPY of NOx emissions.

Those emission units at a single facility that cumUlatively emit only the pollutant(s) falling below these de minimus thresholds were listed but excused from further review.

## 5.7 BART Determination Overview

A BART determination evaluates retrofit options for an individual source, starting with the most stringent level, until the appropriate level is determined. Since local air districts permit stationary sources, the local air districts are responsible for the BART determination taking into account: .

1. available retrofit control options;
2. any pollution control equipment in use at the source (which affects the availability of options and their impacts);
3. costs of compliance for control options;
4. remaining useful life of the facility;
5. energy and non-air quality environmental impacts of control options, and
6. visibility impacts analysis.

Where MACT or LAER standards exist for a source category, California views these as meeting or exceeding a BART level of control. . The permitee may be able to show compliance with a lesser level of control when the six factors listed above are considered. .

## 5.8 BART-eligible List and Results. of SUbject-to-BART Modeling

Table 5-2 lists the BART-eligible sources in California identified and evaluated by ARB and the air districts. The list also summarizes which BART-eligible units needed subject-to-BART visibility modeling and why the others did not. Only one modeled facility had a visibility impact greater than 0.5 deciviews over the threshold.

**Table 5-2 List of BART-eligible Sources (Emission Units)**

| Air District | BART-Eligible Source [1] | BART-Level Control (for specific District rule details go to http://www.arb.ca.gov/drdb/drdbltxt.htm) | Further Action Needed |
|---|---|---|---|
| Bay Area Air Quality Management District | Chevron Refinery (Richmond)<br>- #4 Rheniformers, F-3550 & F-3560<br>- #4 Rheniformers, F-3570 & F-3580<br>- #5 Rheniformers, F550 & F560<br>- #5 Rheniformers, F570 & F580<br>- #1 JHT Furnace #247<br>- #1 JHT Furnace #21 OA&B<br>- Furnaces for #5 Naptha Hydrotreaters F410 &F447<br>- Furnace) VGO Desulfurizer F-1610<br>- #4 Crude Unit F 1100a<br>- #4 Crude Unit F1100b<br>- #4 Crude Unit F1160<br>- LSFO Cooling Tower<br>- 3 CAT Cooling Tower E460<br>- F-100 Asphalt Solution Heater SDA Isomax<br>- F-110 Asphalt Solution Heater SDA Isomax<br>- F-120 Asphalt Solution Heater SDA Isomax<br>- F-'320 Naphtha Vaporizer, H2 Plant Isomax<br>- F-330 Naphtha Vaporizer, H2 Plant<br>- F-41 0 & F-420TKC Feed FurnacesfTKC Isomax Umits<br>- F-510 & F-520 & F-530 TKNFeed Furnace/lsomax<br>- F-610 & F-620 &F-630 Isocracker Feed Furnace and Isomax W/Ultra Low NOx Burners<br>- F-710 TKC Fractionator and Isomax<br>- F-730 Isocracker Splitter Feed Furnace and Isomax W/Ultra Low NOx Burners<br>- F-731 Isocracker Reboiler and Isomax W/Ultra Low NOx Burners | BAAQMD Regulation 9, Rule 1<br><br>BAAQMD Regulation 9, Rule 10, Section 303<br><br>40 CFR 60, Subpart J<br><br>40 CFR63, Subpart UUU<br><br>Consent Decree with U.S. EPA | NO<br><br>Modeled visibility impact is 0.393' dv above the threshold |



416

**Table5-2 List of BART-eligible Sources (Emission Units) (continued)'**

| Air District | BART-Eligible Source [1] | BART-Level Control (for specific District rule details go to http://www.arb.ca.gov/drdb/drdbltxt.htm) | Further Action Needed |
|---|---|---|---|
| | Chevron Refinery (Richmond) (continued)<br>– F305 H2 Reforming Furnace, H2 pfant<br>- F355 Reforming Furnace, H2 Plant<br>- Isomax Cooling Tower -E-261<br>- Alkane Cooling Water Tower<br>– F-2170Stack Gas Heater #1 SRU Cat. Crack.<br>– F-2270 Tail Gas Heater #2 SRU<br>- F-2370 Tail Gas Heater #3 SRU<br>- *High Level Flare, LSFO (6010)<br>- *V-282 South Isomax Flare (6012)<br>-. *North Isomax Flare V-281 (6013 | | |
| Bay Area Air Quality Management District | Conoco-Phillips Refinery and Carbon Plant under single permit (Rodeo)<br>– Kiln (stack 2)<br>- U240 B-1 Boiler<br>- U240:B-2 Boiler<br>- U240 B-101 Heater<br>- U240:B-202 Heater<br>- U240 B-401 Heater<br>- U244:Heaters: B-501 & B-502 & B-503 & B-504 & B-505<br>- U244_B-506 Heater'<br>- U244_B-507 Heater<br>-U248J3-606 Heater<br>- U236 Cooling Tower<br>- U240 Cooling Tower<br>– U200 Cooling Tower<br>- *Dedust Oil Storage Tank (no emissions)<br>- *Rotary Cooler#2 (no emissions)<br>– *Sulfur Pit 236 (no emissions)<br>- *Sulfur Pit 238 (no emissions | - BAAQMD Regulation 9, Rule 1<br>- BAAQMO Regulation 9, Rule 10, Section 303<br>- 40 CFR 60, Subpart J<br>- Consent decree with EPA | NO<br><br>Modeled visibility impact is 0.366 dv above the threshold |



417

**Table 5-2 List of BART-eligible Sources (Emission Units) (continued)**

| Air District | BART-Eligible Source [1] | BART-Level Control (for specific District rule details go to http://www.arb.ca.gov/drdb/drdbltxt.htm) | Further Action Needed |
|---|---|---|---|
| | Conoco-Phillips Refinery and Carbon Plant under single permit (Rodeo) (continued)<br>- *C-1 Flare<br>- *U240..:..Uni-Cracking Unit 240<br>-. *U244 Reforming Unit 244<br>- *U248 Unisar Unit 248<br>- *U40 Raw Materials Receivin | | |
| Bay Area Air Quality Management District | Mirant Power Plants under single permit<br>Antioch (A0018)<br>- Boiler #10 (Low NOx Burners & SCR)<br>Pittsburg (A0012)<br>- Boiler No.7<br>- Emergency Diesel Generator36<br>- No. 7-1 Diesel Fire Pump<br>- No. 7-2 Diesel Fire Pump<br>Potrero (A0026)<br>- Boiler No. 3-1 | - BAAQMD Regulation 9, Rule 11, Section 308 for NOx (0.28lb NOxlMMbtu)<br>- Permit requires exclusive use of low sulfur natural gas to control PM10 and S02 at the boilers at facilities A0012 and A0018 | NO<br><br>Already at BART level |
| Bay Area Air Quality Management District | Rhodia Sulfuric Acid Plant (Martinez)<br>- Sulfuric acid plant<br>- Cooling tower·<br>- *Natural Gas Preheater Furnace (start-up only, below 40 TPY)<br>- *Sulfur Storage Tank T-2<br>- *Sulfur Storaae Tank T-12 | - Consent Decree limits SOx emissions to 2.2 lbs S02 per Ton; current actual emissions range 0.6 to 0.8 lbs S02 per Ton with baseline period maximum of 1.74 tons per day for sulfur plant<br>- Storage tanks have no reported emissions | NO<br><br>Modeled visibility impact is 0.092 dv above the threshold |

**Table 5-2 List of BART-eligible Sources (Emission Units) (continued)**

| Air District | BART-Eligible Source [1] | BART-Level Control (for specific District rule details go to http://www.arb.ca.gov/drdb/drdbltxt.htm) | Further Action Needed |
|---|---|---|---|
| Bay Area Air Quality Management District | Shell Refinery (Martinez)<br>- EMSR7 Cooling Tower # 32 (LOP)<br>- Thermal Oxidizers S.P. # 1 (stack 3)<br>- Thermal Oxidizers S.P. # 2 (stack 3)<br>- EMSR1-CO Boiler # 2 (SCR & ESP)<br>- *LMSR1 Utilities Lime Storage Bin 1<br>- *EMSR1 Utilities Lime Storage Bin 2<br>- *Misc. Sand Hopper (storage, not used routinely, no vents)<br>- *LOG LPG Loading Flare (abatement device for LPG loading rack)<br>- *LOP Auxiliary Flare (emergency use only)<br>- *LUBS2 Cooling Tower # 35 (not operating since 2003' | - BAAQMD Regulation 9, Rule 10 covers NOx from CO Boiler which is abated with SCR and ESP<br>- Many BART-era units are closed or controlled storage systems with no reported emissions<br>- 40 CFR 60, SUbpart J<br>-- Consent decree with EPA | NO<br>Modeled visibility impact is 0.169 dv above the threshold |
| Bay Area Air Quality Management District | Tesoro Refinery (Martinez)<br>- #51 Furnace-#2 Reformer Auxiliary Reheat<br>- Alkylation Turbine<br>- No.3 Crude Unit Cooling Tower<br>- Sulfur Recovery Unit<br>- *Tank 691 Safety Flare | - BAAQMD Regulation 9, Rule 1<br>- BAAQMD Regulation 9,.Rule 9 (55 ppmv NOx @15% 02 at alkylation turbine)<br>- BAAQMD Regulation 9, Rule 10, Section 303<br>- 40 CFR 60, SUbpart J<br>- 40 CFR 63, SUbpart UUU<br>- Consent decree with EPA | NO<br>Modeled visibility impact is 0.069 dv above the threshold |

**Table 5-2 List of** BART-eligible Sources **(Emission Units) (continued)**

| Air District | BART-Eligible Source [7] | BART-Level Control (for specific District rule details go to http://www.arb.ca.gov/drdb/drdbltxt.htm) | Further Action Needed |
|---|---|---|---|
| Bay Area Air Quality Management District | Valero Refinery (Benicia)<br>- Crude pre-Heat Process Furnace F-101 (Main Stack P-1)<br>- Reduced Crude pre-Heat Process Furnace F-102 (Main Stack P-1)<br>- FCCU Regenerator R-702 (Main Stack P-1)<br>- Coker (Main Stack P-1)<br>- Stacks P30 & P31: Reformer Furnaces S211*S22<br>- Stacks P19 & P20: TurbinelWaste Heat Boiler SG-701<br>- Stack P47: TurbinelWaste Heat Boiler SG-702<br>- Stacks P17 & P18: TurbinelWaste Heat Boiler SG-401<br>- Stacks P24 & P25: TurbinelWaste Heat Boiler SG-1031<br>- Stack P50: Claus Units 1 & 2<br>- Cooling Tower<br>- Sulfur Storage Tank (any emissions routed to stacks P24/25)<br>- *Acid Gas Flare<br>- *Butane Flare ST-1701<br>- *South Flare ST-2101 (Flare Gas Recovery System)<br>- *North Flare ST-2103 (Flare Gas Recovery System)<br>- *Sulfur Storage Pit at Sulfur Plant (any emissions routed to SRU)<br>- *TK 2325: Brine Saturator (no emissions)<br>- *Sulfur Plant 'A' Tail Gas Incinerator F-1302A (used only for SRU upset)<br>- *Sulfur Plant 'B' Tail Gas Incinerator F-1302B (used only for SRU upset)<br>- *Lime Silo 2303 controlled by baghouse; permit-limited throuahout 292 TPY | - Claus Units are at MACT level; subject to NSPS and NESHAPS limits<br>- BAAQMD Regulation 9, Rule 1<br>- BAAQMD Regulation 9, Rule 9<br>- BAAQMD Regulation 9, Rule 10, Section 303<br>-40 CFR 60, Subpart J<br>- 40 CFR 63, Subpart UUU<br>- Flares subject to consent decree | YES<br>Modeled visibility impact is 0.758 dv above the threshold<br>BART Determination required.. |

**Table 5-2 List of** BART-eligible Sources **(Emission Units) (continued)**

| Air District | BART-Eligible Source [1] | BART-Level Control<br>(for specific District rule details go to http://www.arb.ca.gov/drdb/drdbltxt.htm) | Further Action Needed |
|---|---|---|---|
| Mojave Desert Air Quality Management District | Coolwater Reliant <Daggett)<br>(EGU, all units>250MMBTU/hr)<br>- Boiler 2 (#1078) (paired w/ Boiler #1, which is not a "BART-era" boiler)<br>- Turbine 31 (#1079)<br>- Turbine 32 (#1080)<br>- Turbine 41 (#1 081)<br>- Turbine 42 (#1082)<br>(gaseous fuel, very limited use of liquid fuel as emeraencv back-u | Boilers: FGR<br>NOx: 70 ppm (0.09 lb/MMBtu) (gas)<br>115 ppm (0.15 lb/MMBtu) (liquid)<br>per MDAQMD Rule 1158 .<br>(Boilers permit limited to 1319 TPY total combined emissions)<br><br>Turbines: WI<br>NOx: 42 ppm (gas), 65 ppm NOx (liqUid) per MDAQMD Rule 1158 | NO<br><br>Modeled visibility impact is 0.489 dv above the threshold |
| Mojave Desert Air Quality Management District | Searles Industrial (Searles Lake)<br>(boilers >250 MBTUlhr)<br>- Argus Boiler 554 (#26)<br>- Argus Boiler 555 (#25)<br>- Backup Boiler #483 (#22)<br>• < 40TPY each of NOx, SOx<br>• <15 TPY PM<br>(Coal fuel, tangentially fired design) | Boilers:<br>Argus Boilers have FGR, LNB, OFA, voluntary urea injection, wet scrubber, ESP<br>Boiler #22 has permit-limited hours of operation<br>NOx: 221 lb/hr (0.22lb/MMBtu)<br>SOx: 44.7 lb/hr (0.04 lb/MMBtu)<br>PM10: 45 lb/hr (0.04 lb/MMBtu)<br><br>Turbine: SCR<br>NOx: 42 ppm | NO<br><br>Modeled visibility impact is 0.208 dv above the threshold |
| Mojave Desert Air Quality Management District | TXI Cement (Oro Grande)<br>(Portland Cement plant)<br>- 5 kilns (each 130MMBTU/hr).<br>- 2 Kilns (each 120MMBTUlhr with waste boiler)<br>- 1 Dre-calciner kiln (727 MMBTUlhr | Complete Replacement in 2007 with new kilns under New Source Review<br>(old kilns and boilers went out of service early 2008) . | NO |

**Table 5-2 List of BART-eligible Sources (Emission Units) (continued)**

| Air District | BART-Eligible Source [1] | BART-Level Control (for specific District rule details go to http://www.arb.ca.gov/drdb/drdbltxt.htm) | Further Action Needed |
|---|---|---|---|
| Monterey Bay Unified Air Pollution Control District | Dynergy Moss Landing, LLC (formerly Duke Energy, Moss Landing Power Plant) (EGU)<br>– Boiler Unit 6<br>– Boiler Unit 7 | - Both tangential-fired boilers retrofit post-1980with SCR, regulatory limit of 10ppm NOx and 1Oppm ammonia slip<br>- Burns natural gas; fuel oil not allowed<br>- CEM on this facility report annually to district<br>- NOx: Rule 4-31 limit 0.30 Ibs/million Btu<br>- SOx: low sulfur fuel only<br>- Cooling System best achievable non-air environmental impact per California: Energy Commission's Order No. 00-1025-24 | NO |
| San Diego County Air Pollution Control District | Cabrillo Encina Plant (Carlsbad) (EGU)<br>- Units 1-5 have SCR<br>- Unit 6 is peaking unit with water injection & permit limited to 877 hours of operation | SCR or permit-limited operation | NO |
| San Diego County Air Pollution Control District | Duke Energy (South Bay) (EGU)<br>- Units 1-4 have SCR<br>- Unit 5 is peaking unit with water injection & ermit limited to 877 hours of ooeration | SCR or permit-limited operation | NO |

**Table 5-2 List of BART-eligible Sources (Emission Units) (continued)**

| Air District | BART-Eligible Source [1] | BART-Level Control (for specific District rule details go to http://www.arb.ca.gov/drdb/drdbltxt.htm) | Further Action Needed |
|---|---|---|---|
| San Joaquin Valley Air Pollution Control District | J R Simplot Company (Nitrogenous Fertilizer and Sulfuric Acid Plant (Lathrop)<br>- Sulfuric Acid Plant | - TOTAL PTE NOx + SOx + PM10= 660 TPY<br>- Distance to nearest Class 1 Area> 100 .kilometers and facility is not clustered with other sources, OlD < 10 | NO |
| San Joaquin Valley Air Pollution Control District | Big West (formerly Eguilon Bakersfield Refinery) (also former IVEC and Tosco refineries in Bakersfield)<br>- Process Heaters/ Boilers/ Steam Generators/Internal Combustion Engines (all less than 250MMBTUlhr.)<br>- Flares<br>- Cooling Towers<br>- Tanks | .- NOx controlled by BARCT Rules 4305, 4306, 4701,4702<br>- Flares controlled by Rule 4311<br>- Tanks: .Rule 4623<br>- During Baseline: NOx>250 TPY PTE, but phased reductions bring current operations to Total PTE NOx+SOx+PM10 ~ 313 TPY<br>- Distance to nearest Class 1 Area = 80 . kilometers and facility is not clustered with other sources, OlD < 10 | NO |
| San Joaquin Valley Air Pollution Control District | Aera Energy LLC (Coalinga oil fields - southwest of Fresno on west side of Valley)<br>(Permit 1121) .<br>-7.600 barrels of heavy crude per da | - Boilers: BARCT Rules 4305 & 4306<br>- Tanks: Rule 4623<br>- Low sulfur fuel used | NO |
| San JoaqUin Valley Air Pollution Control District | Aera Energy LLC<br>(Midway Sunset Complex NW of Bakersfield)<br>(Combinea Permit 1136/1548)<br>- IC engines<br>- Iiaht oil production field -50,000 barrels per day | - IC engines: BARCT Rules 4701 & 4702<br>- Tanks: Rule 4623<br>- Low sulfur fuel used where system not electrified | NO |
| San Joaquin Valley Air . .Pollution . Control District | Aera Energy LLC<br>(Bellridge Complex oil fields near Fellows)<br>(also former Shell California Production Western E & P)<br>(Combined Permit 1135/1547)<br>heavy oil production field >140,000 barrels per·day<br>all boiler steam aenerators <250 MMBTUlHr heat input | - Boilers: BARCT Rules 4305 & 4306<br>- Tanks: Rule 4623<br>- Low sulfur fuel used<br>-Shell Facility during baseline period now part of Aera Bellridge Complex | NO |

**Table 5-2 List of BART-eligible Sources (Emission Units) (continued)**

| Air District | BART-Eligible Source [1] | BART-Level Control (for specific District rule details go to http://www.arb.ca.gov/drdb/drdbltxt.htm) | Further Action Needed |
|---|---|---|---|
| San Joaquin Valley Air Pollution Control District | Chevron (by 2008) formerly Nuevo Energy Co. aka Plains Exploration & Production Co. (Fresno County "Address": S. 7fT. 20s R. 16e (Permit 2885)<br>- gas & light oil production<br>*(Actual NOxlSOxIPM10 <250TPY during baseline vears; PTE not available* | - IC engines: BARCT Rules 4701 & 4702<br>- Tanks: Rule 4623<br>- Low sulfur fuel used<br>- Converting to electrified engines | NO |
| San Joaquin Valley Air Pollution Control District | Nuevo Energy Company aka Plains Exploration & Production Company (Kern CounM (Permit 1372)<br>- heavy oil production<br>- all boiler steam generators <250 MMBTUIHr heat input<br>*(Actual NOx/SOxIPM10 < 250TPY during baseline vears; PTE not available* | - Boilers: BARCT Rules 4305 & 4306<br>- Tanks: Rule 4623<br>- Low sulfur fuel used | NO |
| San Joaquin Valley Air Pollution Control District | Spreckels Sugar Company (Mendota) (Permit 1179)<br>- 311 MBTU/hr Boiler | - Boiler: BARCT Rules 4305 & 4306<br>– Low sulfur fuel used | NO |
| San Joaquin Valley Air Pollution Control District | Occidental Of Elk Hills, Inc. (by 2008) aka Vintage Petroleum Inc (Kern County) (Permit 1738)<br>- light oil production<br>Occidental Of Elk Hills, Inc. (linked to Vintage) (Gas Plant) (Tupman, Kern County) (Permit 2234)<br>- Crude Petroleum & Natural Gas production<br>- 2000 horsepower IC enaine | - IC engines: BARCT Rules 4701 & 4702<br>- Tanks: Rule 4623<br>- Low sulfur fuel used<br>- Converting to electrified engines | NO |

424

**Table 5-2 List of BART-eligible Sources (Emission Units)(continued)**

| Air District | BART-Eligible Source [1] | BART-Level Control (for specific District rule details go to http://www.arb.ca.gov/drdb/drdbltxt.htm) | Further Action Needed |
|---|---|---|---|
| San Joaquin Valley Air Pollution Control District | Chevron USA Inc. (Fresno) aka Chevron-Texaco ,(Permit 0311)<br>- heavy oil production<br>- Large boiler | Boilers: BARCT Rules 4305 & 4306<br>Tanks: Rule4623 .<br><br>Low-sulfur fuel used | |
| | Chevron USA Inc (Kern) aka Chevron-Texaco (Kern County) (Permit 1127)<br>- Heavy Oil·Production | *(All these facilities may have been operating under separate permits during the baseline years but they are all under one permittee by 2008)* | NO |
| | Texaco Exploration aka Chevron-Texaco (Fresno) (Permit 1311)<br>- Heavy Oil Production | *(Permits 1127, 1128, 1129,0311, 1131, 1141 are all connected)* | |
| | Santa Fe Energy Resources, Inc aka Chevron-Texaco (Permit 1311)<br>(sold to Texaco and dismantled 1998) | | |
| | Chevron USA Inc aka Chevron-Texaco (Kern County) (Permit 1128)<br>- Heavy Oil Production | | |
| | Chevron USA Inc aka Texaco Explor & Prod Inc aka Chevron-Texaco .<br>(Kern County)(Permit 1129)<br>- Heavy Oil Production | | |
| | Texaco California Inc. (TCI) .aka Chevron-Texaco (Kern County)(Permit 1141)<br>- Heavv Oil Western | | |

**Table 5-2 List of BART-eligible Sources (Emission Units) (continued)**

| Air District | BART-Eligible Source [1] | BART-Level Control (for specific District rule details go to http://www.arb.ca.gov/drdb/drdbltxt.htm) | Further Action Needed |
|---|---|---|---|
| San Luis Obispo County Air Pollution Control District | Duke Energy (Morro Bay EGU)<br>– Unit 3 retrofit 1994-5 (OFA, LNB, FGR)<br>– Unit 4 retrofit 1994-5 (OFA, LNB, FGR)<br>(application to replace entire facility pending approval by California Energy Commission) | NOX: entire facility permit limited to 2.5 TPD. bubbled with post 1977 units 6 and 7, (facillty<1000TPY)<br>SOX: natural gas fired - State low sulfuduellimits | NO |
| San Luis Obispo County Air Pollution Control District | Conoco-Phillips (formerly TOSCO) (Santa Maria Refinery)<br>– coke calciner | Conoco-Phillipssurrendered permit for Santa Maria Calciner in November 2007 per agreement with CA Attorney General for GHG reductions | NO |

**Table 5-2 List of BART-eligible Sources (Emission Units) (continued)**

| Air District | BART-Eligible Source [1] | BART-Level Control (for specific District rule details go to http://www.arb.ca.gov/drdb/drdbltxt.htm) | Further Action Needed |
|---|---|---|---|
| South Coast Air Quality Management District | Rhodia Sulfuric Acid Plant (Carson) . | SOx & NOx: RECLAIM'[2]<br>PTE for PM10 is <15TPY | NO |
| South Coast Air Quality Management District | California Portland Cement (Colton) | SOx & NOx: RECLAIM<br>PM10: Rule 1156 and kilns vented to baghouse equipped with pulse jet electronic control | NO |
| South Coast Air Quality Management District | So Cal Gas<br>(Natural Gas Transmission) (Northridge) | SOx & NOx: RECLAIM<br>PTE for PM10 is <15TPY | NO |
| South Coast Air Quality Management District· | BP West Coast Products (refinery)(Carson)<br>- Coke handling Unit<br>- FCCU<br>- Coolin Towers | SOx & NOx: RECLAIM<br>PM: R1158 & R1105.1 as adopted in 1999 & 2003 . | NO |
| South C.oast Air Quality Management District | BP Wilmington Calciner (refinery)(Wilmington)<br>- Coke handling Unit<br>- FCCU<br>- Coolin Towers | SOx & NOx: RECLAIM<br>PM: R1158 & R1105.1 as adopted in 1999 & 2003 | NO |
| South Coast Air Quality Management District | Ultramar. Inc. (refinery) (Wilmington)<br>- Coke handling Unit<br>- FCCU<br>- Coolina Towers | SOx & NOx: RECLAIM<br>PM: R1158 & R1105.1 as adopted in 1999 & 2003 | NO |

427

**Table 5-2 List of,BART-eligible Sources (Emission Units) (continued)**

| Air District | BART-Eligible Source [1] | BART-Level Control (for specific District rule details go to http://www.arb.ca.gov/drdb/drdbltxt.htm) | Further Action Needed |
|---|---|---|---|
| South Coast Air Quality Management District | Chevron Products Company . (refinery) (El Segundo)<br>- Coke handling Unit<br>- FCCU<br>- Coolin Towers | SOx & NOx: RECLAIM [2]<br>PM: R1158 & R1105.1 as adopted in 1999 & 2003 | NO |
| South Coast Air Quality Management District | Exxon Mobil Oil Corporation (refinery) (Torrance)<br>- Coke handling Unit<br>- FCCU<br>- Coolin Towers | SOx & NOx: RECLAIM<br>PM: R1158 & R11 05.1 as adopted in 1999 & 2003 | NO |
| South Coast Air Quality Management· District | Conoco Phillips Company (refinery) (Carson)<br>- Coke handling Unit<br>- FCCU<br>- Coolin Towers | SOx & NOx: RECLAIM<br>PM: R1158 & R1105.1 as adopted in 1999 & 2003 | NO |
| South Coast Air Quality Management District | Conoco Phillips Company (refinery) (Wilmington)<br>- Coke handling Unit<br>- FCCU<br>- Coolin Towers | SOx & NOx: RECLAIM<br>PM: R1158 & R11 05.1 as adopted in 1999 & 2003 | NO |
| South Coast Air Quality Management District | Tesoro Corporation (refinery) (Wilmington)<br>- Coke handling Unit<br>- FCCU<br>- Coolina Towers | SOx & NOx: RECLAIM<br>PM: R1158 & R11 05.1 as adopted in 1999 & 2003 | NO |

**Table 5-2 List of BART-eligible Sources (Emission Units) (continued)**

| Air District | BART-Eligible Source [1] | BART-Level Control (for specific District rule details go to http://www.arb.ca.gov/drdb/drdbltxt.htm) | Further Action Needed |
|---|---|---|---|
| Ventura County Air Pollution Control District | Reliant EGU (Ormond Beach)<br>- Unit 1 Steam Generator (SCR in 1990's, AI)<br>- Unit 2 Steam Generator (SCR in 1990's, AI) (natural gas, lo-sulfur fuel)<br>- two auxiliary steam generators (LNB, FGR in 1990's) | BARCT (California Best Available Retrofit Control Level for Ventura)<br>Total facility emission levels given as illustrative example only:<br>Permitted Emissions ITPYI 2004 Actual Emissions (TPY)<br>86.70 ROC 38.3 ROC<br>621.58 NOx 84.5 NOx<br>154.34 PM 28.9 PM<br>37.04 SOx 6.9 SOx<br>2778.20 CO 520.5 CO<br>ermit allows full time use of Unit Nos. 1 & 2 | NO |

1 For the facilities requiring sUbject-to-BART modeling, listed units preceded with an asterisk were not modeled for one of the following reasons:

- the unit is utilized during start-up, shut-down, malfunction, and other unpredictable, non-routine upsets;
- the unit is used for emergency relief, when upstream control units cannot accommodate sudden, non-routine emissions;
- the unit has minimal emissions into a closed system where its emissions are captured and routed to another unit,which was modeled; or
- the unit is permit-limited to an emission level that is below the de minimus levels for NOx, SOx, and PM10, and is effectively controlled to BART level such that there is no more stringent control option available for the unit.

The emissions from these units are very low, but they were "brought into" BART-eligible listing because emissions from other BART-eligible' units at the facility exceeded the 250 TPY threshold.

2 The RECLAIM Program in the South Coast Air Quality Management District is designed to generally substitute a cap-and-trade market mechanism for a com'mand-and-control regulatory structure in the pursuit of NOx and SOx emissions reductions from major facilities within the District. The intent of the program is to reduce emissions of these pollutants at a faster rate than could be achieved by traditional methods and at lower overall cost.

The RECLAIM Program was originally adopted in 1993, and requires three stages of emission reduction by 2011. In the first stage, which extended to 2000, facilities were required to comp'ute emissions using historical activity rates and emission factors representing best available retrofit technology (BARCT) in 1993. Facilities were further required to meet facility-wide emission targets based on these 1993 BARCT factors by 2000. In the second phase of emission reductions, affected facilities were required to reduce NOx and SOx emissions between 2000 and 2003 by a uniform percentage calculated by the District. RECLAIM rules require that this reduction be sufficient to bring the aggregate of affected facility emissions to attainment targets specified in the 1991 Air Quality Management Plan.

429

In 2005, the District conducted a study to determine whether reductions under these first two phases were equivalent or greater than those that would have been achieved by the application of BARCT rules to all affected facilities. This study concluded that BARCT limits were more restrictive in 2005 than!n 1993, and recommended amendments to the RECLAIM program to achieve these new lower levels. The RECLAIM rules were amended in 2005 and regulated facilities now must further reduce emissions by 2011 to achieve facility-wide emission levels equivalent to those represented by 2005 BARCT limits.

As a result of the scope of the RECLAIM Program in covering all facilities emitting four or more tons per year of NOx or SOX, and the diligence with which SCAQMD staff have analyzed and compared the benefits ofthis program to the universal application of BARCT to all stationary sources, the RECLAIM Program can be deemed equivalent in terms of emission reduction to the application of a universalBARCT regulation or the eqUivalent BART limitation under U.S. EPA's visibility protection program.

## Abbreviations Used in Table 5-2

AI- Ammonia Injection
BARCT - Best Available Retrofit Control Technology
dv - Deciview or deciviews
EGU - Electric Generating Unit
ESP - Electrostatic Precipitator
FCCU- Fluid Catalytic Cracking Unit
FGR - Flue Gas Recirculation
GHG - Greenhouse gas
IC -Internal Combustion (engines)
lbs- pounds
JHT - Jet Hydrotreater
LNB - Low NOx burner
MMBTU - One million British Thermal Units, (also a thousand thousand BTUs)
NOx - Oxides of Nitrogen
NSCR - Non-Selective Catalytic Reduction
OFA - Over Fire Air
PM - Particulate Matter (usually followed by 10 or 2.5 to denote the largest particle size in microns)
ppm - Parts per million
PTE - Potential to Emit
*Q/D* - Q is the total of PTE for NOx + SOx + PM10 divided by distance in kilometers to Class 1 Area
ROC - Reactive Organic Carbon
SCR - Selective Catalytic Reduction
SOx - Oxides of Sulfur
SRU - Sulfur Recovery Unit
TBD - To be determined
TPD -Tons per Day
TPY - Tons per Year
WI - Water Injection

## 5.9 BART Determination

Valero Refining Company (Valero) operates a refinery in Benicia, in Solano' County, in the San Francisco Bay Area Air Quality Management District (BAAQMD). The refinery is about 50 kilometers east of Point Reyes National Seashore. It has 27 individual BART-eligible units.. Eighteen of the units emit to 12 stacks. Four are flares sUbject to a consent decree. Five units have no emissions or very low, non-routine, upset emissions collected and routed to pollution control devices or newer process units after 1977. The 24-hour maximum emissions during 2000-2002 were modeled for the 12stacks.The flares were not modeled due to the non-routine nature of their operations. The remaining units were not modeled for the same reason, and because their minimal emissions are collected by non-BART-eligible controls or processes." The baseline case reflects operations during the modeling period used to obtain subject-to-BART modeling results. .

Since the modeled impact of the cumulative emissions from the BART-eligible units at the facility was more than 0.5 dv, but less than one deciview over the threshold, the impacts are considered to contribute to, but not cause, haze at the Point Reyes National Seashore on the coast north of San Francisco. Therefore, BAAQMD completed a BART determination for the BART-eligible sources at the facility (Appendix D).

The BAAQMD evaluated every source for the most stringent level of technical control first. If a technology was not feasible due to physical or operational constraints, energy or non-air quality related impacts, or compliance cost, it was ruled out. The existing level of control and the lifetime of the existing equipment were also considered 'in evaluating the options. The Claus Units and the Cooling Tower are already operating at BART level, considering the available technology, operational constraints, and the cost of replacement for minimal emission reductions. In other words, no retrofit controls are available for the Cooling Tower and the Claus Units better than what currently exists, short of a complete rebuild. Also, these two types of units exist in part to control emissions. The Cooling Tower has internal baffles to dampen the emissions of condensable aerosol particles and the Claus Units are part of a SOx capture and recovery system. Further, the sulfur storage tank is a "closed system" built before 1977, but connected since then to the Claus units as a means of. eliminating any emissions.

Based on the BAAQMD analysis, ARB modeled visibility impact for two scenarios. Option 1 includes the most stringent controls feasible for five of the emission units, including potential replacement of one reformer furnace with a Best Available Control Technology (BACT) level unit under New Source Review. The existing reformer furnace currently operates at BART level, but Option 1 includes the furnace replacement to BACT standards to evaluate the visibility impact. Option 2 adds selective catalytic reduction for the four boiler-turbine sets to Option 1, to determine whether the incremental benefit to visibility is cost-effective. The summary of modeled options for the Valero Refinery in Benicia are in Table 5-3.

**Table 5-3 Summary of BART Determination Modeling**

| VALERO REFINERY (Benicia) | BART Determination Modeling | NOx 24-hr. max. TPD | SOx 24-hr. max. TPD | PM10 24-hr. max. TPD | deciviews over threshold on 8th highest day |
|---|---|---|---|---|---|
| Baseline Scenario | Units listed from Table 5-2 summarized as:<br>• Four Main Stack P-1 Units:<br>-Coker<br>-Process Furnace F101<br>-Process Furnace F102<br>-FCCU Regenerator R702<br>• Reformer Furnace S-21<br>• Four Boiler-Turbine Sets<br>• Two Claus Units<br>• One Cooling Tower | 3.83 | 17.14. | 0.77 | 0.758 dv |
| Option 1 | • Retrofit and replace units contributing to main stack<br>• Potential replacement of reformer furnace to BACT .level under NSR | 3.22 | 1.25 | 0.72 | 0.291 dv |
| Option 2 | • Retrofit and replace units contributing to main stack<br>• Potential replacement of reformer furnace to BACT level under NSR<br>• SCR for Boiler-Turbine Sets | 2.01 | 1.25 | 0.72 | 0.200 dv |

Due to a Consent Decree, the BAAQMD is legally required to implement the BART level controls described in Table 5-4 below. These controls will be implemented within 5 years after U.S. EPA approves the Plan. In 2005, Valero Refinery Company and the U.S. EPA entered into a Consent Decree that underlies the improvements listed for the BART-eligible units emitting to a new Main Stack that will replace Stack P-1. The Consent Decree requires the improvements to be implemented by June 30, 2012, at the latest. The emission limit will be enforceable and assured by permit conditions assigned by the BAAQMD to the permits to construct and permits to operate these specific units at the Valero Refinery.

As explained above, Valero is evaluating the possibility of constructing a new reformer furnace to replace an existing BART-eligible furnace (S-21 or S-22.)

The existing BART-eligible reformer furnaces operate at a BART level of 0.033 pounds of NOx per million BTU of heat input on a refinery-wide basis, based on an operating-day average. CalPuff modeling evaluated the visibility impact of a replacement furnace in lieu of an existing unit in both Options 1 and 2. The potential (BACT-level) replacement would reduce NOx and PM, but slightly increase SOx, for a total change in magnitude of about 80 tons per year of all pollutants combined. The additional visibility improvement at Point Reyes National Seashore due to replacing either existing furnace S-21 or S-22 is estimated to be about 0.02dv, a very marginal impact on visibility for the cost per ton of pollutant reduced. Nevertheless, this analysis does not preclude the refinery from proceeding with upgrades and new construction to reduce emissions in the future.

As explained in the BART Determination Report (Appendix D), adding Selective Catalytic Reduction to the Boiler-Turbine Sets was deemed not cost-effective for the minimal improvement in visibility, about 0.025 dv per linked boiler-turbine set. Lesser controls for these units were not evaluated for Visibility impact. As with the potential reformer furnace replacement discussed above, the incremental improvement in visibility is approaching a level of uncertainty in modeling. Instead, the boiler turbine sets will continue to operate under the existing BAAQMD Prohibitory Regulation 9, Rule 9 requiring a NOx concentration of no more than 55 ppmv at 15% $O_2$.

Although the four BART-eligible flares at the Valero Refinery were not modeled, a consent decree between the U.S. EPA and the Valero Refining Company requires a flare minimization protocol. It also requires a causal analysis for excursions above 500 lbs $SO_2$/day. The flares already have upstream gas recovery systems, which are considered BACT for flares.

A summary of the BART emission limits and retrofit controls on BART-eligible units at the Valero Refinery is found in Table 5-4.

**Table 5-4 BART Determination for Selected Units at Valero Refinery**

| UNIT | NOx Control Type | NOx Emission Limit | $SO_2$ Control Type | $SO_2$ Emission Limit | PM Control Type | PM Emission Limit | BART Implementation Date | Means of Compliance |
|---|---|---|---|---|---|---|---|---|
| "Main Stack:" Valero Coker, -FCCU, I-CO Boilers<br>(Units S3, S4, 'SS, S6) | SCR | 50 ppm on 365-day basis<br>(est. annual emissions: 611 TPY)<br>(baseline ~ 756 TPY) | CANSOLV regenerative Amine scrubber (502 removal)<br>With BELCO pre-scrubber<br>(PM and 503 removal) | 50 ppm S02 @ 0% 02 on a 7-day average basis<br>25 ppmS02@0% 02 on a 365 day baSiS<br>(est. annual emissions: 416 TPY)<br>(baseline ~ 6222 TPY) | Scrubber | (est. annual emissions: 116 TPY)<br>(baseline ~ 179 TPY) | limits incorporated in Title V Permit by December 31,2013 | Federally enforceable permit conditions<br>Terms of Consent Decree |



434

# 6. SOURCE APPORTIONMENT AND MODELING RESULTS

The Regional Haze Rule requires that the Plan contain information regarding the sources contributing to visibility impairment as well as visibility projections for the 2018 milestone year. To provide the necessary technical and policy tools needed by states and tribes to comply with these requirements, the WRAP has established a Regional Modeling Center (RMC) at the University of California, Riverside with assistance from ENVIRON Corporation and the University of North Carolina. The RMC provides assistance to state and tribal agencies in conducting regional haze analyses over the western United States. This analysis has been performed by operating regional scale, three-dimensional air quality models that simulate the emissions, chemical transfC?rmations, and transport of gaseous criteria pollutants and fine particulate matter(PM) and consequent effects on visibility in Class 1 Areas in the western United States. In the RMC analyses, states participated in various forums to help develop a coordinated emissions inventory as discussed in Chapter 3, to evaluate the modeling processes, and to analyze source impacts on regional haze. Detailed information on the WRAP RMC modeling can be found in Appendix E.

## 6.1 Description of Source Apportionment Methods

A variety of modeling and data analysis methods can be used to evaluate the role of different source types in contributing to visibility at a given receptor site. One method, the weighted emissions potential analysis, was developed as a screening tool to decide which source regions have the potential to contribute to haze formation at Class 1 Areas, based on annual emissions inventories, baseline period wind patterns, and source to Class 1 Area distances. Although the weighted emissions potential analyses used a slightly different inventory than the modeling used to estimate future concentrations, it is still a good indicator of the sources contributing to haze.

Another method of source apportionment is to implement a mass-tracking algorithm in an air quality model to explicitly track for a given emissions source, the chemical transformations, transport, and removal of the PM that was formed from that source. This algorithm, the PM Source Apportionment Technology (PSAT), was implemented. in the Comprehensive Air Quality Model with extensions (CAMx) and used for the WRAP modeling analysis. PSAT performs source apportionment based on user-defined source groups. A source group is the combination of a geographic source region and an emissions source category. PSATwas performed for organic carbon, sulfate and nitrate. The different source categories evaluated include point sources, area sources, biogenics, off-shore emissions, natural and anthropogenic fires, on- and off-road mobile sources, road dust, fugitive dust, and wind blown dust.

## 6.2 Source Apportionment Results

Examples of the results of these source apportionment methods are provided in this section in order to highHght how these tools can be used·to identify the key source contributions to haze at California's Class 1 Areas. Results are shown for organic carbon, nitrate, and sulfate, the three drivers of haze in California. These examples illustrate three key groupings of source contributions: 1) anthropogenic sources within the WRAP region, 2) natural sources, and 3) sources, both anthropogenic and natural, from outside the WRAP region. More detailed information on source attribution for each individual Class 1 Area can be found in Appendix B.

### *6.2.1. **Organic Carbon Source Apportionment***

As described in Chapter 2, organic carbon is a key driver of haze at many Class 1 Areas. Figure 6-1 shows source apportionment results for organic carbon· at the Hoover Class 1 Area on the 20 percent worst days. The plot shows the amount of organic carbon that is derived from secondary organic aerosols from biogenic sources, secondary organic aerosols from anthropogenic emissions, and organic carbon that is directly emitted from both biogenic and anthropogenic sources. The secondary biogenic contributions to haze are the result ofVaC emissions from plants, which react in the atmosphere to form organic aerosols. Biogenic contributions are significant throughout the year, but increase substantially during the summer months when plants are in their most active growth phase. The contribution from anthropogenic secondary organic aerosols (i.e. from anthropogenic vac emissions) is very small. The remaining organic carbon comes from directly emitted sources, which also increase during the summer.

Figure 6-2 shows the results of the weighted emissions potential analysis for sources of directly emitted organic carbon at Hoover on the 20 percent worst days in 2002 as compared to 2018. The weighted emissions potential analysis shows that natural fire (wildfires) is the largest contributor, representing approximately 50 percent of the directly emitted organic carbon. This contribution is expected to remain constant in 2018. A large contribution from natural fire is seen at many Class 1 Areas in Northern California and the Sierras, with some areas such as Dome Lands indicating that almost 90 percent of the directly emitted organic carbon can be attributed to natural fire.

Figure 6-1 **Organic** Aerosol Source Attribution

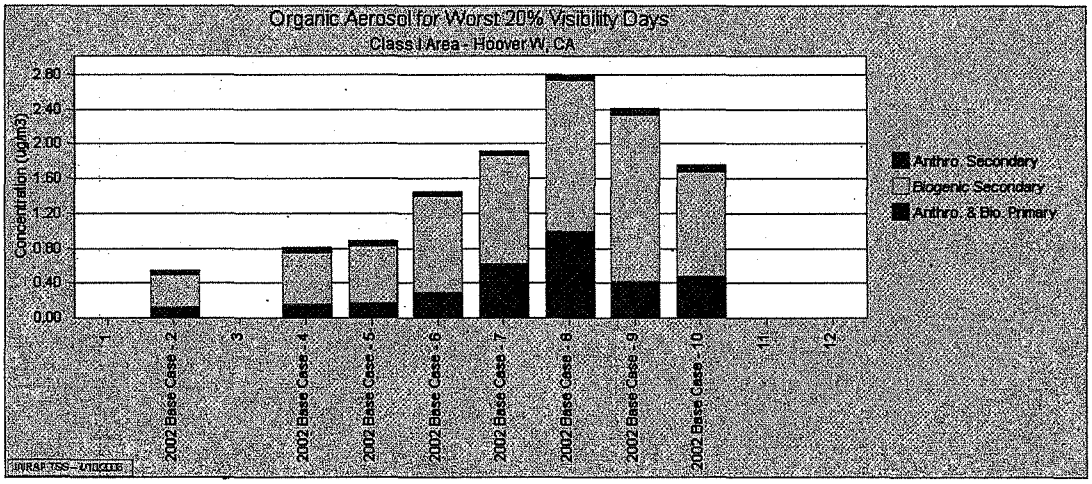
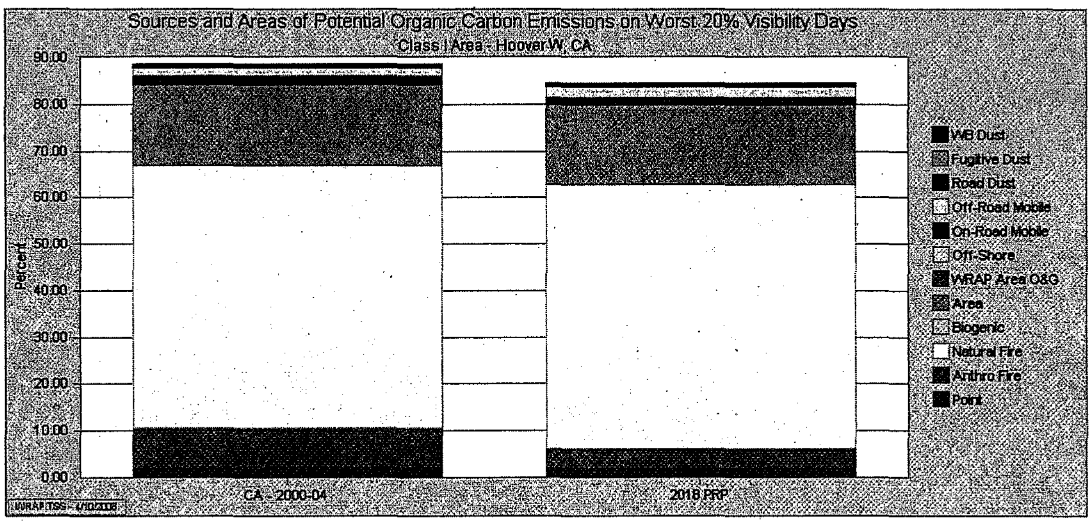



Figure 6-2 Sources of Organic Carbon on Worst 20 Percent Haze Days




### *6.2.2 Nitrate (NOx) Source Apportionment .*

Figures 6-3 and 6-4 illustrate the results of the nitrate PSAT analysis. for the San Gabriel Wilderness Area on the 20 percent worst days. In contrast to the previous organic carbon example, the bulk of nitrate contributions at San Gabriel were found to come from anthropogenic sources, with roughly 75 percent of the nitrate from sources within the WRAP region. Of this, the largest contributions were from on- and off-road mobile source emissions in California. The figures also highlight the substantial future visibility improvement that will result from mobile source sector emission reductions. Similar findings regarding the predominance of California mobile sources were found for nitrate at the majority of other Class 1 Areas.

Figure 6-3 Sources of Nitrogen Oxides on Worst 20 Percent Haze Days

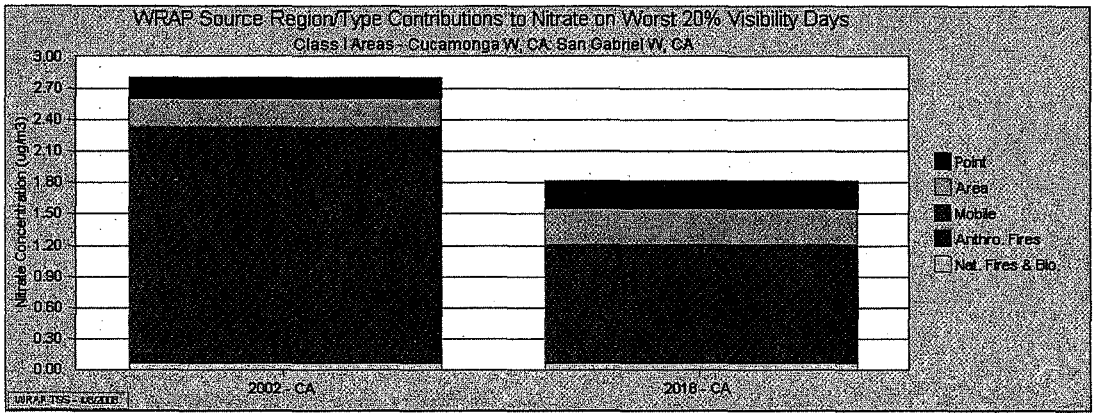
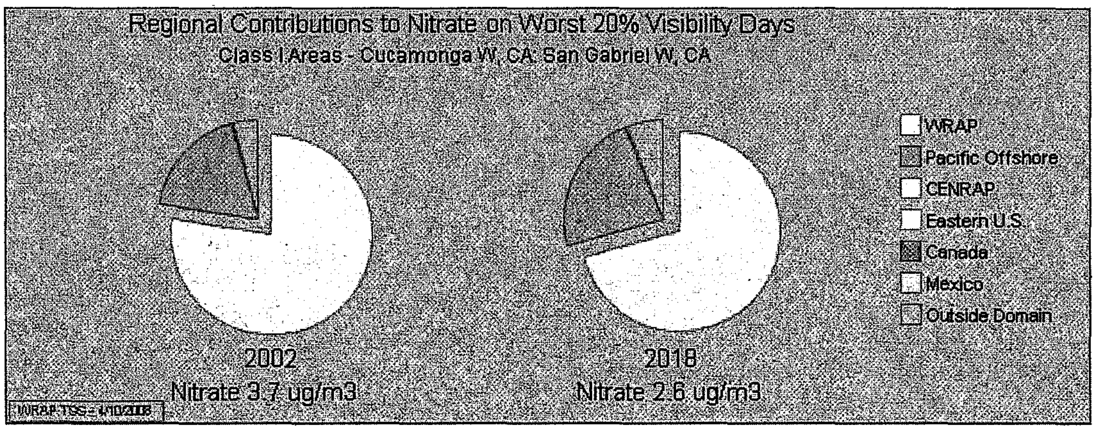



Figure 6-4 Source Region Origin of Nitrate on Worst 20 Percent Haze Days




### *6.2.3 Sulfate Source Apportionment*

Figure 6-5 shows the results of sulfate PSAT analysis for Redwoods National Park on the 20 percent worst days. Point and area sources represent the largest category of California emissions- for sulfate, however, California's aggregate contribution is less than 2 percent to the modeled sulfate contributions at Redwoods. On the coast, sU,lfur oxide sources include natural emissions from marine'organisms, as well as large contributions from shipping in the Pacific Off-Shore region. Figure 6-6 provides an example of the impact of different source regions at the Redwoods Class 1 Area based on the PSAT analysis. This analysis illustrates that not only do the emissions that are quantified in the Pacific Offshore region contribute significantly, but that emissions outside the WRAP modeling domain contribute approximately half of the sulfate at this Class 1 Area.

Similar impacts from non-WRAP·source regions were seen at California's other Coastal and Southern California SUb-region sites.

Figure 6-5 Sources of Sulfur Oxides on Worst 20 Percent Haze Days

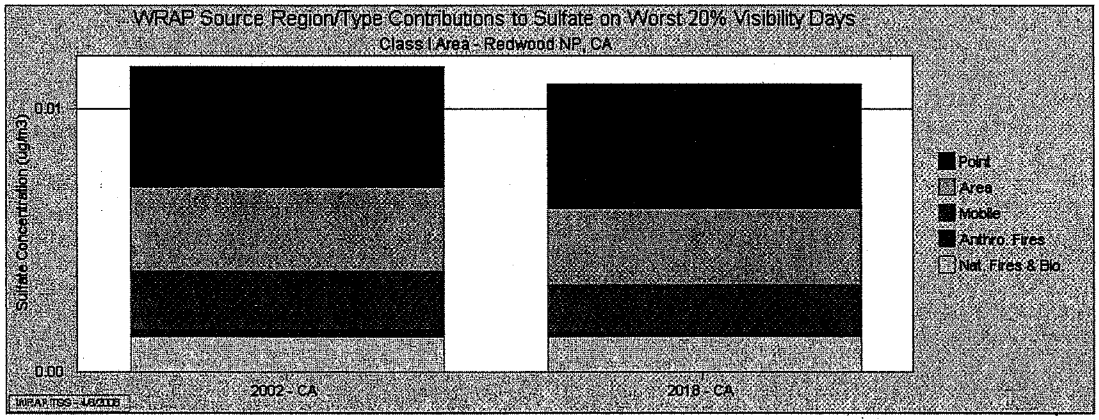
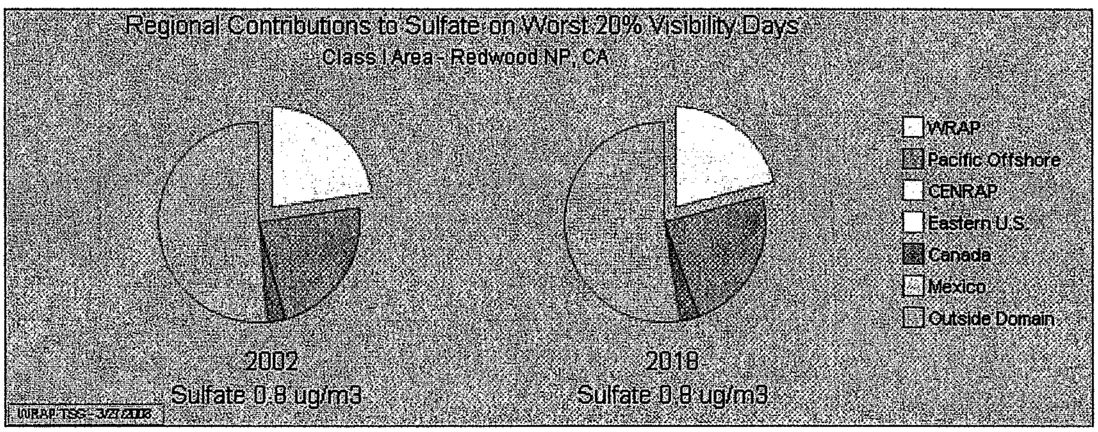



Figure 6-6 Source Region Origin of Sulfate on Worst 20 Percent Haze Days




### *6.2.4 Summary of California Source Apportionment*

Using the weighted emissions potential analyses, estimates for the 20 percent worst haze days ba"sed on baseline conditions were made for each Class 1 Area of the contribution from directly emitted organic carbon emissions that are derived from California anthropogenic emission sources. California anthropogenic, directly emitted, organic carbon appears to contribute approximately half or less of the organic carbon in most areas except Point Reyes National Seashore (67 percent) and Pinnacles Wilderness Area (73 percent). Class 1 Areas in Southern California show less than 40 percent contributions from the anthropogenic, directly emitted, organic carbon sources. As explained in earlier sections, much of the directly emitted organic carbon in

California comes from wildfires. In addition, source apportionment modeling found that the majority of secondary organic carbon is derived from biogenic emission sources.

PSAT modeling was also conducted to provide estimates of the source region/categories contributing to nitrate and sulfate at each Class 1 Area. For nitrate, California anthropogenic NOx sources contribute 50 percent or more of the nitrate in all California Class 1 Areas with the exception of Redwoods National Park (7 percent). In contrast, the California anthropogenic sulfate contribution ranges from 1 to 35 percent Class 1 Areas in California, especially the Coastal sub-region and in Southern California see larger impacts from off-shore shipping. Class 1 Areas in Southern California show slightly higher contributions from California anthropogenic sulfate (22 percent to 35 percent) than other Class 1 Areas, reflecting the proximity to point sources such as refineries as well as port-related activities. Using the information from the California anthropogenic emission sources in combination with the examples provided in Figures 6-1 through 6-6, the three primary drivers of haze in California will continue to come from natural sources for carbon, mobile sources for nitrate, and off-shore and non-WRAP region sources for sulfate. As stated in Chapter 4, California's 2018 Progress Strategy focuses on achieving significant reductions from sources within our jurisdiction, particularly mobile sources.

## 6.3 Transported Sources that Impact Baseline Visibility

As illustrated in the previous section, while sources within California have an influence on visibility at California Class 1 Areas, sources outside of California also cause an impact The varied and complex terrain of California; ·coupled with complex meteorology allow for the transport of emission sources to Class 1 Areas from areas as close as neighboring states, Mexico, and the Pacific Ocean, to as far away as Asia. The following sections provide brief descriptions of the source regions outside of California that also cause visibility impacts in California's Class 1 Areas.

### *6.3.1 Mexico*

Mexican emissions, particUlarly SOx, can be significant contributors to decreased visibility. The Class 1 Areas in the Salton Sea and the San Diego Air Basins are particularly influenced by transport from Mexico. California is strongly involved in collaborative efforts to complete emissions inventories and conduct pollutant monitoring to better characterize these impacts.

### 6.3.2 *Asian dust*

Asian dust has been seen in North America for a few very large events, most notably in April 1998 and again in April 2001. Some of this dust is natural but it is often accompanied by biomass smoke, agricultural dust, motor vehicle and industrial emissions. Asian aerosols can be a major component of PM in otherwise "clean" rural sites, but control of this source is difficult. Figure 6-7 shows the 2001 Asian dust storm and its affects on California monitors. Figure 6-8 shows a satellite photo of an Asian dust cloud.

Figure 6-7 Asian Dust Storm affect on CA monitors

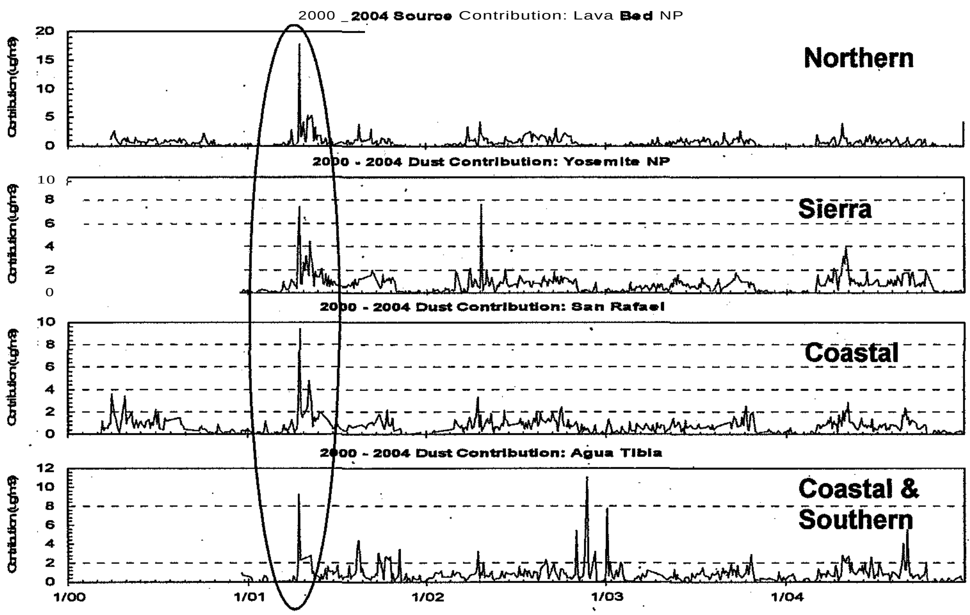
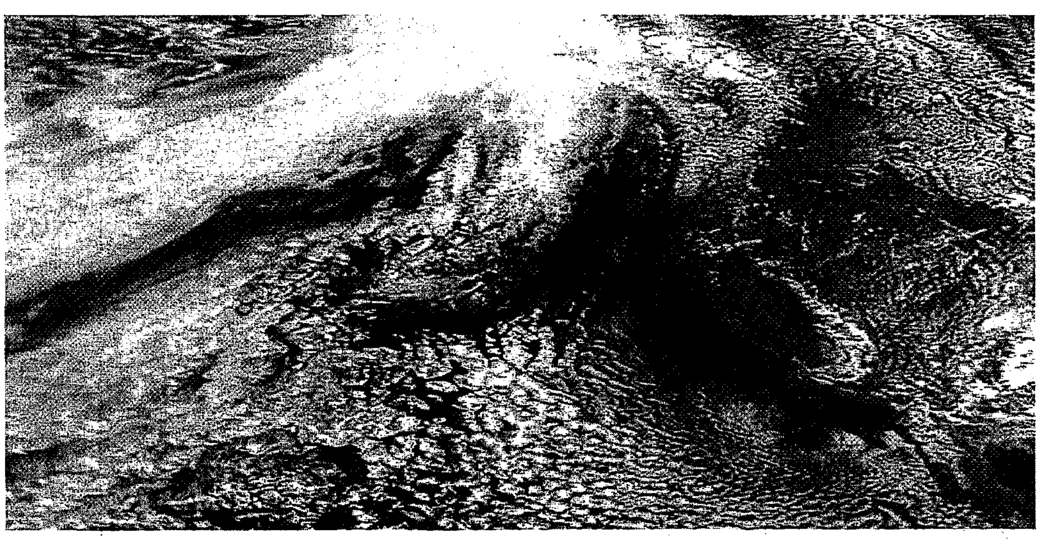



Figure 6-8 Asian Dust Storm traveling over to North America



### *6.3.3 Pacific Ocean, shipping emissions*

Emissions from ocean-going vessels are a substantial contributor to sulfate visibility impairment at many of California's Class 1 Areas near the coast. Significant growth in shipping activity is expected in the near future. Ships have little or no emissions controls and tend to run on high emitting bunker fuel. The WRAP 'Pacific Offshore category looks at the combined offshore emissions from California, Washington, and Oregon. California control efforts for the near-shore portion of these emissions within our jurisdiction are described in Chapter 4, however, additional national and international efforts are needed to reduce the emissions from ships in transit further offshore.

### *6.3.4 Neighboring States*

With mountains in the east and north, the ocean to the west, and prevailing weather patterns that move from west to east, emissions fromneighborin'gstates are not expected to significantly impact California, except for smoke from large wildfires. The western states are working in partnership through the WRAP to provide for coordinated haze planning in the West.

## 6.4 CMAQ Modeling Results for 2018

The previous sections provided an assessment of the sources contributing to haze. The Regional Haze Rule also requires an estimate of the effectiveness of California's 2018 Progress Strategy in improving visibility to be used in setting reasonable progress goals. In order to understand how emission source projections impact visibility in the future, the RMC used the Community Multi-scale Air Quality (CMAQ) model to simulate expected visibility levels in 2018 for the WRAP region. The CMAQ model has been designed to approach air quality as a whole by including state-of-the-science capabilities for m9deling mUltiple air quality issues, including visibility degradation, fine particles, ozone, toxics, and acid deposition. In this way, CMAQ combines the capabilities to enable a community modeling practice. CMAQ is also designed to have multi-scale capabilities so that it can be used for urban and regional scale model simulations. The number and size of grid cells and the number and thicknesses of layers are defined by the user, based in part on the size of the modeling domain to be used for each modeling project. CMAQ offers a variety of choices in the numerical algorithms for treating many of these processes, and it is designed so that new algorithms can be included in the model.

CMAQ was used to project visibility levels from the mandated five-year (2000-2004) baseline period to 2018, the end of the first progress period, for both the 20 percent worst and 20 percent best days. This reflects the WRAP Plan02c and 2018b emissions scenarios. The visibility levels are estimated using baseline meteorological conditions and baseline and future emission inventories. Since it is difficult to replicate actual values, the model is used in a relative sense to evaluate the impact of emission changes. This relative change is called the Relative Response Factor (RRF), which is defined as the ratio onhe future-year modeling results to the current-year modeling results. The calculated RRFs are then applied to the baseline observed visibility conditions to project 2018 'observed visibility.

Table 6-1 shows the 2018 modeling results for the 20 percent worst and 20 percent best days. It is based on the monthly weighted RRFs comparing the 2000-04 baseline emissions to 2018 emissions. California selected the monthly weighted RRFs since they more accurately reflected the seasonality of the visibility problem. As shown in Table 6-1, the 2018 modeled projections ,for the 20 percent worst visibility days in all Class 1 Areas in California make progress towards natural conditions despite only having control of up to 50 percent of the problem. The 2018 modeled projections for the 20 percent best visibility days in all Class 1 Areas in California also show improving visibility.

The degree of improvement is dependent upon the contributions in each area from anthropogenic versus natural emission sources, as well as from sources outside of California. For example, in San Gorgonio, a wilderness area that is just downwind of the South Coast Air Basin, the improvement in visibility is nearly eight times larger than that achieved at Desolation, a wilderness area near Lake Tahoe. Because visibility is largely due to anthropogenic emissions in the upwind urban areas of the South Coast, the comprehensive control programs of ARB and the South Coast Air Quality Management District to attain the federal ozone and particulate matter standards will result in significant improvements in visibility at San Gorgonio. In contrast, analysis of the nature of the visibility problem at Desolation has found that wildfires as well as· natural emissions from plants are a large portion of visibility impairment. in the area. Therefore controls on anthropogenic emissions have a much more limited impact.

Table 6·1 Visibility Progress Summary (deciviews, Haze Algorithm II)

| Class 1 Area(s)<br>*WA=Wilderness Area*<br>*NP=National Park*<br>*NM=National Monument*<br>*NS=National Seashore* | 20% Worst Haze Days Baseline (2000-04) | 20% Worst Haze Days Modeled Projection for 2018 | 20% Worst Haze Days Natural Conditions Target (2064) | 20% Best Visibility Days Baseline (2000-04) | 20% Best Haze Days Modeled Projection for 2018 |
|---|---|---|---|---|---|
| ***NORTHERN CALIFORNIA*** | | | | | |
| Lava BedsNP<br>South Warner WA | 15.1 | 14.4 | 7.9 | 3.2 | 3.0 |
| Lassen Volcanic NP<br>CaribouWA<br>Thousand Lakes WA | 14.2 | 13.3 | 7.3 | . 2.7 | 2.5 |
| Marble Mountain WA<br>Yolla Boll -Middle Eel WA | 17.4 | 16.4 | 7.9 | 3.4 | 3.2 |
| ***SIERRA CALIFORNIA*** | | | | | |
| Desolation WA<br>Mokelumne WA | 12.6 | 12.3 | 6.1 | 2.5 | 2.5 |
| HooverWA | 12.9 | 12.5 | 7.7 | 1.4 | 1.3 |
| Yosemite NP<br>Emi rantWA | 17.6 | 16.7 | 7.6 | 3.4 | 3.2 |
| Ansel Adams WA<br>KaiserWA<br>John MuirWA | 15.5 | 14.9 | 7.1 | 2.3 | 2.1 |
| Sequoia NP<br>Kin s Can on NP | 25.4 | 22.7 | 7.7 | 8.8 | 8.1 |
| Dome LandsWA | 19.4 | 18.1 | 7.5 | 5.1 | 4.7 |
| ***SOUTHERN CALIFORNIA*** | | | | | |
| San GabrielWA<br>Cucambn aWA | | | 7.0 | 4.8 | 4.1 |
| San Gorgonio WA<br>San Jacinto WA | 22.2 | 19.9 | 7.3 | 5.4 | 5.0 |
| Joshua Tree WA | 19.6 | 17.9 | 7.2 | 6.1 | 5.7 |
| Agua Tibia WA | 23.5 | 21.6 | 7.6 | 9.6 | 8.9 |
| ***COASTAL CALIFORNIA*** | | | | | |
| RedwoodNP | 18.5 | | 13.9 | 6.1 | 5.8 |
| Point Reyes NS | 22.8 | | 15.8 | 10.5 | 10.1 |
| Pinnacles WA<br>VentanaWA | 18.5 | | 8.0 | 8.9 | 8.1 |
| San RafaelWA | 18.8 | 17.3 | 7.6 | 6.4 | 5.8 |

TSS Date: *11/12/2008*

To provide insight into the visibility improvement that will result from NOx (primarily mobile source sector) emission reductions, Table 6-2 shows 2018 modeled visibility progress from nitrate reductions. The 2018 nitrate modeled projections for the 20 percent worst visibility days in all Class 1 Areas in California make tremendous progress. Between the baseline period and 2018, modeled nitrate is reduced from 21 percent to 56 percent atGlass 1 Areas in California. Tables 6-3 and 6-4 show 2018 modeled visibility progress from sulfate and organic carbon (OC) reductions, respectively. Even though the sulfate and OC reductions do not make as much progress as nitrate, the 2018 modeled projections for 20 percent worst visibility days in all Class 1 Areas in California are reduced up to 5 percent for sulfate and from 4 to 22 percent for OC. Sulfate and OC show less progress due to the impacts of uncontrollable sources such as shipping/offshore and biogenic/wildfire emissions.

Table 6-2 Modeled visibility progress from nitrate reduction with California's 2018 Progress Strategy

| **Class 1 Area(s)**<br>***WA=Wilderness Area***<br>***NP=National Park***<br>***NM=National Monument***<br>***NS=National Seashore*** | **20% Worst Haze Days Baseline (2000-04) (Mm-1)** | **20% Worst Haze Days Modeled Projection for 2018 (Mm-1)** | **Nitrate Visibility Progress towards 2018 (%)** |
|---|---|---|---|
| ***NORTHERN CALIFORNIA*** | | | |
| Lava Beds NP<br>South Warner WA | 3.5 | 2.4 | 31 |
| Lassen Volcanic NP<br>CaribouWA<br>Thousand Lakes WA | 3.7 | 2.1 | 43 |
| Marble Mountain WA<br>Yolla Boll -Middle Eel WA | | 3.6 | 41 |
| ***SIERRA CALIFORNIA*** | | | |
| Desolation WA<br>Mokelumne WA | 2.4 | 1.7 | 29 |
| HooverWA | 1.6 | 1.2 | 25 |
| Yosemite NP<br>Emi rantWA | 8.1 | 5.3 | 35 |
| Ansel Adams WA<br>KaiserWA<br>John MuirWA | 7.0 | 5.5 | 21 |
| Sequoia NP<br>Kin sCan on NP | 60.7 | 30.4 | 50 |
| Dome Lands WA | 16.0 | 8.5 | 47 |
| ***SOUTHERN CALIFORNIA*** | | | |
| San Gabriel WA<br>Cucamon aWA | 27.7 | 16.1 | 42 |
| San Gorgonio WA<br>San Jacinto WA | 44.9 | 28.8 | 36 |
| Joshua Tree WA | 27.3 | 17.8 | 35 |
| Agua Tibia WA | 29.9 | 16.3 | 45 |
| ***COASTAL CALIFORNIA*** | | | |
| Redwood NP | 6.0 | 4.2 | 30 |
| Point Reyes NS | 38.4 | 21.2 | 45 |
| Pinnacles WA<br>VentanaWA | 17.1 | 9.1 | 47 |
| San Rafael WA | 12.6 | 5.6 | 56 |

TSS Date: *11/12/2008*

**Table 6-3 Modeled visibility progress from sulfate reduction with California's 2018 Progress Strategy**

| Class 1 Area(s)<br>*WA=Wilderness Area*<br>*NP=National Park*<br>*NM=National Monument*<br>*NS=National Seashore* | 20% Worst Haze Days Baseline (2000-04) (Mm-1) | 20% Worst Haze Days Modeled Projection for 2018 (Mm-1) | Sulfate Visibility Progress towards 2018 (%) |
|---|---|---|---|
| ***NORTHERN CALIFORNIA*** | | | |
| Lava Beds NP<br>South Warner WA | 6.8 | 6.6 | 3 |
| Lassen Volcanic NP<br>CaribouWA<br>Thousand.Lakes WA | 6.8 | 6.6 | 3 |
| Marble Mountain WA<br>Yolla Boll -Middle Eel WA | | 8.1 | 4 |
| ***SIERRA CALIFORNIA*** | | | |
| Desolation WA<br>Mokelumne WA | 5.1 | 5.1 | 0 |
| HooverWA | 5.0 | 4.9 | 2 |
| Yosemite NP<br>Emi rantWA | 7.9 | 7.7 | 3 |
| Ansel Adams WA<br>KaiserWA<br>John MuirWA | 7.6 | 7.5 | 1 |
| Sequoia NP<br>Kin sCan on NP | 16.5 | 16.2 | 2 |
| Dome Lands WA | | 11.8 | 2 |
| ***SOUTHERN CALIFORNIA*** | | | |
| San Gabriel WA<br>Cucam6n aWA | 12.3 | 11.7 | 5 |
| San Gorgonio WA<br>San Jacinto WA | 13.2 | 12.8 | 3 |
| Joshua Tree WA | 12.3 | 11.8 | 4 |
| Agua Tibia WA | 31.8 | 30.2 | 5 |
| ***COASTAL CALIFORNIA*** | | | |
| "Redwood NP | 14.9 | 14.2 | 5 |
| Point Reyes NS | 14.1 | 13.8 | 2 |
| Pinnacles WA<br>Ventana WA | 13.9 | 13.6 | 2 |
| San RafaelWA | 20.4 | 19.9 | 2 |

TSS Date: *11/12/2008*

Table 6-4 Modeled visibility progress from organic carbon reduction with California's 2018 Progress Strategy

| Class 1 Area(s)<br>*WA=Wilderness Area*<br>*NP=National Park*<br>*NM=National Monument*<br>*NS=National Seashore* | 20% Worst Haze Days Baseline (2000-04) (Mm-1) | 20% Worst Haze Days Modeled Projection for 2018 (Mm-1) | OC Visibility Progress towards 2018 (%) |
|---|---|---|---|
| ***NORTHERN CALIFORNIA*** | | | |
| Lava Beds NP | | | |
| South Warner WA | 22.0 | 20.9 | 5 |
| Lassen Volcanic NP | | | |
| CaribouWA | | | |
| Thousand Lakes WA | 17.2 | 15.6 | 9 |
| Marble Mountain WA | | | |
| Yolla Boll -Middle Eel WA | 35.3 | 32.5 | 8 |
| ***SIERRA CALIFORNIA*** | | | |
| Desolation WA | | | |
| Mokelumne WA | 14.1 | 13.3 | 6 |
| HooverWA | 15.4 | 14.5 | 6 |
| Yosemite NP | | | |
| Emi rantWA | 29.0 | 26.4 | 9 |
| Ansel Adams WA | | | |
| KaiserWA | | | |
| John MuirWA | 16.8 | 15.7 | 7 |
| Sequoia NP | | | |
| Kin s Can on NP | 32.4 | 30.2 | 7 |
| Dome Lands WA | 17.1 | 16.2 | 5 |
| ***SOUTHERN CALIFORNIA*** | | | |
| San Gabriel WA | | | |
| Cucamon aWA | 15.3 | 11.9 | 22 |
| San Gorgonio WA | | | |
| San Jacinto WA | 14.0 | 12.6 | 10 |
| Joshua lree WA | 10.3 | 9.5 | 8 |
| Agua Tibia WA | 17.6 | 16.5 | 6 |
| ***COASTAL CALIFORNIA*** | | | |
| Redwood NP | 8.0 | 7.7 | 4 |
| Point Reyes NS | 12.1 | 11.5 | 5 |
| Pinnacles WA | | | |
| VentanaWA | 13.2 | 12.1 | 8 |
| San Rafael WA | 12.4 | 11.2 | 10 |

TSS Date: *11/12/2008*

In summary, modeling and source apportionment results show that all 29 California Class 1 Areas make progress towards improving visibility in 2018 and that California's 2018 Progress Strategy is effective at reducing emission sources under State control.

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# 7. Demonstration of Reasonable Progress Goals

## 7.1 Reasonable Progress Requirements

The Regional Haze Rule requires California to establish goals for the year 2018 that provide for reasonable progress towards achieving natural visibility conditions in 2064 at each of its Class 1 Areas. The Reasonable Progress Goals (RPGs) must be expressed in deciviews and indicate the planned improvement in visibility for the 20 percent most-impaired days (worst days) of the baseline years by 2018. The Plan must also ensure no degradation in visibility for the 20 percent least-impaired days (best days) of the baseline years.

In establishing the RPGs, a state must consider four factors:

1. costs of cornpliance;
2. time necessary for compliance;
3. energy and non-air quality environmental impacts of compliance; and
4. remaining useful'life of any potentially affected sources.

California included a demonstration showing how these factors were taken into consideration in the previous discussion of the 2018 Progress Strategy. The rulemaking process for both ARB and the local air districts in California have embodied consideration of the four factors for decades. Continuous efforts to attain and maintain the federal and State health-based air quality standards are the reason that California feels confidentthat every reasonable measure is included in the State's 2018 Progress Strategy backing the RPGs.

It is also important to note that the Regional Haze Rule states that the RPGs established by a state are not directly enforceable, but rather will'be cohsidered by U.S. EPA in evaluating the adequacy of the measures in the Plan to achieve the progress goal adopted by a state. Specifically, U.S. EPA noted in the Regional Haze Rule that:

> "There are no presumptive targets that states are required to meet to achieve reasonable progress. States have flexibility in determining their reasonable progress goals based on consideration of the statutory factors. However, the final rule requires states to conduct certain analyses to ensure that they consider the possibility of setting an ambitious reasonable progress goal, one that is aimed at reaching natural conditions in 2064."

## 7.2 Reasonable Progress Goals in California

California has set RPGs for each California Class 1 Areas as shown in Table 7-2. These RPGs are based Lipon the results of the WRAP modeling scenario described in Chapter 6. While the 2018 scenario that was modeled includes the benefits of control measures adopted by ARB and local air districts, it does not include possible BART reductions because they were not available at the time of WRAP modeling. However, reductions due to BART expected in California and from upwind states will have. minimal effect on haze at the California IMPROVE monitors. These reductions will be included in future regional modeling and progress re-evaluated at the mid-course review.

The projected deciview levels are the modeled results of the phased implementation of California's 2018 Progress Strategy. This strategy represents an ambitious and far-reaching level of control for achieving reductions in the anthropogenic contributions to Visibility impairment in California. California's 2018 Progress Strategy for reducing haze has focused on identifying the major drivers of haze on worst days, and determining the primary sources of those species and their precursors. In particular, significant reductions in.the nitrate component of haze are predicted due to the extensive NOx emission reductions from California's mobile source control programs. However, evidence from source apportionment analysis showed that not all of the emissions contributing to haze come from anthropogenic sources within California's control. Emissions from natural sources such as wildfires and biogenics, whether from in-State or out-of-State, can contribute significantly to impaired visibility at all Class 1 Areas in California. In addition, visibility impacts are also seen from international sources outside the WRAP states.

Hence, for this first planning period, our focus is on demonstrating the improvements in visibility that will result from California's broad spectrum of control efforts. We believe the RPGs are reasonable for the first planning period considering: (a) California is controlling in-State anthr9Pogenic sources at levels well beyond those achieved through national programs; (b) the 2018 Progress Strategy has embodied the four-factor analysis requirement for decades and is, therefore, reasonable from a western regional perspective; (c) there are significant contributions from sources not included in the WRAP region, and (d) there is uncertainty in the values being reflected in the current natural conditions due to wildfires and biogenics which may underestimate the true natural conditions for the West.

The RPGs displayed in Table 7-2 show that visibility will improve on the worst days and will not deteriorate on the best days by 2018. While visibility is expected to improve in 2018 throughout the West, the greatest gains will be seen in California. Coastal and Southern California Class 1 Areas make the greatest progress.. Sites in these regions have large contributions from nitrate and therefore California's mobile source NOx control program provides significant reductions in the nitrate component by 2018. Lesser progress is seen in Northern California and Sierra Nevada Class 1 Areas. While significant reductions in nitrate are also seen at these sites, the continuing impacts of natural fire, biogenics, offshore shipping and other emissions not included in the WRAP region limit the amount of overall progress that can be achieved.

In the following sections we have summarized the role of controllable versus uncontrollable emissions and the benefits of California's control programs for each haze component.

- **Organic carbon** is the primary or secondary driver of worst day haze, in all of. the State but Southern California. The WRAP source apportionment analysis suggests that wildfires, biogenics (natural plant, animal, and soil organism emissions), and area sources are the primary oontributors to organic carbon constituting from 25 percent to 90 percent on worst days. Biogenic emissions peak during the dry wildfire season, and contribute the most natural organic carbon annually. ARB's emissions inventory indicates the largest category of area source emissions of organic carbon may be winter-time residential wood combustion. Many air districts in California are developing programs to minimize the emissions from this source by requiring use of U.S. EPA certified woodstoves, and instituting voluntary or mandatory no-burn day programs. Stringent ARB controls for mobile sources are also helping to curb both'directly emitted PM and volatile organic carbon emissions that contribute to the organic carbon component of visibility impairment.

- **Nitrates** are a key driver of haze at many sites, especially in Southern California and'other sites located near major urban areas and transportation corridors. In-State anthropogenic NOx emissions are estimated to account for 7 percent to 86 percent of nitrate contributions to haze at California Class 1 Areas. Reducing this precursor to nitrate formation is a major first step in reducing regional haze. The gradient of least to most influence corresponds directly to the amount of mobile source NOx emissions nearby. Back-trajectory analyses and future conditions modeling indicate that substantial reductions in nitrate, roughly 50 percent at every State Class 1 Area are achievable due to planned mobile source NOx emission reductions.

- **Sulfates** also drive haze at all IMPROVE monitors on some worst days, but the. influence is most perceptible along the coast. Offshore arid non-WRAP region sources are the largest contributors, accounting for approximately 50 to 75 percent of the measured sulfate levels. In-State anthropogenic emissions are estimated to account for 1 percent to 35 percent. There are very few large SOx sources in California and low sulfur fuel is already reqUired for both mobile,and stationary sourceS. Offshore emissions appear to contribute both natural marine sulfates and SOx from marine commercial shipping activities. California's Goods Movement Program is designed to address many.port-related SOx emissions. The feasibility of further SOx reduction measures will be evaluated during the mid-course review.

- **Coarse Mass** does not drive haze on worst days in California, although occasionally it may contribute to a single worst day at some of the drier Class 1 Areas in the Mojave Desert and on the lee side of the Sierra Nevada.

The days with slightly elevated coarse mass are almost always associated with windblown dust events, including transport from Asian dust storms. These wind-driven events also cause very slight elevations in fine soil (PM2.5 fraction of dust), but this species never drives worst days. The 2018 Progress Strategy includes localized du·st controls that keep these species at very low concentration's throughout the year.

- **Elemental Carbon** is not a driver of haze on worst days in California. Despite its strong capability to extinguish light, emissions are very low and are not expected to increase. In 2000, California initiated a Diesel Risk Reduction Program that focuses on reducing toxic air contaminants in diesel exhaust, specifically carcinogenic ·hydrocarbons and soot particles. California has realized benefits from this program as elemental carbon trends at IMPROVE monitors have already shown progress. Future benefits are expected as rules adopted during the baseline period continue their phased implementation. The WRAP modeling has demonstrated significant reductions in the contributions from elemental carbon in 2018 due to California's programs to address on- and off-road mobile sources.

- **Fine soil** is not a driver of haze on worst days. In fact, it contributes the least to haze Statewide. It is less than 1 percent of the annual contribution to light extinction at many IMPROVE monitors on best and worst days, with the highest annual average worst day contribution being just over 5 percent at one isolated IMPROVE monitor (HOOV) in the rain shadow (dryer, lee side) of the Sierra Nevada. On a day-to-day basis, fluctuations in concentration at the IMPROVE monitors are associated with high wind events, including receiving fallout from intercontinental transport after Asian dust storms. Dust control programs to reduce coarse mass also affect fine soil.

## 7.3 Uniform Rate of Progress

As part of the goal setting process, the Regional Haze Rule requires states to assess a linear path towards natural conditions for each Class 1 Area. This linear path is termed the Uniform Rate of Progress (URP). It represents a uniform rate of deciview reduction if haze levels on the worst days decreased the same number of deciviews per year over 60 years beginning in 2004·and ending at natural conditions in 2064. This can also be expressed as the glide path or slope of the line between 2004 and 2064. Figure 7-1 illustrates these concepts. States must compare their RPGs to the level that would be achieved in 2018 if progress were to follow this linear glide path. The URP is not a regulatory goal or standard but merely a benchmark, against which progress towards natural conditions can be evaluated,

If a state establishes RPGs for 2018 that result in a slower rate of visibility improvement than the glide path, a state must demonstrate how the selected RPG and the consequent rate of progress are reasonable. A state must also provide an assessment of the number of years it would take to achieve Natural Conditions if improvement continues at the rate different from the uniform rate of progress. Using Sequoia National Park as an example, Figure 7-2 shows a possible alternative path to Natural Conditions if the slope to reach the selected 2018 RPG (22.7 deciviews) at SEQU is maintained beyond 2018. Figure 7-2 " shows that the Natural Conditions worst days (7.7 deciviews) would be reached by 2096, if the rate of progress in future planning periods is the same as in this first planning period.

**Figure** 7-1 Uniform Rate of Progress Illustration"

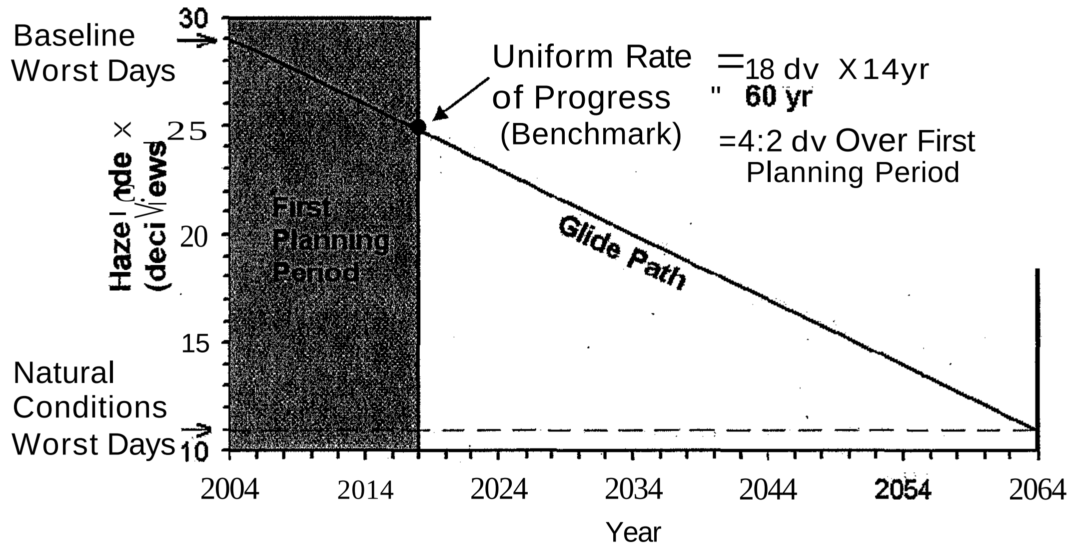
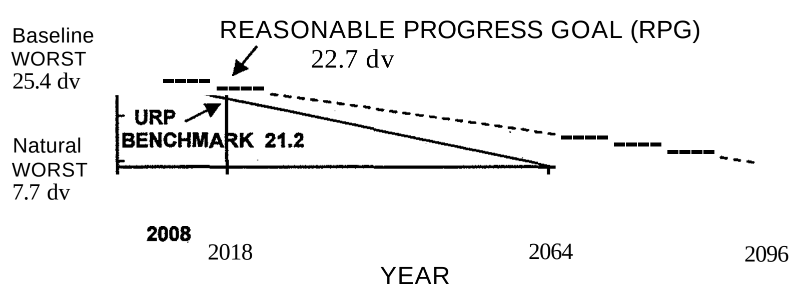



Figure 7.2 Example of Alternate Glide **Path** to Natural Conditions

SEQU: Sequoia and King's Canyon National Parks



The URP goals for each of the 17 IMPROVE monitors and their respective Class 1 Areas are included at the end of this Chapter in Table 7-2. Table 7-2 also provides an estimate of the number of years to achieve natural conditions if the current rate of progress were to continue. California makes progress towards the URP goals at.all Class 1 Areas. Class 1 Areas in the Coastal and Southern California sub-regions make 51 percent to 94 percent progress towards the 2018 benchmark on the glide path, while Class 1 Areas in Northern California and the Sierra Nevada make 20 percent to 64 percent progress.

Past experience has shown that the path to cleaner air quality does not move in a straight line, although steady incremental improvements have been made in the past fifty years. Technological breakthroughs, changing land use patterns, the global economy, and climate change will affect the slope of the glide path in future planning periods beyond 2018. While no area meets the 2018 benchmark due to the influence of natural emissions from wildfires and biogenics, as well contributions from sources outside the WRAP region, each area makes significant progress and the rationale for the appropriateness of California's reasonable progress goals was provided earlier in this chapter.

To highlight the visibility improvement that will result from mobile source sector emission reductions, Table 7-1 shows 2018 modeled visibility progress from nitrate reductions. The 2018 nitrate modeled projections for 20 percent worst visibility days in most Class 1 Areas in California meet the 2018 URP benchmarks for nitrate except at San Gorgonio and Kaiser Wilderness Areas. In most Class 1 Areas, the 2018 nitrate modeled projection is even lower than the 2018 URP benchmark by up to 38 percent. At the San Gorgonio and Kaiser Wilderness Areas, the 2018 nitrate modeled projections fall short only 3 percent and 4 percent, respectively, of meeting the 2018 worst days URP benchmark. Nitrate is the haze component which comes primarily from NOx emissions within California. This analysis demonstrates that California's control program goes well beyond what is required.

As noted above, the WRAP analysis· has indicated that sourceS not included in the WRAP region, such as from international shipping and emissions from Mexico and Asia, can provide substantial contributions to visibility impairment. Class 1 Areas nearest the Pacific Ocean are particularly impacted from offshore shipping emissions. California's Goods Movement Program targets reducing port and offshore emissions from sources that are under the Air Resources Board's regulatory control. However, given the expected growth in shipping activity, California is working with the federal government and intern'ational organizations to reduce the contributions to visibility impairment from these sources under federal and international control.

It also should be recognized that the URP for each Class 1 Area is bas.ed on the U.S. EPA calculated default natural visibility conditions. As stated previously, California, along with the western region, is researching what the definition of natural conditions should be in order to better reflect the impact of biogenic . emissions, wildfires, and global dust transport. An increase in 2064 natural condition levels would decrease the slope of the URP and therefore better align the progress that can be achieved from sources under the control of the western states with the glide path. At each mid-course review and with every 10-year Plan revision, the slope beyond 2018 will be re-evaluated based upon the monitoring data, new controls, and a better understanding of natural conditions.

Table 7-1 Modeled visibility progress from nitrate reduction with California's 2018 Progress Strategy

| Class 1 Areas<br><br>*WA=Wilderness Area*<br>*NP=National Park*<br>*NM=National Monument*<br>*NS=National Seashore* | 20 Percent Worst Haze Days Baseline (2000-04) (Mm-1) | 20 Percent Worst Haze Days Benchmark for 2018 (Mm-1) | 20 Percent Worst Haze Days Modeled Projection for 2018 (Mm-1) | Visibility Progress beyond Benchmark for 2018 (%) |
|---|---|---|---|---|
| ***NORTHERN CALIFORNIA*** | | | | |
| Lava Beds NP | | | | |
| South Warner WA | 3.5 | 3.1 | 2.4 | 23 |
| Lassen Volcanic NP | | | | |
| CaribouWA | | | | |
| Thousand Lakes WA | 3.7 | 3.2 | 2.1 | 33 |
| Marble Mountain WA | | | | |
| Yolla Bolly-Middle Eel WA | 6.1 | 5.1 | 3.6 | **29** |
| ***SIERRA CALIFORNIA*** | | | | |
| Desolation WA | | | | |
| Mokelumne WA | 2.4 | 2.0 | 1.7 | 16 |
| HooverWA | 1.6 | 1.4 | 1.2 | 19 |
| Yosemite NP | | | | |
| Emigrant WA | 8.1 | 6.2 | 5.3 | 15 |
| Ansel Adams WA | | | | |
| KaiserWA | | | | |
| John Muir WA | 7.0 | 5.3 | 5.5 | |
| Sequoia NP | | | | |
| Kings Canyon NP | 60.7 | 36.0 | 30.4 | **16** |
| Dome Lands WA | 16.0 | 11.2 | 8.5 | **24** |
| ***SOUTHERN CALIFORNIA*** | | | | |
| San Gabriel WA | | | | |
| Cucamonga WA | 27.7 | 18.4 | 16.1 | 12 |
| San Gorgonio WA | | | | |
| San Jacinto WA | **44.9** | **27.7** | 28.8 | **-4** |
| Joshua Tree WA | **27.3** | **18.1** | 17.8 | **1** |
| Agua Tibia WA | **29.9** | **19.5** | 16.3 | **17** |
| ***COASTAL CALIFORNIA*** | | | | |
| Redwood NP | 6.0 | 5.6 | 4.2 | 26 |
| Point Reyes NS | 38.4 | 24.2 | 21.2 | 12 |
| Pinnacles WA | | | | |
| Ventana WA | 17.1 | 12.1 | 9.1 | 25 |
| San Rafael WA | 12.6 | 9.1 | 5.6 | 38 |

TSS Date: *4/2/2008*

## 7.4 Conclusion

From a national perspective, California has gone well beyond national control levels in terms of reducing emissions. This enhanced level of control, along with the fact that natural and non-WRAP sources limit California's ability to meet the uniform glide path benchmark, support the selection of California's 2018 Progress Strategy as reasonable for setting RPGs for the Class 1 Areas within the State.

However, visibility protection must be viewed from the broader standpoint of all of the environmental protection efforts in California as we continue to reduce emissions and drive new technology development in the future. In 2007, due to the need to attain federal air quality standards for 8-hour ozone and PM2.5, ARB developed a comprehensive strategy of measures that target NOx, SOx, and diesel PM emissions. This strategy sets the framewor.k for attaining the standards and provides for emission reductions through the 2023 timeframe.

In general, California has already tackled the easy to find emission reductions. The emission reductions in the 2007 Statewide Strategy target clean-up of in-use heavy duty trucks, off-road sources, and goods movement sources. ARB is proposing a comprehensive fleet modernization program that would be equivalent to the entire 2014 truck fleet meeting 2007 truck standards. ARB is requiring on-road mobile source technology be used on off-road sources. Meeting the federal standards in the South Coast and the San Joaquin Valley, the two regions with the most severe air quality problems, will require an 88 and 75 percent reduction in NOx emissions from 2006 levels, respectively. In addition, California is targeting the health impacts near our busy goods movement sectors. In 2006, ARB approved a *2006 Emission Reduction Plan for Ports and Goods Movement.* That Plan maps the strategies to reduce emissions near ports, railways, and transportation corridors and is an essential component of California's effort to reduce community exposure to air pollution.

In addition, in 2006, California passed legislation (AB 32) that established the first-in-the-world comprehensive program of regulatory and market mechanisms to achieve real, quantifiable, cost-effective reductions of greenhouse gases. AB 32 requires the State to reduce greenhouse gas emissions to 1990 levels by 2020. California is required to have a plan for reaching this target by January 1, 2009. California will be evaluating many sectors inclUding electricity, land use, oil and gas, transportation, cement facilities, agriculture, and waste management as to their impact on greenhouse gas emissions. Strategies to reduce greenhouse gas emission from these sectors will also provide reductions in other pollutants.

These future programs will provide further benefits in improving visibility throughout California. California will continue to revaluate progress and goals in the mid-course review time frame and in future planning periods. Since this is the first planning period, California anticipates more information regarding regional haze will be updated for each planning period including a better understanding of natural conditions, the impact of sources and controls, and new technology. California will examine these factors during the mid-course review and during development of future Plan revisions.

Table 7-2 Summary of Reasonable Progress Goal and Uniform Rate of Progress to Future Natural Conditions

| California Class 1 Areas (Vis.ibility Calculated in Deciviews) IMPROVE Monitor | Class 1 Area(s) | 2018 Worst Days RPG | 2018 Worst Days URP | 2064 Natural Conditions Worst Day | Percent Progress by 2018 towards Natural Conditions | Future Date for Reaching Natural Conditions at Current Rate | Current Best Day Conditions | '2018 Best Day Projection |
|---|---|---|---|---|---|---|---|---|
| **NORTHERN CALI** | | | | | | | | |
| TRIN (1014 m.) | Marble Mountain Wilderness<br>Yolla Bolly-Middle Eel Wilderness | 16.4 | 15.2 | 7.9 | 11% | 2137 | 3.4 | 3.2 |
| LABE (1460 m.) | Lava Beds National Monument<br>South Warner Wilderness | 14.4 | 13.4 | 7.9 | 10% | 2148 | 3.2 | 3.0 |
| LAVa (1733 m.) | Lassen Volcanic National Park<br>Caribou Wilderness<br>Thousand Lakes -Wilderness | 13.3 | 12.6 | 7.3 | 12% | 2123 | 2.7 | 2.5 |
| **SIERRA CALIFORNIA** | | | | | | | | |
| BLIS (2131 m.) | **Desolation Wilderness<br>Mokelumne Wilderness** | **12.3** | **11.1** | **6.1** | **5%** | **2307** | **2.5** | **2.5** |
| HOOV (2561 m.) | Hoover Wilderness | 12.5 | 11.7 | 7.7 | 8% | 2186 | 1.4 | .1.3 |
| YOSE (1603 m.) | Yosemite National Park<br>Emigrant Wilderness | 16.7 | 15.3 | 7.6 | 9% | 2160 - | 3.4 | 3.2 |
| KAIS (2598 m.) | Ansel Adams Wilderness<br>Kaiser Wilderness<br>John Muir Wilderness | 14.9 | 13.6 | 7.1 | 7% | 2200 | 2.3 | 2.1 |
| SEQU (519 m.) | Sequoia National Park<br>Kings Canyon National Park | 22.7 | 21.2 | 7.7 | 15% | 2096 | 8.8 | 8.1 |
| DOME (927 m.) | Dome, Lands Wilderness | **18.1** | **16.6** | **7.5** | **11%** | **2132** | **5.1** | **4.7** |
| **COASTAL CALIFORNIA** | | | | | | | | |
| REDW (244 m.) | **Redwood National Park** | **17.8** | **17.4** | **13.9** | **15%** | **2096** | **6.1** | **5.8** |
| PORE (97 m.) | Point Reyes National Seashore | 21.3 | 21.2 | 15.8 | 21% | 2069 | 10.5 | 10.1 |
| PINN (302 m.) | Pinnacles Wilderness<br>Ventana Wilderness | 16.7 | 16.0 | 8.0 | 17% | 2086 | 8.9 | 8.1 |
| RAFA (957 m.) | **San Rafael Wilderness** | **17.3** | **16.2** | **7.6** | **13%** | **2109** | **6.4** | **5.8** |
| **SOUTHERN CALIFORNIA** | | | | | | | | |
| SAGA (1791 m.) | San Gabriel Wilderness<br>Cucamonga Wilderness | **17.4** | **16.9** | **7.0** | **19%** | **2076** | **4.8** | **4.1** |
| SAGO (1726 m.) | San Gorgonio Wi.lderness<br>San Jacinto Wilderness | 19.9 | 18.7 | 7.3 | 15% | 2095 | 5.4 | 5.0 |
| AGTI (508 m.) | Agua Tibia Wilderness | 21.6 | 19.8 | 7.6 | 12% | 2121 | 9.6 | 8.9 |
| JOSH (1235 m.) | Joshua Tree National Park | 17.9 | 16.7 | 7.2 | 14% | 2106 | 6.1 | 5.7 |

# 8. Consultation

The Regional Haze Rule requires consultation between states and Federal Land Managers during preparation of the Plan. Consultation with upwind and downwind states is important for mutual agreement on actions to support the respective Reasonable Progress Goals (RPGs) in each state. The Federal Land Managers, as caretakers of the Class 1 Areas, have a key role in preparation and implementation of the Plan. Consultation with Tribes is necessary when activities within state or Tribal lands cause or contribute to visibility impairment in respective Class 1 Areas.

## 8.1 Tribal Consultation

No Tribes requested input from California in development of their Tribal Implementation Plans. There are no tribal lands with Class 1 Area status in California. As a courtesy, California provided the WRAP coordinator for Tribes a written request to distribute an announcement of the release of the draft Plan for review.

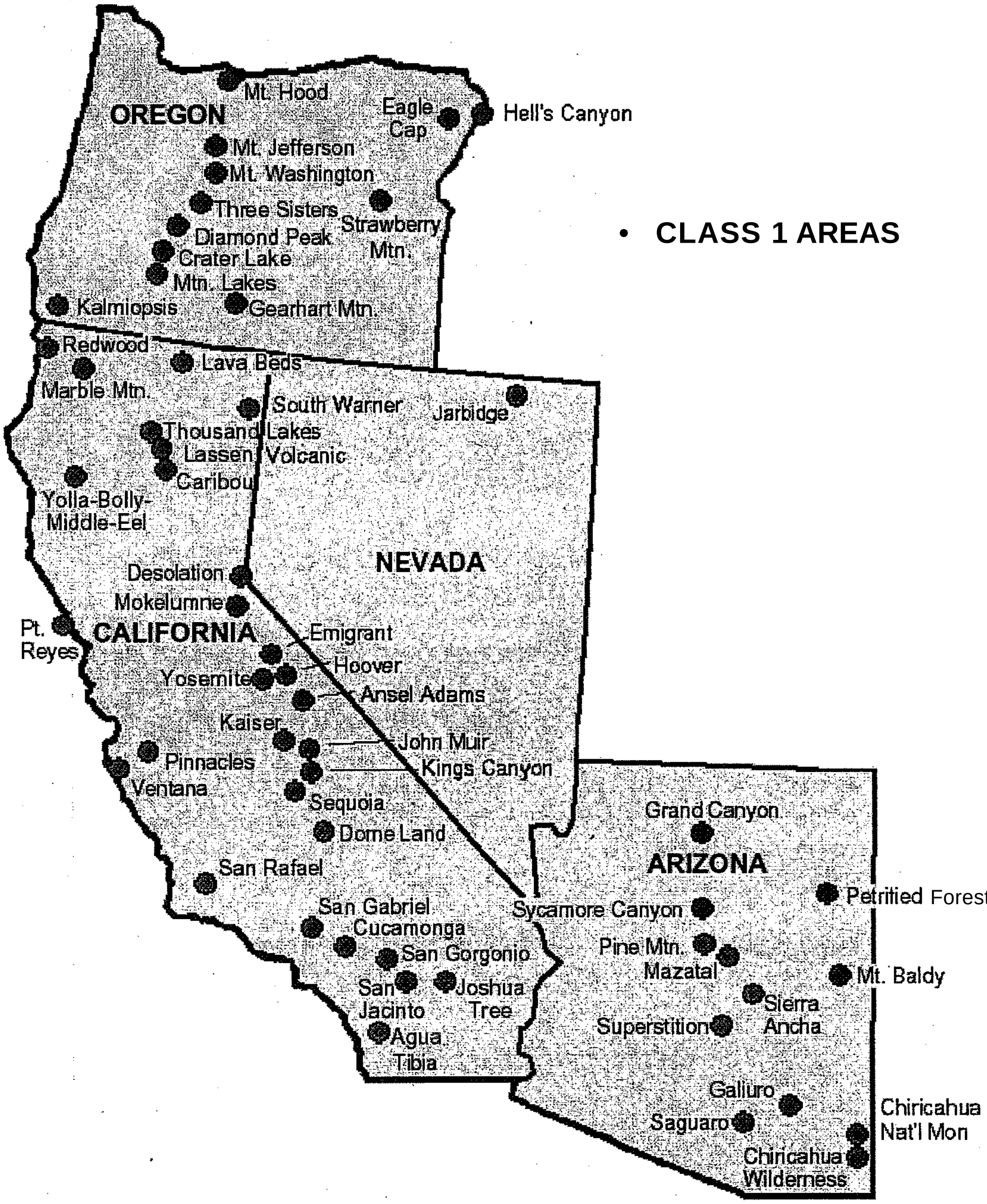
## 8.2 Interstate Consultation

California has worked cooperatively since 1991 with other western states to address regional haze, first through the Grand Canyon Visibility Transport Commission (GCVTC) and then through the WRAP. Preparation of this initial Plan is the result of continuous consultation with fourteen other western states through regular meetings of the WRAP Working Groups and Forums, via conference calls, face-to-face meetings, and workshops. This coordination resulted in resolution of all technical tasks and policy decisions related to monitoring, emissions, fire tracking, BART, source attribution, modeling, and control measure issues as each Regional Haze Rule task was addressed. As a result of this extensive coordination, this Plan reflects California's element of a regionally consistent approach to addressing visibility impairment in the West.

Extensive documentation of all WRAP meetings and work products are provided on the WRAP website at http://wrapair.org. For specific details about meetings and topics of discussion, the various Forums and Work Groups web pages are found at http://wrapair.org/commforum.html.

In developing the RPGs for each Class 1 Area, each state must consult with those states which may reasonably be anticipated to cause or contribute to visibility impairment in a mandatory Class 1 Area. California used baseline period visibility data from the IMPROVE monitors along with the WRAP baseline modeling results to estimate California's emissions impact on neighboring states' Class 1 Areas (see Figure 8.1).

**Figure 8.1 California, Oregon, Nevada, and Arizona Class 1 Areas**




• **CLASS 1 AREAS**

in the charts below, the first column shows the contribution of nitrates and sulfates to light extinction at these Class 1 Areas calculated from the IMPROVE monitoring data *measured* during the baseline period to provide perspective on the role of nitrates and sulfates to overall extinction. The second column shows California's contribution to particle mass.calculated from the *modeled* concentrations of nitrate and sulfate for the baseline years. Particlelight extinction calculated from actual monitoring data is somewhat different than relative species contributions derived from modeling due the model's abiiity to recreate each day. However, independently, they do show two things: (1) the role of nitrates and sulfates in driving light extinction at the Class 1 Area, and (2) the probable share of California emissions contributing to the pollutant species.

Table 8.1 Nitrate Contribution to Haze in Baseline Years

| State and Class 1 Area | 2000-2004 Average Annual Nitrate Share of Particle Light Extinction (measured values) | | 2000-2004 California's Average Annual Share of Nitrate Concentration (based on modeling) | |
|---|---|---|---|---|
| | Worst Davs | Best Days | Worst Days | Best Days |
| Nevada | | | | |
| Jarbidae Wilderness | 4% | 4% | 8% | 17% |
| Oregon | | | | |
| Kalmiopsis Wilderness Area | 9% | 2% | 13% | 37% |
| Crater Lake National Park | 7% | 3% | 20% | 53% |
| Arizona | | | | |
| Sycamore Canyon Wilderness Area | 5% | 4% | 6% | 23% |
| Grand Canyon National Park | 9% | 5% | 34% | 10% |

When modeled, California NOx emissions contribute up to 34 percent of the nitrate concentrations at some neighboring states on worst days. As shown in Table 8.1, however, nitrate contributes less than 10 percent of the light extinction at the nearest Class 1 Areas in neighboring states. Hence, only a small portion of out-of-State visibility degradation is due to nitrate formed from California emissions. By 2018, NOx emissions from California are expected to decrease by more than 40 percent due to emission reductions from mobile sources in California. This will significantly reduce California's impact to the out-of-State Class 1 Areas.

Table 8.2 SLilfate Contribution to Haze in aaseline Years

| State and Class 1 Area | 2000·2004 Average Annual Share of Particle Light Extinction (based on measurements) | | 2000·2004 California's Average Annual Share of Sulfate Concentration (based on modeling) | |
|---|---|---|---|---|
| | Worst Days | Best Days | Worst Days | Best Days |
| Nevada | | | | |
| Jarbidge Wilderness | 16% | 18% | 5% | 3% |
| **Oregon** | | | | |
| KalmioDsis Wilderness | 29% | 7% | 1% | 7% |
| Crater, Lake National Park | 19% | 11% | 5% | 19% |
| Arizona | | | | |
| Sycamore Canyon Wilderness | 13% | 10% | 8% | 3% |
| Grand Canyon National Park | 21% | 18% | 8% | 1% |

As shown in Table 8.2, sulfate contributes less than 30 percent of the light extinction at the nearest Class 1 Areas in neighboring states. In the baseline years, modeling shows that California SOx emissions contribute less than 10 percent of the total concentration of sulfates at the nearest out-of-State Class 1 Areas on worst days. Thus, similar to nitrate, only a small portion of visibility degradation from sulfates are attributed to California emissions. By 2018, total SOx emissions from California are not expected tochange, despite current forecasts of a 30 percent population increase in California. Considerable reductions in mobile source emissions and early reductions in the SOx content of fuels statewide will offset a small amount of possible growth in other sectors. In the mid-course review, California plans to evaluate changes in the SOx emissions inventory and the subsequent impact on sulfates measured at the monitors.

Due to the topography and prevailing weather patterns, neighboring states do not significantly impact California very frequently. However, when they do, regional modeling of current controls shows that reductions to be implernented by 2018 in other states do help improve visibility. at some California Class 1 Areas. California has determined that these controls are adequate for making reasonable progress in improving visibility in California. Preliminary visibility impact modeling for BART-eligible sources indicate that certain stationary sources in Arizona, Nevada, Oregon, and Washington may cause or contribute to visibility impairment in some California Class 1 Areas, on some days. The modeling reflects worst case emissions under all meteorological patterns. Whether any further reductions of emissions from these sources will show a beneficial impact on the worst days deciview level at any California Class 1 Area will not be known until final regional modeling is performed after this Plan submission. Therefore, any adjustments to California's RPGs to reflect benefits from BART will be made during the mid-course review.

In addition to ongoing interactions through the WRAP, California also consulted via telephone with our neighboring states, Oregon, Arizona, and Nevada, as well as Colorado, to discuss the impact of California emissions. In addition, California sent a written announcement to the WRAP primary contact in each of the WRAP states advising them of the availability of the draft Plan for comment, in advance of the public ARB hearing. ·Continuous consultation with all of the other fourteen western states of the WRAP in setting RPGs did not·result in any concerns that have not been resolved.

## 8.3 Federal Consultation

Early in the Plan development process, California provided contacts at the ARB to the Federal Land Managers as required. Consultation with the Federal Land Managers on Plan ,development began in November 2006,'with an in-person Regional Haze Teach-In at ARB headquarters that included State and regional representatives of the U.S. Forest Service (USFS), the National Park Service (NPS), the' Bureau of Land Management (BLM), the U.S. Fish and Wildlife Service (FWS), the U.S. EPA and interested air districts. At the meeting, California's proposed 2018 Progress Strategy and RPGs were discussea.

After the November 2006 face-to-face meeting, an ad hoc ARB/Federal Land Managers Regional Haze Steering Committee (Steering Committee), which also, included U.S. EPA Region 9 representatives, was formed and conducted monthly conference calls. Regional representatives of federal land management agencies were invited to participate to voice out-of-State issues. During these calls, ARB reviewed progress on the Plan tasks and requirements, and solicited input from the Federal Land Managers on updating information about Class 1 Areas and other concerns relating to visibility and the causes of regional haze. All proposed RPGs were discussed during these calls,'

Some of the concerns raised by the Federal Land Mangers during the Steering Committee calls were incorporated in the technical tasks associated with Plan preparation and others addressed long-term actions. The input contributed to the descriptions of "controllable" and "uncontrollable" anthropogenic and natural sources. Federal Land Managers' knowledge of local sources did not indicate any existing stationary sources with specific reasonably attributable visibility impacts (RAVI), but did help identify pending growth in both stationary and area sources. These included specific stationary source locales with pending land use or energy siting applications and regional growth trends.

All of these growth nodes will occur in' areas which are currently nonattainment for national and State air quality standards. The air districts are already charged with continuous improvement of their stationary and area source rules to achieve reductions to offset growth. Changing emissions will be updated in the regional haze inventory when they occur and will be included in the mid-course review assessments. Also, the USFS expressed their longstanding concern about ozone damage to forest health, and agreed that continued reductions in ozone precursors throughout the State would also be beneficial in reducing haze species formation.

As a result of input from the Federal Land Managers, two items will be continued in detail during the mid-course review because further research is required.

- The State is concerned that the U.S. EPA default for Natural Conditions in California may not adequately incorporate the impacts of wildfire smoke as well as biogenic emissions, thereby underestimating the deciview value of Natural Conditions. The Federal Land Managers are assisting in tracking the temporal and regional impacts of wildfire smoke which is necessary for development of an equitable attribution of this natural, uncontrollable source. If there is consensus, after collecting more data in the future, the "Natural Conditions" values at some Class 1 Areas in California may be adjusted upward.s.

- The Federal Land Managers also requested that the Plan point to the possibility of coordinated administration of the Prevention of Significant Deterioration Program (PSD) with the Regional Haze Program. The U.S. EPA representatives participating in the discussion agreed that improvements for tracking impact increments have been a national concern. In California, local air districts and U.S. EPA Region 9 are currently responsible for PSD reviews of new sources. The ARB recommends that this item be addressed regularly through existing committees and reported on in the mid-course review,

The draft Plan has been released for review by the Federal Land Managers at least 60 days before the Board Hearing with a written request for comments to the reviewers specified by the three Federal Land Management agencies which manage the Class 1 Areas in California: the U.S. Forest Service, the National Park Service, and the Bureau of Land Management. The Steering 'Committee also supported the plans for a public weOcast.workshop in Sacramento on the Plan on December 15,2008, over one month prior to the public hearing. A webcast workshop facilitates broad participation by Federal Land Manager field' office staff in remote locations via internet. Webcast workshops also enable "live" question and answer format for all participating in person and via the web. Both ARB staff who prepared the Plan, as well as the Federal Land Manager representatives and the public attending the workshoplwebcast, are able to comment and respond in a non-hearing setting. The official written comments of the Federal Land Managers, as a result of the 60-day advance review, will be placed in Appendix F when received.

## 8.4 Required Continued Consultation with Federal Land Managers

California will continue to coordinate and consult with the Federal Land Managers during the development of future progress reports and 'Plan revisions, as well as during the implementation of programs having the potential to contribute to visibility impairment in the mandatory Class 1 Areas via three eXisting venues: the Interagency Air and Smoke Council, the Air and Land Managers Group, and the WRAP.

Prior to Plan development, the Federal Land Management agencies in California, California Department of Forestry and Fire Protection (CDF), ARB, and local air districts met routinely in technical and policy forums. Since the 1990's, technical staff has met quarterly as the chartered Interagency Air and Smoke Council (IASC) to discuss measurement, monitoring, regulatory, planning, and outreach issues, among other things related to smoke management.

Beginning in 2002, upper management representatives from the same.agencies began meeting on a regular basis as the Air and Land Managers Group (ALM) to resolve policy issues relating to smoke management. The Steering Committee formed as· an ad hoc subset of the AIM specifically to address the Plan development. After Plan submittal, the ALM will continue to keep regional haze as a regular update item on their meeting agendas. In addition, the ARB will continue to foster coordination and communication' with neighboring states to discuss issues related to inter-state smoke impacts.

The WRAP has agreed to host an annual convocation on regional haze,' as a Board meeting or as a separate workshop, to discuss regional haze issues and foster continued .communication between the states, Tribes, and the Federal Land Managers.

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# 9. FUTURE REGIONAL HAZE REQUIREMENTS

## 9.1 Introduction

This section addresses other future requirements specified in the Regional Haze Rule. In the future, the Regional Haze Rule requires states to:

- Include a monitoring strategy;
- Submit periodic reports evaluating progress towards the Reasonable Progress Goals (RPG), an assessment of significant changes in anthropogenic emissions, and adequacy of the Plan every five years; and
- Revise the Plan in 2018 and every ten years thereafter.

## 9.2 IMPROVE Monitoring Strategy

California will depend on the IMPROVE monitoring program to collect and report data for reasonable progress tracking as specified in the Regional Haze Rule for all Class 1 Areas in the State. The current IMPROVE monitoring network listed in Table 2-1 is adequate for analyzing California Class 1 Areas. Because Regional Haze is a long-term tracking program with a 60-year implementation period, California expects the configuration of the monitors, sampling site locations, laboratory analysis methods. and data quality assurance, and network operation protocols will not change, or if changed, will remain directly comparable to those operated by the IMPROVE program during the 2000-2004 Regional Haze baseline period. Technical analyses and reasonable progress goals in this plan are based on data from these sites. California must be notified and agree to any changes in the IMPROVE program affecting the Regional Haze tracking sites, before changes are made.

California plans to use data reported by the IMPROVE program as part of the regional technical support analysis tools found at the Visibility Information Exchange Web System (VIEWS), as well as other analysis tools and efforts sponsored by the WRAP. California will participate in the regional analysis activities of the WRAP collectively to assess and. verify progress towa,rd RPGs, and support interstate consultation as the Regional Haze Rule is implemented.

California will depend on the routine" timely reporting of monitoring data by the IMPROVE program to VIEWS for the reasonable prog·ress tracking sites. Further, California will continue to rely on U.S. EPA to operate the IMPROVE monitoring network.

## 9.3 Periodic Progress Reports

In 2013, California will initiate a mid-course review of progress in reaching the RPGs. During the mid-course review, California will:

- Report on additional emission reductions from post-2004 control measures not reflected in the 2018 Progress Strategy;
- Update natural conditions to reflect new information if available;.
- Update the RPGs with latest WRAP modeling if appropriate;
- Re-evaluate the RPGs to determine if they should be adjusted to better reflect achievable improvements in visibility, as future control measures are adopted and implemented;
- Compare the actual deciview calculations against progress towards reaching the RPGs and the uniform rate of progress;
- Assess the impact at the monitors from BART-specific and post-2004 .adopted and implemented measures; and
- Evaluate the adequacy 6f the existing Plan elements.

While California's 2018 Progress Strategy provides a comprehensive and aggressive basis for setting the RPGs in this Plan, attainment of new federal. standards for ozone and particulate matter will require adoption of even more stringent measures as reflected in California's State Strategy adopted in 2007. These future measures go beyond the basic requirements for the regional haze program.. However, the additional benefits realized from future control strategies implemented by 2012 will be evaluated in the context of the 2013 mid-course review.

## 9.4 Plan Revisions

As with the current Plan, California believes the elements needed for a Plan revision should be done on a regional basis. The regional process has been very effective in identifying issues that concern all of the western states and facilitating consultation. Two issues that should continue to be evaluated from a western regional perspective are natural conditions and visibility calculations. Natural wildfires tend to drive poor visibility in the West. However; currently, they are not excluded nor is their magnitude appropriately considered as part of natural conditions. The impact of wildfires needs to be accounted for so they are appropriately considered in achieving natural visibility. California plans to work with the WRAP and the Federal Larid Managers in tracking wildfires to achieve a better understanding of the wildfire cycle near Class 1 Areas. Long term wildfire tracking will provide a solid foundation for incorporating wildfires into the natural conditions estimate. Also, as more information becomes available regarding how pollutants impact visibility, the western region should work together to update visibility calculations. This process has worked well in developing the Regional Haze II algorithm.

Finally, as part of the western region, California will revise the Plan in 2018 and every ten years there after. The Plan revision will include:

- Current calculation methodologies for visibility;
- Evaluation of the appropriateness of naturar condition levels and updates ifappropriate;
- Current visibility conditions for most impaired and least impaired days;
- Progress towards natural conditions;
- Effectiveness of California's 2018 Progress Strategy;
- Affirmation or .revision of reasonable progress goals;
- Updated emission inventories; and
- Re-evaluation of the monitoring strategy.

The Plan revision will also follow the appropriate inter-state and Federal Land Manager procedure consultations established in this Plan.

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# 10. California Environmental Quality Act

## 10.1 Introduction

The California Environmental Quality Act (CEQA) requires that State and local agency projects be assessed for potential significant environmental impacts. A projectincludes an activity undertaken by a public agency which may cause either a direct physical change in the environment or a reasonably foreseeable indirect change in the environment. Every project which requires a discretionary governmental approval will require at least some environmental review pursuant to CEQA, unless an exemption applies. The action of ARB to approve or disapprove this Regional Haze Plan (Plan) project is discretionary. As a certified State regulatory program, ARB is required to include in the CEQA environmental impact assessment the project description, analysis of alternatives, and an environmental analysis.

## 10.2 Description of the Proposed Project

The federal Clean Air Act requires states to prepare a plan demonstrating progress to achieve natural visibility conditions at federal Class 1 Areas by 2064. The 1999 Regional Haze Rule, promulgated by the United States Environmental Protection Agency (U.S. EPA), lays out specific reqUirements that each state must include in their plan to address the federal Clean Air Act visibility reqUirements. The Regional Haze Plan sets forth California's goals for improving visibility by 2018 at 29 Class 1 Areas in California to meet these requirements. These goals are based on already adopted control measures that insure visibility improvement at all of California's Class 1 Areas by 2018.

The Regional Haze Rule requires the Plan to contain the following key elements:

- Baseline and natural visibility conditions;
- Base and future year emission inventories;
- Long-term control strategy based on already adopted measures;
- Reasonable progress goals for 2018;
- Best available retrofit technology analysis;
- Consultation with states, tribes, and federal land managers; and
- Monitoring strategy..

One of the key elements in the Plan is the best available retrofit technology (BART) requirement. The BART requirement directs the State to evaluate large older sources from 26 categories to determine whether emission controls could be installed that would improve visibility at Class 1 Areas. This analysis was based on emissions from these sources during the baseline period (2000 through 2004) and identified sources emitting over 250 tons per year. ARB evaluated these larger sources to determine if existing controls were already at a BART-level control. Sources not controlled at a BART-level were then analyzed to determine whether they caused or contributed to visibility impairment at any

Class 1 Area. Through this extensive analysis, one source, Valero Refining Company, was identified as contributing to visibility impairment and needing to install BART-level controls on certain units at the facility pursuant to this requirement. Due to a 2005 consent decree between U.S. EPA and Valero Refining Company, Valero Refining Company is already required to install the BART-level controls. Therefore, the BART-level controls are pre-existing and not a result of the requirements in this Plan.

### 10.2 Alternatives to the Proposed Project

Because the Plan is required by federal law and because the Plan relies entirely on previously adopted measures, the environmental review of each measure was performed at the time each measure was adopted. No new measures are being proposed as part of the Plan.

The only alternative to the Plan would be the "No Project" alternative. With this alternative, ARB would not submit a plan to U.S. EPA for the protection of visibility in California's Class 1 Areas. The "No Project" alternative would mean that California would not meet federal Clean Air Act requirements and U.S. EPA would be required to put in place a Federal Implementation Plan to address these requirements. Therefore, staff determined that the "No Project" alternative is not appropriate and the alternative was rejected.

### 10.3 Evaluation of Potential Effects on the Environment

This Plan is based on already adopted emission control measures and existing actions. The emission control measures have already been analyzed for environmental impacts as part of the rulemaking adoption process by ARB and the local districts. Therefore, the adopted and already implemented measures, along with the requirements of the consent decree are considered as part of the existing setting, and their impact will not be further analyzed.

# APPEN'DIXA

## Deciview Calculation Methodology

The California Regional Haze Plan uses the Haze Algorithm II for estimating the deciview values used in this plan. Haze pollutants are particles that have the ability to absorb and reflect light radiation; both actions extinguish light and decrease visibility. Particle mass, humidity, and temperature influence the amount of light extinction caused by haze species. Rayleigh scattering is affected by elevation and temperature. The following explains the process for estimating the deciview values.

1. The "HAZE ALGORITHM" uses Species' Mass → to determine Light Extinction → which is converted to a Deciview Value.

2. Every third day, 24-hour mass measurements are made of all the haze species collected at each IMPROVE monitor and the Haze Algorithm is used to deliver individual species and total species Light Extinction in inverse megameters (Mm-1).

3. The Haze Algorithm for calculating Light Extinction *(bext)* weights the Species Mass *(ug/m3)* measured at the IMPROVE monitors using particle size, humidity, and elevation as follows:

   *bSulfate* = 2.2 x fS(RH) x [small S04] + 4.8 x fL(RH) x [large S04]
   bNitrate = 2.4 x fS(RH) x [small N03] + 5.1 x fL(RH) x [large N03]
   bOrganic Material Carbon = 2.8 x [Small OM] + 6.1 x [Large OM]
   bElemental Carbon = 10 x [EC]
   bFine Soil = 1 x [Fine Soil]
   bSea Salt = 1.7 x fSS(RH) [Sea salt]
   *bCoarse* Mass = 0.6 x [CM]
   bRayleigh = (Site Specific factor, related to elevation, ranging from 7+ to 11+ in California)
   bNitric Oxide gas= 0.33 x [N02 (ppb)] (not measured at most IMPROVE monitors).

4. The sum of the weighted extinction values gives the total daily extinction (Total *bext)* for each day of measurement:

   Total *bext* = *bSulfate* + bNitrate + *bEC* + *bOMC* + bSoil + *bCM* + *bSS* + bRayleigh + *bN02*

5. The deciview scale was created to describe the 'total light extinction capability of all haze species in the ambient air at a given time at a given location. The Deciview Value (dv) is the natural logarithm of the total calculated light extinction on each day of measurement. Mass measurements for all species must be available. to calculate the dv for a given day.

   DeciviewValue (dv) = 10 ln (Total bext/10)

# APPENDIX B

California Class 1 Area Visibility Descriptions

# TRIN1 Monitor

The TRIN1 monitor location represents two wilderness areas located in the Marble and Klamath Mountains in Northern California. The wilderness areas associated with the TRIN1 monitor are Marble Mountain and Yoila-Bolly Middle Eel Wilderness Areas. The TRIN1 site has been operating since July 2000. This site does not have sufficient data for the entire baseline period. Data was not available for the year 2000.

## Section I.. TRIN1 Wilderness Area Descriptions

### *I.a. Marble Mountain Wilderness Area*

The Marble Mountain Wilderness Area (Marble Mountain) consists of about 200,000 acres of the Marble Mountains of northern California. Its northern boundary is about 25 miles south of the Oregon/California border. Its principal drainage is Wooley Creek that flows westward into the Salmon River drainage and Pacific Ocean via the Klamath River. Terrain is forested mountains, with highest elevations 2,103 meters to 2,195 meters. The lowest elevation is about 198 meters on the western boundary where Wooley Creek exits the Wilderness.

**Figure 1. Marble Mountain Wilderness area**

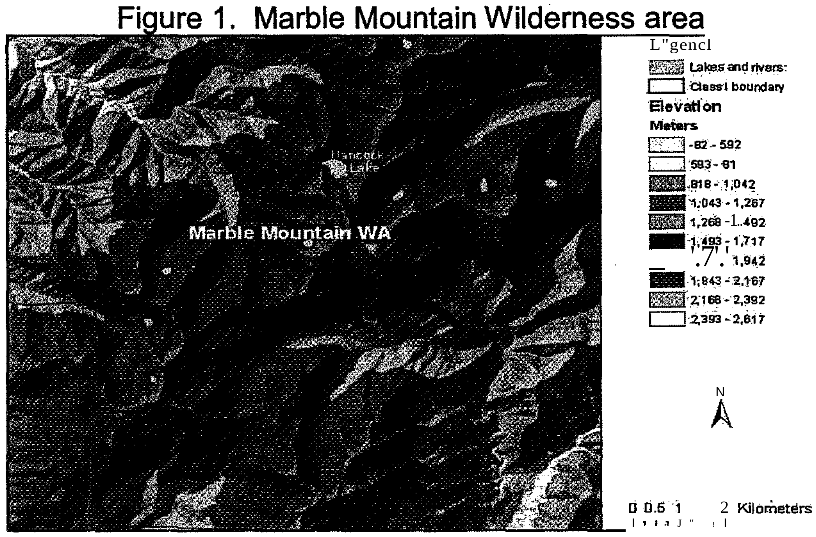
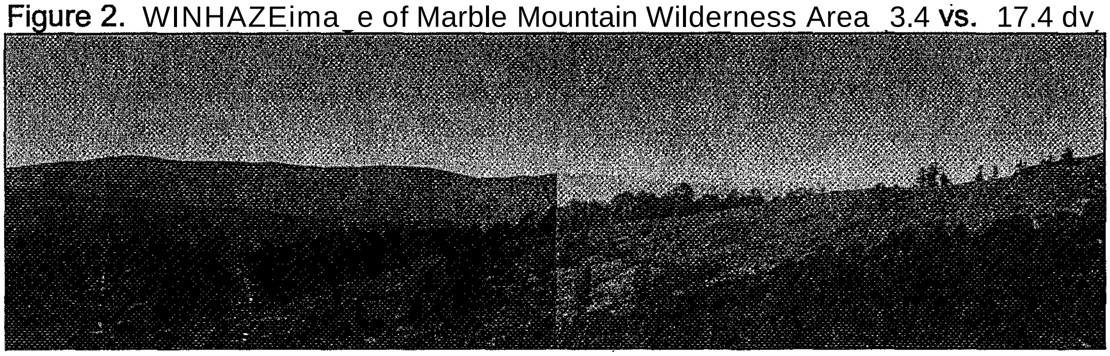



**Figure 2.** WINHAZEima_e of Marble Mountain Wilderness Area 3.4 **vs.** 17.4 dv



*I.b. Yolla-Bolly Middle Eel Wilderness Area*

The Yolla Bolly - Middle Eel Wilderness Area (Yolla Bolly) lies on about 150,000 acres in the Klamath Mountains region near the southern extent of the Cascade Range in northern California. The wilderness ,is just west of the north end of the Sacramento Valley near Redding. Onthe west side the Wilderness the, North and Middle Forks of the Eel River flow west into the Pacific Ocean near Redwood National Park. On the east side the South Fork of Cottonwood Creek flows to the northern Sacramento Valley between Redding and Red Bluff. The lowest elevation, about 792 meters, is on the eastern boundary where Cottonwood Creek exits the Wilderness, about 610 meters' above the northern Sacramento Valley floor at Redding. The highest elevation is 2,467 meters at the peak of Mt Linn.

Figure 3. Yolla Bolly – Middle Eel Wilderness area

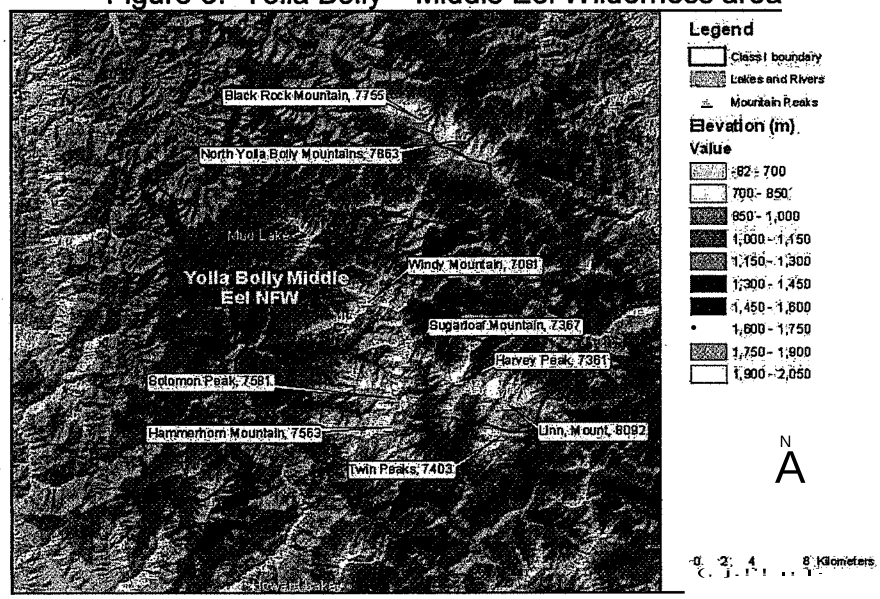



Figure 4. WINHAZE image of Yolla Bolly Wilderness Area (3.4 vs. 17.4 dv)

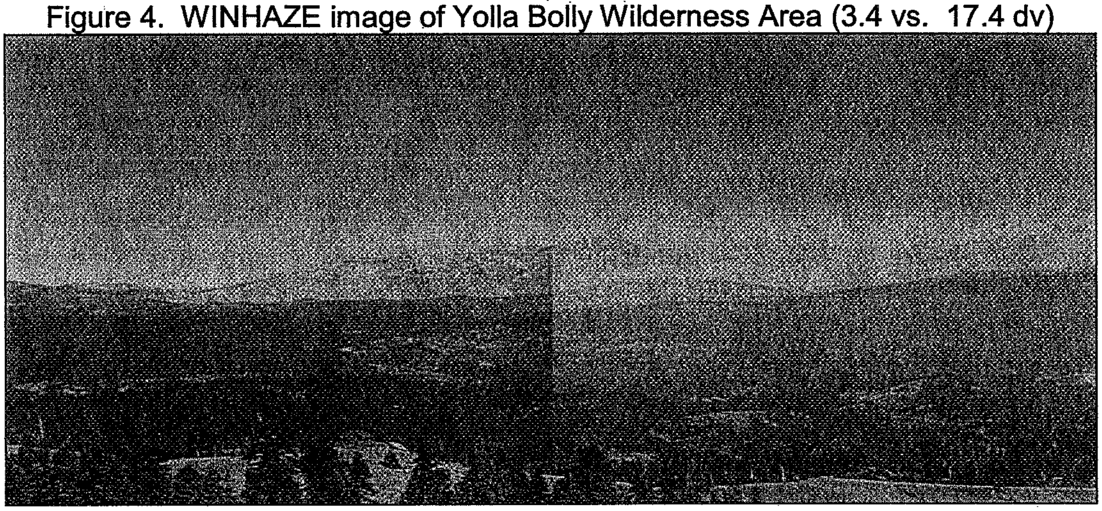
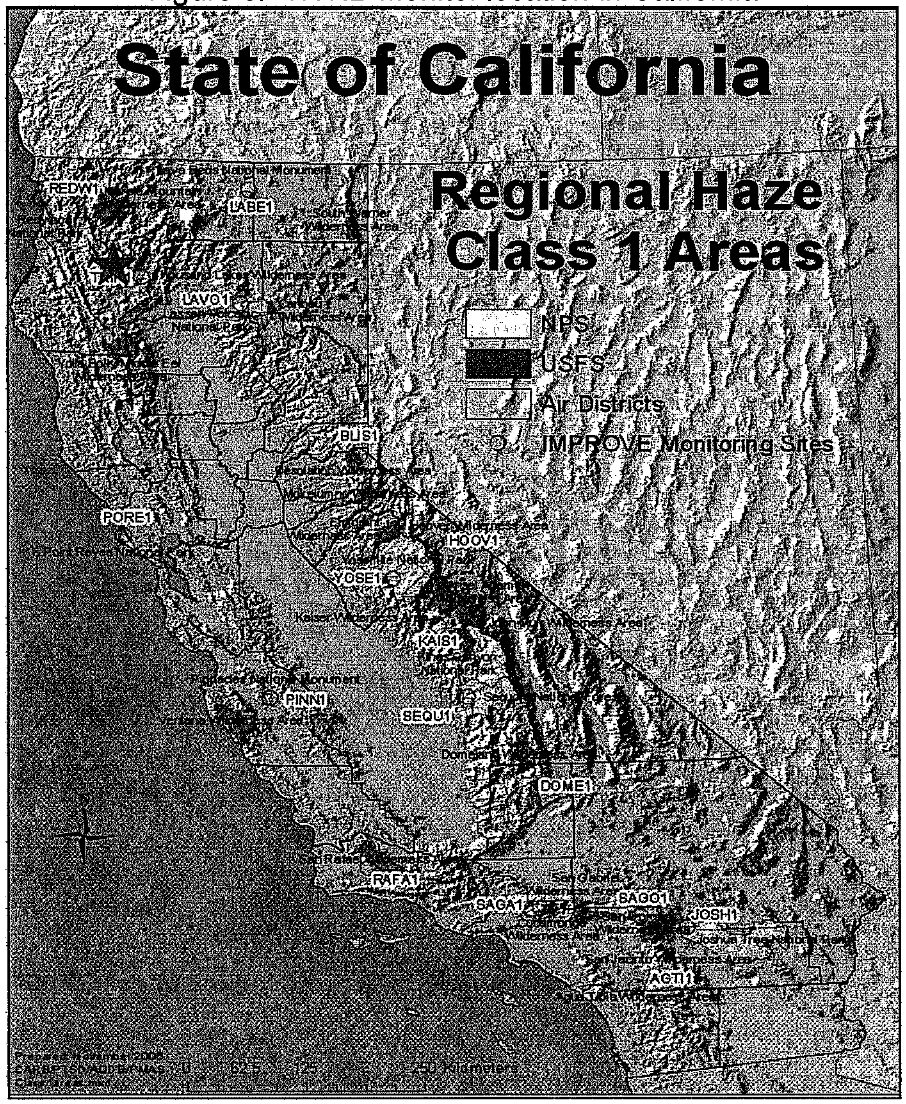


Figure 5. TRIN1 Monitor location in California




## Section II. Visibility Conditions:

### *II.a. Marble Mountain Wilderness Area*

Visibility conditions for Marble Mountain are currently monitored by the TRIN1 IMPROVE monitor in the Trinity Alps. The monitor is located at 40.7864 north latitude and 122.8046 west longitude, located midway between the Marble Mountain Wilderness Area and the Yolla Bolly - Middle Eel Wilderness Area in the Trinity Alps. TRIN1 is situated on a ridge crest of Pettijohn Mountain at an elevation of 1,014 meters. It is about 40 miles southeast of the Marble Mountain Wilderness, in the Trinity River drainage, with an intervening 1,798 to 1,981 meter crest line.

The monitoring location, TRIN1, may not be influenced by the same local sources that impact the Marble Mountain Wilderness because of the distance and intervening terrain. In particular, it may be more subject to Sacramento Valley emissions than the Marble Mountain Wilderness. It should be representative of aerosol characteristics in the Marble Mountain during periods of more uniform regional haze resulting from regional forest fire events or transport from more distant source regions on a global scale. The closest source region with anthropogenic emissions thatmay contribute to aerosol and haze at the TRIN1 si"te is the Sacramento Valley. The communities of Redding and Red Bluff are about 25 miles southeast of the site. The Sacramento Valley may provide a link between TRIN1 aerosol measurements and emissions from the larger Sacramento and San Francisco Bay areas during low level southerly flow. Marble Mountain is more distant, about 40 miles northwest of TRIN1 and 50 to 60 miles from the northern Sacramento Valley.

The TRINllocation is adequate for assessing the 2018 reasonable progress goals for the Marble Mountain Wilderness Class 1 area. .

### *II.b.* ***Yolla-Bolly Middle Eel Wilderness Area***

Visibility conditions for the Yolla Bolly - Middle Eel Wilderness are currently monitored by the TRIN1 IMPROVE monitor in the upper Trinity River valley. The monitor is located at 40.7864 north latitude and 122.8046 west longitude midway between the Marble Mountain Wilderness Area and .the Yolla Bolly - Middle Eel Wilderness Area in the upper Trinity River valley. TRIN1 is situated on a ridgecrest of Pettijohn Mountain at an elevation of 1,014 meters. It is 40 to 50 miles north of Yolla Bolly - Middle Eel Wilderness. Also, it is within the Trinity River valley and separated from the northern Sacramento Valley by the intervening Trinity Mountains crestline with elevations of 2,820 meters and higher. "

TRIN1 is probably not influenced by local transport from the Sacramento Valley to the same extent as Voila Bolly when Valley emissions are transported across the Trinity Range during southerly flow conditions. It should be representative of aerosol characteristics at Yolla Bolly during periods of more uniform regional haze, resulting from regional forest fire events or transport from more distant source regions on a global scale. The Sacramento Valley is the closest source region with emissions that may contribute to haze in the Yolla Bolly. Sacramento Valley may provide a link to emissions from the larger Sacramento and San Francisco Bay areas during low level southerly flow. "

The TRIN110cation is adequate for assessing the 2018 reasonable progress goals for the Yolla Bolly - Middle Eel Wilderness Class 1 area.

*II.c. Baseline Visibility*

Baseline visibility is determined from TRIN1 IMPROVE monitoring data for the 20% best and the 20% worst days for the years 2000 through 2004. The baseline visibility for the TRIN1 monitor is calculated at 3.4 deciviews for the 20% best days and 17.4 deciviews for the 20% worst days. Figure 6 represents the worst baseline visibility conditions.

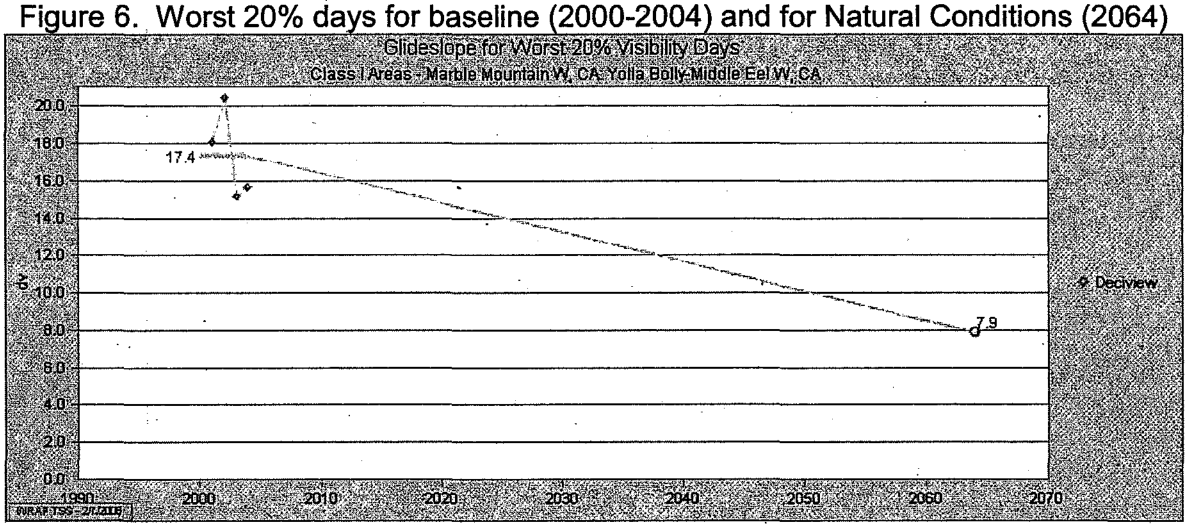
*II.d. Natural Visibility*

Natural visibility represents the visibility condition that would be experienced in the absence of human-caused impairment. Based on EPA gUidance, the natural visibility for the TRIN1 monitor is 1.2 deciviews for the 20% best days and 7.9 deciviews for the 20% worst days. It is possible that the Natural Conditions deciview value for 2064 could change in the future as more is learned about natural plant emissions and wildfire impacts.

*II.e. Presumptive Glide Slope and the Uniform Rate of Progress*

Figure 6 also shows the uniform rate of progress, or "glide slope." The glide slope is the rate of reduction in the 20% worst days deciview average that would have to be achieved to reach natural conditions at a uniform pace in the 60 years following the baseline period. The first benchmark along the path towards achieving natural conditions.occurs in 2018. The glide slope shows that the 2018 benchmark for the 20% worst days is 15.15 deciviews. According to the Regional Haze Rule, the 20% best days baseline visibility of 3.4 deciviews must be maintained or improved by 2018, the end of the first planning period.

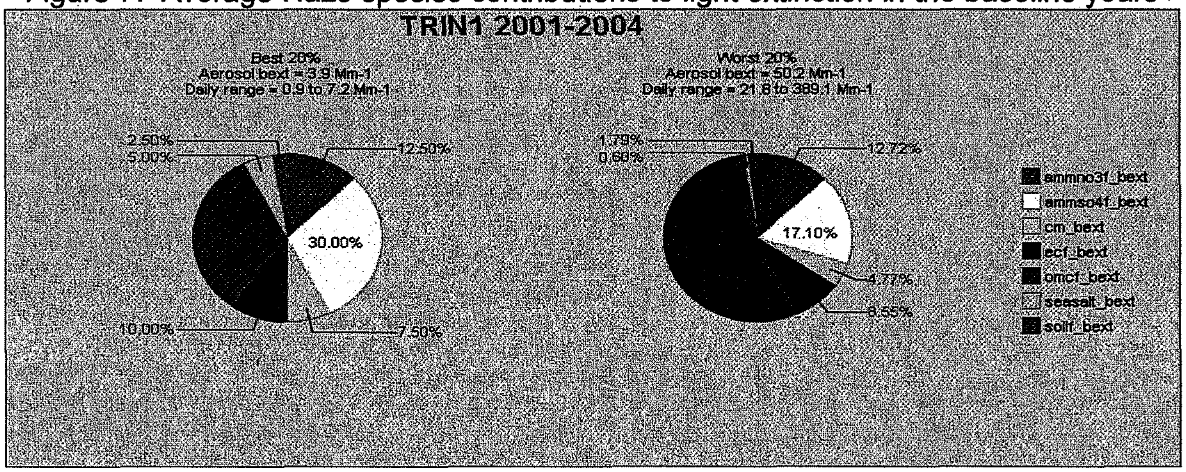
**Figure 6. Worst 20% days for baseline (2000-2004) and for Natural Conditions (2064)**



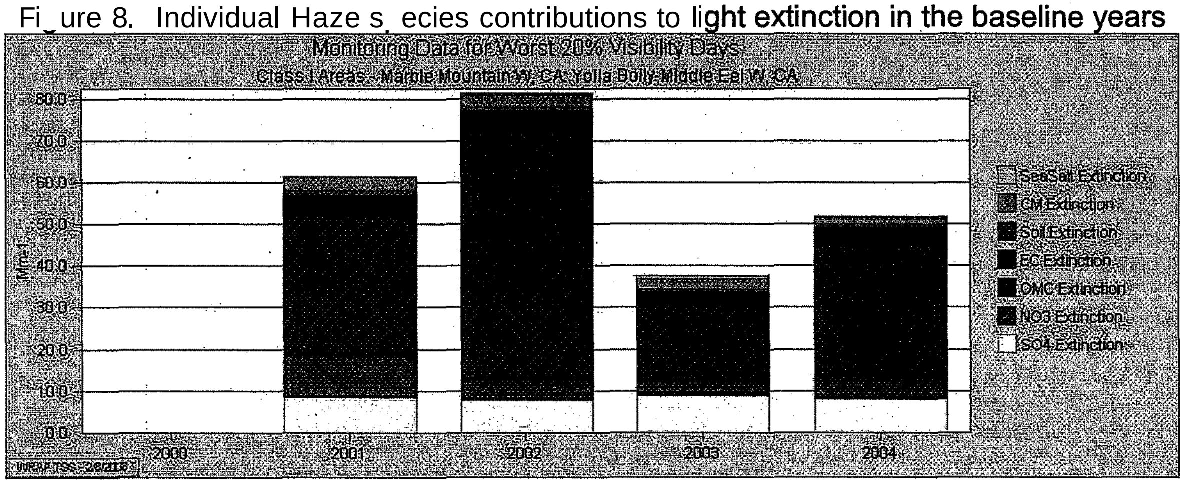
### ***II.f.*** *Species Contribution*

Each pollutant species causes light extinction but its contribution differs on best and worst days. Figure 5 shows the contribution of each species to the 20% best and worst days in the baseline years at TRIN1.

**Figure 7. Average Haze species contributions to light extinction in the baseline years**




Fi_ure 8. Individual Haze s_ecies contributions to light extinction in the baseline years




As shown in Figures 7 and 8, organic matter, sulfates, and nitrates have the strongest contributions to degrading visibility on worst days at the TRIN1 monitor. Organic matter dominates both the best and worst days at the TRIN1 monitor.

Figure 9 depicts the individual species contribution to worst days in 2002. Nitrates increase in the winter and early spring while sulfates increase slightly in the summer months. Organic matter remains high throughout the summer. Or.9anic matter clearly dominates the other haze species on worst days, but nitrates, sulfates, coarse mass and elemental carbon also contribute to the worst days in the summer. There are only trace amounts of sea saltand soil present throughout the years.

Figure 10 illustrates the individual species contribution on worst days in 2000-2004 by monthly average. The trend shown is comparative to Figure 9 for organic matter, nitrates,and sulfates. High organic periods vary from year to year due to the unpredictable occurrence of wild fires.

Figure 9. Species contribution on the 20% worst days in 2002

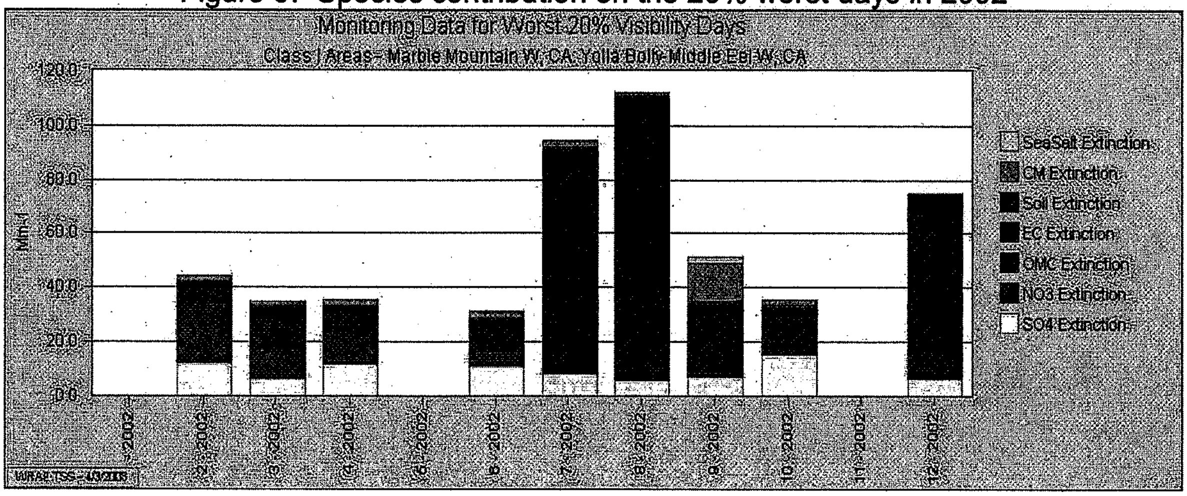
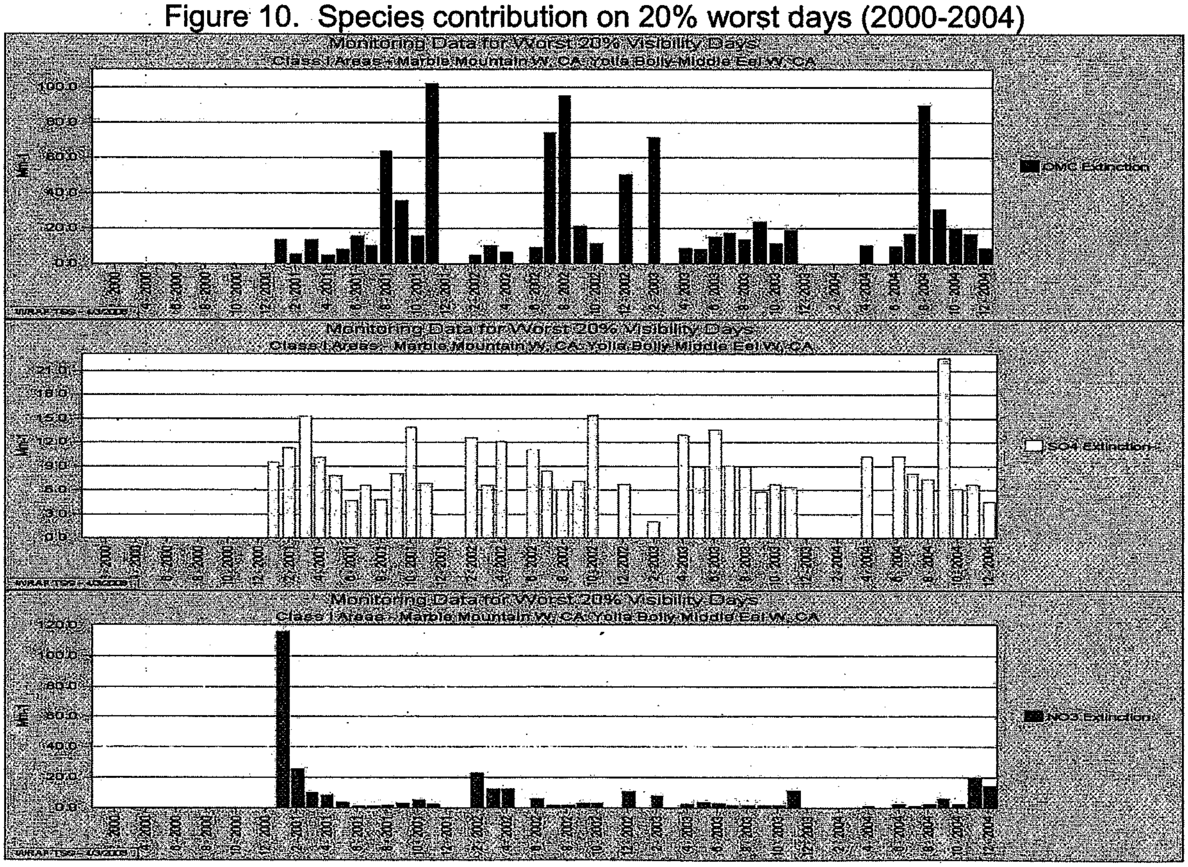



Figure 10. Species contribution on 20% worst days (2000-2004)



### *II.g. Sources of Haze Species*

Both natural and man-made sources contribute to the calculated deciview levels made by haze pollutants at TRIN1. Some haze species arise from sources that are within the control of the State of California or neighboring states. Others arise from natural, uncontrollable situations such as wildfires, sea salt or dust storms in natural areas, whether they are from in-state or out-of-state (and out-of-country) sources. Finally, other uncontrollable, man-made sources are those industrial pollutants and other man-made (anthropogenic) emissions transported from outside the United States.

Figure 11 shows the primary organic carbon source contribution from California.and the outside regions.. The largest contributor to primary organic carbon 'at the TRIN1 monitor is from natural fire sources within Oregon. Oregon represents 67% of all natural fire source contributions.

Figure 12 illustrates the total organic carbon source apportionment from 2000-2004 for anthropogenic and biogenic sources. The biogenic secondary emissions account for 62% of the total organic carbon. Anthropogenic and biogenic primary source emissions account for 36% of the total organic carbon emissions and anthropogenic secondary is responsible for the remaining emissions.

Figures 13 and 14 represent the regional contributions to sulfate on the 20% worst days in 2002 and 2018 at TRIN1. The WRAP region represents 41% of the sulfate contributions in 2002 and 2018,followed by the emissions from the Outside Domain Region (38%) and the Pacific Offshore Region (17%). California contributes 15% of the total sulfate emissions seen at the TRIN1 monitor.

Individually, emissions from outside the modeling domain contribute the most to sulfate concentrations at the TRIN1 monitor. The next largest contributor to sulfate concentration is from area sources in the Pacific Offshore Region.

Figures 15 and 16 represent the regional contributions to nitrates on the 20% worst days. The WRAP region represents the largest contribution to nitrate in 2002 and 2018 (80%), followed by the Outside Domain Region (13%) and emissions from Pacific Offshore (5%). Mobile sources within California contribute the most nitrate at the TRIN1 monitor. In 2002, California accounted for 81% of all mobile sources. California mobile source emissions reductions are mainly responsible for improvement in nitrates in 2018.

**Figure 11.** Or_anic carbon source contribution from, CA and outside re_ions

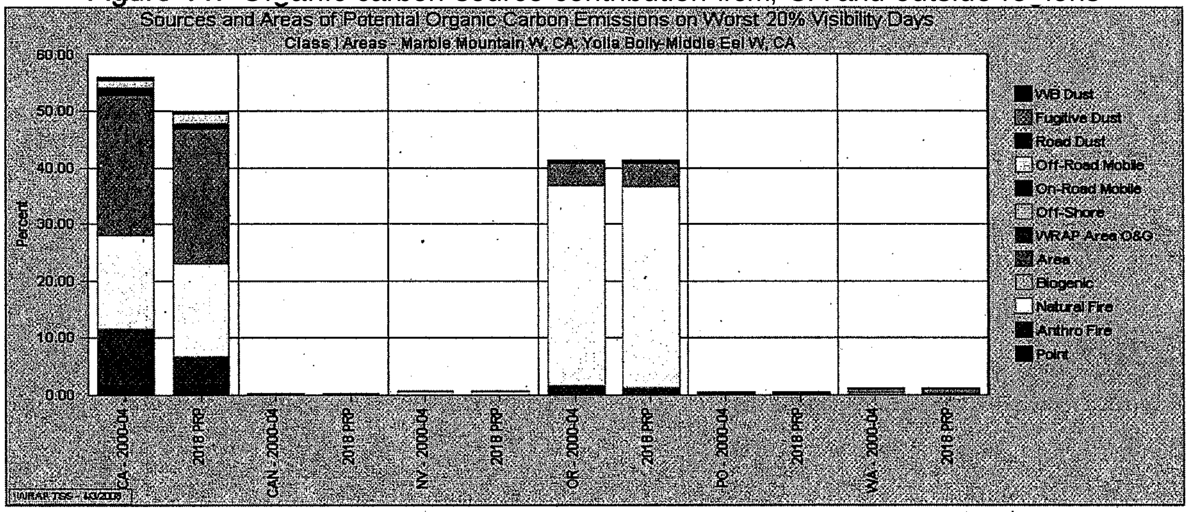



**Figure 12.** Organic carbon Anthropogenic and Biogenic Source Apportionment

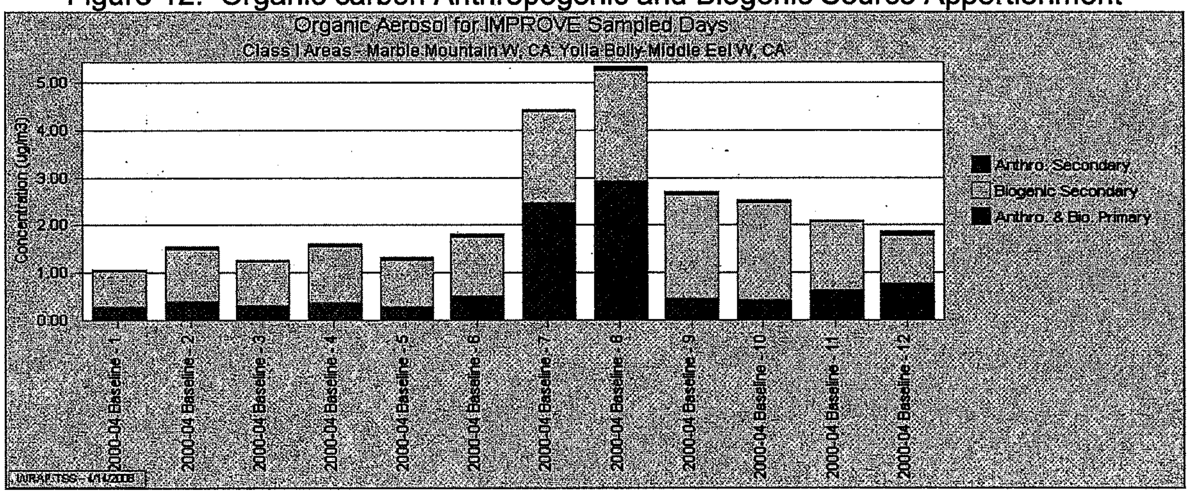
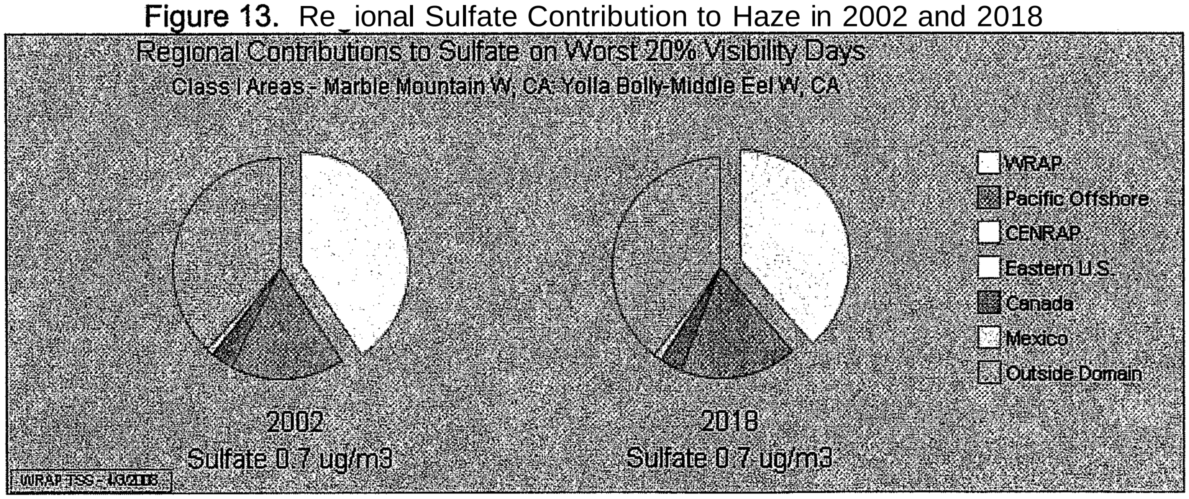



**Figure 13.** Re_ional Sulfate Contribution to Haze in 2002 and 2018



Fi_ure 14. Sulfate source contribution from CA and outside regions

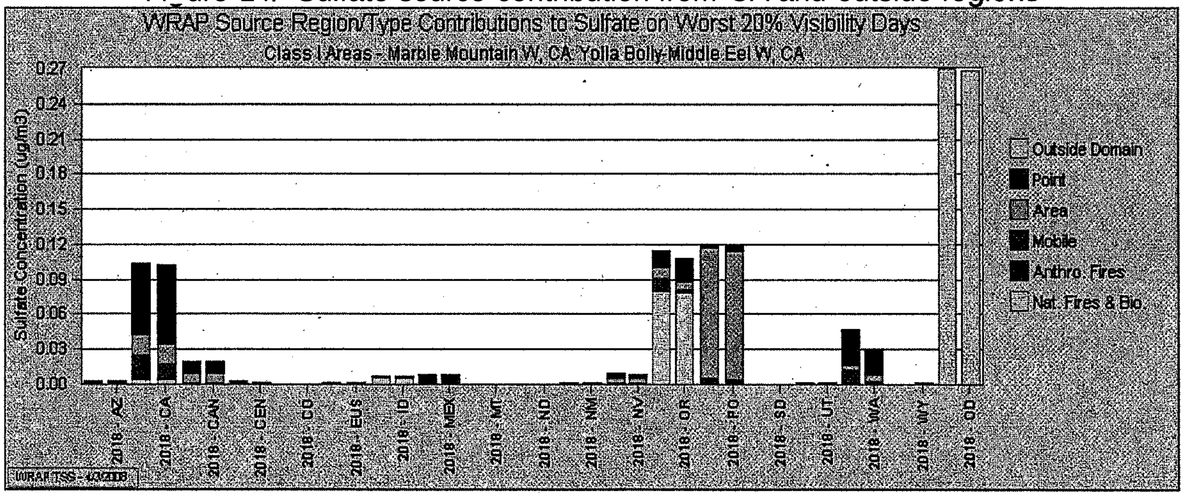
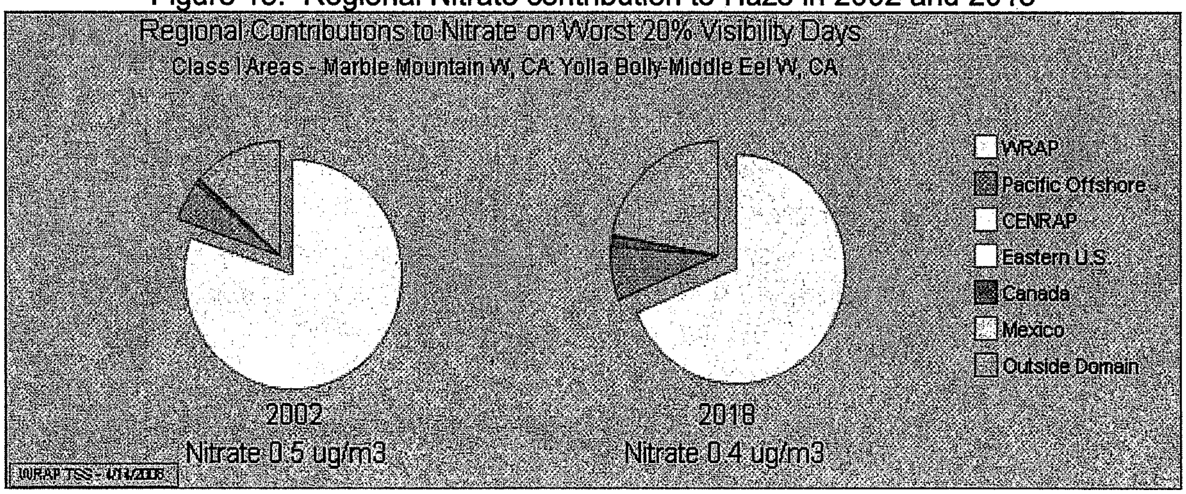
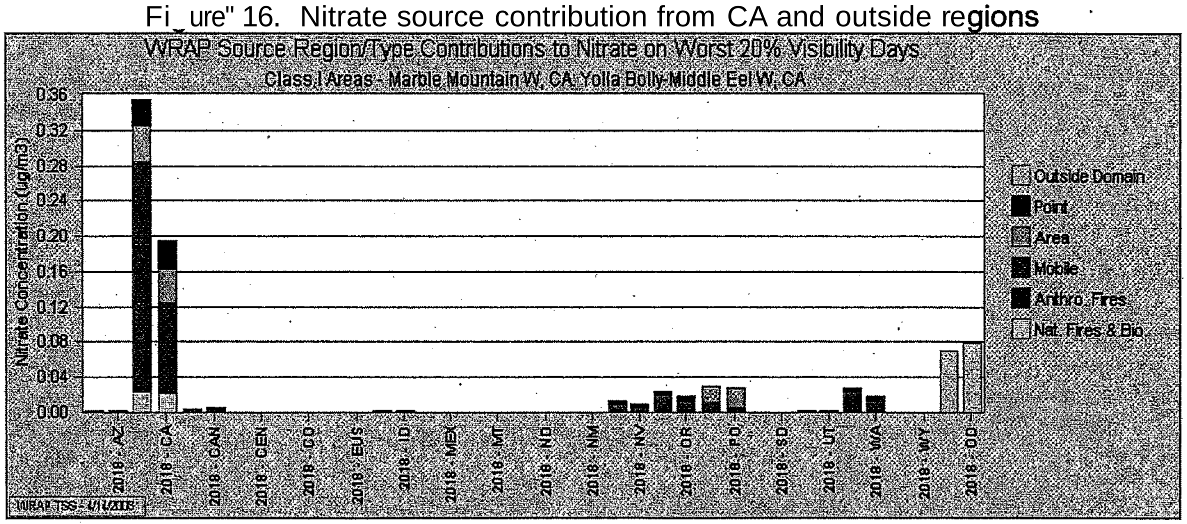



Figure 15. Regional Nitrate contribution to Haze in 2002 and 2018




Fi_ure" 16. Nitrate source contribution from CA and outside regions



## LABE1 Monitor

The LABE1 monitor location represents two wilderness areas located within Siskiyou and Modoc Counties. The wilderness areas associated with the LABE1 monitor are Lava Beds Wilderness area and South Warner Wilderness area. The LABE1 site has been operating since March 2000. This site does not have sufficient data for the entire baseline period. Data was not available for year 2000.

### Section I. LABE1 Wilderness Area Descriptions

#### *I.a. Lava Beds Wilderness Area*

The Lava Beds Wilderness Area (Lava Beds) consists of 28,460 acres in the Lava Beds National Monument in northeastern California, bordering the eastern slopes of the Sierra Nevada range, 43 miles northeast of Mt. Shasta. Lava Beds terrain' is flat, gently sloping upwards towards the southwest. Elevations range from about 1,219 meters to 1,737 meters.

**Figure 1. LABE1 Monitor location**

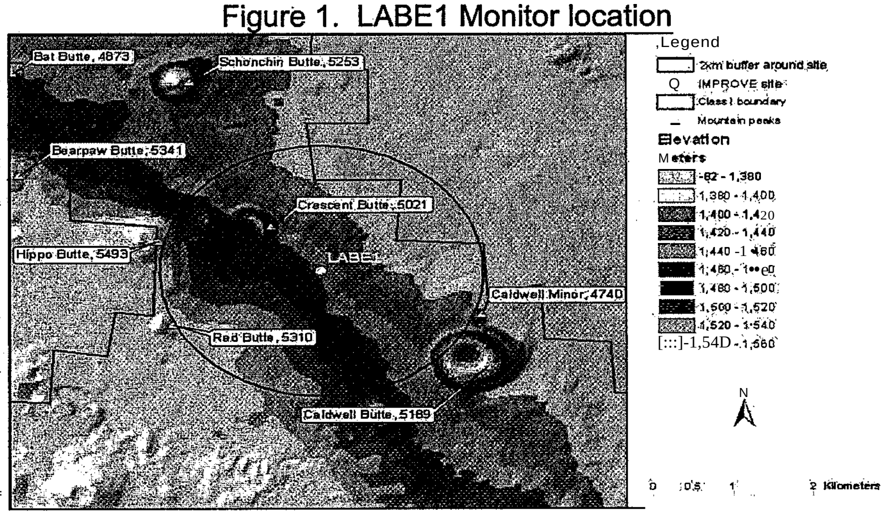
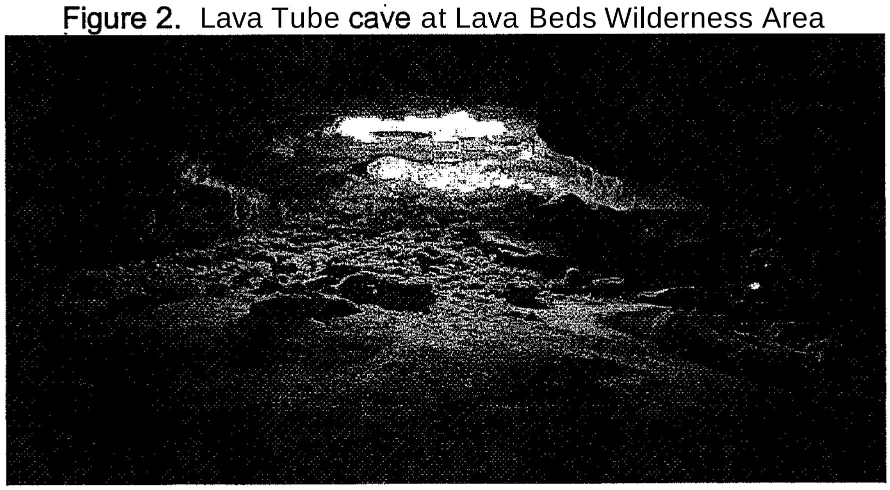



**Figure 2.** Lava Tube cave at Lava Beds Wilderness Area



*I.b. South Warner Wilderness Area*

The South Warner Wilderness consists of 70,385 acres on the Warner Mountain Range, an isolated spur of the Cascade Range in extreme northeastern California.' Elevations range from about 1,600 meters along the eastern Wilderness Boondaryto 3,015 meters at the crest of Eagle Peak. The terrain'is gently rolling on the western slopes, with steeper eastern slopes.

Fi_ure3. South Warner Wilderness Area

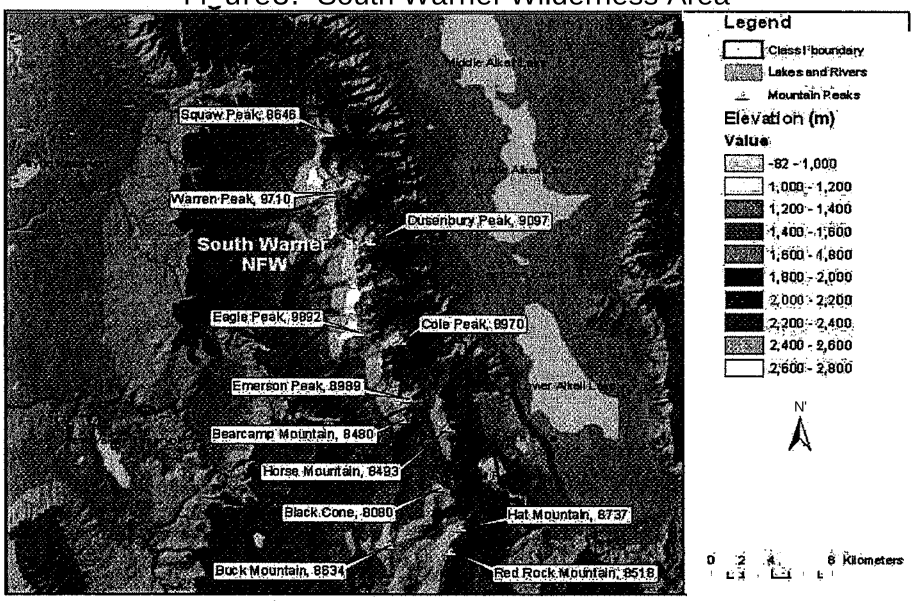



Figure 4. South Warner Wilderness Area

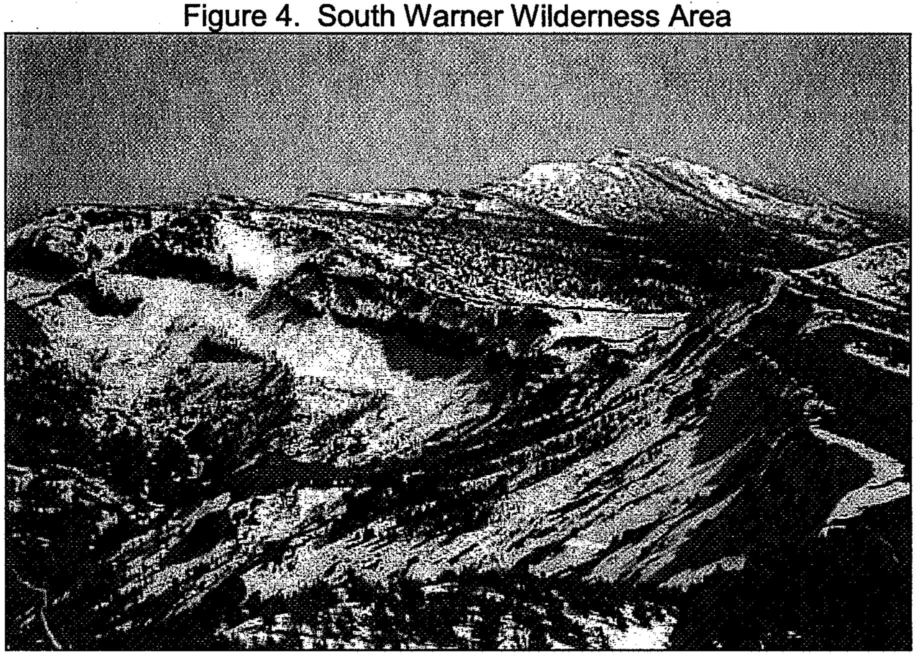
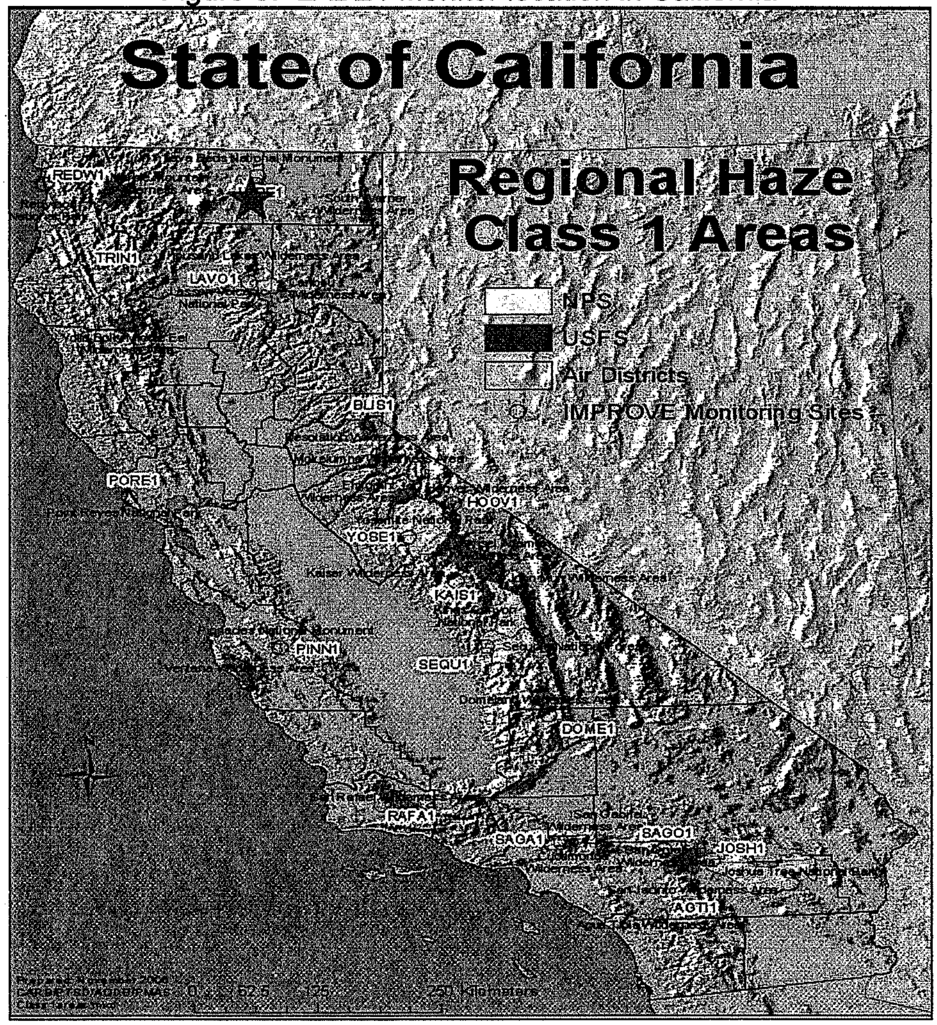


Figure 5. LABE1 Monitor location in California




Section II. Visibilitv Conditions:

*II.a. Lava Beds Wilderness Area*

Visibility conditions for Lava Beds are currently monitored by the LABE1 IMPROVE monitor. The monitor is located at 41.711'7 north latitude and 121.5068 west longitude, located near the southern end of Lava Beds Wilderness at an elevation of 1,460 meters.

Lava Beds is located at the northwestern fringe of the Great Basin physiographic region. The nearest population area and potential source region is the northern Sacramento Valley to the southwest, separated from the Lava Beds and South Warner Wilderness areas by the northern Sierra Nevada and southern Cascade Ranges. High aerosol concentrations at LABE1 may result from regional forest fires. Entrained crustal material from exposed desert surfaces may be a source of particulate matter during strong wind episodes. At times during the extended summer a significant southerly component of flow from the Sacramento Valley could bring lofted emissions to the area over relatively low lying terrain between the southern Cascade Range and northern Sierra Nevada Range. Worst haze c()nditions at LABE1 may result from regional forest fires during regional stagnation episodes.

The LABEl location is adequate for assessing the 2018 reasonable progress goals for the Lava Beds Wilderness Class 1 area.

### *II.b. South Warner Wilderness Area*

Visibility conditions for the South Warner Wilderness are currently monitored by the LABE1 IMPROVE monitor located near the southern end of Lava Beds Wilderness. The monitor is located at 41.7117 north latitude, 121.5068 west longitude, at an elevation of 1,460 meters, 70 miles northwest of the South Warner Wilderness Area.

The LABE1 IMPROVE site should be representative of the South Warner Wilderness Area during regionally homogeneous atmospheric conditions that prevail during worst haze conditions in this isolated area of northeastern California. The nearest population area and potential source region, with respect to the LABE1 IMPROVE site, is the northern Sacramento Valley to the southwest, separated from the South Warner Wilderness by the northern Sierra Nevada and southern Cascade Ranges. High aerosol concentrations at LABE1 may result from regional forest fires. Entrained crustal material from exposed desert surfaces may be a source of particulate matter during strong wind episodes.

The LABE1 location is adequate for assessing the 2018 reasonable progress goals for the South Warner Wilderness Class 1 area.

### *II.c. Baseline Visibility*

Baseline visibility is determined from LAB,E1 IMPROVE monitoring data for the 20% best and the 20% worst days for the years 2000 through 2004. The baseline visibility· for the LABE1 monitor is calculated at 3.2 deciviews for the 20% best days and 15.1 deciviews for the 20% worst days. Figure 6 represents the worst baseline visibility conditions.

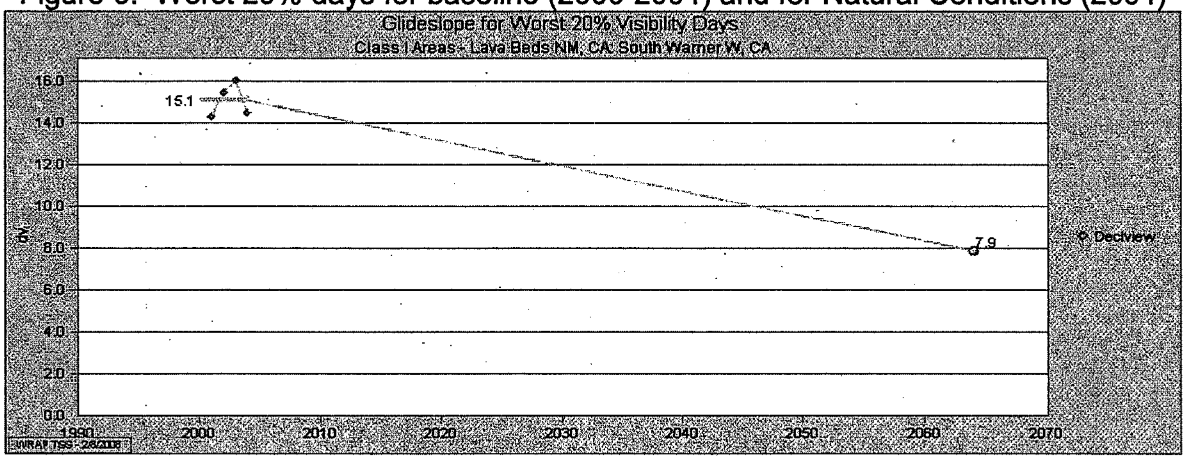
### *II.d. Natural Visibility*

Natural visibility represents the visibility condition that would be experienced in the absence of human-caused impairmerit. Based on EPA guidance, the natural visibility for the LABE1 monitor is 1.3 deciviews for the 20% best days and 7.9 deciviews forthe 20% worst days. It is possible that the Natural Conditions deciview value for 2064 could change in the future as more is learned about natural plant emissions and wildfire impacts.

*II.e. Presumptive Glide Slope and the Uniform Rate of Progress*

Figure 6 also shows the uniform rate of progress, or "glide slope." The glide slope is the rate of reduction in the 20% worst days deciview average that would have to be achieved to reach natural conditions at a uniform pace in the 60 years following the baseline period. The first benchmark along the path towards achieving natural conditions occurs in 2018. The glide slope shows that the 2018 benchmark for the 20% worst days is 13.37 deciviews. According to the Regional Haze Rule, the 20% best days baseline visibility of 3.2 deciviews must be maintained or improved by 2018, the end of the first planning period.

**Figure 6. Worst 20% days for baseline (2000-2004) and for Natural Conditions (2064)**




*1I.t. Species Contribution*

Each pollutant species causes light extinction but its contribution differs on best and worst days. Figure 7 shows the contribution of each species to the 20% best and worst days in the baseline years at LABE1.

**Figure 7. Average Haze species contributions to light extinction in the baseline years**

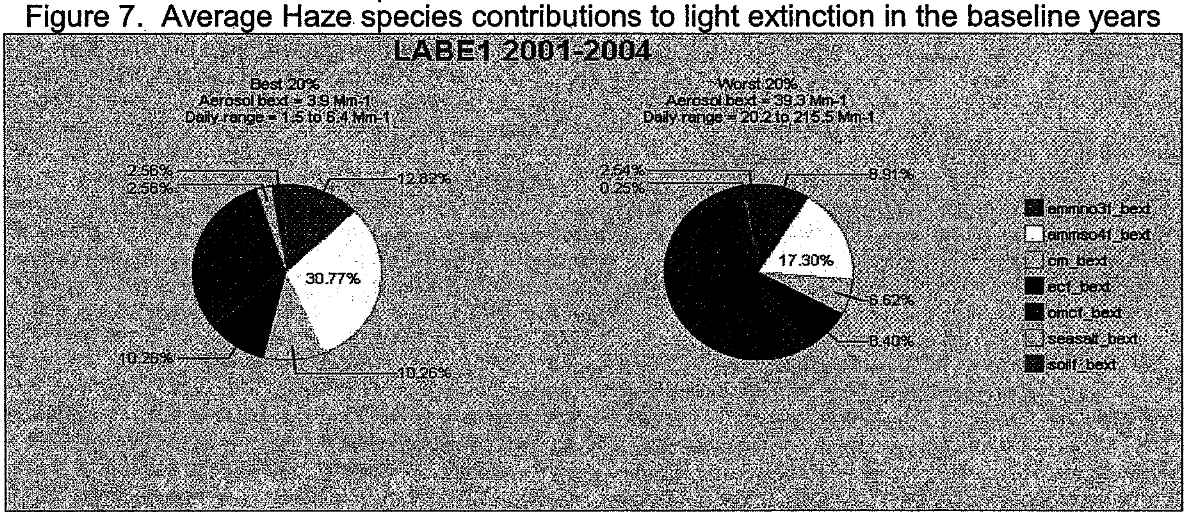
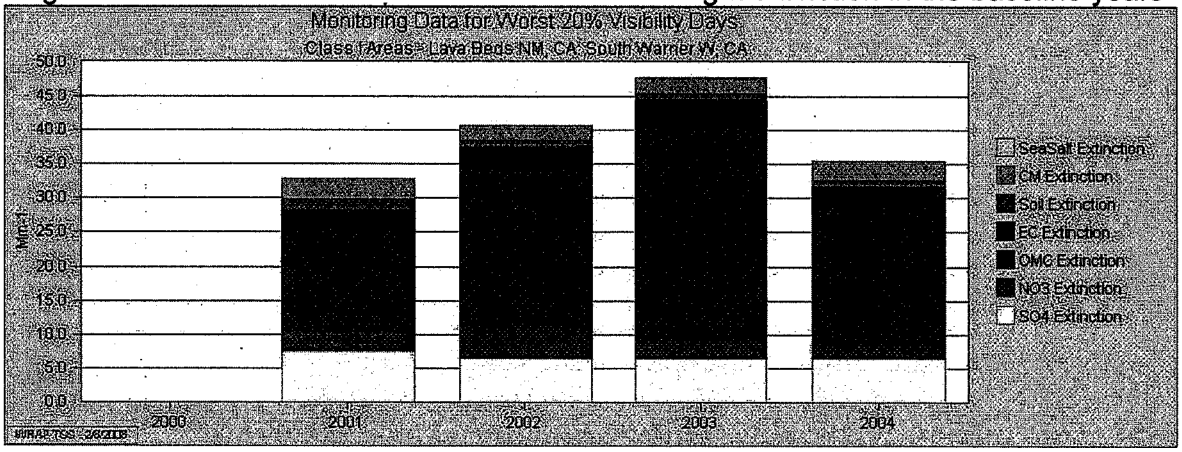


Figure 8. Individual Haze species contributions to light extinction in the baseline years




As shown in Figures 7 and 8, organic matter, sulfates, and nitrates have the strongest contributions to degrading visibility on worst days at the LABE1 monitor. The worst days are dominated by organic matter while the best days are dominated equally by sulfates and organic matter. Data points for 2000 were insufficient for calculating best and worst days per the Regional Haze Rule Guidance.

Figure 9 depicts the individual species contribution to worst days in 2002. Nitrates increase iii the winter while sulfates increase slightly in the spring. Organic matter remains high throughout the summer. Organic matter clearly dominates the other haze species on worst days, but nitrates, sulfates; coarse mass and elemental carbon also contribute to the worst days in the summer. Sea salt and soil are present at the LABE1 monitor but in very small amounts.

Figure 10 illustrates the individual species contribution on worst days in 2000-2004 by monthly average. The trend shown is comparable to Figure 9 for organic matter, nitrates, and sulfates. High organic periods vary from year to year due to the unpredictable occurrence of wild fires.

Figure 9. Species contribution on the 20% worst days in 2002

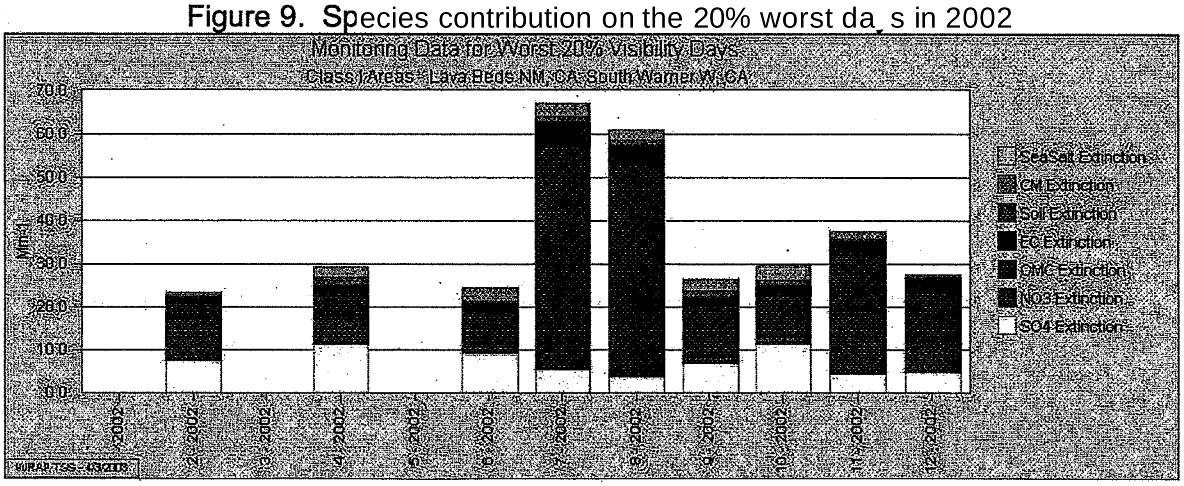
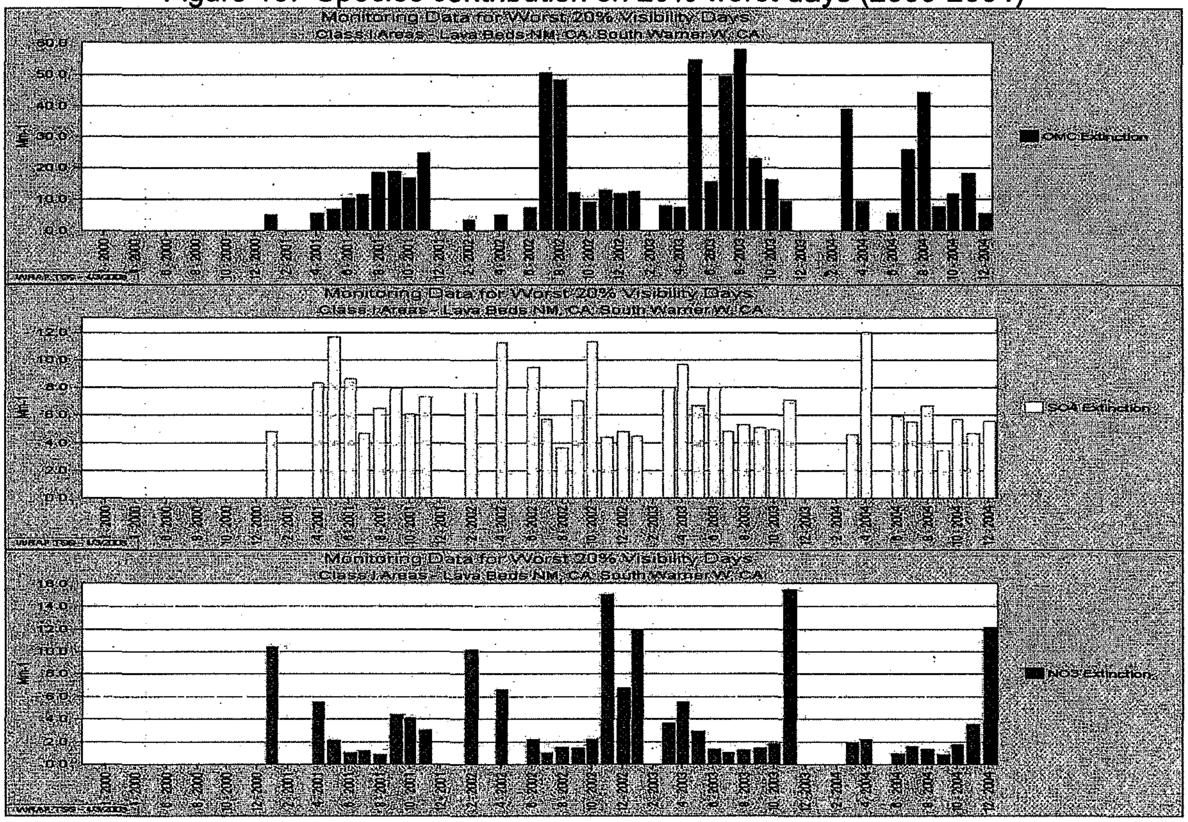


Figure 10. Species contribution on 20% worst days (2000-2004)




### *II.g.* ***Sources of Haze Species***

Both natural and man-made sources contribute to the calculated deciview levels made by haze pollutants at LABE1. Some haze species arise from sources that are within the control of the State of California or neighboring states. Others arise from natural, uncontrollable situations such as wildfires, sea salt or dust storms in natural areas, whether they are from in-state or out-of-state (and out-of-country) sources. Finally, other uncontrollable, man-made sourceS are those industrial pollutants and other man-made (anthropogenic) emissions transported from outside the United States.

Figure 1,1 shows the primary organic carbon source contribution 'from California.and the outside regions. The largest contributor to primary organic carbon at the LABE1 monitor is from natural fire sources within Oregon. Oregon represents 67% of all natural fire source contributions.

Figure 12 illustrates the total organic carbon source apportionment from 2000-2004 for anthropogenic and biogenic sources. The biogenic secondary emissions account for. 76% of the total organic carbon. Anthropogenic and biogenic primary source emissions account for 22% of the total organic carbon emissions and anthropogenic secondary is . responsible for the remaining emissions.

Figures 13 and 14 represent the regional contributions to sulfate on the 20% worst days in 2002 and 2018 at LABE1. The Outside Domain region represents 53% of the sulfate contributions in 2002 and 2018, followed by the emissions from the WRAP Region (31%) and the Pacific Offshore Region (11%). California contributes 13% of the total sulfate emissions seen at the LABE1 monitor.

Individually, emissions from outside the modeling domain contribute the most to sulfate concentrations at the LABE1 monitor. The next largest contributor to sulfate concentration is from area sources in the Pacific Offshore Region.

Figures 15 and 16 represent the regional contributions to nitrates on the 20% worst days. The WRAP region represents the largest contribution to nitrate in 2002 and 2018 (74%), followed by the Outside Domain Region (21%) and emissions from Pacific Offshore (4%). Mobile sources within California contribute the most nitrate at the LABE1 monitor. In 2002, 51 % of the nitrate at the LABE1 monitor can be attributed to California. California accounts for 69% of all mobile source nitrate emissions. California mobile source emissions reductions are mainly responsible for improvement in nitrates in 2018.

**Figure 11. Organic carbon source contribution from CA and outside regions**

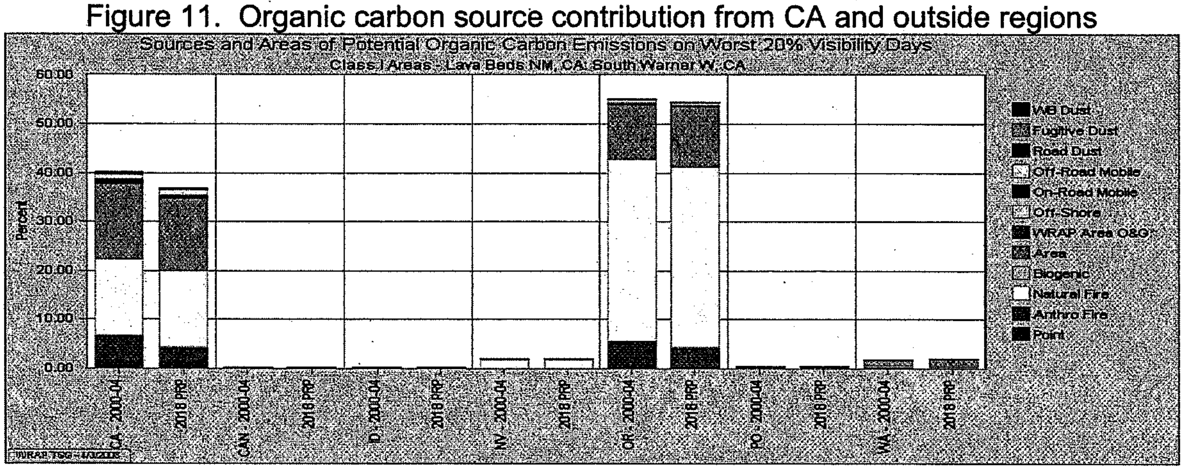



**Figure 12. Organic carbon Anthropogenic and Biogenic Source Apportionment**

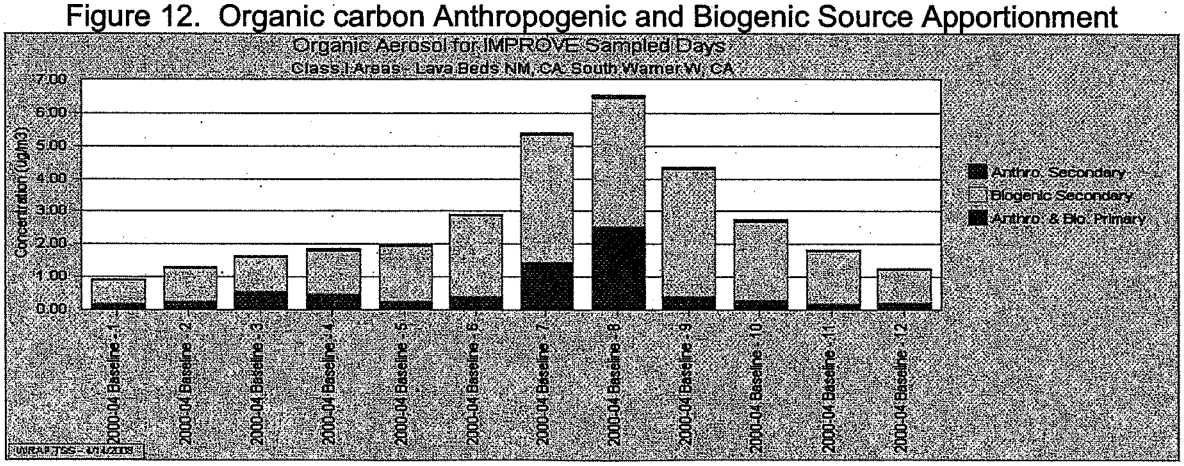


Figure 13. Re_ional Sulfate contribution to Haze in 2002 and 2018

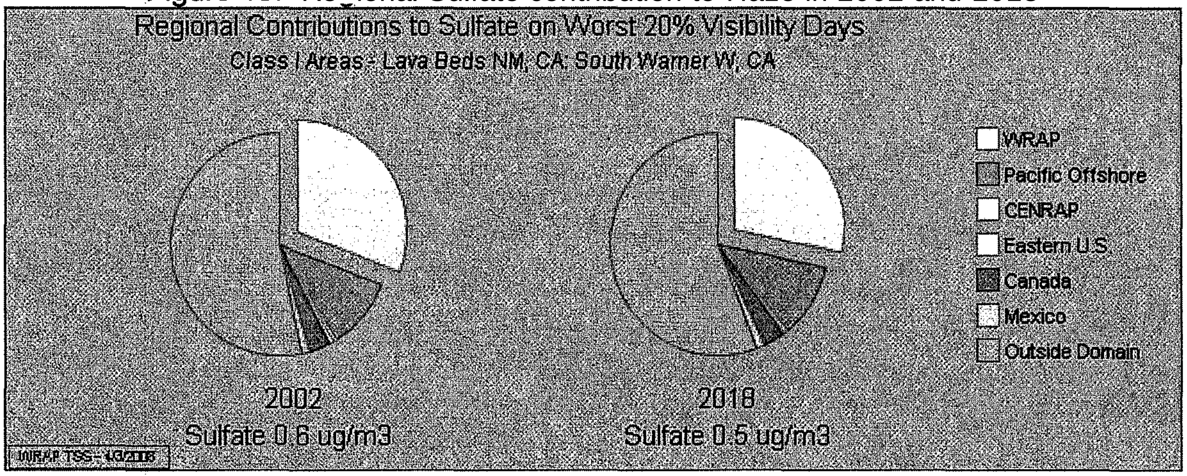



Figure 14. Sulfate source contribution from CA and outside regions

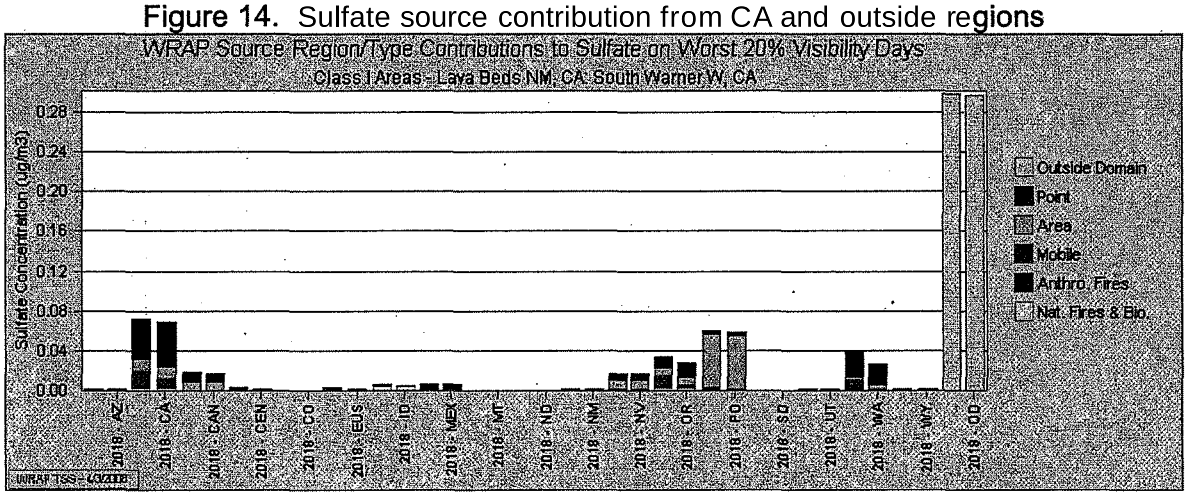
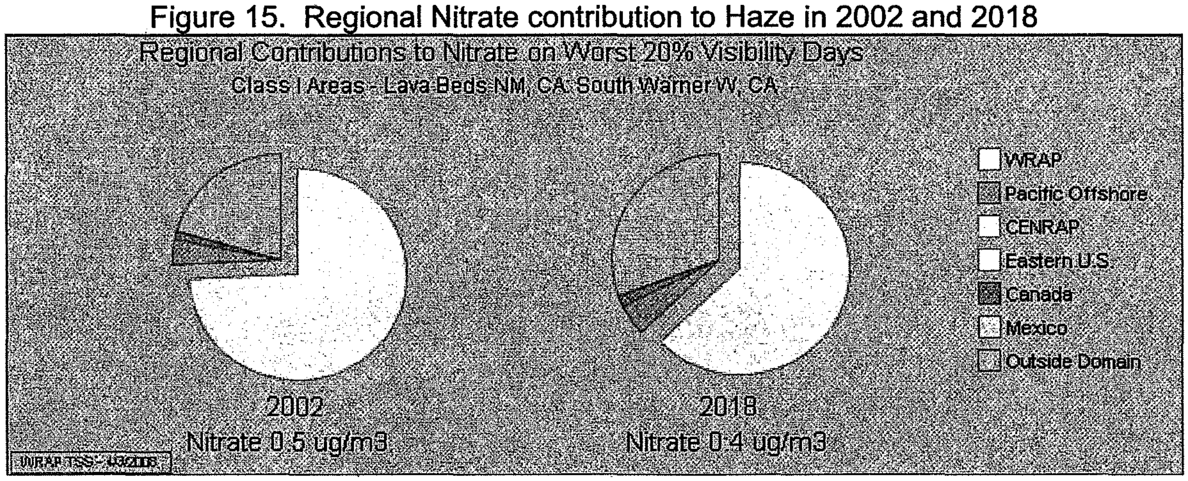
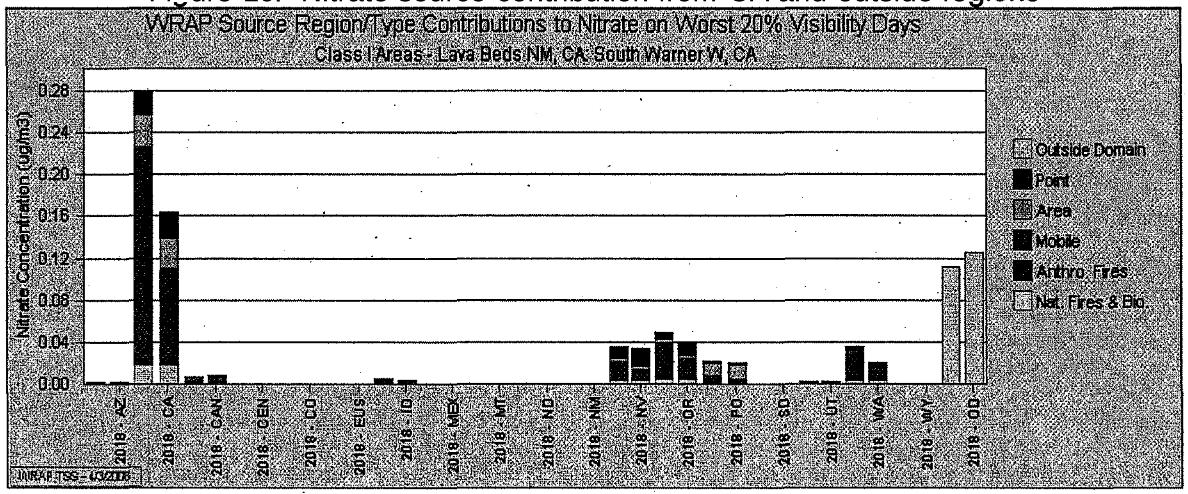



Figure 15. Regional Nitrate contribution to Haze in 2002 and 2018



Fi_ure 16. Nitrate source contribution from CA and outside regions



## LAV01 Monitor

The LAV01 monitor location represents three wilderness areas located in Northern California near the Southern extreme of the Cascade Range. The wilderness areas associated with the LAV01 monitor are Caribou Wilderness Area, Lava Beds Wilderness area and South Warner Wilderness area. The LAV01 site has been operating since March 1988. This site has sufficient data for the entire baseline period.

## Section I. LABE1 Wilderness Area Descriptions

### *I.a. Caribou Wilderness Area*

The Caribou Wilderness Area (Caribou) consists of 20,500 acres in Northern California at the southern extreme of the Cascade Range and immediately adjacent to Lassen Volcanic National Park on its west side. Elevations range from nearly 1829 meters to the highest point, Red Cinder, at 2551 meters. The headwaters of the Susan River, which flows eastward towards Susanville and Honey Lake on the east slope of the Cascade Range, originate in Caribou Wilderness.

Figure 1. Caribou Wilderness Area

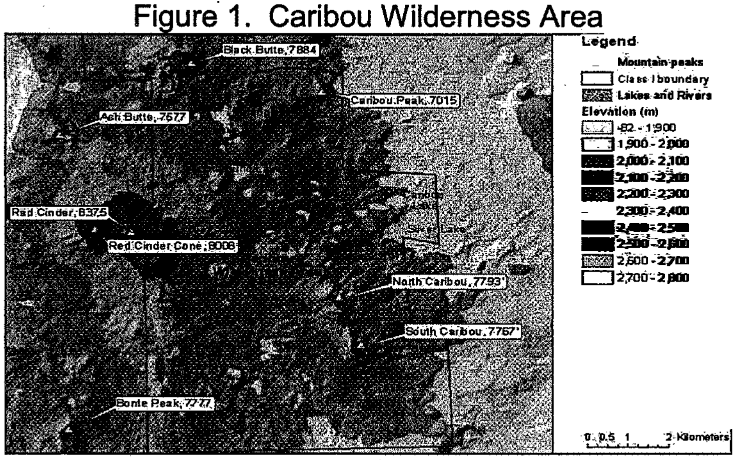
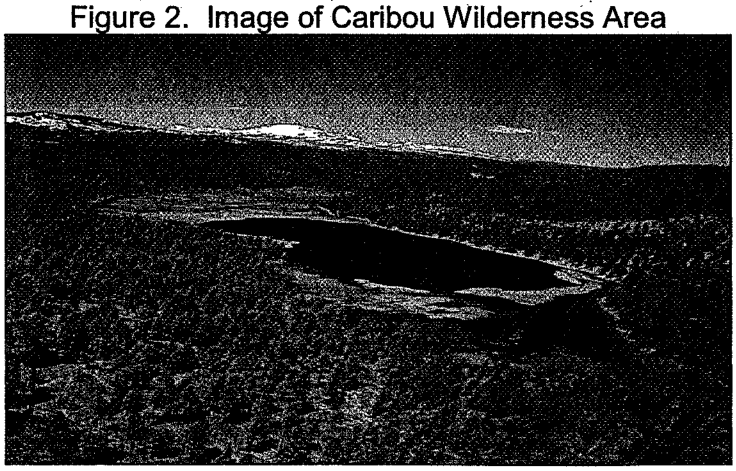



Figure 2. Image of Caribou Wilderness Area



### *I.b.* ***Lassen Volcanic National Park***

Lassen Volcanic National Park (Lassen) consists of.105,800 acres in northern California, at the southern extreme of the Cascade' Range. Lassen consists of slopes and area surrounding Lassen Peak, .elevation 3,187 meters. Lassen terrain consists of several volcanic cones in addition to LassenPeak, and surrounding and intervening terrain. Lowest elevations are near 1,707 meters at points where streams exit the park. The entire Lassen park area is generally in terrain to the east of the north end of the Sacramento Valley, and is thus subject to upwind flow from the south and west, the directions to' northern Sacramento Valley communities of Redding, Red Bluff, and Chico roughly 50 miles to the west, west-southwest, and south-southwest respectively. Typical northern Sacramento Valley elevations are 152 to 183 meters, or about 1,524 meters lower than the lowest Lassen elevations.

Figure 3. LAV01 Monitor location

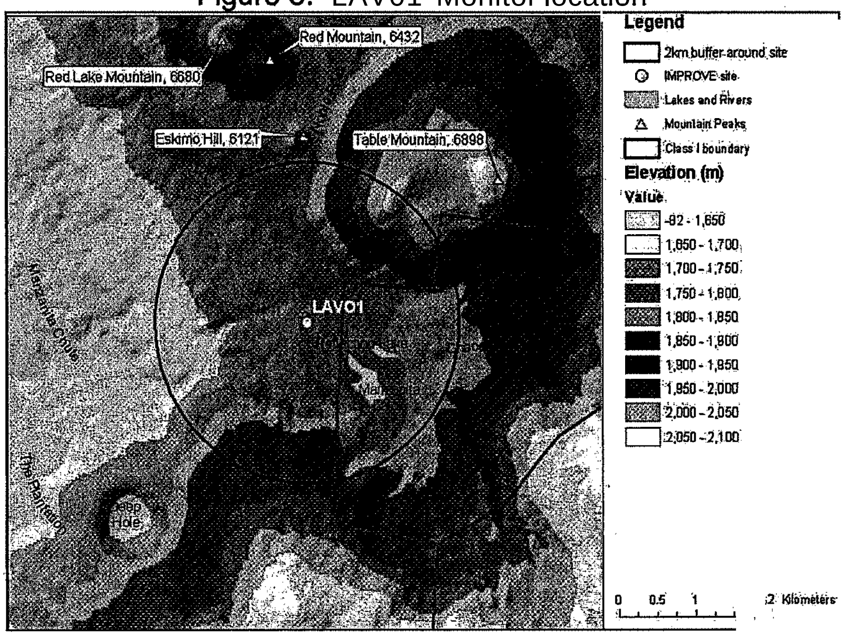
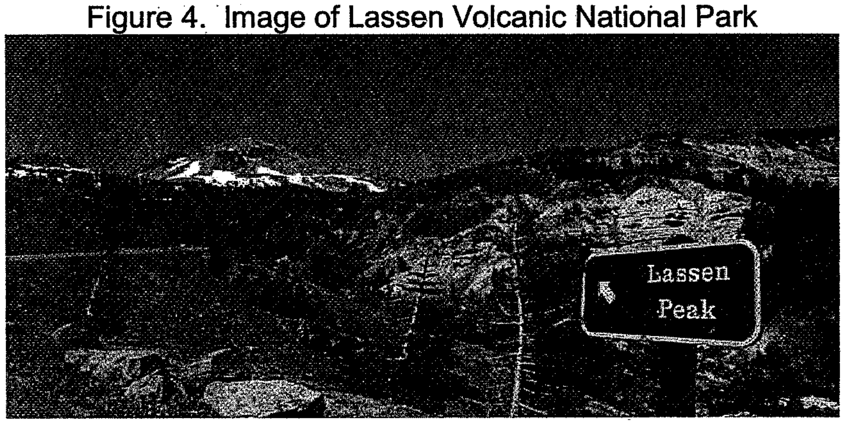


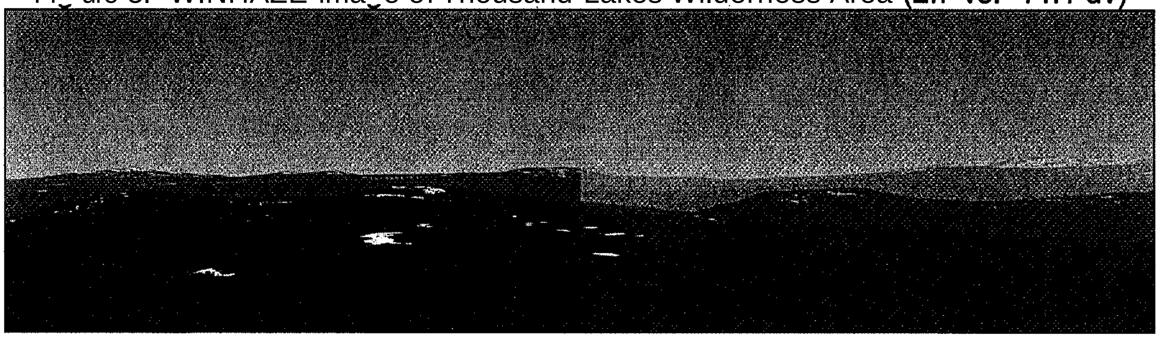

Figure 4. Image of Lassen Volcanic National Park



### *I.e.* ***Thousand Lakes Wilderness Area***

The Thousand Lakes Wilderness Area (Thousand Lakes) consists of 16,335 acres, 10 miles northwest of Thousand Lakes Wilderness Area near the southern extreme of the Cascade Range. It consists mainly of slopes extending downward from Crater Peak, elevation 2,645 meters. The lowest Wilderness elevation is 1,690 meters at the base of Crater Peak. The Thousand Lakes Wilderness Area, Thousand Lakes Wilderness Area and the Caribou Wilderness are in the same general area and all share the same general topographic features.

Fi_·ure 5. WINHAZE ima_e of Thousand Lakes Wilderness Area (2.7 vs. 14.1 dv)



Fi_ure 6. LAV01 Monitor location in California

## Section II. Visibility Conditions:

### *II.a. Caribou Wilderness Area*

Visibility conditions for Caribou are currently monitored by the LAV01 IMPROVE monitor located in Lassen Volcanic National Park, near the northwest entrance Ranger station. The monitor is located at 40.54 north latitude, 121.57 west longitude, 25 yards ,southeast of the Fire Station, at an elevation of 1733 meters. The site may be influenced by channeled flow in the Manzanita Creek drainage which flows west from the National Park and ultimately to the northern Sacramento Valley. ,

The CaribouWildemess Area, Lassen Volcanic National Park, and Thousand Lakes Wilderness Area are in the same general area and share the same general topographic features. The Caribou Wilderness has a somewhat more direct link to the eastern , slopes of the Cascades via the Susan River that flows into Honey Lake in northeastern California, apprOXimately 50 miles east of the Wilderness. Caribou Wilderness may see somewhat more influence by sources on the western slope of the Cascade Range during infrequent east-west transport conditions that may not be represented by data from LAV01. Potential haze sources on the eastern slopes of the Cascade Range include' dry and intermittent lakes, sources of alkali dust, and windblown desert dust that could impact the Wilderness during extreme dust storms with an easterly direction component.

The LAVOI location is adequate for assessing the 2018 reasonable progress goals for the Caribou Wilderness Class 1 area.

### *II.b. Lassen Volcanic National Park*

Visibility conditions for Lassen are currently monitored by the LAV01 IMPROVE monitor. The monitor is located at 40.5398 north latitude and 121.5768 west longitude, near the northwest park entrance Ranger station, 25 yards, southeast of the Fire Station, at an elevation of 1,733 meters. The site may be influenced be channeled flow in the Manzanita Creek drainage that flows west from the Park and ultimately to the 'northern Sacramento Valley.

The monitoring location is near the low end of the range of Lassen elevations. It should be representative of park locations in general. During surface inversion conditions, it should still be representative of lower elevations, and hence of worst (highest aerosol concentrations) conditions. It is located within or near the Manzanita Creek drainage that is a channel for nighttime drainage flow. The closest source region with emissions that may contribute to aerosol and haze in Lassen is the northern Sacramento Valley. Lassen may also be linked to emissions form the Sacramento area 120 to 150 miles south and from the San Francisco Bay area, during low level southerly flow through the .central valleys.

The LAVOllocation is adequate for assessing the 2018 reasonable progress goals for the Lassen Volcanic National Park Class 1 area.

*II.c. Thousand Lakes Wilderness Area*

Visibility conditions for Thousand Lakes are currently monitored by the LAV01 IMPROVE monitor located near the entrance to Thousand Lakes Wilderness Area. The monitor is located at 40.5398 north latitude and 121.5768 west longitude, near the northwest park entrance Ranger station, 25 yards southeast of the Fire Station, at an elevation of 1,733 meters. The site may be influenced be channeled flow in the Manzanita Creek drainage that flows west from the Park and ultimately to the northern Sacramento Valley.

The monitoring location should be representative of park locations in general. During surface Inversion conditions, it should still be representative of lower elevations, and hence of worst (highest aerosol concentrations) conditions. It is located within or near the Manzanita Creek drainage which is a channel for nighttime drainage flow. The closest source region with emissions that may contribute to aerosol and haze in Thousand Lakes Wilderness is the northern Sacramento Valley. Thousand Lakes may also be linked to emissions form the Sacramento area 120 to 150 miles south and from the San Francisco Bay area, during low level southerly flow through the central valleys.

The LAV01 location is adequate for assessing the 2018 reasonable progress goals for the Thousand Lakes Wilderness Class 1 area.

*II.b. Baseline Visibility*

Baseline visibility is determined from LAV01 IMPROVE monitoring data for the 20% best and the 20% worst days for the years 2000 through 2004. The baseline visibility for the LAV01 monitor is calculated at 2.7 deciviews for the 20% best days and 14.1 deciviews for the 20% worst days. Figure 7 represents the worst baseline visibility conditions.

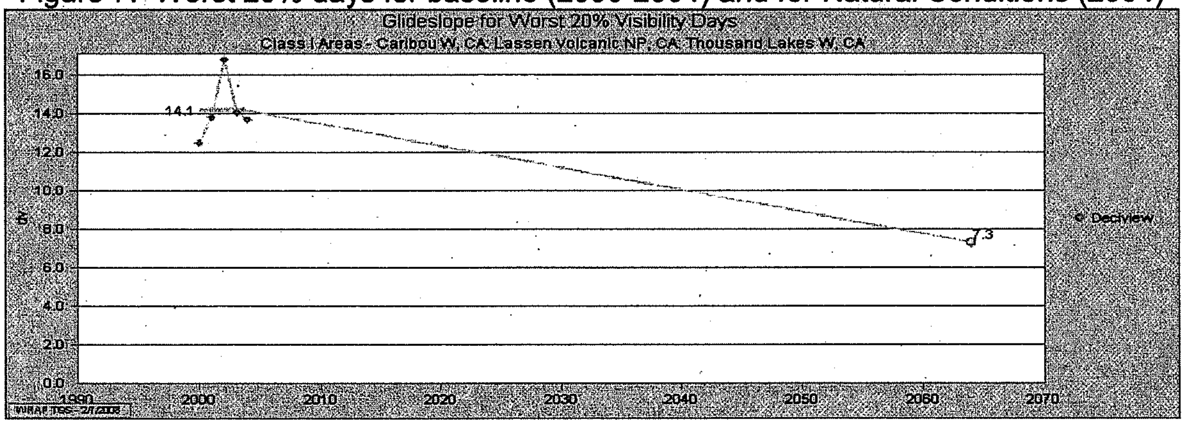
*II.c. Natural Visibility*

Natural visibility represents the visibility condition that would be experienced in the absence of human-caused impairment. Based on EPA guidance, the natural visibility for the LAV01 monitor is 1.0 deciviews for the 20% best days and 7.3 deciviews for the 20% worst days. It is possible that the Natural Conditions deciview value for 2064 could change in the future as more is learned about natural plant emissions and wildfire impacts.

*II.d. Presumptive Glide Slope and the Uniform Rate of Progress*

Figure 7 also shows the uniform rate of progress, or "glide slope." The glide slope is the rate of reduction in the 20% worst days deciview average that would have to be achieved to reach natural conditions ata uniform pace in the 60 years following the ' baseline period. The first benchmark along the path towards achieving natural conditions occurs in 2018. The glide slope shows that the 2018 benchmark for the 20% worst days is 12.55 deciviews. According to the Regional Haze Rule, the 20% best days baseline visibility of 2.7 deciviewsmust be maintained or improved by 2018, the end of the 'first planning period.

**Figure 7. Worst 20% days for baseline (2000-2004) and for Natural Conditions (2064)**




*II.e. Species Contribution*

Each pollutant species causes light extinction but its contribution differs on best and worst days. Figure 8 shows the contribution of each species to the'20% best and worst days in the baseline years at LAV01.

**Figure 8. Average Haze species contributions to light extinction in the baseline years**

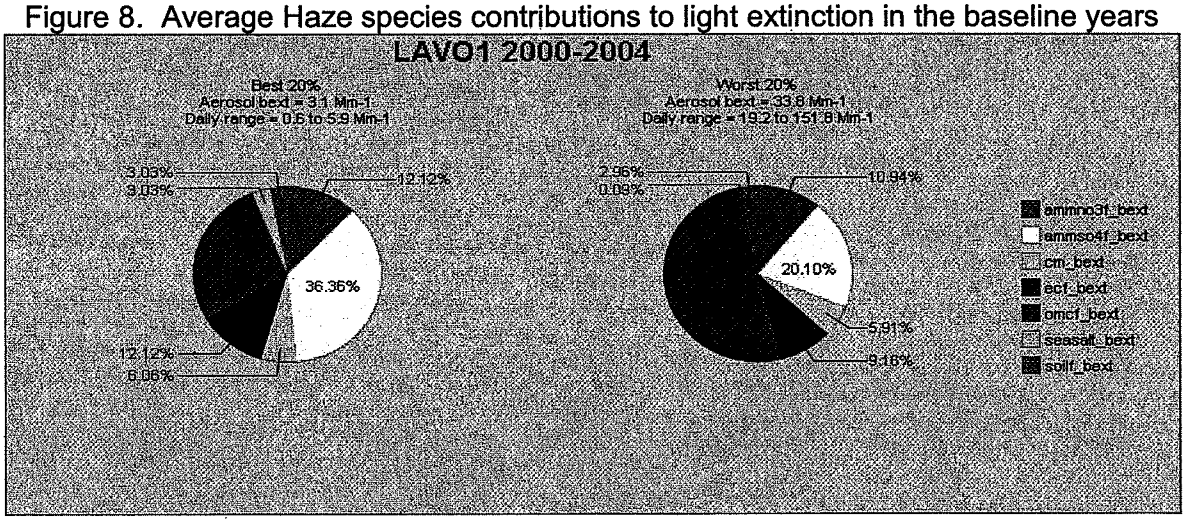
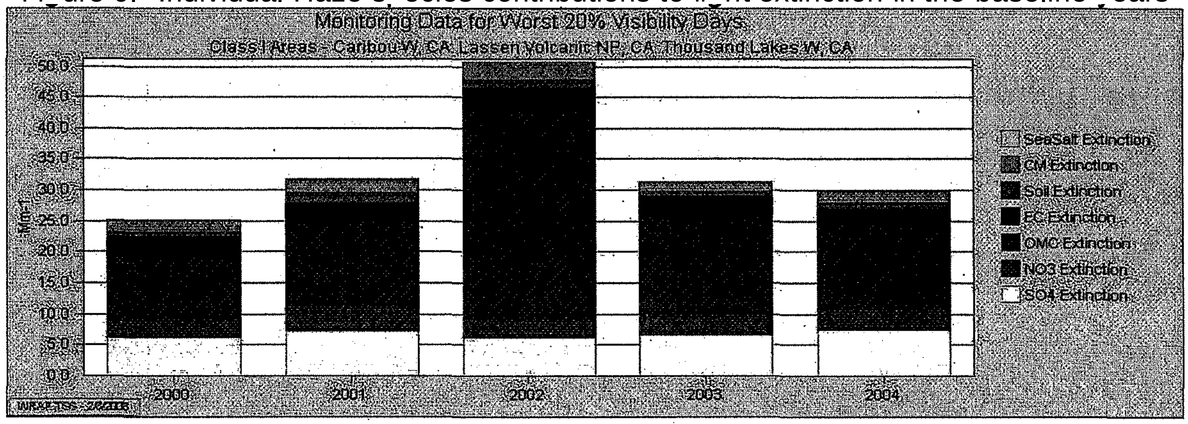


Figure 9. Individual Haze species contributions to light extinction in the baseline years




As shown in Figures 8 and 9, organic matter, sulfates, and nitrates have the strongest. contributions to light extinction which degrades visibility on worst days at the LAV01 monitor. The worst days are dominated by organic matter, while the best days are dominated by sulfate.

Figure 10 depicts the individual species contribution to worst days in 2003. Nitrates increase in the winter while sulfates increase slightly in the spring. Organic matter remains high throughout the summer. Organic matter clearly dominates the other haze species on worst days, but nitrates, sulfates, coarse mass and elemental carbon also contribute to the worst days in the summer. Sea salt is not present at the LAV01 monitor.

Figure 11 illustrates the individual species cohtribution on worst days in 2000-2004 by monthly average. The trend shown is comparable to Figure 10 for organic matter, nitrates, and sulfates. High organic periods vary from year to year due to the unpredictable occurrence of wild fires.

**Figure 10. Species contribution on the 20% worst days in 2003**

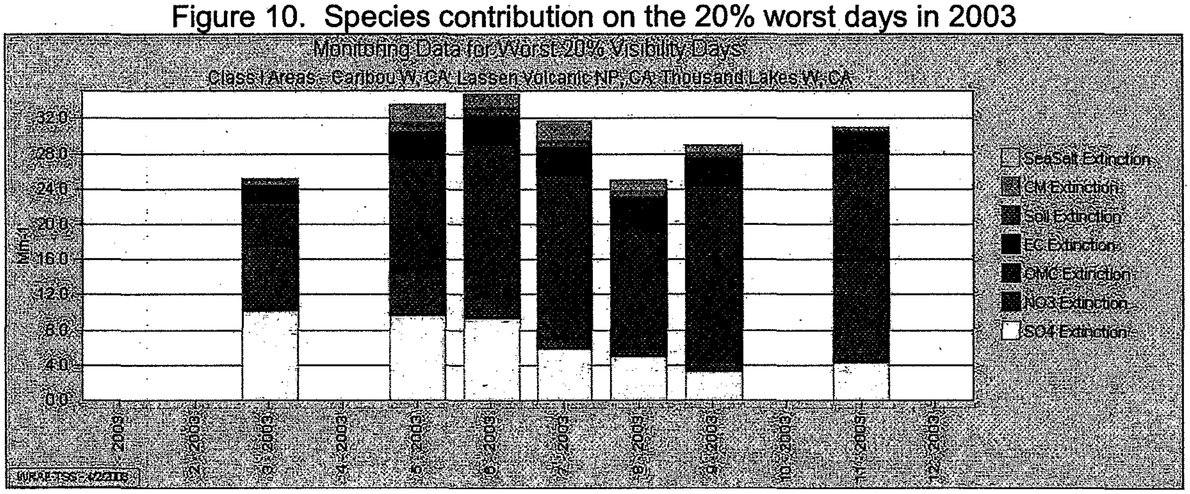
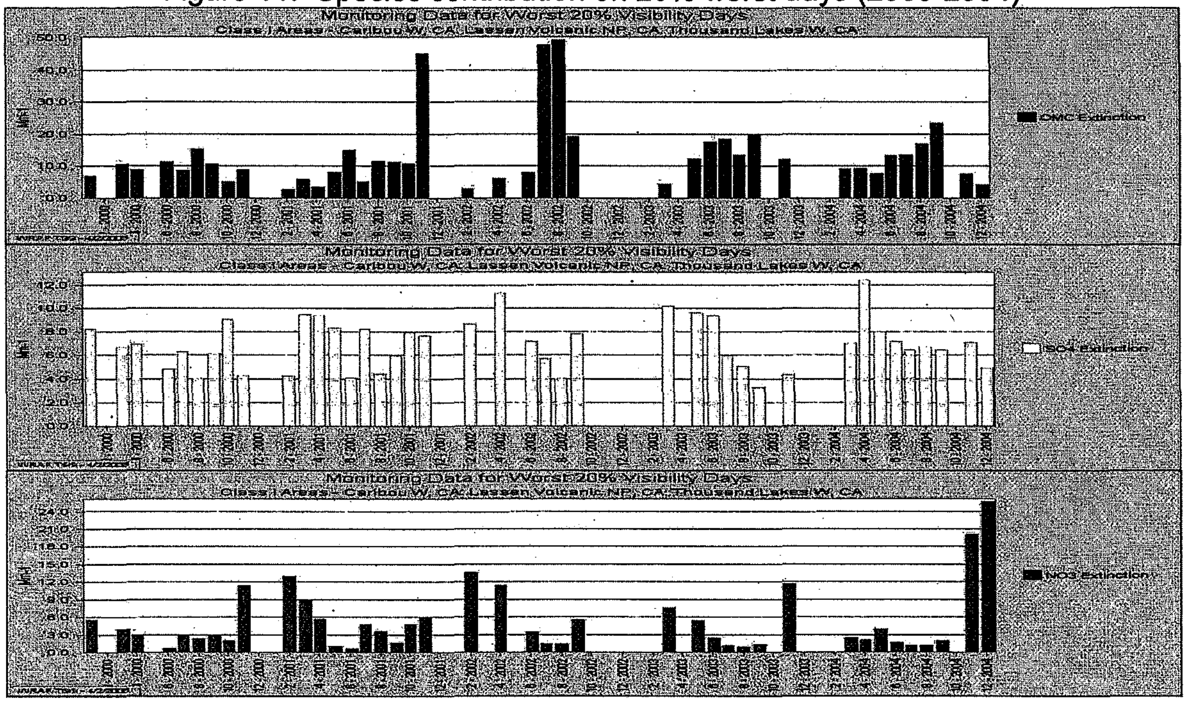


Figure 11. Species contribution on 20% worst days (2000-2004)




*1l.f. Sources* of *Haze Species*

Both natural and man-made sources contribute to the calculated deciview levels made by haze pollutants at LAVO1. Some haze species arise from sources that are within the control of the State of California or neighboring states. Others arise from natural, uncontrollable situations such as wildfires, sea salt or dust storms in natural areas, whether they are from in-state or out-of-state (and out-of-country) sources. Finally, other uncontrollable, man-made sources are those industrial pollutants and other man-made (anthropogenic) emissions transported from outside the United States.

Figure 12 shows the primary organic carbon source contribution from California and the outside regions. The largest contributor to primary organic carbon at the LAV01 monitor is from area sources within California. California represents 90% of all area source contributions.

Figure 13 illustrates the total organic carbon source apportionment from 2000-2004 for anthropogenic and biogenic sources. The biogenic secondary emissions account for 70% of the total organic carbon. Anthropogenic and biogenic primary source emissions account for 27% of the total organic carbon emissions and anthropogenic secondary is responsible for the remaining emissions.

Figures 14 and 15 represent the regional contributions to sulfate on the 20% worst days in 2002 and 2018 at LAV01. The WRAP region represents 41% of the sulfate contributions in 2002 and 2018, followed by the emissions from the Outside Domain

Region (37%) and the Pacific Offshore Region (17%). California contributes 20% of the total sulfate emissions seen at the LAV01 monitor.

Individually, emissions from outside the modeling domain contribute the mosUo sulfate concentrations at the LAV01 monitor. The next largest contributor to sulfate concentration is from area sources in the Pacific Offshore.

Figures 16 and 17 represent the regional contributions to nitrates on the 20% worst days. The WRAP region represents the largest contribution to nitrate in 2002 and 2018 (82%), followed by the Outside Domain Region (12%) and emissionS from Pacific Offshore (6%). Mobile sources within California contribute the most nitrates at the LAV01 monitor. In 2002, 72% of the nitrate at the LAV01 monitor can be attributed to California.

From the WRAP Region; California is shown to contribute the most to nitrate concentrations at the LAV01 monitor in 2002 and 2018. Currently, California mobile sources are 74% of California contributions to nitrate at the LAV01 *monitor*. California mobile source emissions reductions are mainly responsible for improvement in nitrates in 2018.

**Figure 12.** Organic carbon ·source contribution from CA and outside regions

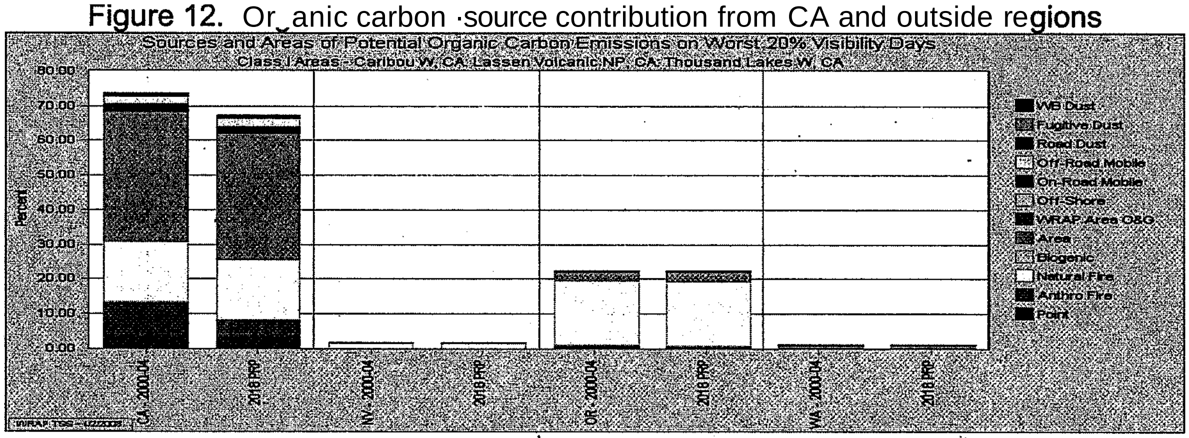



**Figure 13. Organic carbon Anthropogenic and Biogenic Source Apportionment**

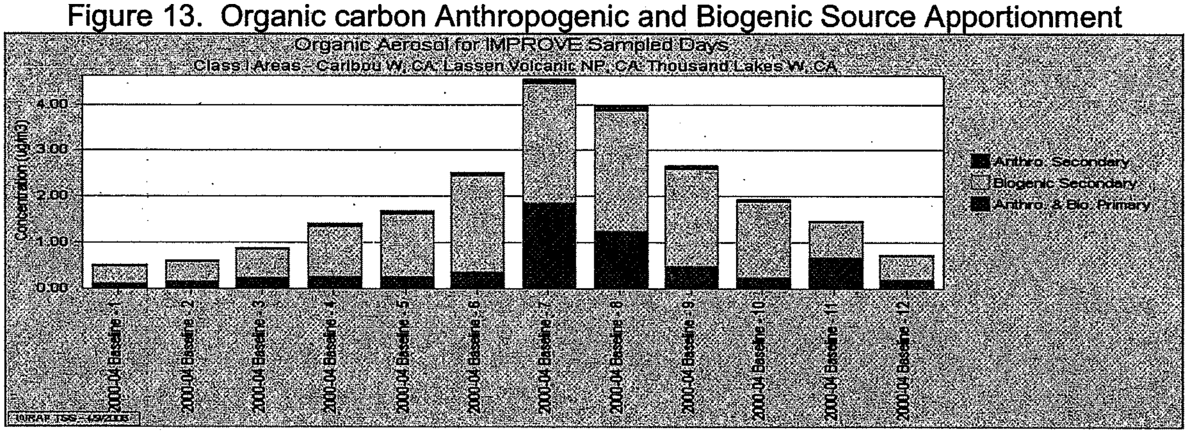
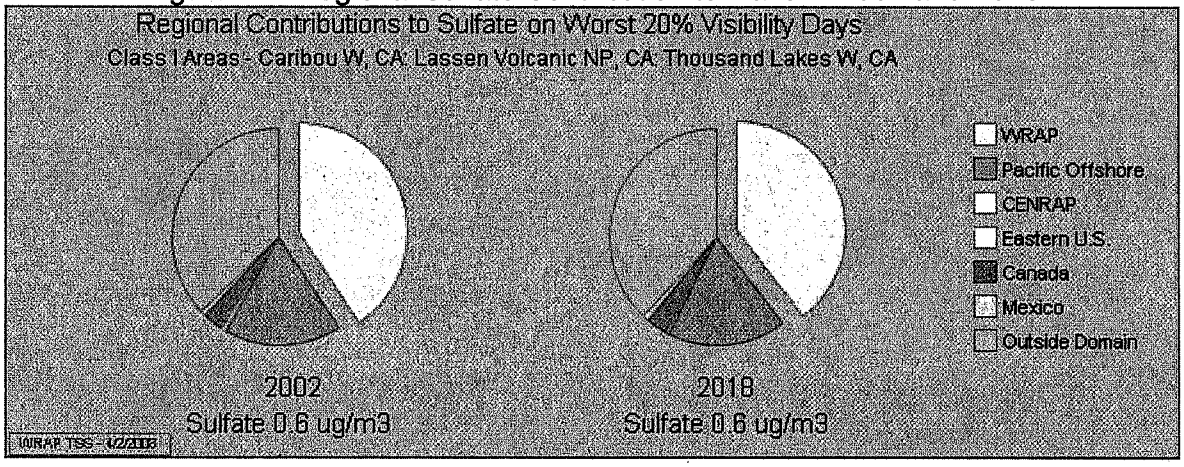


**Figure 14. Reg**ional Sulfate Contribution to Haze in 2002'and 2018




Fi_ure 15. Sulfate source contribution from CA and outside re**gions**

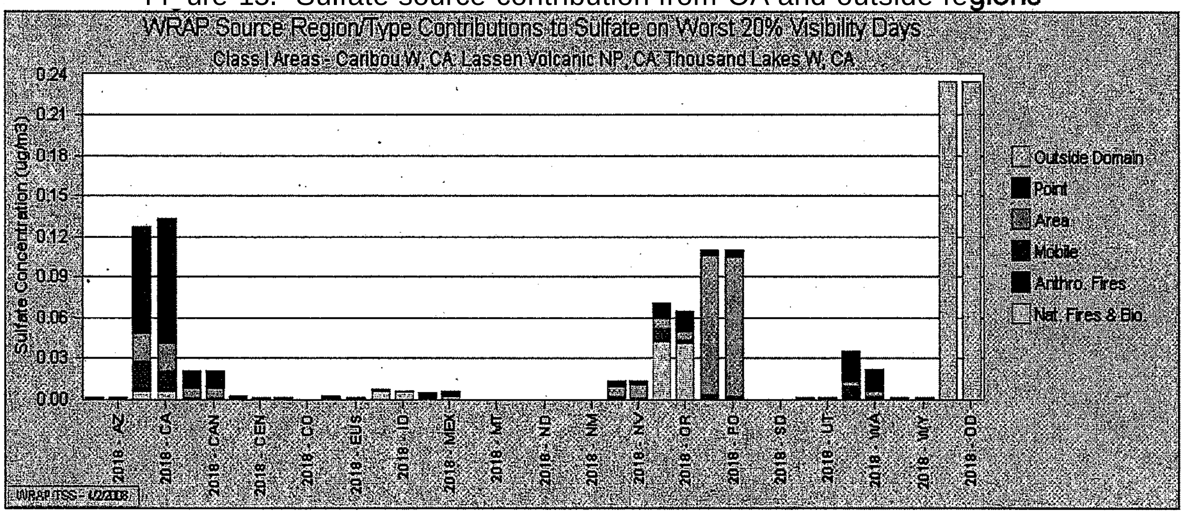
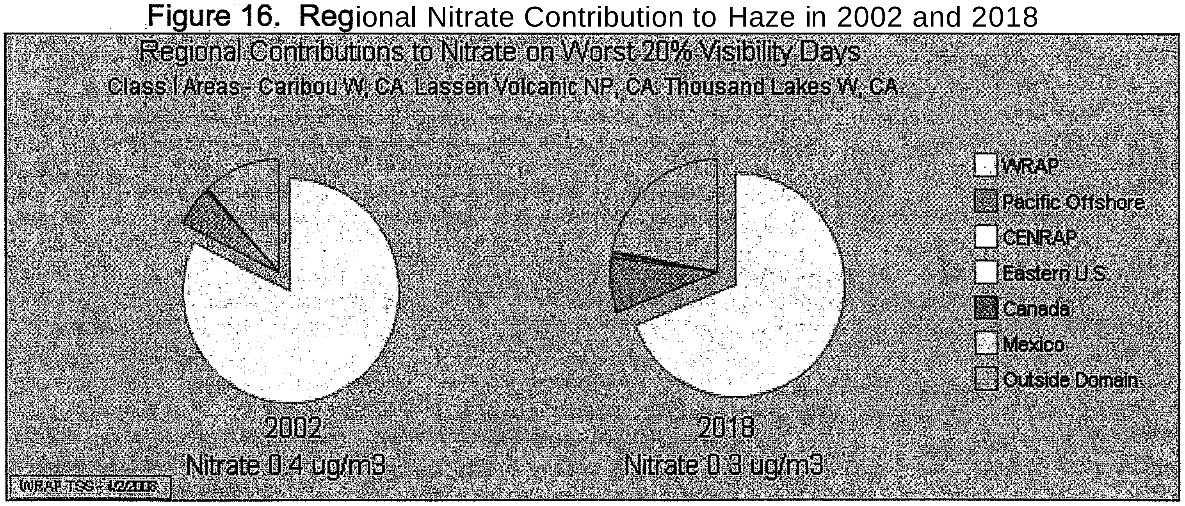
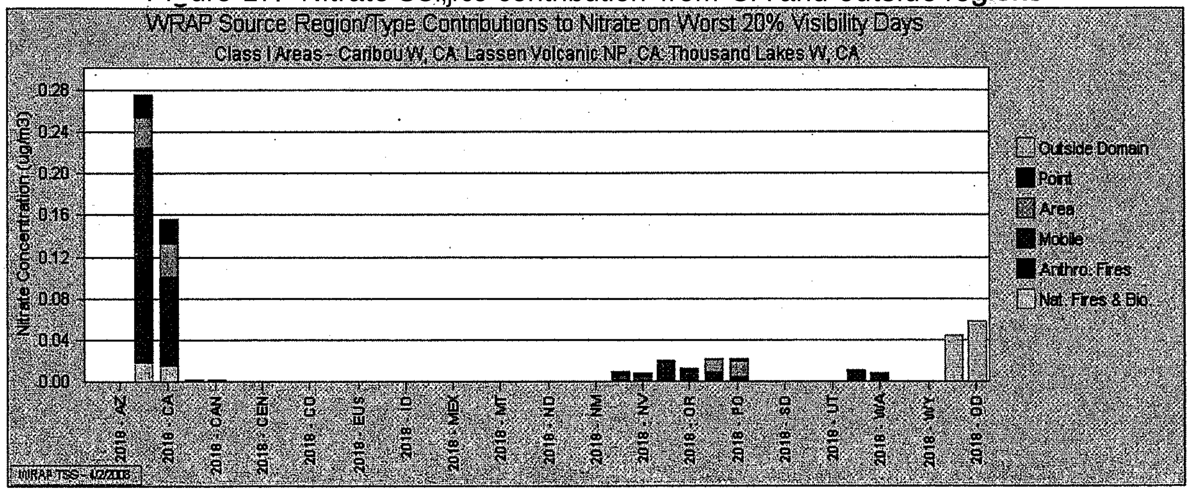



**Figure 16. Reg**ional Nitrate Contribution to Haze in 2002 and 2018



Fi_ure 17. Nitrate SOl,jrce contribution·from CA and outside regions



## BLIS1 Monitor

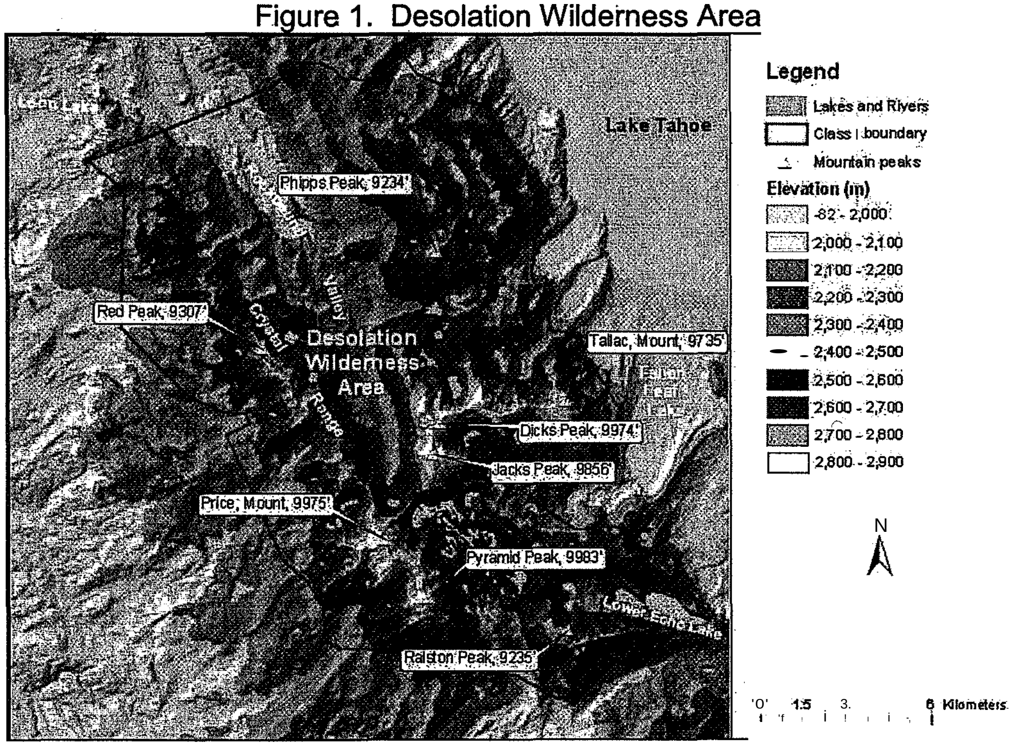
The BLIS1 monitor location represents two wilderness areas located along the crest of the Sierra'Nevada mountain range, just west of Lake Tahoe. The wilderness areas associated with the BLIS1 monitor are Desolation Wilderness area and Mokelumne Wilderness area. The BLIS1 site has been operating since November 1990. This site does not have sufficient data for the entire baseline period. Data was not available for the year 2004.

Section I. **BLIS1** Wilderness Area Descriptions

*I.a. Desolation Wilderness Area*

The Desolation Wilderness Area (Desolation Wilderness) consists of 63,500 acres d.irectly to the west of Lake Tahoe. It is bisected by the Rubicon River that flows northward from its source in the southern Wilderness to eventually flow into the headwaters of the American River and towards the. San Joaquin Valley of central California. Wilderness elevations range from around 1,981 meters to 3,048 meters at the highest peaks. Lowest elevations are thus near Lake Tahoe's elevation of1 ,897 meters. The nearest source of local emissions is probably the Lake Tahoe basin, immediately east of the Desolation Wilderness. However, most of the Wilderness is not part of the nearby Lake Tahoe air shed, although easternmost east facing slopes are.

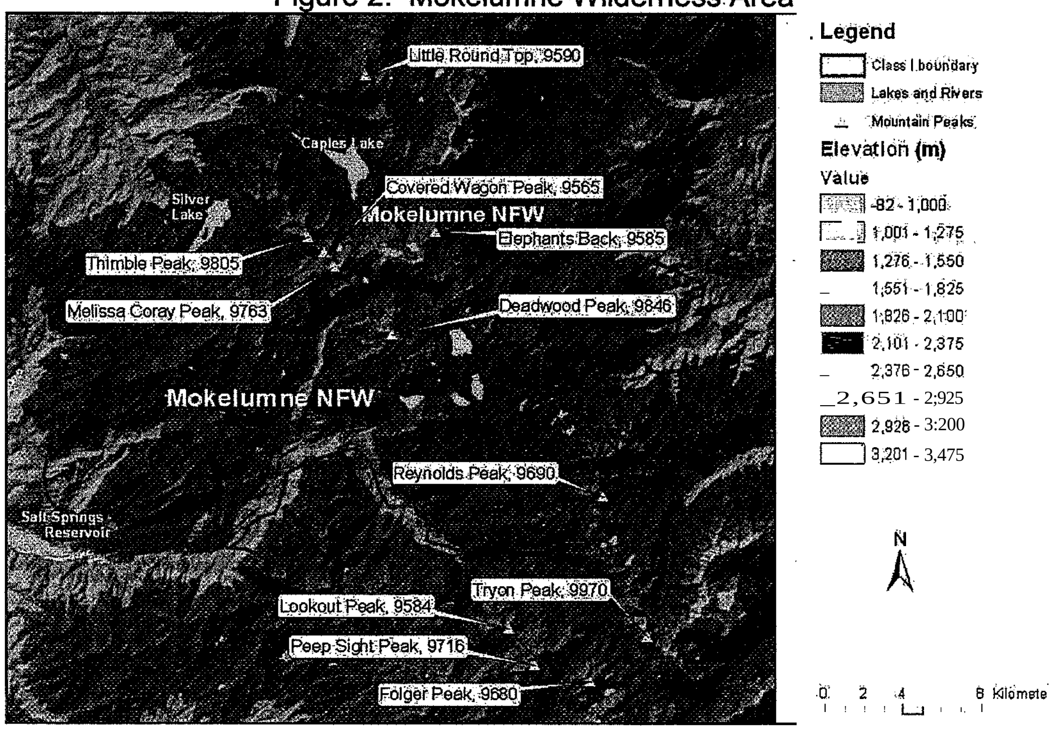
**Figure 1. Desolation Wilderness Area**



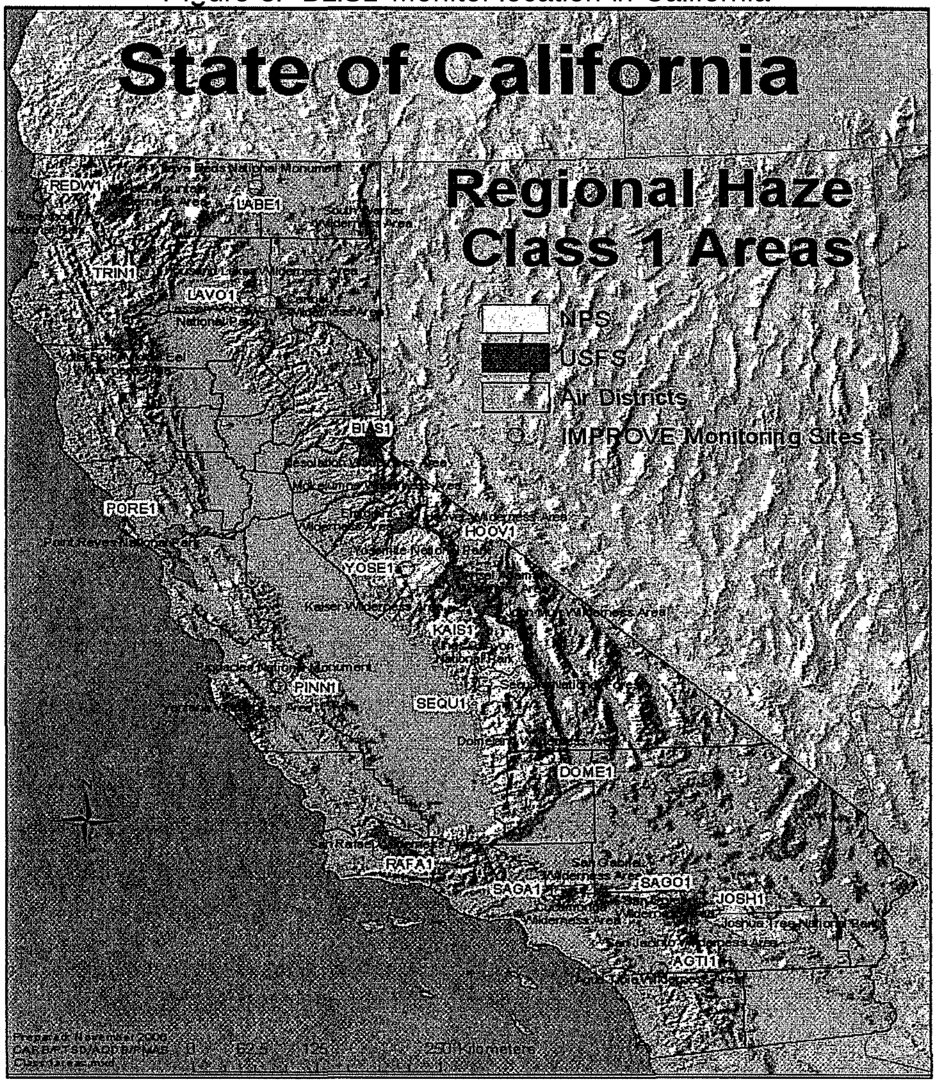
*I.b. Mokelumne Wilderness Area*

The Mokelumne Wilderness Area (Mokelumne) consists of 105,165 acres and straddles the crest of the central Sierra Nevada range 15 to 20 miles south of Lake Tahoe. Watersheds drain to the Mokelumne River on the west slope and the Carson River on the east slope. The Mokelumne River opens up into the central San Joaquin Valley about 50 miles to the west. The prominent Wilderness topographic feature is the Mokelumne River Canyon. Elevati,ons range from about 1,189 meters near Salt Springs Reservoir where the Mokelumne River exits the Wilderness on the south side to 3,164 meters at Round Top on the north side. Precipitation averages 50 inches annually on the west slope and as little as 15 inches on the east slope, 80 percent of it in the form of snow.

Figure 2. Mokelumne Wilderness Area



Fi ure 3. BLIS1 Monitor location in California




Section II. Visibility Conditions:

*II.a. Desolation Wilderness Area*

Visibility conditions for Desolation Wilderness are currently monitored by the BLIS1 IMPROVE monitor located at Bliss State Park. The monitor is located at 38.9761 north latitude, 120.1035 west longitude, near the western shore of Lake Tahoe at an elevation of 2,131 rneters, about 219 meters above the shore of Lake Tahoe and near lowest elevations on the eastern slopes of Desolation Wilderness.

The BLIS1 monitoring site is about219 meters above the shore of Lake Tahoe, and near the lowest Wilderness locations on slopes facing Tahoe Basin. It is likely more susceptible to local and trapped emissions in the Tahoe Basin that do not extend to higher Desolation Wilderness elevations. It is probably representative of Desolation

Wilderness locations on lower eastern slopes facing Lake Tahoe that may be worst case conditions overall, and during conditions of uniform regional haze. The closest source region with emissions that could contribute to haze in the Desolation Wilderness is the Lake Tahoe Basin. The more distant central Valley of California near Sacramento, from which emissions could be transported to Desolation Wilderness, is about 50 miles southwest, linked to Desolation Wilderness by the American River and Rubicon River. The Reno, Nevada area is about the same distance to the northeast but is generally downwind for prevailing wild directions and in a distant air shed.

Potential emission transport from source regions to the west in the California Central Valley occurs mainly iii the summer. Locally, eastern Wilderness locations may be predominantly influenced by emissions within the Tahoe Basin. Highest summertime' measured concentrations at BLIS1 are associated with regional forest fire events. In the absence of such regional events there is likely to be a significant contribution from vehicle traffic in the Tahoe Basin to aerosol measures at BLIS1. In the fall and winter there may be wood smoke impacts associated with prescribed burns and residential burning in the Tahoe Basin.

The BLiSI location is adequate for assessing the 2018 reasonable progress goals for the Desolation Wilderness Class 1 area.

### *II.b. Mokelumne Wilderness Area*

Visibility conditions for Mokelumne are currently monitored by the BLIS1 IMPROVE monitor located at Bliss State Park. The monitor is located at 38.9761 north latitude and 120.1035 west longitude near the western shore of Lake Tahoe at an elevation of 2,131 meters, about 219 meters above the shore of Lake Tahoe.

The BLiSt IMPROVE site is close to and about 219 meters above the" shore of Lake Tahoe, within the Tahoe Basin. There is no direct link to Mokelumne Wilderness, which is generally outside of the Tahoe Basin, except via the headwaters ofthe Upper Truckee River, separated from the Wilderness by higher terrain. BLIS1 is likely more susceptible to local and trapped emissions in the Tahoe basin that do not extend to Mokelumne Wilderness locations.. It may be more representative of Mokelumne Wilderness locations during conditions· of uniform regional haze. Emissions from Sacramento and Stockton, about 50 miles southwest, could be transported to the Mokelumne Wilderness. via the Mokelumne River. The Reno Nevada area is abouUhe same distance to the northeast but is "generally downwind for prevailing wind directions and in a distant air shed.

The BLIS110cation is adequate for assessing the 2018 reasonable progress goals for the Mokelumne Wilderness Class 1 area.

*II.b. Baseline Visibility*

Baseline visibility is determined from BLIS1 IMPROVE monitoring data for the 20% best. and the 20% worst days for the·years 2000 through 2004. Thebaseline visibility for the BLIS1 monitor is calculated at 2.5 deciviews for the 20% best days and 12.6 deciviews . for the 20% worst days. Figure 4 represents the worst baseline visibility conditions.

*II.c. Natural Visibility*

Natural visibility represents the visibility condition that would be experienced in the absence of human-caused impairment. Based on EPA gUidance, the natural visibility for the BLIS1 monitor is 0.4 deciviews for the 20% best days and 6.1 deciviews for the 20% worst days. It is possible that the Natural Conditions deciview value for 2064 could change in the future as more ·is learned about natural plant emissions and wildfire impacts.

*II.d. Presumptive Glide Slope and the Uniform Rate of Progress*

Figure 4 also shows the uniform rate of progress, or "glide slope." The glide slope is the rate of reduction in the 20% worst days deciview average that would have to be achieved to reach natural conditions at a uniform pace in the 60 years following the baseline period. The first benchmark along the path towards achieving natural conditions occurs in 2018. The glide slope shows that the 2018 benchmark for the 20% worst days is 11.10 deciviews. According to the Regional Haze Rule, the 20% best days baseline visibility of 2.5 deciviews must be maintained or improved by 2018,. the end of the first planning period.

**Figure 4. Worst 20% days for baseline (2000-2004) and for Natural Conditions (2064)**

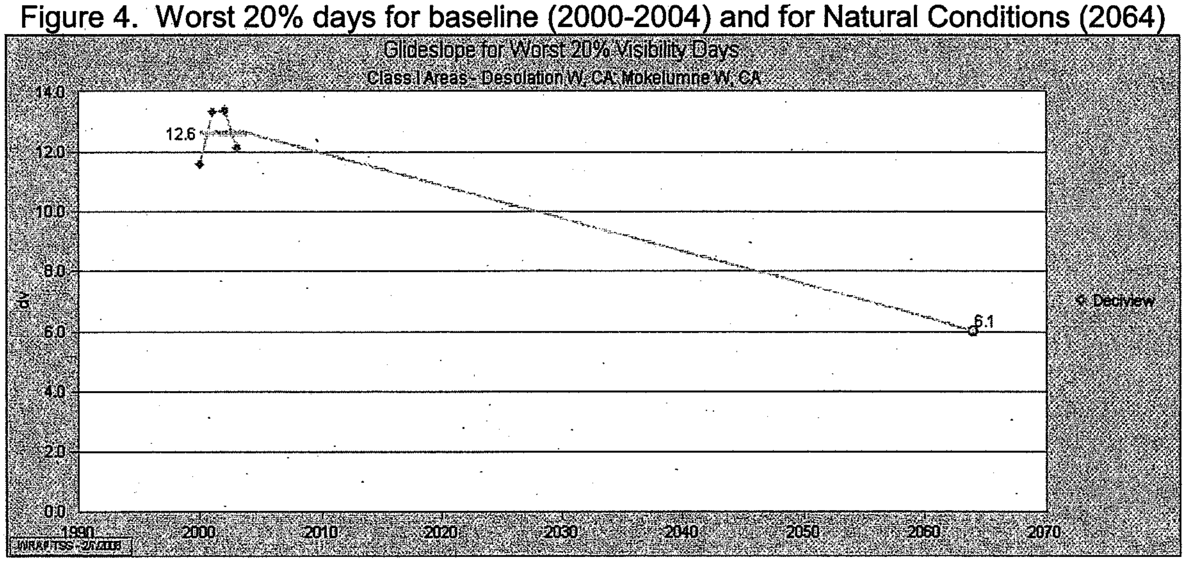
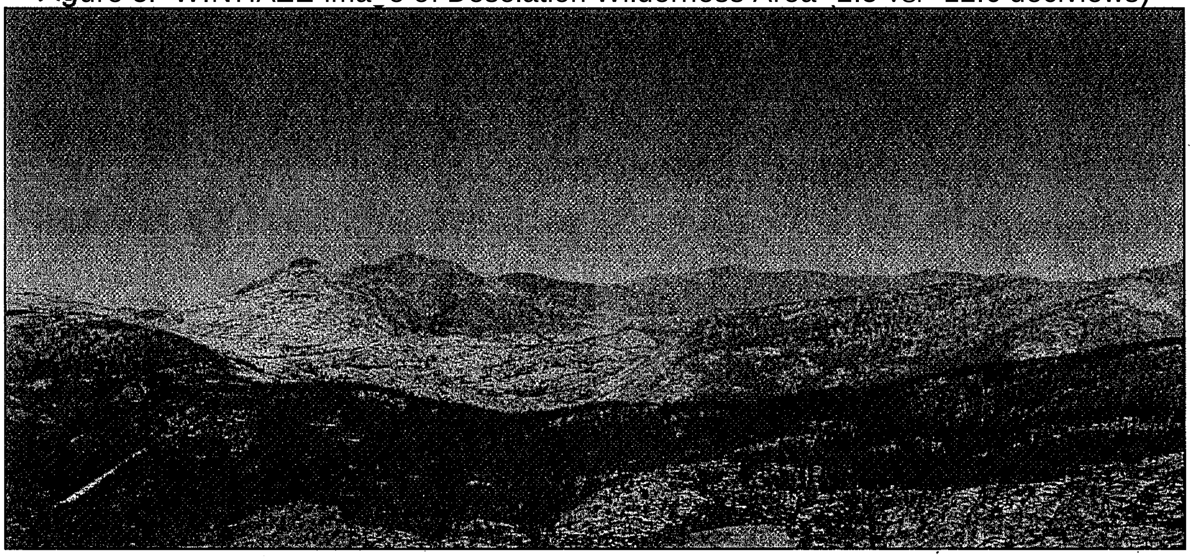


Figure 5. WINHAZE ima_e of Desolation Wilderness Area 2.5 vs. 12.6 deciviews)



*II.e. Species Contribution*

Each poltutant species causes light extinction but its contribution differs on best and worst days. Figure 6 shows the contribution of each species to the 20% best and worst days in the baseline years at BLIS1.

Figure 6. Average Haze species contributions to light extinction in the baseline years

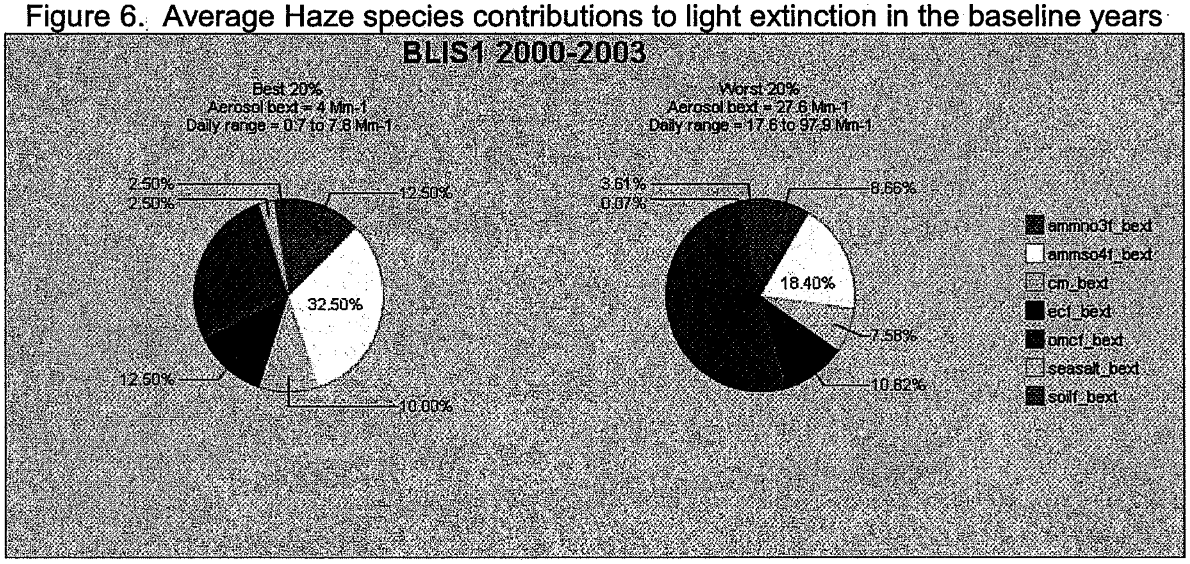
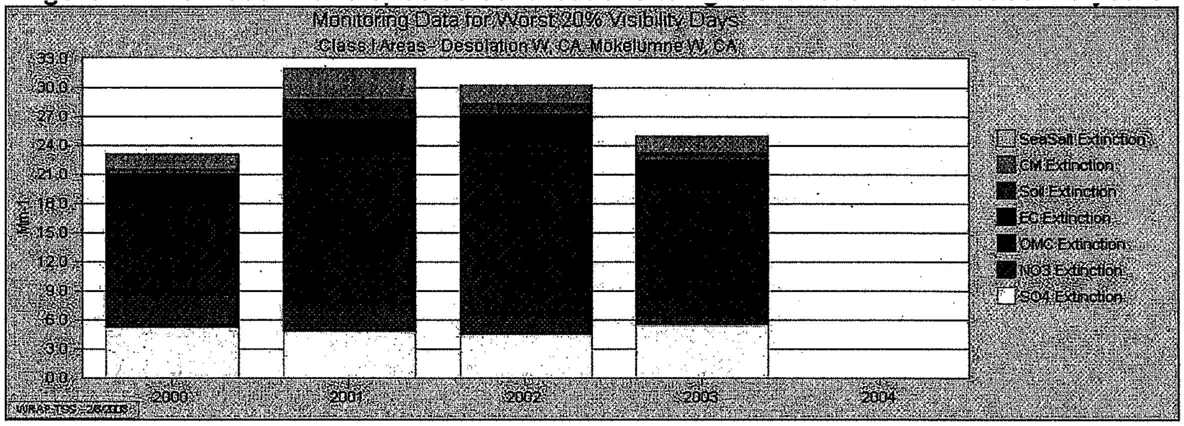


Figure 7. Individual Haze species contributions to light extinction in the baseline years




As shown in Figures 6 and 7, organic matter, sulfates,and elemental carbon have the strongest contributions to degrading visibility on worst days at the BLIS1 monitor. The worst days are dominated by organic matter, while the best days are dominated by sulfate. Data points for 2004 were insufficient for calculating best and worst days per the Regional Haze Rule Guidance.

Figure 8 depicts the individual species contribution to worst days in 2002. Organic matter increases in the summer while sulfates increase slightly in the spring. The occurrence of elevated elemental carbon concentrations is sporadic throughout the year. Organic matter clearly dominates the other haze species-on worst days, but sulfates, nitrates, elemental carbon, and coarse mass also contribute to the worst days. Sea salt has a very small contribution to haze at the BLIS1 monitor.

Figure 9 illustrates the individual species contribution on worst days in 2000-2004 by monthly average. The trend shown is comparable to Figure 8 for organic matter, sulfates, elemental carbon, and nitrates. High organic periods vary from year to year due to the unpredictable occurrence of wild fires.

**Figure 8. Species contribution on the 20% worst days in 2002**

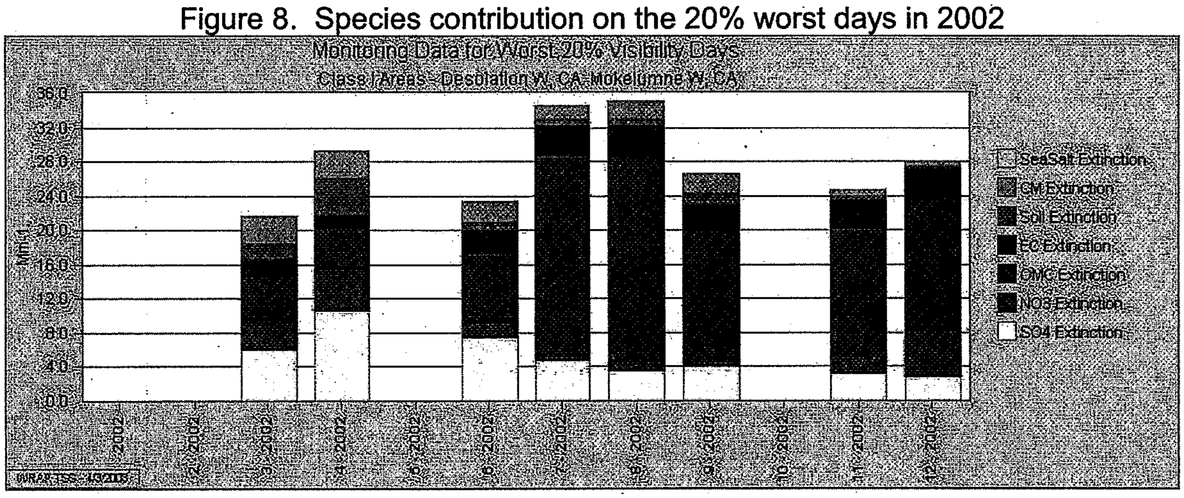
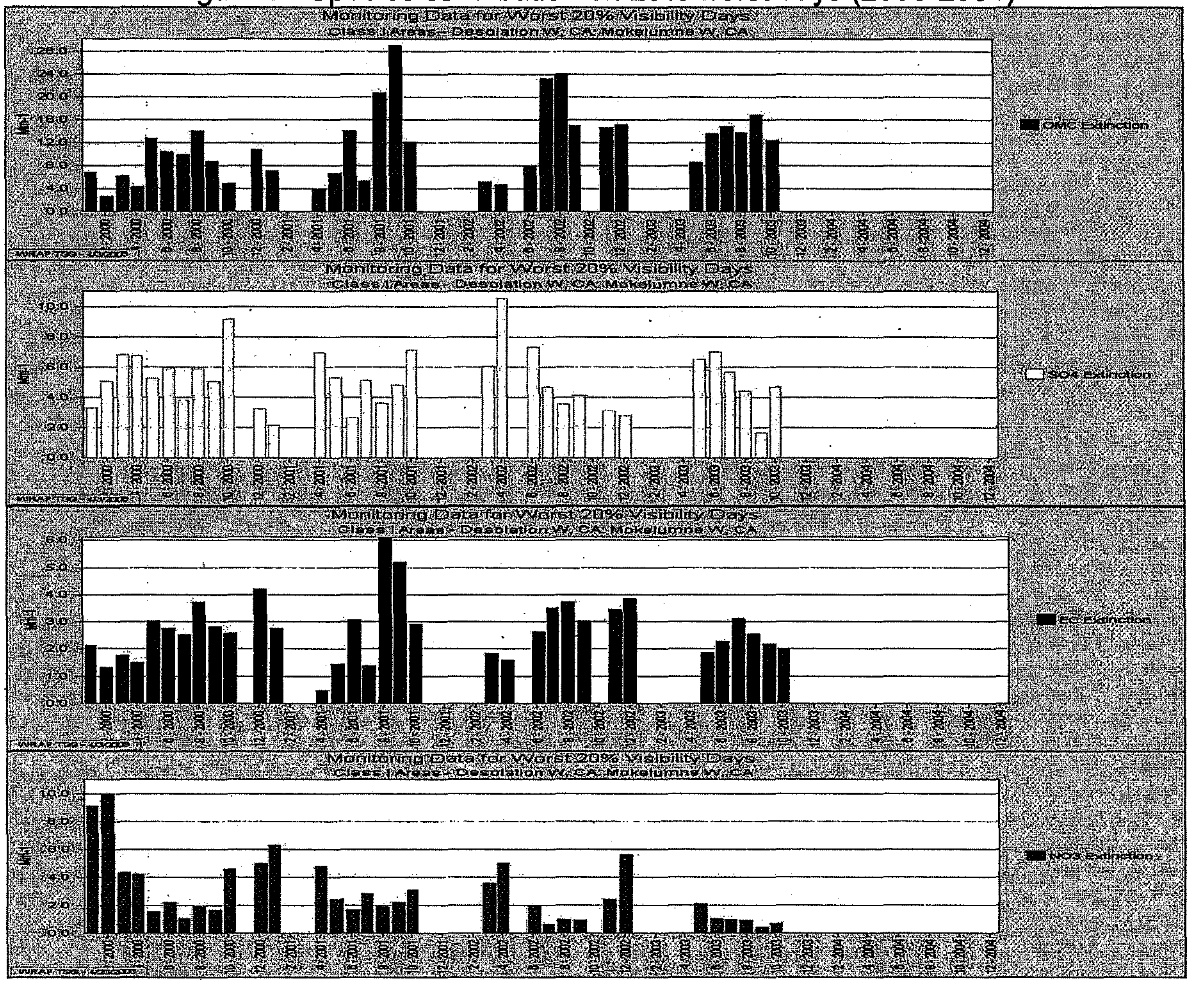


Figure 9. Species contribution on 20% worst days (2000-2004)




### *11.f. Sources of Haze Species*

Both natural and man-made sources contribute to the calculated deciview levels made by haze pollutants at BLIS1. Some haze species arise from sources that are within the control of the State of California or neighboring states. Others arise from natural, uncontrollable situations such as wildfires, sea salt or dust storms in natural areas, whether they are from in-state or out-of-state (and out-of-country) sources. Finally, other uncontrollable, man-made sources are those industrial pollutants and other man-made (anthropogenic) emissions transported from outside the United States.

Figure 10 shows the primary organic carbon source contribution from California and the outside regions. The largest contributor to primary organic carbon at the BLIS1 monitor is from natural fire sources within California. California represents 70% of all natural fire source contributions.

Figure 11 illustrates the'total organic carbon source apportionment from 2000-2004 for anthropogenic and biogenic sources. The biogenic secondary emissions account for 63% of the·total organic carbon. Anthropogenic and biogenic primary source emissions account for 33% of the total organic carbon emissions and anthropogenic secondary emissions ,are responsible for the remaining emissions.

Figures 12 and 13 represent the regional contributions to sulfate on the 20% worst days .in 2002 and 2018 at BLiS1. The Outside Domain region represents 41 %of the sulfate contributions in 2002 and 2018, followed by the emissions from the WRAP Region (39%) and the Pacific Offshore Region (13%). California contributes 20% of the total sulfate emissions seen at the BLIS1 monitor.

Individually, emissions from outside the modeling domain contribute the most sulfate concentrations at the BLIS1 monitor. The next largest contributor to sulfate concentration is area sources in the Pacific Offshore Region.

Figure 14 represents the elemental carbon source contribution from CA and outside regions. Natural fire occurrences within California contribute the highest concentration of elemental carbon at the BLIS1 monitor. California is responsible for 70% of the elemental carbon emissions from wild fires, followed by Nevada wild fire emissions (25%).

Figures 15 and 16 represent the regional contributions to nitrate on the 20% worst days in 2002 and 2018 at the BLIS1 monitor. The WRAP Region represents the largest contribution to nitrate in 2002 and 2018 (76%) followed by the Outside Domain Region (19%) and emissions from the Pacific Offshore (3%). In 2002, 57% of nitrate at the BLIS1 monitor can be attributed to California.

From the WRAP Region, California is shown to contribute the most nitrate concentrations at the AGT1 monitor in 2002 and 2018. Currently, California mobile sources are 72% of all California contributions at the AGT1 monitor. California mobile source emissions reductions are mainly responsible for improvement in nitrates in 2018.

**Figure 10. Organic carbon source contribution from CA and outside regions**

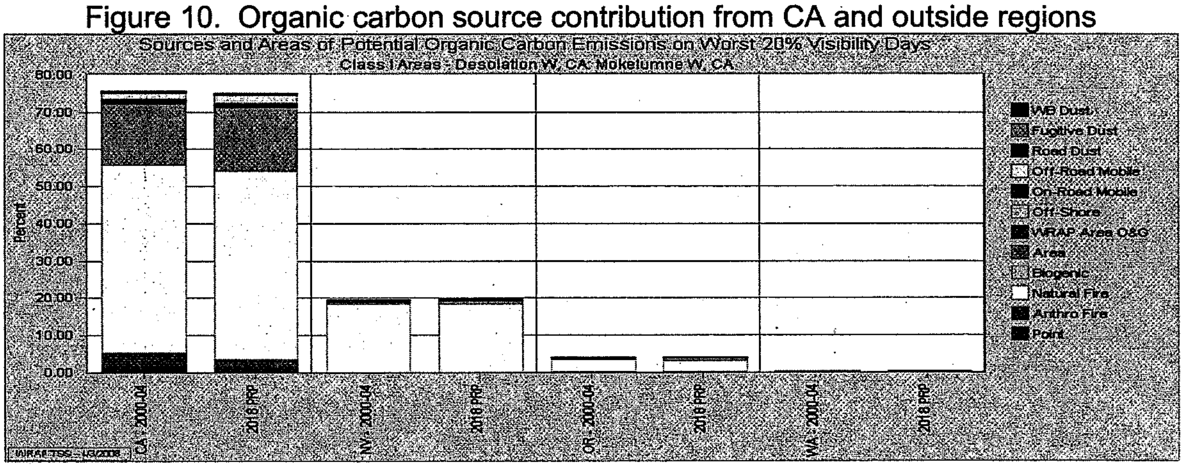


Figure 11. Organic carbon Anthropogenic and Biogenic Source Apportionment

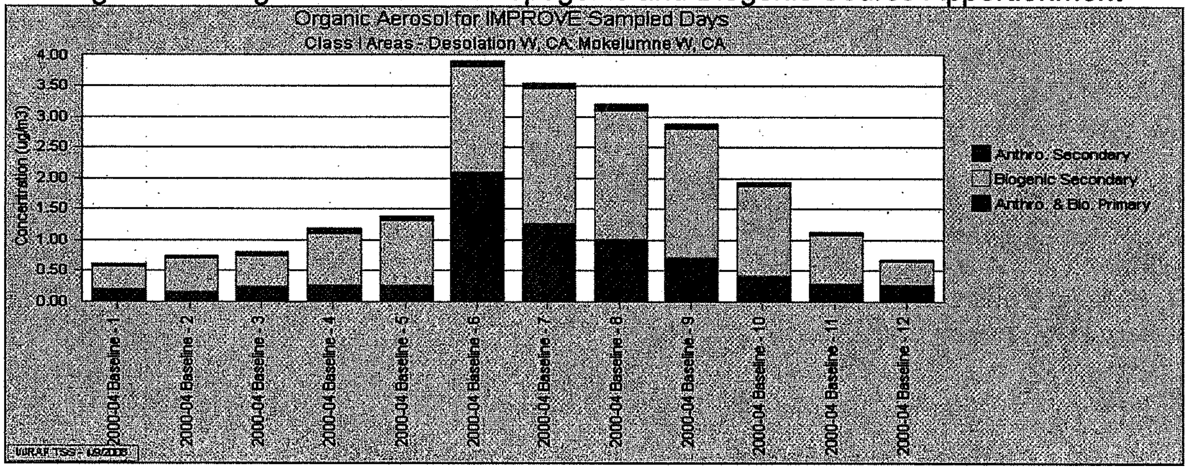
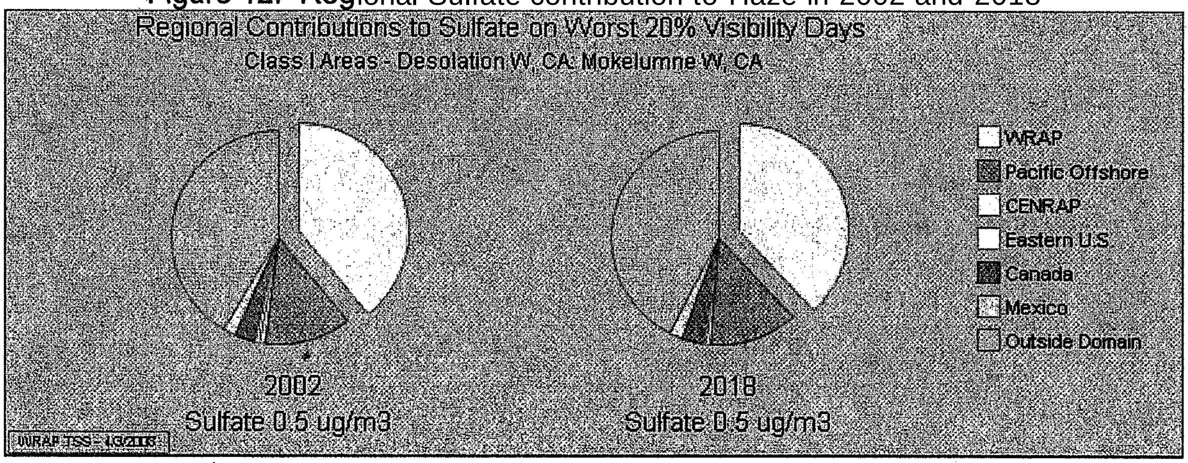



Figure 12. Regional Sulfate contribution to Haze in 2002 and 2018




Fi_ure 13. Sulfate source contribution from CA and outside regions

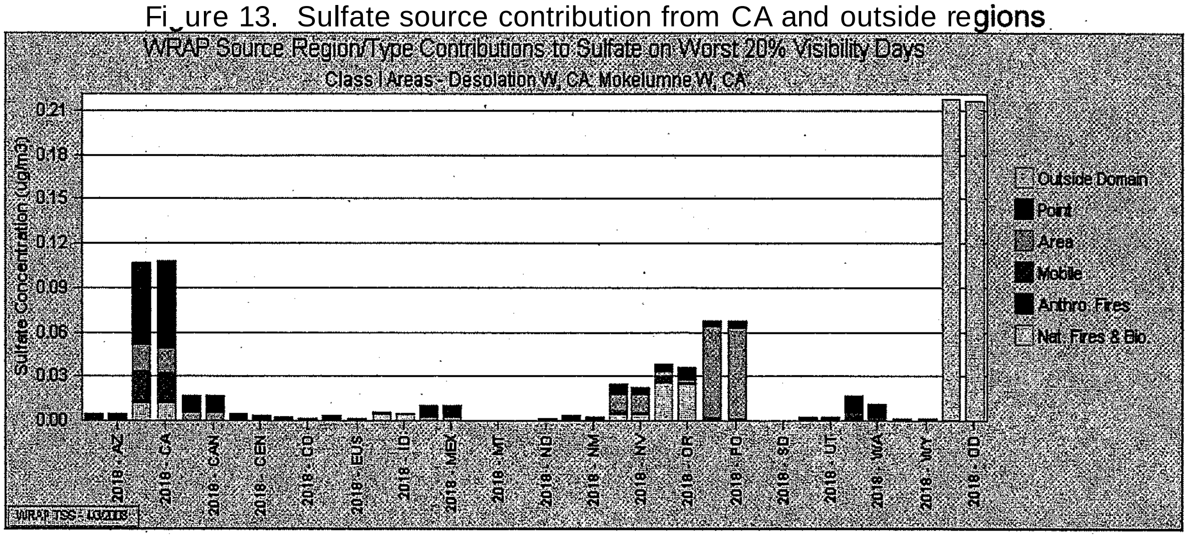


Figure 14. Elemental Carbon source contribution from CA and outside regions

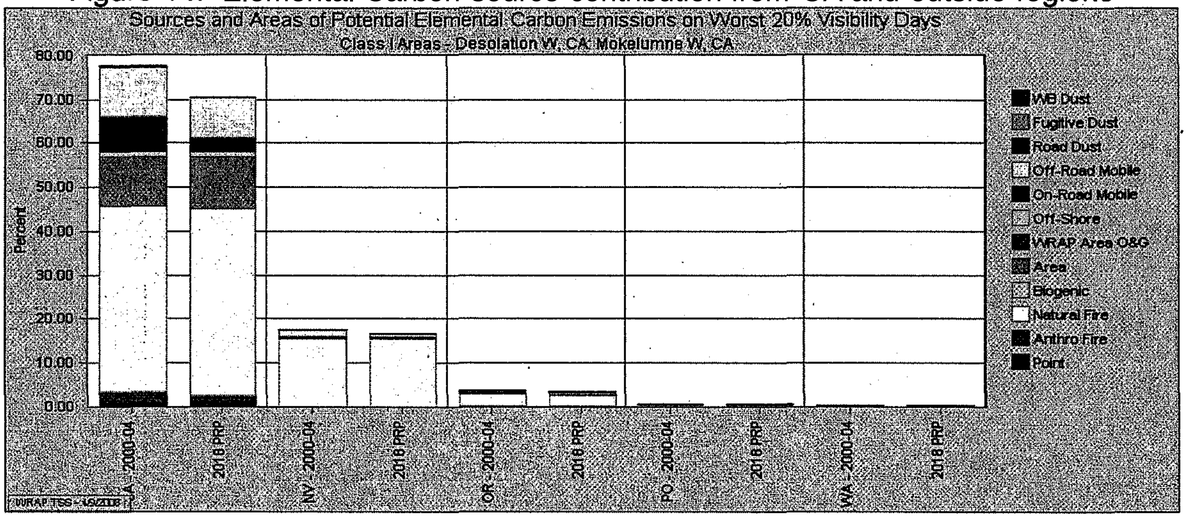



Figure 15. Regional Nitrate contribution to Haze in 2002 and 2018

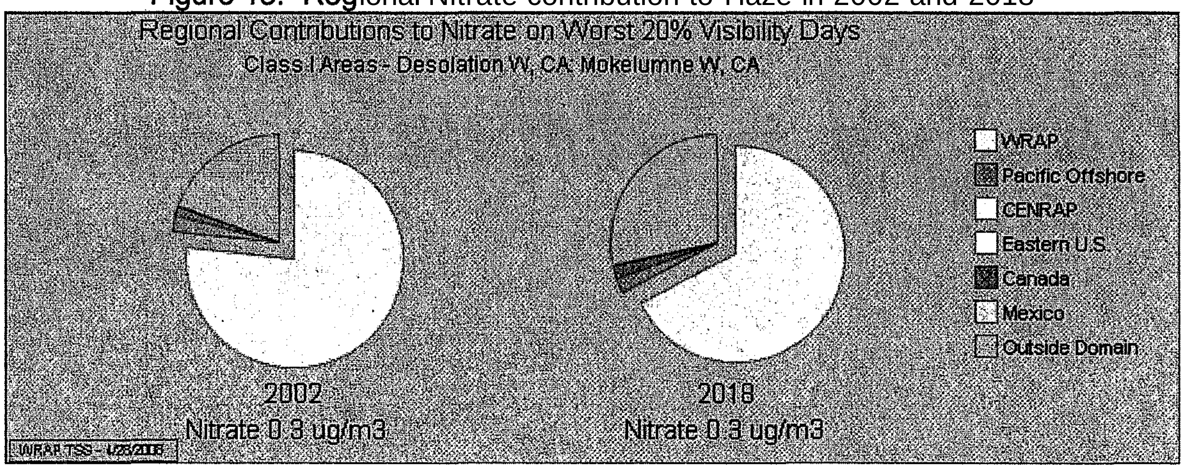
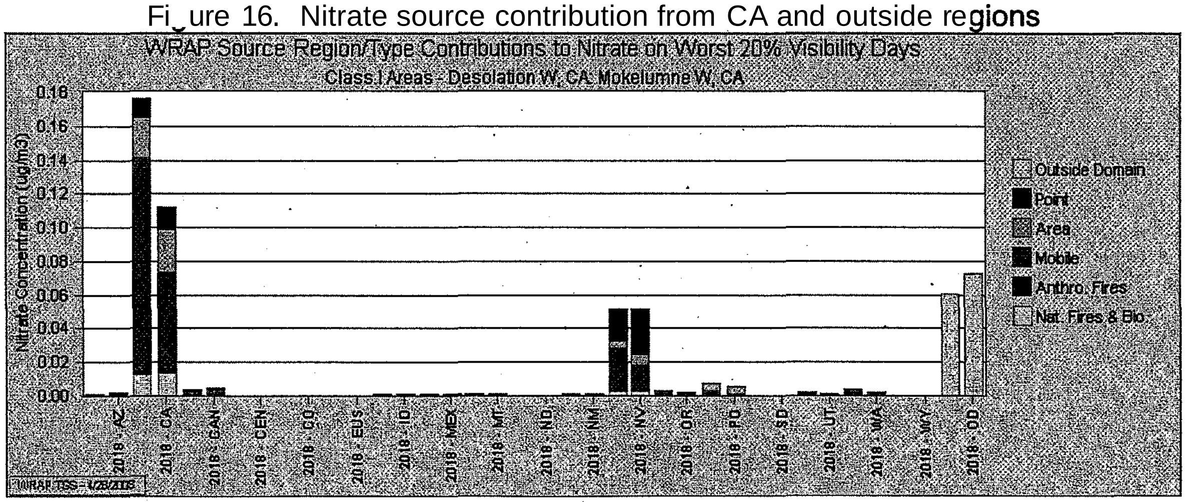



Figure 16. Nitrate source contribution from CA and outside regions

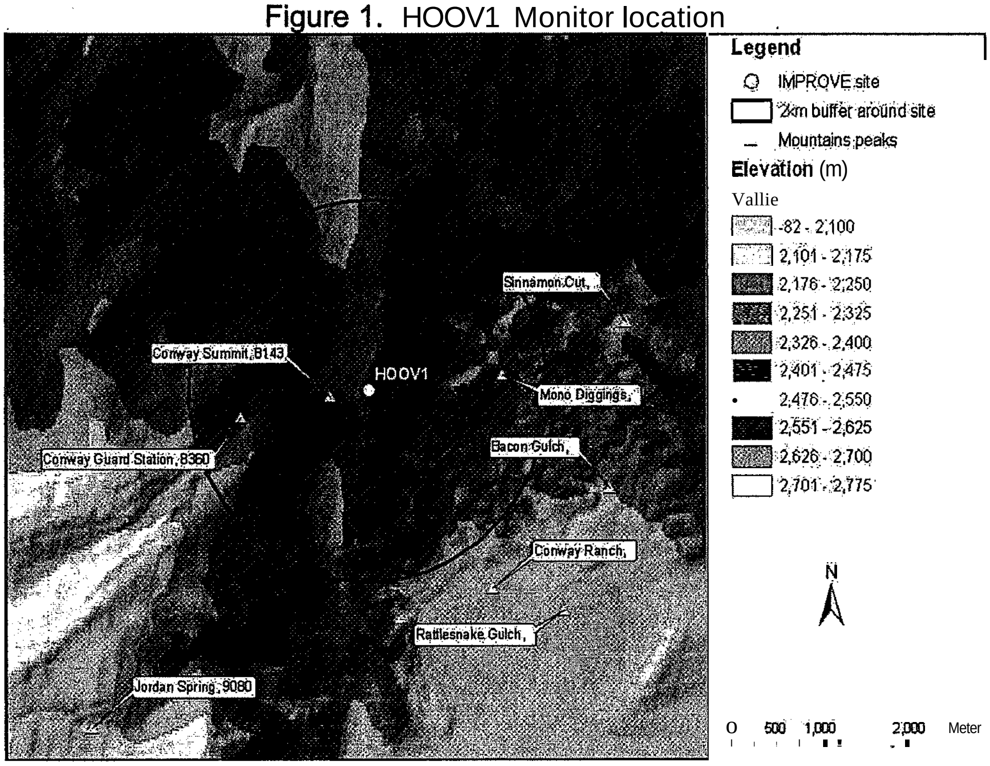


## HOOV1 Monitor

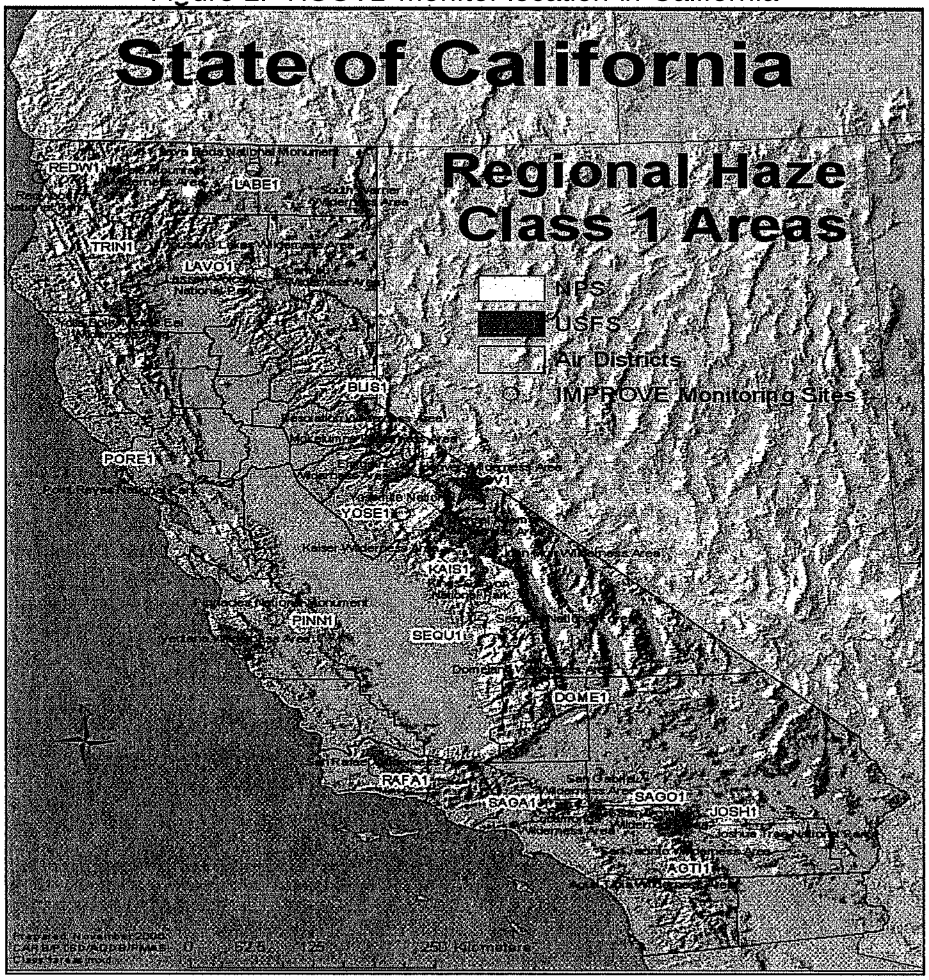
### Section I. Description

The Hoover Wilderness is an area of approximately 48,000 acres in the Sierra Nevada range, east of the crest and primarily in the rain shadow of.the Sierra Nevada. It is located between Mono'Lake and the eastern portion of Yosemite National Park. Elevations within the wilderness range from about 2,561 meters on lower slopes to over 3,658 meters on the crest. Streams flow eastward into Bridgeport Valley and Mono Valley from the northern Wilderness and into Mono Valley from the southern Wilderness. Mono Lake is a terminal lake with no outlet. Mono Lake and Owens Lake 93 miles to the south are major sources of windblown alkali dust that may impact visibility in the Wilderness.

**Figure 1.** HOOV1 Monitor location



Fi ure 2. HOOV1 monitor location in California




Section II. Visibilitv Conditions:

*II.a. Visibility Monitor Location*

Visibility cQnditions for Hoover Wilderness are currently monitored by the HOOV1 IMPROVE rnonitor. The monitor is located at 38.0881 north latitude and 119.1771 west longitude in a well-exposed location with an unobstructed vista into the Hoover Wilderness to the west. The monitor elevation is near the lower end of the range of Wilderness elevation and is about 488 to 610 meters above the Bridgeport and Mono Valley floors. HOOV1 data should be generally representative of aerosol characteristics in the Hoover Wilderness. During episodes of windblown dust from the valley floors it should represent worst visibility conditions at the most impacted lower Wilderness elevations; The site has been operating since July 2001. This site does not have sufficient data for the entire baseline period. Data was not available for the years 2000 and 2001.

The Hoover Wilderness Area is on the east slopes of the Sierra Nevada, adjacent to Mono and Bridgeport Valleys. Mono Lake and Owens Lake 93 miles to the south are potential sources of alkali dust from these desiccated lake beds. Dust from these sources can be transported larger distances because it is unusually fine-grained compared to dust from other natural sources. The largest anthropogenic source region is the Central Valley, which could be a source of aerosols mixed upwards and transported across the Sierra Nevada crest by prevailing westerly winds.

The HOOVI location is adequate for assessing the 2018 reasonable progress goals for the Hoover Wilderness Class 1 area.

### *II.b.* ***Baseline Visibility***

Baseline visibility is determined from HOOV1 IMPROVE monitoring data for the 20% best and the 20% worst days for the years 2000 through 2004. The baseline visibility for the Hoover Wilderness Area is calculated at 1.4 deciviews for the 20% best days and 12.9 deciviews for the 20% worst days. Figure 3 represents the worst baseline visibility conditions.

### *II.c.* ***Natural Visibility***

Natural visibility represents the visibility condition that would be experienced in the absence of human-caused impairment. Based on EPA guidance, the natural visibility for the Hoover Wilderness Area is 0.1 deciviews for the 20% best days and 7.7 deciviews for the 20% worst days. It is possible that the Natural Conditions deciview value for 2064 could change in the future as more is learned about natural plant emissions and wildfire impacts.

### *II.d.* ***Presumptive Glide Slope and the Uniform Rate of Progress***

Figure 3 also shows the uniform rate of progress, or "glide slope." The glide slope is the rate of reduction in the 20% worst days deciview average that would have to be achieved to reach natural conditions at a uniform pace in the 60 years following the baseline period. The first benchmark along the path towards achieving natural conditions occurs in 2018. The glide slope shows that the 2018 benchmark for the 20% worst days is 11.66 deciviews. According to the Regional Haze Rule, the 20% best days baseline visibility of 1.4 deciviews must be maintained or improved by 2018, the end of the first planning period.

Figure 3. Worst 20% days for baseline (2000-2004) and for Natural Conditions (2064)

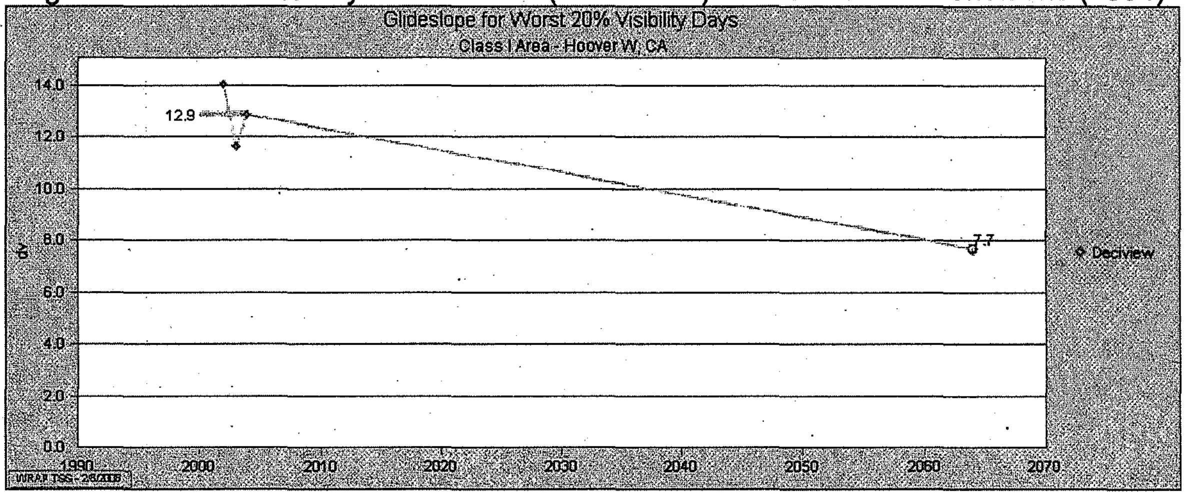
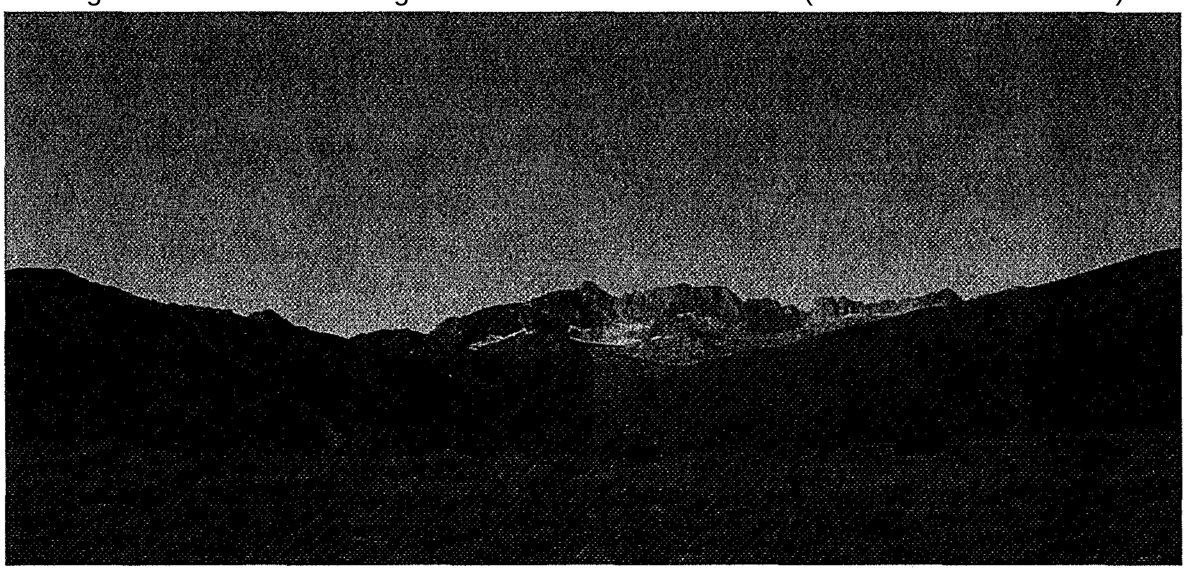



Figure 4. WINHAZE image of Hoover Wilderness Area (1.4vs. 12.9 deciviews)



*II.e. Species Contribution*

Each pollutant species causes light extinction but its contribution differs on best and worst days. Figure 5 shows the contribution of each species to the 20% best and worst days in the baseline years at HOOV1.

Figure 5. Average Haze species contributions to light extinction in the baseline years

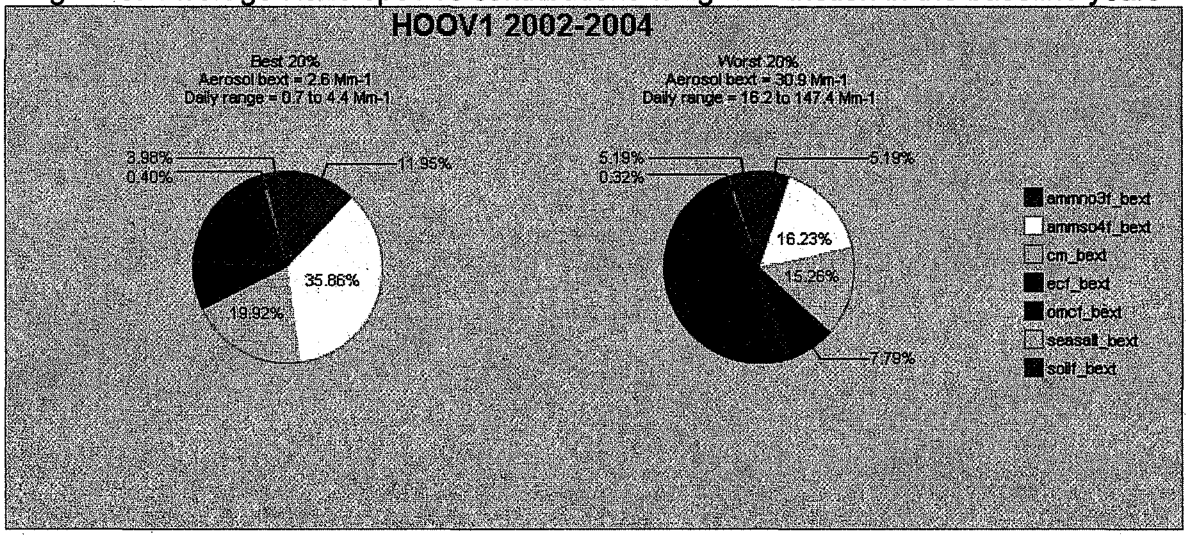
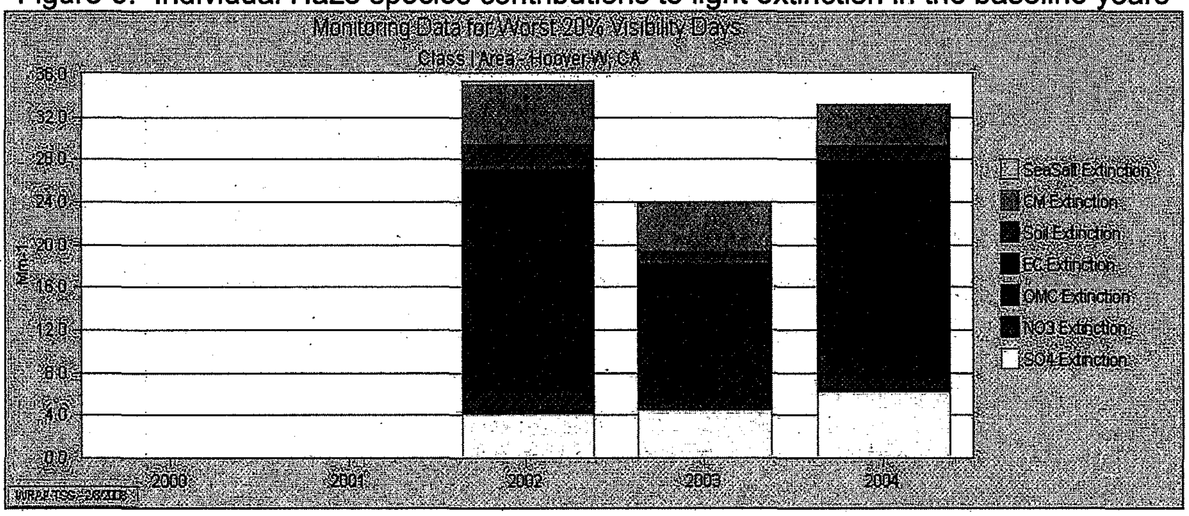



Figure 6. Individual Haze species contributions to light extinction in the baseline years




As shown in Figures 5 and 6, organic matter, sulfates, and coarse mass have the strongest contributions to degrading visibility on worst days at Hoover Wilderness Area. The worst days are dominated by organic matter, while the best days are dominated by sulfates. Data points for 2000 and 2001 were insufficient for calculating best and worst days per the Regional Haze Rule Guidance.

Figure 7 depicts the individual species contribution to worst days in 2002. Organic matter is seen to increase in the summer and winter. 'Sulfates increase in the late winter and early spring months. Coarse mass is not very predictable but does increase in the month of February. Organic matter clearly dominates the other haze species on worst days, but sulfate, nitrate, elemental carbon, coarse mass, and soil also contribute to worst days throughout the years. There are only trace amounts of sea salt present at this monitor.

Figure 8 illustrates the individual species contribution on worst days in 2000-2004 by monthly average. The trend shown is comparable to Figure 7 for organic matter, sulfates, coarse mass., and nitrates. High organic periods vary from year to year due to the unpredictable occurrence of wild fires.

Figure 7. Species contribution on the 20% worst days in 2002

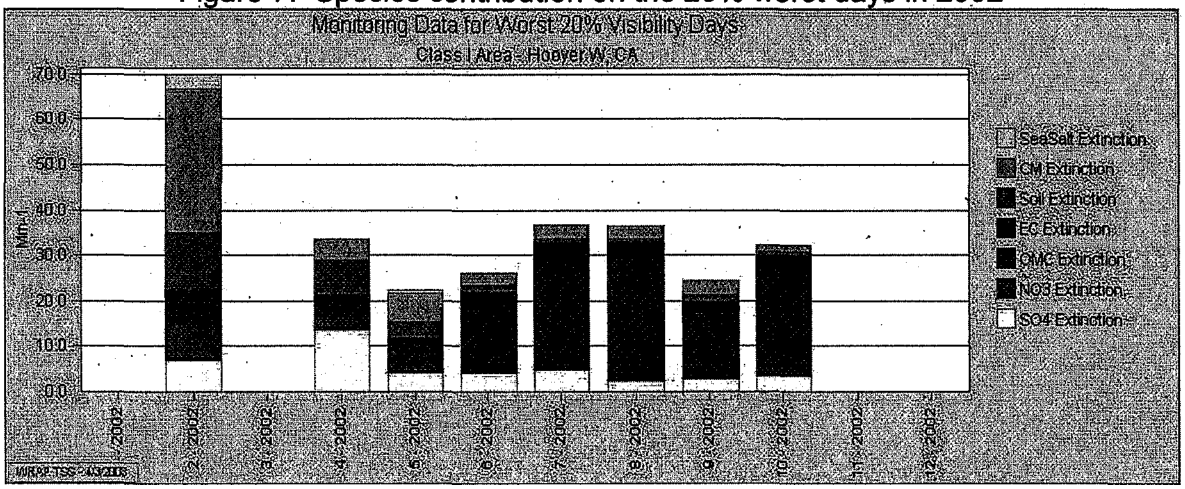
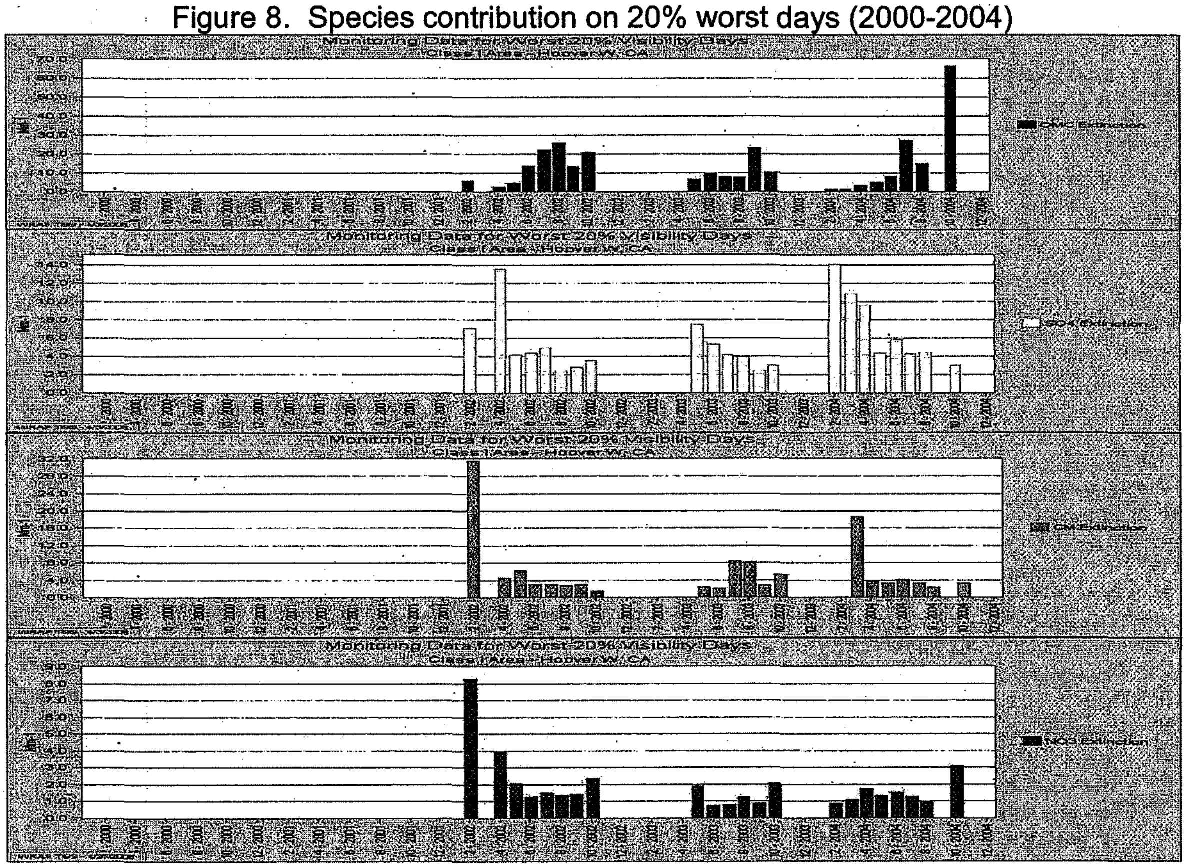



Figure 8. Species contribution on 20% worst days (2000-2004)



*1l.f. Sources of Haze Species*

Both natural and man-made sources contribute to the calculated deciview levels made by haze pollutants at HOOV1. Some haze species arise from sources that are within the control of the State of California or neighboring states. Others arise from natural, uncontrollable situations such as wildfires, sea salt or dust storms in natural areas, whether they are from in-state or out-of-state (and out-of-country) sources. Finally, other uncontrollable, man-made sources are those industrial pollutants and other man-made (anthropogenic) emissions transported from outside the United States.

Figure 9 shows the primary organic carbon source contribution from California and the outside regions. The largest contributor to primary organic carbonat the HOOV1 monitor is from natural fire sources within California. California represents 86% of all natural fire source contributions.

Figure 10 illustrates the total organic carbon source apportionment from 2000-2004 for anthropogenic and biogenic sources. The biogenic'secondary emissions account for 63% of the total organic carbon. Anthropogenic and biogenic primary source emissions account for 33% of the total organic carbon emissions and anthropogenic secondary is responsible for the remaining emissions.

Figures 11 and 12 represent the regional contributions to sulfate on the 20% worst days in 2002 and 2018 at HOOV1. The Outside Domain region represents 45% of the sulfate contributions in 2002 and 2018, followed by the emissions from the WRAP Region (35%) and the Pacific Offshore Region (12%). California contributes 19% of the total sulfate emissions seen at the HOOV1 monitor.

Individually, emissions from outside the modeling domain contribute the most to sulfate concentrations at the HOOV1 monitor. The next largest contributor to sulfate con'centration is from area sources in the Pacific Offshore Region.

Figure 13 shows the coarse mass source contribution from California and the outside regions. The largest contributor to coarse mass at the HOOV1 monitor is from road dust within California. California represents 95% of all road dust source contributions.

Figures 14 and 15 represent the regional contributions to nitrates on the 20% worst days at the HOOV1 monitor. The WRAP region represents the largest contribution to nitrate in 2002 and 2018 (68%), followed by the Outside Domain Region (27%) and emissions from Pacific Offshore (4%). Mobile sources within California contribute the most nitrates at the DOME1 monitor. In 2002, 52% of the nitrate at the HOOV1 monitor can be attributed to California.

From the WRAP Region, California is shown to contribute the most to nitrate concentrations at the HOOV1 monitor in 2002 and 2018. Currently, California mobile sources are 73% of California contributions to nitrate at the DOME1 monitor. California mobile source emissions reductions are mainly responsible for improvement in nitrates in 2018.

Figure 9. Or_anic carbon source contribution from CA and outside regions

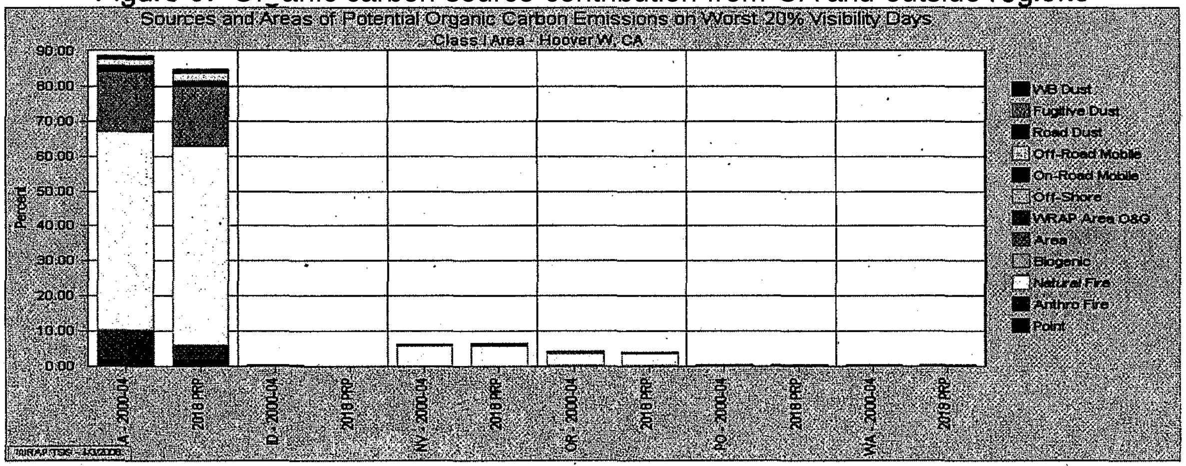



Figure 10. Organic carbon Anthropogenic and Biogenic Source Apportionment

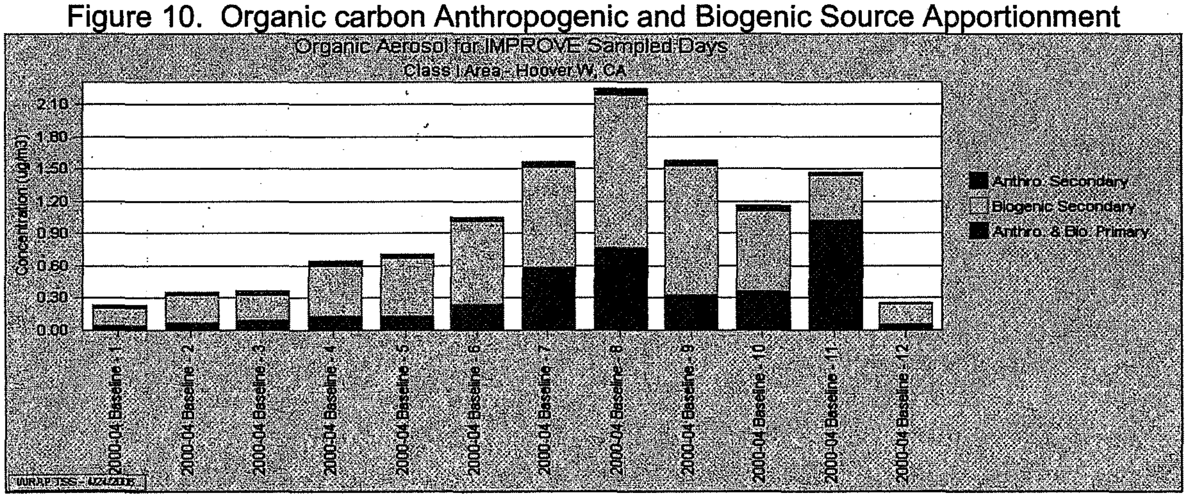



Figure 11. Regional Sulfate contribution to Haze in 2002 and 2018

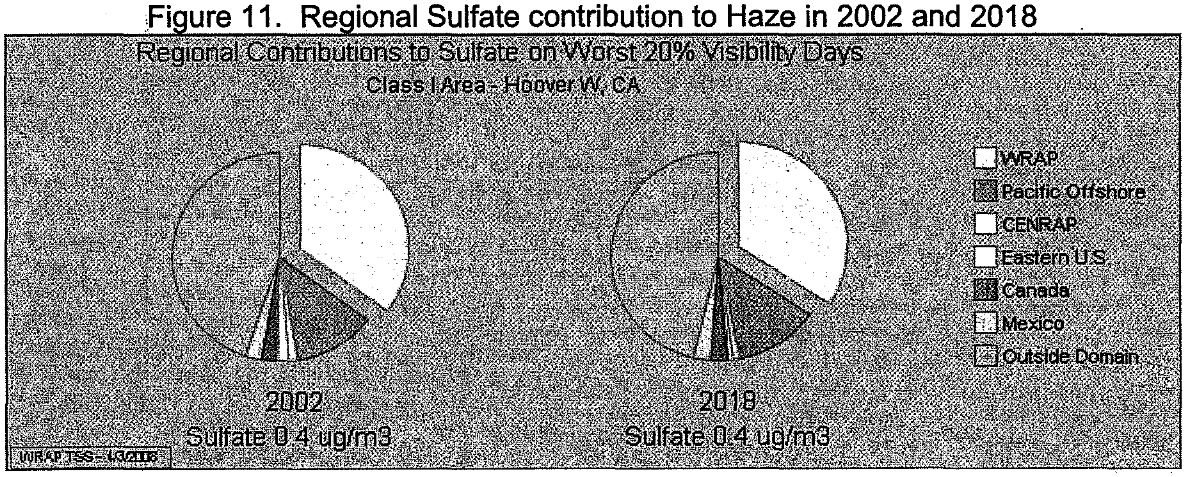


Figure 12. Sulfate source contribLition from CA and outside regions

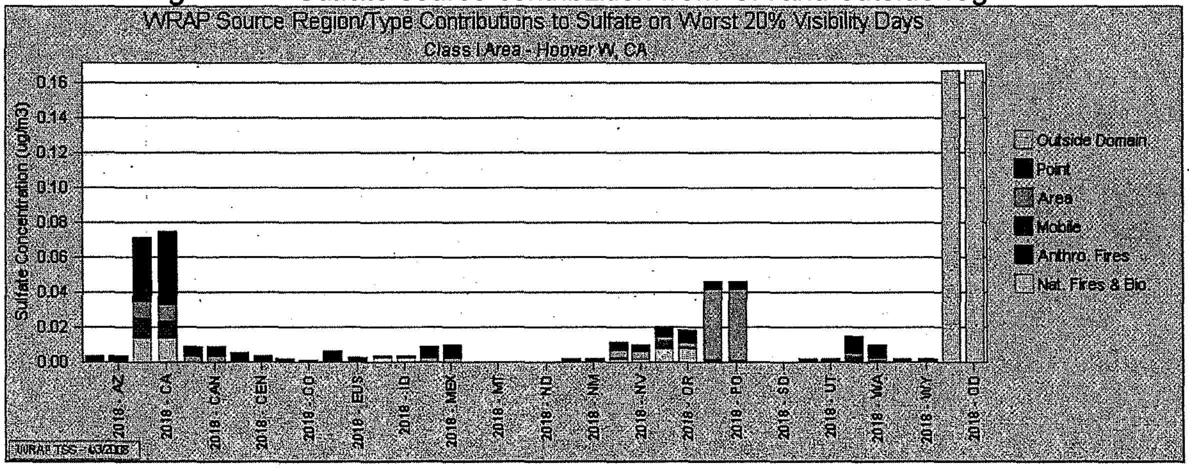



Figure 13. Coarse mass source contribution from CA and outside regions.

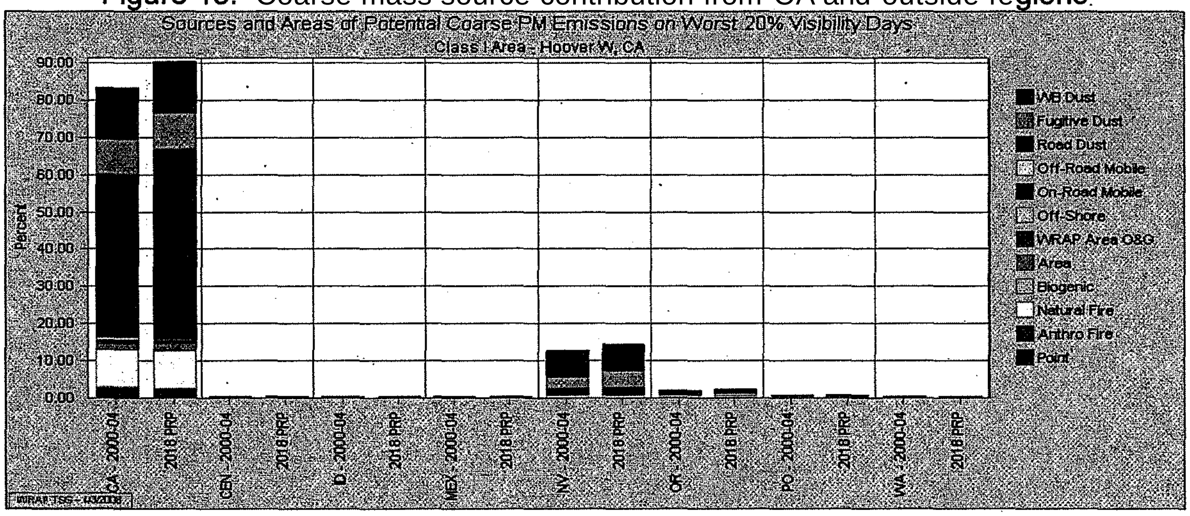
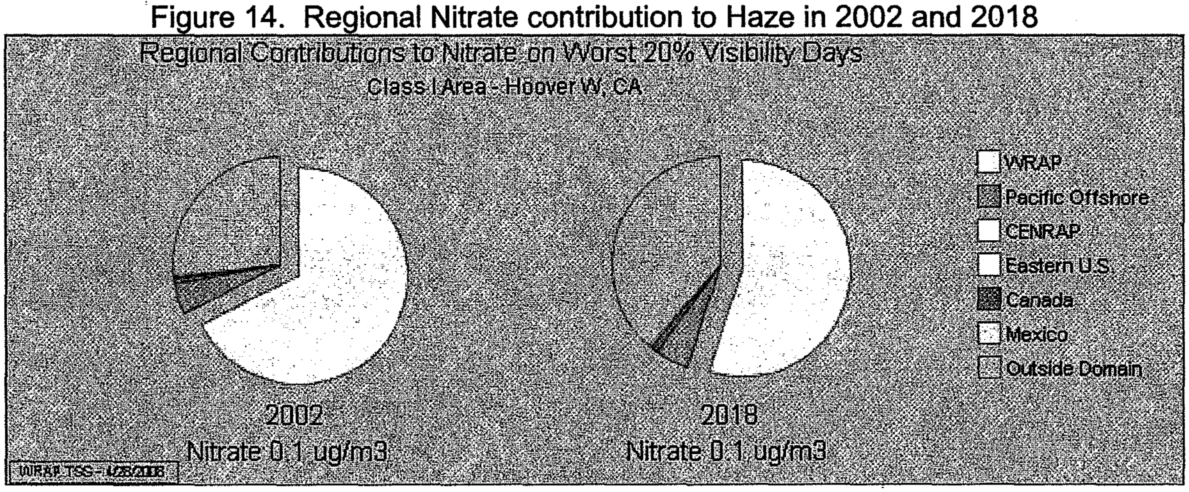
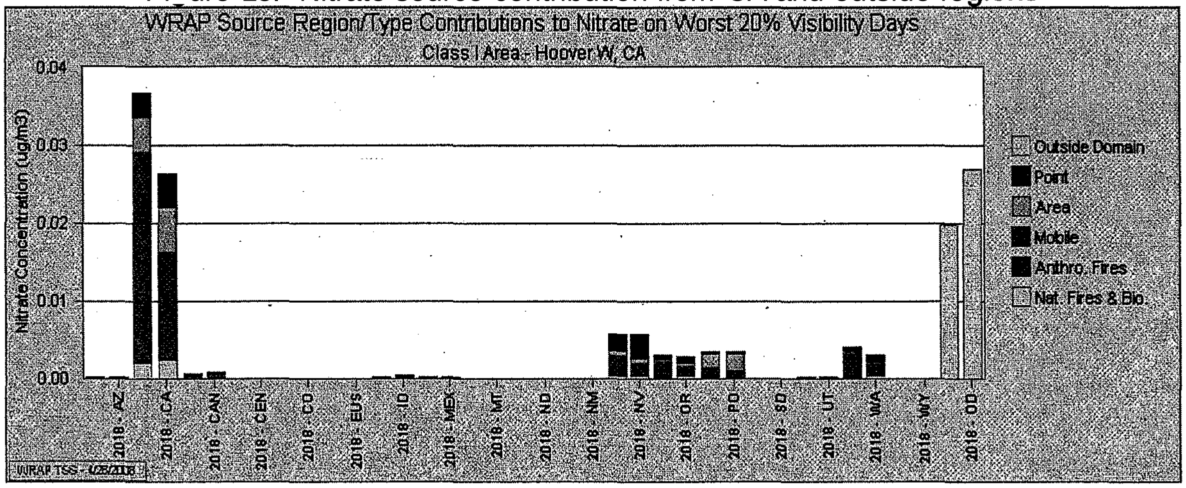



Figure 14. Regional Nitrate contribution to Haze in 2002 and 2018



Fi_ure 15. Nitrate source contribution from CA and outside regions



# YOSE1Monitor

The YOSE1 monitor location represents two wilderness areas located in the central Sierra Nevada Range. The wilderness areas associated with the YOSE1 monitor are Emigrant Wilderness Area and Yosemite National Park. The site has been operating since March 1988. The monitor has sufficient data for the five baseline years of 2000 - 2004.

## Section I. YOSE1 Wilderness Area Descriptions

### *I.a. Emigrant Wilderness Area*

The Emigrant Wilderness Area consists of 113,000 acres on the upper western slope of the central Sierra Nevada Range. It is bordered by Yosemite National Park.on the south. Watersheds drain to the Stanislaus via the south Fork of the Stanislaus in the northern Wilderness,and the Tuolumne River via Cherry Creek in the southern Wilderness. The Stanislaus and Tuolumne Rivers flow southwest and open up into the San Joaquin Valley about 30 miles southwest of the Wilderness boundary. The central San Joaquin Valley area is the nearest major source region for anthropogenic emissions that could affect visibility in the Wilderness. Wilderness elevations range from about 1,524 meters at Cherry Reservoir to 3,527 meters at Leavitt Peak on the Sierra Nevada crest.

**Figure 1. Emigrant Wilderness Area**

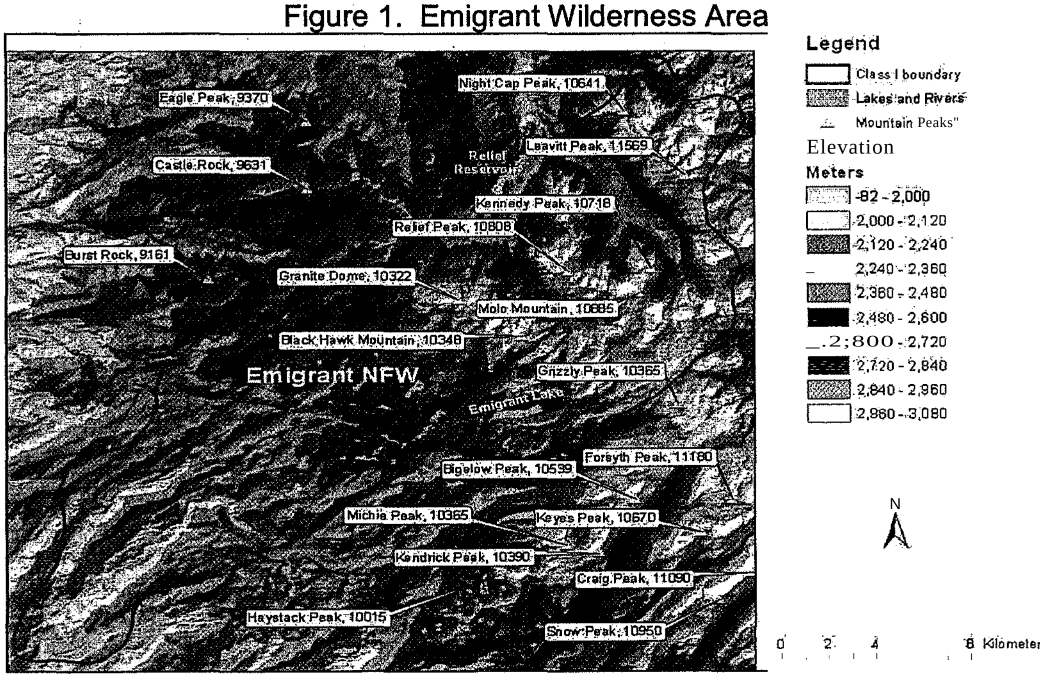
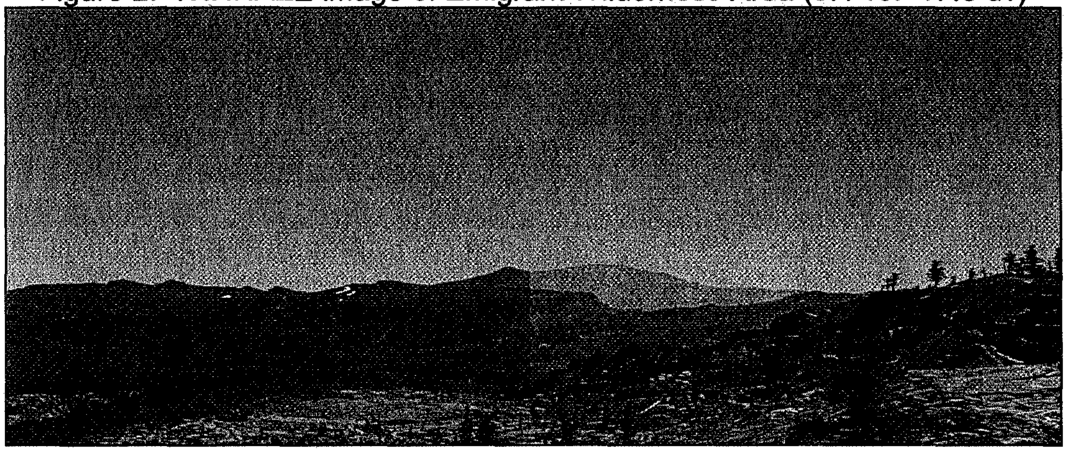


Figure 2. WINHAZE image of Emigrant Wilderness Area (3.4 vs. 17.6 dv)



### I.b. *Yosemite National Park*

Yosemite National Park (Yosemite) consists of approximately 750,000 acres in the central Sierra Nevada range, west of the crest. It includes headwaters of the Tuolumne River in the north, and the Merced River to the south. The Tuolumne and Merced Rivers flow west and open up into the San Joaquin Valley about 20 miles west of the Yosemite boundary. The central San Joaquin Valley is the nearest major source region for anthropogenic emissions that could affect visibility in Yosemite. Park elevations range from about 600 meters where the Tuolumne River exits the Park and 1,000 meters where the Merced River exits the Park, to up to 4,000 meters at the Sierra Nevada crest which forms the Park's eastern boundary. Lowest elevations are 457 meters or more above the San Joaquin Valley floor. The Tuolumne and Merced Rivers form steep canyons, the Grand Canyon of the Tuolumne River and Yosemite Valley, respectively, and are oriented east to west in the heart of Yosemite.

Figure 3. YOSE1 Monitor location

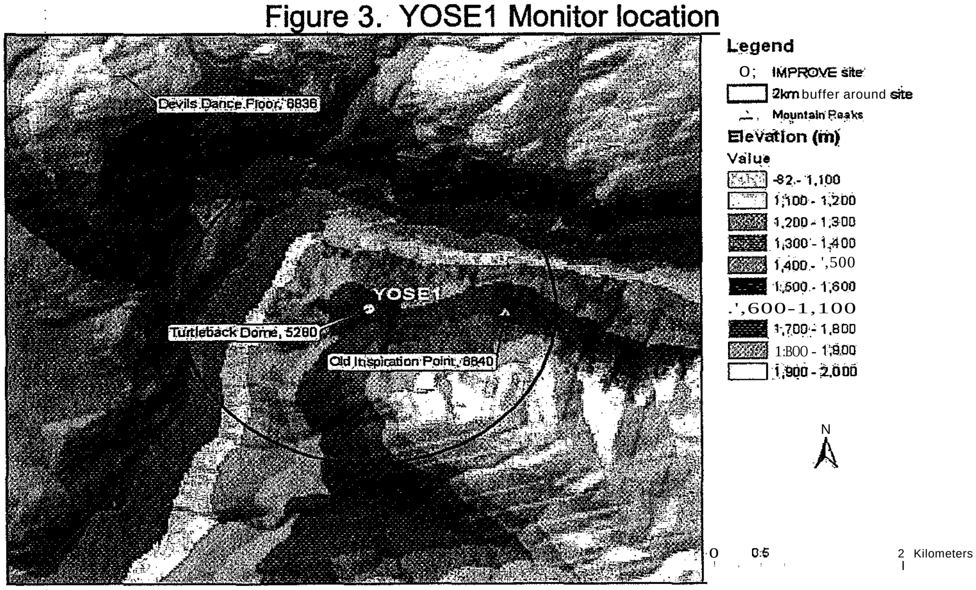
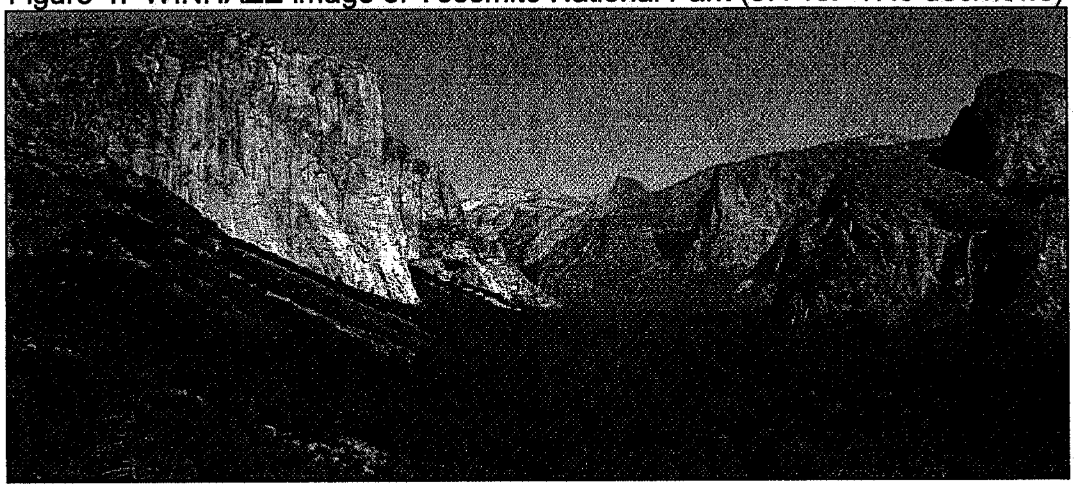
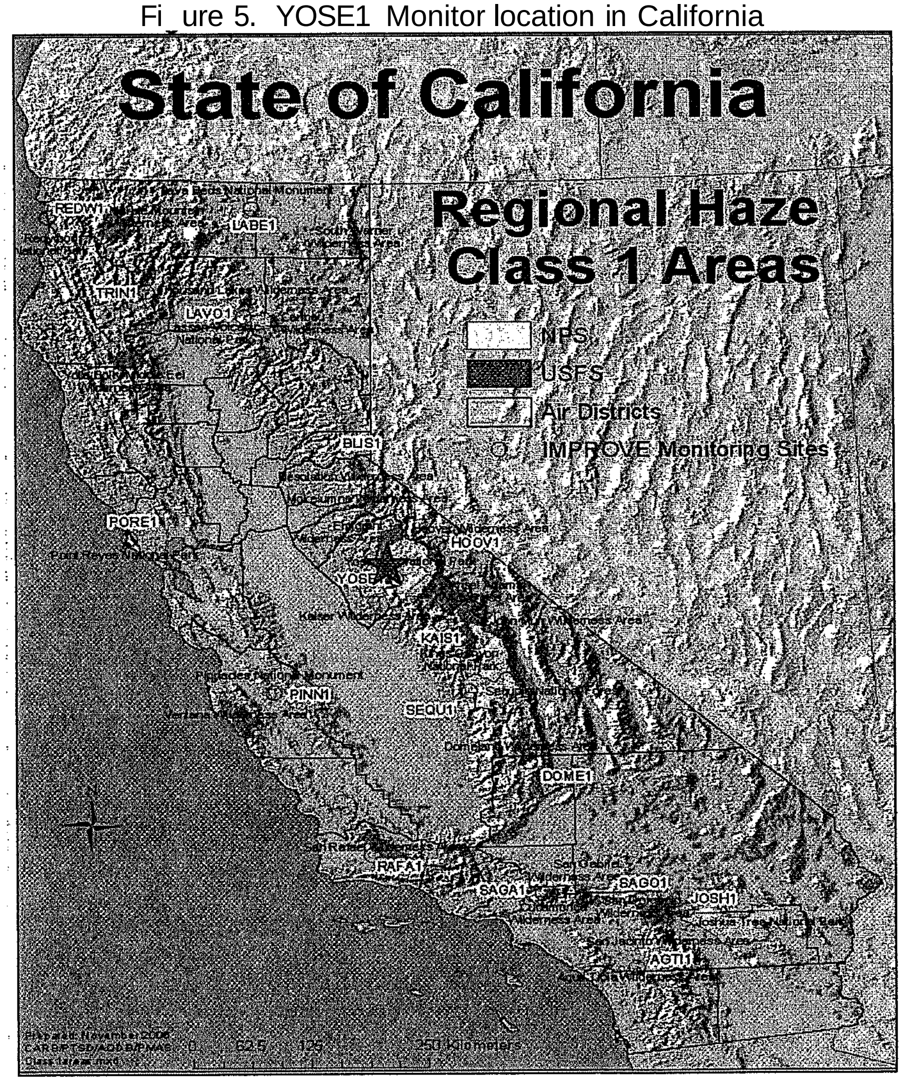


Figure 4. WINHAZE image of Yosemite National Park (3.4 vs. 17.6 deciviews)



Fi_ure 5. YOSE1 Monitor location in California



## Section II. Visibility Conditions:

### *II.a. Emigrant Wilderness Area*

Visibility conditions for the Emigrant Wilderness are currently monitored by the YOSE1 IMPROVE monitor in Yosemite National Park. The monitor is located at 37.7133 north latitude and 119.7061 west longitude near the west end of Yosemite Valley at an elevation of 1,603 meters.

The lowest elevations in Emigrant Wilderness are higher than the lowest Yosemite Park elevations, but are still near the YOSE1 elevation. Data from YOSE1 should be representative of aerosol concentrations and composition in the Merced and Tuolumne River areas of central Yosemite National Park and in the upper Stanislaus *River* area of the Emigrant Wilderness Area, except when the areas are influenced by different local sources such as wild land fires. The nearest major population center and source region for emissions that could contribute to haze in the Emigrant Wilderness and measured at YOSE1 is the San Joaquin Valley, 30 miles west of the western park boundary.

The YOSE110cation is adequate for assessing the 2018 reasonable progress goals for the Emigrant Wilderness Class 1 area.

### *II.b. Yosemite National Park*

Visibility conditions for Yosemite are currently monitored by the YOSE1 IMPROVE monitor. The monitor is located at 37.7133 north latitude and 119.7061 west longitude nearthe west end of Yosemite Valley at an elevation of 1,603 meters.

Data from YOSE1 should be representative of aerosol concentration and composition in the Yosemite Valley and Merced River areas of central Yosemite National Park. It should also be representative of the Tuolumne River area except when the two areas are influenced by different local sources such as wildland fires. YOSE1 is at an elevation of 1,603 meters, 300 to 400 meters above the canyon floor, so there could be times when canyon bottom locations are within a surface inversion that does not extend upward to the monitoring site elevation. The nearest major population center and source region for emissions that could contribute to haze measured at YOSE1 is the San Joaquin Valley, 20 miles west of the western Park boundary to which it is linked by the Tuolumne and Merced River *valleys.*

The YOSE1 location is adequate for assessing the 2018 reasonable progress goals for the Yosemite National Park Class 1 area.

### *II.c. Baseline Visibility*

Baseline visibility is determined from YOSE1 IMPROVE monitoring data fpr the 20% best and the 20% worst days for the years 2000 through 2004. The baseline visibility for the YOSE1 monitor is calculated at 3.4 deciviews for the 20% best days and 17.6

deciviews for the 20% worst days. Figure 6 represents the worst baseline visibility conditions.

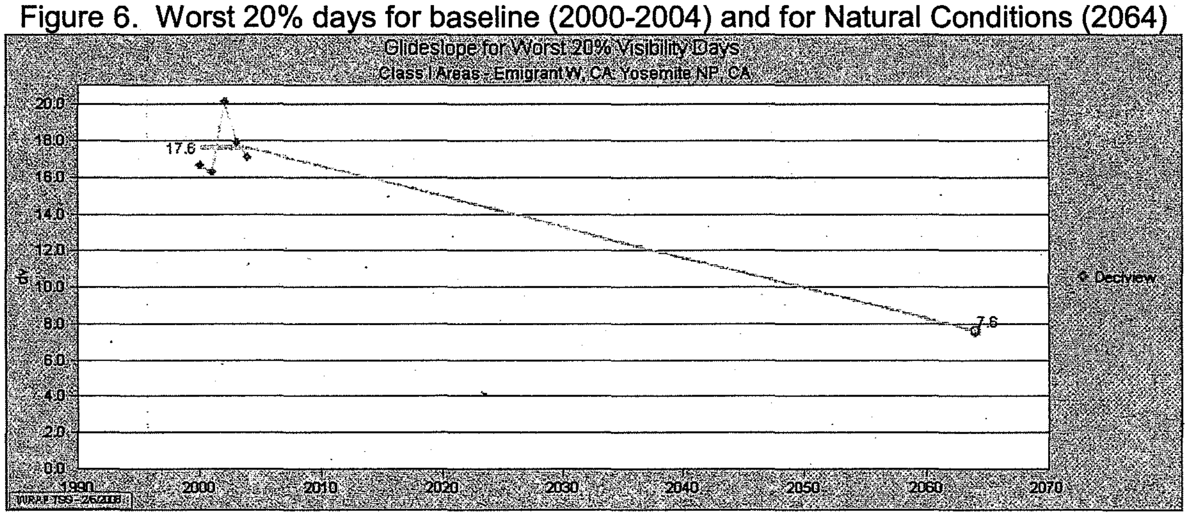
*II.d. Natural Visibility*

Natural visibility represents the visibility condition that would be experienced in the absence of human-caused impairment. Based on EPA guidance, the natural visibility for the VOSE1 monitor is 1.0 deciviews for the 20% best days and 7.6 deciviews for the 20% worst days. It is possible that the Natural Conditions deciview value for 2064 could change in the future as more is learned about natural plant emissions and wildfire impacts.

*II.e. Presumptive Glide Slope and the Uniform Rate of Progress*

Figure 6 also shows the uniform rate of progress, or "glide slope." The glide slope is the rate of reduction in the 20% worst days deciview average that would have to be achieved to reach natural conditions at a uniform pace in the 60 years following the baseline period. The first benchmark along the path towards achieving natural conditions occurs in 2018. The glide slope shows that the 2018 benchmark for the 20% worst days is 15.30 deciviews. According to the Regional Haze Rule, the 20% best' days baseline visibility of 3.4 deciviews must be maintained or improved by 2018, the end of the first planning period.

**Figure 6. Worst 20% days for baseline (2000-2004) and for Natural Conditions (2064)**




*II.f. Species Contribution*

Each pollutant species causes light extinction but its contribution differs on best and worst days. Figure 7 shows the contribution of each species to the 20% best and worst days in the baseline years at VOSE1.

Figure 7. Average Haze species contributions to light extinction in the baseline years

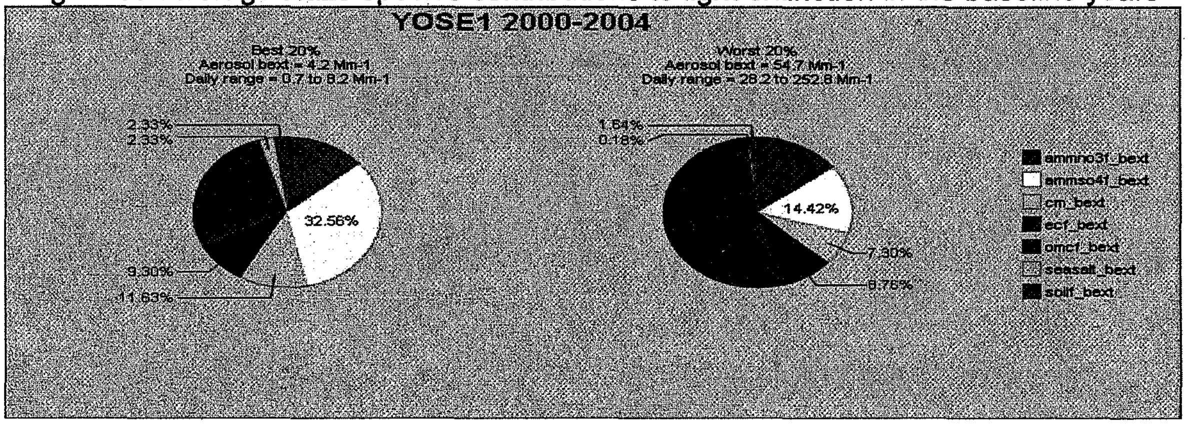
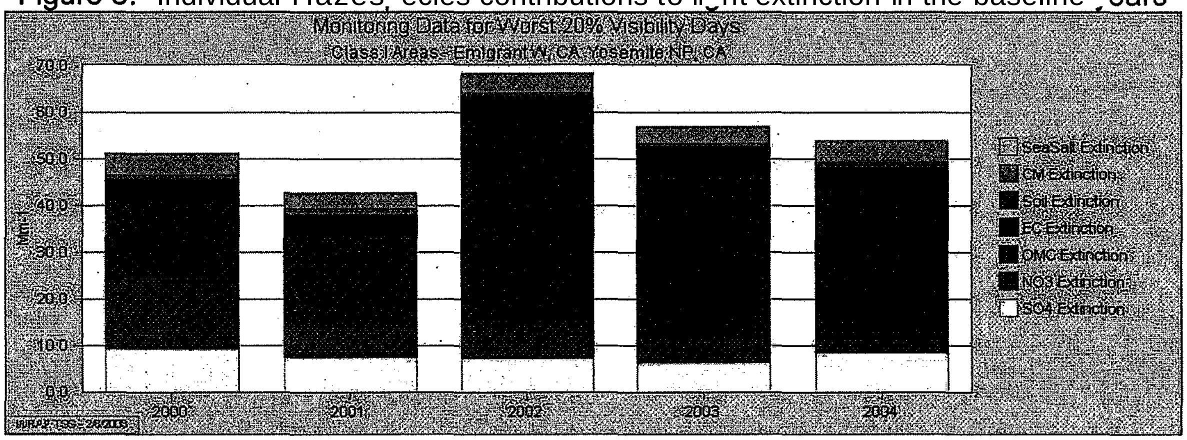



Figure 8. Individual Hazes ecies contributions to li ht extinction in the baseline ears




As shown in Figures 7 and 8, organic matter, nitrates, and sulfates have the strongest contributions to degrading visibility on worst days at the YOSE1 monitor. The worst days are, dominated by organic matter, while the best days are dominated by sulfate. The monitor has sufficient data for the five baseline years of 2000 - 2004.

Figure 9 depicts the individual species contribution to worst days in 2002. Organic matter increases in the fall and winter and nitrates increase in the winter months. SUlfates remain relatively stable throughout the year but do see a slight increase in the summer. Organic matter clearly dominates the other haze species on worst days but nitrates, sulfates; elemental carbon, and coarse mass also contribute to the worst days throughout the year. There are only trace amounts of soil and sea'salt present at this monitor.

Figure 10 illustrates the individual species contribution on worst days in 2000-2004 by monthly average. The trend shown is comparable to Figure 9 for organic matter, nitrates, and sulfates. High organic periods vary from year to year due to the unpredictable occurrence of wild fires.

Figure 9. Species contribution on the 20% worst da_s in 2002

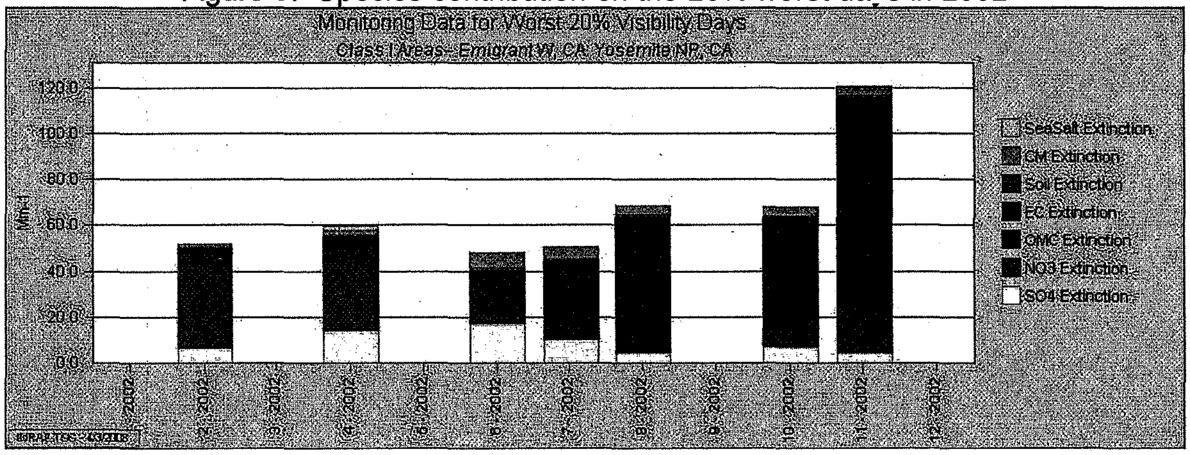
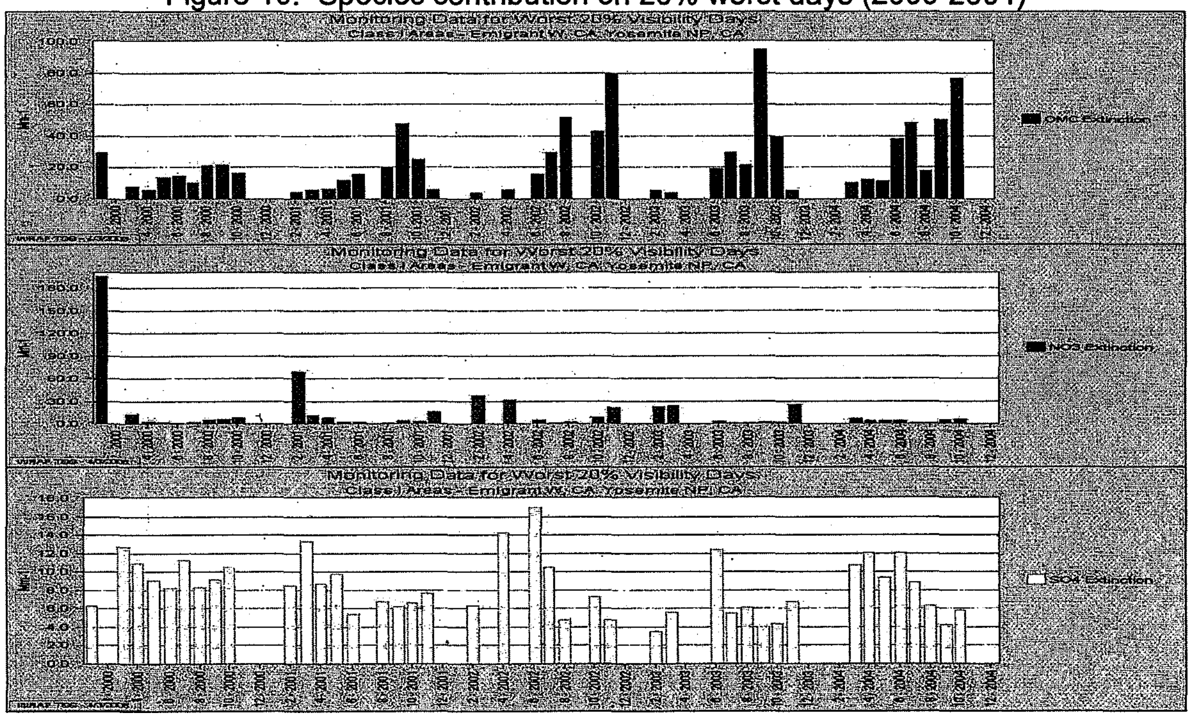



Figure 10. Species contribution on 20% worst days (2000-2004)




*II.g. Sources* of *Haze Species*

Both natural and man-made sources contribute to the calculated deciview levels made "by haze pollutants at YOSE1. Some haze species arise from sources that are within the control of the State of California or neighboring states. Others arise from natural, uncontrollable situations such as wildfires, sea salt or dust storms in natural areas, " whether they are from in-state or out-of-state (and out-af-country) sources. Finally, other uncontrollable, man-made sources are those industrial pollutants and other man-made (anthropogenic) emissions transported from outside the United States.

Figure 11 shows the primary organic carbon source contribution from California and the outside regions. The largest contributor to primary organic carbon at the YOSE1 monitor is from natural fire sources within California. California represents 88% of all natural fire source contributions.

, Figure ,12 illustrates the total organic carbon source apportionment from 2000-2004 for anthropogenic and biogenic sources. The biogenic secondary emissions account for 60% of the total organic carbon. Anthropogenic and biogenic primary source emissions account for 36% of the total organic carbon emissions and anthropogenic secondary is responsible for the remaining emissions.

Figures 13 and 14 represent the regional contributions to nitrates on the 20% worst days. The WRAP region represents the largest contribution to nitrate in 2002 and 2018 (78%), followed by the Outside Domain Region (17%) and emissions from Pacific Offshore (5%). Mobile sources within California contribute the most nitrates at the YOSE1 monitor. In 2002,87% of the nitrate from mobile sources at the YOSE1 monitor can be attributed to California. California mobile source emissions reductions are mainly responsible for improvement in nitrates in 2018.

Figures 15 and 16 represent the regional contributions to sulfate on'the 20% worst days in 2002 and 2018 at the YOSE1 monitor. The Outside Domain region represents 43% of the sl:llfate contributions in 2002 and 2018, followed by the emissions from the WRAP Region (36%) and the Pacific Offshore Region (15%). California contributes 22% of the total sulfate emissions seen at the YOSE1 monitor.

Individually, emissions from outside the modeling domain contribute the most to sulfate concentrations at the YOSE1 monitor. The next largest contributor to sulfate concentration is from area sources in the Pacific Offshore.

**Figure 11.** Organic carbon source contribution from CA and outside regions

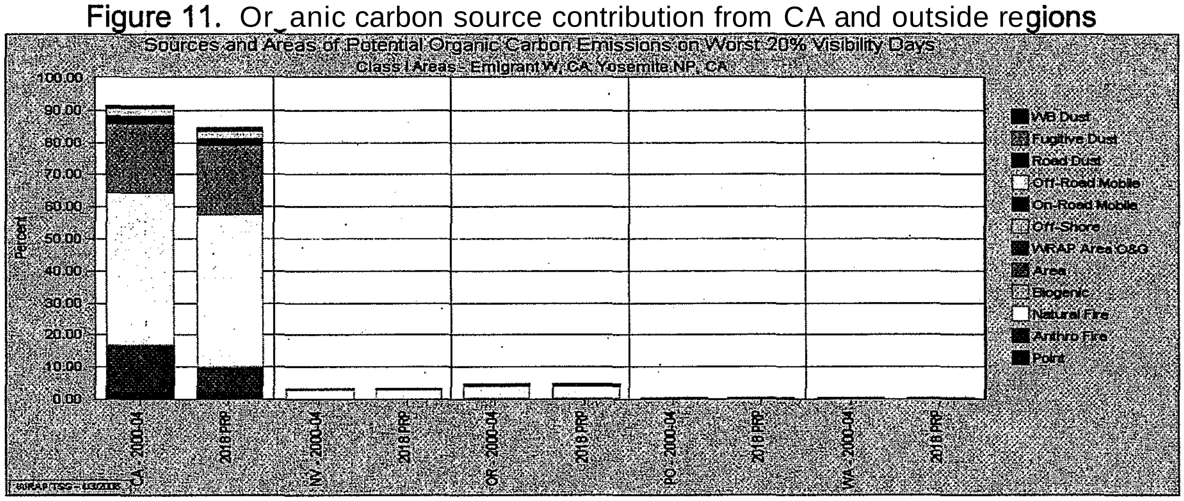


**Figure 12.** Or_anic Carbon Anthro_o_enic and Bio_enicSource **Apportionment**

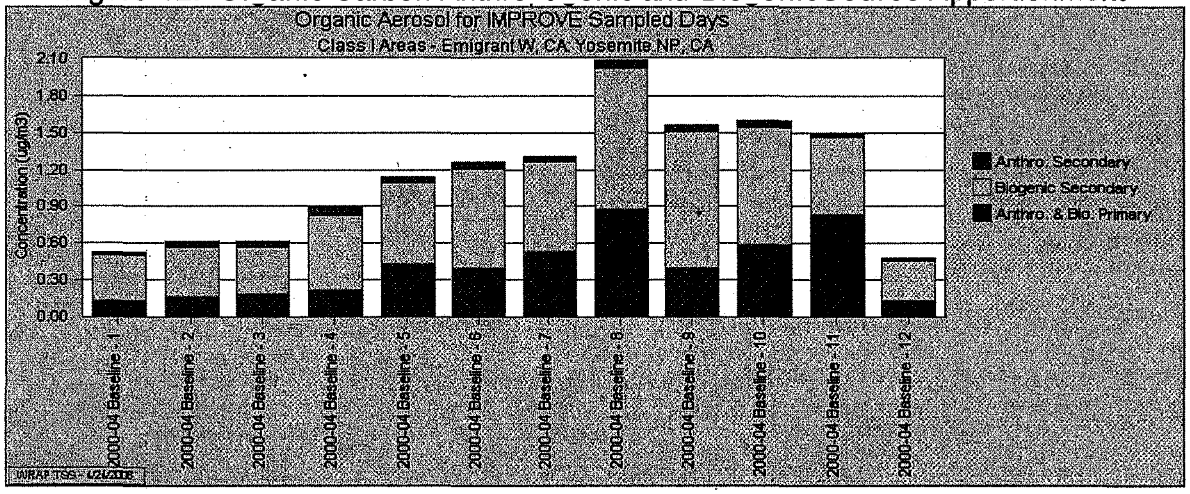



**Figure 13. Regional Nitrate contribution to Haze in 2002 and 2018**

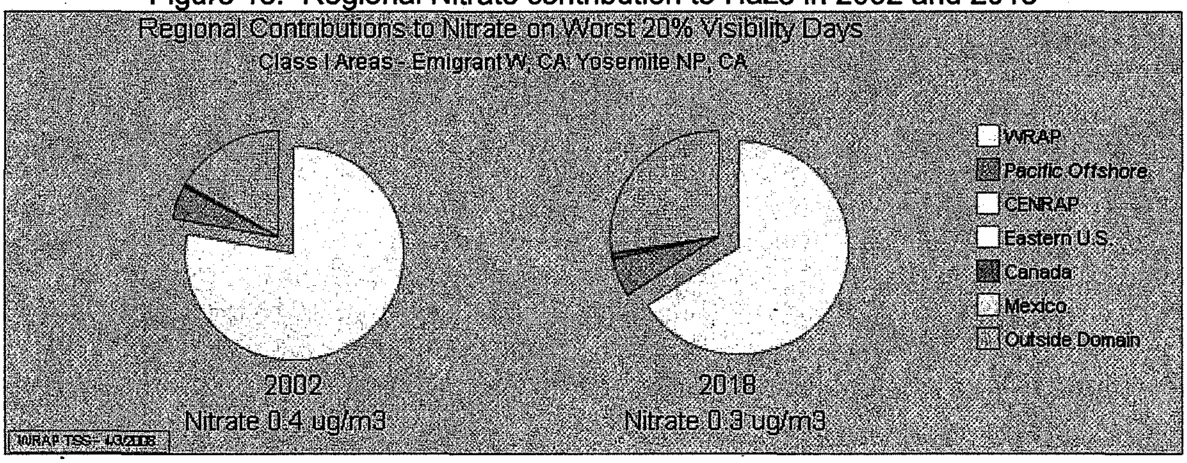



**Figure 14.** Nitrate source contribution from CA and outside re**gions**

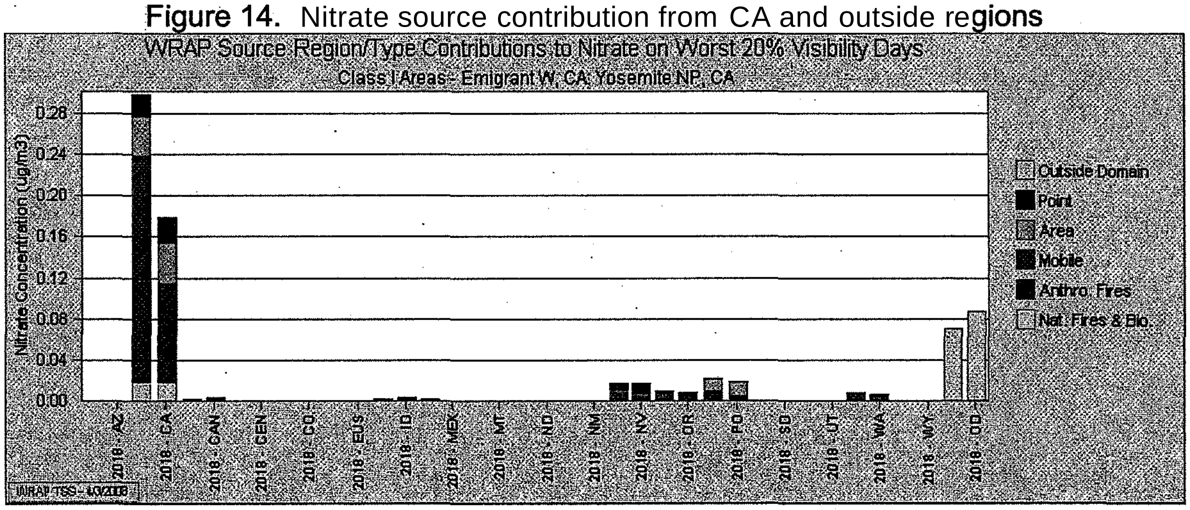
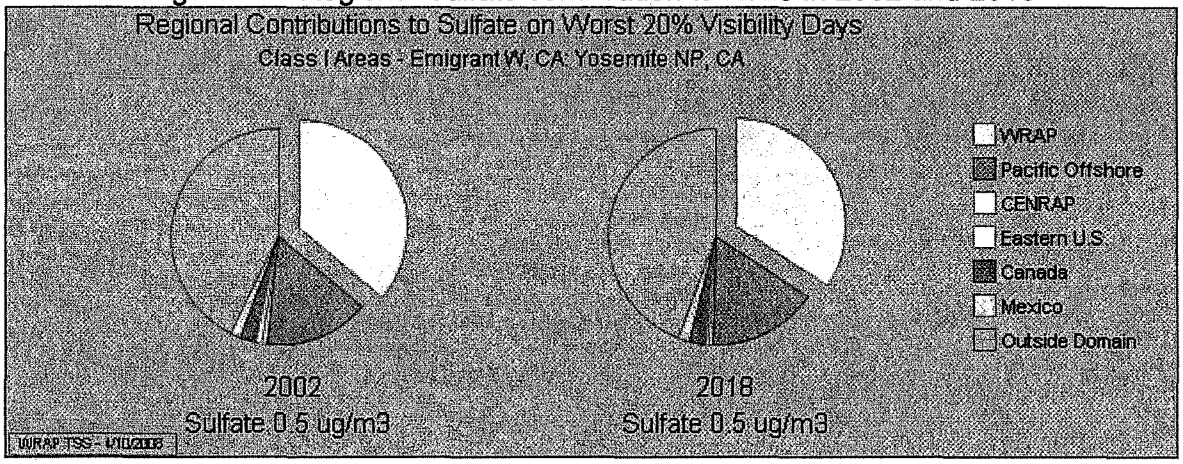
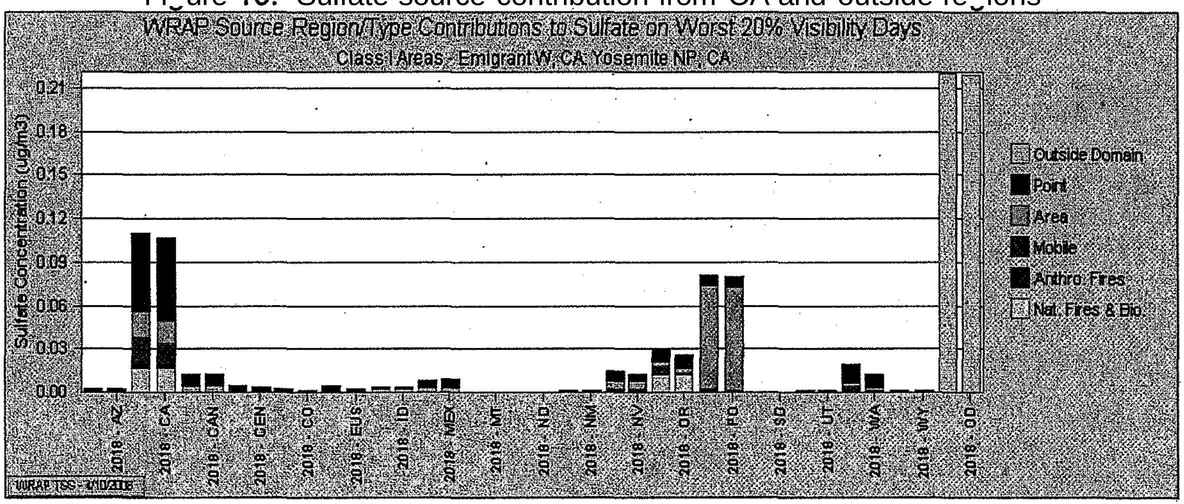


Figure 15. Regional Sulfate contribution to Haze in 2002 and 2018




Fi ure 16. Sulfate source contribution from CA and outside re ions



## KAIS1 Monitor

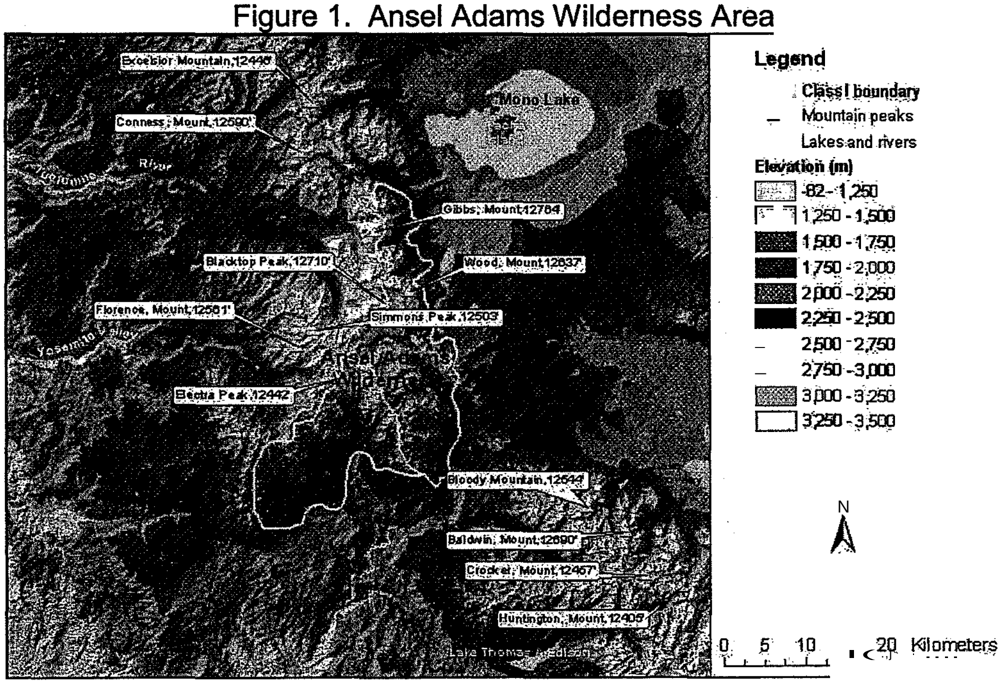
The KAIS1 monitor location represents three wilderness areas within the Sierra Nevada mountain range. The wilderness areas associated with theKAIS1 monitor are Ansel Adams Wilderness area, John Muir Wilderness area, and Kaiser Wilderness area. The KAIS1 site has been in operation since January of 2000. This site does not have sufficient data for the entire baseline period. Data was not available for the years 2000 and 2001.

### Section I.· KAIS1 Wilderness Area Descriptions

#### *I.a. Ansel Adams Wilderness Area*

The Ansel Adams Wilderness Area formerly known as the Minarets Wilderness, is located in both the Sierra and Inyo National Forests and covers approximately 228,500 acres (138,660 acres are in Sierra National Forest). Ansel Adams is characterized by spectacular alpine scenery with barren granite peaks, steep-walled gorges and rock outcroppings. Elevations range from 1,067 meters to 4,010 meters and there are several small glaciers on the north and n.ortheast facing slopes of the highest peaks. There are also a number of fairly large lakes on the eastern slope of the precipitous Ritter Range. The Ansel Adams Wilderness contains the headwaters of the·North and Middle Forks of the San Joaquin River. The San Joaquin River flows south and west from the Wilderness and eventually opens up into the San Joaquin Valley 20 to 25 miles west of the Wilderness and just north of Fresno. This central San Joaquin Valley area is the nearest major source region for anthropogenic emissions that could affect visibility in the Wilderness.

Figure 1. Ansel Adams Wilderness Area

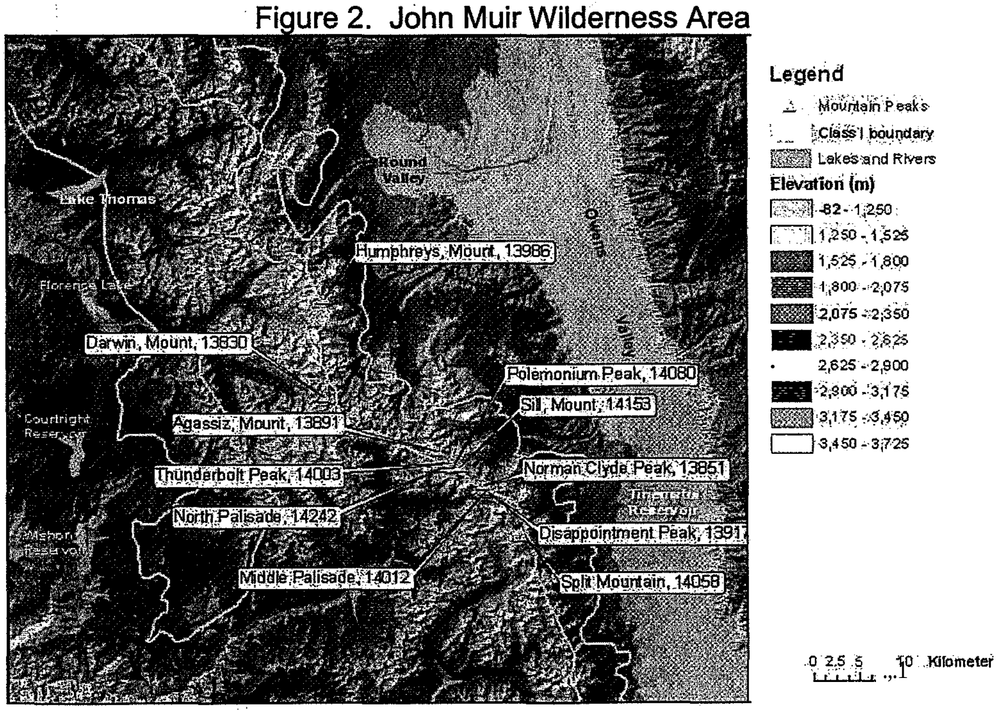


### *I.b. .John **Mufr Wilderness Area***

The John Muir Wilderness Area consists of 581 ,000 acres, and extends for 100 miles along the crest and on both sides of the Sierra Nevada in the Inyo and Sierra National Forests. The wilderness extends from Reds Meadow (near Mammoth Mountain) in the north, to south of Mount Whitney. The wilderness area also spans the Sierra north of Kings Canyon National Park, and extends in the west side of the park down to the Monarch Wilderness.. West of the crest, it includes the headwaters of the South and Middle Forks of the San Joaquin River and the North Fork of the Kings River. The San Joaquin and Kings rivers flow westward into the San Joaquin Valley, about 30 miles west of the western wilderness boundary. The wilderness contains the most spectacular and highest peaks of the Sierra Nevada. The peaks are typically made of granite from the Sierra Nevada batholiths and are dramatically shaped by glacial action. The southernmost glacier in the United States (the Palisades Glacier) is contained with the wilderness area.

Western elevations extend from the Sierra Nevada crest down to·1,219 meters where the South Fork of the San Joaquin River exits the Wilderness. East of the crest, the Wilderness includes eastern slopes of the Sierra Nevada roughly between Mammoth Lakes in the north and Owens Lake in the south, a distance of nearly 100 miles,and elevations between the highest elevation at Mt. Whitney (4,418 meters) and lowest elevations near 1,524 meters on the west side of the Owen Valley. Eastern portions are generally in the rain shadow of the Sierra Nevada. The San Joaquin Valley is the . nearest major source region for emissions that could· affect visibility in Wilderness areas west of the Sierra Nevada crest.

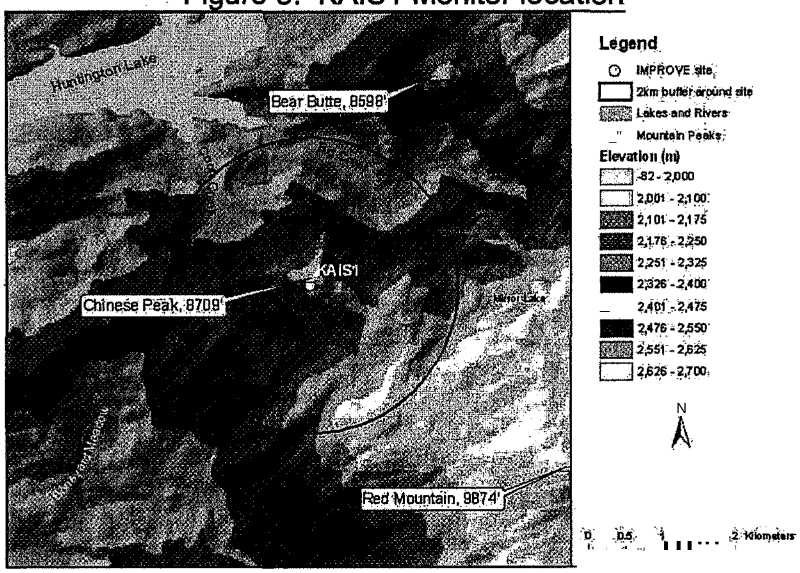
Figure 2. John Muir Wilderness Area



### *I.c. Kaiser Wilderness Area*

The Kaiser Wilderness Area consists of 22,700 acres within the western slopes of the Sierra Nevada's Pacific Crest. It includes Kaiser Ridge, with elevations ranging from about 2,195 meters to 3,146 meters on Kaiser Peak in the center of the Wilderness. On the north side streams flow north into the San Joaquin River, and on the south side into Big Creek which merges with the San-Joaquin River west of the Wilderness. The San Joaquin River flows westward and eventually opens up into the San Joaquin Valley 20 miles west of the Wilderness and just north of Fresno. The central San joaquin Valley is the nearest major source region for emissions that could affect visibility within the, Wilderness.

Figure 3. KAIS1 Monitor location




Fi ure 4. Looking west from the Kaiser monitoring site

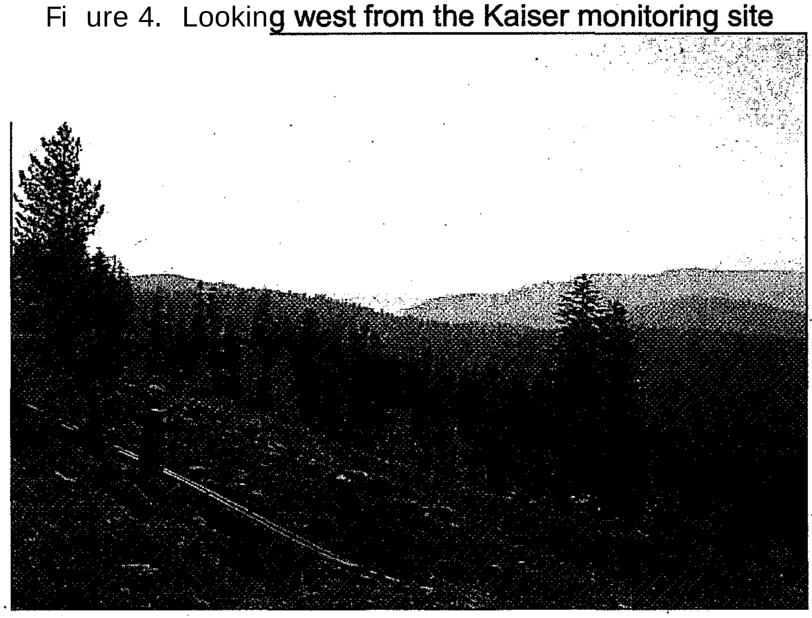
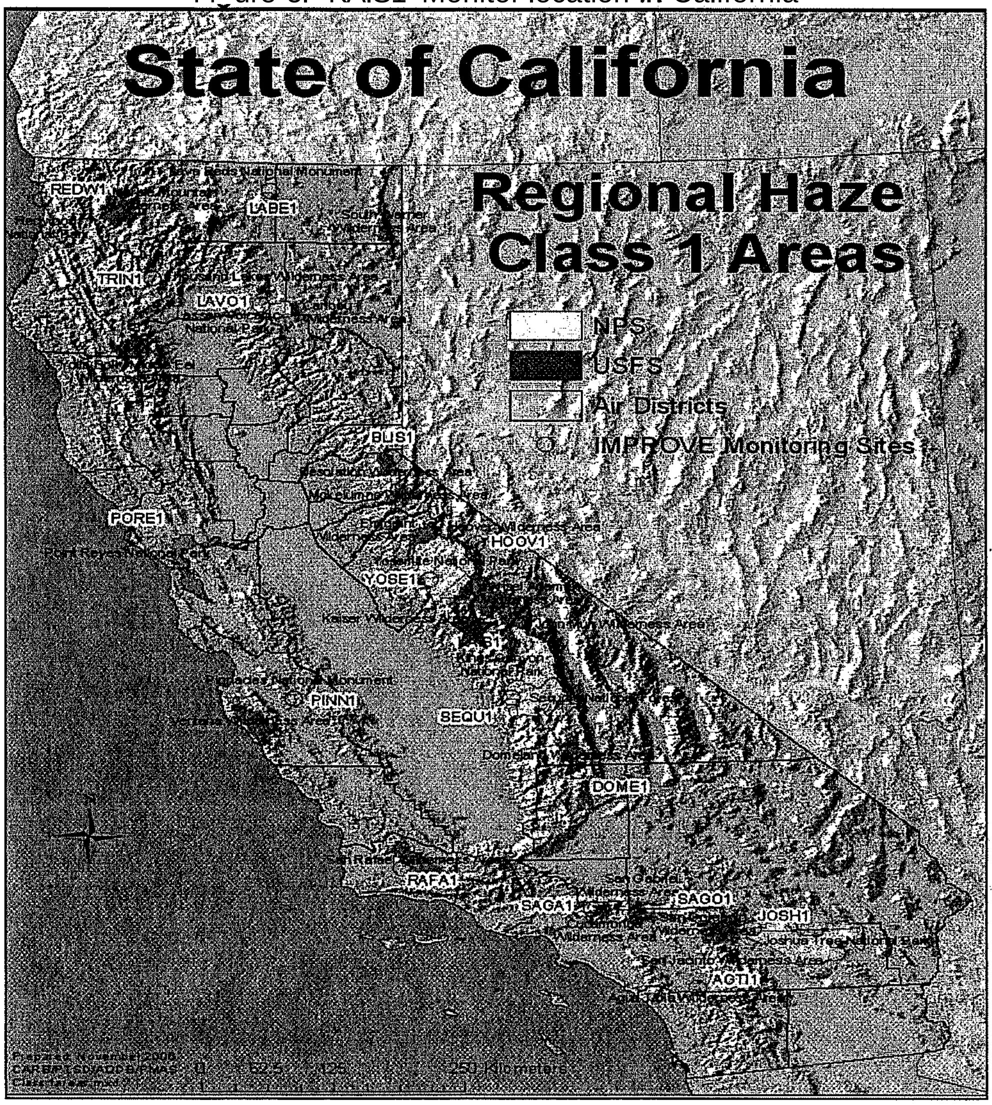


Figure 5. KAIS1 Monitor location in California




Section II.! Visibility Conditions:

*II.a. Ansel Adams Wilderness Area*

Visibility conditions for Ansel Adams Wilderness area are currently monitored by the KAIS1 IMPROVE monitor located in the Kaiser Wilderness Area. The monitor is located at 37.22 north latitude and 119.1546·west longitude, 79 meters below the crest of Chinese Peak across Huntington Lake and the Big Creek drainage to the south. The KAIS1 monitor is at an elevation of 2,598 meters, about 10 miles south of the southernmost boundary of Ansel Adams Wilderness Area. Data from KAIS1 should be representative of aerosol concentration and composition in Ansel Adams Wilderness Area.

The Ansel Adams Wilderness Area and vicinity are drained by,the San Joaquin River, which flows into the San Joaquin Valley, the nearest source region. The San Joaquin River channel opens up into the San Joaquin Valley 20 to 25 miles to the southwest, where the primary population center is Fresno.

The KAIS1 location is adequate for assessing the 2018 reasonable progress goals for the Ansel Adams, John Muir, and Kaiser Wilderness Class I areas.

### *II.b. John 'Muir Wilderness Area*

Visibility conditions for the John Muir Wilderness Area are currently monitored by the KAIS1 IMPROVE monitor in the Kaiser Wilderness Area. The monitor is located at 37.2207 north latitude and 119.1546 west longitude, 79 meters below the crest of Chinese Peak at an elevation of 2,598 meters, about 3 miles west of the western boundary of the John Muir Wilderness Area. The KAIS1 site is in a well exposed location with an unobstructed vista into the South Fork of the San Joaquin River headwaters. Data from KAIS1 should thus be representative of aerosol concentrations and composition in western portions of the John Muir Wilderness except at valley and canyon bottom locations during valley inversion conditions. KAIS1 is much less representative of John Muir Wilderness locations east of the Sierra Nevada crest, which are probably more susceptible to local emissions in the Owen Valley area, notably from Owens Dry Lake near the southern Wilderness boundary and a major source of windblown alkaii dust.

The western John Muir Wilderness Area and vicinity are drained by the San Joaquin River, which flows into the San Joaquin Valley, the nearest source region. The San' Joaquin River channel opens up into the San Joaquin Valley 20 to 25 miles to the southwest, where the primary population center is Fresno. The eastern John Muir Wilderness, on the eastern slopes of the Sierra Nevada, comprised much of the west side of the Owens Valley, the nearest local source region for emissions that could affect visibility west of the Sierra Nevada crest. Owens Valley includes Owens Lake, a major source of windblown dust.

TheKAIS1 location is adequate for assessing the 2018 reasonable progress goals for the John Muir Wilderness Class 1 area.

### *II.c. Kaiser Wilderness Area*

Visibility conditions for Kaiser are currently monitored by the KAIS1 IMPROVE monitor. The monitor is located at 37.2207 north latitude and 119'.1546 west longitude, 79 meters below the crest of Chinese Peak across Huntington'Lake and the Big Creek drainage to the south. KAIS1 is well exposed, with an unobstructed vista into Kaiser Wilderness from a distance of 3 to 6 miles. The elevation at KAIS1 is 2598 meters.

Data from KAIS1 should be very representative of aerosol concentrations and composition in the Kaiser Wilderness Area. The Kaiser Wilderness Area and vicinity are drained by the San Joaquin River, which flows into the San Joaquin Valley, the nearest source region. The San Joaquin River channel opens up into the San Joaquin Valley 15 to 20 miles to the Southwest, where the primary population center is Fresno. Potential local transport routes into the Kaiser Wilderness area include San Joaquin Valley emissions transported directly via diurnal upslope/down slope flow, or trapped under a persistent inversion. The most likely season for transport of San Joaquin emissions into the Kaiser Wilderness is summer. Springtime transport may be associated with agricultural and forest prescribed burning in San Joaquin Valley and National Forest lands. Autumn transport is less frequent because of a persistent San Joaquin Valley inversion that confines emissions to lower elevations.

The KAIS1 location is adequate for assessing the 2018 reasonable progress goals for the Kaiser Wilderness Class 1 area.

### *II.d. Baseline Visibility'*

Baseline visibility is determined from KAIS1 IMPROVE monitoring data for the 20% best and the 20% worst days for the years 2000 through 2004. The baseline visibility for the KAIS1 wilderness areas is calculated at 2.3 deciviews for the 20% best days and 15.5 deciviews for the 20% worst days. Figure 6 represents the worst baseline visibility conditions.

### *II.e. Natural Visibility*

Natural visibility represents the visibility condition that would be experienced in the absence of human-caused impairment. Based on EPA gUidance, the natural visibility for the KAIS1 wilderness areas is 0.04 deciviews for the 20% best days and 7.1 deciviews for the 20% worst days. It is possible that the Natural Conditions deciview value for 2064 could change in the future as more is learned about natural plant emissions and wildfire impacts.

### *II.f. Presumptive Glide Slope and the Uniform Rate of Progress*

Figure 6 also shows the uniform rate of progress, or "glide slope." The glide slope is the rate of reduction in the 20% worst days deciview average that would have to be achieved to reach natural conditions at a uniform pace in the 60 years following the baseline period. The first benchmark along the path towards achieving natural conditions occurs in 2018. The glide slope shows that the 2018 benchmark for the 20% worst days is 13.57 deciviews. According to the Regional Haze Rule, the 20% best days baseline visibility of 2.3 deciviews must be maintained or improved by 2018, the end of the first planning period.

Figure 6. Worst 20% days for baseline (2000-2004) and for Natural Conditions (2064)

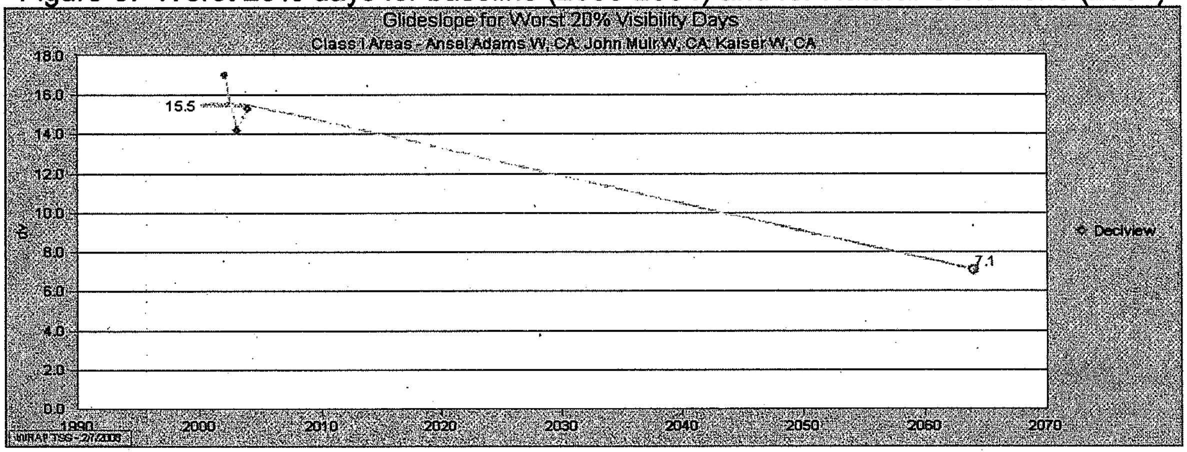
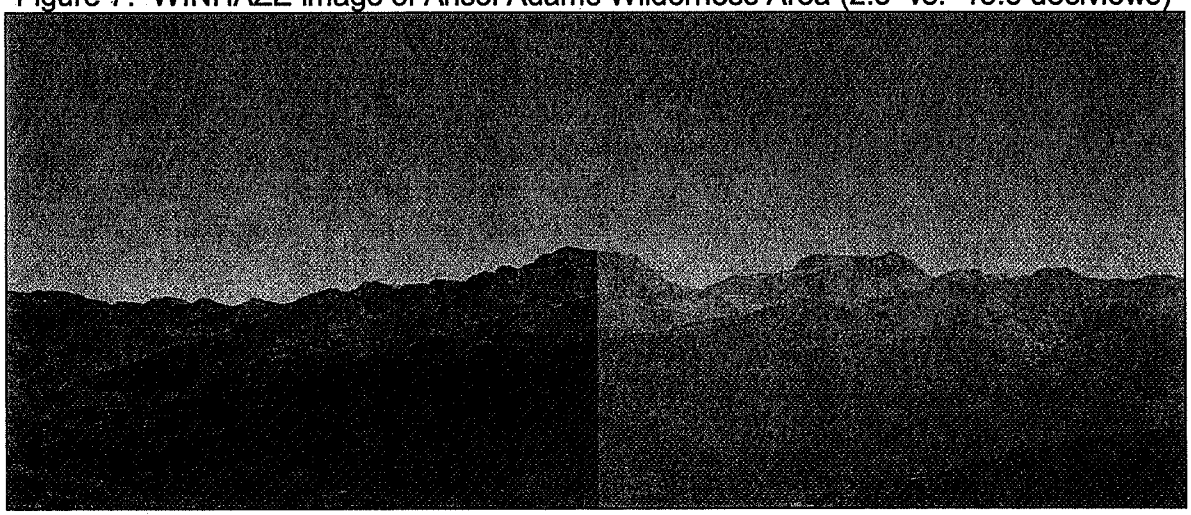



Figure 7. WINHAZE image of Ansel Adams Wilderness Area (2.3 vs. 15.5 deciviews)



### *II.g.* ***Species Contribution***

Each pollutant species causes light extinction but its contribution differs on best and worst days. Figure 8 shows the contribution of each species to the 20% best and worst days in the baseline years at KAIS1.

**Figure 8. Average haze species contributions to light extinction in the baseline years**

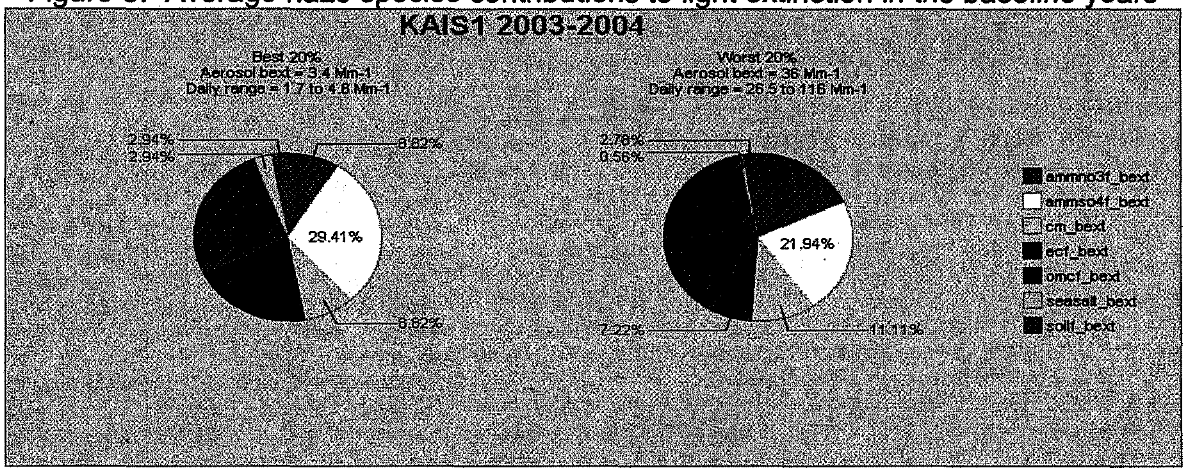
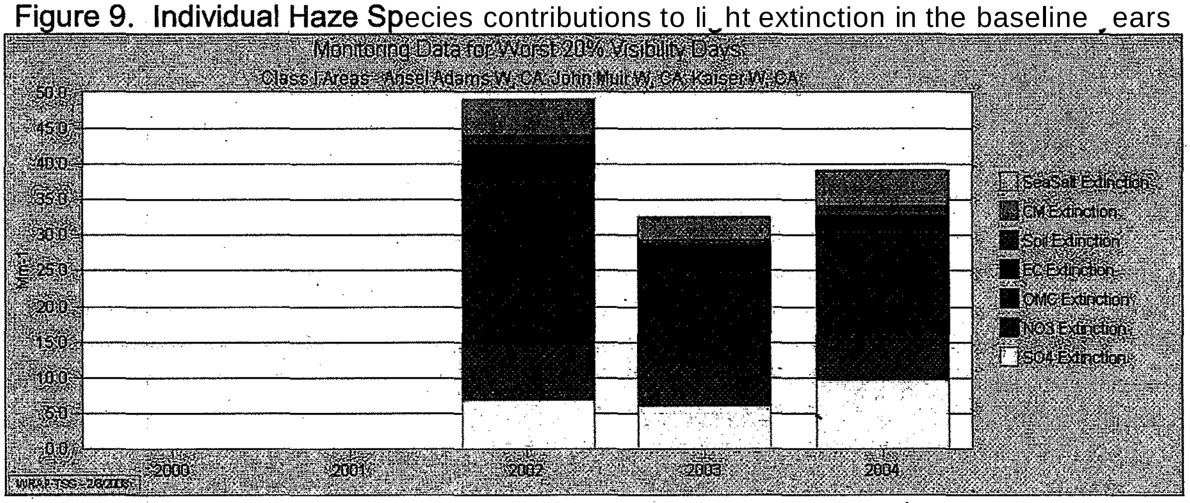



**Figure 9. Individual Haze Species contributions to light extinction in the baseline years**




As shown in Figures 8 and 9, organic matter, sulfates, and nitrates have the strongest contributions to degrading visibility on the worst days at the KAIS1 monitor. The worst days are dominated by organic matter, while the best days are dominated by sulfate. Data points for 2000 and 2001 were insufficient for calculating. best and worst days per the Regional Haze Rule Guidance.

Figure 10 depicts the individual species contribution to worst days in 2002. Nitrates increase in the winter and early spring while sulfates increase slightly in the summer months. Organic matter remains high throughout the summer. Organic matter clearly dominates the other haze species on worst days, but nitrates, sulfates, coarse mass and elemental carbon also contribute to the worst days in the summer. There are only trace amounts of sea salt seen throUghout the year.

Figure 11 illustrates the individual species contribution on worst days in 2000-2004 by monthly average. The trend shown is comparable to Figure 10 for organic matter, nitrates, and sulfates. High organic periods vary from year to year due to the unpredictable occurrence of wild fires. The spike in late" July of 2002 can be attributed to smoke transported into the Central Valley of California from the Biscuit Fire which burned almost 500,000 acres in the Siskiyou National Forest in southwestern Oregon and the SIx Rivers National Forest in northwestern California. The spike in organic carbon for the months of August and September of 2002 can be attributed to the MoNally fire which burned 150,670 acres In the Sequoia National Forest.

**Figure 10. Species contribution on the 20% worst days in 2002**

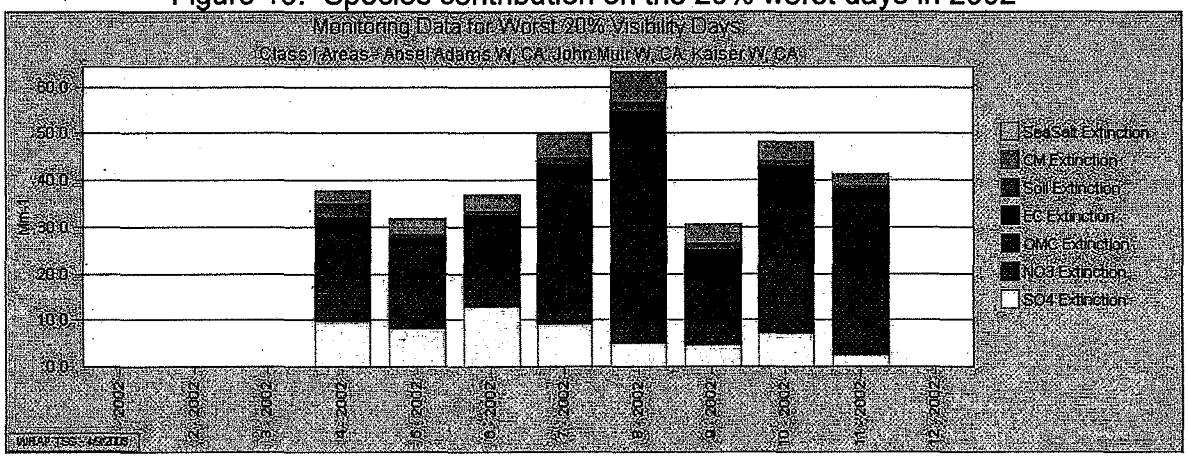
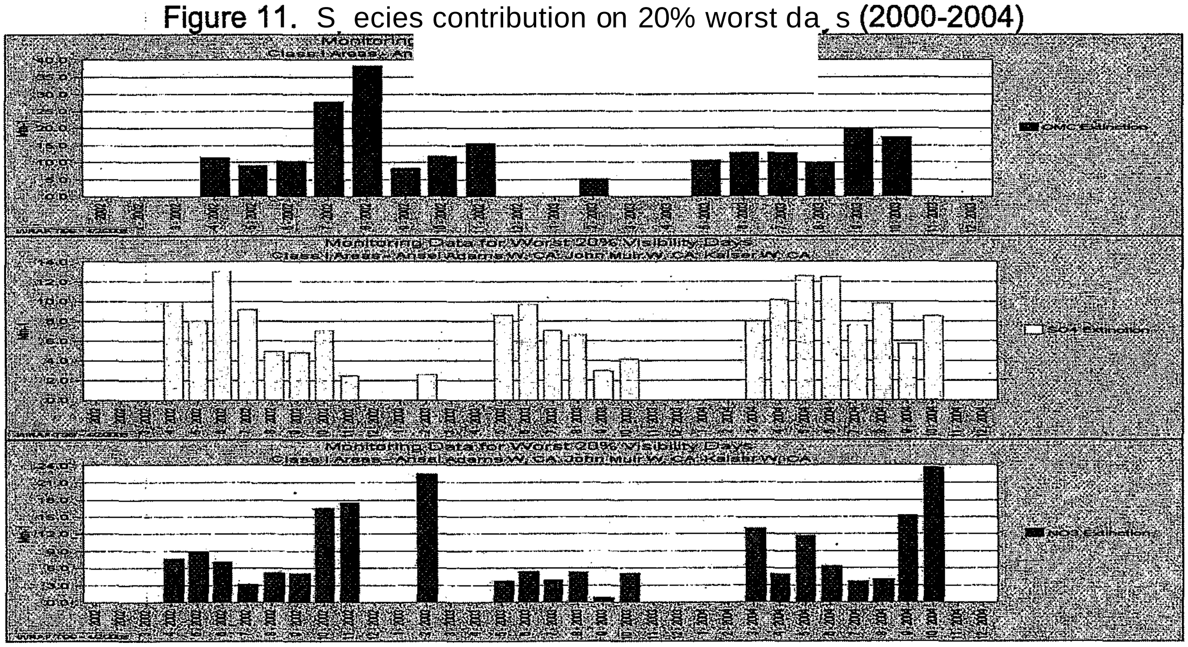



**Figure 11.** Species contribution on 20% worst days **(2000-2004)**



### II.g. *Sources of Haze Species*

Both natural and man-made sources contribute to the calculated deciview levels made by haze pollutants at KAIS1. Some haze species arise from sources that are within the control of the State of California or neighboring states. Others arise from natural, uncontrollable situations sLich as wildfires, sea salt or dust storms in natural areas, . whether they are from in-state or out-of-state (and out-of-country) sources. Finally, other uncontrollable, man-made sources are those industrial pollutants and other man-made (anthropogenic) emissions transported from outside the United States.

Figure 12 shows the primary organic carbon source contribution from California and the outside regions. The largest contributor to primary organic carbon at the KAIS1 monitor is from natural fire sources within Califomia. California represents 86% of all natural fire source contributions.

Figure 13 illustrates the total organic carbon source apportionment from 2000-2004 for anthropogenic and biogenic sources. The biogenic secondary emissions account for 73% of the total organic carbon. Anthropogenic and biogenic primary source emissions account for 24% of the total organic carbon emissions and anthropogenic secondary is responsible for the remaining emissions.

Figures 14 and 15 represent the regional contributions to sulfate on the 20% worst days in 2002 and 2018. at KAIS1. The Outside Domain region represents 45% of the sulfate. contributions in 2002 and 2018, followed by the emissions from the WRAP Region (35%) and the Pacific Offshore Region (15%). California contributes 19% of the total sulfate emissions seen at the KAIS1 monitor.

Individually, emissions from outside the modeling domain contribute the most to sulfate concentrations at the KAIS1 monitor. The next largest contributor to sulfate. concentrations is from area sources in the Pacific Offshore Region.

Figures 16 and 17 represent the regional contributions to nitrates on the 20% worst days. The WRAP region represents the largest contribution to nitrate in 2002 and 2018 (74%), followed by the Outside Domain Region (20%) and emissions from Pacific Offshore (6%). Mobile sources within California contribute the most nitrate at the KAIS1 monitor. In 2002, 63% of the nitrate at the KAIS1 monitor can be attributed to California.

From the WRAP Region, California is shown to contribute the most to nitrate concentrations at the KAIS1 monitor in 2002 and 2018. Currently, California mobile sources are 73% of California contributions to nitrate at the KAIS1 monitor. California mobile source emissions reductions are mainly responsible for improvement in nitrates in 2018.

Figure 12. Or_anic carbon source contribution from CA and outside regions

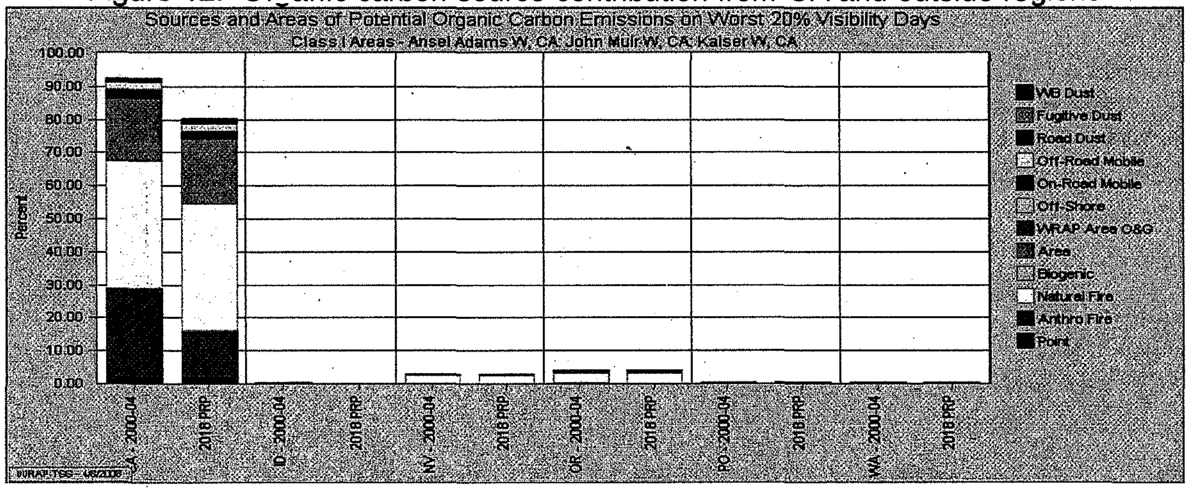



Figure 13. Organic carbon Anthropogenic and Biogenic Source Apportionment

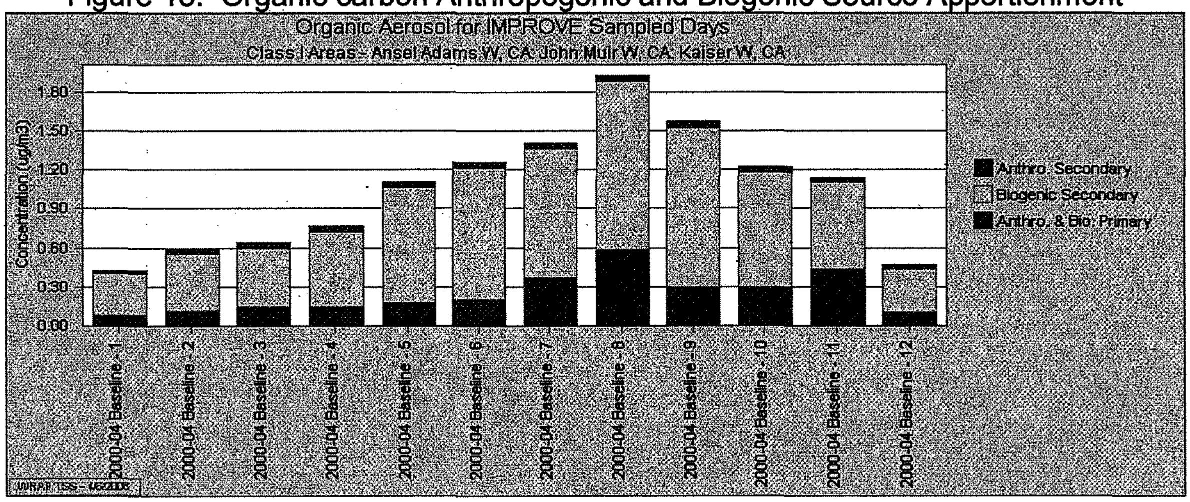



Figure 14. Regional Sulfate Contribution to Haze in 2002 and 2018

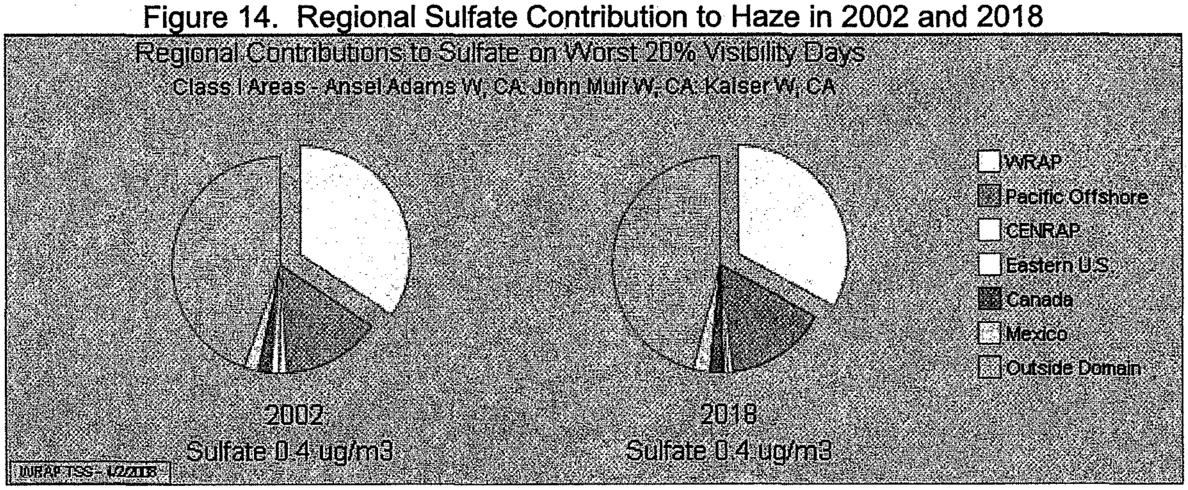


Figure 15. Sulfate source contribution from CA and outside regions

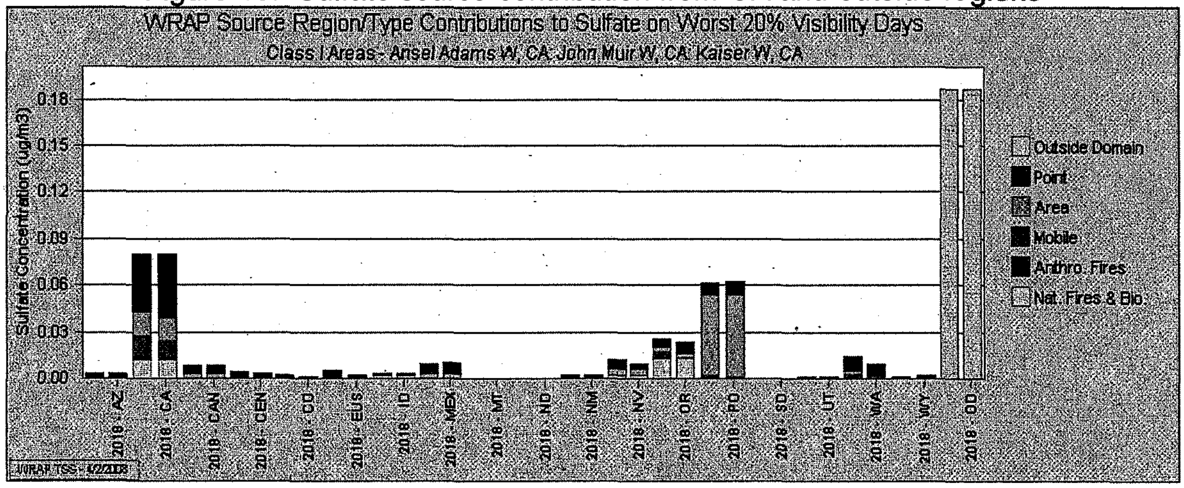



Figure 16. Regional Nitrate Contribution to Haze in 2002 and 2018

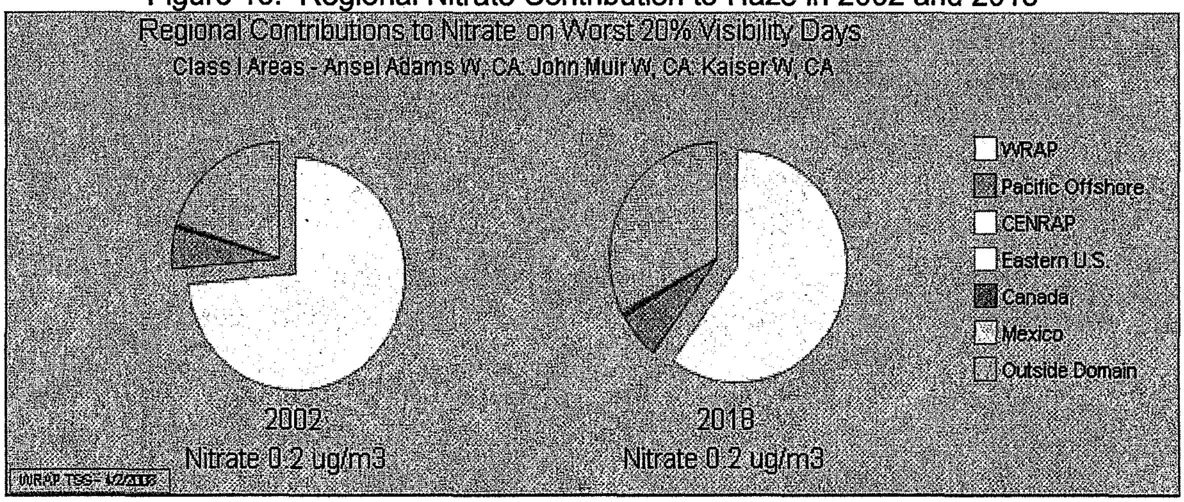
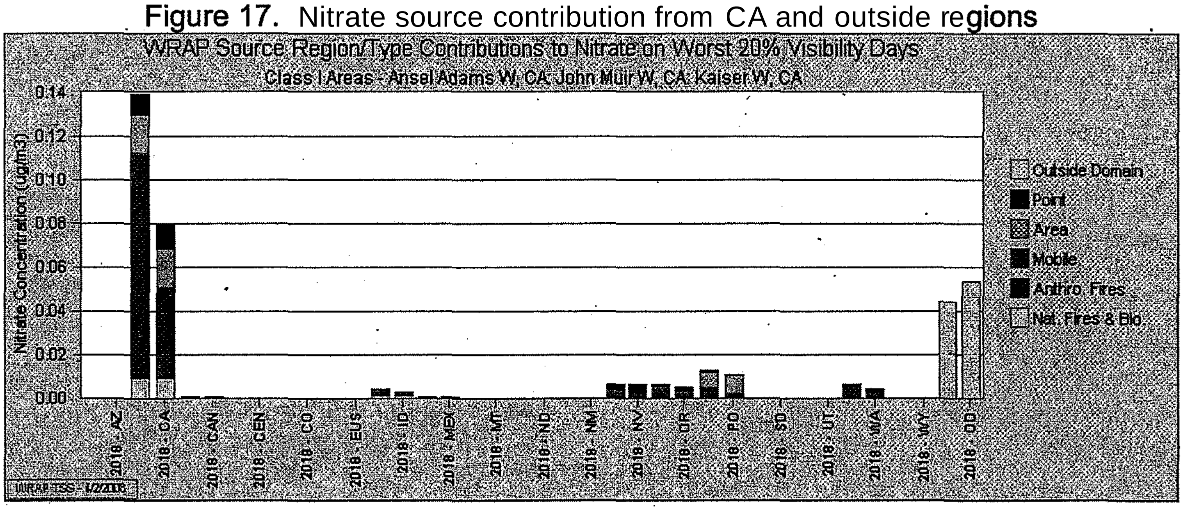



Figure 17. Nitrate source contribution from CA and outside regions



## SEQU1 Monitor

The SEQU1 monitor location represents two wilderness areas located in the Southern Sierra Nevada Mountain Range. The wilderness areas associated with the SEQU1 monitor are Kings Canyon and Sequoia National Parks. Although data on haze pollutants has only been collected since 1997, the site has been operating since March 1992. This site has sufficient data for the five baseline years of 2000 - 2004.

### Section I. SEQU1 National Park Descriptions

#### *.I.a. Kings Canyon National Park*

Kings Canyon National Park consists of 459,994 acres of the western slopes of the southern Sierra Nevada range. Sequoia and Kings Canyon National Parks share a long boundary and are managed as one park, with Kings Canyon NP to the north of Sequoia NP. Kings Canyon National Park elevations range from around 1,219 meters where westward flowing streams exit the Park on the west side, to over 3,962 meters along the Sierra Nevada crest that forms the eastern boundary and culminates at the peak of Mt. Whitney at the Sequoia NP boundary. Essential topographic features of Kings Canyon include the Middle and South Forks of the Kings River that flow from the Sierra Nevada crest and merge 6 miles west of the National Park boundary, ultimately flowing into Pine Flat Reservoir and opening up into the San Joaquin Valley 25 miles east of Fresno. The Middle Fork of Kings River flows through the steep and narrow Kings Canyon, near 762 meters deep and 1 to 2 miles wide at the rim. Lowest elevations atthe western boundary where the tow Forks of the Kings River exit the National Park are, near 1,219 meters. San Joaquin Valley is the source of most local emissions that affect visibility within the Park.

Figure 1. Kings Canyon National Park

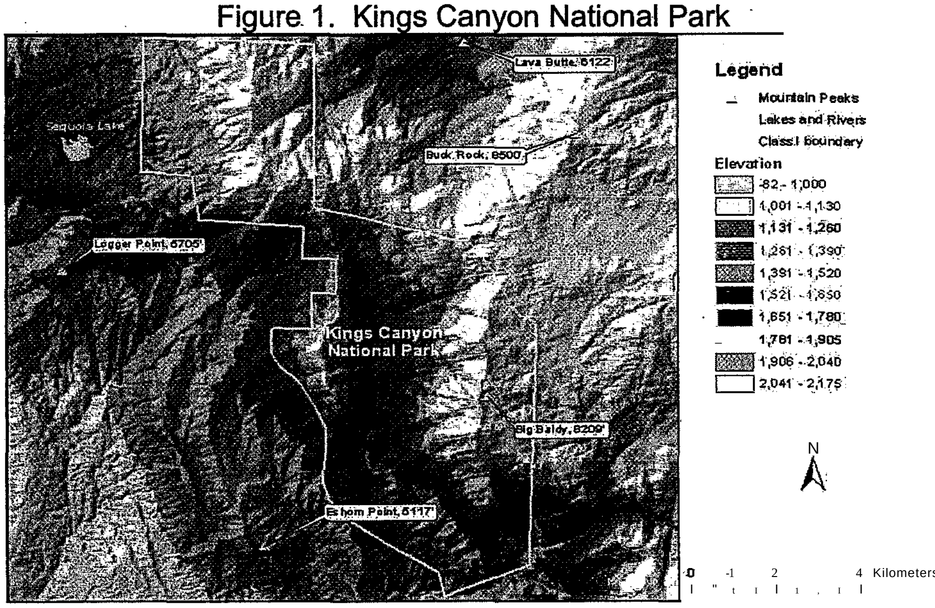
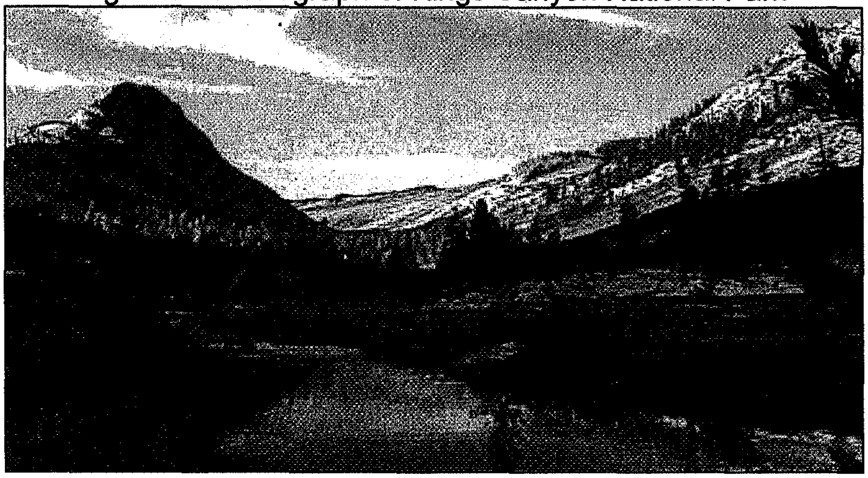


Figure 2. Photograph of Kings Canyon National Park



*I.b. Sequoia National Park*

Sequoia National Park (Sequoia) consists of 386,642 acres of the western slopes of the southern Sierra Nevada range. Sequoia and Kings Canyon National Parks share a long boundary and are managed as one park, with Kings Canyon National Park (Kings Canyon) to the north of Sequoia. Elevations range from around 457 meters where westward flowing streams exit the Park on the west side, to over 3,962 meters along the Sierra Nevada crest that forms the eastern boundary and culminates at the peak of Mt. Whitney, at an elevation of 4,417 meters. Essential topographic features include the North, Midd.le and East Forks of the Kaweah River that flow out of the Park on the west side and the Kern River that flows southward out of the eastern Park area. These drainages connect the Park with central and southern portions of the San Joaquin Valley, the source for most local emissions that affect visibility within the Park.

Figure 3. SEQU1 Monitor location

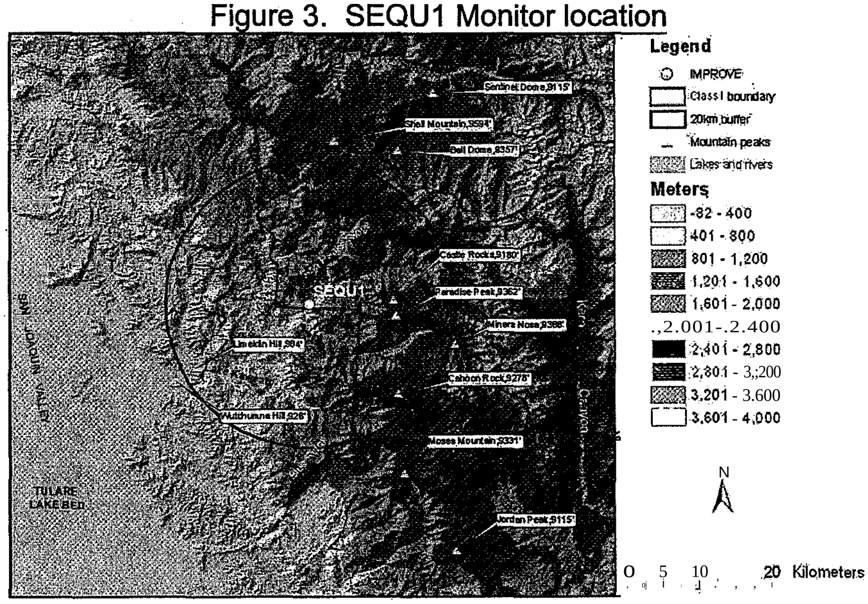


Figure 4. Photograph of Sequoia National Park

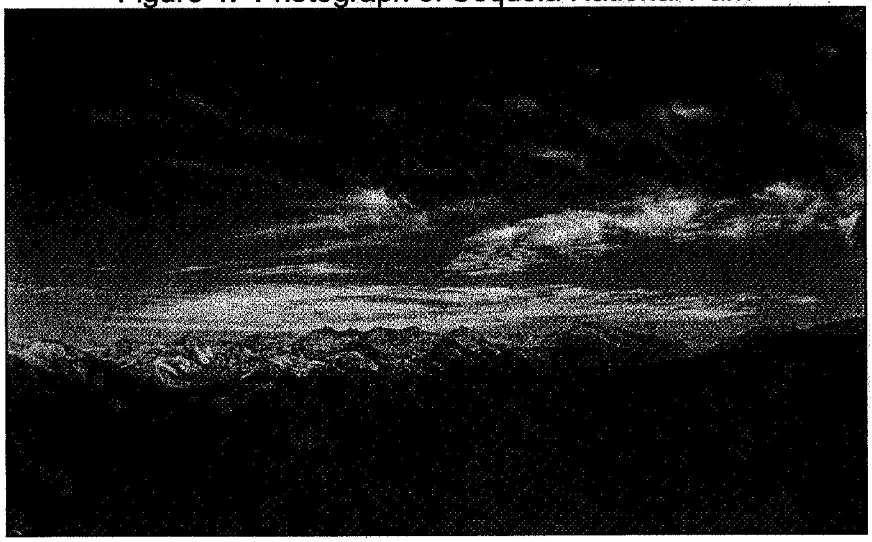
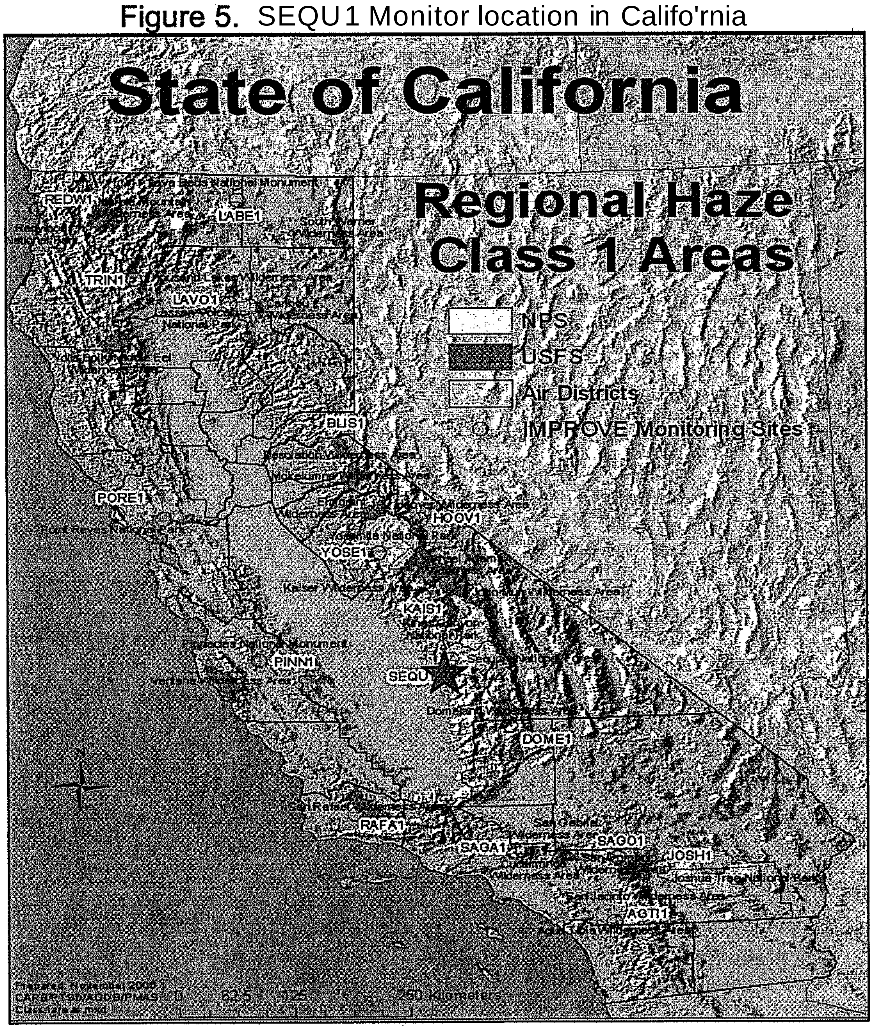


Figure 5. SEQU1 Monitor location in Califo'rnia



Section II. Visibility Conditions:

*II.a. Kings Canyon National Park*

Visibility conditions for Kings Canyon are currently monitored by the SEQU1 IMPROVE monitor. The monitor is located at 36.49 north latitude and 118.83 west longitude in the Middle Fork of the Kaweah River drainage near its exit from the Sequoia National Park south of Kings Canyon. At an elevation of 519 meters, the site is about 64 meters above the river.

SEQU1 is situated near the bottom of one of the valleys that drain Sequoia National Park on its west side, at the very lowest end of elevation ranges within Sequoia NP and well below the lowest Kings Canyon elevations. It is well located for observing San Joaquin Valley emissions at western park boundaries, and emissions from more local sources, and may represent highest aerosol concentrations and most severe visibility impacts within Park boundaries. During inversion conditions it may not be as representative of aerosol concentrations and composition at highest Sequoia and Kings Canyon elevations that could be impacted by emission from more distant source regions on a synoptic to global scale. It may be less representative of aerosol characteristics in the more distant Kings Canyon National Park than in Sequoia National Park. Kings River Middle and South Forks exit Kings Canyon about 25 miles east of central San Joaquin Valley and 50 miles east of Fresno. Lowest elevations of Kings Canyon are.arourid 701 meters higher than lowest elevations of Sequoia and the SEQU1 monitoring site, and are near the upper end of the typical summertime San Joaquin Valley mixing heights. SEQU1 aerosol data should still represent maximum impactwithin the two Parks due to San Joaquin Valley emissions.

The SEQU I location is adequate for assessing the 2018 reasonable progress goals for the Kings Canyon National Park Class 1 area.

*II.b. Sequoia National Park*

Visibility conditions for Sequoia are currently monitored by the SEQU1 IMPROVE monitor operated by the National Park Service. The monitor is located at 36.49 north latitude and 118.83 west longitude in the Middle Fork of the Kaweah River drainage near its exit from the Park. At an elevation of 519 meters, the site is about 64 meters above the river.

The monitoring location is at the western boundary of the Sequoia National Forest, in the foothills of the Sierra Nevada, and in the lowest elevation range of the Forest. It is well-located for observing localized air flows along the Kaweah River drainage and from the adjacent San Joaquin Valley. The elevation of the SEQU1 IMPROVE monitoring station is within both the summer and winter inversion layers of the San Joaquin Valley. Since it receives transported emissions from the San Joaquin Valley, the monitor may register the highest aerosol concentrations and most severe visibility impacts within the Forest boundaries. During inversion conditions, the measurements may not be as representative of aerosol concentration and composition at higher Park elevations that could be impacted by emissions from more distant source regions on a synoptic to global scale.

The SEQU I location is adequate for assessing the 2018 reasonable progress goals for the Sequoia National Park Class 1 area.

### *II.c.* ***Baseline Visibility***

Baseline visibility is determined from SEQU1 IMPROVE monitoring data for the 20% best and the 20% worst days for the years 2000 through 2004. The baseline visibility for the SEQU1 monitor is calculated at 8.8 deciviewsfor the 20% best days and 25.4 deciviews for the 20% worst days. Figure 6 represents the worst baseline visibility. conditions.

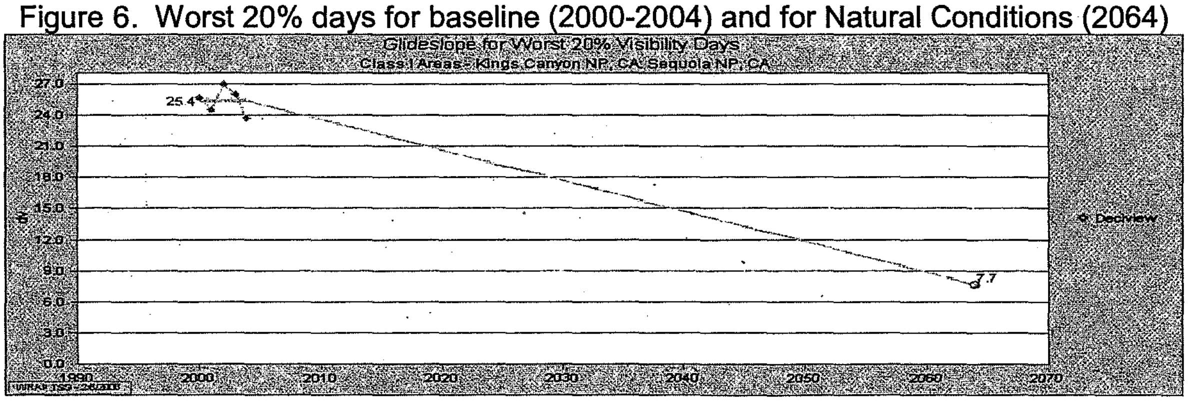
### *II.d.* ***Natural Visibility***

Natural visibility represents the visibility condition that would be experienced in the absence of human-caused impairment. Based on EPA guidance, the natural visibility for the SEQU1 monitor is 2.3 deciviews for the 20% best days and 7.7 deciviews for the 20% worst days. It is possible that the Natural Conditions deciview value for 2064 could change in the future as more is learned about natural plant emissions and wildfire impacts.

### *II.e.* ***Presumptive Glide Slope and the Uniform Rate of Progress***

Figure 6 aiso shows the uniform rate of progress, or "glide slope." The glide slope is the rate of reduction in the 20% worst days deciview average that would have to be achieved to reach natural conditions at a uniform pace in the 60 years following the baseline period. The first benchmark along the path towards achieving natural conditions occurs in 2018. The glide slope shows that the 2018 benchmark for the 20% worst days is 21.24 deciviews. According to the Regional Haze Rule, the 20% best days baseline visibility of 8.8 deciviews must be maintained or improved by 2018, the end of the first planning period.

**Figure 6. Worst 20% days for baseline (2000-2004) and for Natural Conditions (2064)**



### *11.f. Species Contribution*

Each pollutant species causes light extinction but its contribution differs on best and worst days. Figure 7 shows the contribution of each species to the 20% best and worst days in the baseline years at SEQU1.

Figure 7. Average Haze species contributions to light extinction in the baseline years

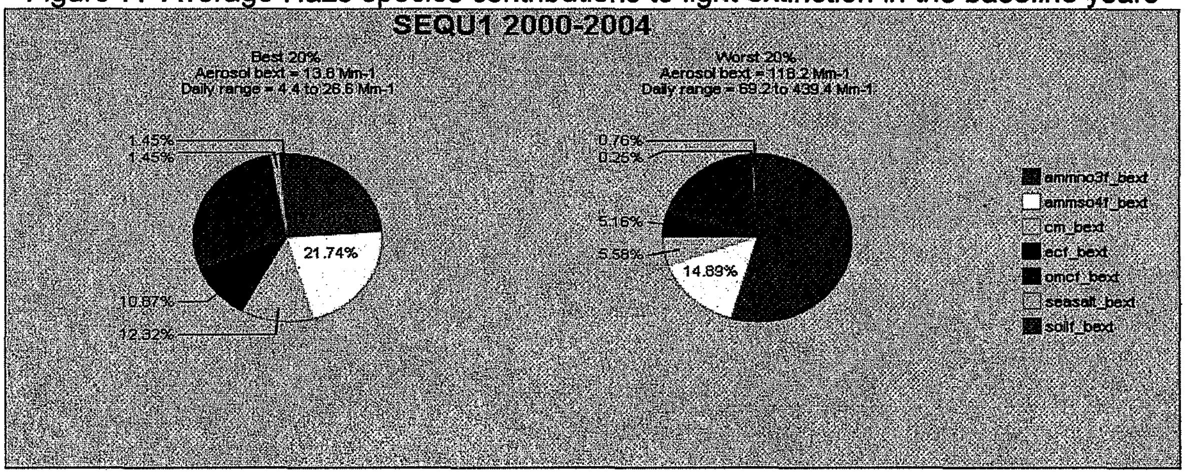
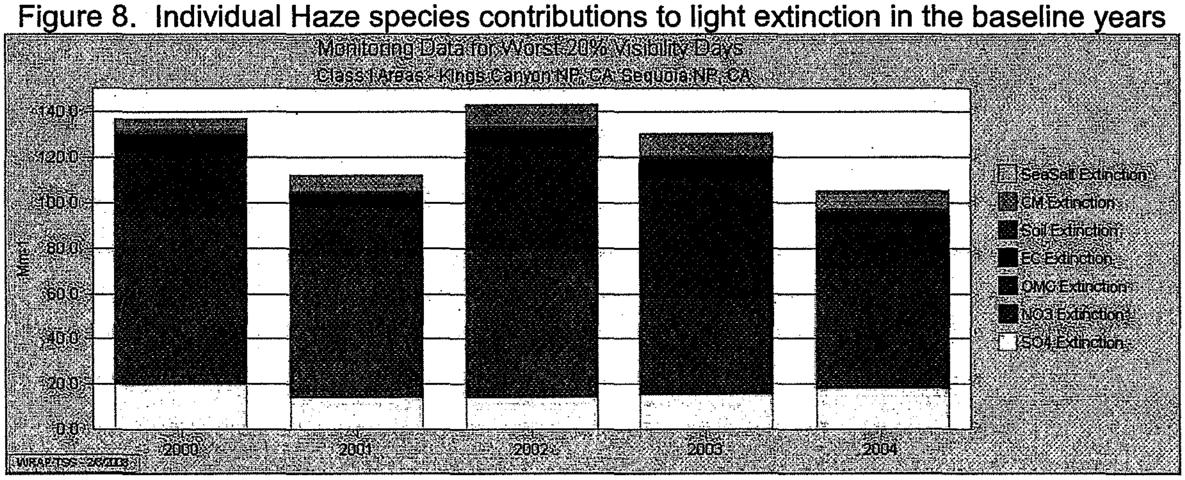



Figure 8. Individual Haze species contributions to light extinction in the baseline years




As shown in Figures 7 and 8, nitrates, organic matter, and sulfates have the strongest contributions to light extinction which degrade visibility on worst days at the SEQU1 monitor. The worst **days** are dominated by nitrates, while the best days are dominated by organic matter.

Figure 9 depicts the ind.ividual species contribution to worst days in 2002. Nitrates increase in the winter and spring while sulfates increase slightly in the spring and summer months. Organic matter remains high throughout the summer. Nitrates clearly dominate the other haze sp.ecies on worst days, but organic matter, sulfates, coarse mass and elemental carbon also contribute to the worst days in the summer. There are only trace amounts of sea salt and soil present throughout the year.

.Figure 10 illustrates the individual species contribution on worst days in 2000-2004 by monthly average. The trend shown is comparable to Figure 9 for nltrates, organic matter, and sulfates. High organic periods vary from year to year due to the unpredictable occurrence of wild fires.

Figure 9. Species contribution on the 20% worst days in 2002

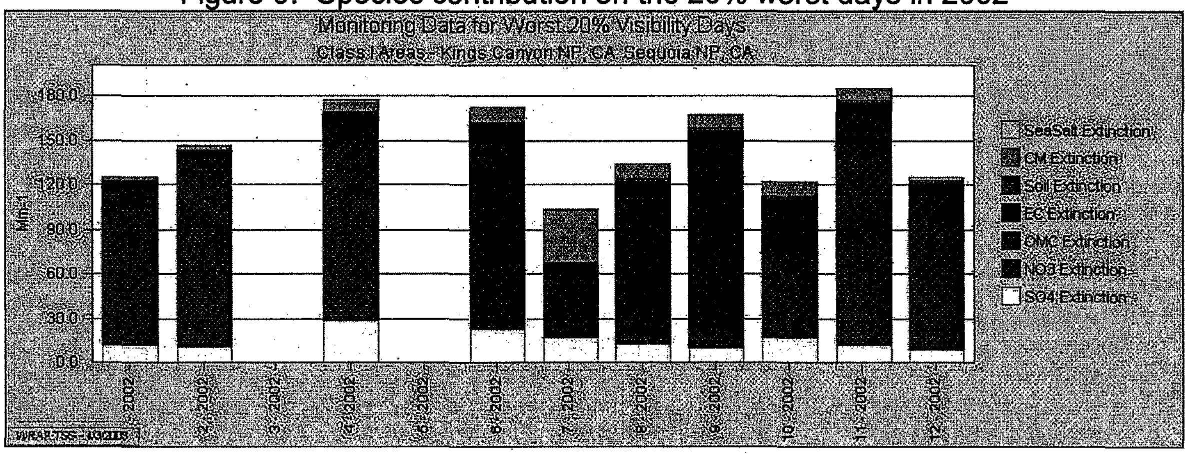
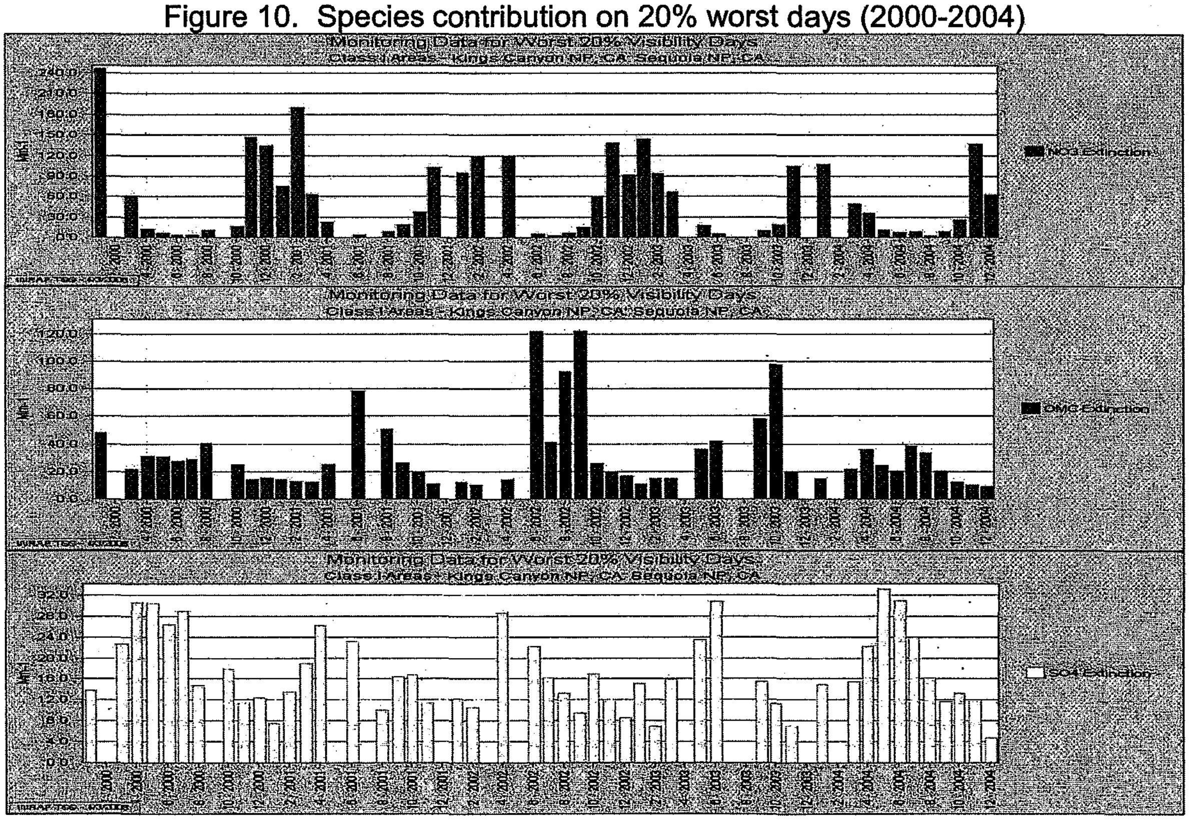



Figure 10. Species contribution on 20% worst days (2000-2004)



### II.g. Sources of Haze Species

Both natural and man-made sources contribute to the calculated deciview levels made by haze pollutants at SEQU1. Some haze species arise from sources that are within the control of the State of California or neighboring states. Others arise from natural, uncontrollable situations such as wildfires, sea salt or dust storms in natural areas, whether they are from in-state or out-of-state (and out-of-country) sources. Finally, other uncontrollable, man-made sources are those industrial pollutants and other man-made (anthropogenic) emissions transported from outside the United States.

Figures 11 and 12 represent the regional contributions to nitrates on the 20% worst days. The WRAP region represents the largest contribution to nitrate in 2002 and 2018 (86%), followed by the Outside Domain Region-(9%) and emissions from Pacific Offshore (4%). Mobile sources within California contribute the most nitrates at the SEQU1 monitor. In 2002,94% of the nitrate from mobile sources at the SEQU1 monitor can be attributed to California. California mobile source emissions reductions are mainly responsible for improvement in nitrates in 2018. .

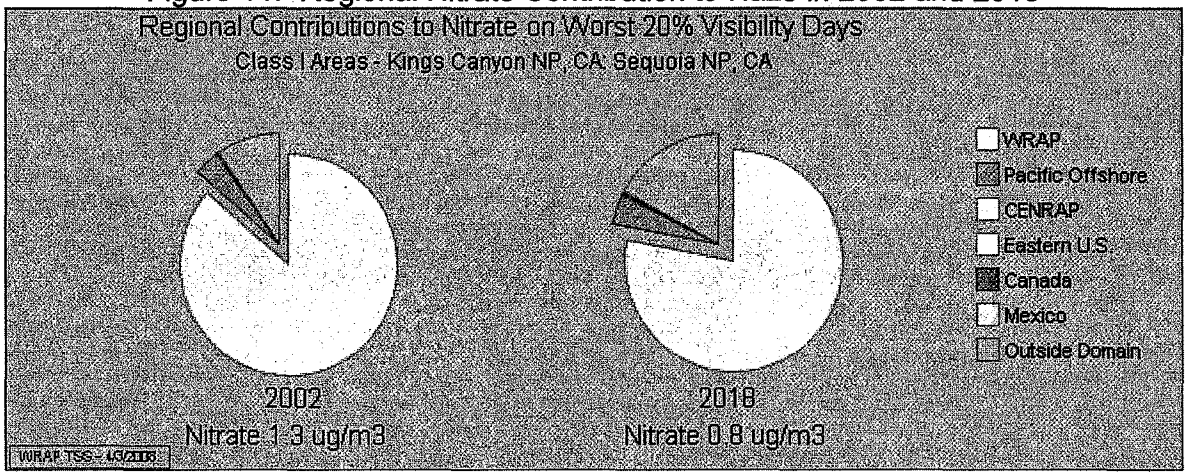
Figure 13 shows the primary organic carbon source contribution from California and the outside regions. The largest contributor to primary organic carbon at the SEQU1 monitor is from natural fire sources within·California.- California represents 97% of all natural fire source contributions.

Figure 14 illustrates the total organic carbon source apportionment from 2000-2004 for anthropogenic and biogenic sources. The biogenic secondary emissions account for 60% of the total organic carbon. Anthropogenic and biogenic primary source emissions account for 35% of the total organic carbon emissions and anthropogenic secondary is responsible for the. remaining emissions.

Figures 15 and 16 represent the regional contributions to sulfate on the 20% worst days in 2002 and 2018 at SEQU1. The Outside Domain region represents 48% of the sulfate contributions in 2002 and 2018, followed by the emissions from the WRAP Region (35%) and the Pacific Offshore Region (13%). California contributes 25% of the total sulfate emissions seen at the SEQU1 monitor.

Individually, emissions from outside the modeling domain contribute the most to sulfate concentrations at the SEQU1 monitor. Pacific Offshore area sources and California point sources contribute an equal amount to the. sulfate concentrations at the SEQU1 monitor following outside the modeling domain.

Figure 11. Regional Nitrate Contribution to Haze in 2002 and 2018




Fi ure 12. Nitrate source contribution from CA and outside regions

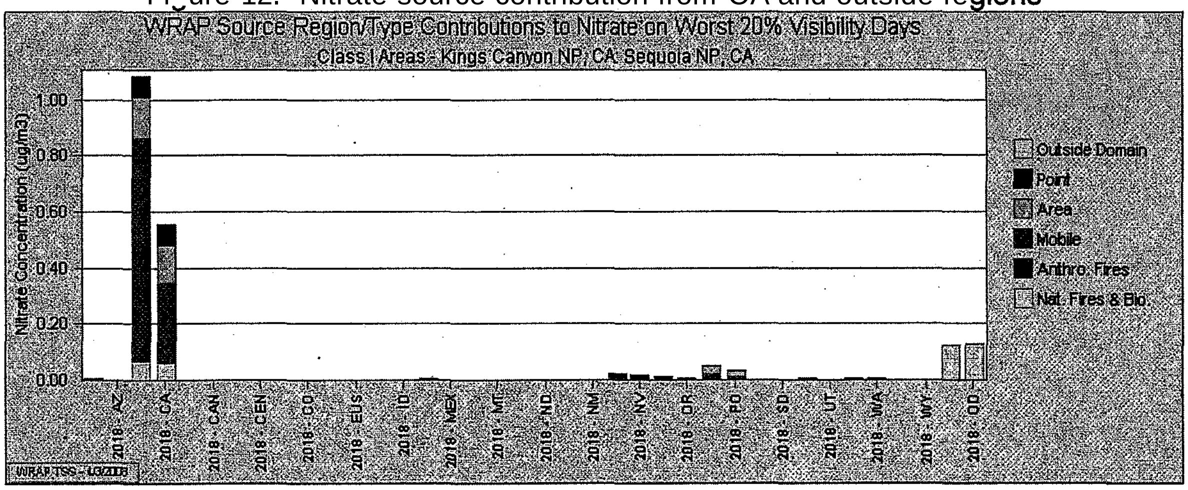



Figure 13. Or anic carbon source contribution from CA and outside regions

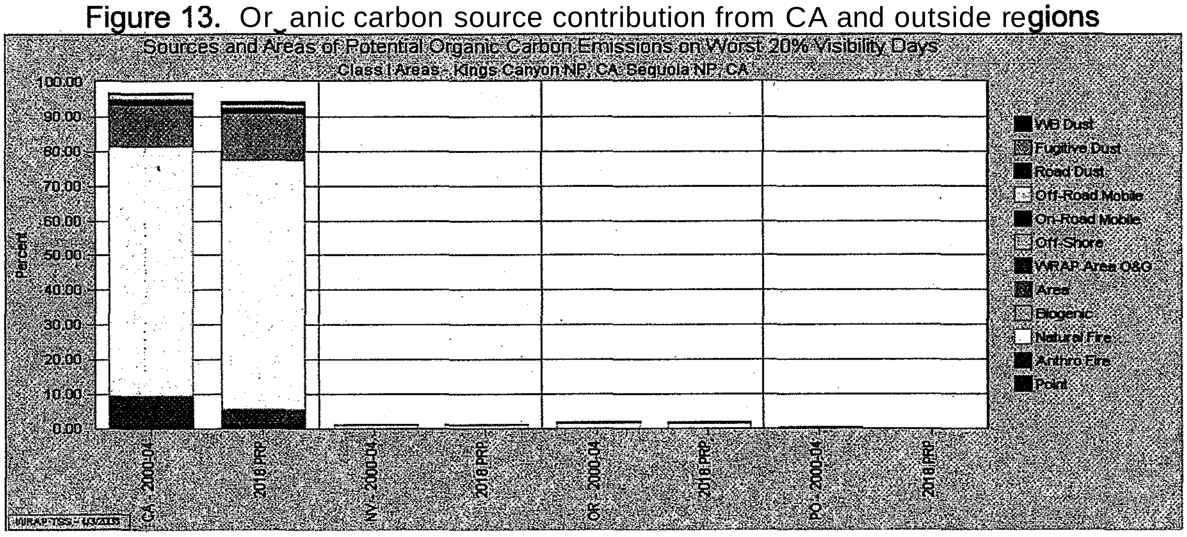


**Figure 14. Organic carbon Anthropogenic and Biogenic Source Apportionment**

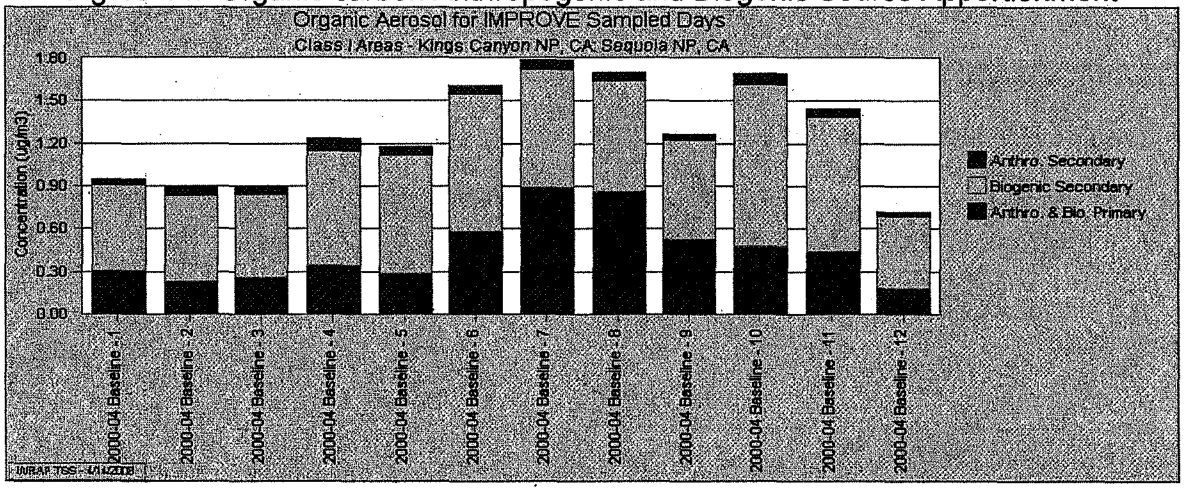



**Figure 15.** Re͜ional Sulfate Contribution to Haze in 2002 and 2018

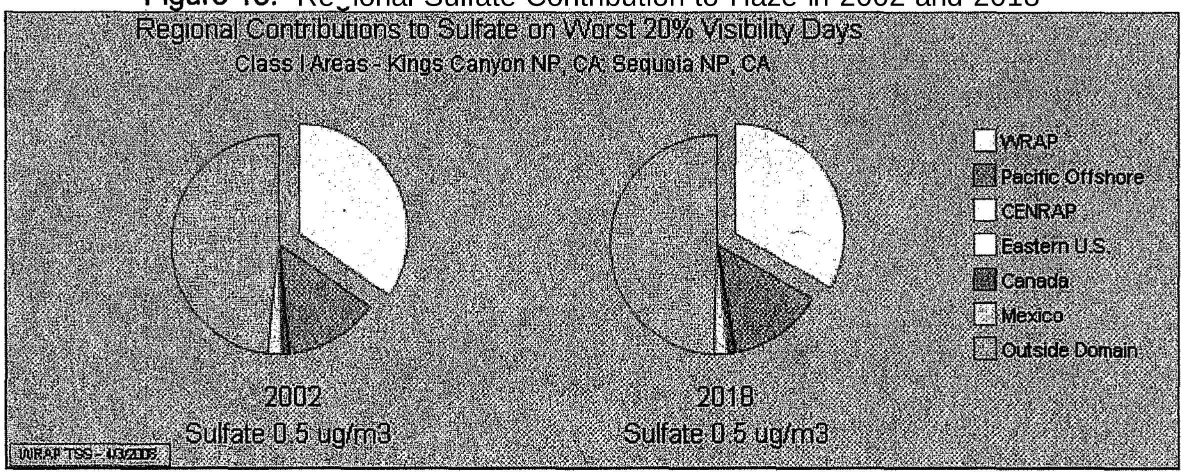
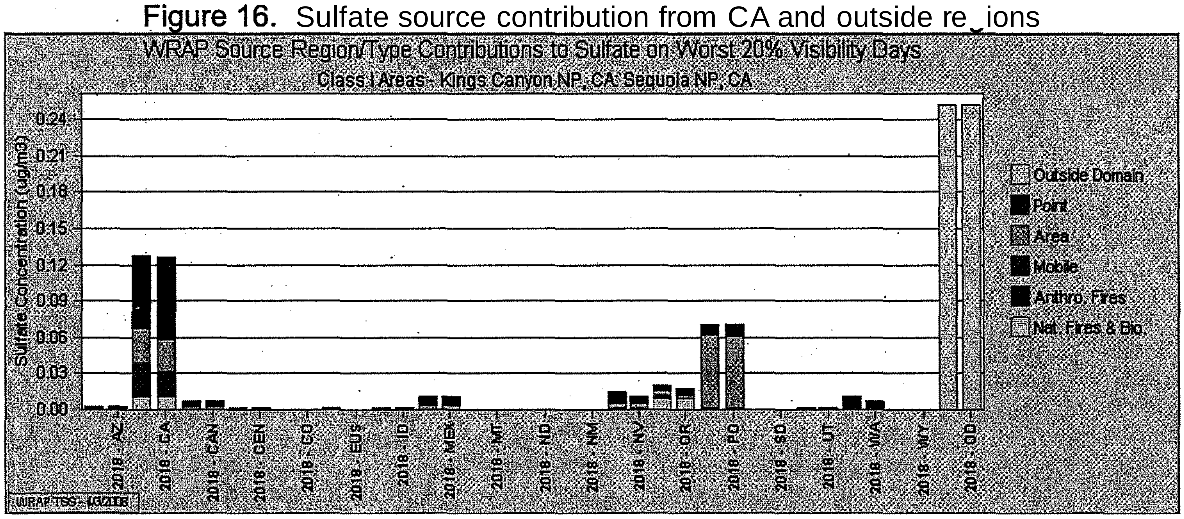



**Figure 16.** Sulfate source contribution from CA and outside re͜ions



# DOME1 Monitor

## Section I. Description

**Dome Land Wilderness Area (Dome Land) consists of about 131,000 acres of the southern end of the Kern Plateau, 70 miles northeast of Bakersfield. Elevations range from 914 to 2,966 meters. Dome Land Wilderness is bisected by the South Fork of the Kern River that flows southwest towards Bakersfield and the southern end of the San Joaquin Valley, where the elevation is near 152 meters and which is the nearest source region for anthropogenic emissions that may affect Visibility in the Dome Land Wilderness Area.**

Figure 1. DOME1 Monitor location

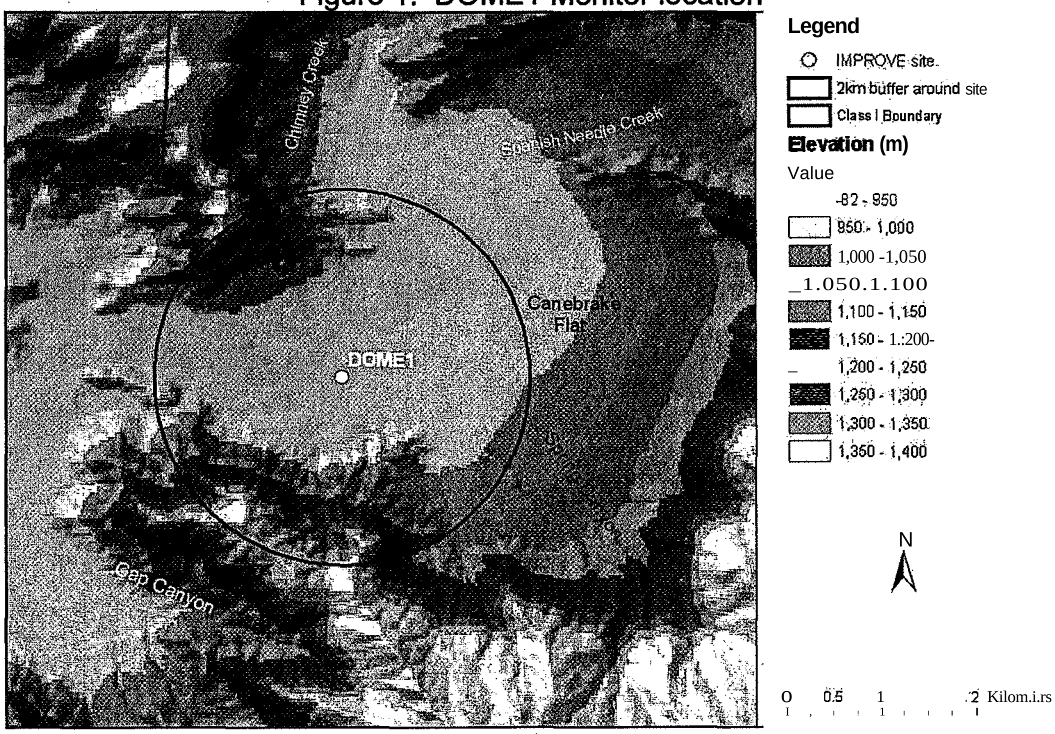



Figure 2. WINHAZE image of Dome Land Wilderness Area (5.1 vs. 19.4 deciviews)

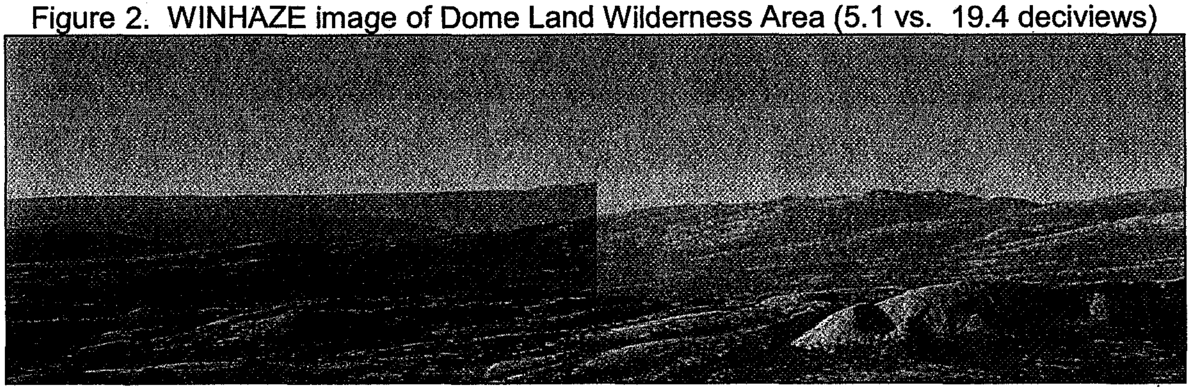
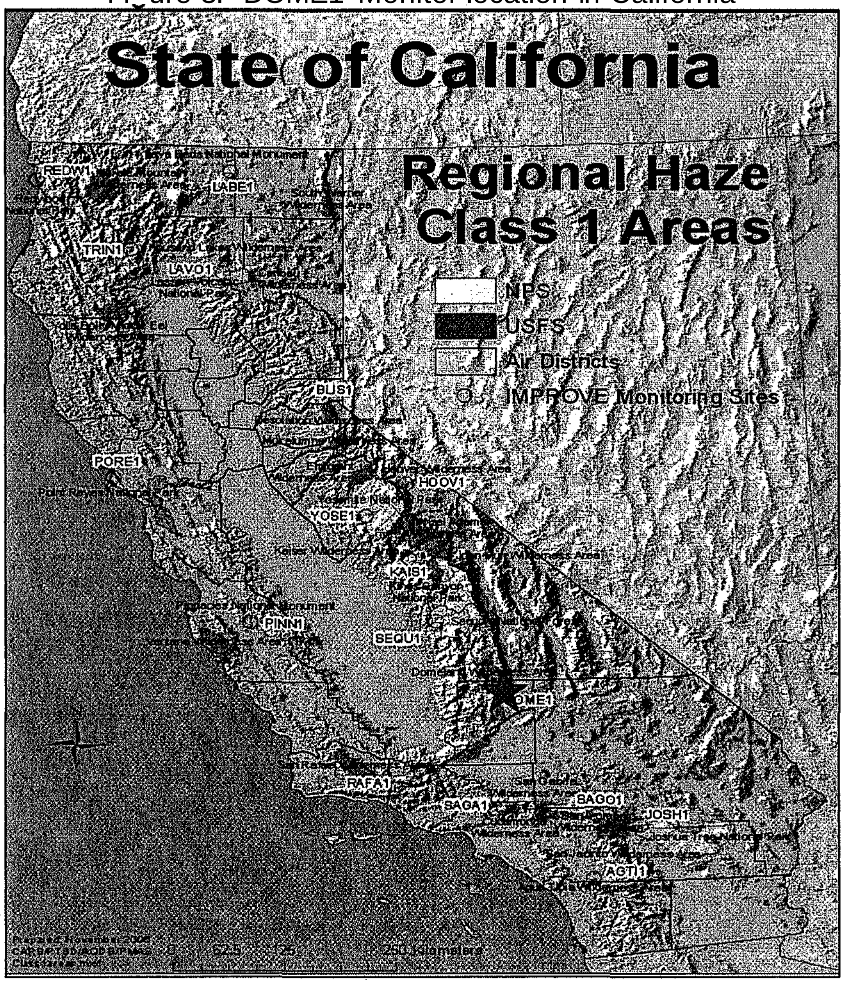


Figure 3. DOME1 Monitor location in California




Section II. Visibility Conditions:

*II.a. Visibility Monitor Location*

Visibility conditions for Dome Land Wilderness are currently monitored by the DOME1 IMPROVE monitor. The monitor is located at 35.7278 north latitude and 118.1377 west longitude in the valley of the South Fork of the Kern River a few miles downstream from its exit from the wilderness. The DOME1 site elevation is 927 meters, the lowest end of the range of Dome Land Wilderness elevations. The site has been operating since February 2000. This site does not have sufficient data.for the entire baseline period. Data was not available for the year 2000.

Aerosol data from DOME1 shoLild be representative of locations in Dome Land Wilderness Area. The nearest population center is Bakersfield and the southern San Joaquin Valley, 70 miles southwest. This source region is the nearest source for emissions that could contribute to haze in Dome Land Wilderness, via low-level transport up the South Fork of the Kern River, via upward mixing and upper level transport by prevailing westerly winds, or trapped beneath a regional subsidence inversion.

The DOME1 location is adequate for assessing the 2018 reasonable progress.goals for the Dome Land Wilderness Class 1 area.

### *II.b.* ***Baseline Visibility***

Baseline visibility is determined from DOME1 IMPROVE monitoring data for the 20% best and the 20% worst days for the years 2000 through 2004. The baseline visibility for the Dome Land Wilderness is calculated at 5.1 deciviews for the 20% best days and 19.4 deciviews for the 20% worst days. Figure 3 represents the worst baseline visibility conditions.

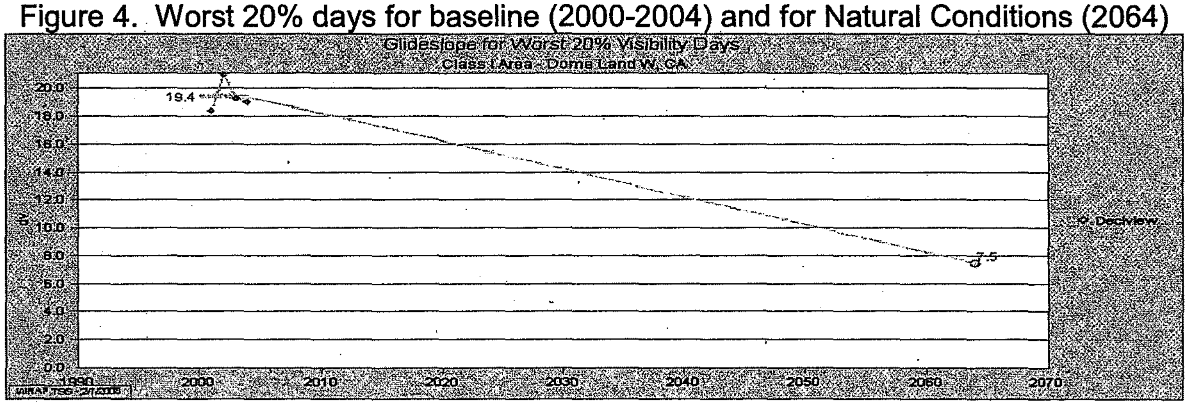
### *II.c.* ***Natural Visibility***

Natural visibility represents the visibility condition that would be experienced in the absence of human-caused impairment. Based on EPA guidance, the natural visibility for the Dome Land Wilderness is 1.2 deciview$ for the 20% best days and 7.5 deciviews for the 20% worst days. It is possible that the Natural Conditions deciview value for 2064 could change in the future as more is learned about natural plant emissions and wildfire impacts.

### *II.d.* ***Presumptive Glide Slope and the Uniform* Rate of *Progress***

Figure 3 also shows the uniform rate of progress, or "glide slope." The glide slope is the rate of reduction in the 20% worst days deciview average that would have to be achieved to reach natural conditions at a uniform pace in the 60 years following the baseline period. The first benchmark along the path towards achieving natural conditions occurs in 2018. The glide slope shows that the 2018 benchmark for the 20% worst days is 16.64 deciviews. According to the Regional Haze Rule, the 20% best days baseline visibility of 5.1 deciviews must be maintained or improved by 2018, the end of the first planning period.

**Figure 4. Worst 20% days for baseline (2000-2004) and for Natural Conditions (2064)**



### *II.e. Species Contribution*

Each pollutant species causes light extinction but its contribution differs on best and worst days. Figure 5 shows the contribution of each species to the 20% best and worst days in the baseline years at DOME1.

Figure 5. Average Haze species contributions to light extinction in the baseline years

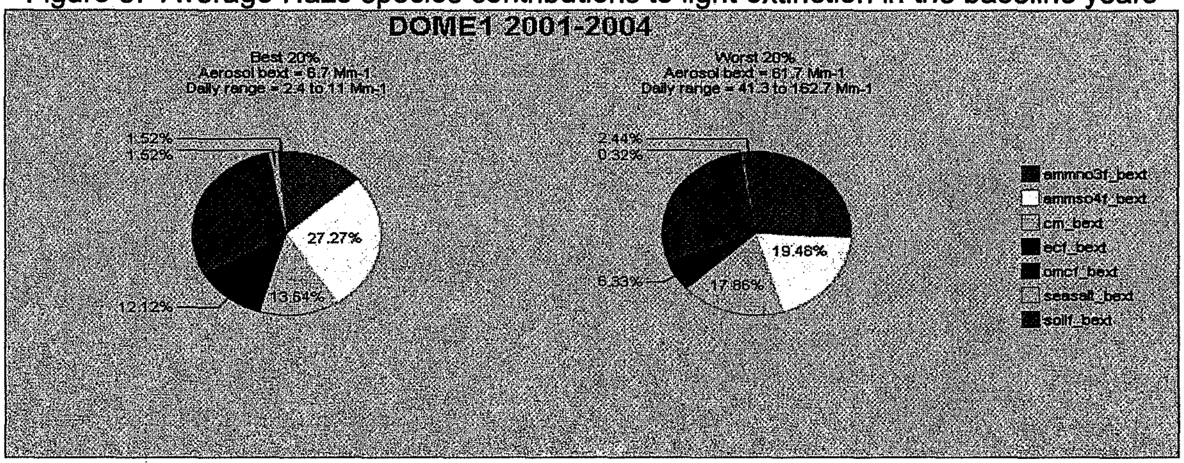
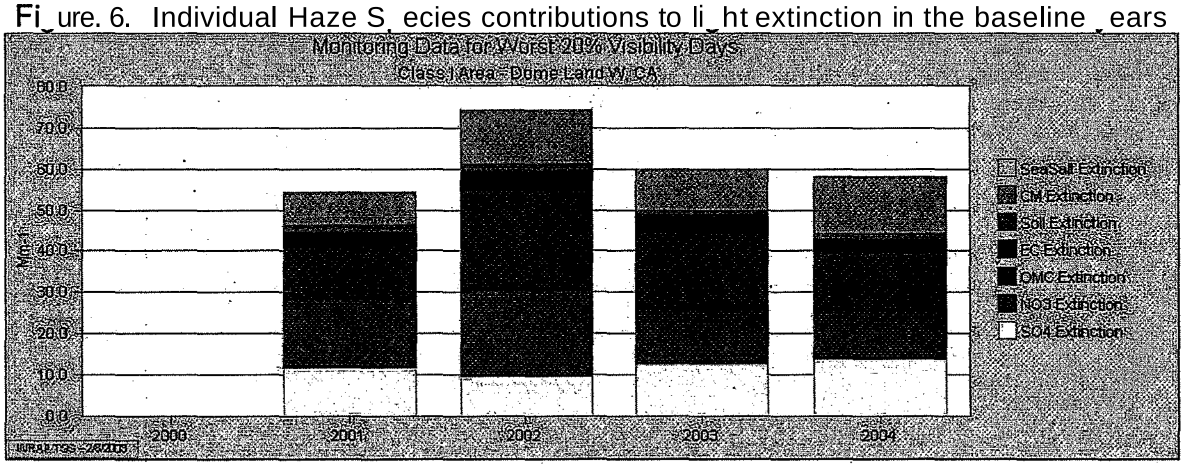



Figure. 6. Individual Haze Species contributions to light extinction in the baseline years




As shown in Figures 5 and 6, organic matter, nitrates, and sulfates have the strongest contributions to degrading visibility on worst days at Dome Land Wilderness Area. The worst and best days are dominated by organic matter. Data points for 2000 were insufficient for calculating best and worst days per the Regional Haze Rule Guidance.

Figure 7 depicts the individual species contribution on worst days in 2003. The occurrence of elevated organic matter concentrations is sporadic throughout the year. Sulfates remain relatively stable throughout the year but see a slight increase in the early summer. Nitrates increase in the winter months and coarse mass increases slightly in the summer. Organic matter clearly dominates the other haze species on worst days, but nitrates, sulfates, and coarse mass also contribute to the worst days throughout the year. There are only trace amounts of soil and sea salt present throughout the years.

Figure 8 illustrates the individual species contribution on worst days in 2000-2004 by monthly average. The trend shown is comparable to Figure 7 for organic matter, nitrates, and sulfates. High organic periods vary from year to year due to the unpredictable occurrence of wild fires.

**Figure 7.** Species contribution on the 20% worst days in 2003

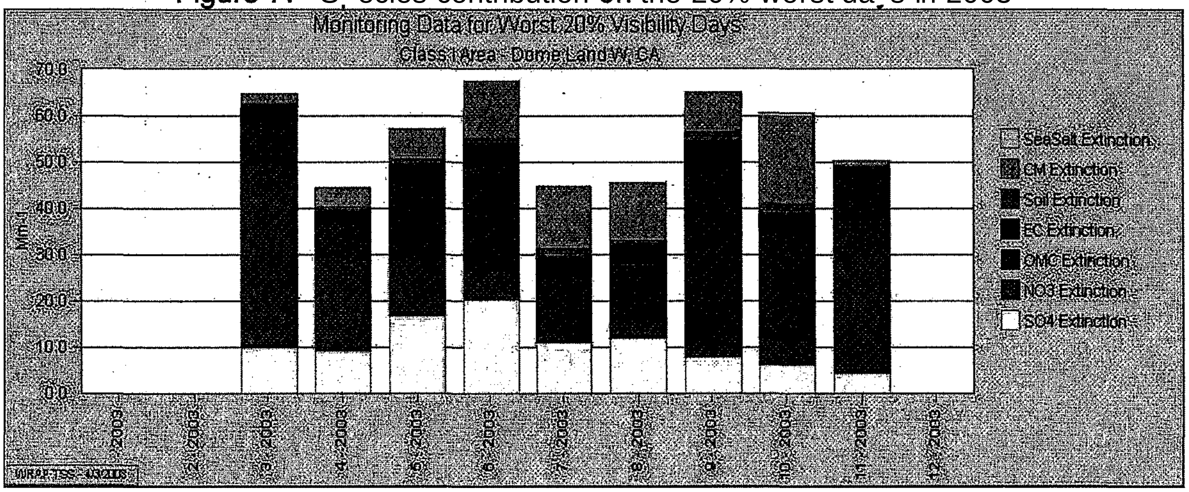
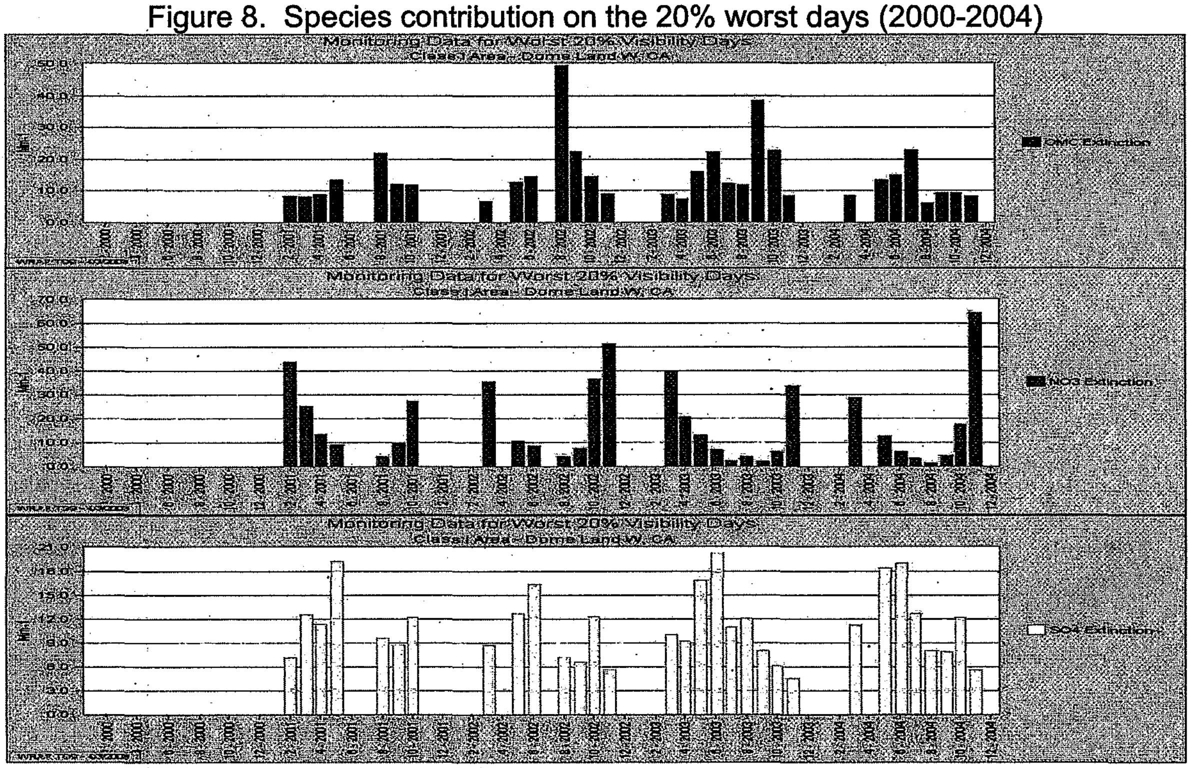



**Figure 8. Species contribution on the 20% worst days (2000-2004)**



*II.f. Sources of Haze Species*

Both natural and man-made sources contribute to the calculated deciview levels made by haze pollutants at DOME1. Some haze species arise from sources that are within the control of the State of California or neighboring states. Others arise from natural, uncontrollable situations such as wildfires, sea salt or dust storms in natural areas, whether they are from in-state or out-of-state (and out-of-country) sources. Finally, other uncontrollable, man-mace sources are those industrial pollutants and other man-made (anthropogenic) emissions transported from outside the United States.

Figure 9 shows the primary organic carbon source contribution from California and the outside regions, The largest contributor to primary organic carbon at the DOME1 monitor is from natural fire sources within California. California represents 99% of all natural fire source contributions.

Figure 10 illustrates the total organic carbon source apportionment from 2000-2004 for anthropogenic and biogenic sources: The anthropogenic and biogenic primary emissions account for 67% of the total organic carbon. Biogenic secondary source emissions account for 31 % of the total organic carbon emissions and anthropogenic secondary is resp.onsible for the remaining emissions.

Figures 11 and 12 represent the regional contributions to nitrates on the 20% worst days. The WRAP region represents the largest contribution to nitrate" in 2002 and 2018 (86%), followed by the Outside Domain Region (11 %) and emissions from Pacific Offshore (3%). Mobile sources within California contribute the most nitrates at the DOME1 monitor. In 2002,81% of the nitrate at the DOME1 monitor can be attributed to" California.

From the WRAP Region, California is shown to contribute the most to nitrate conce"ntrations at the DOME1 monitorin 2002 and 2018. Currently, California mobile sources are 68% of California "contributions to nitrate at the DOME1 monitor. California mobile source emissions reductions are mainly responsible for improvement in nitrates in 2018.

Figures 13 and 14 represent the regional contributions to sulfate on the 20% worst days in 2002 and 2018 at DOME1. The Outside Domain region represents 42% of the sulfate contributions in 2002 and 2018, followed by the emissions from.the WRAP Region (38%) and the Pacific Offshore Region (15%). California contributes 26°(0 of the total sulfate emissions seen at the DOME1 monitor.

Individually, emissions from outside the modeling domain contribute the most to sulfate concentrations at the DOME1" monitor. The next largest contributor to sulfate concentration is area sources in the PaCific Offshore.

Figure 9. Or_anic carbon source contribution from CA and outside regions.

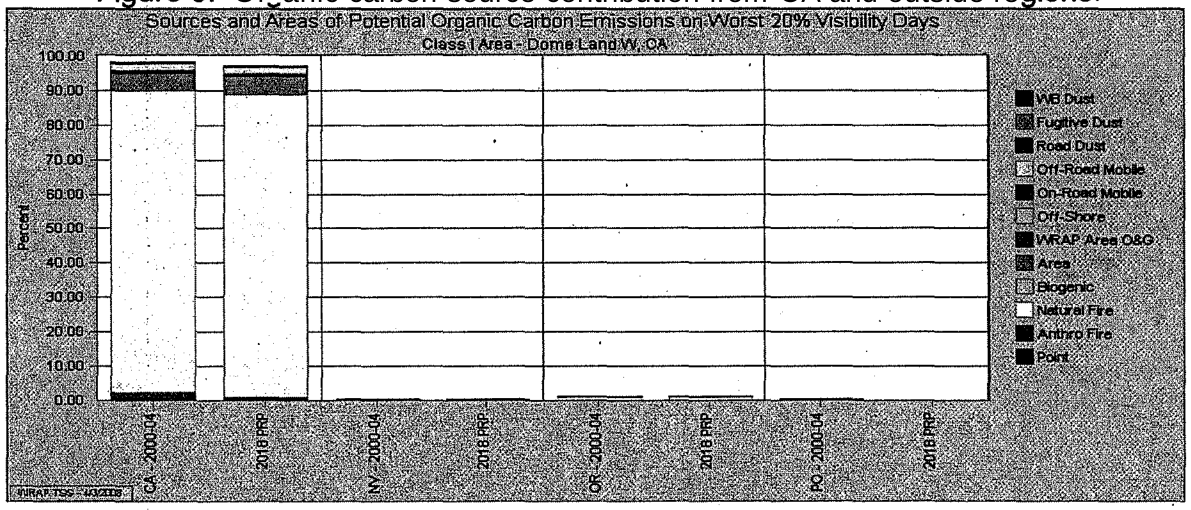



Figure 10. Organic carbon Anthropogenic and Biogenic Source Apportionment

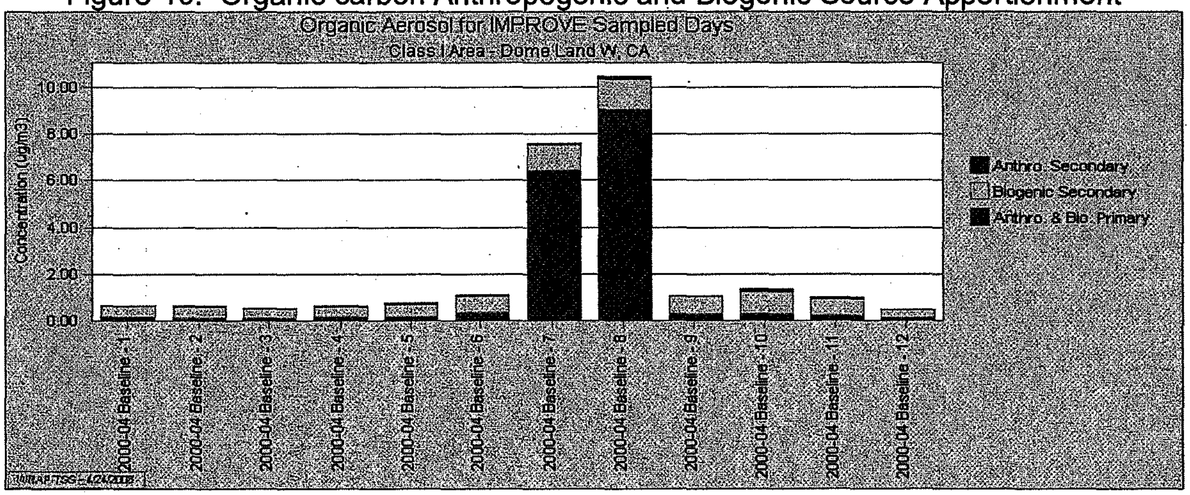



Figure 11. Regional Nitrate contribution to haze in 2002 and 2018

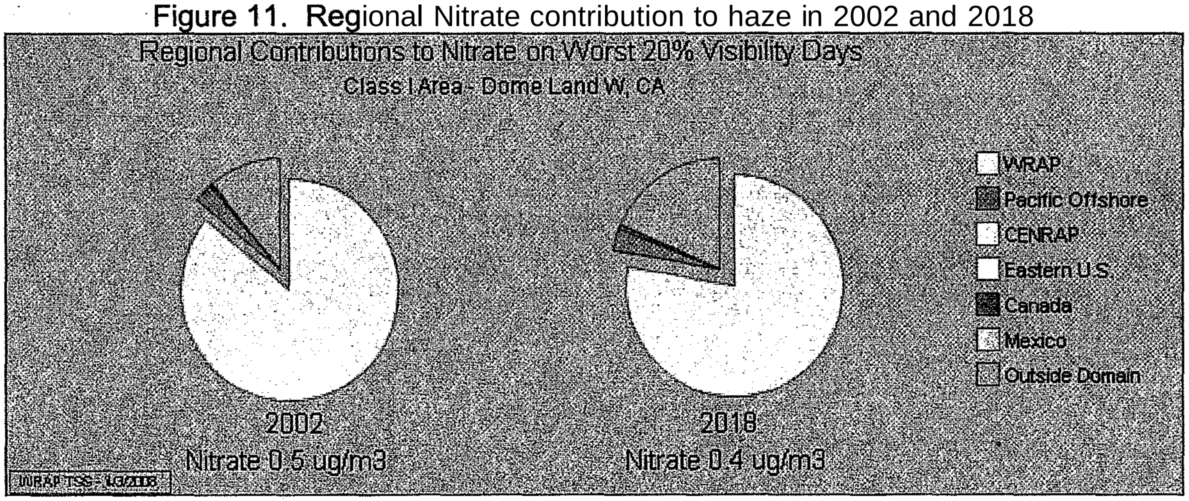


Figure 12. Nitrate source contribution from CA and outside regions

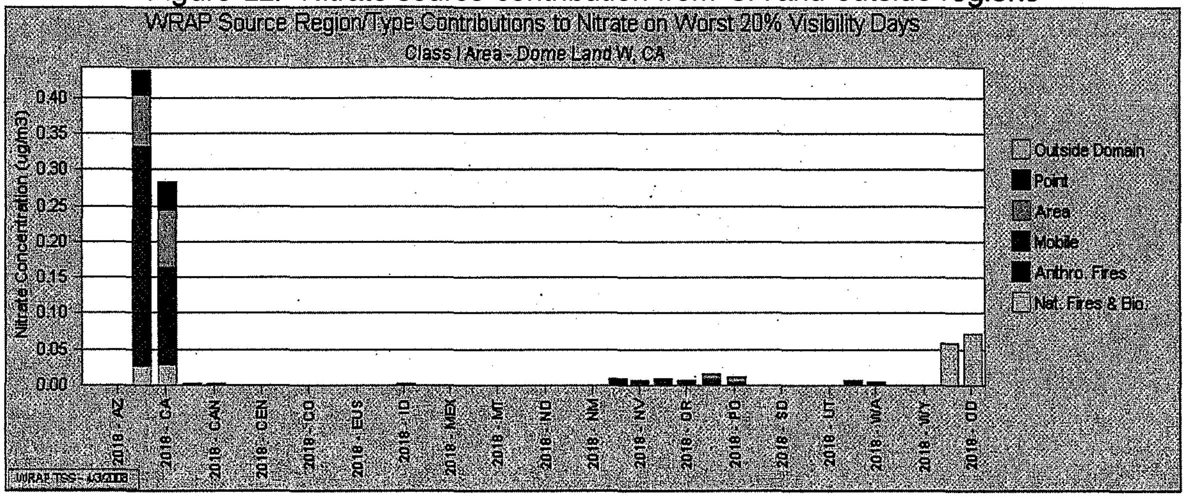



Figure 13. Regional Sulfate contribution to Haze in 2002 and 2018

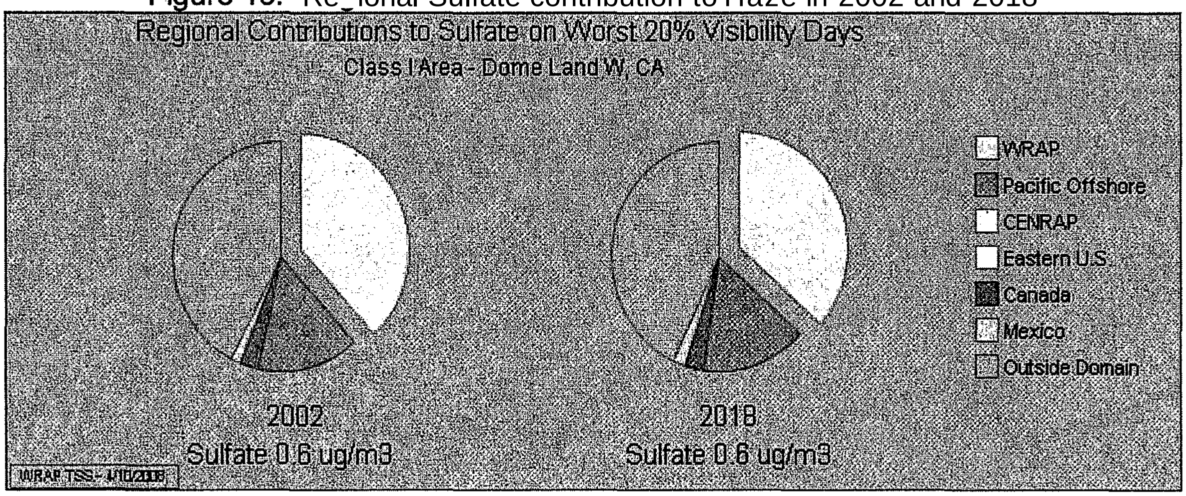
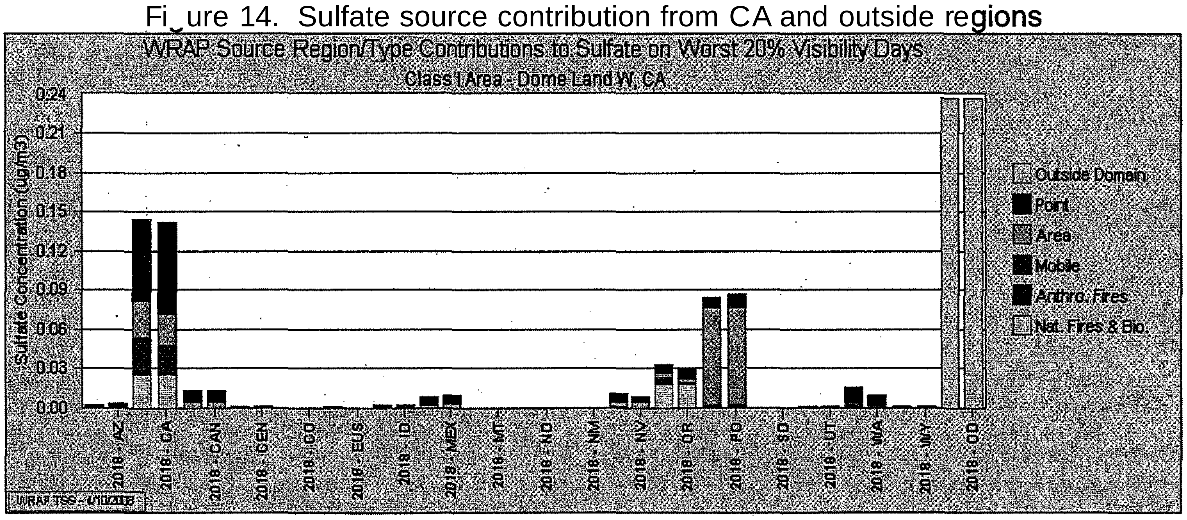



Figure 14. Sulfate source contribution from CA and outside regions



## REDW1 Monitor'

### Section I. Description

Redwood National Park (Redwoods) consists of 27,792 acres of coast and coastal mountains in northern California. The ,several unconnected sections of the Park include 37 miles of coastline between the Oregon border and McKinleyville, California. Elevations' range from sea level to about 914 meters. As part of the coast ranges that present the first obstruction to moist air from the Pacific, it has a relatively high annual average precipitation. Total annual precipitation on the northern California coast is . about 120 inches, mostly during the winter when the Aleutian Low is at its most southerly position over the eastern Pacific. Precipitation varies ,considerably with inland distance and with elevation. The furthest inland extent of Redwoods is about 15 miles from the coast. Besides the coast and mountains, the most signifieant topographic features are the Smith and Klamath Rivers that empty into the Pacific in the northern and southern Redwoods areas; respectively.

Figure 1. REDW1 Monitor location

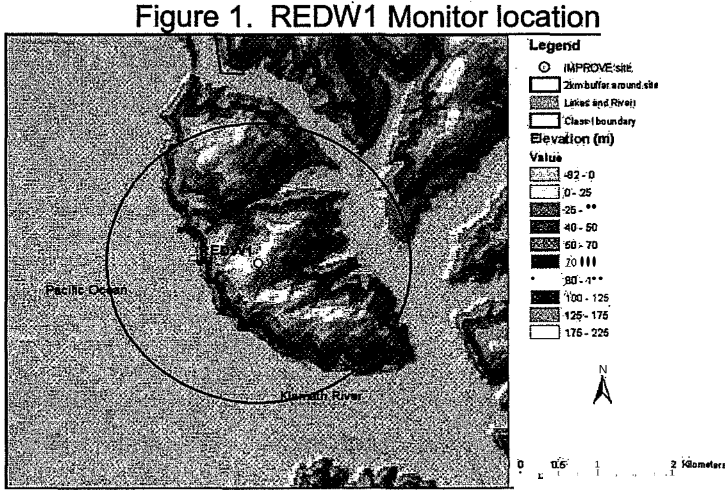



Figure 2. Image taken from Redwood monitor camera

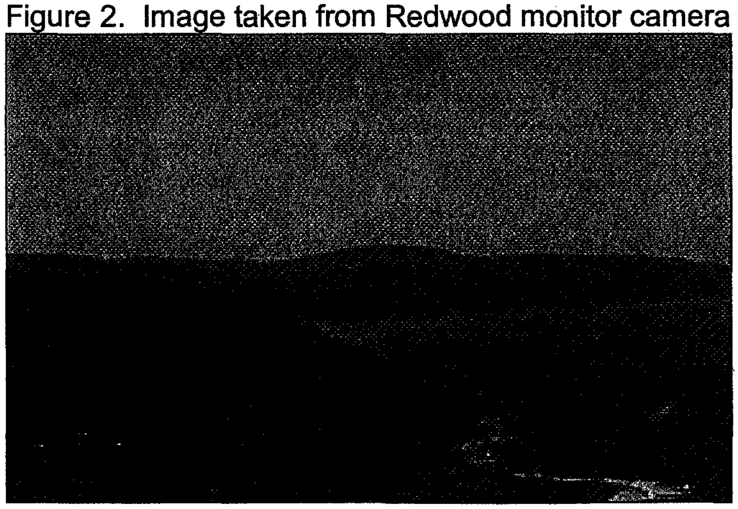
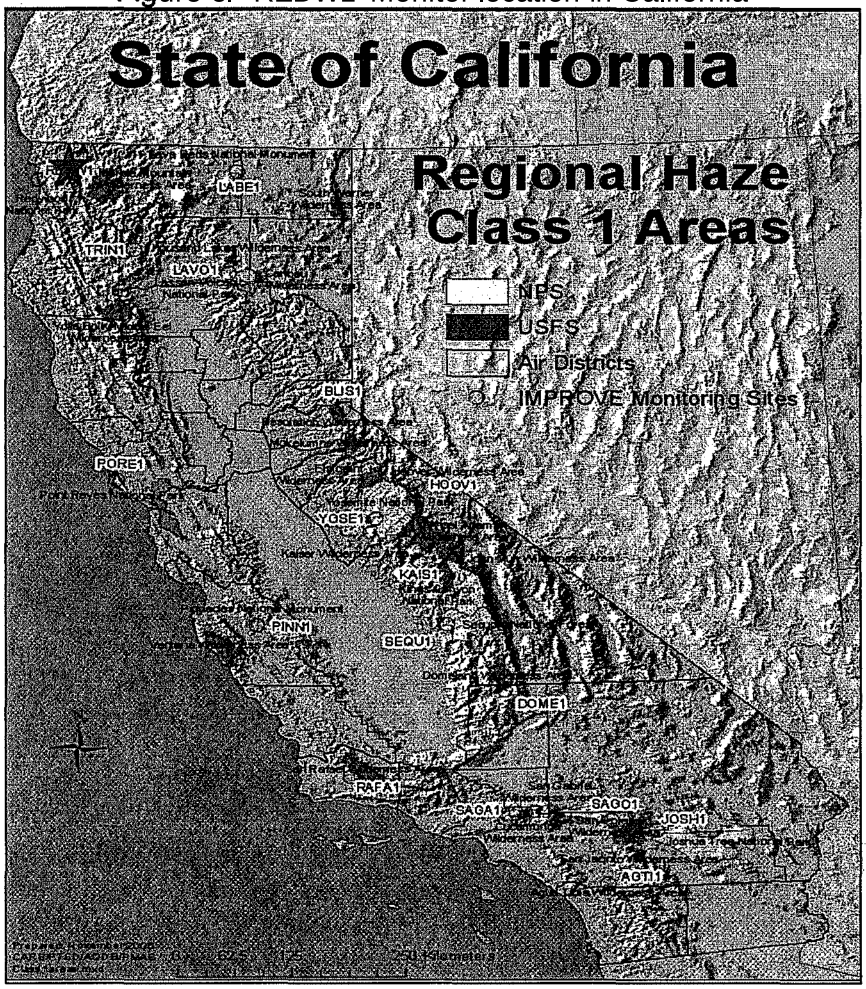


Figure 3.· REDW1 Monitor location in California




Section II. Visibility·Conditions:

*II.a. Visibility Monitor Location*

Visibility conditions for Redwoods are currently monitored by the REDW1 IMPROVE monitor. The monitor is located at 41.5608 north latitude and 1·24.0839 west longitude, located outside of park boundaries, but in a central location with respect to Redwood park sections. It is near the mouth of the Klamath River at an elevation of 244 meters. The site has been operating since March 1988. This site has ·sufficient data for the five baseline years of 2000 - 2004.

The REDW1 IMPROVE site is centrally located with respect to Park locations at a midrange elevation and should be quite representative of aerosol concentration and composition within Redwoods. There may be some modest influence by airflow down the Klamath River, which may be a transport route for emissions from the interior such as wildfire emissions that could influence measurements at the monitoring site locally.

The nearest population center is the Crescent City area near the mouth of the Smith River and the northern boundary of Redwoods.

The REDW1 location is adequate for assessing the 2018 reasonable progress goals for the Redwood National Park Class 1 area.

### *II.b. Baseline Visibility*

Baseline visibility is determined from REDW1 IMPROVE monitoring data for the 20% best and the 20% worst days for the years 2000 through 2004. The baseline visibility for the Redwood National Forest is calculated at 6.1 deciviews for the 20% best days and 18.5 deciviews for the 20% worst days. Figure 4 represents the worst baseline visibility conditions.

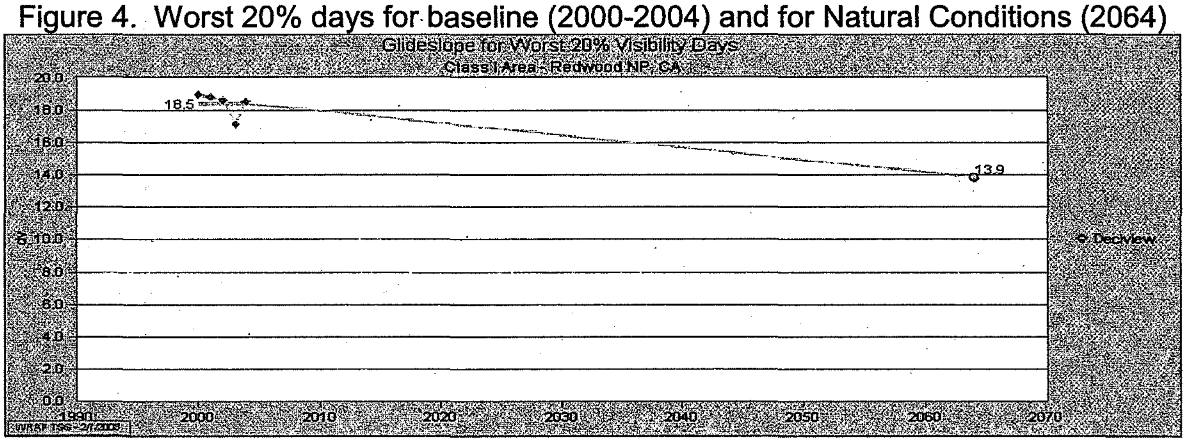
### *II.c. Natural Visibility*

Natural visibility represents the visibility condition that would be experienced in the absence of human-caused impairment. Based on EPA gUidance, the natural visibility for the Redwood National Forest is 3.5 deciviews for the 20% best days and 13.9 deciviews for the 20% worst days. It is possible that the Natural Conditions deciview value for 2064 could change in the future as more is learned about natural plant emissions and wildfire impacts.

### *II.d. Presumptive Glide Slope and the Uniform Rate of Progress*

Figure 4 also shows the uniform rate of progress, or "glide slope." The glide slope is the rate of reduction in the 20% worst days deciview average. that would have to be achieved to reach natural conditions at a uniform pace in the 60 years following the baseline period. The first benchmark along the path towards achieving natural conditions occurs in 2018. The glide slope shows that the 2018 benchmark for the 20% worst days is 17.39 deciviews. According to the Regional Haze Rule, the 20% best days baseline visibility of 6.1 deciviews must be maintained or improved by 2018, the end of the first planning period.

**Figure 4. Worst 20% days for baseline (2000-2004) and for Natural Conditions (2064)**



### II.e. ***Species Contribution***

Each pollutant species causes light extinction but its contribution differs on best and worst days. Figure 5 shows the contribution of each species to the 20% best and worst days in the baseline years at REDW1.

**Figure 5. Average Haze species contributions to light extinction in the baseline years**

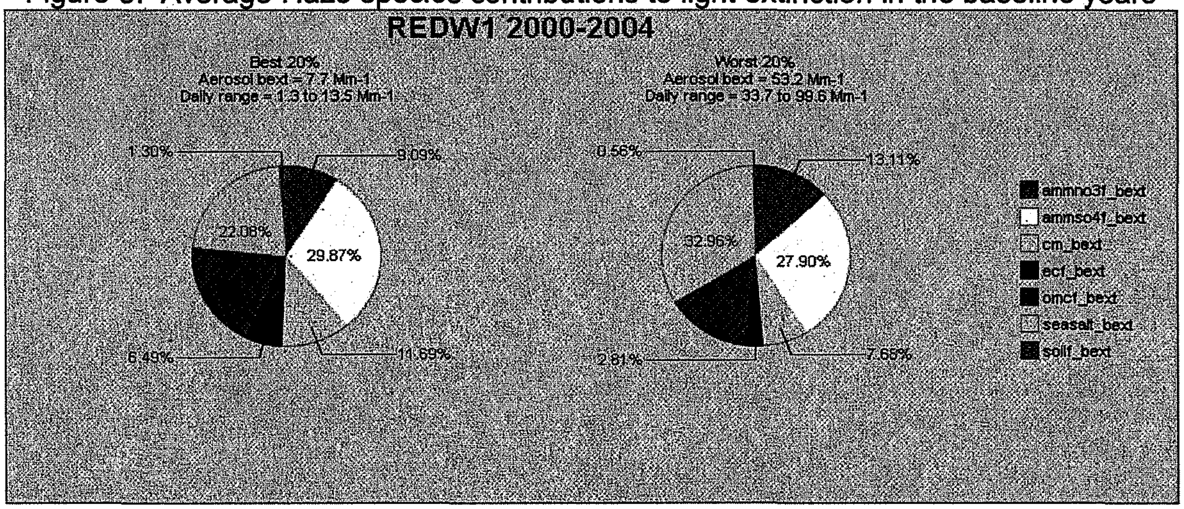
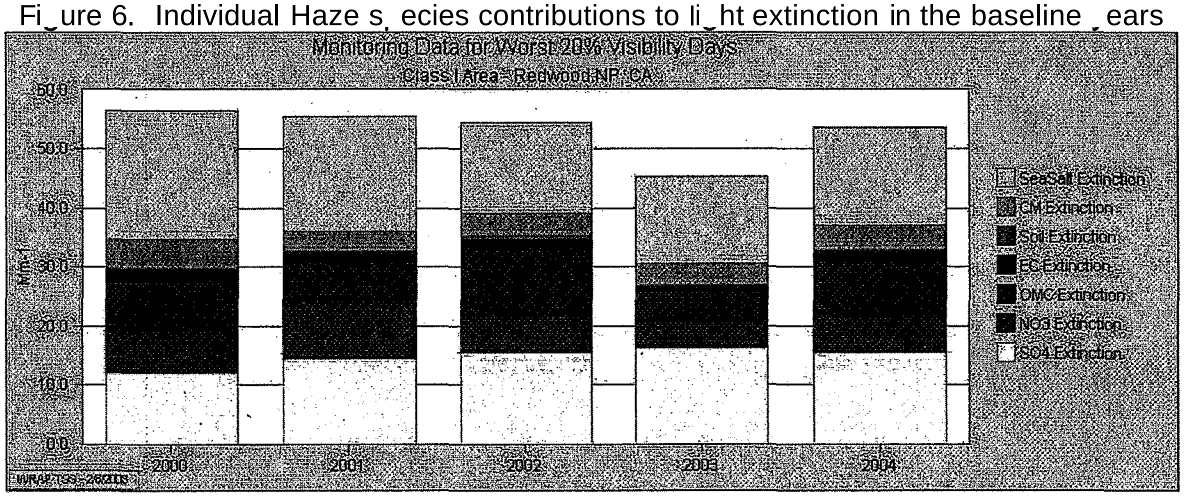



Figure 6. Individual Haze species contributions to light extinction in the baseline years




As shown in Figures 5 and 6, sea salt, sulfates, and organic matter have the strongest contributions to degrading visibility on worst days at Redwood National Park. The worst days are dominated by sea salt, while the best days are dominated by sulfate.

Figure 7 depicts the individual species contribution to worst days in 2002. Sea salt and sulfate increase in the summer months while organic matter increases in the winter' months. Sea salt clearly dominates the other haze species on worst days, but sUlfates, organic carbon, nitrates, and coarse mass also contribute to the worst days. Elemental carbon and soil are present in trace amounts at the REDW1 monitor.

Figure 8 illustrates the individual species contribution on worst days in 2000-2004 by monthly average. The trend shown is comparable to Figure 7 for sea salt, sulfates, organic matter, and nitrates. High organic periods vary from year to year due to the unpredictable occurrence of wild fires.

**Figure 7. Species contribution on the 20% worst days in 2002**

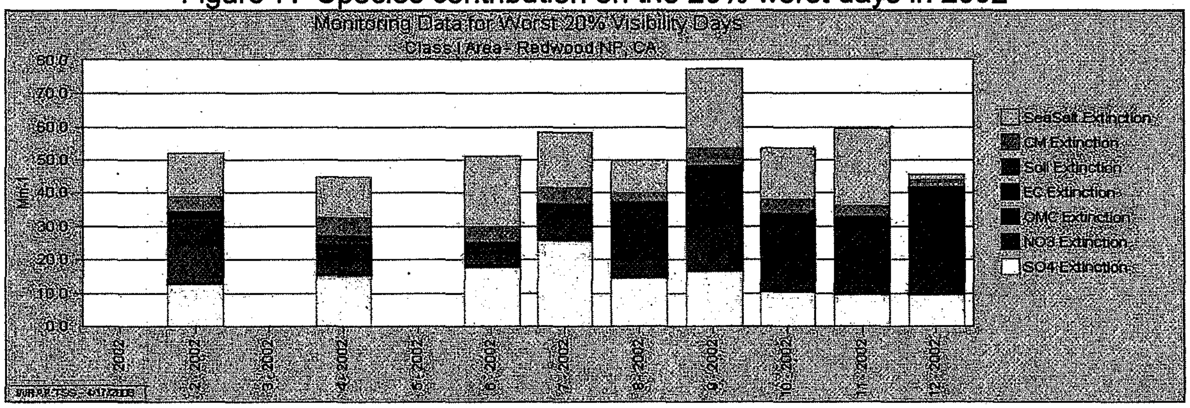
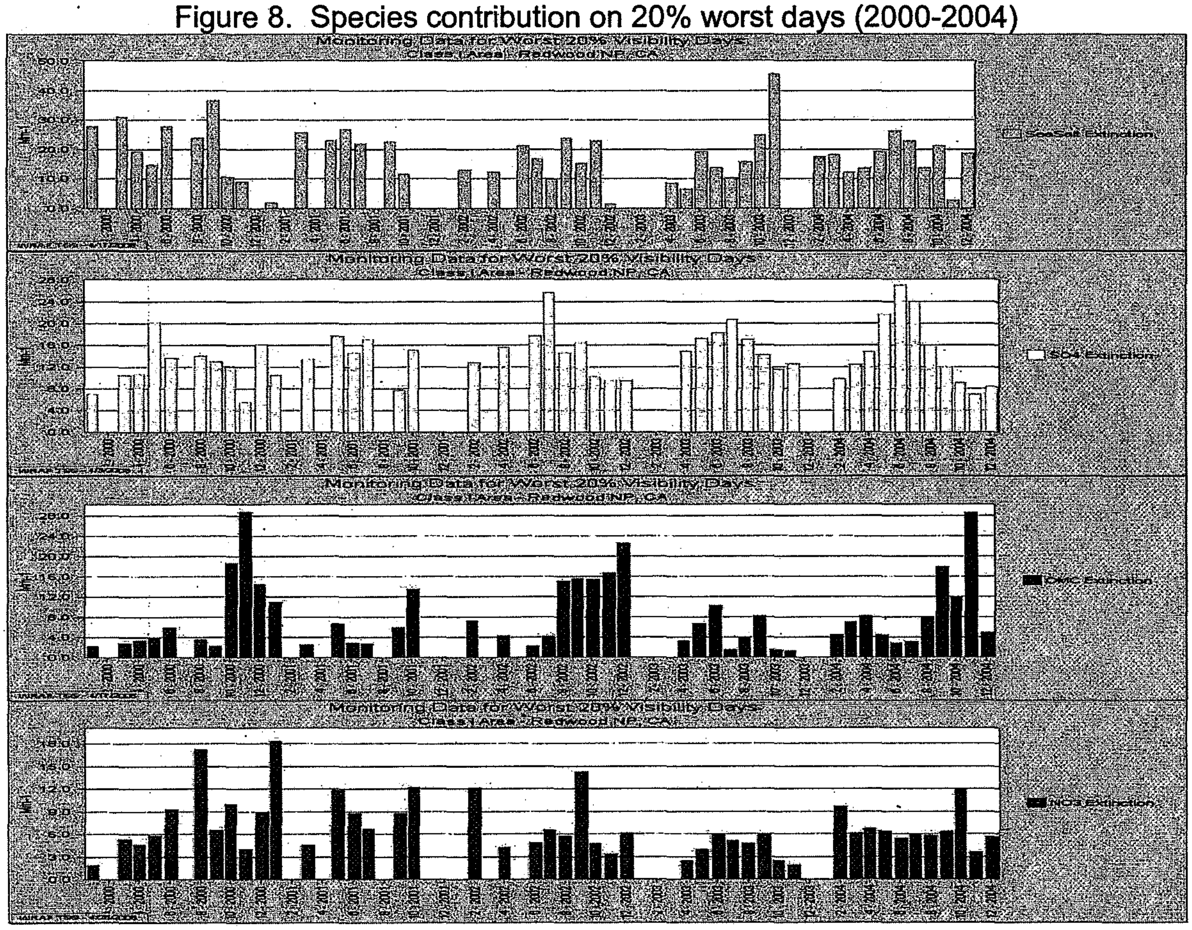



**Figure 8. Species contribution on 20% worst days (2000-2004)**



*1I.f. .Sources of Haze Species*

Both natural and man-made sources contribute to the calculated deciview levels made by haze pollutants at REDW1. Some haze species arise from sources that are within the control of the State of California or neighboring states. Others arise from natural, uncontrollable situations such as wildfires, sea salt or dust storms in natural areas, whether they are from in-state or out-of-state (and out-of-country) sources. Finally, other uncontrollable, man-made sources are those industrial pollutants and other man-made (anthropogenic) emissions·transported from outside the United States.

Figure 9 illustrates the glide slope for the 20% worst visibility days at the REDW1 monitor. Sea salt are the only emissions that actually increase by 2064. This is because as anthropogenic emissions are removed, sea salt will playa larger role in contributing to the haze seen at the REDW1 monitor.

Figures 10 and 11 represent the regional contributions to sulfate on the 20% worst days in 2002 and 2018 at REDW1. The Outside Domain region represents 51 % ofthe sulfate contributions in 2002 and 2018, followed by the emissions from the Pacific Offshore Region (23%) and the WRAP Region (23%). California contributes 1% of the total sulfate emissions seen at the REDW1 monitor.

Individually, emissions from outside the modeling domain contribute the most to sulfate concentrations at the REDW1 monitor. The next largest contributor to sulfate concentration· is from area sources in the Pacific Offshore Region.

Figure 12 shows the primary organic carbon source contribution from California and the outside regions. The largest contributor to primary organic carbon at the REDW1 monitor is from natural fire sources within Oregon. Oregon represents 95% of all natural fire source contributions..

Figure 13 illustrates the total organic carbon source apportionment from 2000-2004 for anthropogenic and biogenic sources. The biogenic secondary emissions account for 52% of the total organic carbon. Anthropogenic and biogenic primary source emissions account for 46% of the total organic carbon emissions and anthropogenic secondary is responsible for the remaining emissions.

Figures 14 and 15 represent the regional contributions to nitrate on the 20% worst days. The WRAP region represents the largest contribution to nitrate in 2002 and 2018 (50%), followed by the Pacific Offshore Region (28%) and emissions from outside the modeling domain (20%). In 2002,8% of the nitrate at the REDW1 monitor can be attributed to California.

From the WRAP region, Oregon is shown to contribute the most to nitrate concentrations at the REDW1 monitor in 2002 and 2018. Currently, Oregon mobile sources are 75% of Oregon contributions to nitrate at the REDW1 monitor. Oregon mobile source emissions reductions are mainly responsible for improvement in nitrates in 2018.

**Figure 9.** REDW1 Glide slope for 20% worst visibility days

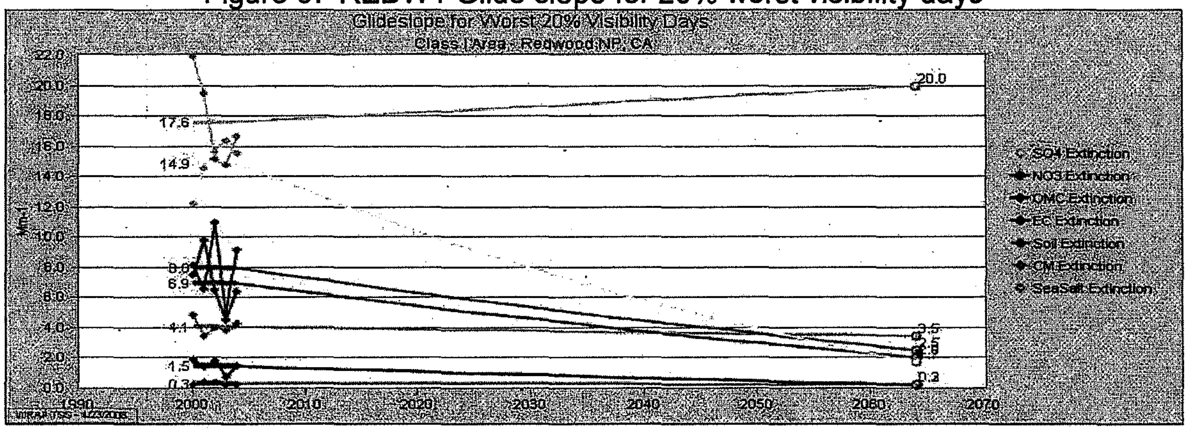



**Figure 10.** Regional Sulfate contribution to haze in 2002 and 2018

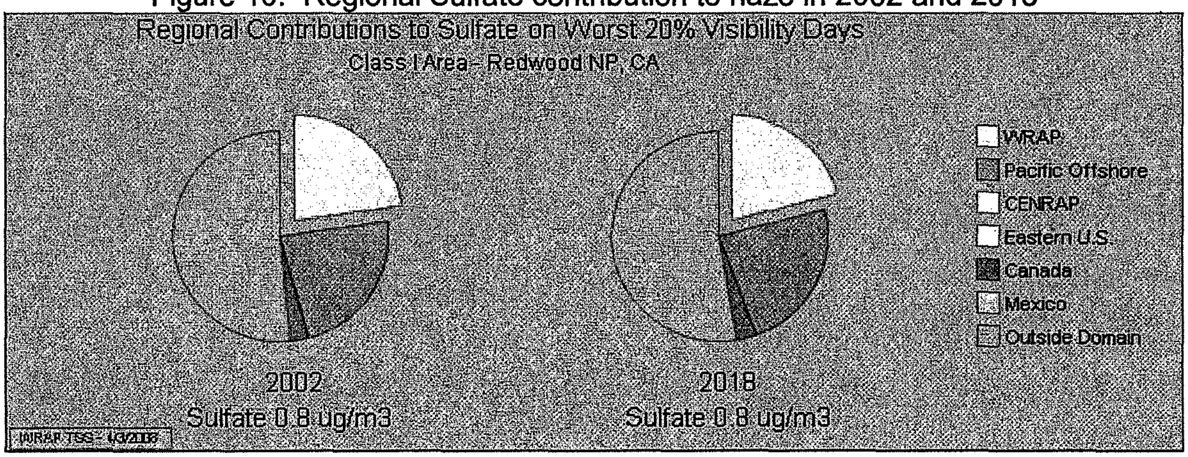



**Figure 11.** Sulfate source contribution from CA and outside regions

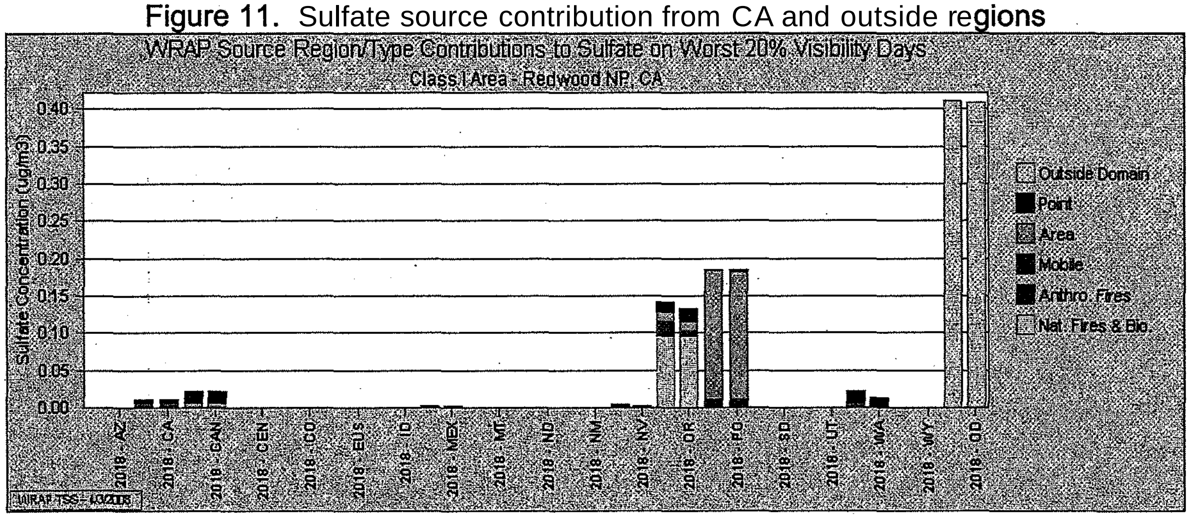


Figure 12. Or anic carbon source contribution from CA and outside regions

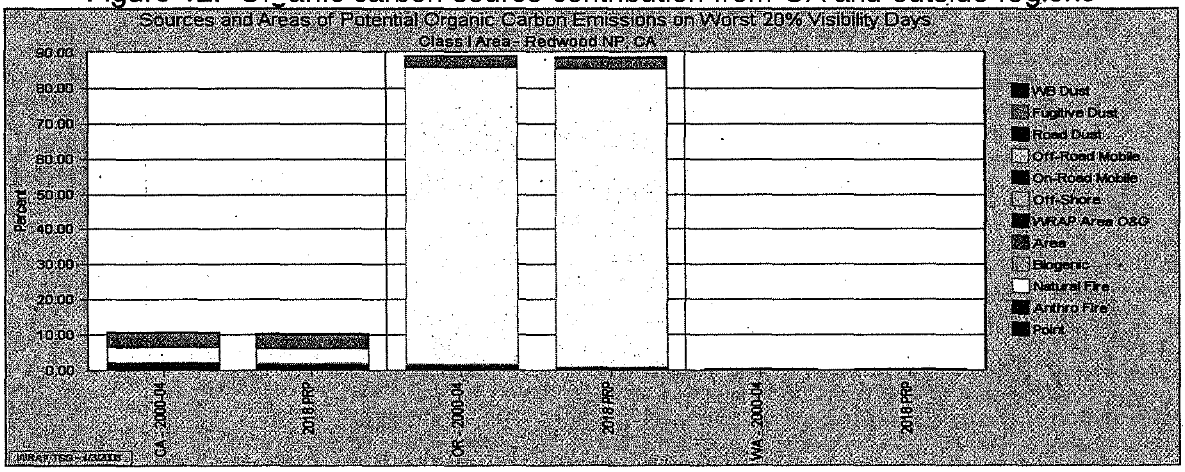



Figure 13. Organic carbon Anthro 0 enic and Bio enic source apportionment

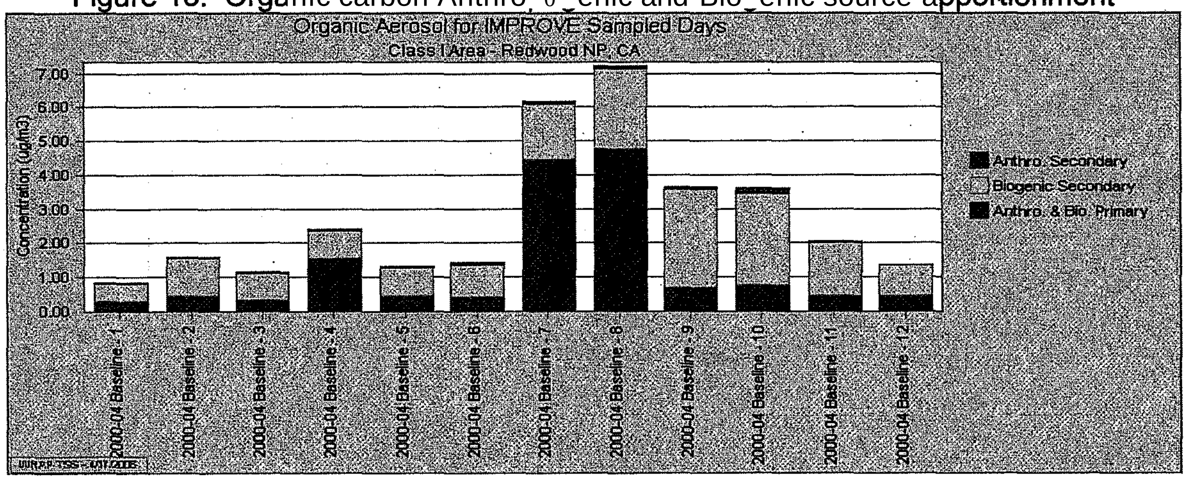



Figure 14. Regional Nitrate contribution to haze in 2002 and 2018

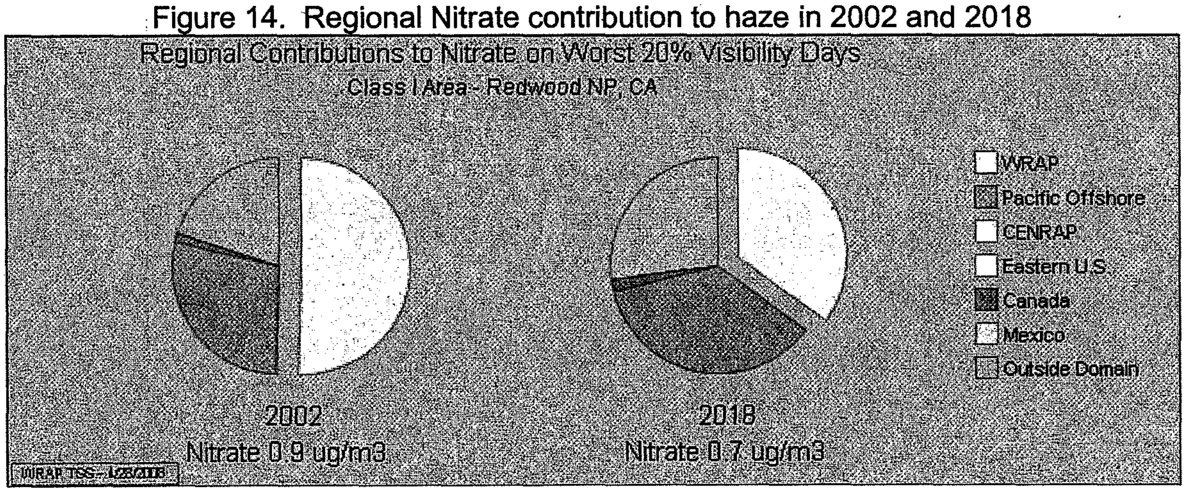
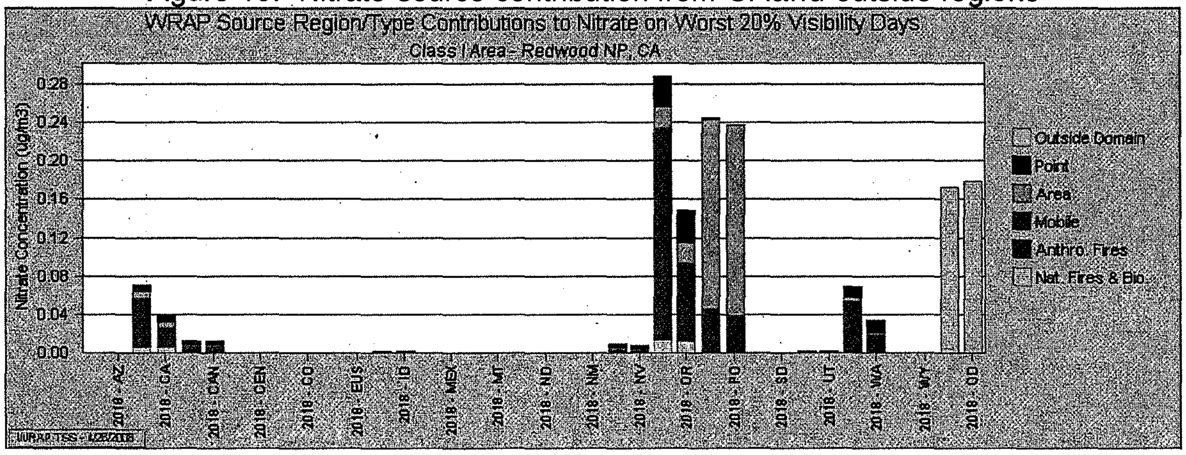


**Figure 15.** Nitrate source contribution from CA and outside regions



# PORE1 Monitor

## Section I.; Description

Point Reyes Wilderness Area (Polnt Reyes) occupies 25,370 acres within the Point Reyes National Seashore situated just north of San Francisco. Point Reyes National Seashore is a peninsula that extends into the Pacific Ocean about 12 miles from the California malnland. The Wilderness consists primarily of the complex terrain section of the peninsula east of and parallel to Highway 1, with elevations ranging from sea level to nearly 427 meters at highest hilltops. The land is composed of estuaries, .windswept beaches, coastal scrub grasslands, marshes, and some coniferous forest at higher elevations;

Figure 1. PORE1 Monitor location

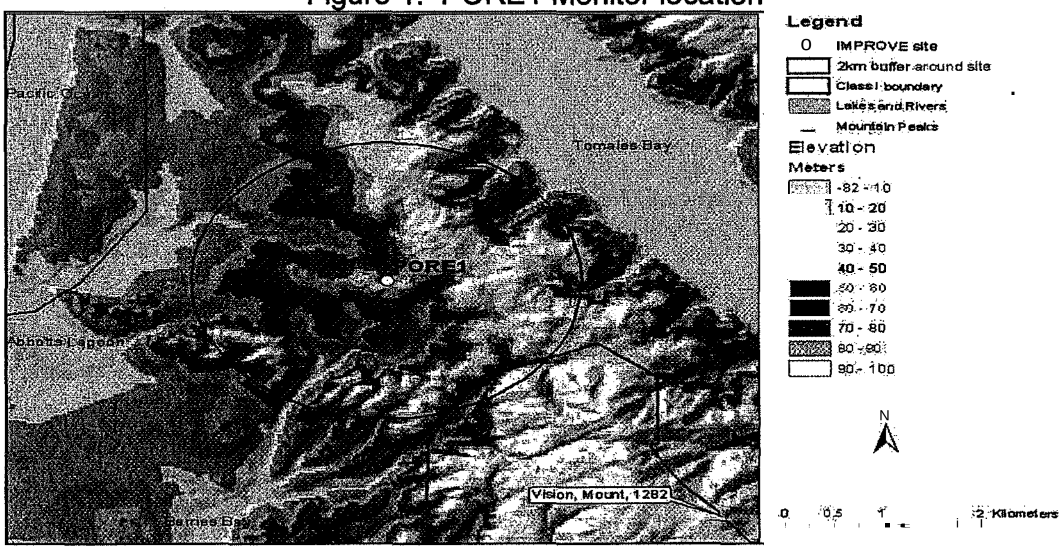
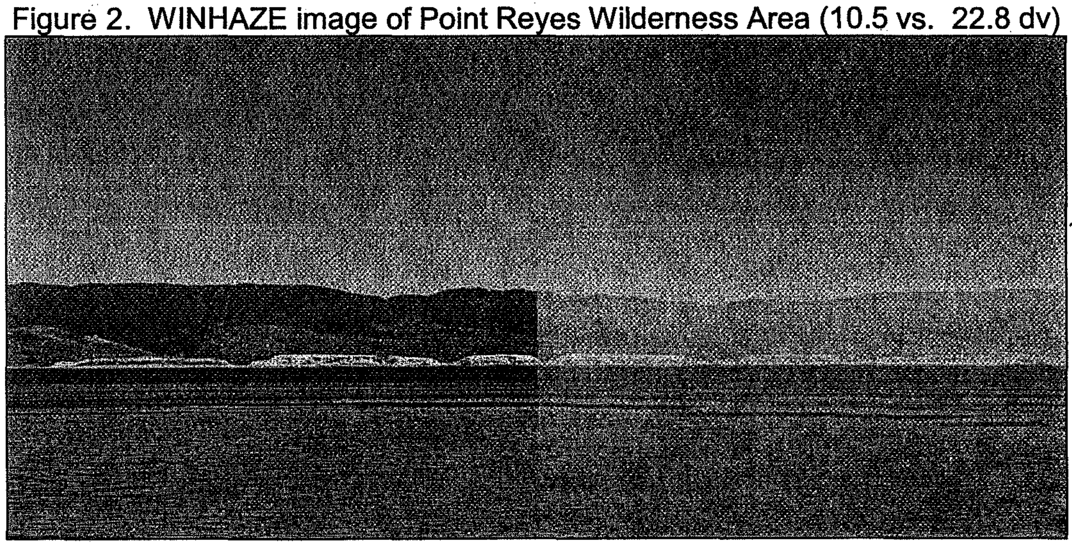
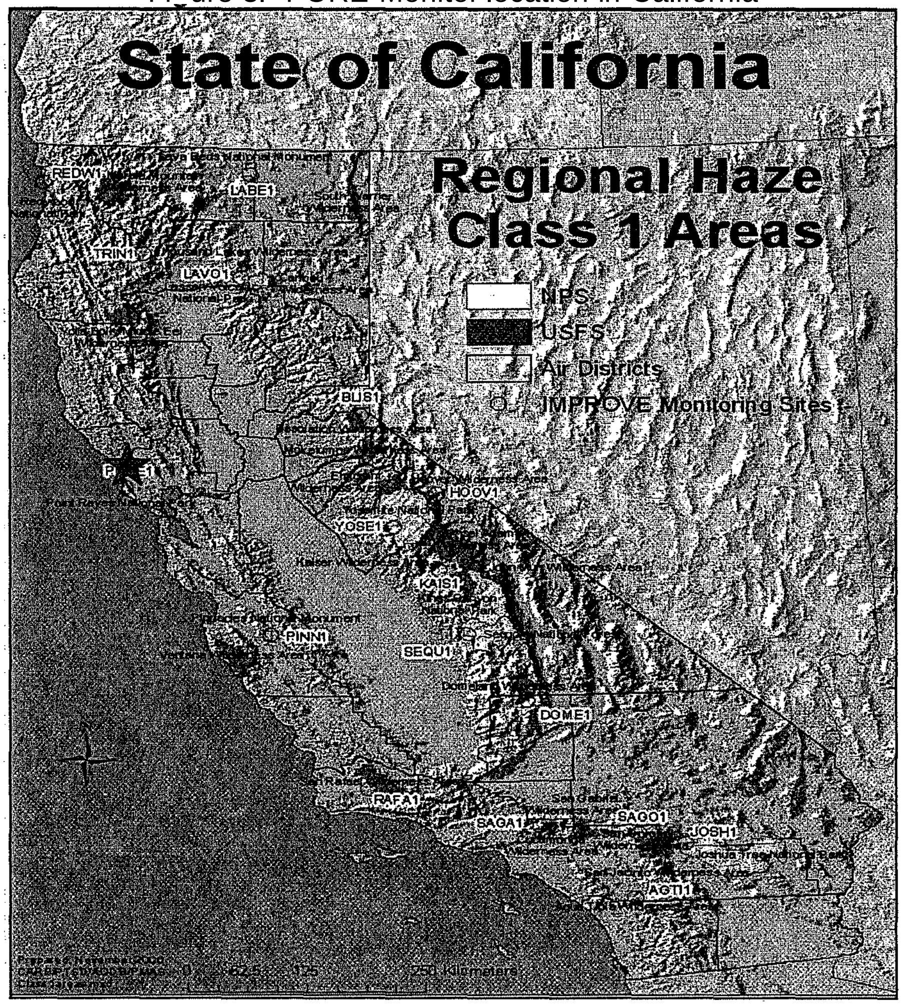



Figure 2. WINHAZE image of Point Reyes Wilderness Area (10.5 vs. 22.8 dv)



Fi_ure 3. PORE Monitor location in California




Section II. Visibility Conditions:

*II.a. Visibility Monitor Location*

Visibility conditions for Point Reyes are currently monitored by the PORE1 IMPROVE monitor. The monitor is located at 38.1224 north latitude and 122.9085 west longitude, and located in the center of three distinct areas of the wilderness at an elev.ation of 97 meters. The site has been operating since March 1988. This site does not have sufficient data for the entire baseline period. Data was not available for the years 2001 and 2003.

The PORE1 IMPROVE site is located centrally within the small range of Wilderness elevations. It is very representative of aerosol composition and concentration at Point Reyes Wilderness locations.. The nearest major population and industrial center is the San Francisco Bay area to which Point Reyes is almost adjacent but separated from by the Marin Peninsula north of the Golden Gate. Downtown San Francisco is about 20 miles to the south. North Bay communities of Petaluma and San Rafael are about 15 miles east, on the east side of the Bolinas Ridge.

The PORE1 location is adequate for assessing the 2018 reasonable progress goals for the Point Reyes Wilderness Class 1 area.

### *II.b.* ***Baseline Visibility***

Baseline visibility is determined from PORE1 IMPROVE monitoring data for the 20% best and the 20% worst days for the yea"rs 2000 through 2004. The baseline visibility for the Point Reyes Wilderness Area is calculated at 10.5 deciviews for the 20% best days and 22.8 deciviews for the 20% worst days. Figure 3 represents the worst baseline visibility conditions.

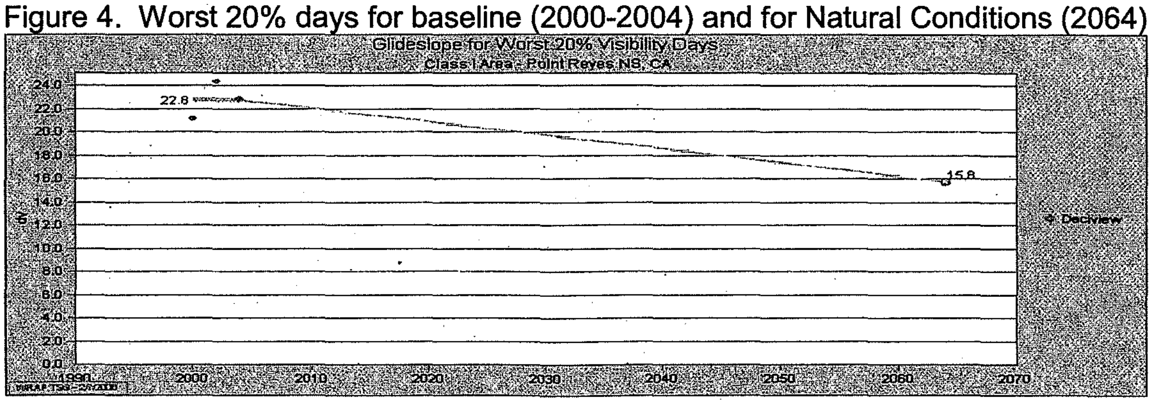
### *II.c.* ***Natural Visibility***

Natural Visibility represents the visibility condition that would be experienced in the absence of human-caused impairment. Based on EPA gUidance, the natural visibility for the Point Reyes Wilderness Area is 4.8 deciviews for the 20% best days and 15.8 deciviews for the 20% worst days. It is possible that the Natural Conditions deciview value for 2064 could change in the future as more is learned about natural plant emissions and wildfire impacts.

### *II.d.* ***Presumptive Glide Slope and the Uniform Rate of Progress***

Figure 3 also shows the uniform rate of progress, or "glide slope." The glide slope is the rate of reduction in the 20% worst days deciview average that would have to be achieved to reach natural conditions at a uniform pace in the 60 years following the baseline period. The first benchmark along the path towardsachreving natural conditions occurs in 2Q18. The glide slope shows that the 2018 benchmark for the 20% worst days is 21.17 deciviews. According to the Regional Haze Rule, the 20% best days baseline visibility of 10.5 deciviews must be maintained or improved by 2018, the end of the first planning period.

**Figure 4. Worst 20% days for baseline (2000-2004) and for Natural Conditions (2064)**



### *II.e.* ***Species Contribution .***

Each pollutant species causes light extinction but its contribution differs on best and worst days. Figure 5 shows the contribution of each species to the 20% best and worst days in the baseline years at PORE1.

Figure 5. Average Haze species contributions to light extinction in the baseline years

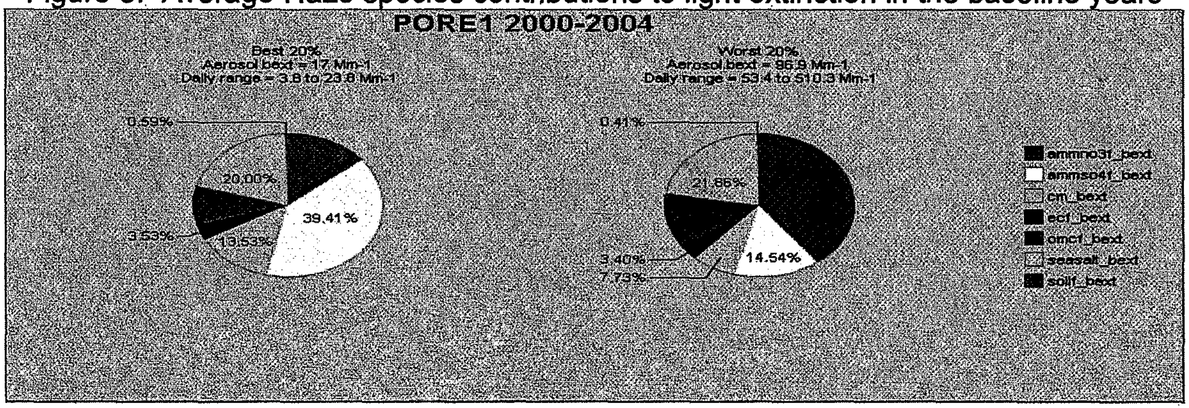
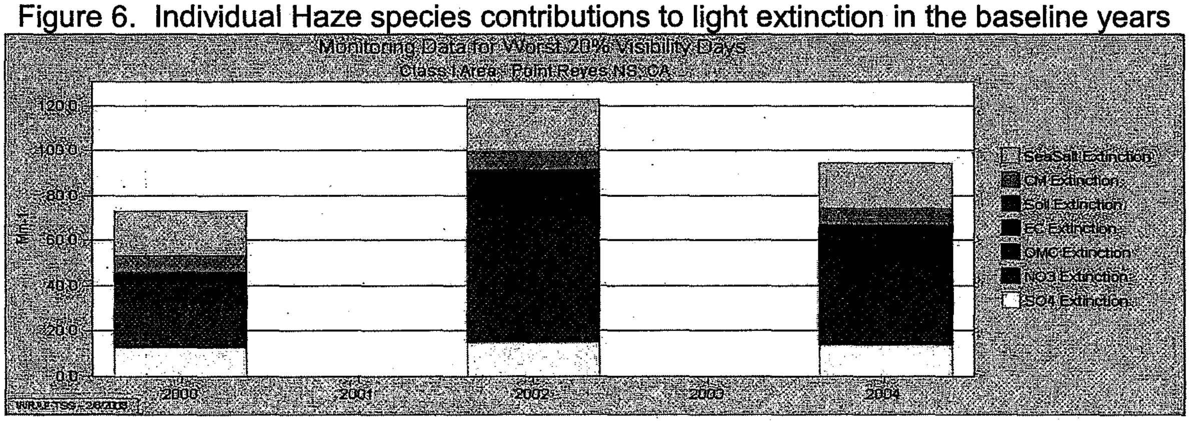



Figure 6. Individual Haze species contributions to light extinction in the baseline years




As shown in Figures 5 and 6, nitrates, sea salt, and sulfates have the strongest contributions to degrading visibility on worst days at Point Reyes Wilderness Area. The worst days are dominated by nitrate, while the best days are dominated by sulfate. Data points for 2001 and 2003 were insufficient for calculating best and worst days per the Regional Haze Rule Guidance.

Figure 7 depicts the individual species contribution to worst days in 2002. Nitrates increase in the winter months and sea salt is always present but peaks in the months of March-June. The worst days occur when sea salt is elevated. Sulfates are slightly higher in the summer and they almost double from best to worst days. The occurrence of elevated organic matter concentrations is sporadic throughout the year. Sea salt is driving the worst days for most of the year in 2002. Nitrates clearly dominate the other haze species on worst days, but sea salt, sulfate, and organic matter also contribute to the worst days in the summer. There are only trace amounts of coarse mass and elemental carbon present throughout the years.

Figure 8 illustrates the individual species contribution on worst days in 2000-2004 by monthly average. The trend shown is comparable to Figure 7 for sea salt, nitrates, sulfates, and organic matter. High organic periods vary from year to year due to the unpredictable occurrence of wild fires. For example, the elevated organic carbon concentrations in August 2002 can be attributed to the Biscuit Fire that burned extensive acreage in Southern Oregon and Northern California.

Figure 7. Species contribution on the 20% worst days in 2002

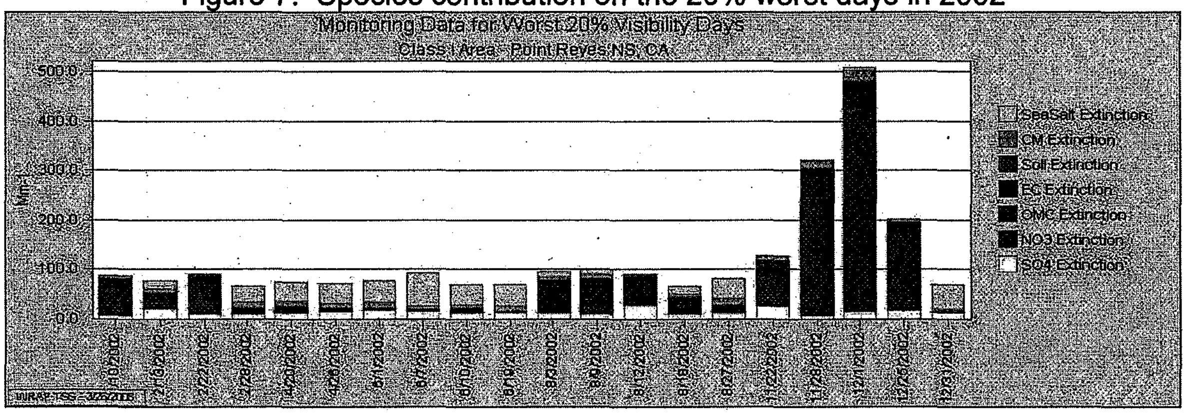
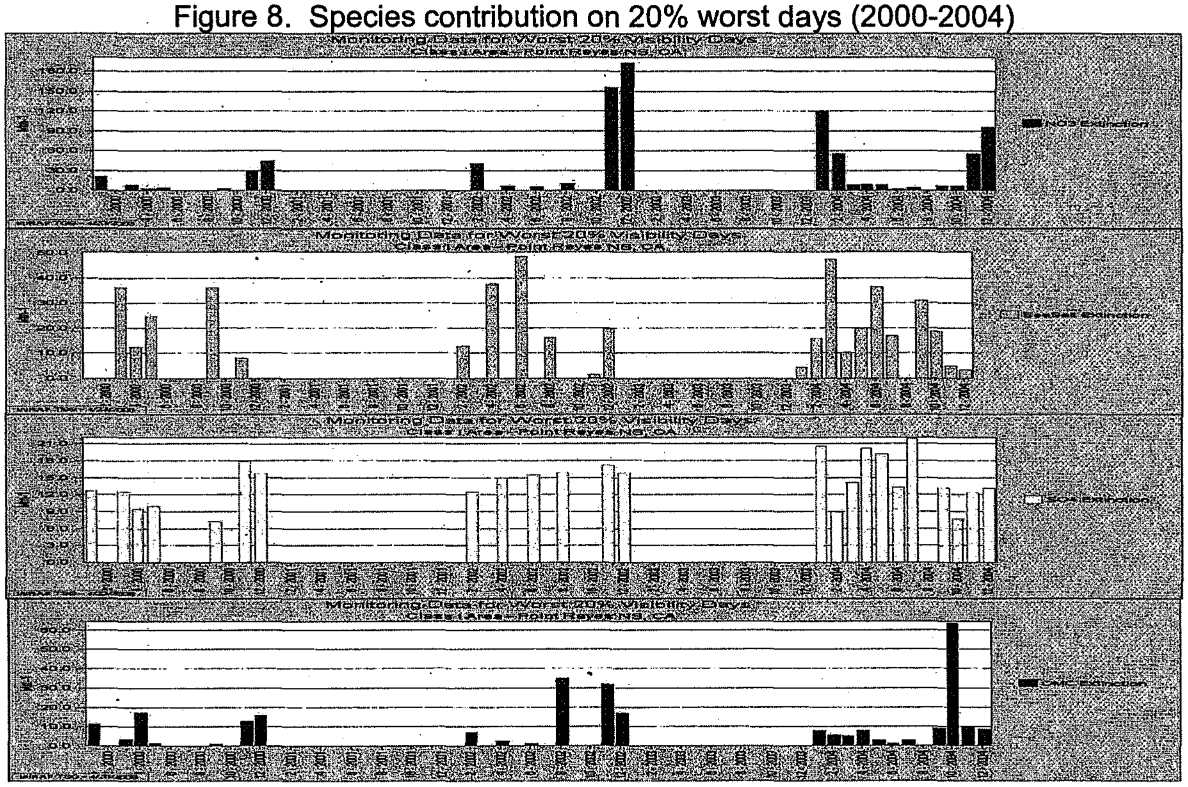



Figure 8. Species contribution on 20% worst days (2000-2004)



*1I.f. Sources of Haze Species*

Both natural and man-made sources contribute to the calculated deciview levels made by haze pollutants at PORE1. Some haze species arise from sources that are within the control of the State of California or neighboring states. Others arise from natural, uncontrollable situations such as wildfires, sea salt or dust storms in natural areas, whether they are from in-state or out-of-state (and out-of-country) sources. Finally, other uncontrollable', man-made sources are those industrial pollutants and other man-made (anthropogenic) emisSions transported from outside the United States.

Figures 9 and 10 represent the regional contributions to nitrate on the 20%.worst days. The WRAP region represents the largest contribution to nitrate in 2002 and 2018 (85%), followed by the Pacific Offshore Region (9%) and emissions from outside the modeling domain (6%). In 2002, 76% of the nitrate at the PORE monitor can be attributed to California.

From the, WRAP region, California is shown to contribute the most to nitrate concentrations at the PORE monitor in 2002 and 2018. Currently, California mobile sources are 75% of California contributions to nitrate at the PORE monitor. California mobile source emissions reductions are mainly responsible for improvement in nitrates in 2018.

Figure 11 illustrates the 20% worst visibility days at the PORE1 monitor. Sea salt emissions are the only source that actually increases in 2064. This is because as anthropogenic emissions are removed, sea salt will playa larger role in contributing to the haze seen at the PORE1 monitor.

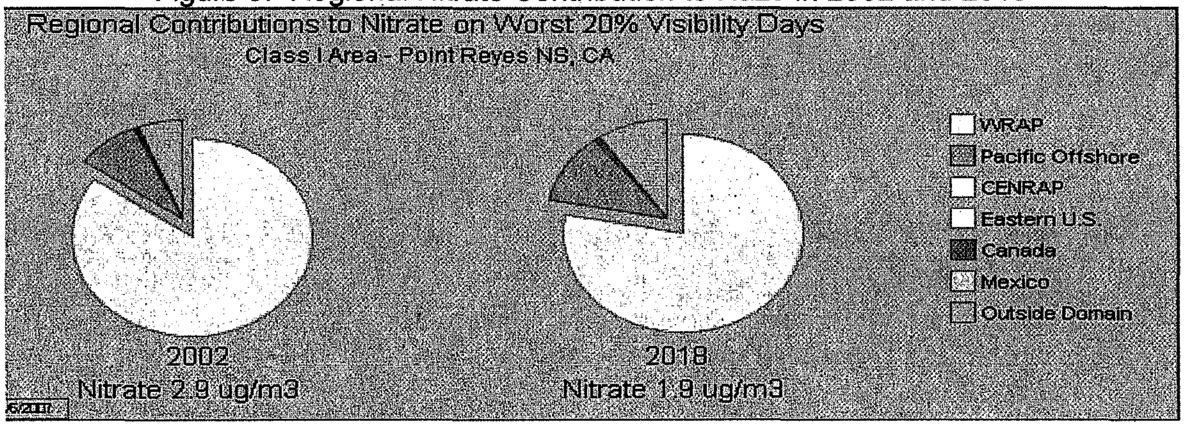
Figures 12 and 13 represent the regional contributions of sulfate on the 20% worst days in 2002 and 2018 at PORE. The WRAP region represents 38% of the sulfate contributions in 2002 and 2018, followed by the emissions from outside the domain (35%) and the Pacific Offshore Region (23%). California contributes 17% of the total sulfate emissions seen at the PORE1 monitor.

Individually, emissions from outside the modeling domain contribute the most to sulfate concentrations at the PORE1 monitor. The next largest contributor to sulfate concentration is from area sources in the Pacific Offshore Region.

Figure 14 shows the primary organic carbon source contribution from California and the outside regions. The largest contributor to primary organiccarbon at the PORE1 monitor is from area sources within California. California represents 92% of all area source contributions.

Figure 15 illustrates the total organic carbon source apportionment from 2000-2004 for anthropogenic and biogenic sources. The anthropogenic and biogenic primary source emissions account for 57% of the total organic carbon. Biogenic secondary emissions account for 39% of the total organic carbon emissions and anthropogenic secondary is responsible for the remaining emissions.

**Figure 9. Regional Nitrate Contribution to Haze in 2002 and 2018**




Fi_ure 10. Nitrate source contribution from CA **and outside regions**

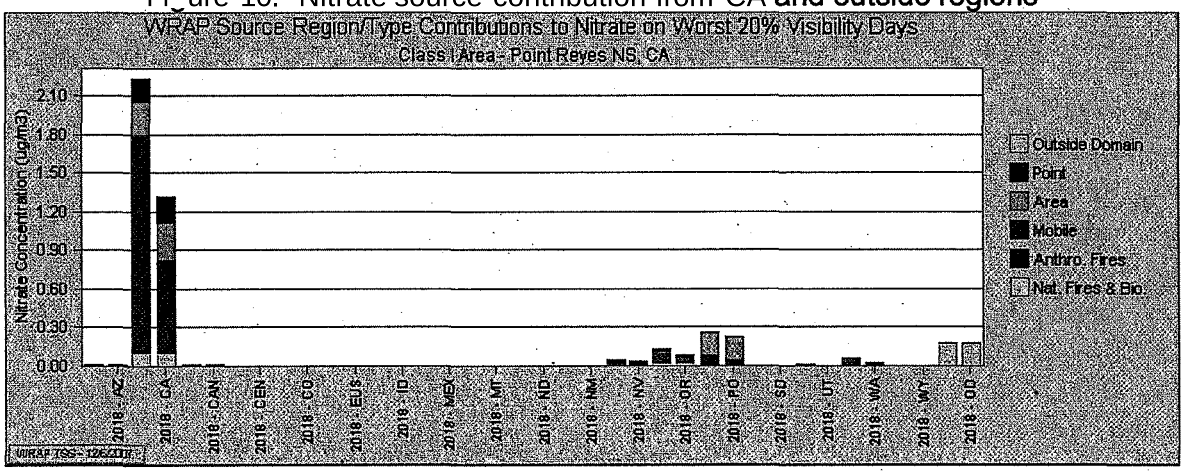



**Figure 11. PORE1 glide slope for the 20% worst visibility days**

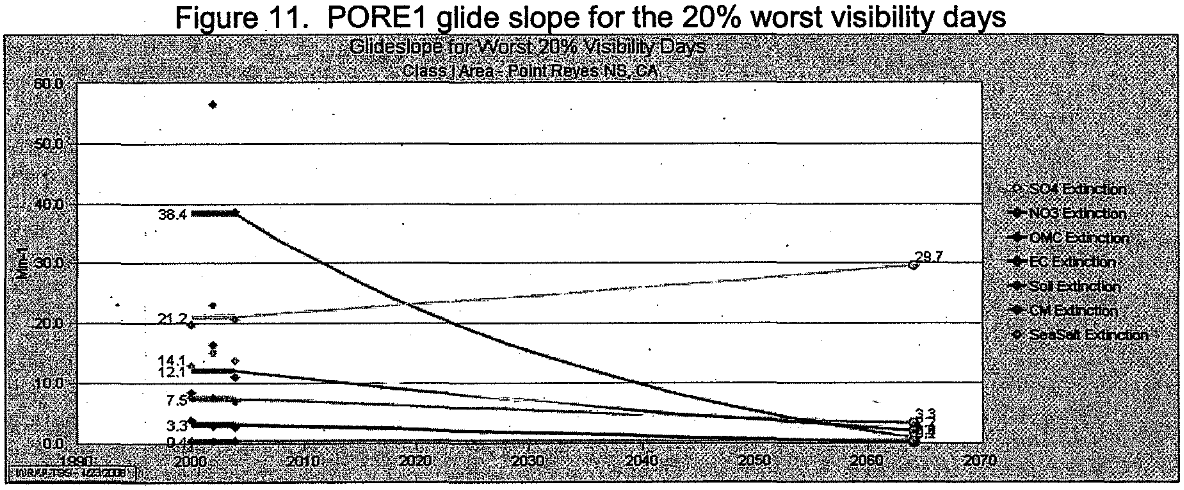
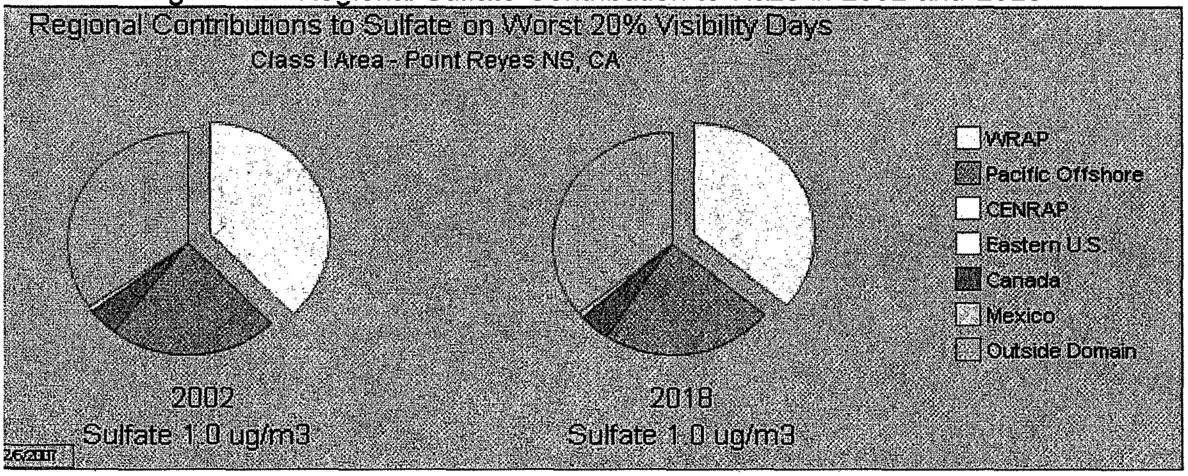


**Figure 12.** Re˯ional Sulfate Contribution to Haze in 2002 and 2018




Fi˯ure 13. Sulfate source contribution from CA and outside regions

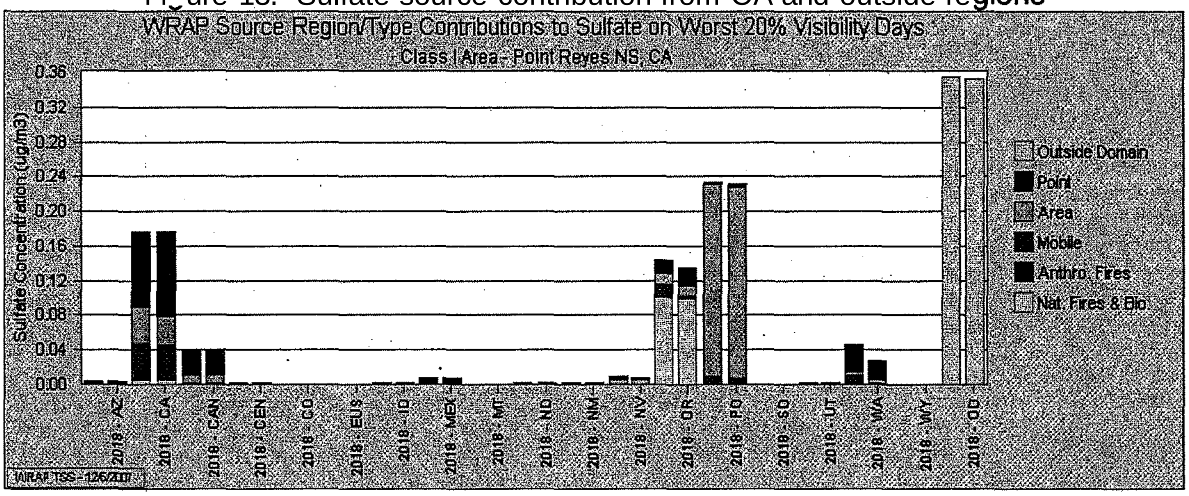



**Figure 14. Organic carbon source contribution from CA and outside regions**

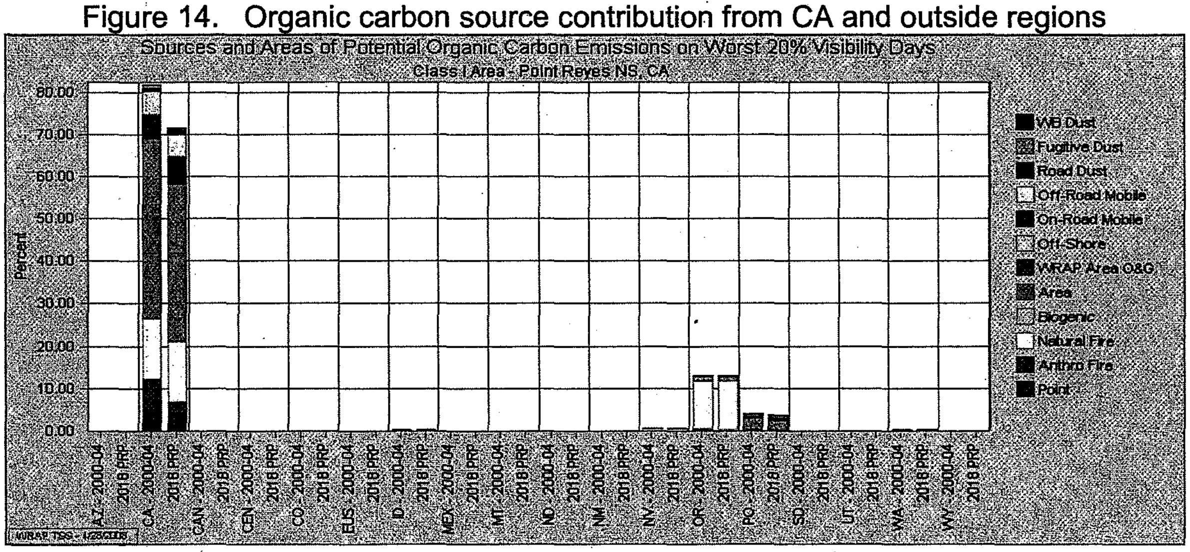
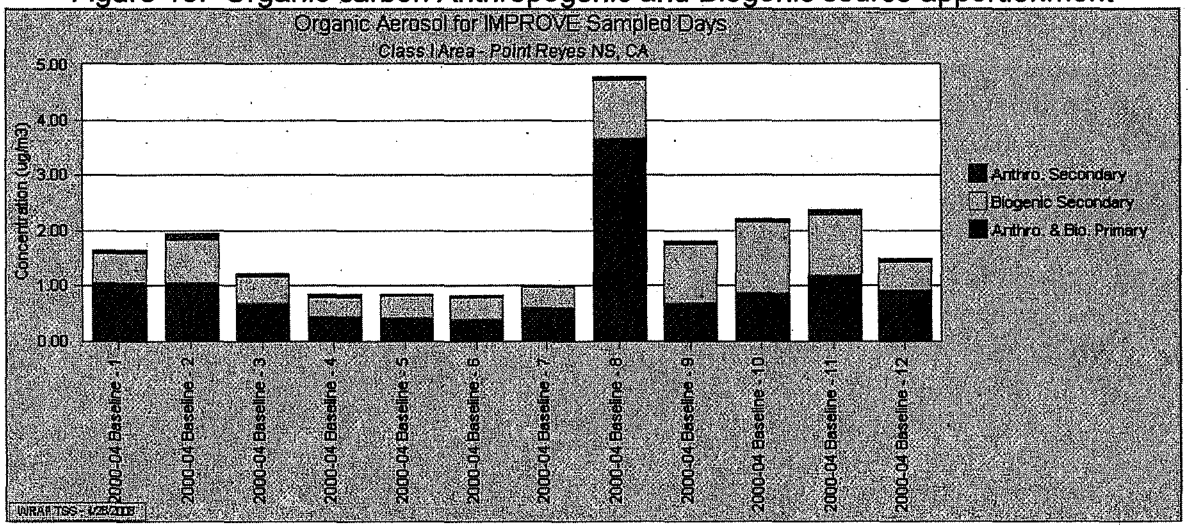


Figure 15. Organic carbon Anthropogenic and Biogenic source apportionment



## PINN1 Monitor

The PINN1 monitor location represents two wilderness areas located near the Central Coast Range in California. The wilderness areas associated with the PINN1 monitor are Pinnacles National Monument and Ventana Wilderness area. The PINN1 site has been operating since March 1988. This site does not have sufficient data for the entire baseline period. Data was not available for the year 2001.

### Section I. PINN1 Wilderness Area Descriptions

#### *I.a. Pinnacles Wilderness Area*

The Pinnacles Wilderness Area (Pinnacles) comprises 12,952 acres within the Pinnacles National Monument. Pinnacles is located in the southern portion of the Gabilan Mountains, one of a series of parallel northwest-southeast ridges that make up the Central Coast Range. Within the Wilderness Area, elevations range from 251 meters along South Chalone Creek to 1007 meters at North Chalone Peak. Much of the terrain is rolling hills. It is about 40 miles inland from the Pacific Ocean, with the Santa Lucia Mountains between, which.modifies the Ocean's influence. The Gabilan range is bounded on the west by the Salinas Valley which provides a conduit to the Pacific coast near Monterey, 40 miles east. It is bounded on the east by the San Benito Valley which is the southern extension of the Santa Clara valley at the southern end of the San Francisco Bay area 60 miles to the north.

**Figure 1. PINN1 Monitor location**

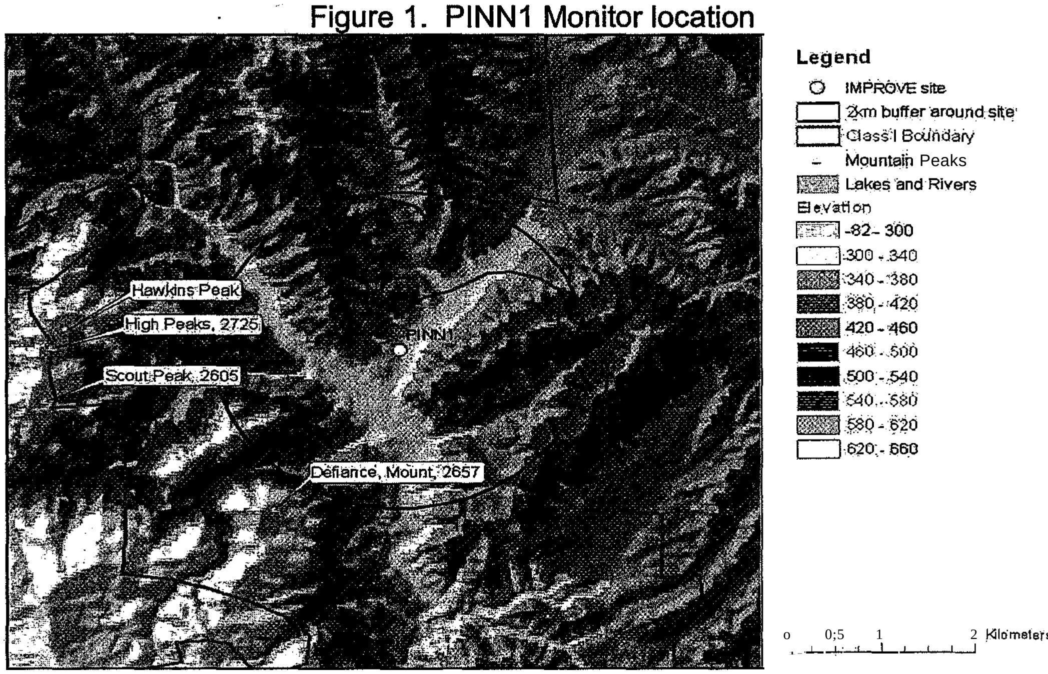
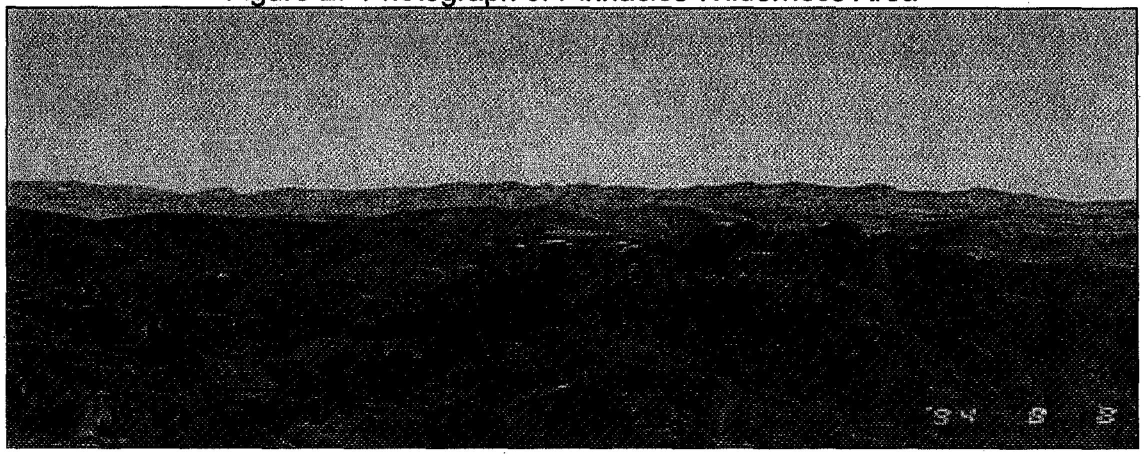


Figure 2. Photograph of Pinnacles Wilderness Area



*I.b. Ventana Wilderness Area*

The Ventana Wilderness Area (Ventana) consists of 95,152 acres straddling the Santa Lucia Mountains, about 15 miles south of Monterey Bay. The terrain is comprised of steep ridges and peaks. The Wilderness is in two sections, a large section consisting of most of the northwest Santa Lucias, and a smaller section to the southeast that includes Juniper Serra Peak. Elevations range from 183 meters where the Big Sur River exits the Wilderness on the west side, to 1,787 meters at the crest of Junipero Serra Peak, the highest point in the Santa Lucia range. The Santa Lucia "range is the first barrier to westerly winds and presents a rain shadow over inland areas. Annual precipitation on the coast side totals up to 75 inches, mostly in the winter, with as little as 25 inches a few miles inland. "Summertime fog can cover lower elevations on the west side, but seldom reaches more than a few miles inland. Ventana Wilderness and the Santa Lucia range are bordered on the west side by the Pacific Ocean and on the east side by Carmel Valley, Sierra de Salinas, and the Salinas Valley. Carmel Valley and Salinas " Valley both exit into the Monterey Bay area to their northwest. The Santa Lucia range is thus within the maritime influence of the Pacific Ocean on the west and east side.

Figure 3. WINHAZE image of Ventana Wilderness Area (8.9 vs. 18.5 deciviews)

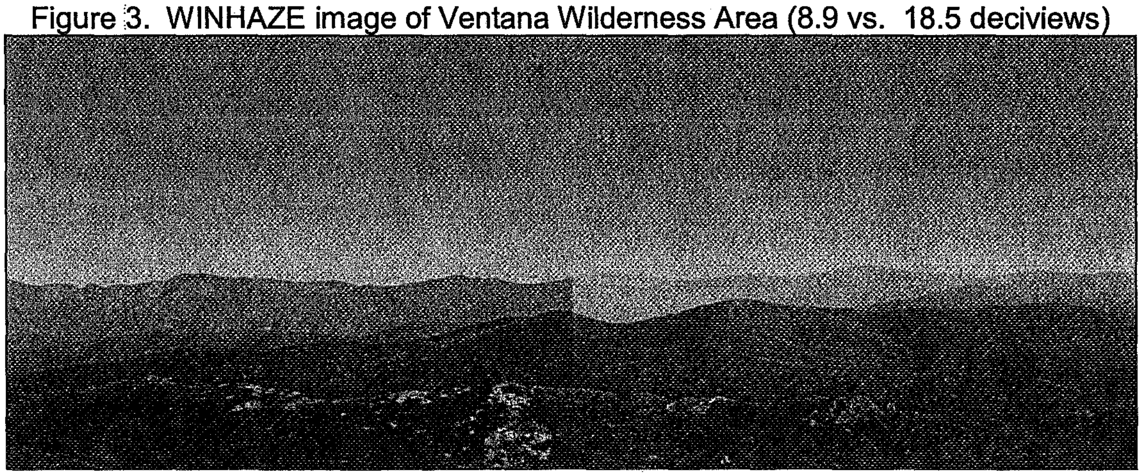
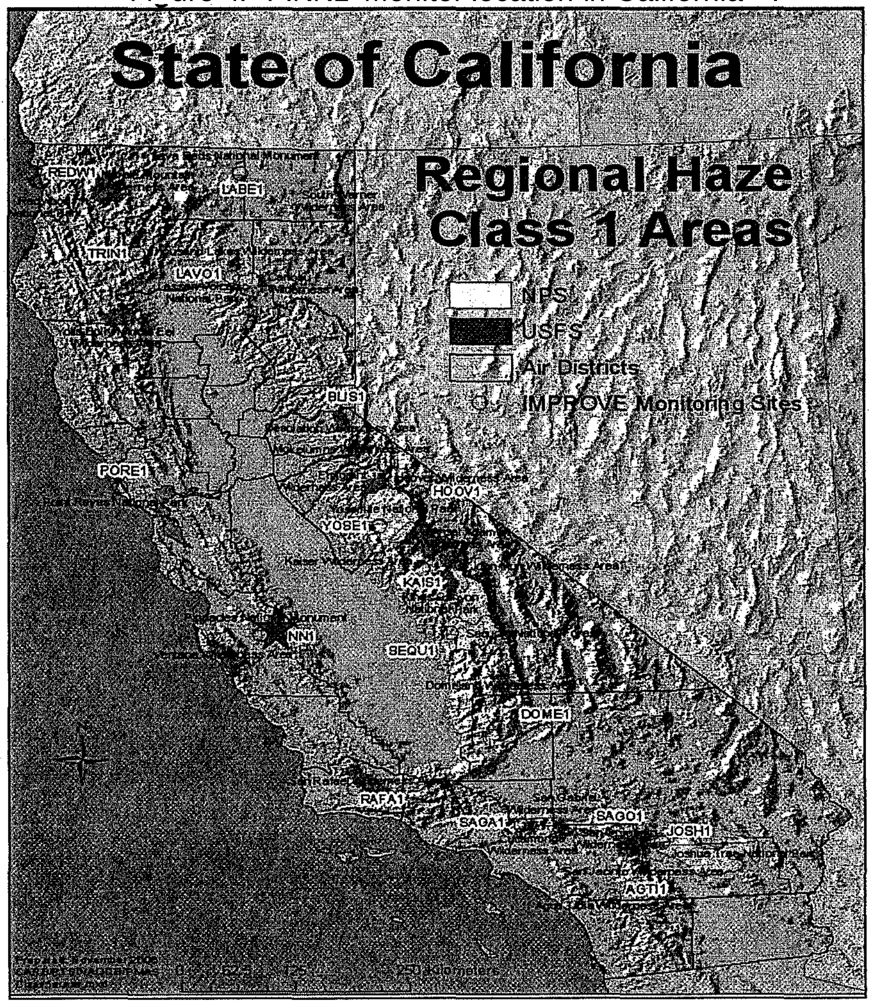


Figure 4. PINN1 Monitor location in California




Section II. Visibility Conditions:

*II.a. Pinnacles National Monument*

Visibility conditions for Pinnacles are currently monitored by the PINN1 IMPROVE monitor. The monitor is located at 36.4833 north latitude and 121.1568 west longitude in the Chalone Creek drainage near the eastern wilderness boundary at an elevation of 302 meters. This is very near the lower end of the Pinnacles Wilderness elevations and apprOXimately 609 meters lower than the highest Wilderness elevation.

The PINN1 IMPROVE site is representative of Pinnacles locations in general, although it is in the Chalone Creek drainage at a relatively low elevation with respect to most of the Wilderness.

The monitor may be isolated from higher elevations if a summertime inversion exists, or by being within a low-level wintertime inversion. These are probably relatively infrequent conditions, given the modest range of Wilderness elevations that extend about 762 meters vertically. The Pinnacles Wilderness is potentially influenced by three California source regions: the San' Francisco Bay area, the San Joaquin Valley, and the Monterey Bay area. Aerosol concentratioos in Pinnacles may be most closely linked to Bay Area emissions during episodic conditions that lead to aerosol accumulations.

The PINN1 location is adequate· for assessing.the 2018 reasonable progress goals for the Pinnacles Wilderness Class 1 area.

### *II.b. Ventana Wilderness' Area*

Visibility conditions for Ventana are currently monitored by the PINN1 IMPROVE monitor on the eastern side of the Pinnacles Wilderness Area. The monitor is located at 36A833 north latitude and 121.1568 west longitude, about 30 miles to the east of Ventana Wilderness, across the Salinas Valley, at an elevation of 302 meters.

PINN1 is likely much more influenced by the San Francisco Bay and San Joaquin Valley source regions, and less influenced by the Pacific Ocean. Its representation of the Ventana Wilderness may thus be marginal, and aerosol concentrations in the . Ventana Wilderness are probably much less than indicated by measurements at PINN1. The nearest population center to the Ventana Wilderness Area is the Monterey Bay area. There may also be some impact from the .Bay Area with transport southward via interior Santa Clara and Santa Bonita valleys, although emissions from those areas are likely pushed further east towards the Galiban Range and Pinnacles Wilderness area.

The PINN1 location is adequate for assessing the 2018 reasonable progress goals for the Ventana Wilderness Class 1 area.

### *II.c. Baseline Visibility*

Baseline visibility is determined from PINN1 IMPROVE monitoring data for the 20% best and the 20% worst days for the years 2000 through 2004. The baseline visibility for the PINN1 monitor is calculated at 8.9 deciviews for the 20% best days and 18.5deciviews for the 20% worst days. Figure 5 represents the worst baseline visibility conditions.

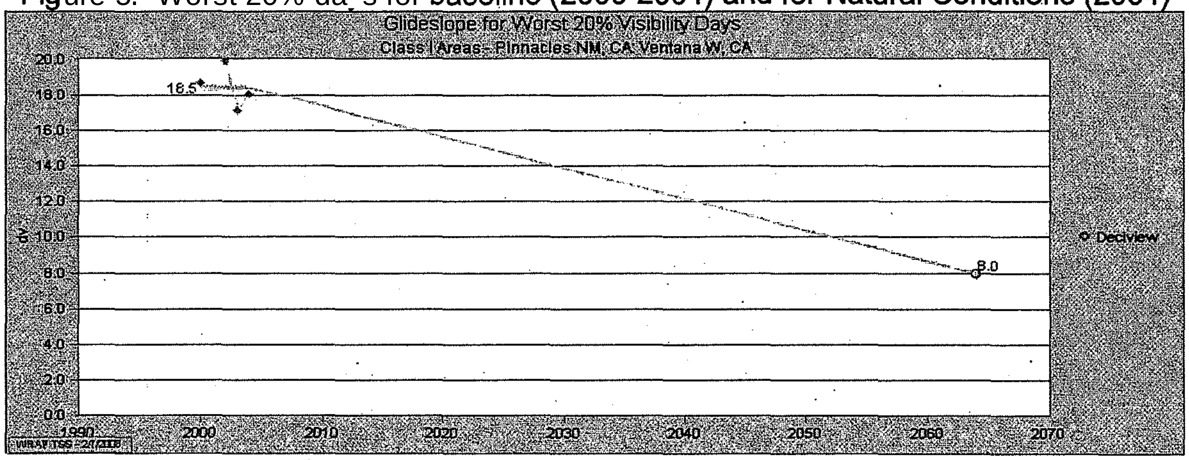
### *II.d. Natural Visibility*

Natural visibility represents the visibility condition that would be experienced in the absence of human-caused impairment. Based on EPA guidance, the natural visibility for the PINN1 monitor is 3.5 deciviews for the 20% best days and 8.0 deciviews for the 20% worst days. It is possible that the Natural Conditions deciview value for 2064 could change in the future as more is learned about natural plant emissions and wildfire impacts.

### *II.e.* ***Presumptive Glide Slope and the Uniform Rate of Progress***

FigureS also shows the uniform rate of progress, or "glide slope." The glide slope is the rate of reduction in the 20% worst days deciview average that would have to be achieved to reach natural conditions at a uniform pace in the 60 years following the baseline period. The first benchmark along the path towards achieVing natural conditions occurs in 2018. The glide slope shows that the 2018 benchmark for the 20% worst days is 16.02 deciviews. According to the Regional Haze Rule, the 20% best days baseline visibility of 8.9 deciviews must be maintained or improved by 2018, the end of the first planning period.

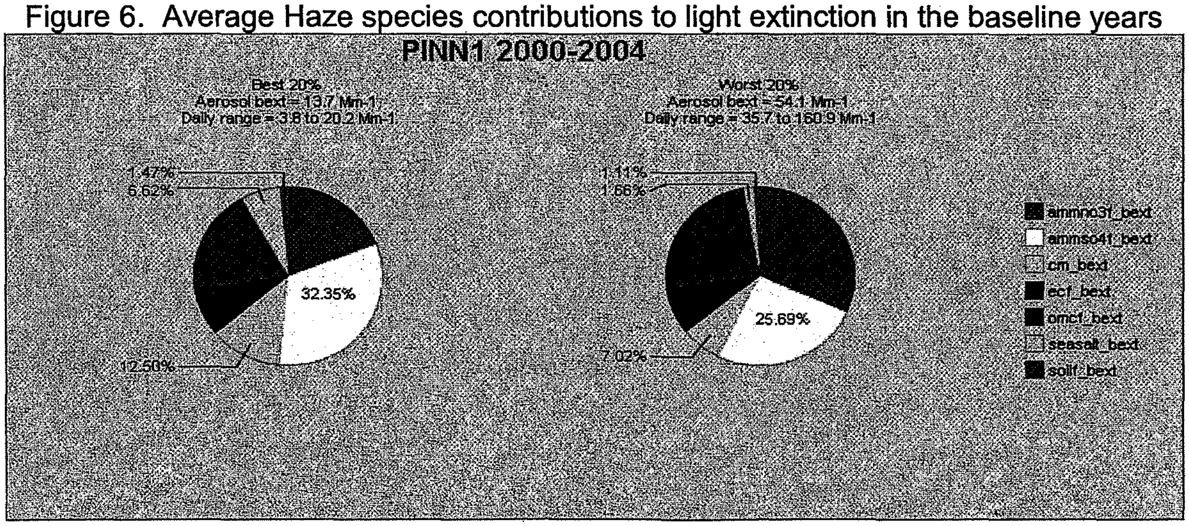
Figure 5. Worst 20% da_s for baseline (2000-2004) and for Natural Conditions (2064)



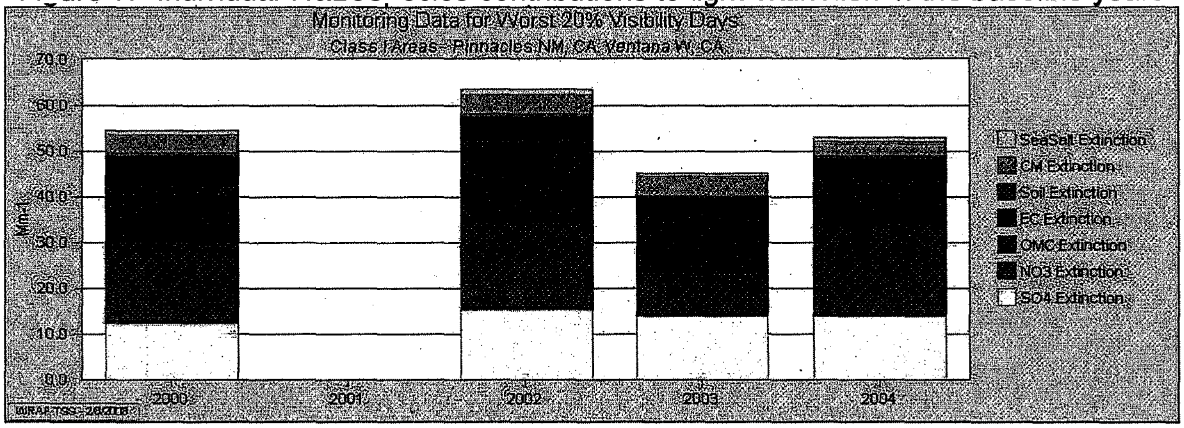

### *II.f.* ***Species Contribution***

Each pollutant species causes light extinction but its.cohtribution differs on best and worst days. Figure 6 shows the contribution of each species to the 20% best and worst days in the baseline years at PINNt.

Figure 6. Average Haze species contributions to light extinction in the baseline years



Fi_ure 7. Individual Hazes ecies contributions to light extinction in the baseline years




As shown in Figures 6 and 7, nitrates, sulfates, and organic matter have the strongest contributions to degrading visibility on worst days at the PINN1 monitor. The worst days are dominated by nitrate, while the best days are dominated by sulfate. Data points for 2001 were insufficient for calculating best and worst days per the Regional Haze Rule Guidance.

Figure 8 depicts the individual species contribution to worst days in 2002. Nitrates increase in the winter time while sulfates increase slightly in the spring and summer time'. The occurrence of elevated organic matter concentrations is sporadic throughout the year. Nitrates clearly dominate the other haze species on worst days, but sulfates, organic matter, coarse mass, elemental carbon, and sea salt also contribute to the worst days. There are only trace amounts of sea salt and soil present throughout the years.

Figure 9 illustrates the individual species contribution on worst days in 2000-2004 by monthly average. The trend shown is comparable to Figure 8 for nitrates, sulfates, and organic matter. High organic periods vary from year to year due to the unpredictable oCCurrence of wild fires.

**Figure 8.** Species contribution on the 20% worst da_s in 2002

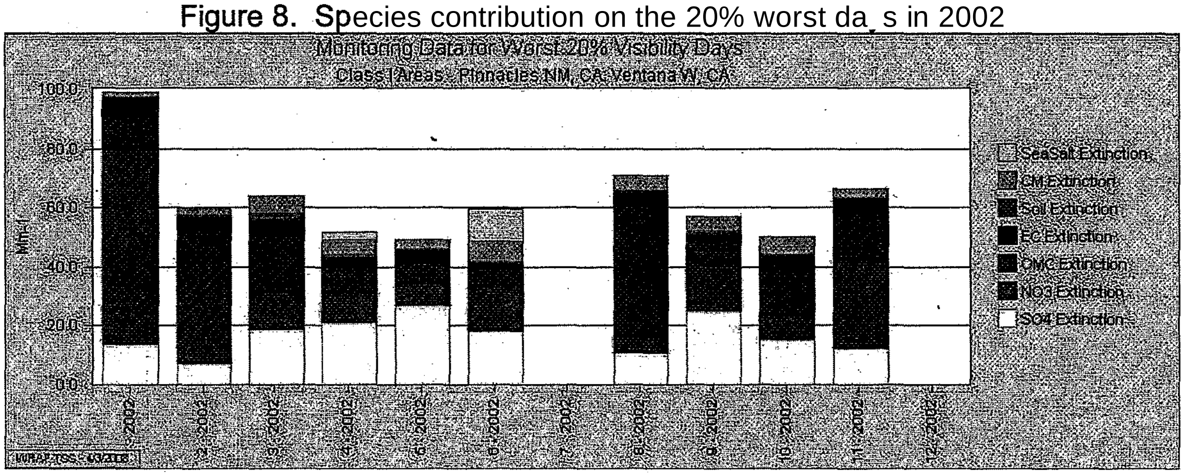
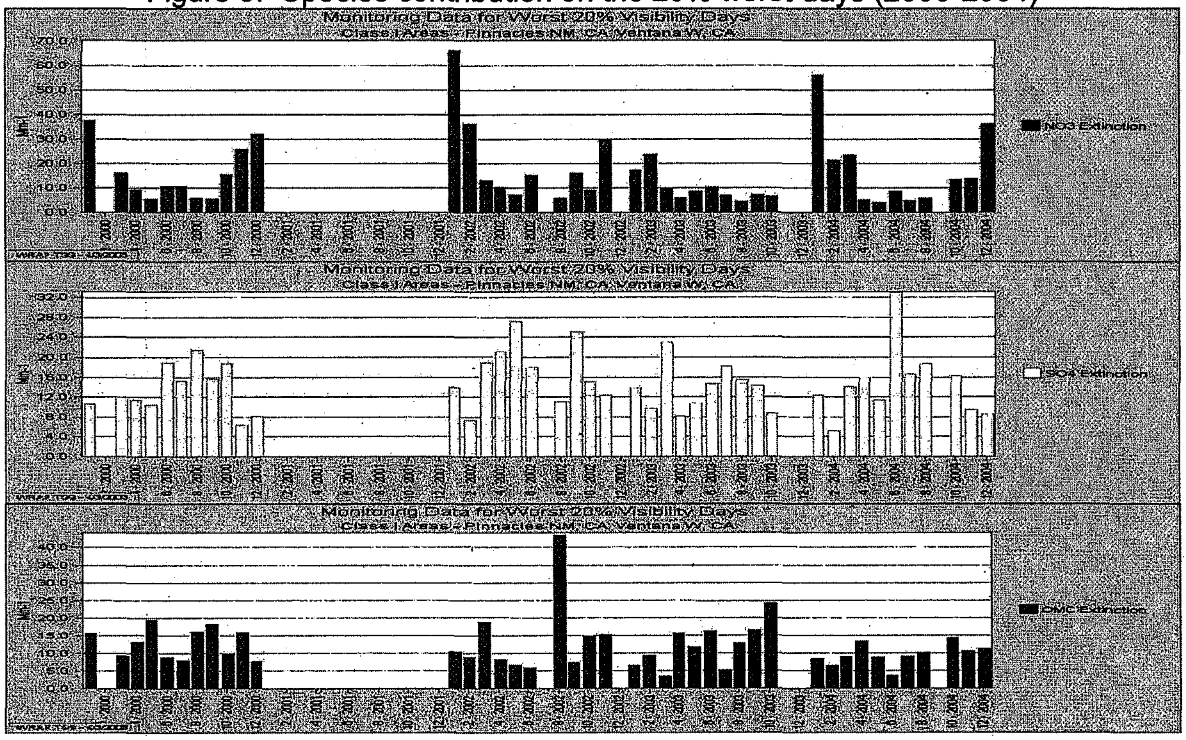


Figure 9. Species contribution on the 20% worst days (2000-2004)




### /I.g. *Sources* of *Haze Species*

Both natural and man-made sources contribute to the calculated deciview *levels* made by haze pollutants at PINN1. Some haze species arise from sources that are within the control of the State of California or neighboring states. Others arise from natural, uncontrollable situations such as wildfires, sea salt or dust storms in natural areas, whether they are from in-state or out-of-state (and out-of-country) sources. Finally, other uncontrollable, man-made sources are those industrial pollutants and other man-made (anthropogenic) emissions transported from outside the United States.

Figures 10 and 11 represent the regional contributions to nitrates on the 20% worst days. The WRAP region represents the largest contribution to nitrate in 2002 and 2018 (85%), followed by the Pacific Offshore Region (9%) and emissions from Outside Domain (5%). Mobile sources within California contribute the most nitrate at the PINN1 monitor. In 2002, 90% of the nitrate from mobile sources at the piNN1 monitor can be attributed to California. California mobile source emissions reductions are, mainly responsible for improvement in nitrates in 2018.

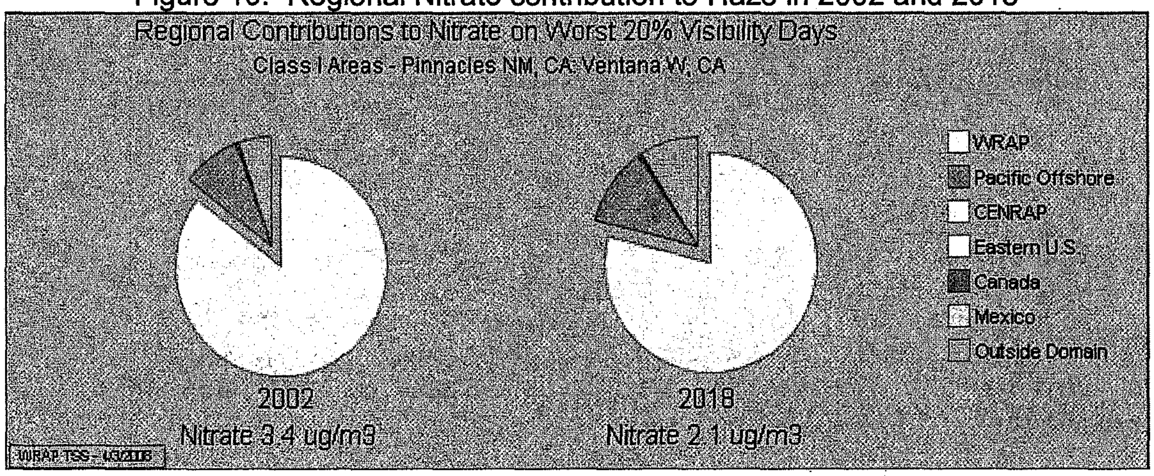
Figures 12 and 13 represent the regional contributions to sulfate on the 20% worst days in 2002 and 2018 at PINN1. The WRAP region represents 36% of the sulfate contributions in 2002 and 2018, followed by the emissions from the Outside Domain' Region (35%) and the Pacific Offshore Region (27%). California contributes 26% of the total sulfate emissions seen at the PINN1 monitor.

Individually, emissions from outside the modeling domain·contribute the most sulfate concentrations at the PINN1 monitor. The next largest contributor to sulfate concentration is area sources in the Pacific Offshore Region.

Figure 14 shows the primary organic carbon source contribution from California and the outside regions. The largest contributor to primary organic carbon at the PINN1 monitor is from area sources within California. California represents 96% of all area source contributions.

Figure 15 illustrates the total organic carbon source apportionment from 2000-2004 for a'nthropogenic and biogenic sources. The anthropogenic and biogenic primary source emissions account for 63% of the total organic carbon. Biogenic secondary emissions account for 31 % of the total organic carbon emissions and anthropogenic secondary is responsible for the remaining emissions.

Figure 10. Regional Nitrate contribution to Haze in 2002 and 2018




.Fi ure 11. Nitrate source contribution from CA and outside regions

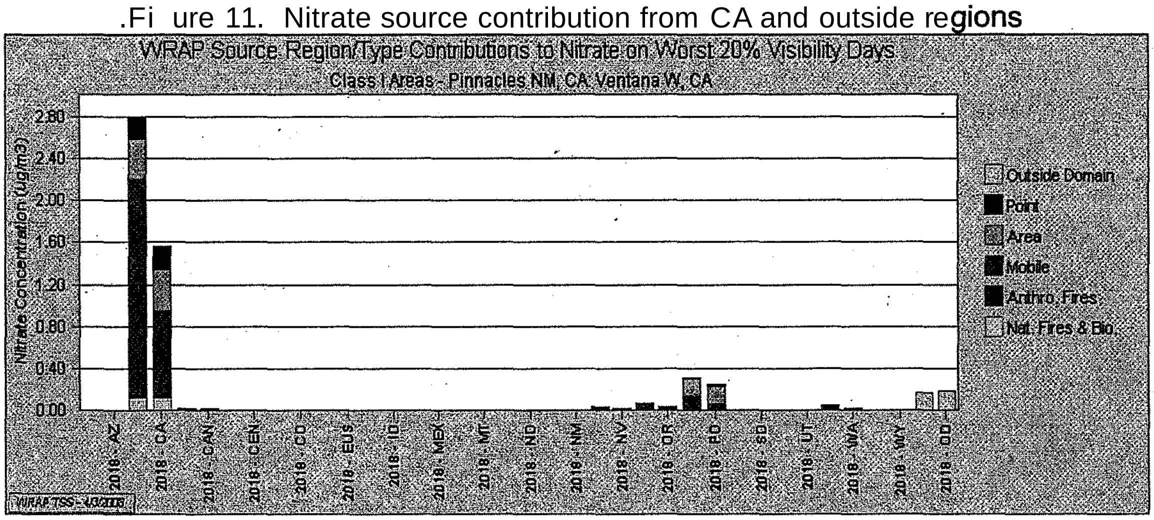


Figure 12. Regional Sulfate contribution to Haze in 2002 and 2018

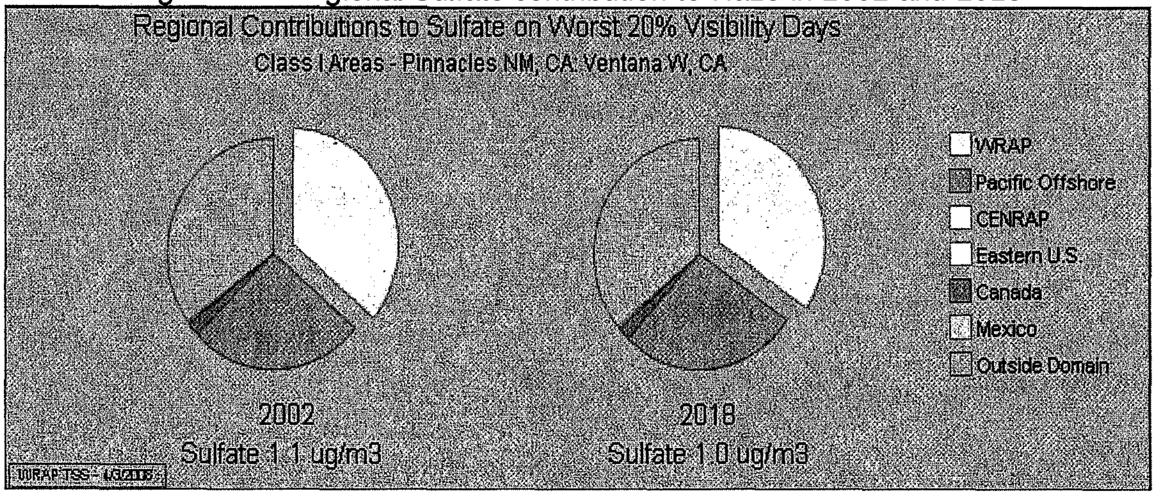



Figure 13. Sulfate source contribution from CA and outside re_ions

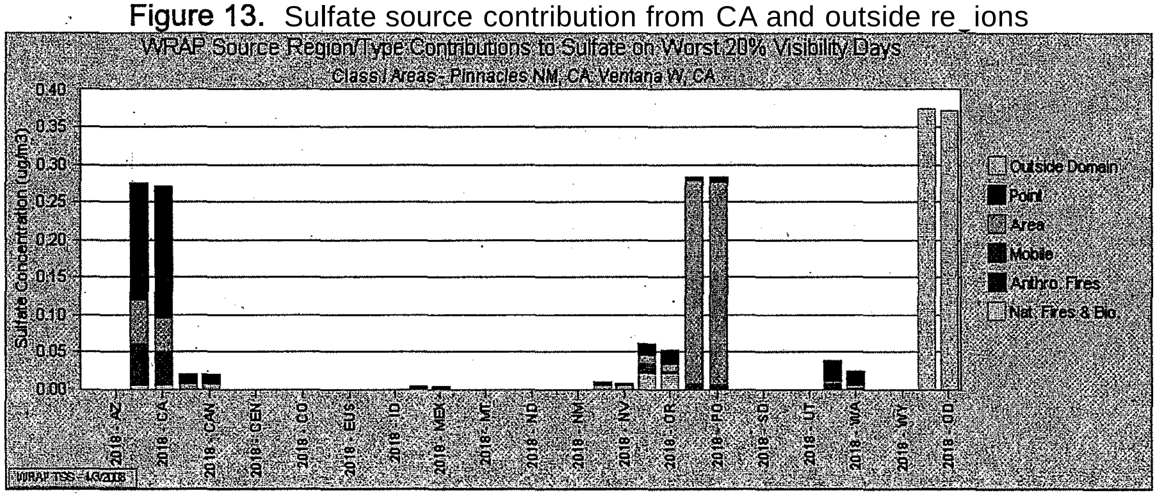



Figure 14. Organic carbon source contribution from CA and outside regions

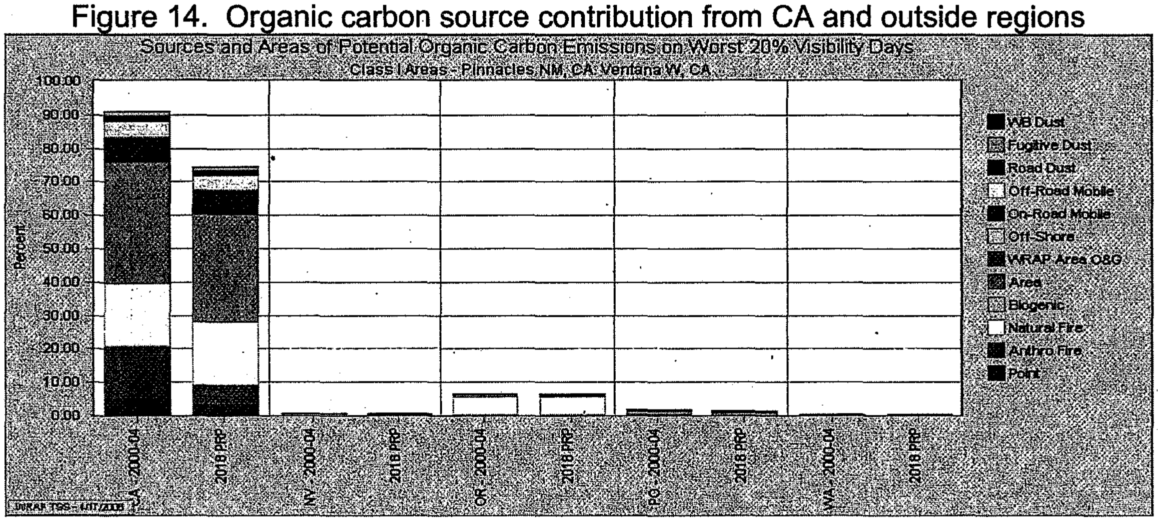
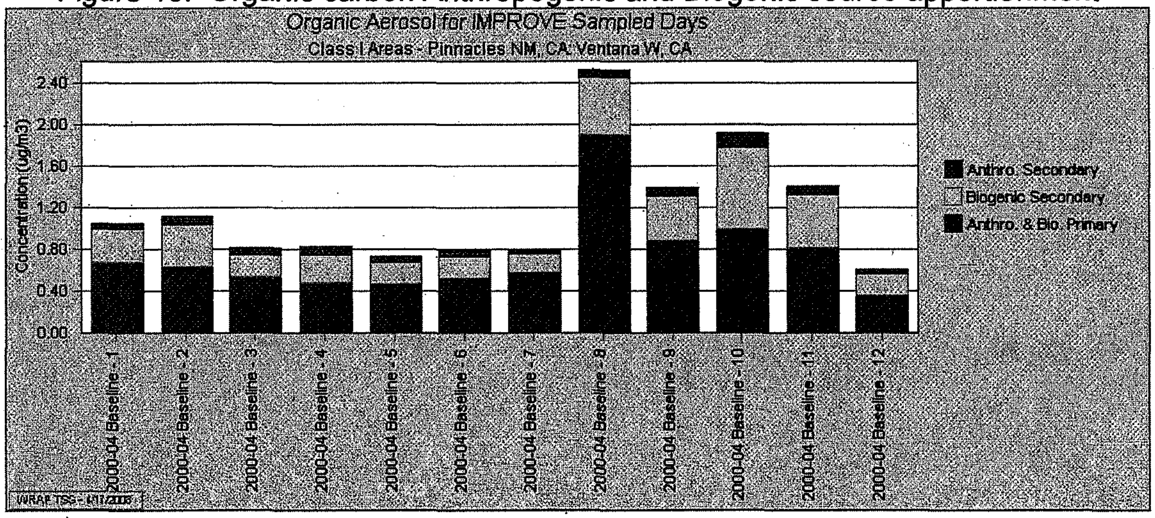


Figure 15. Organic carbon Anthropogenic and Biogenic source apportionment



# RAFA1Monitor

## Section I.· Description

The San Rafael Wilderness Area (San Rafael) consists of 200,000 acres in the San Rafael and Sierra Madre Mountain Ranges in southern California. It is near the southernmost extent of the Coast Ranges that separate the coast from the Central Valley, and deserts of interior California. These east-west ranges form part of the barrier between the southernmost extent of the central valley and the Santa Barbara Coast 20 miles to the south of the southeastern Wilderness boundary. The Sisquoc River flows west towards the Pacific Ocean through the heart of the San Rafael Wilderness from its headwaters near the eastern boundary, between the Sierra Madre range on the north and the San' Rafael range on the south. Elevations range from 355 meters near the confluence of the Sisquoc River with Manzana Creek in the west to over 2,073 meters on Big Pine Mountain near the eastern boundary.

Figure 1. RAFA1 Monitor location

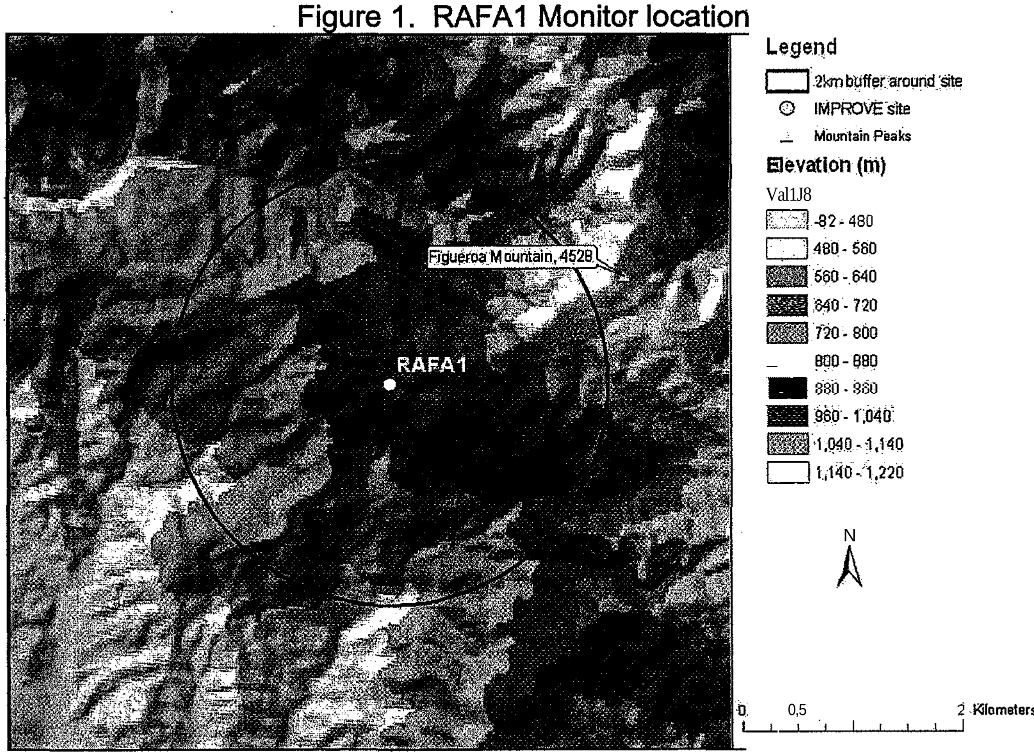
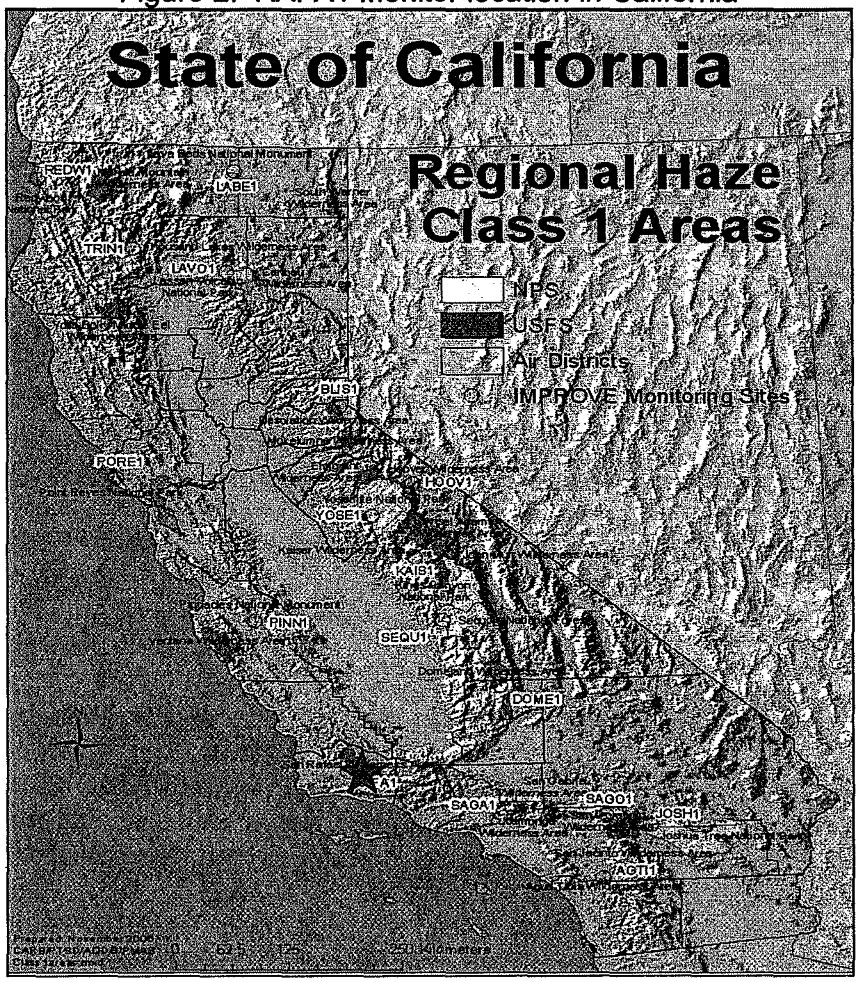


Figure 2. RAFA1 Monitor location in California




Section II. Visibility Conditions:

*II.a. Visibility Monitor Location*

Visibility conditions for San Rafael are currently monitored by the RAFA1 IMPROVE monitor. The monitor is located at 34.7339 north latitude and 120.0074 west longitude, near the crest of a low ridge outside of the southern wilderness boundary at an elevation of 957 meters. The site has been operating since February 2000. This site has sufficient data for the entire baseline period.

The RAFA1 IMPROVE siteshould be quite representative of Wilderness conditions in general. It is on a well-exposed ridge location near the southern boundary at an elevation near the midrange of Wilderness elevations. It may be less representative of lower Wilderness elevations along the Sisquoc River valley if a lower level valley inversion exists. The lower Sisquoc River is also SUbject to occasional onshore flow from the Pacific Ocean, which can bring high humidity and fog, although this may be a relatively infrequent occurrence. The San Rafael Wilderness is centrally located with respect to three areas with potential to impact visibility: the southern Central Valley, coastal areas of Santa Barbara County, and the Los Angeles basin. The southern. Central Valley has potential for impacting visibility during Santa Ana conditions, while emissions from the Los Angeles basin may be channeled into the Wilderness via a coastal river valley near Ojai or transported aloft during easterly upper airflow during the winter.

The RAFA1 location is adequate for assessing the 2018 reasonable progress goals for the San Rafael Wilderness Class 1 area.

### *II.b. Baseline Visibility*

Baseline visibility is determined from RAFA1 IMPROVE monitoring data for the 20% best and the 20% worst days for the years 2000 through 2004. The baseline visibility for the San Rafael Wilderness Area is calculated at 6.4 deciviews for the 20% best days and 18.8 deciviews for the 20% worst days. Figure 3 represents the worst baseline visibility conditions.

### *II.c. Natural Visibility*

Natural visibility represents the visibility condition that would be experienced in the absence of human-caused impairment. Based on EPA guidance, the natural visibility for the San Rafael Wilderness is 1.8 deciviews for the 20% best days and 7.6 deciviews for the 20% worst days. It is possible that the Natural Conditions deciview value for 2064 could change in the future as more is learned about natural plant emissions and wildfire impacts.

### *II.d. Presumptive Glide Slope and the Uniform Rate of Progress*

Figure 3 also shows the uniform rate of progress, or "glide slope." The glide slope is the rate of reduction in the 20% worst days deciview average that would have to be achieved to reach natural conditions at a uniform pace in the 60 years following the baseline period. The first benchmark along the path towards achieving natural conditions occurs in 2018. The glide slope shows that the 2018 benchmark for the 20% worst days is 16.20 deciviews. According to the Regional Haze Rule, the 20% best days baseline visibility of 6.4 deciviews must be maintained or improved by 2018, the end of the first planning period.

Figure 3. Worst 20% days for baseline (2000-2004) and for Natural Conditions (2064)

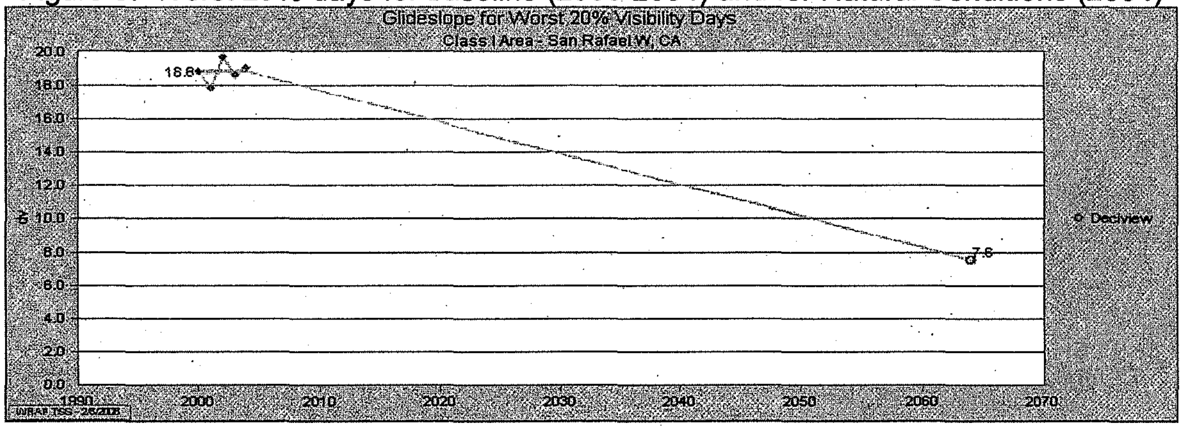



Figure 4. WINHAZE image of San Rafael Wilderness Area (6.4 vs. 18.8 decivewis)

*II.e.* ***Species Contribution***

Each pollutant species causes light extinction but its contribution differs on best and worst clays. Figure 5 shows the contribution of each species to the 20% best and worst days in the baseline years at RAFA1.

Figure 5. Average Haze species contributions to light extinction in the baseline years

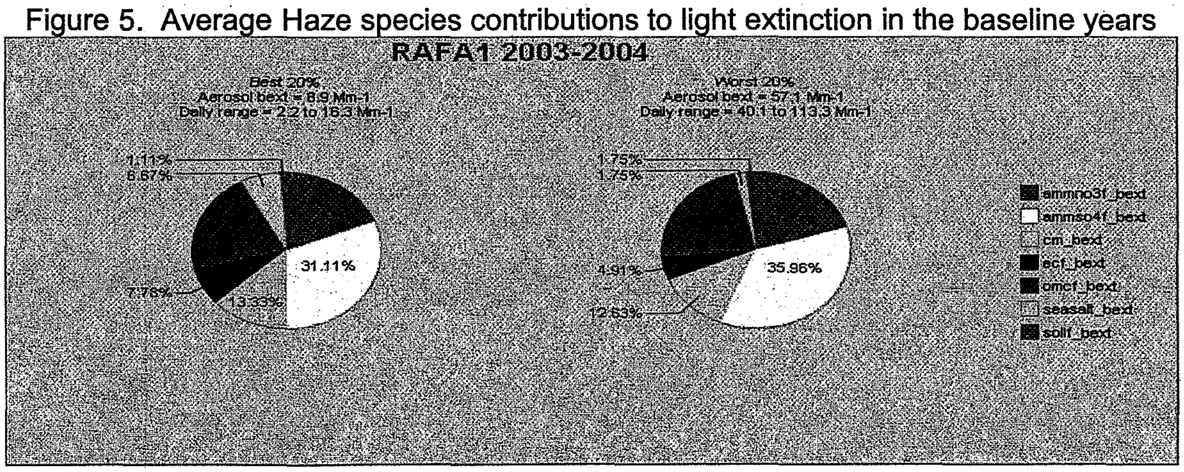
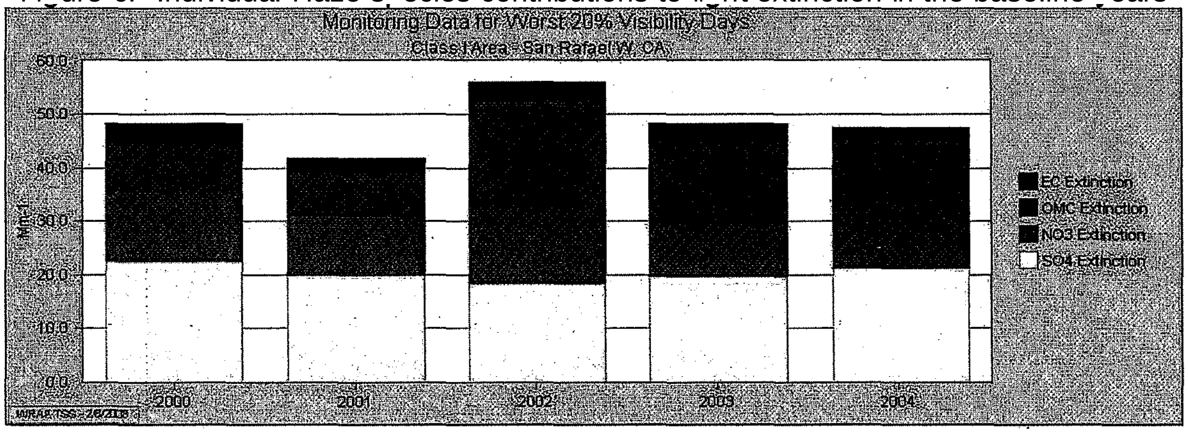


Figure 6. Individual Haze species contributions to light extinction in the baseline years




As shown in Figures 5 and 6, sulfates, organic matter, and nitrates have the strongest contributions to degrading visibility on worst days at San Rafael Wilderness Area. Sulfates dominate on both the worst and best days.

Figure 7 depicts the individual species contribution to worst days in 2002. Sulfates are seen to increase in the summer while nitrates increase in the winter months. The occurrence of elevated organic matter concentrations is sporadic throughout the year. Sulfates clearly dominate the other haze species on worst days, but organic matter, nitrates, coarse mass and elemental carbon also contribute to the worst days. There are only trace amounts of sea salt and soil present throughout the years.

Figure 8 illustrates the individual species contribution on worst days in 2000-2004 by monthly average. The trend shown is comparable to Figure 7 for sulfates, organic matter, and nitrates. High organic periods vary from year to year due to the unpredictable occurrence of wild fires.

**Figure 7. Species contribution on the 20% worst days in 2002**

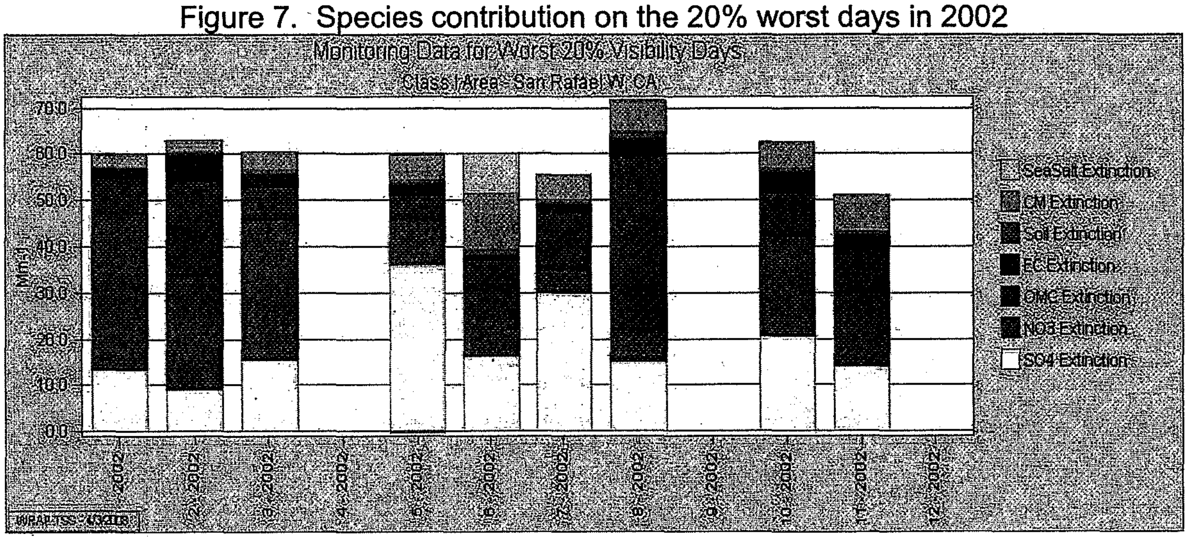
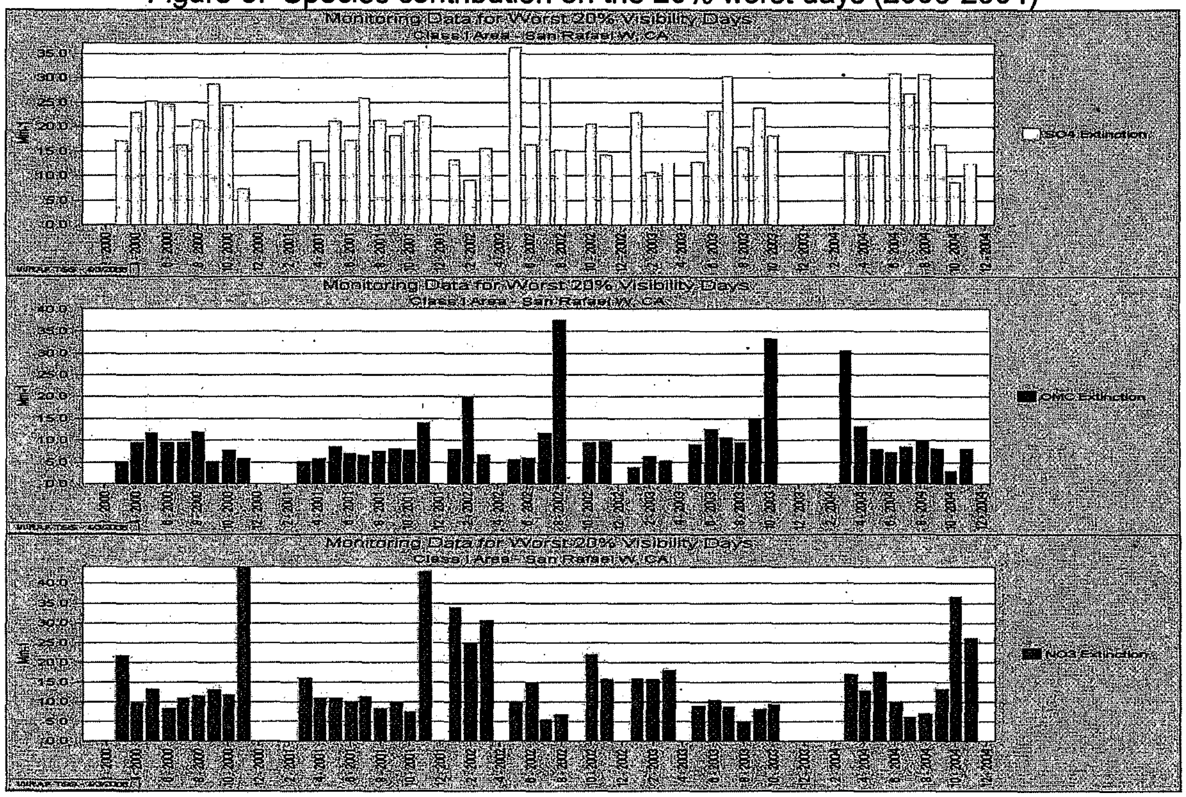


Figure 8. Species contribution on the 20% worst days (2000-2004)




*II.f. Sources of Haze Species*

Both natural and man-made sources contribute to the calculated deciview levels made by haze pollutants at RAFA1. Some haze 'species arise from'sources that,are within the control of the State of California or neighboring states. Others arise from natural, uncontrollable situations such as wildfires, sea salt or dust storms in natural areas, whether or not they are from in-state or out-of-state (and out-of-country) sources. Finally, other uncontrollable, man-made sources are those industrial pollutants and (anthropogenic) emissions transported from outside'the United States.

Figures 9 and 10 represent the regional contributions to sulfate on the 20% worst days in 2002 and 2018 at RAFA1. The Pacific Offshore region represents 34% of the sulfate contributions in 2002 and 2018, followed by the emissions from the WRAP Region (32%) and the Outside Domain Region (30%). California contributes 20% of the total sulfate emissions seen at the RAFA1 monitor.

Individually, emissions from area sources in the Pacific Offshore contribute the most to sulfate concentrations at the RAFA1 monitor. The next largest contributor to sulfate concentrations is from outside the modeling domain.

Figure 11 shows the primary organic carbon source contribution from California and the outside regions. The largest contributor to primary organic carbon at the RAFA1 monitor is from natural fire sources within California. California represents 95% of all " natural fire source contributions.

Figure 12 illustrates the total organic carbon source apportionment from 2000-2004 for anthropogenic and biogenic sources. The anthropogenic and biogenic primary source emissions account for 60% of the total organic carbon. Biogenic secondary emissions account for 33% of the total organic carbon emissions and anthropogenic secondary is responsible for the remaining emission"s.

Figures 13 and 14 represent the regional contributions to nitrates on the 20% worst days. The WRAP region represents the largest contribution to nitrate in 2002 and 2018 (82%), followed by the Pacific Offshore Region (10%) and emissions from Outside Domain (7%). Mobile sources within California contribute the most nitrate at the RAFA1 monitor. In 2002, 90% of the nitrate from. mobile sources at the RAFA1 monitor can be attributed to California. California mobile source emissions reductions are mainly responsible for improvement in nitrates in 2018.

**Figure 9. Regional Sulfate contribution to haze in 2002 and 2018**

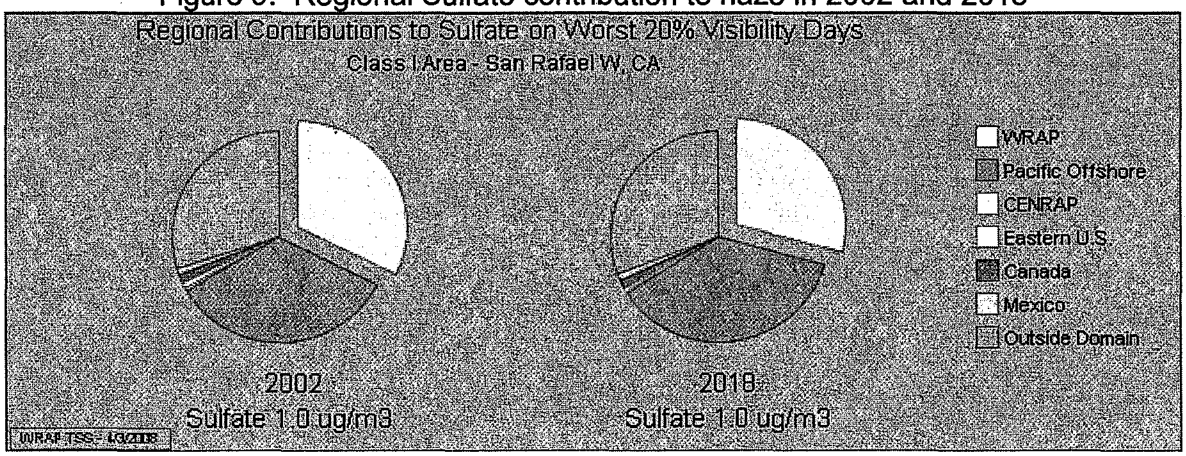



**Figure 10.** Sulfate source contribution from CA and outside re͜ions

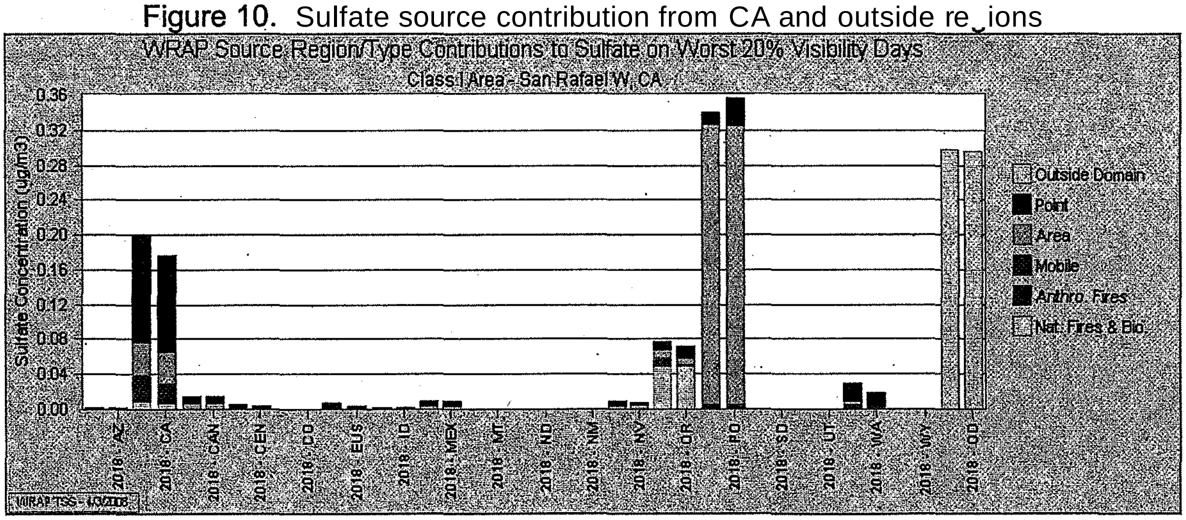


**Figure 11.** Or_anic carbon source' contribution from CA and outside re_ions

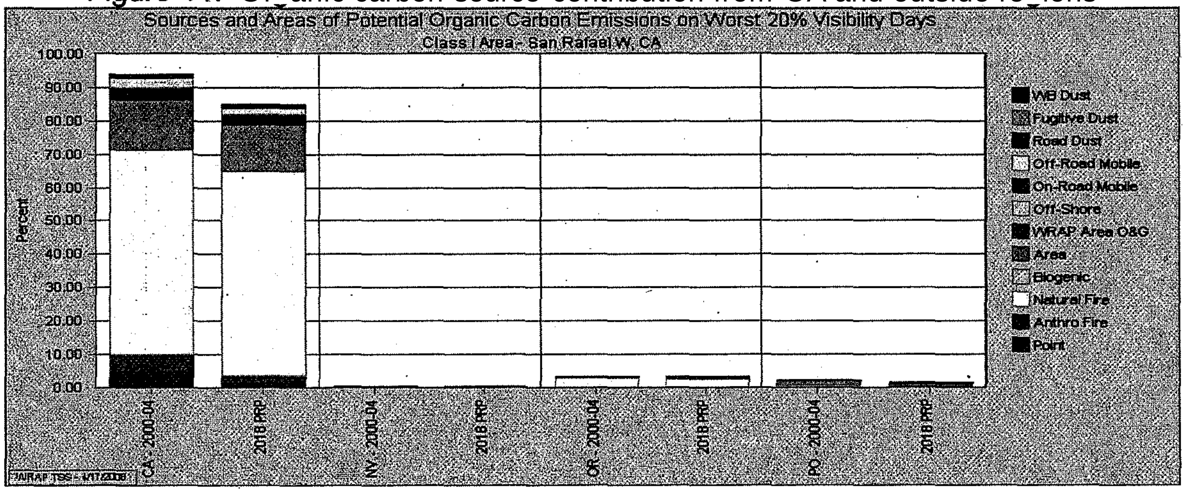



**Figure 12. Organic carbon Anthropogenic and Biogenic Source apportionment**

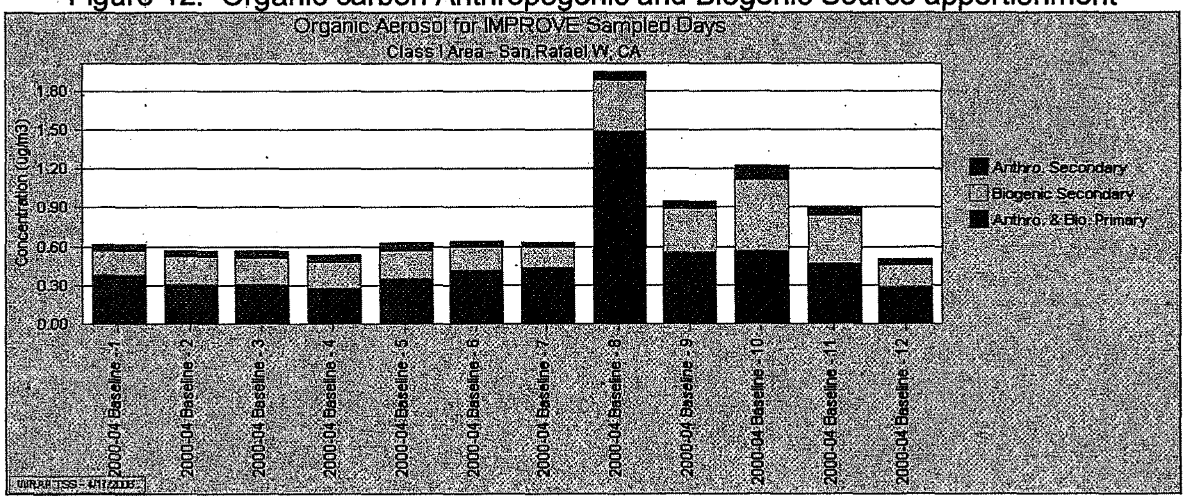
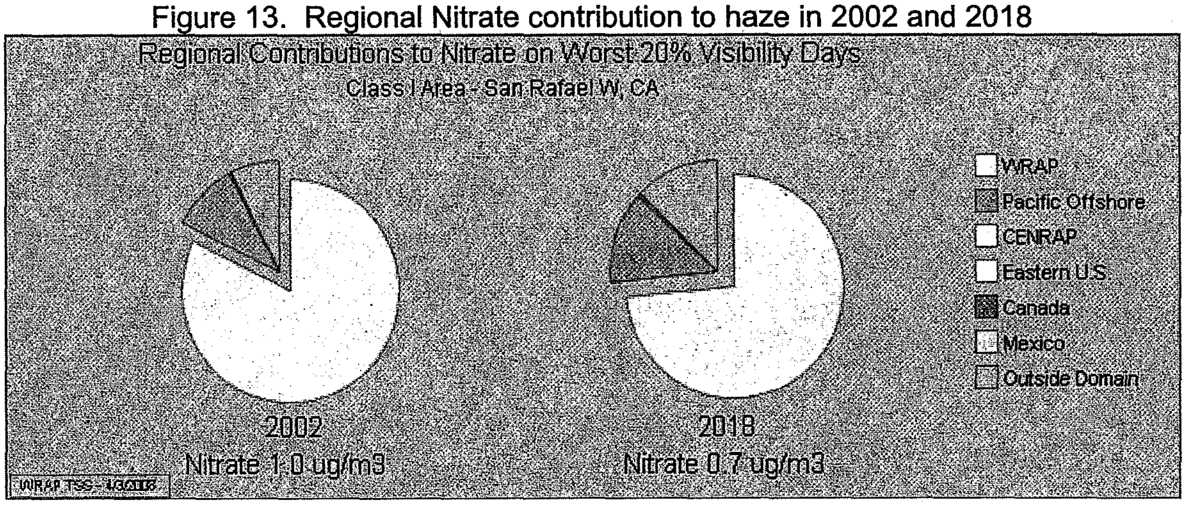
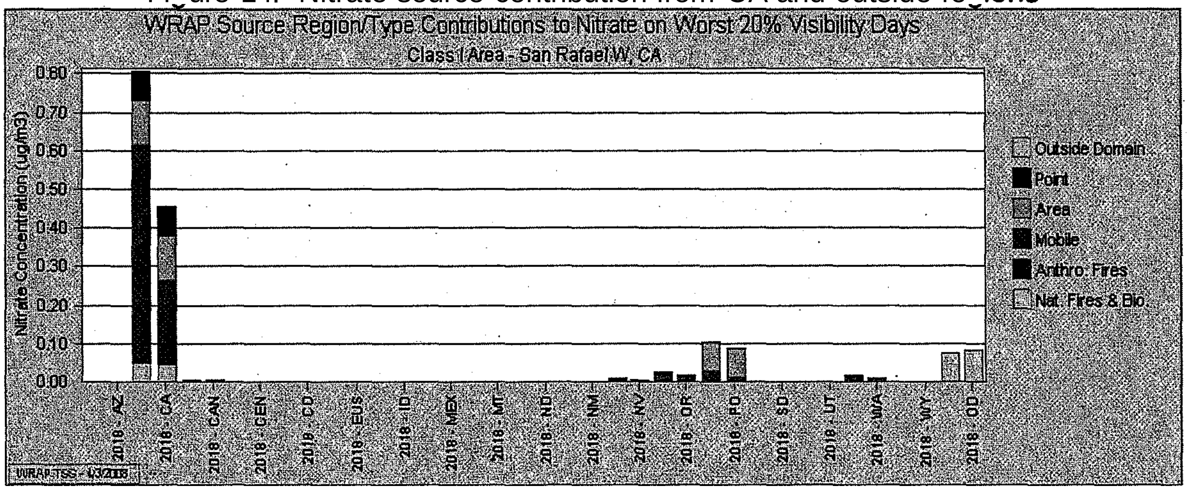



**Figure 13. Regional Nitrate contribution to haze in 2002 and 2018**



Fi_ure 14. Nitrate source contribution from CA and outside re_ions



## SAGA1 Monitor

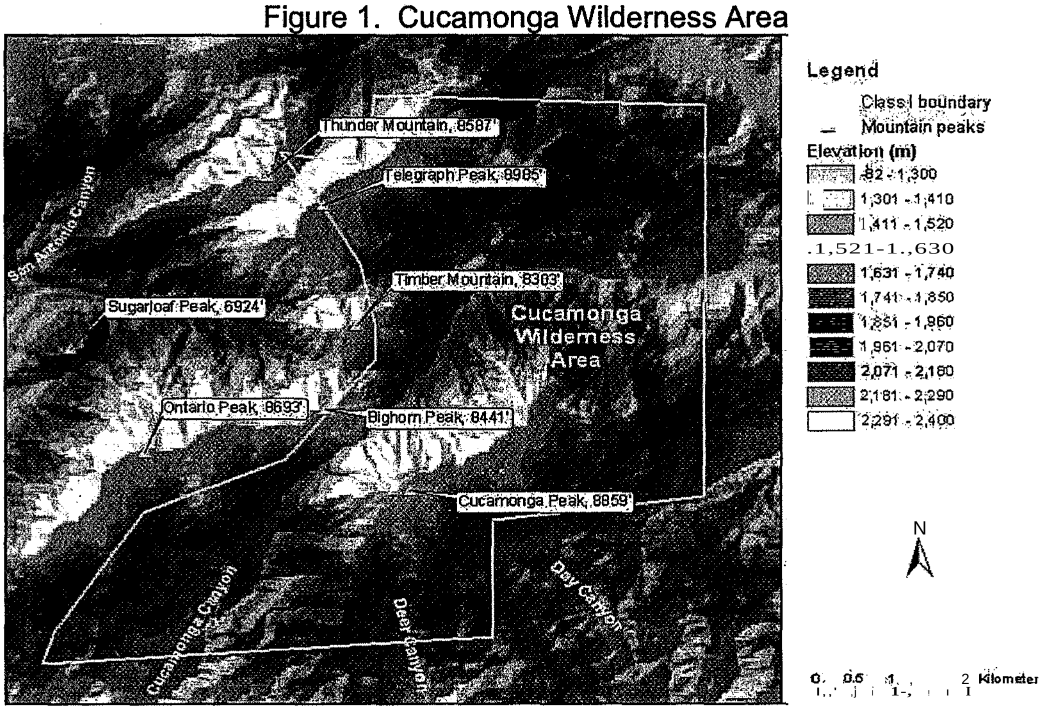
The SAGA1 monitor location represents two wilderness areas located jn the San Gabriel Mountains. The wilderness areas associated with the SAGA1 monitor are Cucamonga Wilderness Area and San Gabriel Wilderness area. The SAGA1 site has been operating since December 2000. This site does not have sufficient data for the entire baseline period. Data was not available for the years 2000 and 2001.

### Section I. SAGA1 Wilderness Area Descriptions

#### *I.a.Cucamonga Wilderness Area*

The Cucamonga Wilderness Area (Cucamonga) occupies 12,981 acres on the western end of the San Gabriel Mountains, one of the Transverse Ranges that lie along an east-west axis from the SantaBarbara coast to the Mojave Desert creating a natural barrier between central and southern California. Wilderness elevations range from about 131.0 meters to 2500 meters, with highest elevations at the crests of Telegraph Peak (2738 meters) and Cucamonga Peak (2700 meters). Cucamonga and Deer Canyons drop south from Cucamonga Peak to the southern Wilderness boundary, then south 4 to 6 miles into the Los Angeles basin near the cities of Pomona, Ontario, and Rancho Gucamonga,forming the most direct route for low elevation urban pollution transport into the Wilderness.

Figure 1. Cucamonga Wilderness Area



*I.b. San Gabriel Wilderness Area*

The San' Gabriel Wilderness Area (San Gabriel) occupies 34,118 acres on the southern slopes of the San Gabriel Mountains, one of the Transverse Ranges that lie along an. east-west axis from the Santa Barbara coast to the Mojave Desert. Elevations range from 488 meters to 2500 meters. Highest elevations are along the ridge of the San Gabriel Mountains that forms the northern San Gabriel boundary. Lowest elevations are along the West Fork of the San Gabriel River that flows eastward in this are,a and forms the southern San Gabriel boundary. From the southeast corner of the Wilderness the San Gabriel River flows southward about 6 miles into the Los Angeles Basin between Pasadena and Pomona. This stretch of the San Gabriel Canyon includes San Gabriel and Morris Reservoirs. The San Gabriel River Valley thus forms the most direct conduit for low elevation urban pollution transport into the Wilderness.

Figure 2. SAGA1 Monitor location

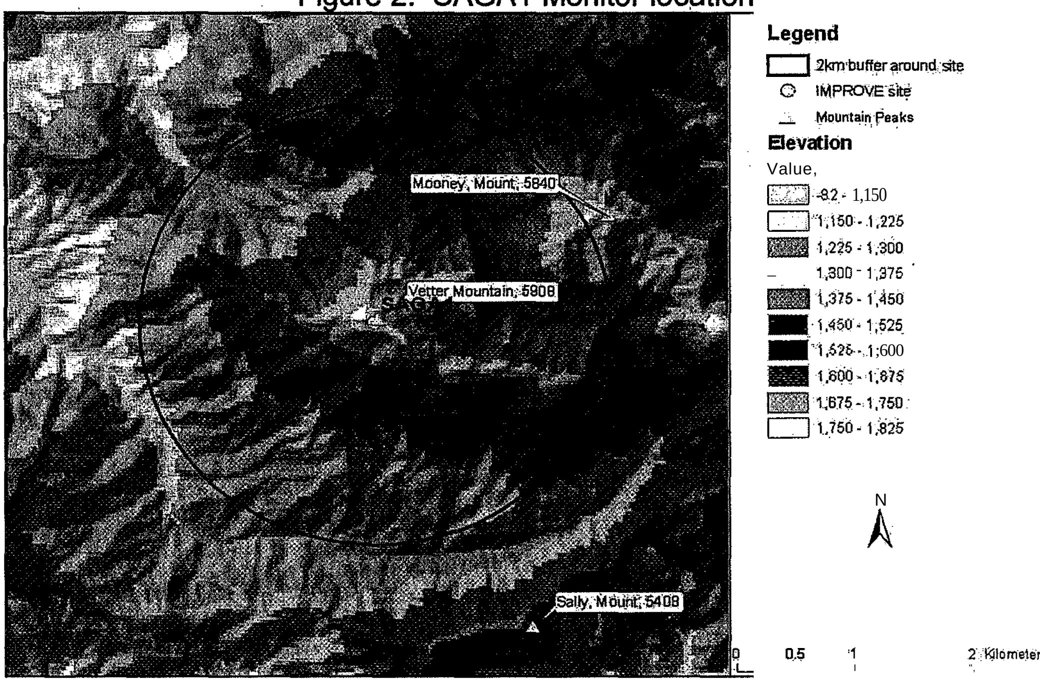
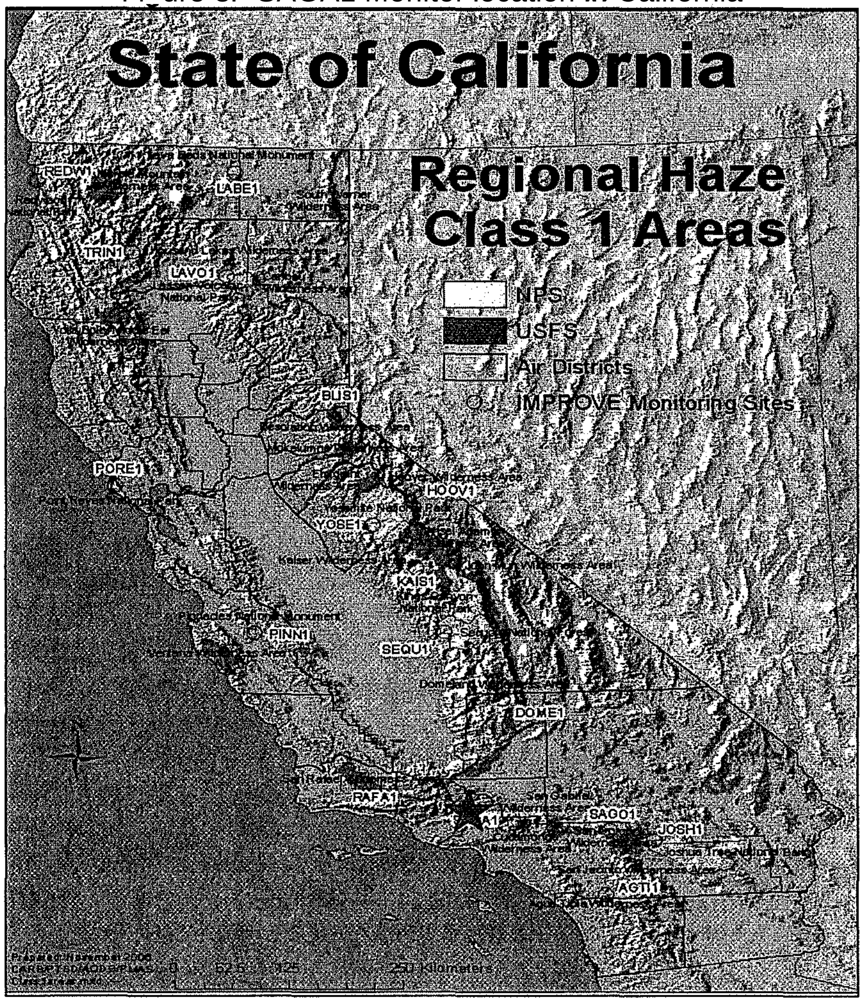


Figure 3. SAGA1 Monitor location in California




## Section II. Visibility Conditions:

### *II.a. Cucamonga Wilderness Area*

Visibility conditions for Cucamonga Wilderness are currently monitored by the SAGA1 IMPROVE monitor located just outside the western boundary of the San Gabriel Wilderness. The monitoring site is located at34.2969 north latitude and 118.0282 west longitude, about 20 miles west of the Cucamonga Wilderness, with mountainous intervening terrain. It is a well-exposed ridge-top site at an elevation of 1791 meters, near the lower end of the range of elevations within the Cucamonga Wilderness.

The SAGA1 monitoring site is separated from the Cucamonga Wilderness by about 20 miles of intervening complex mountainous terrain. It should be representative of aerosol composition and concentration at Cucamonga locations when the atmosphere is well mixed and haze is uniform over the region. It should also be representative of the impact of Los Angeles basin emission on the San Gabriel Mountains in general.

Lowest Wilderness elevations are probably above the regional marine layer that frequently overlies the Los Angeles basin and that typically thickens and advances inland during the night and early morning hours, before burning off around midday. It will be less representative of Cucamonga" locations when impacted by local sources.

The SAGAI location is adequate for assessing the 2018 reasonable progress goals for the Cucamonga Wilderness Class 1 area.

*II.b. San Gabriel Wilderness Area*

Visibility conditipns for San Gabriel are currently monitored by the SAGA1 IMPROVE monitor. The monitor is located at 34.2969 north latitude 36.49 and 118.0282 west longitude, just outside the western San Gabriel boundary. The monitor is in a well-exposed ridge-top site at an elevation of 1,791 meters, which is in the middle of the range of San Gabriel elevations.

The SAGA1 IMPROVE site should be well representative of aerosol composition and concentration at San Gabriel Wilderness locations, especially higher locations. It should also be representative of the impact of Los Angeles basin emissions within the San Gabriel Mountains generally. There may be times when lower Wilderness elevations, especially within Devils Canyon in the western Wilderness and the Bear Creek drainage in the eastern Wilderness, are contained within the r.egional marine layer that covers the Los Angeles basin much of the year, especially from late spring to early fall. The Los Angeles basin marine layer typically extends vertically to 305-610 meters. Elevations in these canyon and valley bottoms are about 600 meters, or about 914 meters lower than the SAGA1 IMPROVE site. The San Gabriel Wilderness is within 6 miles of the sprawling and heavily populated and industrialized South Coast Air Basin and is subject to its influence. The nearest Los Angeles area communities are Pasadena, El Monte, and Pomona.

The SAGA1 location is adequate for assessing the 2018 reasonable progress goals for the San Gabriel Wilderness Class 1 area.

*II.c. Baseline Visibility*

Baseline visibility is determined from SAGA1 IMPROVE monitoring data for the 20% best and the 20% worst days for the years 2000 through 2004. The baseline visibility for the SAGA1 monitor is calculated at 4.8 deciviews for the 20% best days and 19.9 deciviews for the 20% worst days. Figure 4 represents the worst baseline visibility conditions; "

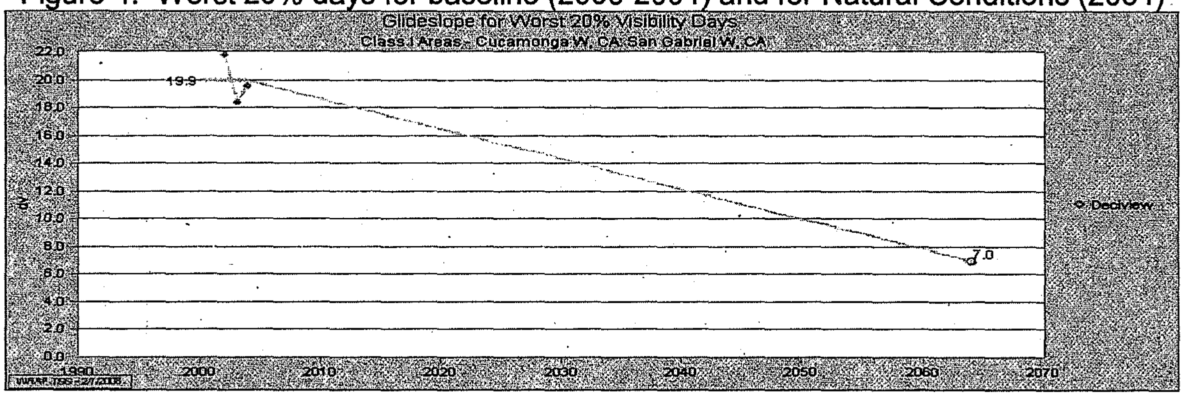
*II.d. Natural Visibility*

Natural visibility represents the Visibility condition that would be experienced in the absence of human-caused impairment. Based on EPA guidance, the natural visibility for the SAGA1 monitor is 0.4 deciviews for the 20% best days and 7.0 deciviews for the 20% worst days. It is possible that the Natural Conditions deciview value for 2064 could change in the future as more is learned about natural plant emissions and wildfire impacts.

*fl.e. Presumptive Glide Slope and the Uniform Rate of Progress*

Figure 4 also shows the uniform rate of progress, or "glide slope." The glide slope is the rate of reduction in the 20% worst days deciview average that would have to be achieved to reach natural conditions at a uniform pace in the 60 years following the baseline period. The first benchmark along the path towards achieving natural conditions occurs in 2018. The glide slope shows that the 2018 benchmark for the 20% worst days is 16.92 deciviews. According to the Regional Haze Rule, the 20% best days baseline visibility of 4.8 deciviews must be maintained or improved by 2018, the end of the first planning period.

**Figure 4. Worst 20% days for baseline (2000-2004) and for Natural Conditions (2064)**




*/I.f. Species Contribution*

Each pollutant species causes light extinction but its contribution differs on best and worst days. Figure 5 shows the contribution of each species to the 20% best and worst days in the baseline years at SAGA1.

**Figure 5. Average Haze species contributions to light extinction in the baseline years**

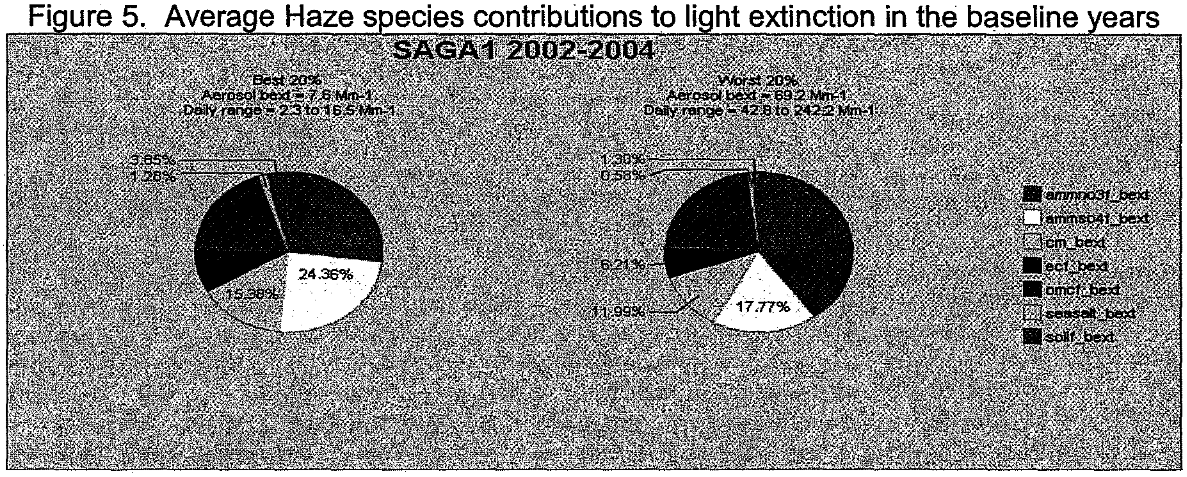
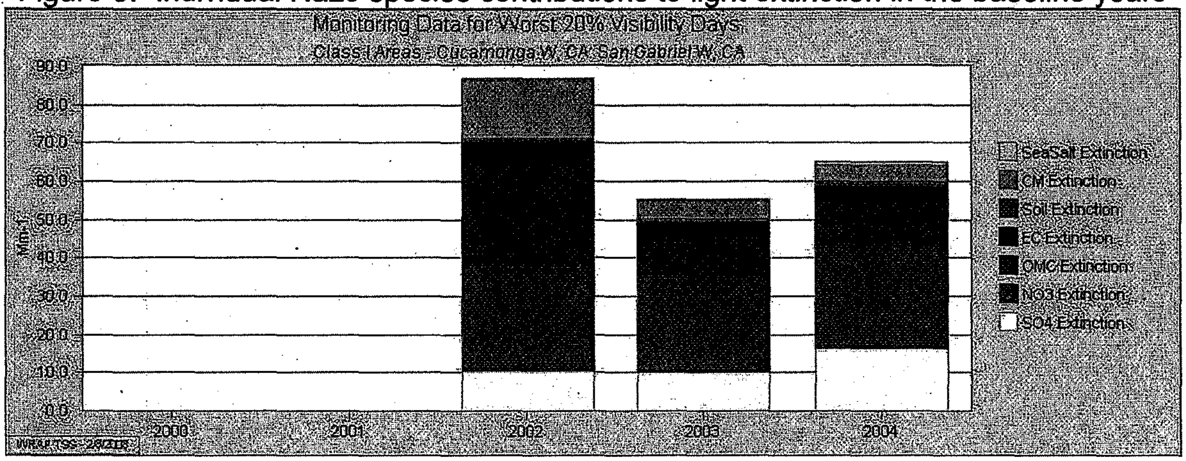


Figure 6. Individual Haze species contributions to light extinction in the baseline years




As shown in Figures 5 and 6, nitrates, organic matter, and sulfates have the strongest contributions to light extinction which degrade visibility on worst days at the SAGA1 monitor. The worst days and best days are dominated by nitrates. Data points for 2000 and 2001 were insufficient for calculating best and worst days per the Regional Haze Rule Guidance.

Figure 7 depicts the individual species contribution to worst days in 2002. Nitrates increase in the winter and spring while sulfates increase slightly in the spring and summer. Organic matter remains stable throughout mostof the year but then peaks in August and September of 2002. Nitrate clearly dominates the other haze species on worst days, butorganic matter, sulfates, coarse mass and elemental carbon also contribute to the worst days; Sea salt is present in trace amounts at the SAGA1 monitor.

Figure 8 illustrates the individual sp.ecies contribution on worst days in 2000-2004 by monthly average. The trend shown is comparable to Figure 7 for organic matter, nitrates, sUlfates, and coarse mass. High organic periods vary from year to year due to the unpredictable occurrence of wild fires.

Figure 7. Species contribution on the 20% worst days in 2002

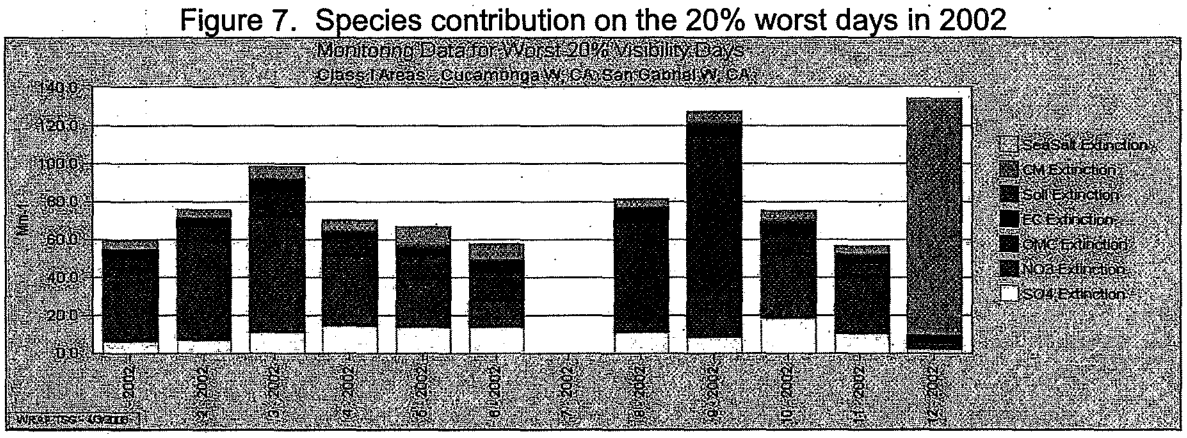
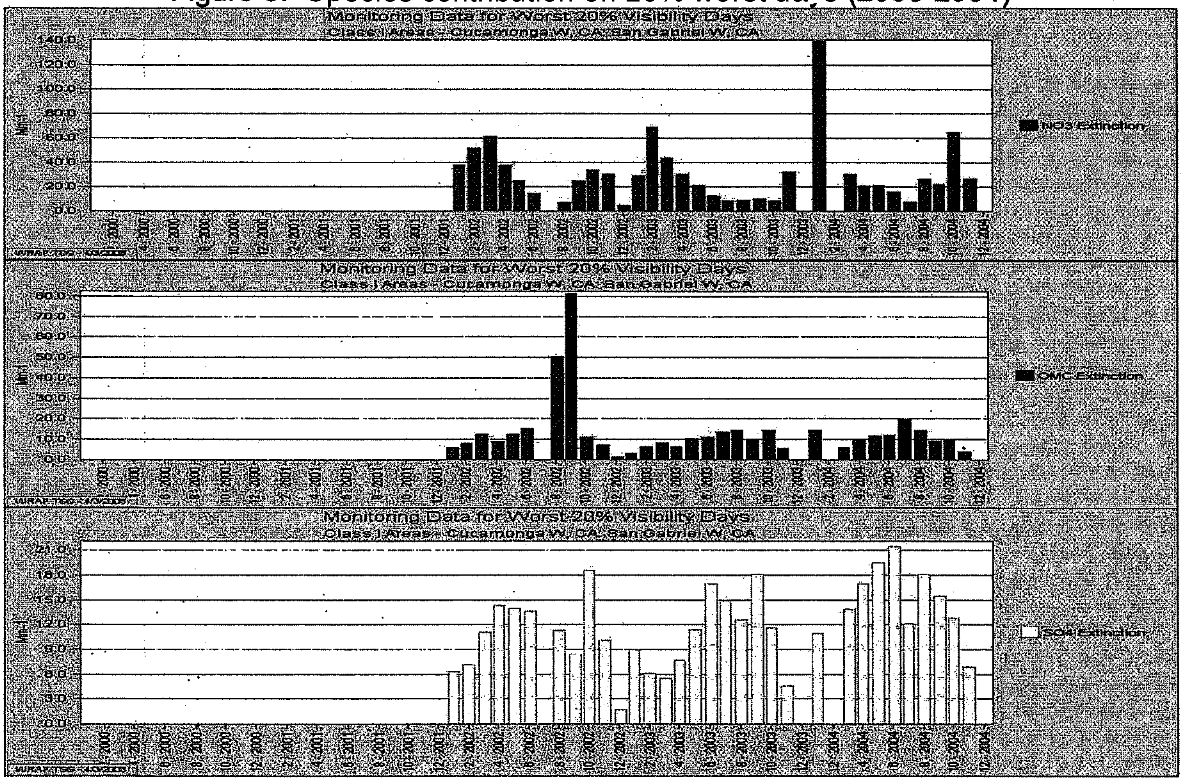


Figure 8. Species contribution on 20% worst days (2000-2004)




*II.g. Sources of Haze Species*

Both natural and man-made sou'rces contribute to the calculated deciview levels made by haze pollutants at SAGA1. Some haze species arise from sources that are within the control of the State of California or neighboring states. Others arise from natural, uncontrollable situations such as wildfires, sea salt or dust storms in natural areas, whether they are from in-state or out-of-state (and out-of-country) sources. Finally, other uncontrollable, man-made sources are those industrial pollutants and other man-made (anthropogenic) emissions transported from outside the United States.

Figures 9 and 10 represent the regional contributions to nitrates on the 20% worst days. The WRAP region represents the largest contribution to nitrate in 2002 and 2018 (78%), followed by the Pacific Offshore Region'(18%) and emissions from the Outside Domain (4%). Mobile sources within' California contribute the most nitrates at the SAGA1 monitor. In 2002, 76% of the nitrate at the SAGA1 monitor can be attributed to California.

From the WRAP Region, California is shown to contribute the most to nitrate concentrations at the SAGA1 monitor in 2002 and 2018. Currently, California Mobile sources are 81% of California contributions to nitrate at the SAGA1 monitor. California mobile source emissions reductions are mainly responsible for improvement in nitrates in 2018.

Figure 11 shows the primary organic carbon source contribution from California and the outside regions. The largest contributor to primary organic carbon at the SAGA1 monitor is from natural fire sources within California. California represents 99% of all natural fire source contributions.

Figure 12 illustrates the total organic carbon source apportionment from 2000-2004 for anthropogenic and biogenic sources. The anthropogenic and biogenic primary source emissions account for 80% of the total organic carbon. Biogenic secondary emissions account for 14% of the total organic carbon emissions and anthropogenic secondary is responsible for the remaining emissions.

Figures 13 and 14 represent the regional contributions to sulfate on the 20% worst days in 2002 and 2018 at SAGA1. The WRAP region represents 43% of the sulfate contributions in 2002 and 2018, followed by the emissions from the Pacific Offshore Region (33%) and the Outside Domain Region (22%). California contributes 36% of the total sulfate emissions seen at the SAGA1 monitor.

Individually, emissions from area sources in the Pacific Offshore contribute the most to sulfate concentrations at the SAGA1 monitor. The next largest contributor to sulfate concentrations is from outside the modeling domain.

**Figure 9. Regional Nitrate Contribution to Haze in 2002 and 2018**

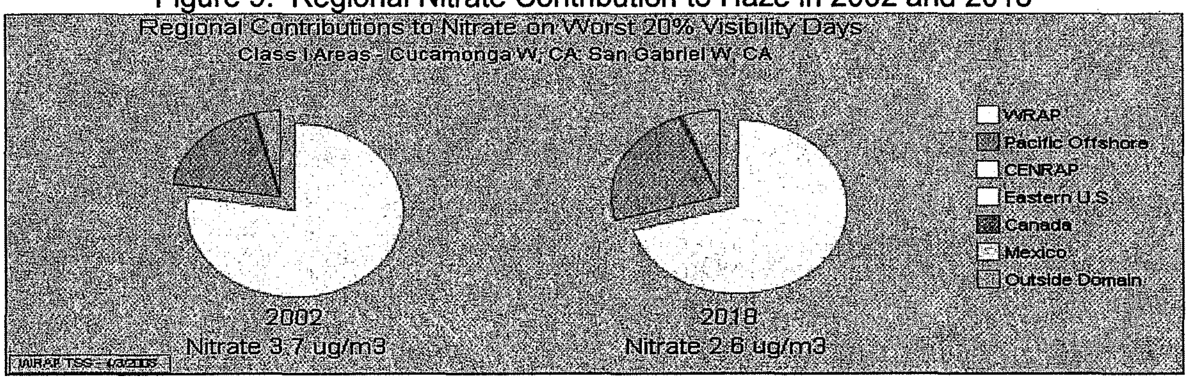



**Figure 10.** Nitrate source contribution from CA and outside regions

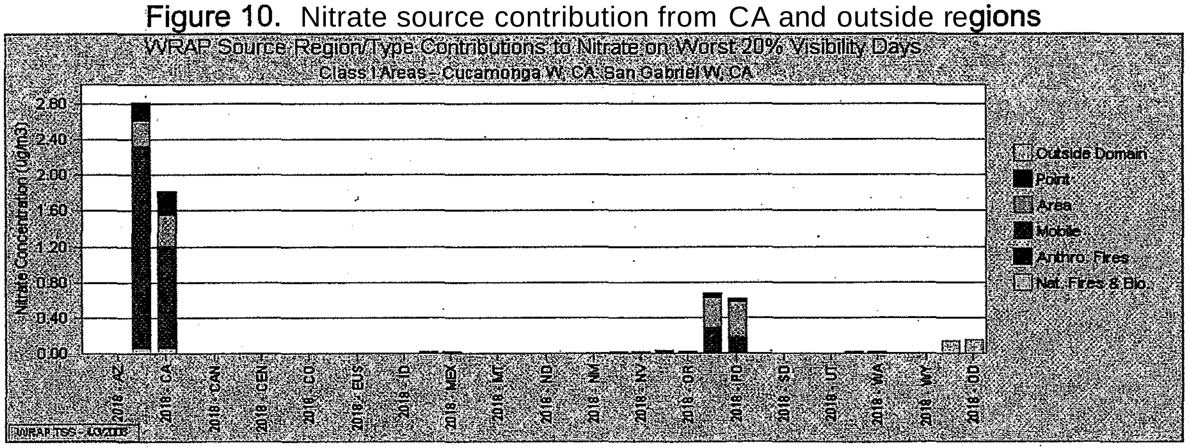


Figure 11. Or_anic carbon source contribution from GA and outside re_ions

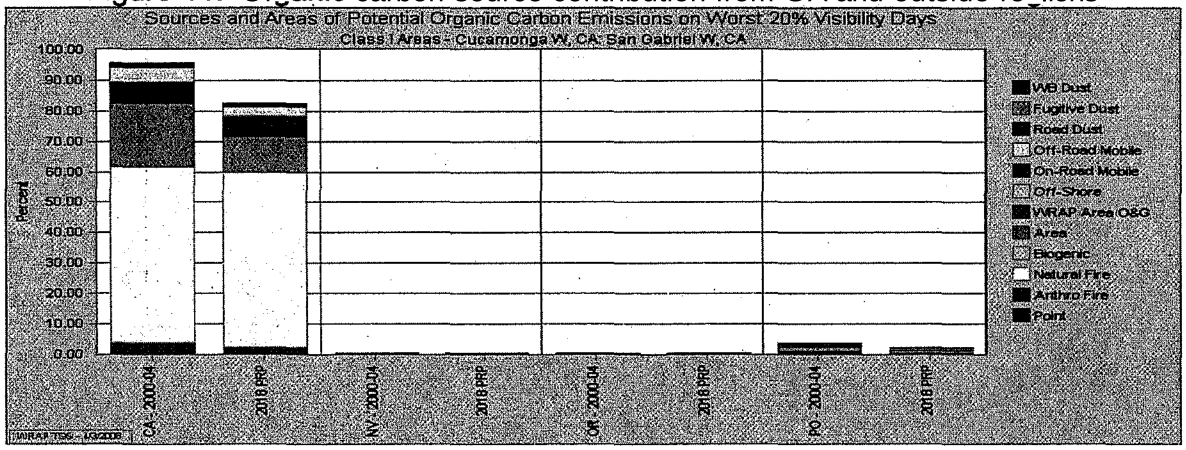



Figure 12. Organic carbon Anthropogenic and Biogenic Source Apportionment

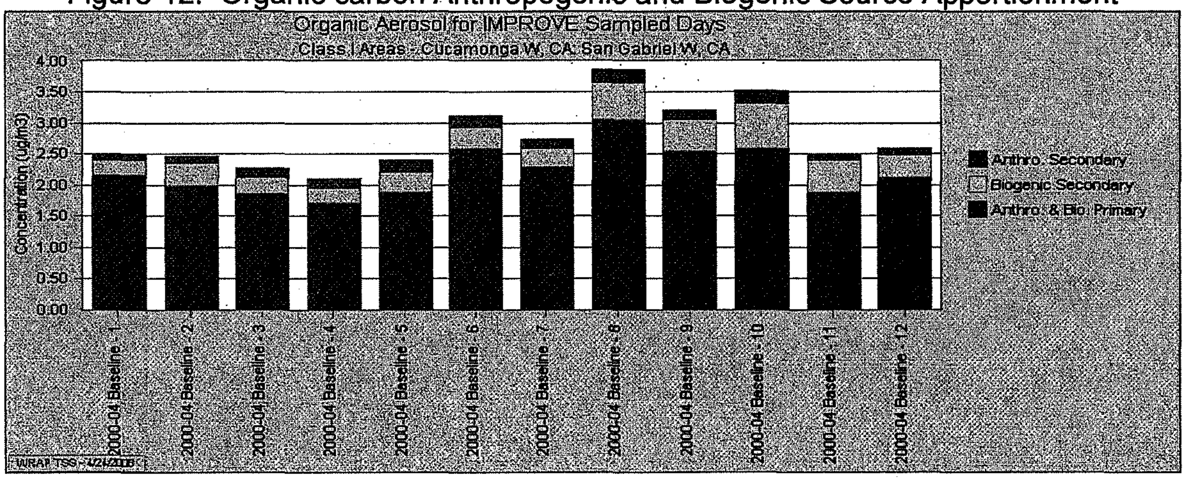
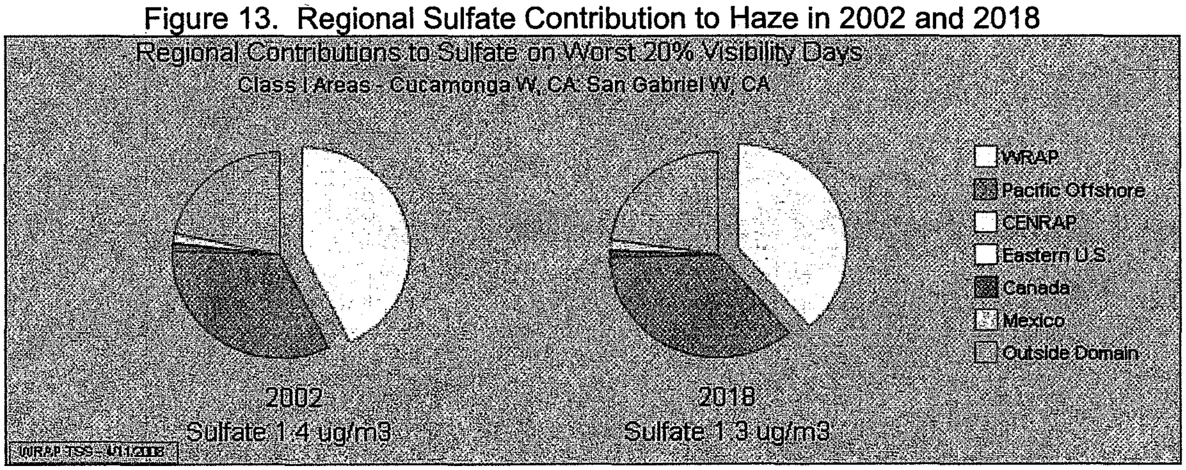
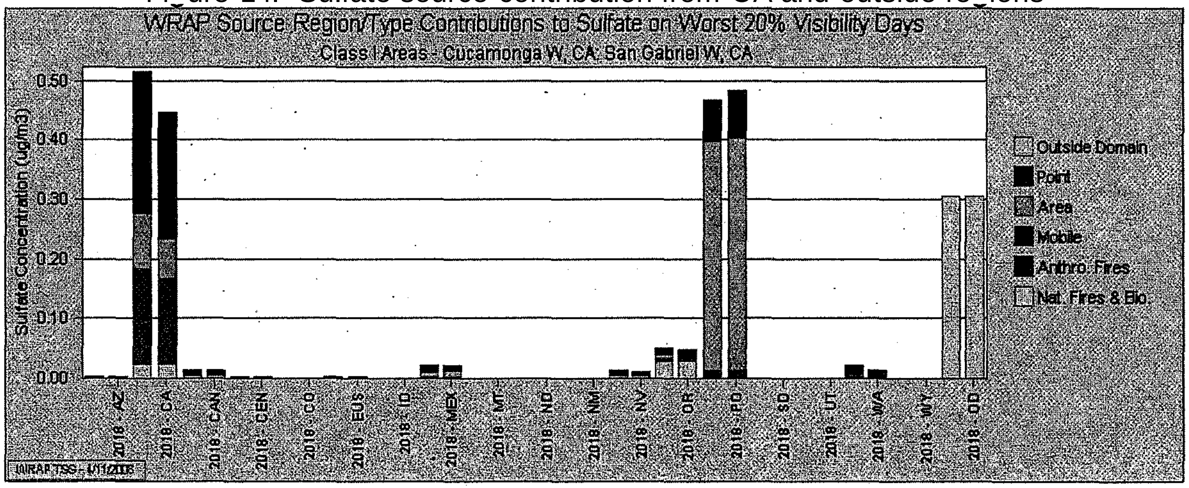



Figure 13. Regional Sulfate Contribution to Haze in 2002 and 2018



Fi_ure 14. Sulfate source contribution from CA and outside re_ions



# SAG01 Monitor

The SAG01 monitor location represents two wilderness areas located in the San Bernardino and San J.acinto Mountains in Southern California. The wilderness areas associated with the SAG01 monitor are San Gorgonio Wilderness Area and San Jacinto Wi.lderness area. The SAG01 site has been operating since March 1988. This site does riot have sufficient data for the entire baseline period. Data was not available for the year 2000.

## Section I. SAG01 **Wilderness** Area Descriptions

### *I.a. San Gorgonio Wilderness Area*

The San Gorgonio Wilderness Area (San Gorgonio) occupies 34,644 acres of the San Bernardino Mountains of southern California, approximately 75 miles east of Los Angeles. Elevations range from 1,341 meters to 3,505 meters at the crest of Mt.San Gorgonio; however most of the wilderness is above the 2,134 meter level. Eleven of the 12 peaks in the Wilderness are above 3,048 meters. Two rivers, the Santa Ana and the White, flow out of the Wilderness. Two small. lakes, several meadows, and.large, heavily forested areas provide a beautiful sub-alpine oasis in the dry lands that surround the mountain range.

**Figure 1. SAGO1 Monitor location**

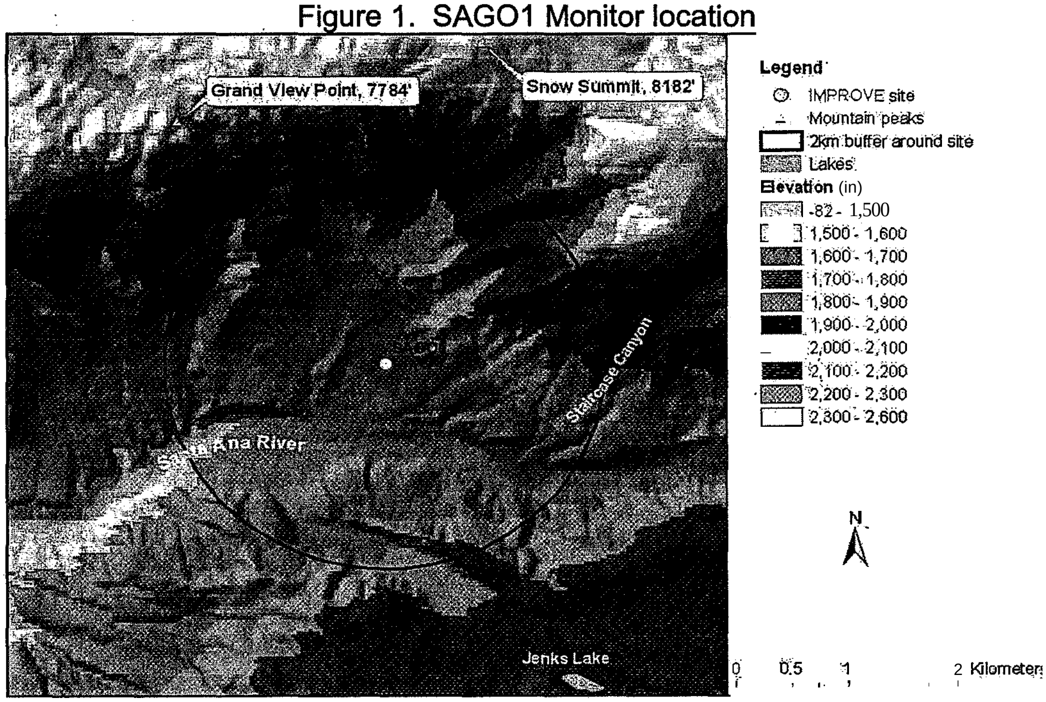
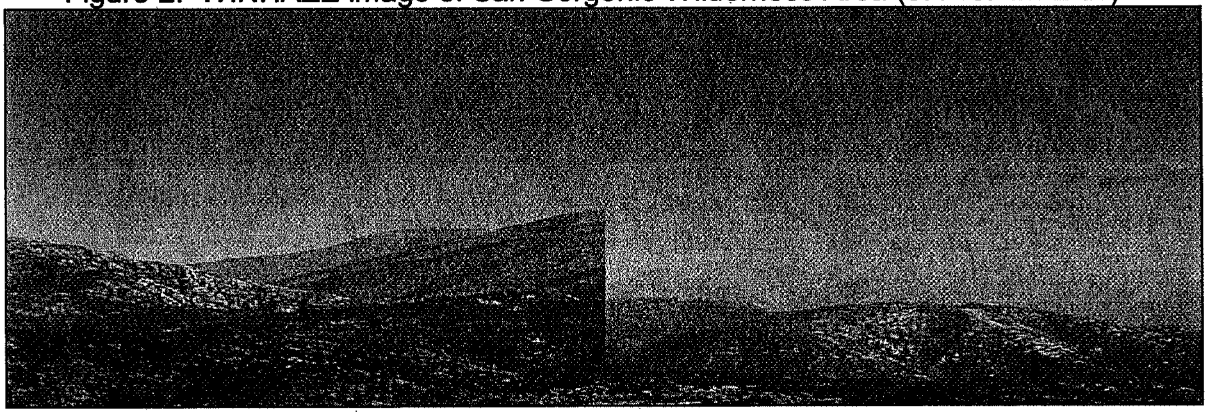


Figure 2. WINHAZE image of San Gorgonio Wilderness Area (5.4 vs. 22.2 dv)



*I.b.* ***San Jacinto Wilderness Area***

The San Jacinto Wilderness Area (San Jacinto) is part of the San Jacinto Mountains in southern California, adjacent to the Los Angeles Basin to the west, which can be seen from its higher elevations. It is one of the Peninsular Ranges that extend south from the Los Angeles Basin to the tip of the Baja Peninsula and separate the Los Angeles Basin from the Mohave Desert to the east. It occupies 20,564 acres and is split into a north Wilderness and a south Wilderness, separated by the Mount San Jacinto State Park and Wilderness. It is separated from the San Bernardino Mountains and San Gorgonio Wilderness by San Gorgonio Pass. Elevations range from less than 610 meters on the north edge within San Gorgonio Pass to almost 3,353 meters at its higher peaks. The highest peak in the area is San Jacinto Peak located between the north and south Wilderness sections, at an elevation of 3,293 meters.

Figure 3. San Jacinto Wilderness Area

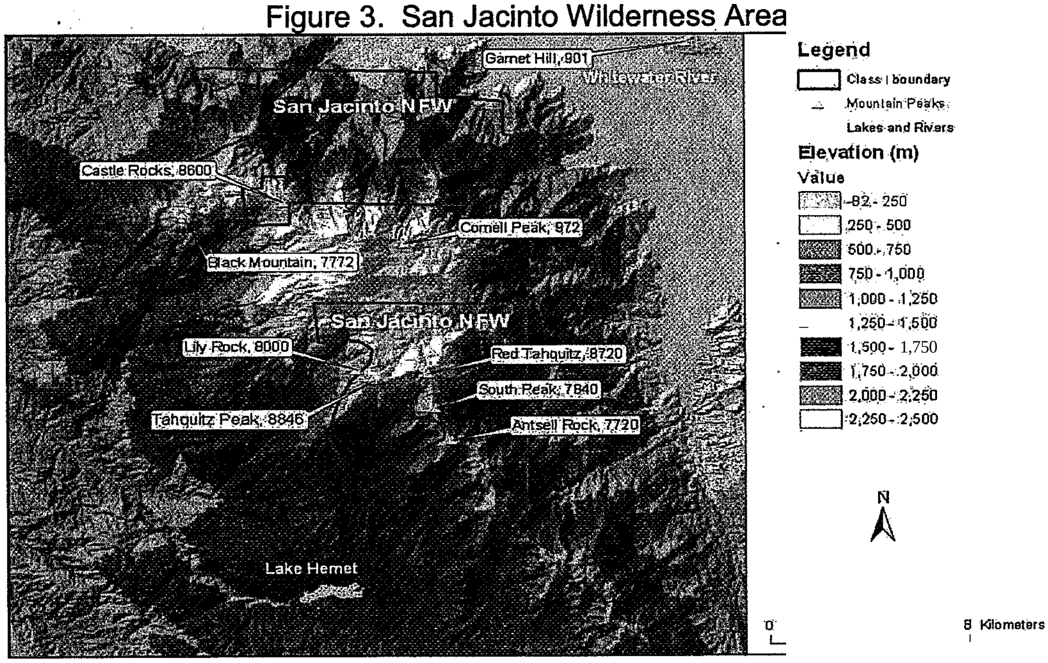


Figure 4. Photograph of San Jacinto Wilderness Area

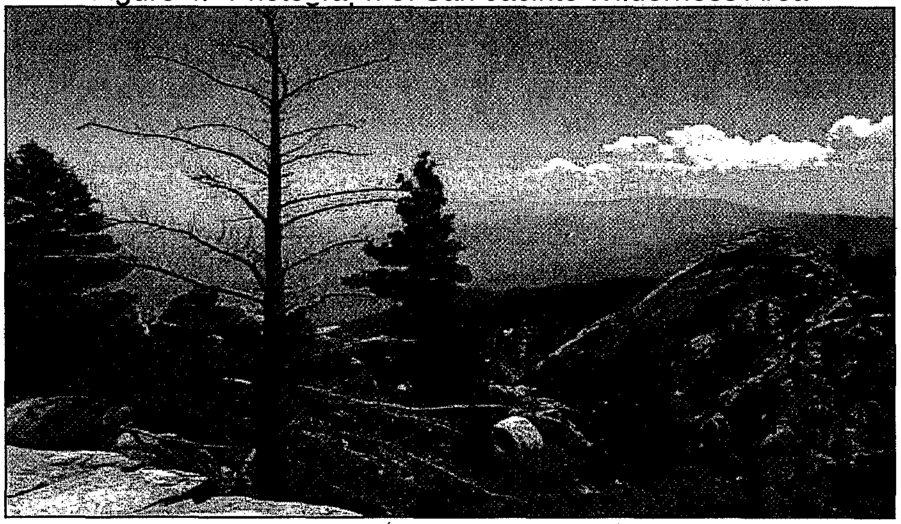
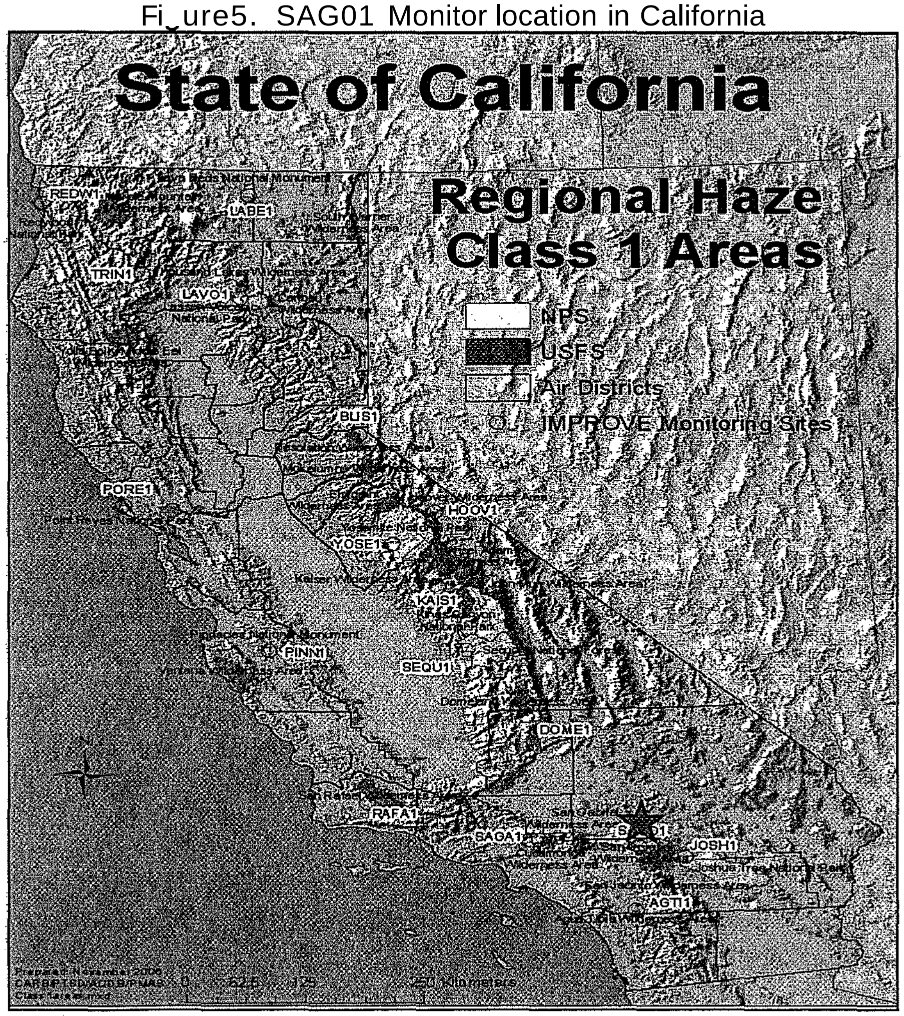


Figure 5. SAG01 Monitor location in California



## Section II. Visibility Conditions:

### *II.a. San Gorgonio Wilderness Area*

Visibility conditions for San Gorgonio are currently monitored by the SAG01 IMPROVE monitor. The monitor is located at 34.1939 north latitude and 116.9132 west longitude, in the upper Santa Ana River valley north of the northern San Gorgonio boundary. The orientation of the Santa Ana River valley is west to· east, with its mouth to the west, exiting into the Los Angeles basin. The valley bottom location nearest the site is about 1,646 meters, just south of the monitoring site. Elevations rise to about 2,347 meters at the ridgecrest, about 2' miles north, and to about 2,987 meters at the ridge crest about 7 miles·south of the site.

The SAG01 IMPROVE site is near the bottom of the Santa Ana River valley at an elevation Off 1,726 meters. This is well below typical San Gorgonio elevations which extend to over 3,048 meters on some of the peaks. Aerosol composition and concentration measured at SAG01 may not be representative of higher San Gorgonio elevations. When the atmosphere is well mixed to San Gorgonio elevations the SAG01 site should be representative.

The SAG01 location is adequate for assessing the 2018 reasonable progress goals for the San Gorgonio Wilderness Class 1 area.

### *II.b.* **San *Jacinto Wilderness Area***

Visibility conditions for San Jacinto are currently monitored by the SAG011MPROVE monitor in the San Gorgonio Wilderness Area. The monitor is located at 34.1939 north latitude and 116.9132 west longitude north of San Gorgonio Pass in the upper Santa Ana River Valley. The monitor is at an elevation of 1726 meters and about 20 miles north of the Wilderness boundary across the San Gorgonio Pass. It is also separated from the San Jacinto Wilderness by the San Gorgonio Wilderness that includes the so-called "Ten Thousand Foot Ridge", with elevations in excess of 3,048 meters.

The SAG01 IMPROVE site is near the bottom of the Santa Ana River valley and is separated from the.San Jacinto Wilderness by the San Gorgonio Wilderness, which presents a massive intervening obstruction. It should be representative of lower .Wilderness elevations when the atmosphere is weH mixed, but may not be as representative when it is within a local trapping inversion in the Santa Ana River Valley, or beneath a regional inversion between the SAG01 elevation and San Jacinto elevations. The San Gorgonio Pass, a potential air"pollution corridor between the Los Angeles Basin and the Mohave Desert to the east, also lies between SAG01 and the San Jacinto Wilderness and could at times create a gradient in concentrations' between the SAG01 monitoring site and San Jacinto Wilderness locations. There could also be a difference in aerosol composition if and when the SAG01 site is influenced by local sources such as wild land fires.

The SAG01 location is adequate for assessing the 2018 reasonable progress goals for the San Jacinto Wilderness Class 1 area.

### II.c. *Baseline Visibility*

Baseline visibility is determined from SAG01 IMPROVE monitoring data for the 20% best and the 20% worst days for the years 2000 through 2004. The baseline visibility for the SAG01 monitor is calculated at 5.4 deciviews for the 20% best days and 22.2 deciviews for the 20% worst days. Figure 6 represents the worst baseline visibility conditions.

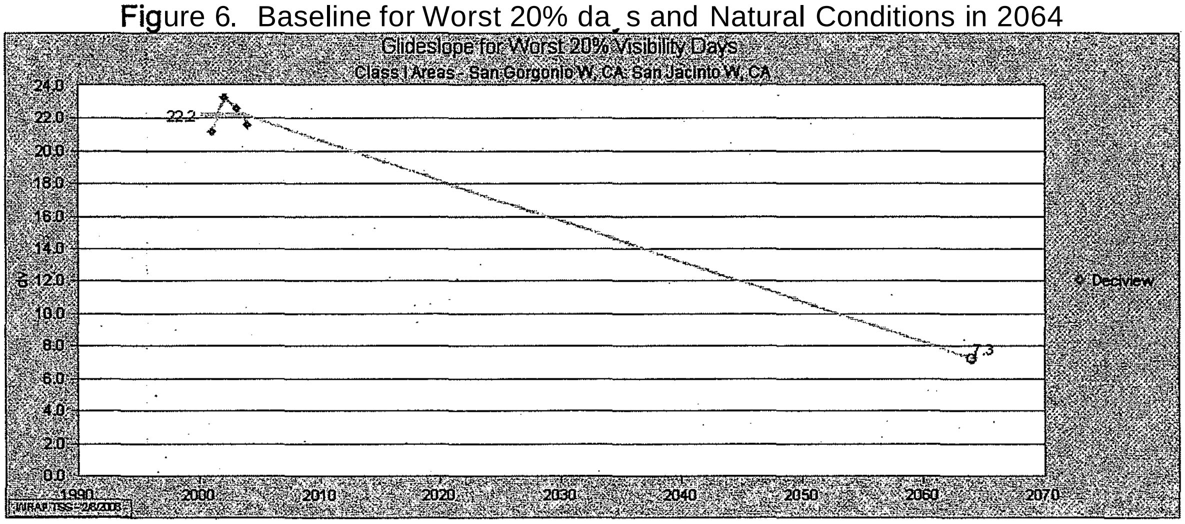
### II.d. *Natural Visibility*

Natural Visibility represents the visibility condition that would be experienced in the absence of human-caused impairment. Based on EPA gUidance, the natural visibility for the SAG01 monitor is 1.2 deciviews for the 20% best days and 7.3 deciviews for the 20% worst days. It is possible that the Natural Conditions deciview value for 2064 could change in the future as more is learned about natural plant emissions and wildfire impacts.

### II.e. *Presumptive Glide Slope arid the Uniform Rate of Progress*

Figure 6 aiso shows the uniform rate of progress, or "glide slope." The glide slope is the rate of reduction in the 20% worst days deciview average that would have to be achieved to reach natural conditions at a uniform pace in the 60 years following the baseline period. The first benchmark along the path towards achieving natural conditions occurs in 2018. The glide slope shows that the 2018 benchmark for the 20% worst days is 18.70 deciviews. According to the Regional Haze Rule, the 20% best days baseline visibility of 5.4 deciviews mustbe maintained or improved by 2018, the end of the first planning period.

Figure 6. Baseline for Worst 20% da s and Natural Conditions in 2064



### *II.f.* ***Species Contribution***

Each pollutant species causes light extinction but its contribution differs on best and worst days. Figure 7 shows the contribution of each species to the 20% best and worst days in the baseline years at SAG01.

Figure 7. Average Haze species contributions to light extinction in the baseline years

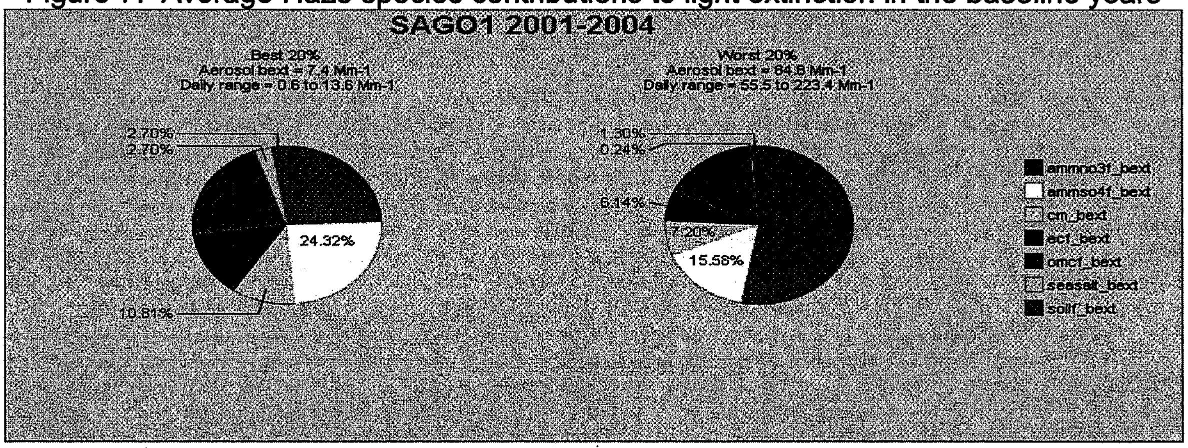
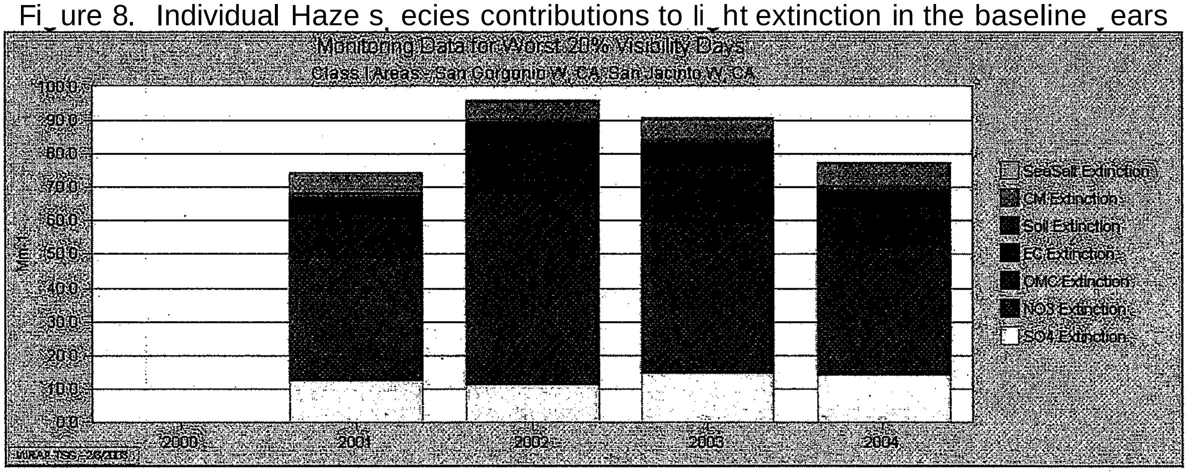



Figure 8. Individual Haze species contributions to light extinction in the baseline years




As shown in Figures 7 and 8, nitrates, organic matter, and sulfates have the strongest contributions to degrading visibility on worst days at the SAG01 monitor. Nitrates clearly dominate on the worst days, bufnitrates and sulfates equally contribute emissions on the best days. Data points for 2000 were insufficient for calculating best and worst days per the Regional Haze Rule Guidance.

Figure 9 depicts the individual species contribution to worst days in 2002. Nitrates increase in the winter and spring months, while organic matter increases in the summer and fall. Sulfates remain relatively stable throughout the year. Nitrates clearly dominate the other haze species on worst days, but organic matter, sulfates, coarse mass and elemental carbon also contribute to the worst days. There are only trace amounts of soil and sea salt present throughout the years.

Figure 10 illustrates the individual species contribution·on worst days in **2000-2004** by monthly average. The trend shown is comparable to Figure 9 for nitrates, organic matter, and sulfates. High organic periods vary from year to year due to the unpredictable occurrence of wild fires.

Figure 9. Species contribution on the 20% worst days in 2002

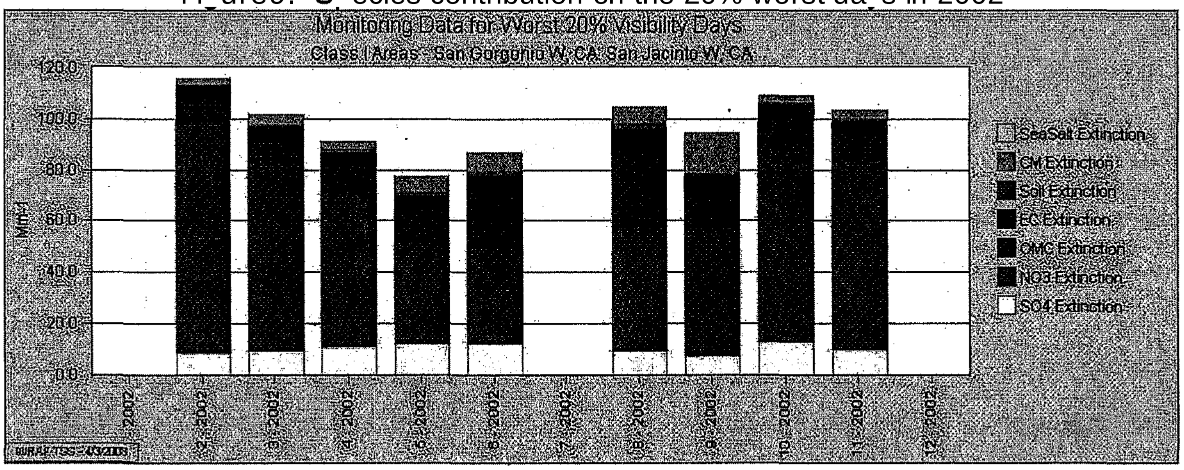
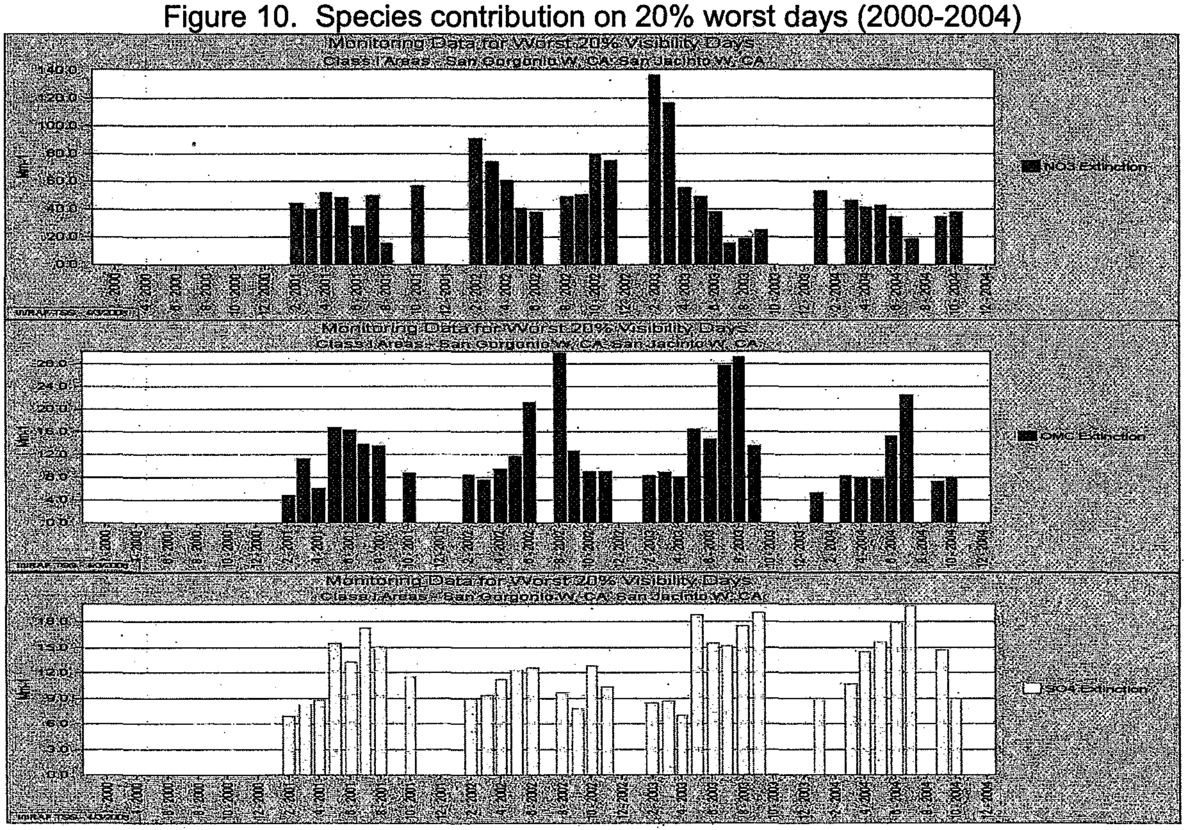



**Figure 10. Species contribution on 20% worst days (2000-2004)**



### *II.g. Sources of Haze Species*

Both natural and man-made sources.contribute to the calculated deciview levels made by haze pollutants at SAG01. Some haze species arise from sources that are within the control of the State of California or neighboring states. Others arise from natural, uncontrollable situations such as wildfires, sea salt or dust storms in natural areas, whether or not they from in-state or out-of-state (and out-of-country) sources. Finally, other uncontrollable, man-made sources are those industrial pollutants and other man-made (anthropogenic) emissions transported from outside the United States.

Figures'11 and 12 represent the regional contributions to nitrates on the 20% worst days. The WRAP region represents the largest contribution to nitrate in 2002 and 2018 (79%), followed by the Pacific Offshore Region (17%) and emissions from Outside Domain (3%). Mobile sources within California contribute the most nitrate at the SAG01 monitor. In 2002, 87% of the nitrate from mobile sources at the SAG01 monitor can be attributed to California. California mobile source emissions reductions are mainly responsible for improvement in nitrates in 2018.

Figure 13 shows the primary organic carbon source contribution from California and the outside regions. The largest contributor to primary organic carbon at the SAG01 monitor is from natural fire sources within California. California represents 99% of all natural fire source contributions.

Figure 14 illustrates the total organic carbon source apportionment from 2000-2004 for anthropogenic and biogenic sources. The anthropogenic and biogenic primary source emissions.account for 59% of the total organic carbon. Biogenic secondary emissions account for 34% of the total organic carbon emissions and anthropogenic secondary is responsible for the remaining emissions.

Figures 15 and 16 represent the regional contributions to sulfate on the 20% worst days in 2002 and 2018 at SAG01. The WRAP region represents 38% of the sulfate contributions in 2002 and 2018, followed by the emissions from Pacific Offshore (31 %) and the Outside Domain Region (27%). California contributes 33% of the total sulfate emissions seen at the SAG01 monitor.

Individually, emissions from outside the modeling domain contribute the most to sulfate concentrations at the ,SAGO1 monitor. The next largest contributor to sulfate concentrations is area sources in the Pacific Offshore.

Figure 11. Regional Nitrate contribution to haze in 2002 and 2018

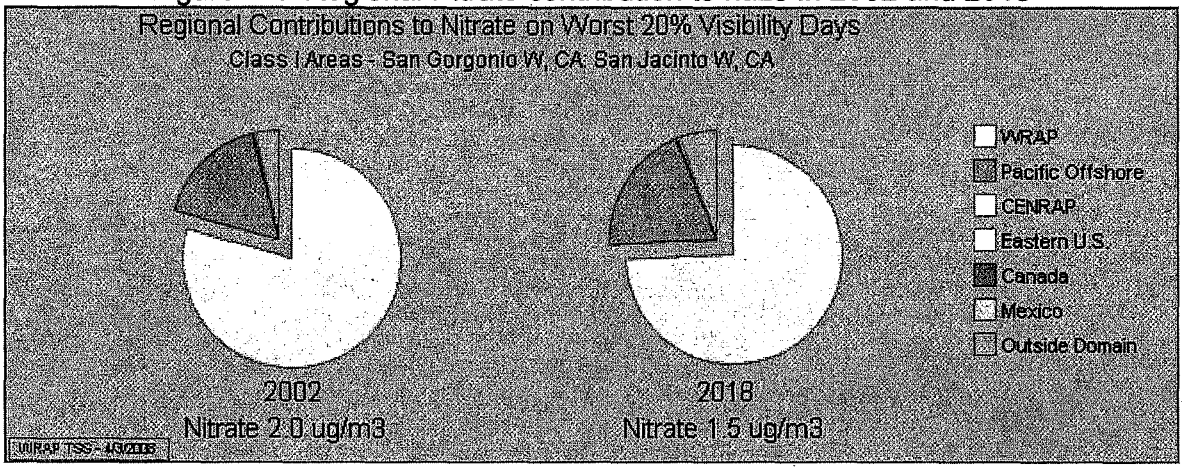



Figure 12. Nitrate source contribution from CA and outside regions

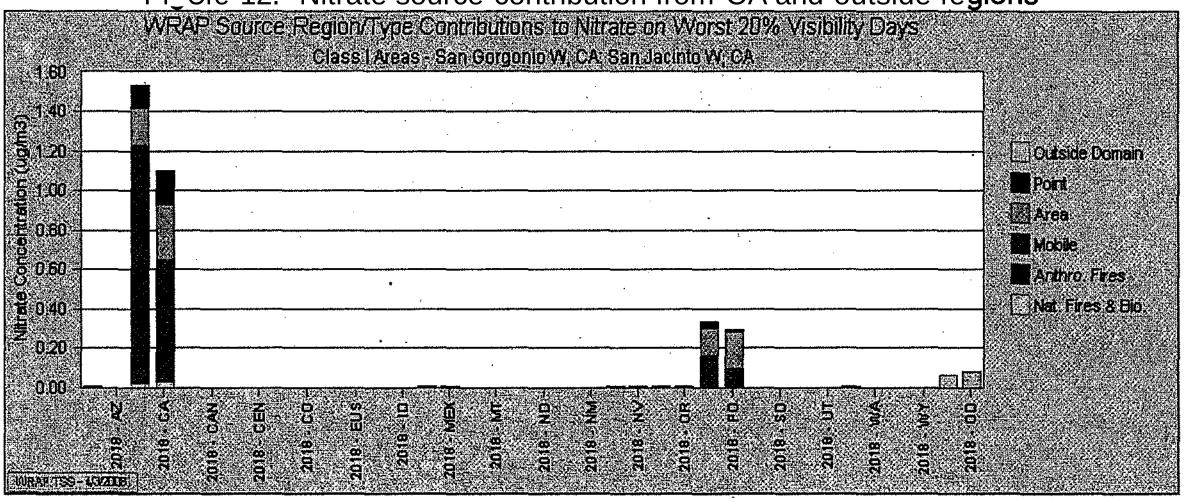



Figure 13. Organic carbon source contribution from CA and outside regions

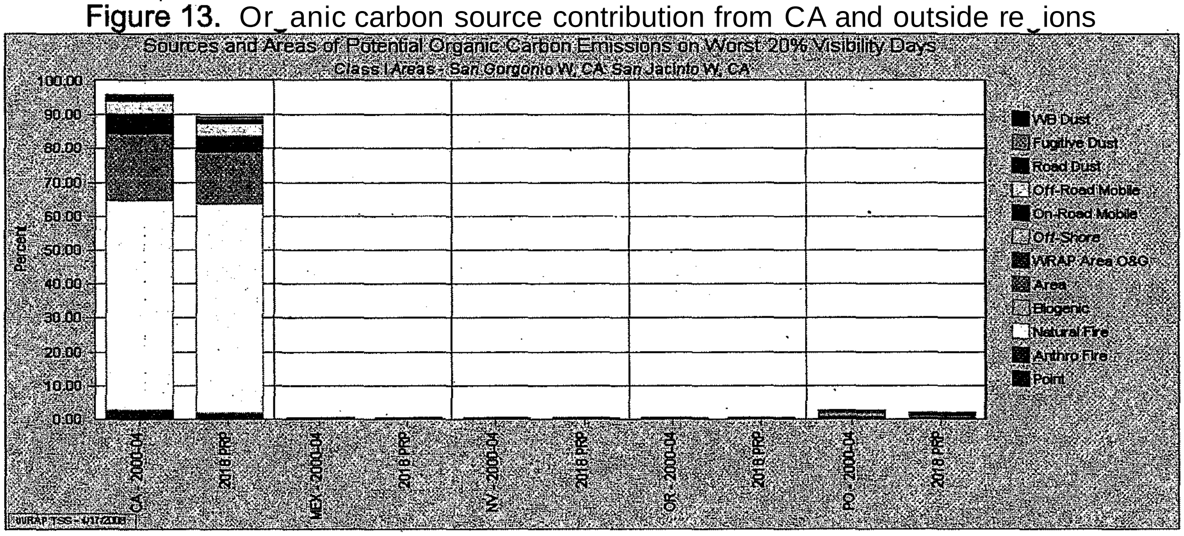


Figure 14. Organic carbon Anthropogenic and Biogenic Source Apportionment

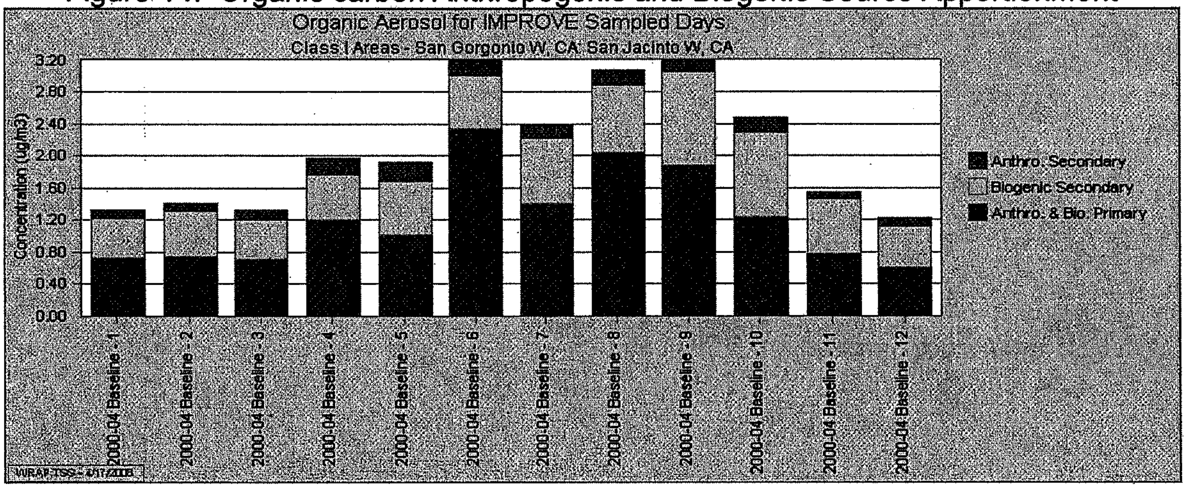
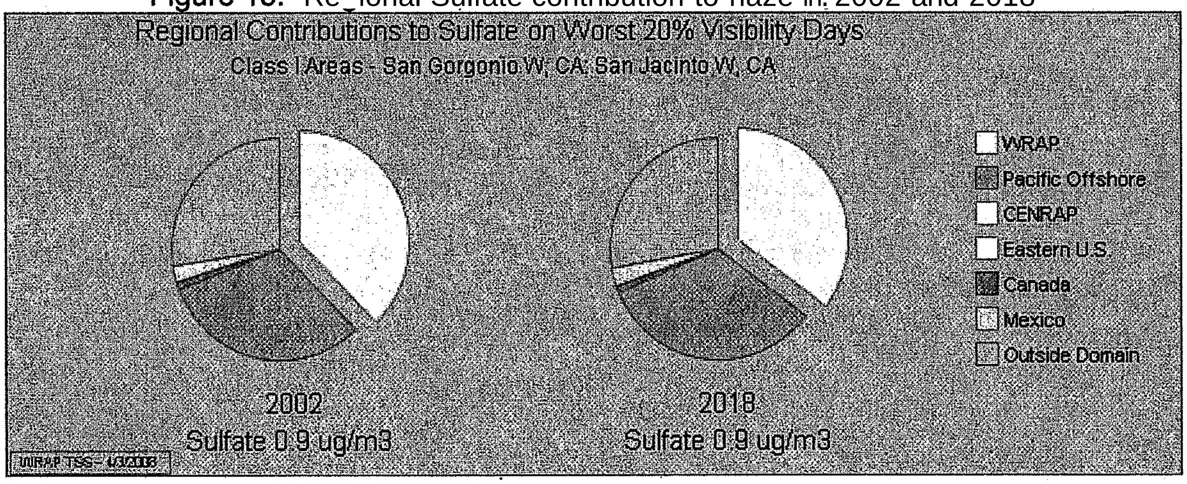
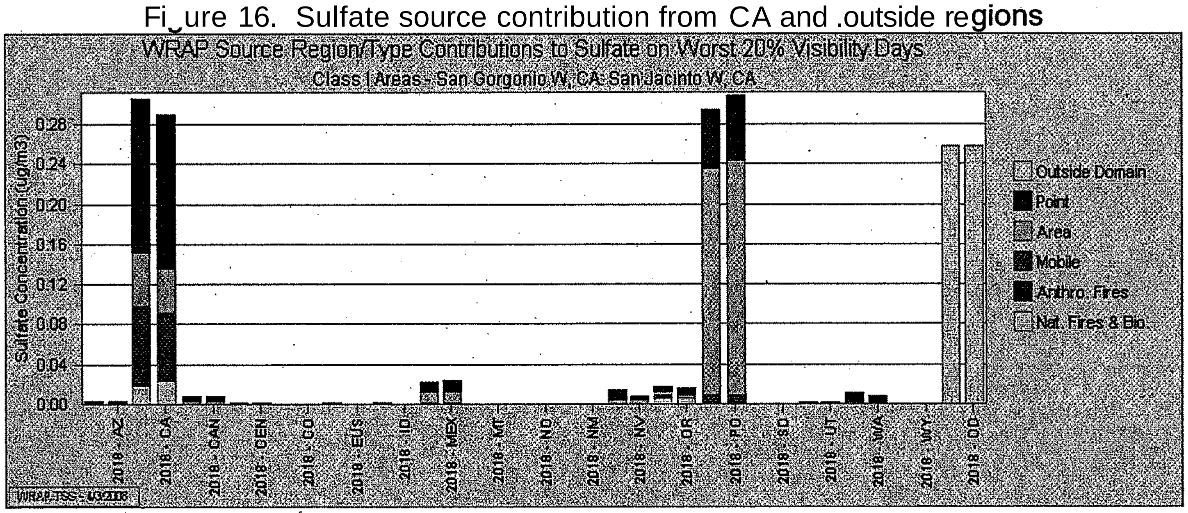



Figure 15. Re_ional Sulfate contribution to haze in 2002 and 2018




Fi_ure 16. Sulfate source contribution from CA and outside regions



# AGT1 Monitor

## Section I., Description

The Agua Tibia Wilderness Area comprises most of the Cleveland National Forest, 15,934 acres, in the northwest part of the isolated Palomar Mountain Range of southern California. The area is mountainous, cut by many deep canyons that reach downward towards flatter terrain of coastal' southern California between Los Angeles and San Diego. Elevations range from nearly 518 meters in the canyon bottoms, to the 1547 meters Eagle Crag Peak at the southeast corner of the Wilderness Area, although there are higher'elevations along the main part of the Palomar Range extending further to the southeast. West of the Wilderness, canyons exit into the San Luis Rey River drainage' that empties into the Pacific Ocean near Oceanside, about 30 mileS southwest of the Wilderness.

Figure 1. AGT1 Monitor location

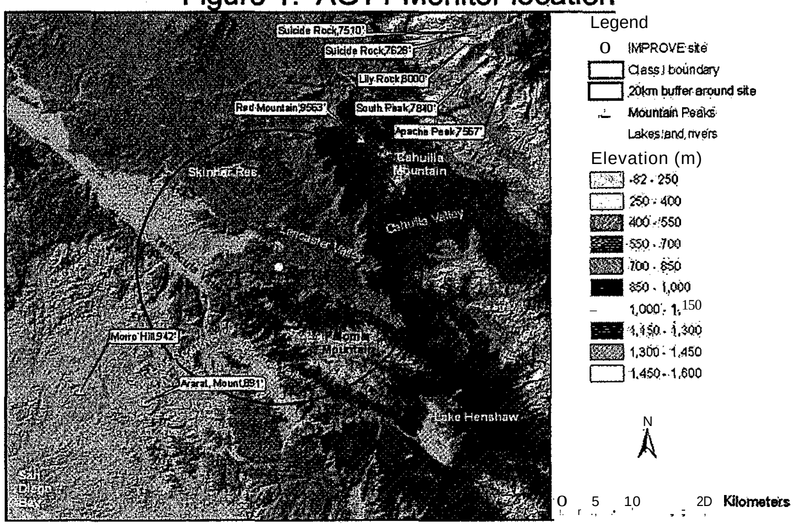



Figure 2. Image of Agua Tibia

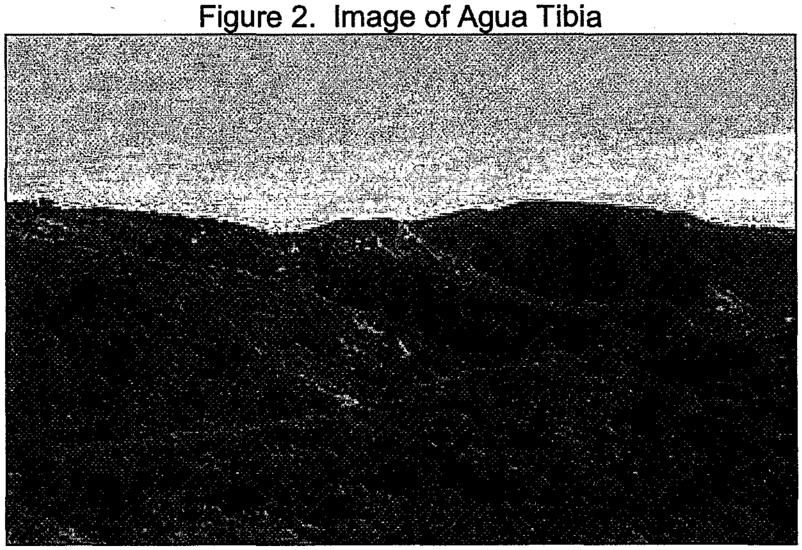
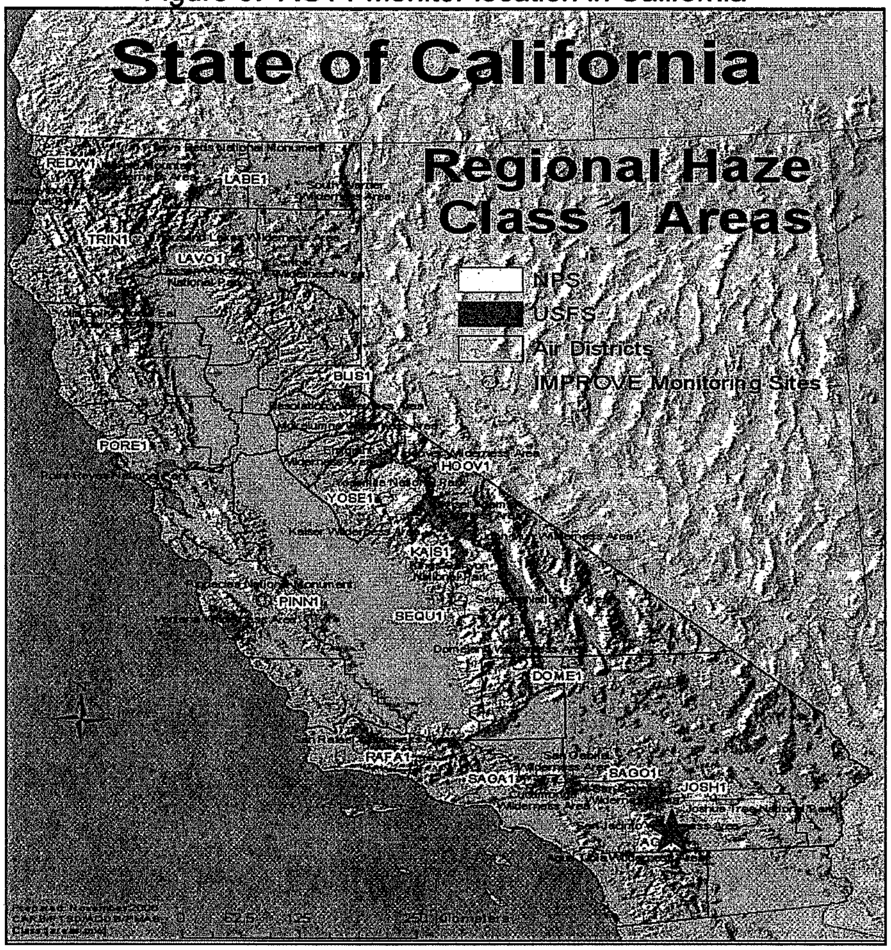


Figure 3. AGT1 Monitor location in California




## Section II. Visibility Conditions:

### I/.a. *Visibility Monitor Location*

Visibility conditions for Agua Tibia are currently monitored by the AGTI1 IMPROVE monitor. The monitor is located at 33.46 north latitude, 116.97 west longitude, close to Highway 79 near the northern Wilderness boundary at an elevation of 508 meters (which is near the lower end of the range of Wilderness elevations). It is also within the typical elevation range for the transition zone between the coastal marine layer and the drier air above. The elevation range for this transition zone is typically 305 to 610 meters. The site has been operating since November 2000. This site does not have sufficient data for the entire baseline period. Data was not available for the year 2000.

The Agua Tibia monitoring site is at an elevation of 508 meters, thus very representative of lower Agua Tibia Wilderness elevations in general. At this elevation it may at times be within the coastal marine inversion, if and when the inversion extends inland to this site. In such cases it would be less representative of higher Wilderness elevations above the penetrating marine layer. The Wildemess is above the foothills of the sprawling and heavily populated and industrialized South Coast Air Basin immediately to the north. The Temecula Valley just to the west of the Wilderness is a rapidly growing area, and associated urban emissions may also have increasing impact on aerosol concentrations in the Agua Tibia Wilderness.

The AGTIllocation is adequate for assessing the 2018 reasonable progress goals for the Agua Tibia Class 1 area.

*II.b. Baseline Visibility*

Baseline visibility is determined from AGTI1 IMPROVE monitoring data for the 20% best and the 20% worst days for the years 2000 through 2004. The baseline visibility for the Agua TibiaWilderness is calculated at 9.6 deciviews for the 20% best days and 23.5 deciviews for the 20% worst days. Figure 4 represents the worst baseline visibility conditions.

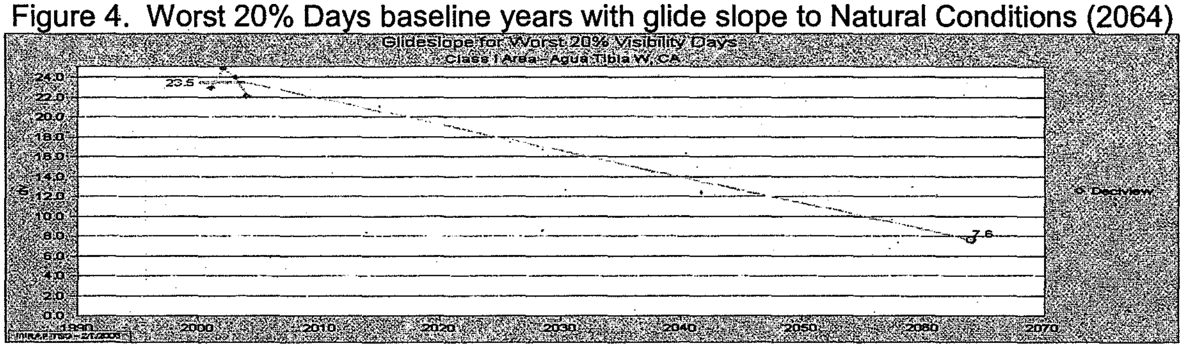
*II.c. Natural Visibility*

Natural visibility represents the visibility condition that would be experienced in the absence of human-caused impairment. Based on EPA guidance, the natural visibility for the Agua Tibia-Wilderness is 2.9 deciviews for the 20% best days and 7.6 deciviews for the 20% worst days. It is possible that the Natural conditions deciview value for 2064 could change in the future as more is learned about natural plant emissions and wildfire impacts.

*II.d. Presumptive Glide Slope and the Uniform Rate of Progress*

Figure 4 also shows the uniform rate of progress, or "glide slope." The glide slope is the rate of reduction in the 20% worst days deciview average that would have to be achieved to reach natural conditions at a uniform pace in the 60 years following the baseline period. The first benchmark along the path towards achieving natural conditions occurs in 2018. The glide slope shows that the 2018 benchmark for the 20% worst days is 19.8 deciviews. According to the Regional Haze Rule, the 20% best days baseline visibility of 9.6 deciviews must be maintained or improved by 2018, the end of the first planning period.

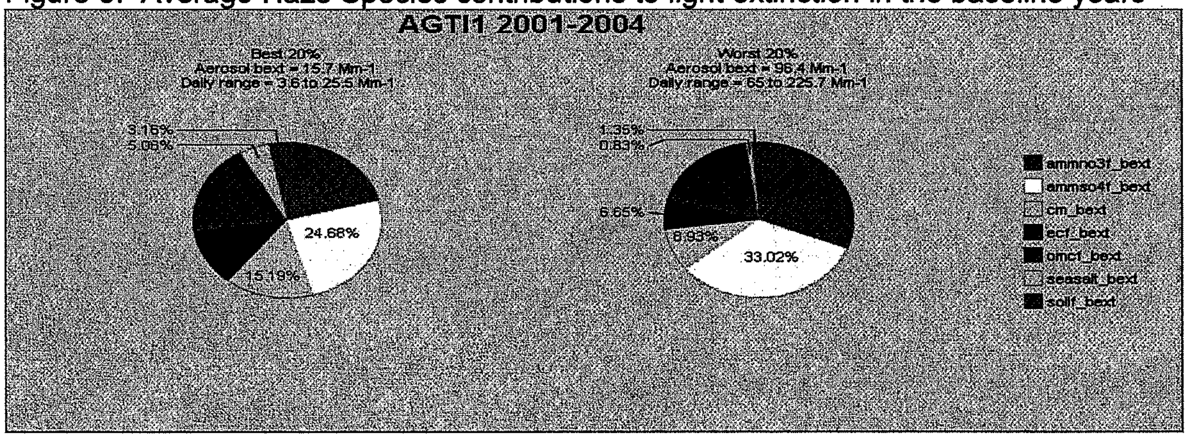
**Figure 4. Worst 20% Days baseline years with glide slope to Natural Conditions (2064)**



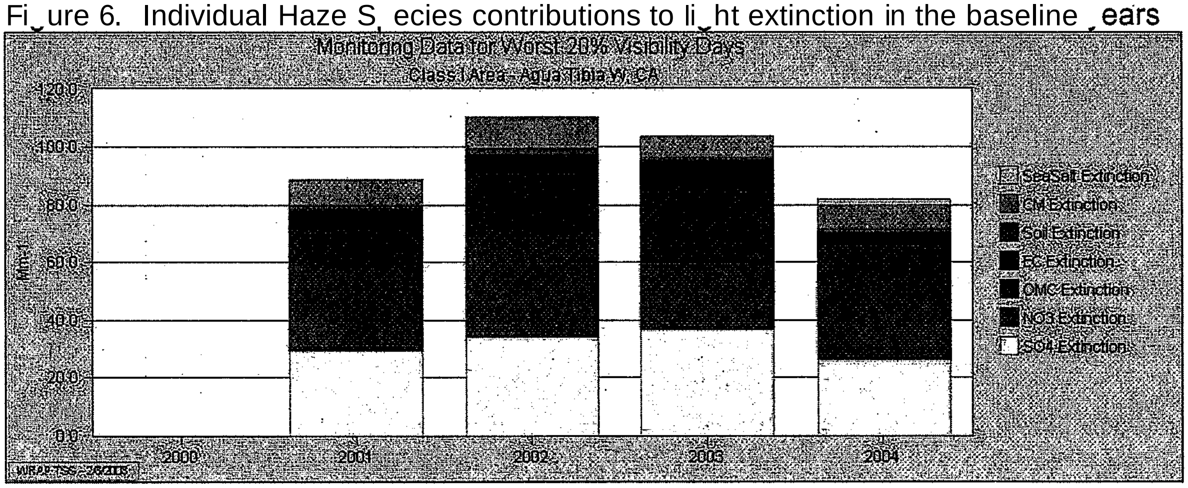
### *II.e. Species Contribution*

Each pollutant species causes light extinction but its contribution differs on best and worst days. Figure 5 shows the contribution of each species to the 20% best and worst days in the baseline years at AGTI1.

**Figure 5. Average Haze Species contributions to light extinction in the baseline years**




Fi ure 6. Individual Haze S ecies contributions to li ht extinction in the baseline ears




As shown in Figures 5 and 6, sulfates, nitrates, and organic matter have the strongest contributions to degrading visibility on worst days at Agua Tibia Wilderness Area. Data points for 2000 were insufficient for calculating best and worst days per the Regional Haze Rule Guidance.

Figure 7 depicts the individual species contribution to worst days in 2002. Nitrates increase in the winter and spring months. Sulfates remain relatively stable throughout the year but do increase slightly in July and August. The occurrence of elevated organic matter concentrations is sporadic throughout the year. Nitrates clearly dominate the other haze species on worst days, but sulfate and organic matter also contribute to the worst days in the summer. There are also small amounts of coarse mass and elemental carbon present throughout the years.

Figure 8 illustrates the individual species contribution on worst days in 2000-2004 by monthly average. The trend shown is comparable to Figure 7 for nitrates, sulfates, -and organic matter. High organic periods vary from year to year due to the unpredictable occurrence of wild fires.

Figure 7. Species contribution on the 20% worst days in 2002

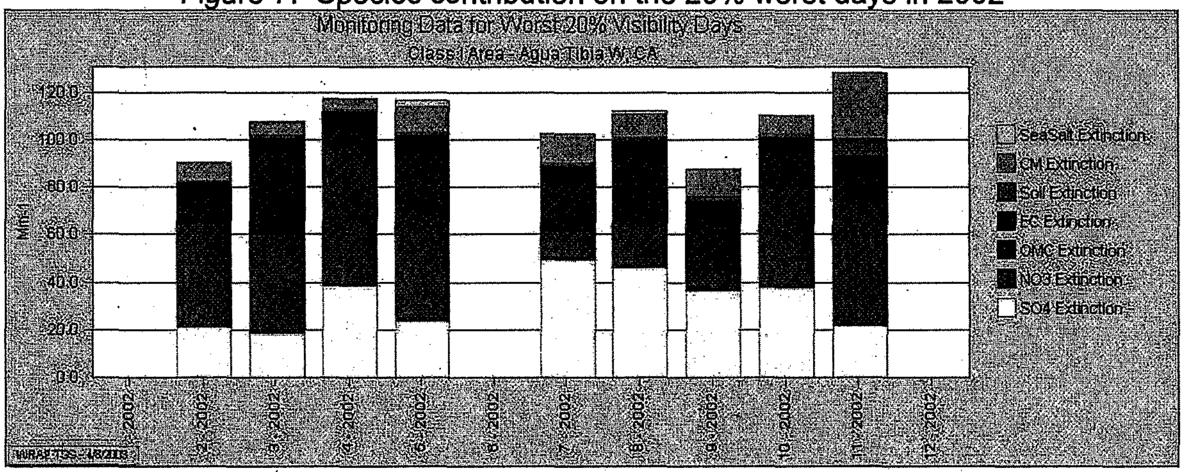
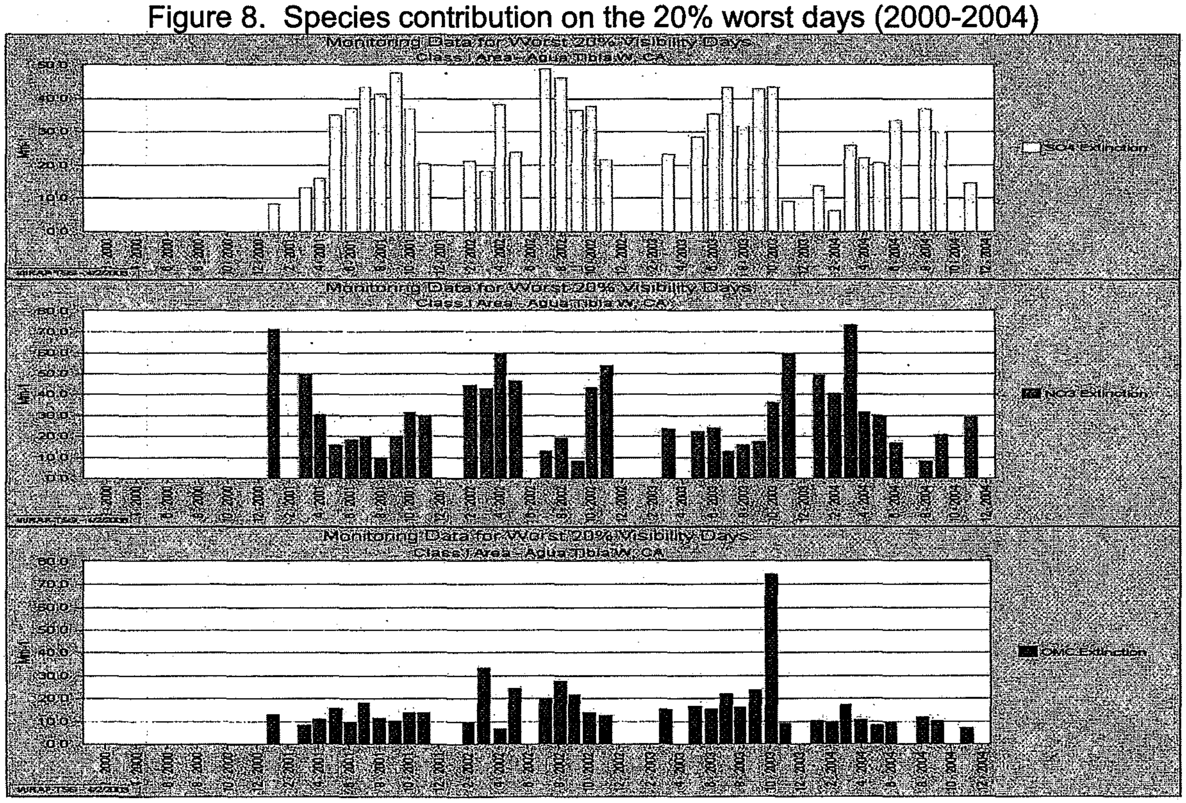



Figure 8. Species contribution on the 20% worst days (2000-2004)



### *II.f. Sources* of *Haze Species*

Both natural and man-made sources contribute to the calculated deciview levels made by haze pollutants at AGTI1. Some haze species arise from sources that are within the control of the State of California or neighboring states. Others arise from natural, uncontrollable situations such as wildfires, sea salt or dust storms in natural areas, whether they are from in-state or out-of-state (and out-of-country) sources. Finally, other uncontrollable, man-made sources are those industrial pollutants and other man-made (anthropogenic) emissions transported from outside the United States..

Figures 9 and 10 represent the regional contributions to sulfate on the 20% worst days. The Pacific Offshore region represents the largest contribution to sulfate in 2002 and 2018 (50%), followed by the WRAP Region (28%) and emissions from outside the modeling domain (17%). In 2002, 23% of the sulfate at the AGT1 monitor can be attributed to California. From the WRAP region, California is shown to contribute the most to sulfate concentrations at the AGT1 monitor in 2002 and 2018. Area sources represent 39% of all sulfate categories at the AGT1 monitor.

Individually, emissions from area sources from the Pacific Offshore contribute the most to sulfate concentrations at the AGT11 monitor. The next largest contributor to sulfate concentrations is point sources in the Pacific Offshore.

Figures 11 and 12 represent the regional contributions of nitrate on the 20% worst days in 2002 and 2018 at AGT1. The WRAP Region represents the largest contribution to nitrate in 2002 and 2018 (72%) followed by the Pacific Offshore Region (24%) and emissions from outside the modeling domain (3%). In 2002, 70% of nitrate at the AGT1 monitor can be attributed to California.

From the WRAP Region, California is shown to contribute the most nitrate concentrations at the AGT1 monitor in 2002 and 2018. Currently, California mobile sources are 82% of California contributions to nitrate at the AGT1 monitor.. California mobile source emissions reductions are mainly responsible for improvement in nitrates in 2018.

Figure 13 shows the primary organic carbon source contribution from California and the outside regions. The largest contributor to primary organic carbon at the AGT1 monitor is from natural fire within California. California represents 98% of all natural fire source contributions.

Figure 14 illustrates the total Organic carbon source apportionment from 2000-2004 for anthropogenic and biogenic sources. The anthropogenic and biogenic primary source emissions account for 59% of the total organic carbon. Biogenic secondary emissions account for 35% of the total organic carbon emissions and anthropogenic secondary is responsible for the remaining 6% of emissions.

Figure 9. Regional Sulfate contribution to Haze in 2002 and 2018

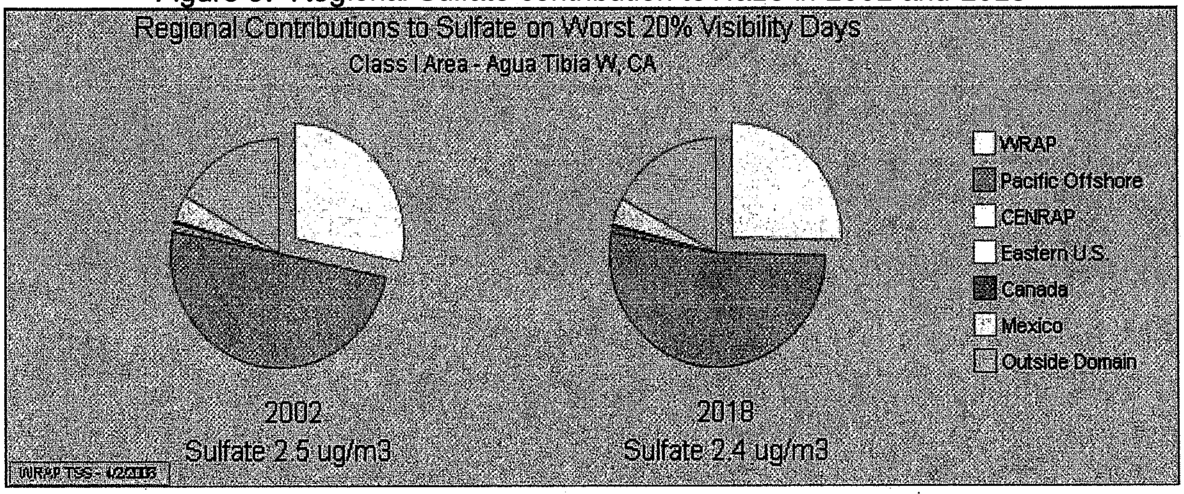



Figure 10. Sulfate source contribution from CA and outside regions

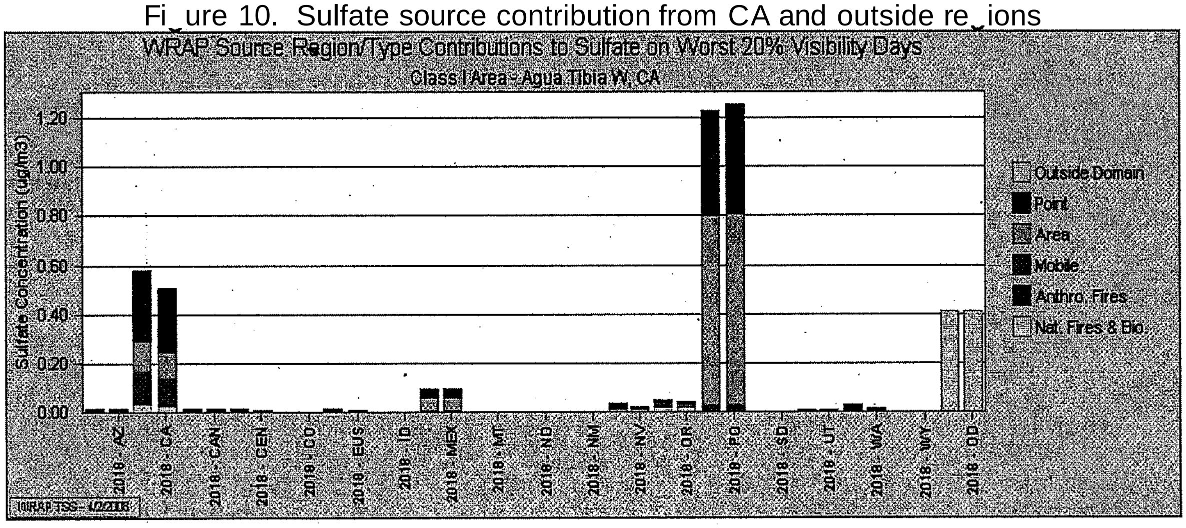
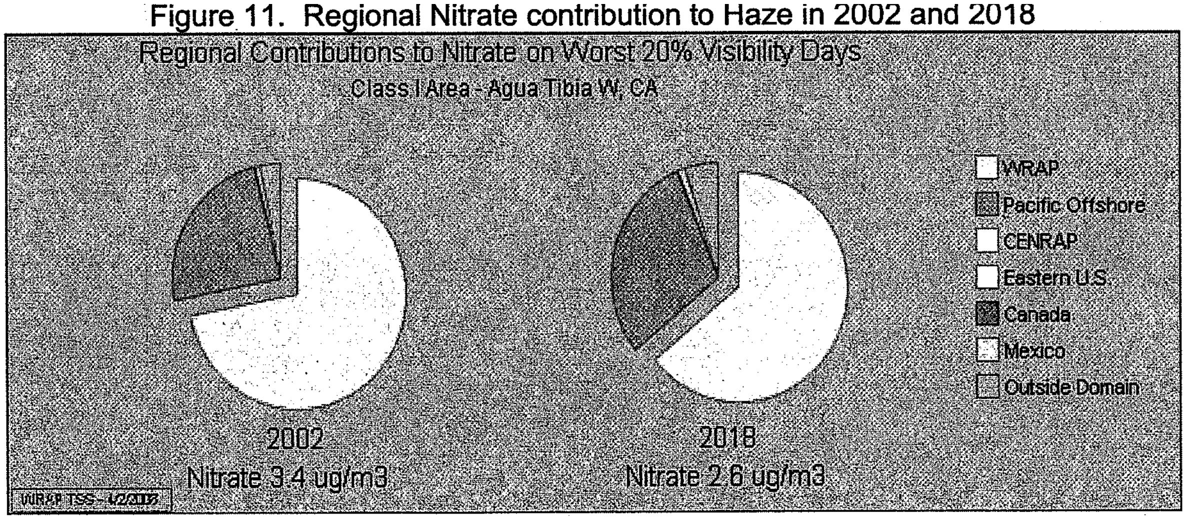



Figure 11. Regional Nitrate contribution to Haze in 2002 and 2018



Fi_ure 12. Nitrate source contribution from CA and outside regions

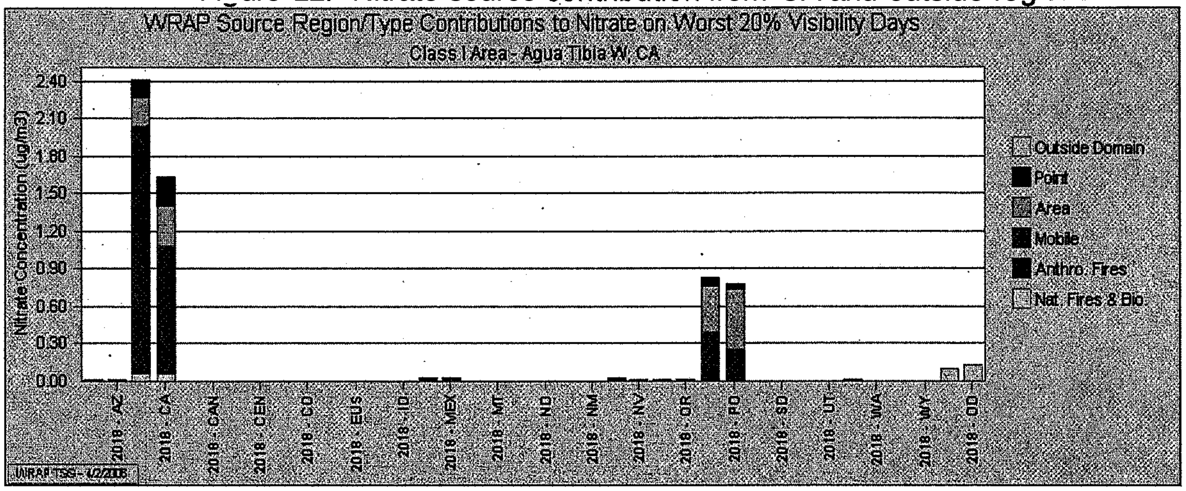



Figure 13. Organic carbon source contribution from CA and outside regions

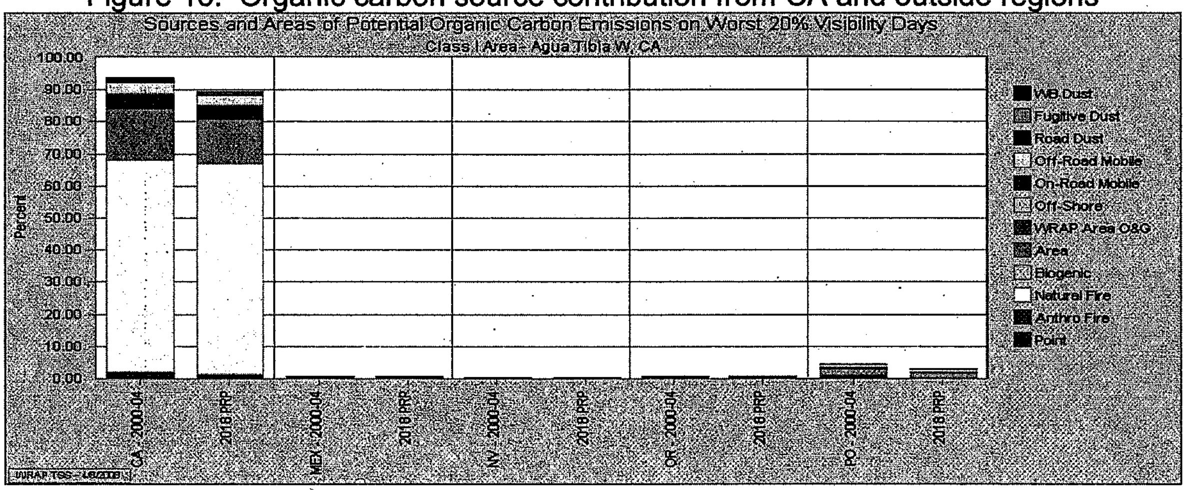
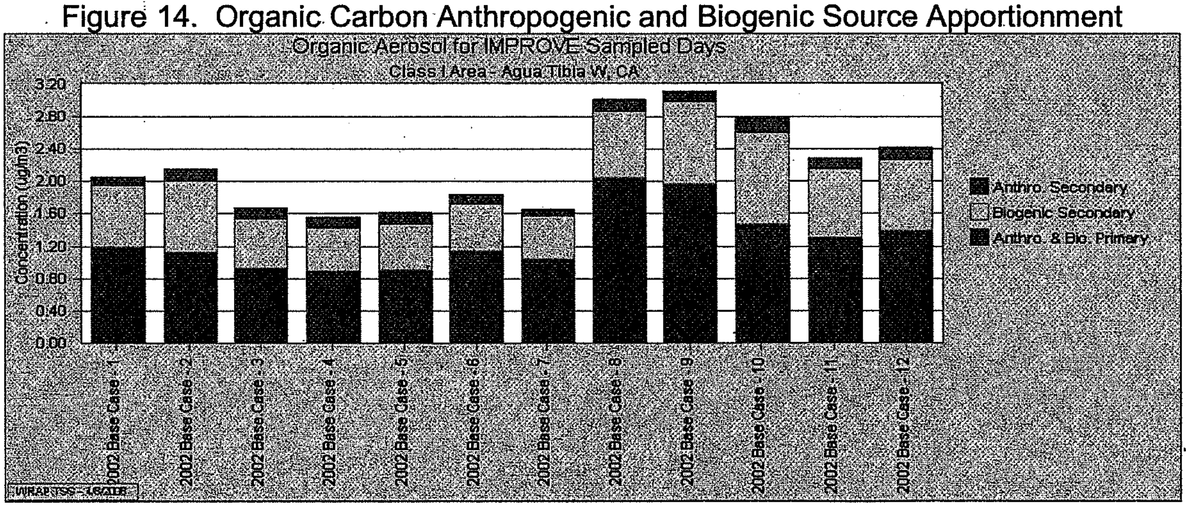



Figure 14. Organic Carbon Anthropogenic and Biogenic Source Apportionment



## JOSH1 Monitor

### Section I. Description

The Joshua Tree Wilderness Area consists of 429,690 acres within Joshua Tree National Park located in the eastern extent of the Mohave Desert of southern California, with the eastern portions also within the Sonoran Desert Physiographic province. It occupies a portion of the Little San Bernardino Mountains. Elevations range from just under 198,meters in the easternmost portions to· near 960 meters at the highest peaks that include Quail Mountain in the west and Monument Mountain in the central portion. The eastern portion of the National Park consists of the dry Pinto Wash that drains to the east. Just to the west is the Whitewater River valley that includes the city of Palm Springs and urban areas near Banning. San Gorgonio Pass is also just west of the Wilderness and National Park. San Gorgonio Pass forms a break between the San Bernardino Mountains to the north and the San Jacinto Mountains to the south and is a natural corridor of air transport between the Mohave Desert and the eastern portions of the South Coast Air Basin.

Fi_ure 1. Joshua Tree National Park

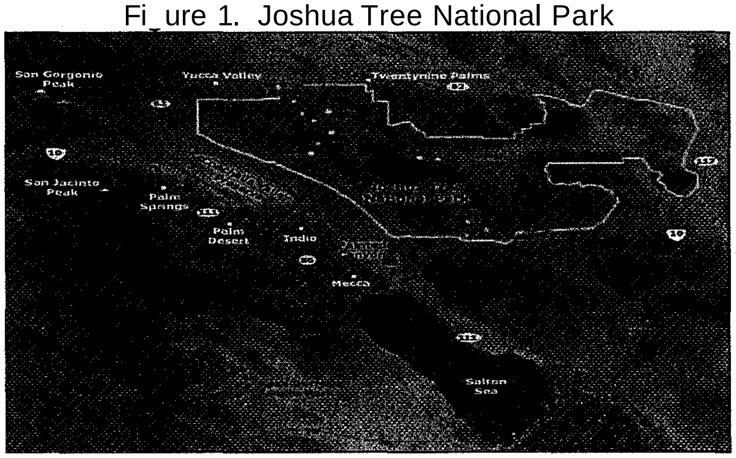



Figure 2. Joshua Tree National Park

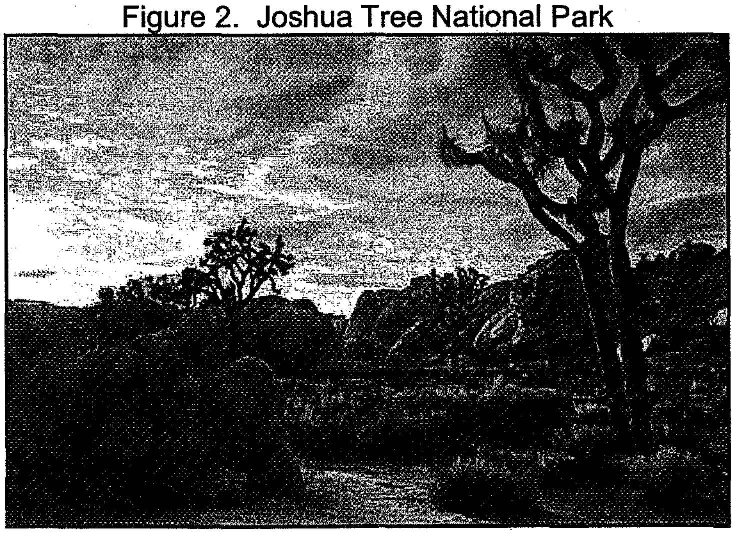
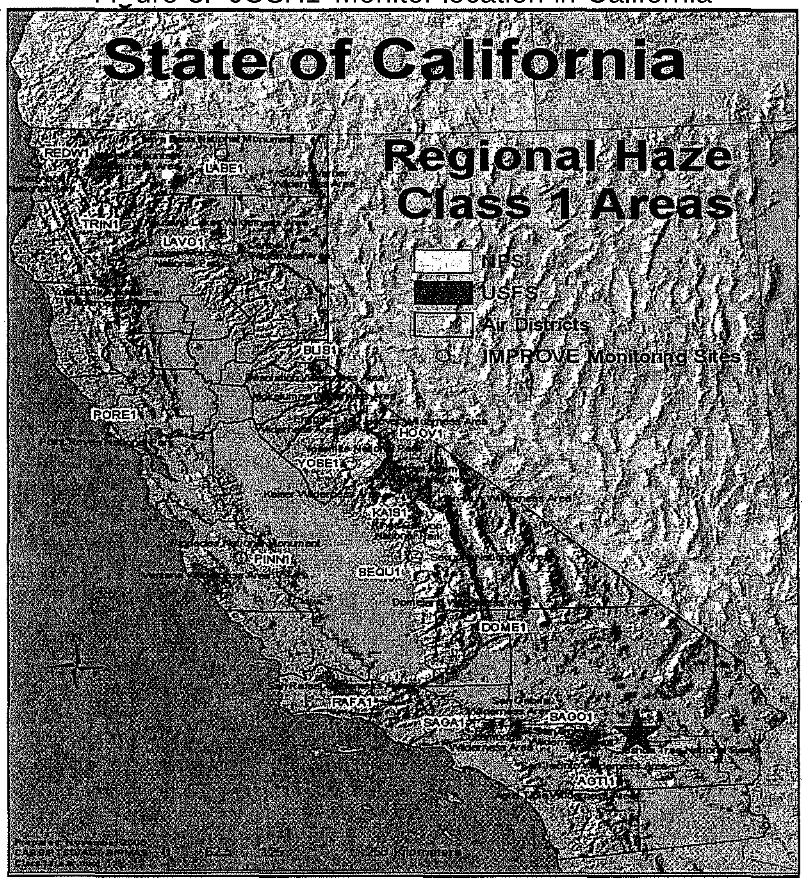


Figure 3. JOSH1 Monitor location in California




Section II. Visibility Conditions:

*II.a. Visibility Monitor Location"*

Visibility conditions for the Joshua Tree Wilderness are currently monitored by the JOSH1 IMPROVE monitor. The monitor is located at 34.0695 north latitude and 116.3889 west longitude, near the northwestern Wilderness boundary at an elevation of 1235 meters. The site is close to the wilderness boundary on the west side and is at an elevation near the midrange of wilderness elevations. It should be very representative of aerosol characteristics within the Joshua Tree Wilderness Area. This site does not have sufficient data for the entire baseline period. Data was not available for the year 2000.

Nearby population centers include the Palm Springs area to the west and developed land near the northern boundary. Joshua Tree Wilderness is also near San Gorgohio Pass, which presents a potential corridor for emissions from the eastern South Coast Air Basin to the west. Potential transport routes into the Joshua Tree Wilderness include long distance transport via upward mixing from more distant source regions and transport into the region via upper level flow. Possible source regions include the South

Coast Air Basin to the west and surrounding desert terrain, especially to the north and east, as a source for windblown dust.

The JOSH1110cation is adequate for assessing the 2018 reasonable progress goals for the Joshua Tree Wilderness Class 1 area.

### *II.b. Baseline Visibility*

Baseline visibility is determined from JOSH1 IMPROVE monitoring data for the 20% best and the 20% worst days for the years 2000 through 2004. The baseline visibility for the Joshua Tree Wilderness Area is calculated at 6.1 deciviews for the 20% best days and 19.6 deciviews for the 20% worst days. Figure.4 represents the worst baseline visibility conditions.

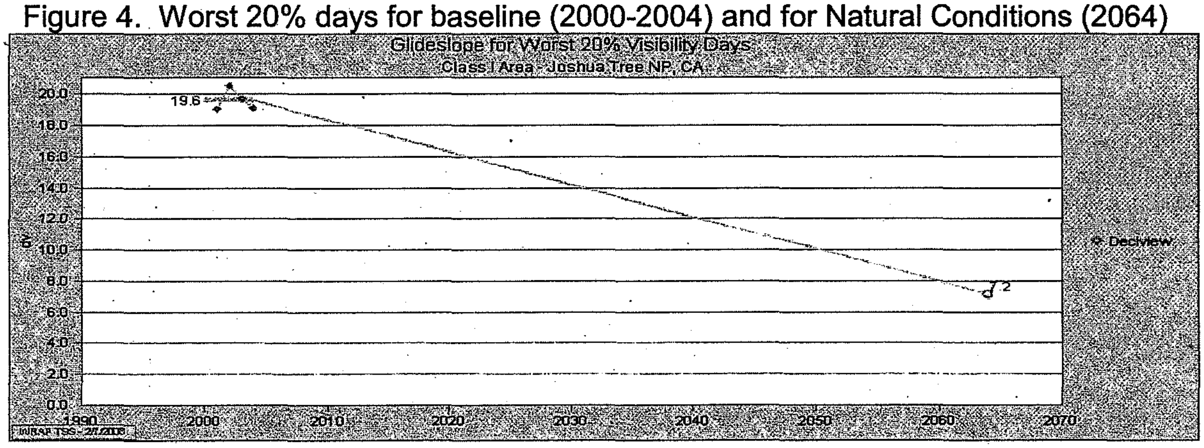
### *II.c. Natural Visibility*

Natural visibility represents the visibility condition that would be experienced in the absence of human-caused impairment. Based on EPA gUidance, the natural visibility for the Joshua Tree Wilderness Area is 1.7 deciviews for the 20% best days and 7.2 deciviews for the 20% worst days. It is possible that the Natural Conditions deciview value for 2064 could change in the future as more is learned about natural plant emissions and wildfire impacts.

### *II.d. Presumptive Glide Slope and the Uniform Rate of Progress*

Figure 4 also shows the uniform rate of progress, or "glide slope." The glide slope is the rate of reduction in the 20% worst days deciview average that would have to be achieved to reach natural conditions at a uniform pace in the 60 years following the baseline period. The first benchmark along the path towards achieving natural' conditions occurs in 2018. The glide slope shows that the 2018 benchmark for the 20% worst days is 16.72 deciviews. According to the Regional Haze Rule, the 20% best days baseline visibility of 6.1 deciviews must be maintained or improved by 2018, the end of the first planning period.

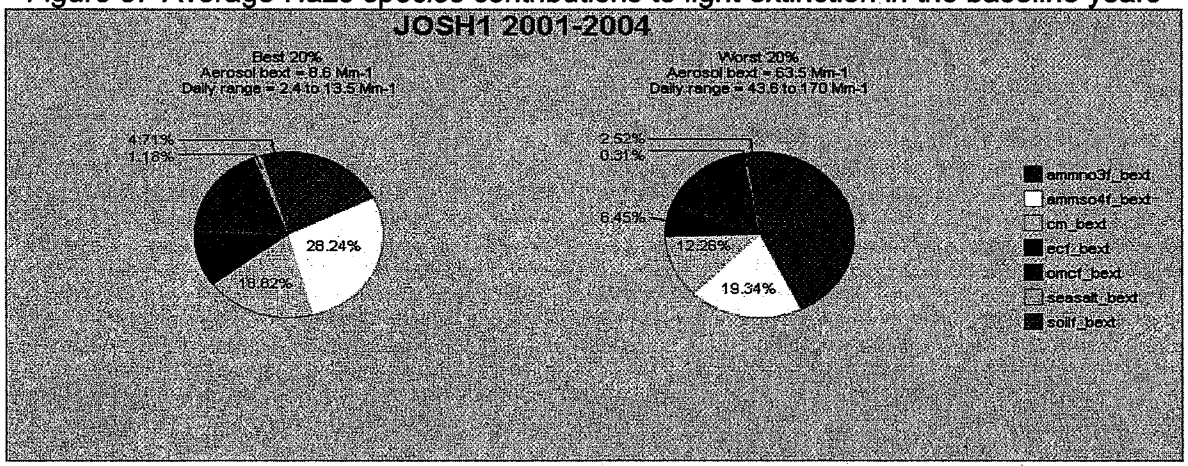
**Figure 4. Worst 20% days for baseline (2000-2004) and for Natural Conditions (2064)**



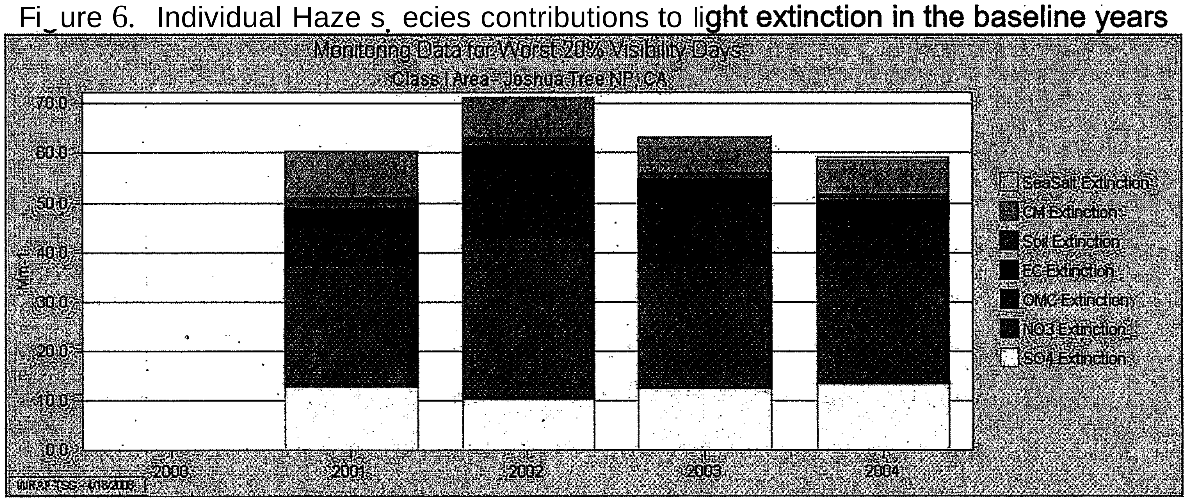
*II.e. Species Contribution*

Each pollutant species causes light extinction but its contribution differs on best and worst days. Figure 5 shows the contribution of each species to the 20% best and worst days in the baseline years at JOSH1.

**Figure 5. Average Haze species contributions to light extinction in the baseline years**




Fi_ure 6. Individual Haze s ecies contributions to light extinction in the baseline years




As shown in Figures 5 and 6, nitrates, sulfates, and organic matter have the strongest contributions to light extinction which degrade visibility on worst days at Joshua Tree National Park. The worst days are dominated by nitrate, while the best days are dominated by sulfate. Data points for 2000 and 2001 were insufficient for calculating best and worst days per the Regional Haze Rule Guidance.

Figure 7 depicts the individual species contribution to worst days in 2002. Nitrates increase in the winter and spring months, while sulfates increase slightly in the summer months. Organic matter increases in the summer. Nitrates clearly dominate the other haze species on worst days, but organic matter, sulfates, coarse mass and elemental carbon also contribute to the worst days. There are only trace amounts of sea salt and soil seen throughout the years.

Figure 8 illustrates the individual species contribution on worst days in 2000-2004 by monthly average. The trend shown is comparable to Figure 7 for nitrates, sulfates, and organic matter. High organic periods vary from year to year due to the unpredictable occurrence of wild fires.

**Figure 7. Species contribution on the 20% worst days in 2002**

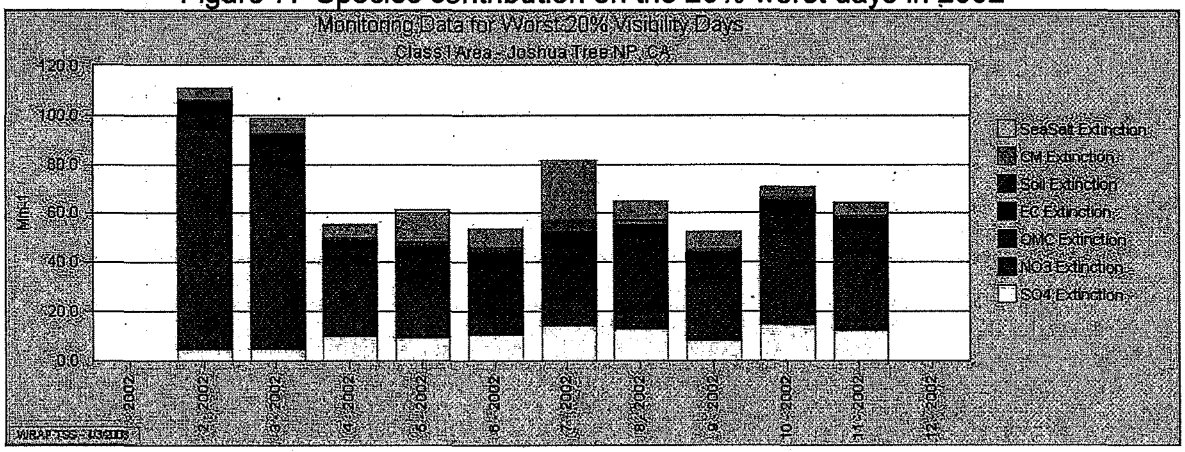
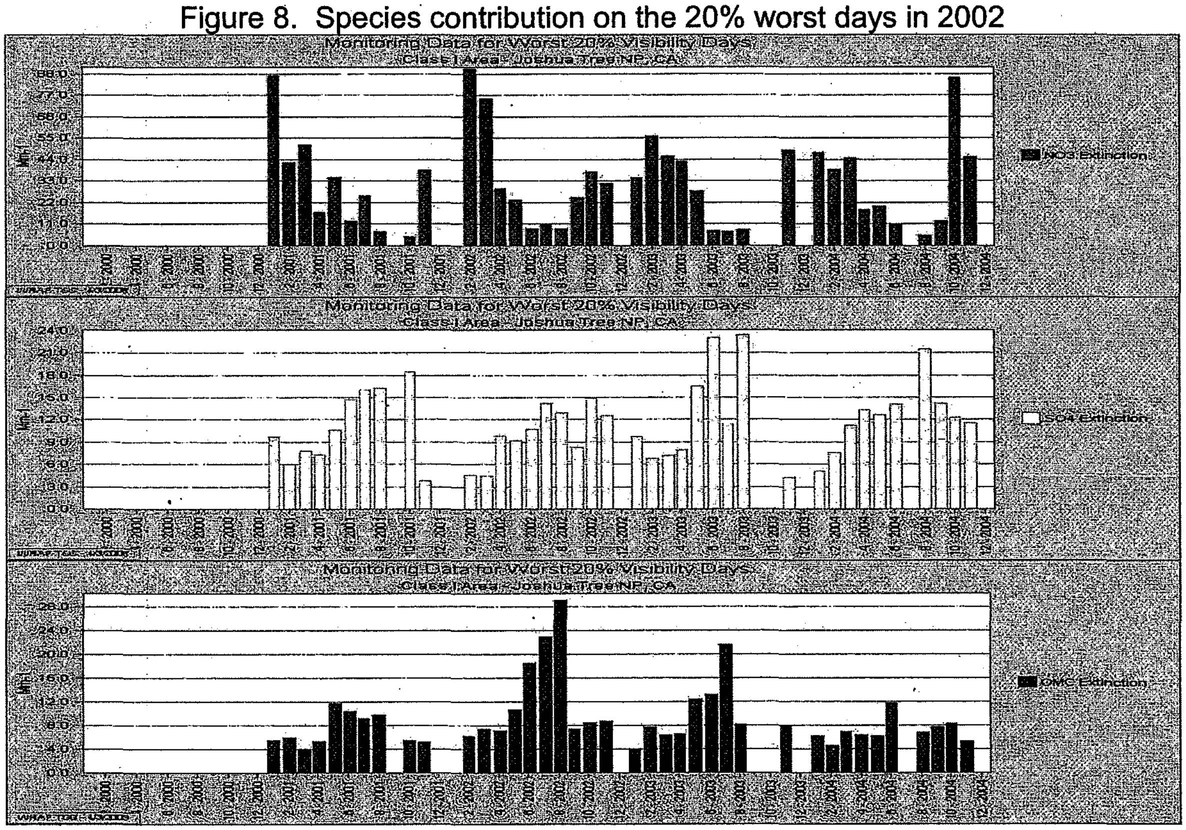



**Figure 8. Species contribution on the 20% worst days in 2002**



*/I.t. Sources of Haze Species*

Both natural and man-made sources contribute to the calculated deciview levels made by haze polliJtants at JOSH1. Some haze species arise from sources that are within the control of the State of California or neighboring states. Others arise from natural, uncontrollable- situations such as wildfires, sea salt or dust storms in natural areas, whether they are from in-state or out-of-state (and out-of-country) sources. Finally, other uncontrollable, man-made sources are those industrial pollutants and other man-made (anthropogenic) emissions transported from outside the United States.

Figures 9 and 10 represent the regional contributions to nitrates on the 20% worst days. The WRAP region represents the largest contribution to nitrate in 2002 and 2018 (81%), followed by the Pacific Offshore Region (15%) and emissions from Outside Domain (4%). Mobile sources within California contribLitethe most nitrate at the JOSH1 monitor. In 2002, 81 % of the nitrate at the JOSH1 monitor can be attributed to California. California mobile source emissions reductions are mainly responsible for improvement in nitrates in 2018. -

Figures 11 and 12 represent the regional contributions to sulfate on the 20% worst days in 2002 and 2018 at JOSH1. The WRAP region represents 36% of the sulfate contributions in 2002 and 2018, followed by the emissions from the Pacific Offshore Region (30%) and the Outside- Domain Region (29%). California contributes 30% of the total sulfate emissions seen at the JOSH1 monitor.

Individually, emissions from outside the modeling domain contribute the most to sulfate concentrations at the JOSH1 monitor. The next largest contributor to sulfate concentrations is area sources in the Pacific Offshore Region.

Figure 13 shows the primary organic carbon source contribution from California and the outside regions. The largest contributor to primary organic carbon at the JOSH1 monitor is from natural-fire sources within California. California represents 98% of all natural fire source contributions.

Figure 14 illustrates the total organic carbon source apportionment from 2000-2004 for anthropogenic and biogenic sources. The anthropogenic and biogenic primary source emissions account for 58% of the total organic carbon. Biogenic secondary emissions account for 36% of thetotal organic carbon emissions and anthropogenic secondary is responsible for the remaining emissions.

Figure 9. Regional Nitrate contribution to Haze in 2002 and 2018

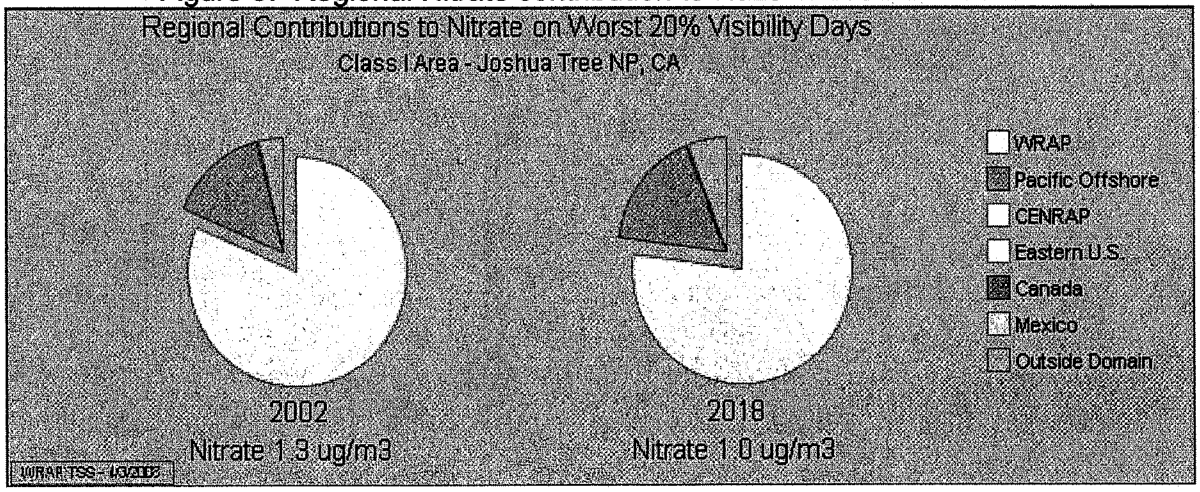



Figure 10. Nitrate source contribution from CA and outside re_ions

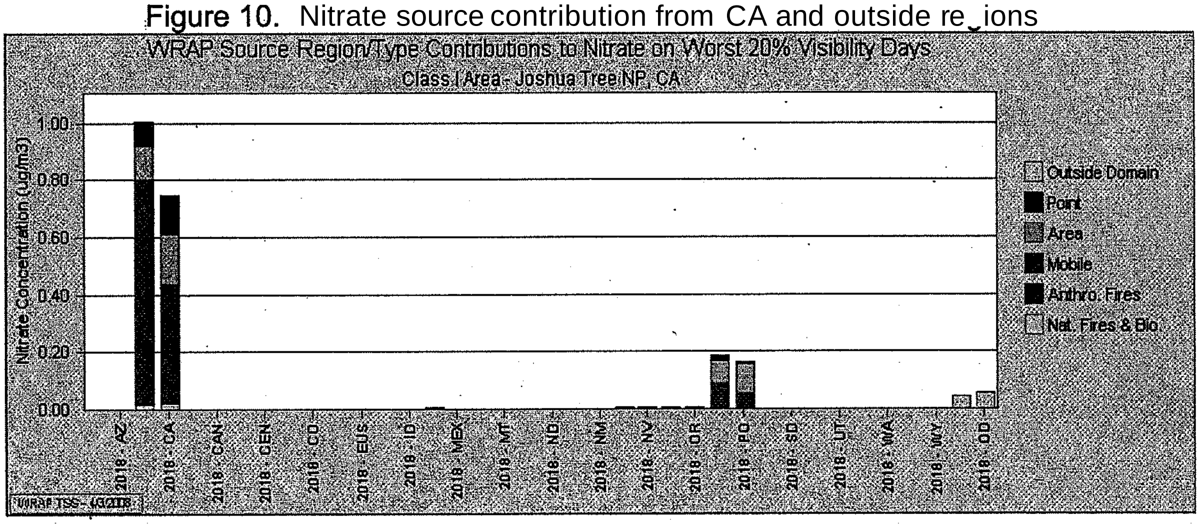



Figure 11. Regional Sulfate contribution to Haze in 2002 and 2018

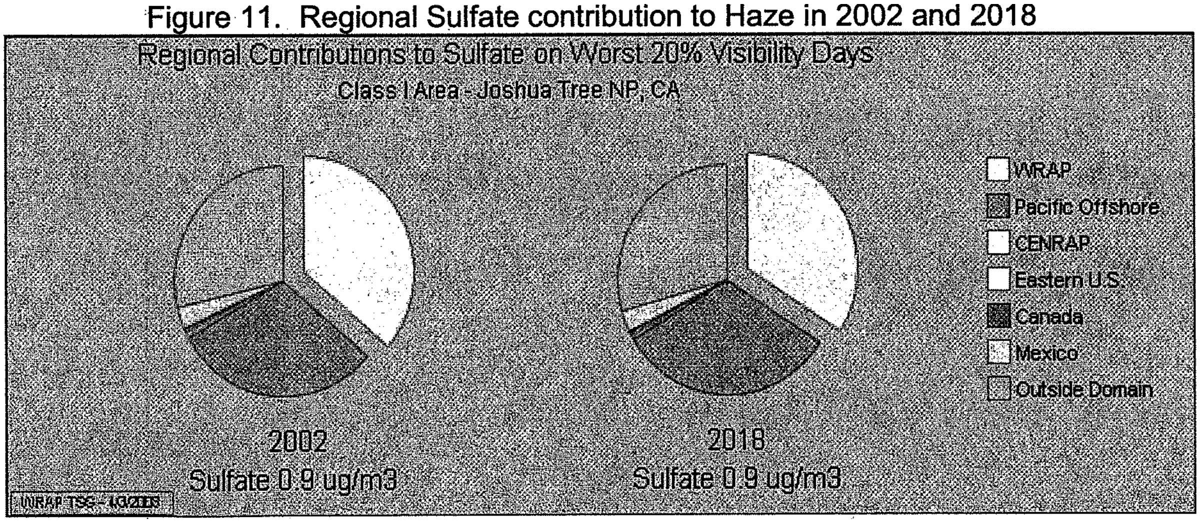


Figure 12. Sulfate source contribution from CA and outside regions

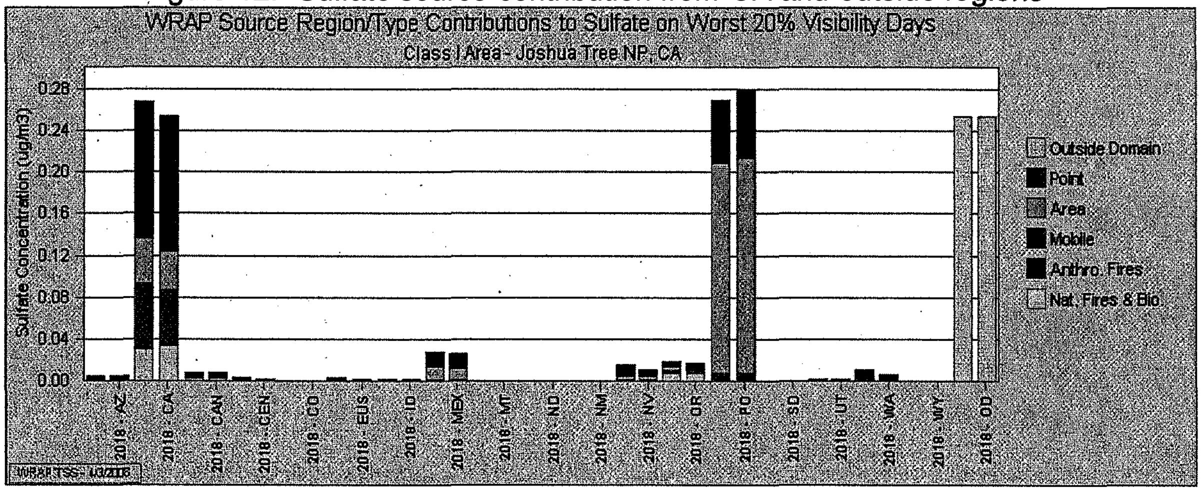



Figure 13. Organic carbon source contribution from CA and outside regions

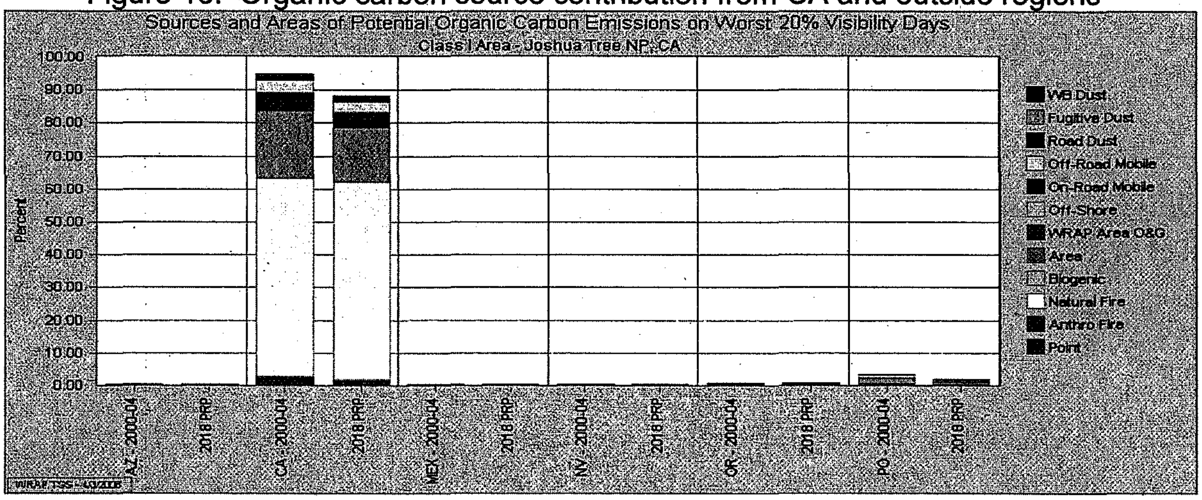
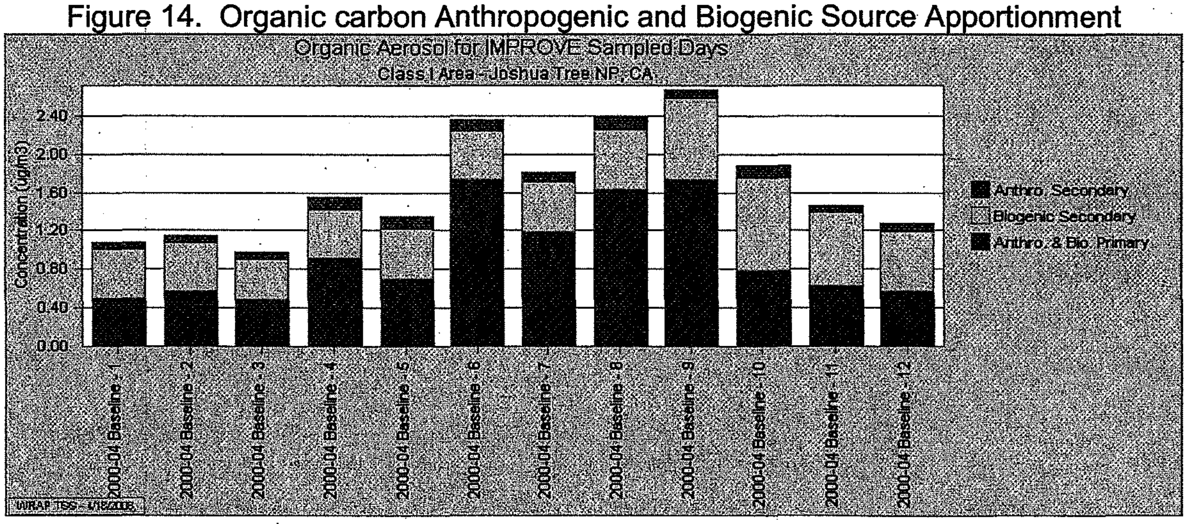



Figure 14. Organic carbon Anthropogenic and Biogenic Source Apportionment



# APPENDIX C

## BART Cal-Puff Modeling

# Results of CALMET/CALPUFF BART Modeling for Class I Federal Area Individual Source Attribution Visibility Impairment

Prepared by:

Atmospheric Modeling and Support Section
Modeling and Meteorology Branch
Planning and Technical Support Division
California Air Resources Board

November 3, 2008

**Acknowledgements:**

The modeling results presented in this report are based on a modeling protocol (Appendix 1). The protocol is based on the EPA-approved modeling protocol submitted by the Colorado Department of Public Health and Environment (CDPHE) Air Pollution control Division (APCD). The only major exception is that a different approach istaken to determine the natural background.

Table of Contents

# 1.. Introduction

This document presents modeling results based on California Air Resources Board (ARB)'s modeling protocol for the initial phase of the Best Available Retrofit Technology (BART) modeling process, referred to as the "subject-to-BART" analysis, which includes 502, $NO_x$, and direct PM10 emissions from all BART-eligible units at a given facility. A copy of the protocol is included in Appendix 1.

Code of Federal Regulations Title 40 Part 51 Appendix Y (hereafter referred to as the BART guideline) requires that the BART control equipment be used for any BART-eligible source that "emits any air pollutant which may reasonably be anticipated to cause or contribute to any impairment of visibility" in any mandatory Class I federal area. Federal Class I areas are defined in the Clean Air Act as national parks over 6,000 acres and wilderness areas and memorial parks over 5,000 acres, established as of 1977. Pursuant to the BART guideline, states have the option of exempting a BART-eligible source from the BART requirements based on dispersion modeling demonstrating that the source cannot.reasonably be anticipated to cause or contribute to visibility impairment in a Class I area.

According to the BART guideline, a BART-eligible source is considered to "contribute" to visibility impairment in a Class I area if the modeled $98^{th}$ percentile change in deciviews is equal to or·greater than the "contribution threshold." Deciview (dv) is defined by and calculated directly from the total light extinction coefficient ($b_{ext}$ expressed in inverse mega meters, $Mm^{-1}$):

$$dv = 10\ln(b_{ext}/10Mm^{-1})$$

The deciview scale is nearly zero for a pristine atmosphere, and each deciview change corresponds to a small but perceptible scenic change that is observed under either clean or polluted conditions. Any BART-eligible source determined to cause or contribute to visibility impairment in any Class I area is subject to BART. Federal regulations implementing the BART requirement afford states some latitude in the criteria for determining whether a BART-eligible source is subject to BART. The ARB uses the "contribution threshold" of 0.5 deciviews for the $98^{th}$ percentile 24-hour change in visibility (delta-deciview) because the BART guideline requires that the threshold is not higher than 0.5 deciviews.

Pursuant.to the BART guideline and to prepare the submittal of a state implementation plan for regional haze, ARB staff performed air quality modeling with the CALPUFF modeling system to assess which BART-eligible sources in California are likely to be subject to BART. ARB staff applied CALPUFF with three years of meteorological data to determine if the 98th percentile 24-hour change in visibility (delta-deciview) from a BART-eligible source is equal to or greater than a contribution threshold of 0.5 deciviews (dv) at any Class I area.

The results presented in this initial subject-to-BART modeling cover eight BART-eligible sources. As such, additional modeling performed by ARB staff or source operators (with ARB's approval) may supersede these results. Subsequent modeling should use modeling techniques consistent with the recommendations in ARB's protocol and the BART guideline. ARB may approve deviations from this protocol for a specific source if the changes are acceptable to U.S. EPA and improve model performance while retaining consistency with the BART guideline. All modeling will be subject to ARB review and approval.

# 2. Short Description of Modeling Procedures

The modeling protocol was followed during the entire modeling process. The following is a short description of the steps involved in the modeling.

The modeling domain is shown in Figure 1. Also shown are locations of emission sources and receptors placed in Class I areas. The Lambert Conformal Conic projection modeling domain covers all Class I areas in California and the locations of California's BART-eligible sources that are required to do detailed modeling and analysis. The domain also includes Class I areas in nearby states that are potentially impacted by California BART-eligible sources. The modeling domain is extended by 50-km beyond all sources and Class I areas to capture potential recirculation of pollutants. The CALMET/CALPUFF domain is 1332 km x 1332 kmin the longitudinal and meridional directions, respectively, with 4-kilometer grid resolution..

CALMET meteorological modeling has been conducted with three years of meteorological data. In the CALMET modeling, surface observational data collected at 279 stations .and MM5 data generated by the prognostic meteorological model, MM5, along with geophysical data, are used.

CALf?UFF uses CALMET output data and hourly ozone observational data as its input. CALPUFF generates hourly concentration data for visibility impact analysis.

The visibility impact analysis is performed with CALPOST. CALPOST processes the hourly, model-simulated concentration data. CALPOST calculates the visibility impact taking into account background concentrations of visibility-impairing pollutants and a relative humidity adjustment factor published by the U.S. EPA (1993).

# 3. Emission Data and Modeling Results

This section is organized by sUbject-to-BART facilities: each subsection describes emission data for an individual facility along with the corresponding visibility impairment modeling results. Visibility impairment pollutants included in the modeling are $SO_2$, $NO_x$ and $PM_{10}$. Emission rates of sulfate, nitrate, elemental carbon, organic carbon, coarse particulates and soil are all set to zero but the background concentrations of these pollutants are considered in the post-processing stage so that their effects on visibility are taken into account to characterize natural conditions in Class I areas. Figure 1 gives an overview of the eight source locations and Class I areas.

The BART guideline requires that the $98^{th}$ percentile daily (24-hour) average of visibility impact be lower than 0.5 dv. Because there are 365 or 366 days in a year, 2 percent of total number of days in a year is 7 days plus a fraction of a day. Therefore the $98^{th}$ percentile of daily average will be the $8^{th}$ highest in a year.

Table 3.0.1 summarizes the maximum visibility impact on Class I areas from the BART-eligible sources, during the baseline years (2000-2002.)

Table 301. Summary of Visibility Impact

| Facility | Maximum 'Impact (in deciviews) | Outcome (exceeds the 0.500 dv threshold?) |
|---|---|---|
| Conoco-Phillips Refinery and Carbon Plant in Bay Area | 0.366 | Does not exceed |
| Reliant Alta Boilers in Mojave Desert | 0.489 | Does not exceed |
| Searles Valley Minerals in Mojave Desert | 0.208 | Does not exceed |
| Rhodia Sulfuric Acid Plant in Bay Area | 0.092 | Does not exceed |
| Valero Refining Company in Bay Area | 0.758 | Exceeds |
| Shell Refining Company in Bay Area | 0.169 | Does not exceed |
| Tesoro Marketing and Refining in Bay Area | 0.069 | Does not exceed |
| Chevron USA Inc in Bay Area | 0.393 | Does not exceed |

' does not reflect proposed emission controls

BART sources and receptors placed in Class I areas

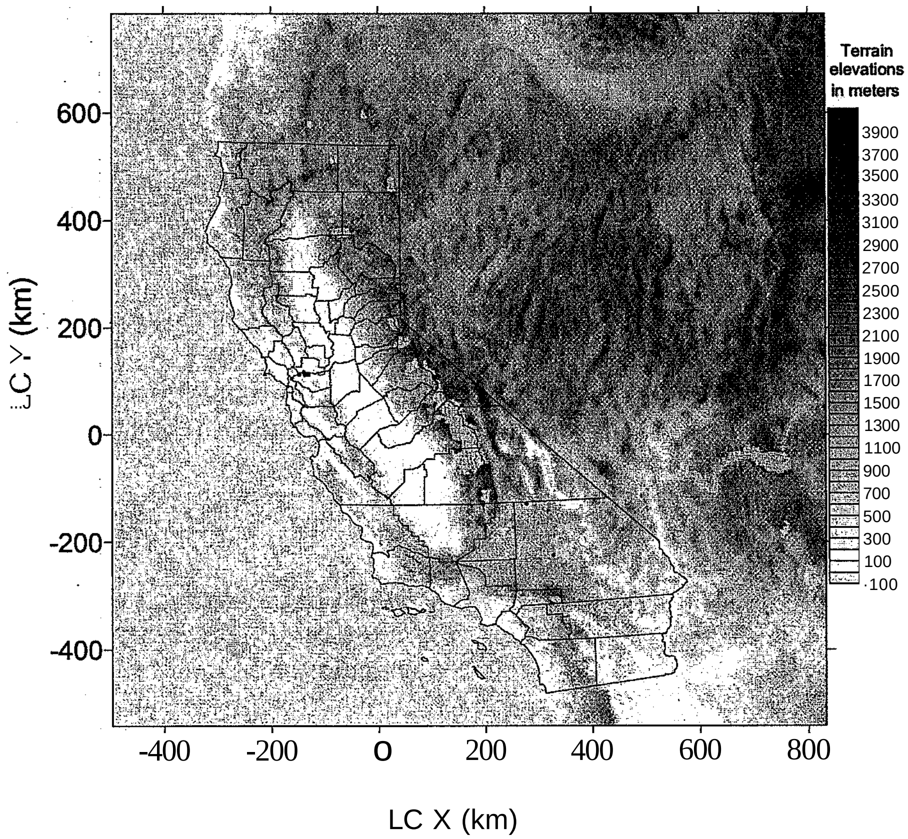



Figure 1. Class I areas and subject-to-BART sources for which initial visibility impairment analysis has been conducted.

## 3.1.. Conoco-Phillips Refinery and Carbon Plant in Bay Area

### 3.1.1. Description of Emission Sources

The Conoco-Phillips Refinery and Carbon Plant is located at 2101 Franklin Canyon Road in Rodeo, California. There are 17 emission units that are considered as BART-eligible, of which the most significant emission source is a kiln that releases S02, $NO_X$ and $PM_{10}$. The latitude and longitude of the kiln are 38°01'11.04" and 122°14'14.7", respectively. Specifications of the major unit needed in the modeling are listed in Table 3.1.1. Units with emission totals less than 1 ton per day are included in the modeling but not shown in the table.

Table 3.1.1. Source and Emission Parameters of Conoco-Phillips Refinery and Carbon Plant

| Source Description | Base Ev. (m) | Stack Height (m) | Stack Diameter (m) | Exit Velocity *(m/s)* | Exit Temp. (K) | S02 *(g/s)* | $NO_x$ *(g/s)* | PM10 (g/s) |
|---|---|---|---|---|---|---|---|---|
| Kiln | 42.98 | 45.72 | 4.17 | 4.35 | 505.3 | 31.528 | 11.035 | 5.044 |

### 3.1.2. Visibility Impact Analysis

With three years worth of meteorological data, the modeling analysis shows that the visibility impact by the Conoco Phillips Refinery and Carbon Plant does not exceed 0.5 dv. Table 3.1.2 lists the 8th highest visibility impact, name of the Class I area that is impacted the most and number of Class I areas on which the BART-eligible source exerts an impact greater than or equal to 0.500 dv.

Table 3.1.2. Visibility Impact Calculated with Three Years Worth of Meteorological Data

| Modeling Year | The 8m highest visibility impact (in deciview) | Names of Class I areas with impact greater than 0.500 dv |
|---|---|---|
| 2000 | 0.366 | None |
| 2001 | 0.343 | None |
| 2002 | 0.307 | None |

Because the 8th highest visibility impact does not exceed the 0.5 dv threshold, there is no need for a BART determination

## 3.2. Reliant Alta (Coolwater) Boilers in Mojave Desert

### 3.2.1. Description of Emission Sources

The Reliant Alta (Coolwater) Boilers are located at 37072 East Sante Fe Road in Daggett, California.· Five emission units are considered as BART-eligible:a group of one boilers and turbines with five stacks that release S02, NOx and PM10; The latitude and longitude of the units are 34°50'17.88" and 116°47'53.52", respectively. Specifications of the units needed in the modeling are listed in Table 3.2.1.

Table 3.2.1. Source and Emission Parameters of Alta (Coolwater) Boiler

| Source Description | Base Ev. (m) | Stack Height (m) | Stack Diameter (m) | Exit Velocity *(m/s)* | Exit Temp. (K) | S02 *(g/s)* | $NO_x$ *(g/s)* | PM10 *(g/s)* |
|---|---|---|---|---|---|---|---|---|
| Boiler 1078 | 597.4 | 44.50· | 3.2 | 12.8 | 394.3 | 0.0657 | 12.698 | 0.214 |
| Turbine 1079 | 597.4 | 21.64 | 5.49 | 10.61 | 449.8 | 0.102 | 19.65 | 0.315 |
| Turbine 1080 | 597.4 | 21;64 | 5.49 | 10.61 | 449.8 | 0.0883 | 16.87 | 0.315 |
| Turbine 1081 | 597.4 | 21.64 | 5.49 | 10.61 | 449.8 | 0.105 | 19.2· | 0.315 |
| Turbine 1082 | 597.4 | 21.64 | 5.49 | 10.61 | 449.8 | 0.106 | 19.7 | 0.315 |

### 3.2.2. Visibility Impact Analysis

With three years worth of meteorological data, the modeling analysis shows that the visibility impact by the Reliant Alta (Coolwater) Units does not exceed 0.5 dv. Table 3.2.2 lists the 8th highest visibility impact, name of the Class I area that is mostly impacted and number of Class I areas on which the BART-eligible source exerts an impact greater than 'or equal toO.5 dv.

Table 3.2.2. Visibility Impact Calculated with Three Years Worth of Meteorological Data

| Modeling Year | The 8th highest visibility impact (in deciview) | Names of Class I areas with impact greater than 0.500 dv |
|---|---|---|
| 2000 | 0.489 | None |
| 2001 | 0.406 | None |
| 2002 | 0.288 | None |

Because the 8th highest visibility impact does not exceed the 0.5 dv threshold, there is no need for a BART determination.

## 3.3. Searles Valley Minerals in Mojave Desert

### 3.3.1. Description of Emission Sources

The Searles Valley Minerals' facility is located at 12801 Maripose Street in Trona, California. Two emission units are considered BART-eligible: two boilers with two stacks that release S02, $NO_X$ and $PM_{10}$. The latitude and longitude of the boilers are 35°46'8.04" and 1.17°22'53.76", respectively. Specifications of the units needed in the modeling'are listed in Table 3.3.1.

Table 3.3.1. Source and Emission Parameters of Searles Valley Minerals

| Source Description | Base Ev. (m) | Stack Height (m) | Stack Diameter (m) | Exit Velocity *(m/s)* | Exit Temp. (K) | S02 (g/s) | $NO_X$ (g/s) | $PM_{10}$ *(g/s)* |
|---|---|---|---|---|---|---|---|---|
| Argus 554 | 510.5 | 64.01 | 3.505 | 13.589 | 325.9 | 2.748 | 23.262 | 0.930 |
| Argus 555 | 510.8 | 64.31 | 3.505 | 13.594 | 326.5 | 3.195 | 23.252 | 0.967 |

### 3.3.2. Visibility Impact Analysis

With three years worth of meteorological data, the modeling analysis shows that the visibility impact by the Searles Valley Minerals' boilers does not exceed 0.5 dv. Table 3.3.2 lists the 8th highest visibility impact, name of the Class I area that is mostly impacted and number of Class I areas on which the BART-eligible source exerts an impact greater than or equal to 0.5 dv.

Table 3.3.2. Visibility Impact Calculated with Three Years Worth of Meteorological Data

| Modeling Year | The 8th highest visibility impact (in deciview) | Names of Class I areas with impact greater than 0.500 dv |
|---|---|---|
| 2000 | 0.192 | None |
| 2001 | 0.103 | None |
| 2002 | 0.208 | None |

Because the 8th highest visibility impact does not exceed the 0.5 dv threshold, there is no need for a BART determination.

## 3.4. Rhodia Sulfuric Acid Plant in Bay Area

### 3.4.1. Description of Emission Sources

The Rhodia Sulfuric Acid Plant is located at 100 Macoco Road in Martinez, California. Two emission units are considered as BART-eligible, one of which is a sulfuric acid plant stack that releases S02, $NO_X$ and PM10. The other emission unit, a combination of cooling towers, is included in the modeling but not shown in the folloWing table because of its low emissions. The latitude and longitude of the plant are 38°01'59.8" and 122°06'59.8", respectively. Specifications of the major unit needed in the modeling are listed in Table 3.4.1.

Table 3.4.1. Source and Emission Parameters of Rhodia Sulfuric Acid Plant

| Source Description | Base Ev. (m) | Stack Height (m) | Stack Diameter (m) | Exit Velocity (m/s) | Exit Temp. (K) | S02 (g/s) | $NO_x$ (g/s) | PM10 (g/s) |
|---|---|---|---|---|---|---|---|---|
| Sulfuric acid plant | 19.81 | 28.96 | 2.13 | 9.75 | 308.15 | 18.29 | 0.513 | 0.397 |

### 3.4.2. Visibility Impact Analysis

With three years worth of meteorological data, the modeling analysis shows that the visibility impact by the Rhodia Acid Plant does not exceed 0.5 dv. Table 3.4.2 lists the 8th highest visibility impact, name of the Class I area that is impacted the most and number of Class I areas on which the BART-eligible source'exerts an impact greater than or equal to 0.5 dv.

Because the 8th highest visibility impact does not exceed the 0.5 dv threshold, there is no need for a BART determination.

Table 3.4.2. Visibility Impact Calculated with Three Years Worth of Meteorological Data

| Modeling Year | The 8th highest visibility impact (in deciview) | Names of Class I areas with impact greater than 0.500 dv |
|---|---|---|
| 2000 | 0.092 | None |
| 2001 | 0.069 | None |
| 2002 | 0.081 | None |

## 3.5. Valero Refining Company in Bay Area

### 3.5.1. Description of Emission Sources

The Valero Refining Company is located at 3400 East 2nd Street in Benicia, California. There are 12 stacks collecting emissions from 17 units that are considered BART-eligible, of which the most significant emission source is a single stack, which is referred to as p1 main stack, collecting emissions from a crude preheat process furnace, a reduced crude preheat process furnace, a FCCU regenerator, and a coker. The latitude and longitude of the plant are 38°04'25.83" and 122°07'57.43", respectively. Specifications of the major unit needed in the modeling are listed in Table 3.5.1. Units with emission totals less than 1 ton per day are included in the modeling but not shown in the table. In the table the source 'P1 main stack' received the S02, $NO_x$, and PM10 emissions from several units including the coker, crude preheat F-101, reduced preheat F-102, and FCCU regenerator R702.

Table 3.5.1. Source and Emission Parameters of Valero Refining Company

| Source Description | Base Ev. (m) | Stack Height (m) | Stack Diameter (m) | Exit Velocity *(m/s)* | Exit Temp. (K) | S02 *(g/s)* | $NO_x$ *(g/s)* | PM10 (g/s) |
|---|---|---|---|---|---|---|---|---|
| P1 main stack | 28.96 | 141.73 | 4.57 | 22.31 | 607.6 | 179.18 | 21.754 | 5.15 |

### 3.5.2. Visibility Impact Analysis

With three years worth of meteorological data, the modeling analysis shows that the visibility impact by the Valero Refining Company exceeds 0.5 dv. Table 3.5.2 lists the 8th highest visibility impact, name of the Class I area that is impacted the most, and number of Class I areas on which the BART-eligible source exerts an impact greater than or equal to 0.500 dv.

Because of the exceedance of the 0.5 dv threshold, control options must be evaluated for the source. A visibility impact analysis must be conducted for each proposed emission control measure. This analysis is part of the BART determination.

Table 3.5.2. Visibility Impact Calculated with Three Years Worth of Meteorological Data

| Modeling Year | The 8th highest visibility impact (in deciview) | Names of Class I areas with impact greater than 0.500 dv |
|---|---|---|
| 2000 | 0.758 | Point Reyes National Seashore |
| 2001 | 0.547 | Point Reyes National Seashore |
| 2002 | 0.524 | Point Reyes National Seashore |

Two emission reduction strategies were proposed for evaluation of their visibility impact. The maximum 24-hour emissions for normal operations were provided by the Bay Area Air Quality Management District. One emission reduction strategy (g1) was to reduce S02, NOx and PM10 emissions from the coker, crude preheat F-101, reduced preheat F-102, and FCCU regenerator R702 that would be routed to a new main stack, and $NO_X$ control on units that would be routed to the p30 west stack and the p31 stack. The other emission reduction strategy (g2) would, beyond g1, further reduce $NO_X$ emissions from units that would be routed to the p19 west stack, p20 west stack, p17 west stack, p18 east stack, p24 stack and p25 stack. After the controls are placed, the emission unit with highest emissions is the new main stack, but the S02 emission rate is significantly reduced. For both g1 and g2, a new main stack will replace the existing p1 main stack. Therefore, some of the emission parameters will be different from what are shown in Table 3.5.1. Emission parameters for the new main stack are shown in Table 3.5.3.

Table 3.5.3. Emission Parameters of the New p1 Main Stack

| Source Description | Base Ev. (m) | Stack Height (m) | Stack Diameter (m) | Exit Velocity (m/s) | Exit Temp. (K) |
|---|---|---|---|---|---|
| New main stack | 17.53 | 65.53 | 4.57 | 25.07 | 378.98 |

Table 3.5.4 provides emission changes in grams/second while Table 3.5.5 provides percentage changes from baseline. Blank cells under the g1 or g2 columns denote that emissions are the same as baseline. The highlighted areas of the tables show that the g1 and g2 scenarios differ only in the treatment of $NO_X$ from stacks P17-P20 and P24-P25.

Modeling analyses were conducted with the two emission reduction strategies. For g1 ,and g2, Tables 3.5.6 and 3.5.7 list, respectively, the 8th highest visibility impact, name of the Class I area that is impacted the most and number of Class I areas on which the BART-eligible source exerts an impact greater than or equal to 0.500 dv.

Table 3.5.4. EXisting Emission Rates with Corresponding G1 and G2 Rate *(g/s)* Changes* from Existing

| Source Description | 502 *(g/s)* Existing | 502 *(g/s)* g1 & g2 | PM10 *(g/s)* Existing | PM10 *(g/s)* g1 & g2 | NOx(g/s) Existing | NOx(g/s) g1 | NOx(g/s) g2 |
|---|---|---|---|---|---|---|---|
| Cooling Tower | 0.00 | | 1.16 | | 0.00 | | |
| New Main Stack | 179.18 | -167.20 | 5.15 | -0.32 | 21.75 | -4.52 | |
| P30 | 0.21 | 0.11 | 0.21 | | 1.37 | -0.95 | |
| P31 | 0.21 | 0.11 | 0.21 | -0.11 | 1.37 | -1.05 | |
| P47 | 0.21 | | 0.42 | | 1.16 | | |
| P50 | 0.00 | | 0.00. | | 0.02 | | |
| P17 | 0.05 | | 0.11 | | 2.42 | | -2.10 |
| P18 | 0.05 | | 0.11 | | 2.42 | | -2.10 |
| P19 | 0.11 | | 0.11 | | 2.83 | | -2.41 |
| P20 | 0.11 | | 0.11 | | 2.83 | | -2.41 |
| P24 | 0.05 | | 0.11 | | 2.10 | | -1.79 |
| P25 | 0.05 | | 0.11 | | 2.10 | | -1.79 |

* Blank cells have no change from baseline.

Table 3.5.5. Existing Emission Rates with Corresponding g1 and g2 Percentage %) ChanQes* from Existing

| Source Description | 502 *(g/s)* EXisting | 502 *(g/s)* g1 & g2 | PM10 *(g/s)* Existing | PM10 *(g/s)* g1 & g2 | NOx *(g/s)* Existing | NOx *(g/s)* g1 | NOx *(g/s)* g2 |
|---|---|---|---|---|---|---|---|
| Cooling Tower | 0.00 | | 1.16 | | 0.00 | | |
| New Main Stack | 179.18 | -93% | 5.15 | -6% | 21.75 | -21% | |
| P30 | 0.21 | +50% | 0.21 | | 1.37 | -69% | |
| P31 | 0.21 | +50% | 0.21 | -50% | 1.37 | -77% | |
| P47 | 0.21 | | 0.42 | | 1.16 | | |
| P50 | 0.00 | | 0.00 | | 0.02 | | |
| P17 | 0.05 | | 0.11 | | 2.42 | | -87% |
| P18 | 0.05 | | 0.11 | | 2.42 | | -87% |
| P19 | 0.11 | | 0.11 | | 2.83 | | -85% |
| P20 | 0.11 | | 0.11 | | 2.83 | | -85% |
| P24 | 0.05 | | 0.11 | | 2.10 | | -85% |
| P25 | 0.05 | | 0.11 | | 2.10 | | -85% |

* Blank cells have. no change from baseline.

Table 3.5.6. Visibility Impact Calculated with Three Years Worth of MeteoroloQical Data (with emission reduction strategy g1)

| Modeling Year | The 8[th] highest visibility impact, (in deciview) | Names of Class I areas with impact greater than 0.500 dv |
|---|---|---|
| 2000 | 0.225 | None |
| 2001 | 0.291 | None |
| 2002 | 0.259 | None |

Table 3.5.7 shows that g2 provides an additional reduction of 0.091dv over g1 for modeling year 2001.

Table 3.5.7. Visibility Impact Calculated with Three Years Worth of Meteorological Data (with emission reduction strategy g2)

| Modeling Year | The 8[th] highest visibility impact (in deciview) | Names of Class I areas with impact greater than 0.500 dv |
|---|---|---|
| 2000 | 0.189 | None |
| 2001 | 0.200 | None |
| 2002 | 0.160 | None |

## 3.6. **Shell** Refinin'g **Company in Bay Area**

### 3.6.1. Description of Emission Sources

The Shell Refining Company is located at 3485 Pacheco Blvd in Martinez, California. Four emission units are considered BART-eligible, of which the most significant emission source isa boiler that releases S02, $NO_x$ and $PM_{10}$. The latitude and longitude of the boiler are 38°00'49.93" and 122°06'46.48", respectively. Specifications of the major unit needed in the modeling are listed in Table 3.6.1. Units with emission totals less than 1 ton per day are included in the modeling but not shown in the table. '

Table 3.6.1. Source and Emission Parameters of Shell Refining Company

| Source Description | Base Ev. (m) | Stack Height (m) | Stack Diameter (m) | Exit Velocity *(nils)* | Exit Temp. (K) | S02 (g/s) | $NO_x$ (g/s) | $PM_{10}$ (g/s) |
|---|---|---|---|---|---|---|---|---|
| Boiler | 17.00 | 49.00 | 2.40 | 15.44 | 550.2 | 18.843 | 9.784 | 0.546 |

### 3.6.2. 'Visibility Impact Analysis

With three'years worth of meteorological data, the modeling analysis shows that the visibility impact by the Shell Refining Company does not exceed 0.5 dv. Table 3.6.2 lists the 8[th] highest visibility impact, name of the Class I area that is impacted the most and number of Class I areas on which the BART-eligible source exerts an impact greater than or equal to 0.500 dv. '

Table 3.6.2. Visibility Impact Calculated with Three Years Worth of Meteorological Data

| Modeling Year | The 8th highest visibility impact (in deciview) | Names of Class I areas With impact greater than 0.500 dv |
|---|---|---|
| 2000 | 0.126 | None |
| 2001 | 0.169 | None |
| 2002 | 0.139 | None |

Because the 8th highest visibility impact does not exceed the 0.5 dv threshold, there is no need for a BART determination.

## 3.7. Tesoro Marketing and Refining in Bay Area

### 3.7.1. Description of Emission Sources

The Tesoro Marketing and Refining is located at 150 Solano Way in Martinez, California. There are four emission units that are considered as BART-eligible, of which the most significant emission source is a sulfur recovery unit with one stack that releases S02, $NO_X$ and $PM_{10}$. The latitude and longitude of the sulfur recovery unit are 38°01'39.07" and 122°03'25.20", respectively. Specifioations of the major unit needed in the modeling are listed in Table 3.7.1. Units with emission totals less than 1 ton per day are included in the modeling but not shown in the table.

Table 3.7.1. Source and Emission Parameters of Tesoro Marketing and Refining

| Source Description | Base Ev. (m) | Stack Height (m) | Stack Diameter (m) | Exit Velocity *(m/s)* | Exit Temp. (K) | S02 *(g/s)* | $NO_X$ *(g/s)* | PM1Q *(g/s)* |
|---|---|---|---|---|---|---|---|---|
| Sulfur, Recovery | 7.01 | 106.68 | 1.83 | 0.82 | 535.9 | 10.648 | 0.016 | 0.00 |

### 3.7.2. Visibility Impact Analysis

With three years worth of meteorological data, the modeling analysis shows that the visibility impact by the Tesoro Marketing and Refining does not exceed 0.5 dv. Table 3.7.2 lists the 8th highest visibility impact, name of the Class I area that is impacted the most and number of Class I areas on which the BART-eligible source exerts an impact greater than or equal to 0.500 dv.

Because the 8th highest visibility impact does not exceed the 0.5 dv threshold, there is no need for a BART determination.

Table 3.7.2. Visibility Impact Calculated with Three Years Worth of Meteorological Data

| Modeling Year | The 8[th] highest visibility impact (in deciview) | Names of Class I areas with impact greater than 0.500 dv |
|---|---|---|
| 2000 | 0.068 | None |
| 2001 | 0.055 | None |
| 2002 | 0.069 | None |

## 3.8. Chevron USA Inc. in Bay Area

### 3.8.1. Description of Emission Sources

The Chevron USA Inc. is located at 841 Chevron Way in Richmond, California. There are 38 emission units emitting to 31 stacks that are considered BART-eligible, of which the most significant emission source is a H2 reforming furnace that releases S02, $NO_x$ and PM10. The latitude and longitude of the H2 reforming furnace are 37°56'49.87" and 122°23'43.19", respectively. Specifications of the major unit needed in the modeling are listed in Table 3.8.1. Units with emission totals less than 1 ton per day are included in the modeling but not shown in the table.

Table 3.8.1. Source and Emission Parameters of Chevron USA Inc.

| Source Description | Base Ev. (m) | Stack Height (m) | Stack Diameter (m) | Exit Velocity *(m/s)* | Exit Temp. (K) | S02 (g/s) | $NO_x$ (g/s) | $PM_{10}$ (g/s) |
|---|---|---|---|---|---|---|---|---|
| H2 Reforming Furnace | 2.70 | 49.38 | 2.80 | 16.20 | 644.3 | 0.339 | 20.494 | 0.722 |

### 3.8.2. Visibility Impact Analysis

With three years worth of meteorological data, the modeling analysis shows that the visibility impact by the 'Chevron USA Inc. does not exceed 0.5 dv. Table 3.8.2 lists the 8[th] highest visibility impact, name of the Class I area that is impacted the most and number of Class I areas on which the BART-eligible source exerts an impact greater than or equal to 0.500dv.

Because the 8[th] highest visibility impact does not exceed the 0.5 dv threshold, there is no need for a BART determination. Also, controls will be placed on the reforming furnace reducing the baseline emissions from what was modeled. A consent decree imposes a limit on the H2 Reforming Furnace of 0.021 lb NOxlMMbtu.

Table 3.8.2. Visibility Impact Calculated with Three Years Worth of Meteorological Data

| MOdeling Year | The 8th highest vjsibility impact (in deciview) | Names of Class I areas with impact greater than 0.500 dv |
|---|---|---|
| 2000 | 0.385 | None |
| 2001 | 0.393 | None |
| 2002 | 0.371 | None |

Reference:

"Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule." U.S. EPA, EPA-454/B-03-005. September 2003.

# CALMET/CALPUFF
# BART Protocol fOr
# Class I Federal Area .
# Individual Source Attribution
# Visibility Impairment Modeling Analysis

Prepared by:

Atmospheric Modeling and Support Section
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Planning and Technical Support Division

August 2007

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This modeling protocol is based on the EPA-approved modeling protocol submitted by the Colorado Department of Public Health and Environment (CDPHE) Air Pollution control Division (APCD). The only major exception is that a different approach is taken to determine the natural background.

# Table of Contents

# 4. Introduction

Federal law requires Best Available Retrofit Technology (BART) for any BART-eligible source that "emits any air poUutant which may reasonably be anticipated to cause or contribute to any impairment of visibility" in any mandatory Class I federal area. Pursuant to federal regulations, states have the option of exempting a BART-eligible source from the BART requirements based on dispersion modeling demonstrating thatthe source cannot reasonably be anticipated to cause or contribute to visibility impairment in a Class I area.

According to 40 CFR Part 51, Appendix Y (BART gUideline), aBART-eligible source is considered to "contribute" to visibility impairment in a Class I area if the modeled $98^{th}$ percentile change in deciviews is equal to or greater than the "contribution threshold." Deciview (dv) is defined by and calculated directly from the. total light extinction coefficient ($b_{ext}$ expressed in $Mm^{-1}$):

$$dv = 10\ln(b_{ext} / 10Mm^{-1})$$

The deciview scale is nearly zero for a pristine atmosphere, and each deciview change corresponds to a small but perceptible scenic change that is observed under either clean or polluted conditions. Any BART-eligible source determined to cause or contribute to visibility impairment in any Class I area is subject to BART. Federal regulations implementing the BART requirement afford states some latitude in the criteria in determining whether a BART-eligible source is sUbject to BART. The ARB sets a "contribution threshold" of 0.5 deciviews for the $98^{th}$ percentile 24-hour change in visibility (delta-deciview) because the BART guideline requires that the threshold not be higher than 0.5 deciviews.

This document serves as ARB's modeling protocol for the initial phase of the BART modeling process, referred to as the "subject-to-BART" analysis, which includes 802, $NO_x$, and direct PM10 emissions from all BART-eligible units at a given facility.

Pursuant to the BART gUideline and to prepare the submittal of a state implementation plan for regional haze, ARB staff will perform air quality modeling with the CALPUFF modeling system to assess which BART-eligible sources in California are likely to be subject to BART. ARB staff will apply CALPUFF with three years of meteorological data to determine if the $98^{th}$ percentile 24-hour change in visibility (delta-deciview) from a·BART-eligible source is equal to or greater than a contribution threshold of 0.5 deciviews at any Class I area.

ARB staff will use this protocol for the initial subject-to-BART modeling. However, additional modenng performed by ARB staff or source operators may supersede the results. Subsequent modeling should use modeling techniques consistent with the recommendations in this protocol and the BART guideline. ARB may approve deviations from this protocol for a specific source if the changes are acceptable to U.S. EPA and improve model performance while retaining consistency with the BART guideline. All modeling will be sUbject to ARB review and approval.

Relevant language from the BART guideline is included to show the modeling recommendations in context. Other sections of this protocol explain how the ARB proposes to implement the recommendations. The BART guidelines set out in 40 CFR Part 51, Appendix Y, are provided in part in Appendix_.

## 4.1. Visibility Calculations

The general theory for performing visibility calculations with the c'ALPUFF modeling system is described in several documents, including:

- "Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 Summary Report and Recommendations for Modeling Long Range Transport Impacts" (IWAQM, 1998)
- "Federal Land Manager's Air Quality RelatedValues Workgroup (FLAG): Phase I Report" (FLAG, 2000)
- "A User's Guide for the CALPUFF Dispersion Model" (Scire, 2000)

In general, visibility is characterized either by visual range (the greatest distance that a large object can be seen) or by the light extinction coefficient, which is a measure of the light attenuation per unit distance due to scattering and absorption by gases and particles.

Visibility is impaired when light is scattered in and out of the line of sight and by light absorbed along the line of sight. The light extinction coefficient ($b_{ext}$) considers light extinction by scattering ($b_{scat}$) and light extinction byapsorption ($b_{abs}$):

$$b_{ext} = b_{scat} + b_{abs}$$

The scattering components of extinction ($b_{scat}$) can be represented by these components:

- light scattering due to air molecules = Rayleigh scattering = $b_{rayleigh}$
- light scattering due to particles = $b_{sp}$

Additionally, particle scattering, $b_{sp}$, can be expressed by its components:

$$b_{sp} = b_{SO4} + b_{NO3} + b_{OC} + b_{soil} + b_{coarse}$$

where:

$b_{SO4}$= scattering coefficient due to sulfates = 3[(NH4)2S04]f(RH)
$b_{NO3}$ = scattering coefficient due to nitrates = 3[NH4N03]f(RH)
$b_{OC}$ = scattering coefficient due-to organic aerosols = 4[OC]
$b_{Soil}$= scattering coefficient due to fine particles = 1[Soil]
$b_{Coarse}$= scattering coefficient due to coarse particles = O.6[Coarse Mass]

The f(RH) term is the relative humidity adjustment factor. The Federal Land Manager's Air Quality Related Values Workgroup (FLAG) (1999) recommends using historic averages of f(RH) for the Class I area(s) of concern. There exist several tabulations of monthly f(RH) values. In this modeling protocol'we recommend using the US EPA 2003 tabulation (U.S. EPA, 2003, EPA-454/B-03-005) of f(RH).

The absorption components of extinction ($b_{abs}$) can be represented by these components:

- light absorption due to gaseous absorption = $b_{ag}$
- light absorption due to particle absorption = $b_{ap}$

According to FLAG (2000), nitrogen dioxide is the only major light-absorbing gas in the lower atmosphere; it generally does not affect hazes. Therefore only particle absorption is.considered in the visibility analysis. Particle absorption from soot is defined as:

- $b_{ap}$ = absorption due to elemental carbon (soot) = 10[EC]

The concentration values (in brackets) are expressed in micrograms per cubic meter. The numeric coefficient at the beginning of each equation is the dry scattering or absorption efficiency in meters-squared per gram.

Based on the discussion of scattering and absorption components above, the simple total atmospheric extinction equation provided on the prior page can be expanded and expressed as:

$$b_{ext} = ( b_{SO4} + b_{NO3} + b_{OC} + b_{Soil} + b_{Coarse}) + 10[EC] + b_{rayleigh} \quad .$$

In this equation, the sulfate (S04) and nitrate (N03) components are referred to as hygroscopic components because the extinction coefficient depends upon relative humidity. The other components are non-hygroscopic.

The CALPUFFmodeling will provide ground level concentrations of visibility impairing pollutants such as sulfate and nitrate. These ground level concentrations will be used to calculate the extinction coefficient, $b_{ext}$, with the equations described above. Similarly, an extinction coefficient can be calculated for background concentrations of visibility impairing pollutants. If the extinction coefficient due to pollutants emitted from the BART source of concern is denoted as $b_{source}$, and the extinction coefficient due to background concentrations is denoted as $b_{background}$, then the delta-deciview, $\Delta dv$, value can be calculated as follows:

$$\Delta dv = 10 \ln((b_{background} + b_{source}) / b_{background}).$$

The delta-deciview is the change in visibility caused by the visibility impairing pollutants from the BART source of concern.

# 5. Emission Estimates

According to the BART guideline,

> *"The emissions estimates used in the models are intended to reflect steady-state operating conditions during periods of high capacity utilization. We do, not generally recommend that emissions reflecting periods of start-up, shutdown, and malfunction be used, as such emission rates could produce higher than normal effects than would be typical of most facilities. We recommend that States use the 24 hour average actual emission rate from the highest emitting day of the meteorological period modeled, unless this rate reflects periods start-up, shutdown, or malfunction."*

Short-term emission rates (≤ 24-hours) should be modeled since visibility impacts are calculated for a 24-hour averaging period. $SO_2$, $NO_X$, and $PM_{10}$ (including condensable and filterable direct $PM_{10}$[1]) should be modeled from-all BART-eligible units at the facility. ARB staff will initially use allowable emission rates or federally enforceable emission limits. If 24-hour'emissions limits do not exist, limits of a different averaging period may be used. Specifically, if limits do not exist, maximum hourly emissions based on emission factors and design capacity may be used.

If the source operator elects to develop emission rates for subject-to-BART modeling, case-by-case procedures should be developed in consultation with ARB staff. In general, the following emission rates are acceptable:

[1] Common speciated PM species for CALPUFF include fine particulate matter (PMF), coarse particulate matter (PMC), soot or elemental carbon (EC),' organic aerosols (SOA), and sulfate ($SO_4$), $H_2SO_4$, for example, is a $PM_{10}$ species emitted from coal-fired units that is typically modeled as $SO_4$ in CALPUFF.

- Short-term (≤ 24-hours) allowable emission rates (e.g., emission rates calculated using the maximum rated capacity of the source).
- Federally enforceable short-term limits (≤ 24-hours).
- Peak 24-hour actual emission rates (or calculated emission rates) from the most recent 3 to 5 years of operation that account for "high capacity utilization" during normal operating conditions and fuel/material flexibility allowed under the source's permit. In situations where a unit is allowed to use more than one fuel, the fuel resulting in the highest emission rates should be used for the modeling, even if that fuel has not been used in the last 3 to 5 years.

If short-term rates are not available, emissions rates based on averaging periods longer than 24-hours are acceptable only in cases where the modeling shows that the source has impacts equal to or greater than the contribution threshold.

# 6. CALMET/CALPUFF Modeling Methodology

For the subject-to-BART modeling, ARB staff will follow recommendations made by the CALPUFF developer to set model parameters arid adjust some default settings to be more representative of terrain features in California.

ARB staffwill use this protocol in the initial subject-to-BART modeling. However, the initial modeling may be superseded by additional modeling performed by ARB staff or the source operator. Subsequent modeling should use modeling techniques consistent with the recommendations in this protocol and the BART guideline. All modeling will be subject to review and approval by the ARB. The ARB may approve deviations from this protocol for a specific source if the changes are acceptable to u.S. EPA and improve model performance while retaining consistency with the BART guideline. This protocol is intended to provide sufficient technical documentation to support the application of CALPUFF at distances up to 300 kilometers. Impacts at Class I areas greater than 300 km may be used, but it should be recognized that the use of puff splitting in CALPUFF would provide more accurate results for Class I areas beyond 300km.

According to the *"Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 Summary Report and Recommendations for Modeling Long Range Transport Impacts"* (IWAQM Phase 2 Report):

*In the context of the Phase 2 recommendation, the focus of the visibility analysis is on haze. These techniques are applicable in the range of thirty to fifty kilometers and beyond from a source. At source-receptor distances less than thirty to fifty kilometers, the techniques for analyzing visual plumes (sometimes referred to as 'plume blight') should be applied.*

## 6.1. CALMET/CALPUFF Model Selection

The following versions will be used:

CALPUFF: version 5.754, level 060202,
CALMET: version 5.724, level 060414,
CALPOST: version 5.6393, level 060202.

This version of the CALPUFF modeling system is recommended by the Visibility Improvement State and Tribal Association of the Southeast (VISTAS) for BART analyses. The use of CALPUFF is recommended in 40 CFR 51 Appendix Y (BARTguideline). The primary niche for CALPUFF is as a long-range transport model. It is a multi-layer, non-steady-state puff dispersion model that can simulate the effects of time,- and space-varying meteorological conditions on pollutant transport, chemical transformations, vertical wind shear, and deposition (Scire, 2000).

### 6.1.1. CALMET

CALMET is a diagnostic meteorological model. It has been under constant update, and improvement by, the developer (Scire, 2000). For this particular study, the model uses a Lambert Conformal Projection coordinate system to account for the Earth's curvature.

CALMET uses a two-step approach to calculate wind fields. In the first step, an initial-guess wind field is adjusted for slope flows and terrain blocking effects, for example, to produce a Step 1 wind field. In the second step, an objective analysis is performed to introduce observational data into the Step 1 wind field.

In this application, the initial guess wind fields are based on 12-km resolution MM5 meteorological fields for 2000 and 2002 and 36-km MM5 data for 2001 (Le., in CALMET IPROG is set to 14). The MM5 files for 2000 were generated by ARB staff and the MM5 files for 2001 and 2002 were provided by WRAP. Because the 2000 MM5 data were generated specifically for applications in California, the data may be more reliable and more representative of the meteorological conditions of California. If modeling results for visibility impairment are substantially different for different years, more weight should be given to the year 2000 result.

The BART guideline does not specify the exact number of years of mesoscale meteorological data to be used in CALPUFF for sUbject-to-BART determination, but according to 40 CFR 51 AppendixW, at least three years of meteorological data should be used. Five years of meteorological data is preferable. At the time of developing this protocol and during the process of carrying out CALPUFF modeling and analysis, five years of mesoscale meteorological data will not be readily available at,reasonable grid resolutions for California; therefore this protocol proposes to use three years of meteorological data for the CALMET/CALPUFF modeling.

#### *6.1.1.1.* ***CALMET Modeling Domain***

The modeling domain is shown in Figure 1. Also shown are locations of receptors to be placed in Class I areas. It is based on a Lambert Conformal Conic projection. The domain covers all Class I areas in California and the locations of Californa's BART-eligible Sources that are required to do detailed modeling and analysis. The domain also includes Class I areas in nearby states that are potentially impacted by California BART-eligible sources. The modeling domain is extended by 50-km beyond all sources and Class I areas to capture potential recirculation of pollutants. The CALMET domain is 1332 km x 1332 km in the longitudinal and meridional directions, respectively, with 4-kilometer grid resolution. This modeling domain will be used to generate a unified meteorological data set so that it can be used in CALPUFF modeling for all BART-eligible sources.

If a source operator elects to perform additional subject-to-BART modeling beyond ARB's initial modeling using a different CALMET/CAl-PUFF setup, the ARB may approve a smaller modeling domain on a case-by-case basis.

.BART sources and receptors placed in Class I areas

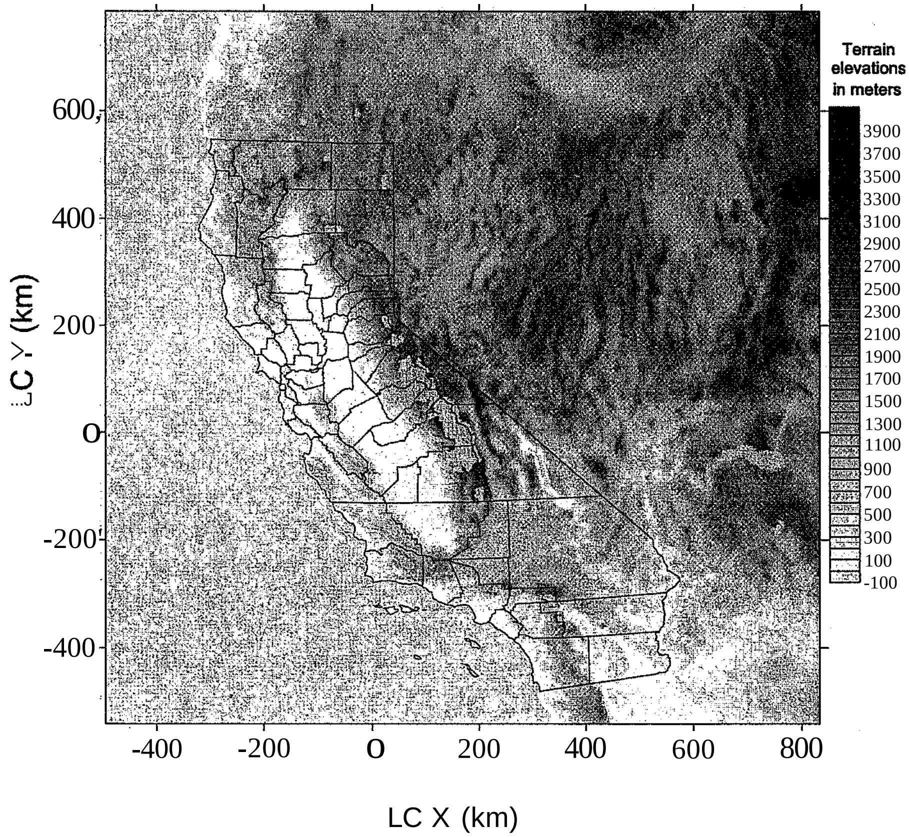


Figure 1. CALMET/CALPUFF modeling domain.

### 6.1.1.2. **CALMET Performance Evaluation**

The meteorological fields developed by the MM5/CALMET modeling system will be checked selectively as well as randomly for reasonableness using' visualization tools. The reasonableness includes consistency of wind fields with terrain forcing, and diurnal variations of both wind and temperature fields. A comprehensive evaluation will not be conducted because of the lack of model, performance evaluation guidelines

### 6.1.1.3. **Terrain**

Gridded terrain elevations' for the modeling domain are derived from 3 arc-second digital elevation models (DEMs) produced by the United States Geological Survey (USGS). The files cover 1-degree by 1-degree blocks of latitude and longitude. USGS 1:250,000 scale OEMs were used. These OEM data have a resolution of about 90 meters. Terrain elevations are shown in Figure 1.

#### 6.1.1.4. Land Use

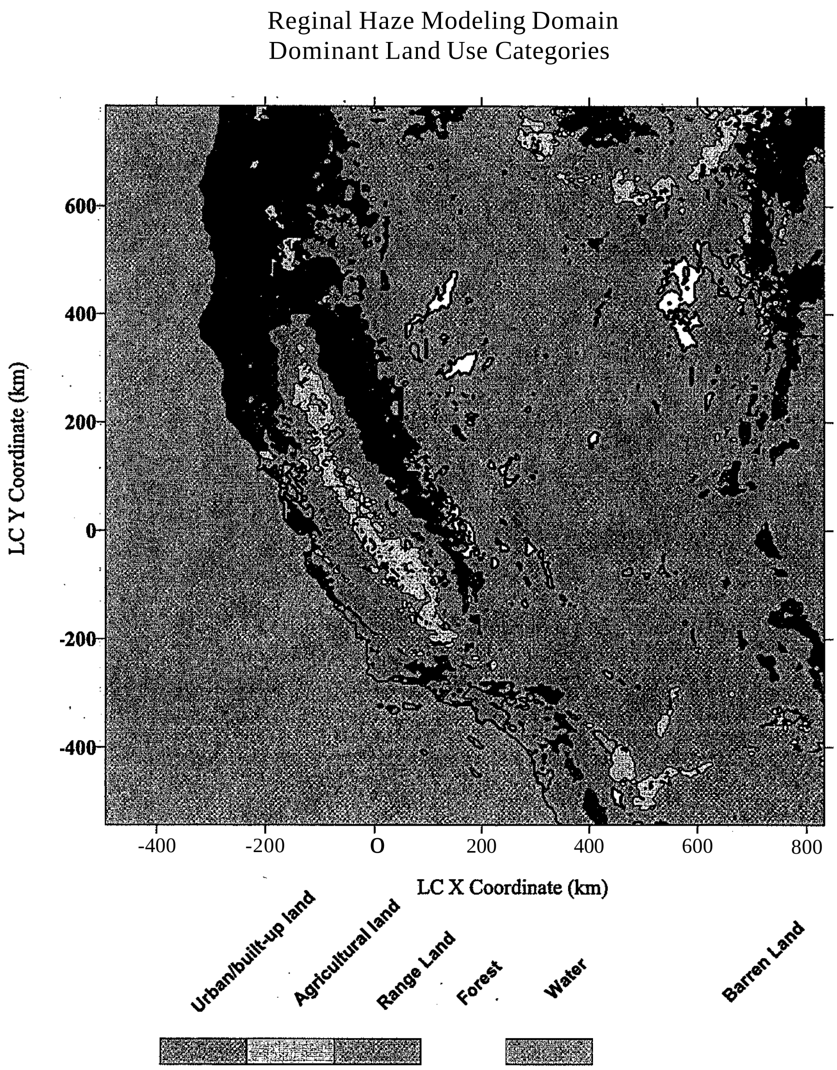


Figure 2. CALMET land use categories.

The land use data are based on the Composite Theme Grid format (CTG) using Level I USGS land use categories. The USGS land use categories will be mapped into 14 CALMET land use categories. Land use categories in the modeling domain are shown in Figure 2. The land use categories are described in Table 1.

Default CALMET Land Use Categories and Associated Geophysical Parameters
Based on the U.S. Geological Survey Land Use Classification System
(14-Category System)

| Land Use Type | Description | Surface Roughness (m) | Albedo | Bowen Ratio | Soil Heat Flux Parameter | Anthropogenic Heat Flux (W/m²) | Leaf Area Index |
|---|---|---|---|---|---|---|---|
| 10 | Urban or Built-up Land | 1.0 | 0.18 | 1.5 | .25 | 0.0 | 0.2 |
| 20 | Agricultural Land - Unirrigated | 0.25 | 0.15 | 1.0 | .15 | 0.0 | 3.0 |
| -20* | Agricultural Land - Irrigated | 0.25 | 0.15 | 0.5 | .15 | 0.0 | 3.0 |
| 30 | Rangeland | 0.05 | 0.25 | 1.0 | .15 | 0.0 | 0.5 |
| 40 | Forest Land | 1.0 | 0.10 | 1.0 | .15 | 0.0 | 7.0 |
| 51 | Small Water Body | 0.001 | 0.10 | 0.0 | 1.0 | 0.0 | 0.0 |
| 54 | Bays and Estuaries | 0.001 | 0.10 | 0.0 | 1.0 | 0.0 | 0.0 |
| 55 | Large Water Body | 0.001 | OJO | 0.0 | 1.0 | 0.0 | 0.0 |
| 60 | Wetland | 1.0 | 0.10 | 0.5 | .25 | 0.0 | 2.0 |
| 61 | Forested Wetland | 1.0 | 0.1 | 0.5 | 0.25 | 0.0 | 2.0 |
| 62 | Nonforested Wetland | 0.2 | 0.1 | 0.1 | 0.25 | 0.0 | 1.0 |
| 70 | Barren Land | 0.05 | 0.30 | 1.0 | .15 | 0.0 | 0.05 |
| 80 | Tundra | .20 | 0.30 | 0.5 | .15 | 0.0 | 0.0 |
| 90 | Perennial Snow or Ice | .20 | 0.70 | 0.5 | .15 | 0.0 | 0.0 |

* Negative values indicate "irrigated" land use

Table 1. Land use categories table from CALMET User's Guide.

### *6.1.1.5. CALMET ZFACE and ZIMAX Settings*

Eleven vertical layers will be used with vertical cell face (ZFACE) heights at: 0, 20, 100, 200, 350, 500, 750, 1000, 2000, 3000, 4000, and 5000 meters. The minimum mixing height will be set to 50 m, and the maximum mixing height will be set to 3000 m.

### *6.1.1.6; CALMET BIAS Setting*

The BIAS settings for each vertical cell determine the relative weight given to the vertically extrapolated surface meteorological observations and upper air soundings. The initial guess field is computed with an inverse distance weighting of the surface and upper air data. It can be modified by the layer-dependent bias factor (BIAS). The values for BIAS can range from -1.0 to 1.0. For example, if BIAS is set to +0.25, the weight of the surface wind observation is reduced by 25%. If BIAS is set to -0.25, the weight ofthe upper air wind observation is reduced by 25%. If BIAS is set to zero, there is no change in the weighting from the normal inverse distance squared weighting. As recommended by the National Park Service (NPS), the default values of 0.0 will be used for all 11 vertical layers in this analysis.

### 6.1.1.7. CALMET RMIN2 and IXTERP Settings

Vertical extrapolation of data from a surface station is skipped if the surface station is close to the upper air station. The variable RMIN2 sets the distance between an upper air station and a surface station that must be exceeded in order for the extrapolation to take place. RMIN2 will be set to the default value of 4, as recommended by the NPS. The default value of -4 for IEXTRP is used. By setting IEXTRP to -4 (as opposed to +4), layer 1 data at upper air stations is ignored. When IEXTRP=±4, the van Ulden and Holtslag wind extrapolation method is used. The method uses similarity theory and observed data to extend the influence of the surface wind speed and direction aloft.

### 6.1.1.8. CALMETSettings: R1, R2, RMAX1, RMAX2, RMAX3

An inverse-distance method is used to determine the influence of observations in the Step 1 wind field. R1 controls weighting of the surface layer and R2 controls weighting of the layers aloft. For example, R1 is the distance from an observational station at which the observation and first guess field are equally weighted. In addition, RMAX1, RMAX2, and RMAX3 determine the radius of influence over land in the surface layer, over land in layers aloft, and over water, respectively. That is, an observation is excluded if the distance from the observational site to a given grid point exceeds the maximum radius of influence. As recommended by the NPS, R1 and RMAX1 will be set to 30 km so that the initial guess field does not overwhelm the surface observations. R2 is set to 50 km and RMAX2 is set to 100 km. For over water surface observation both R3 and RMAX3 are set to 30 km, the same as the parameters for over land stations.

### 6.1.1.9. CALMET Surface Stations

The National Climatology Data Center (NCDC) surface observational data at 279 stations will be used in this initial analysis. The locations of these surface meteorological stations are shown in Figure 3.

### 6.1.1.10. CALMET Upper Air Stations

The initial analysis will not consider upper air observational data for mainly two reasons. The first reason is that a substantial amount of data are missing, and there exists no rigorous method to fill in missing data. Filling in missing data arbitrarily will likely alter the meteorological field generated by the CALMET model. The other reason is that, since the output of the MM5 mesoscale meteorological model provides an adequate coverage of upper air meteorology, neglecting upper air observational data will have an insignificant effect on the CALMET meteorological field. Future analyses may consider upper air observational data.

### 6.1.1.11. *CALMET Precipitation Stations*

The initial analysis will not consider precipitation data. Future analyses may consider observational precipitation data.

Locations of surface meteorological stations

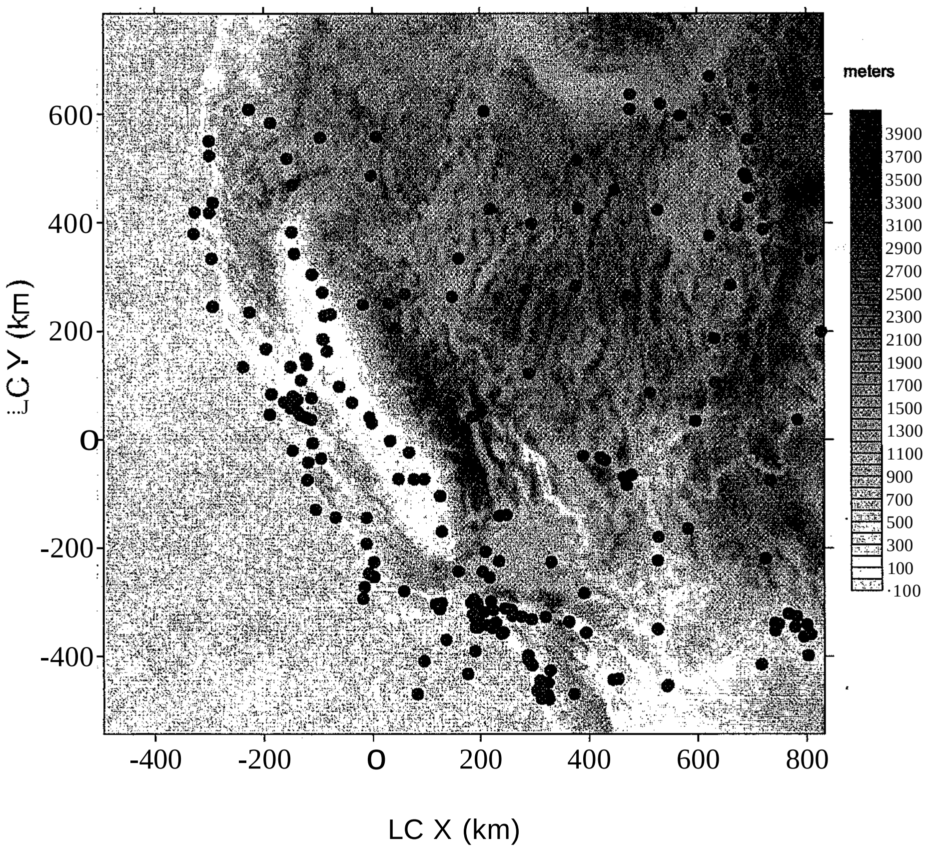


Figure 3. Locations of surface meteorological stations.

### 6.1.1.12. *CALMET Parameter Summary*

Table 2 summarizes some of the key CALMET parameters.

| | | EPA Default | Our Values |
|---|---|---|---|
| GEO.DAT | -Name of Geophvsical data file | GEO.DAT | GEO.DAT |
| SURF.OAT | Name of Surface data file | SURF.DAT | SURF.DAT |
| PRECIP.DAT | Name of Precipitation data file | PRECIP.DAT | NA |
| NUSTA | Number of upper air data sites - | User Defined | 0 |
| UPn.DAT | Names of NUSTA upper air data files | UPn.DAT | NA |
| IBYR | Beginning year | User Defines | User Defines |
| IBMO | Beginning month | User Defines | User Defines |

| | | | |
|---|---|---|---|
| IBDY | Beainnina dav | User Defines | User Defines |
| IBHR | Beainnina hour | User Defines | User Defines |
| IBTZ | Base time zone | User Defines· | 8 |
| IRLG | Number of hours to simulate | User Defines | User Defines |
| IRTYPE | Output file type.to create (must be 1 for CALPUFF) | 1 | 1 |
| LCALGRD | Are w-components and temperature needed? | T | T |
| NX | Number of east-west grid cells | User Defines | 333 |
| NY | Number of north-south arid cells | User Defines' | 333 |
| DGRIDKM | Grid spacina | User Defines | 4 |
| XORIGKM | Southwest grid cell X coordinate | User Defines | -497.152 |
| YORIGKM | Southwest arid cell Y coordinate | User Defines | -544.910 |
| XLATO | Southwest arid cell latitude | User Defines | 31.856 |
| YLONO | Southwest arid celllonQitude | User Defines | 125.797 |
| IUTMZN | UTM Zone | User Defines | NA |
| XLAT1 | Latitude of $1^{51}$ standard parallel | 30 | 30 |
| XLAT2 | Latitude of $2^{na}$ standard parallel | 60 | 60 |
| RLONO | LonQitude used if LLCONF = T | 90 | 120.5 |
| RLATO | Latitude used if LLCONF = T | 40 | 37 |
| NZ | Number of vertical Lavers | User Defines | 12 |
| ZFACE | Vertical cell face heights (NZ+1 values) | User Defines | 0,20,40,80,160,300,6bO,1 000,1500,2000,3000,4000, and 5000 |
| . LSAVE | Save met. Data fields in an unformatted file? | T | T |
| IFORMO | Format of unformatted file (1 for CALPUFF) | 1 | 1 |
| NSSTA | Number of stations in SURF.DAT file | User Defines | 279 |
| NPSTA | Number of stations in PRECIP.DAT | User Defines | 0 |
| ICLOUD | Is cloud data to be input as gridded fields? O=No) | 0 | 0 |
| IFORMS | Format of surface data (2 - formatted) | 2 | 2 |
| IFORMP | Format of precipitation data (2= formatted)' | 2 | 2 |
| IFORMe | Format of cloud data (2= formatted) | 2 | 2 |
| IWFCOD. | Generate winds by diagnostic wind module? (1 = Yes) | 1 | 1 |
| IFRADJ | Adjustwinds using Froude number effects? (1= Yes) | 1 | 1 |
| IKINE | Adjust winds using Kinematic effects? (1 = Yes) | 0 | 0 |
| IOBR | Use O'Brien procedure for vertical winds? (0 = No) | 0 | 0 |
| ISLOPE | Compute slope flows? (1 = Yes) | 1 | 1 |
| IEXTRP | Extrapolate surface winds to upper layers? (-4 = use similarity theory and ignore layer 1 of upper air station data) | -4 | -4 |

| Variable | Description | EPA Default | Our Values |
|---|---|---|---|
| ICALM | Extrapolate surface calms to upper lavers? (0 =No) | 0 | 0 |
| BIAS | Surface/upper-air weighting factors (NZ values) | NZ*O | NZ*O |
| IPROG | Using prognostic or MM-FDDA data? (0 =No) | 0 | 14 |
| LVARY | Use varying radius to develop surface. winds? | F | F |
| RMAX1 | Max surface over-land extrapolation radius (km) | User Defines | 30 |
| RMAX2, | Max aloft over-land extrapolations radius (km) | User Defines | 30 |
| RMAX3 | Maximum over-water extrapolation radius (km) | User Defines | 50 |
| RMIN | Minimum extrapolation radius (km) | 0.1 | 0.1 |
| RMIN2 | Distance (km) around an upper air site where vertical extrapolation is excluded (Set to -1 if IEXTRP =+4) | 4 | 4 |
| TERRAD | Radius of influence of terrain features (km) | User Defines | 50 |
| R1 | Relative weight at surface of Step 1 field and obs | User Defines | 1.0 |
| R2 | Relative weight aloft of Step 1 field and obs | User Defines | 1.0 |
| DIVLIM | Maximum acceptable diveroence | 5.E-6 | 5.E-6 |
| NITER | Max number of passes in divergence minimization | 50 | 50 |
| NSMTH | Number of passes in smoothing (NZ values) | 2,4*(NZ-1) | 2,4*(NZ-1) |
| NINTR2 | Max number of stations for intercolatlons (NA values) | 99 | 99 |
| CRITFN | Critical Froude number | 1 | 1 |
| ALPHA | Empirical factor triggering kinematic effects | 0.1 | 0.1 |
| IDIOPT1 | Compute temperatures from observations (0 =True) | 0 | 0 |
| ISURFT | Surface station to use for surface temperature (between 1 and NSSTA) | User Defines | 1 |
| IDIOPT2 | Compute domain-average lapse rates? (0 =True) | 0 | 0 |
| IUPT | Station for lapse rates (between 1 and NUSTA) | User Defines | NA |
| ZUPT | Depth of domain-average lapse rate (m) | 200 | 200 |
| IDIOPT3 | Compute internally initial guess, winds? (0 =True) | 0 | 0 |
| IUPWND | Upper air station for domain winds (-1 =1/r**2 interpolation of all stations) | -1 | -1 |
| ZUPWND | Bottom and top of layer for 1s, guess winds (m) | 1,1000 | 1,1000 |

| | | | |
|---|---|---|---|
| IDIOPT4 | Read surface winds from SURF.OAT? ( 0 = True) | 0 | 0 |
| IDIOPT5 | Read aloft winds from UPn.DAT? (O =True) | 0 | 0 |
| CONSTB | Neutral mixing height B constant | 1.41 | 1.41 |
| CONSTE | Convective mixing height E constant | 0.15 | 0.15 |
| CONSTN | Stable mixing height N constant | 2400 | 2400 |
| CONSTW | Over-water mixing height W constant | 0.16 | 0.16 |
| FCORIOL | Absolute value of Carioles parameter | 1.E-4 | 1.E-4 |
| IAVEXZI | Spatial averaging of mixing heights? ( 1 = True) | 1 | 1 |
| MNMDAV | Max averaging radius (number of grid cells) | 1 | 1 |
| HAFANG | Half-angle for looking upwind (degrees) | 30. | 30 |
| ILEVZI | Layer to use in upwind averaging (between 1 and NZ) | 1 | 1 |
| DPTMIN | Minimum capping potential temperature lapse rate | 0.001 | 0.001 |
| DZZI | Depth for computing capping lapse rate (m) | 200 | 200 |
| ZIMIN | Minimum over-land mixing height (m) | 50 | 50 |
| ZIMAX | Maximum over-land mixing height (m) | 3000 | 3000 |
| ZIMINW | Minimum over-water mixing height (m) | 50 | 50 |
| ZIMAXW | Maximum over-water mixing height (m) | 3000 | 3000 |
| IRAD | Form of temperature interpolation (1 = *1/r)* | 1 | 1 |
| TRADKM | Radius of temperature interpolation (km) | 500 | 500 |
| NUMTS | Max number of stations in temperature interpolations | 5 | 5 |
| IAVET | Conduct spatial averaging of temperature? (1 = True) | 1 | 0 |
| TGDEFB | Default over-water mixed layer lapse rate (KIm) | -0.0098 | -0.0098 |
| TGDEFA | Default over-water capping lapse rate (KIm) | -0.0045 | -0.0045 |
| JWAT1 | Beginning landuse type defining water. | 999 | 999 |
| JWAT2 | Ending landuse type defining water | 999 | 999 |
| NFLAGP | Method for precipitation interpolation (2= *11r**2)* | 2 | 2 |
| SIGMAP | Precip radius for interpolations (km) | 100 | 100 |
| CUTP | Minimum cut off precip rate *(mm/hr)* | 0.01 | 0.01 |

| Variable | | | |
|---|---|---|---|
| SSn | NSSTA input records for surface stations | User Defines | NA |
| Usn | NUSTA input records for upper-air stations | User Defines | NA |
| PSn | NPSTA input records for precipitations stations | User Defines | NA |

NA= Not Applicable

Table 2. CALMET parameter summary.

### 6.1.2. CALPUFF

CALPUFF is a mUlti-layer, multi-species non-steady-state Gaussian puff dispersion which can simulate the effects of time- and space-varying meteorological conditions on pollutant transport, transformation, and removal. CALPUFF contains algorithms for near-source effects such as bUilding downwash, transitional plume rise, subgrid scale terrain interactions as well as longer range effects such as pollutant removal (wet scavenging and dry deposition), chemical transformation, vertical wind shear, overwater transport and coastal interaction effects.

The default technical options in CALPUFF should be used, unless specified otherwise in this protocol. If non-default options or values are used, the reason should be explained and justified in the modeling report.

#### *6.1.2.1. **Receptor Network and Class I Federal Areas***

The modeling domain should contain all Class I federal areas in California within 300 kilometers of the BART-eligible source. Class I areas outside California within 300 kilometers of any California BART-eligible sources should be included. The setup will include 29 Class I federal areas in California:

Agua Tibia Wilderness Area
Caribou Wilderness Area
Desolation Wilderness Area
Emigrant Wilderness Area
John Muir Wilderness Area
Kaiser Wilderness Area
Lassen Volcanic National park
Marble Mountain Wilderness Area
Pinnacles National Monument
Redwood National Park
San Gorgonio Wilderness Area
San Rafael Wilderness Area
Ansel Adams Wilderness Area
Cucamonga Wilderness Area'
Domeland Wilderness Area
Hoover Wilderness Area
Joshua Tree National Park
Kings Canyon National Park
Lava Beds National Monument
Mokelumne Wilderness Area
Point Reyes National Seashore
San Gabriel Wilderness Area
San Jacinto Wilderness Area
Sequoia National Park

South Warner Wilderness Area
VentanaWilderness Area
Yosemite National Park
Thousand Lakes Wilderness Area
Yolla Bolly-Middle Eel Wilderness Area

Another seven Class I areas outside of California will also be included in the modeling because they are potentially affected by California BART-eligible sources. These Class I areas are:

Kalmiopsis Wilderness Area
Mountain Lakes Wilderness Area
Gearhart Mountain Wilderness Area
Pine Mountain Wilderness Area
Grand Canyon National Park
Sycamore Canyon Wilderness Area
Mazatzal Wilderness Area

The receptors for all of the Class I federal areas were generated by the National Park Service (NPS) using the *NPS Convert Class I Areas* (NCC) computer program. All receptor locations and the computer program are available for download at http://www2.nature.nps.gov/air/maps/Receptors/index.cfm#top. Receptor elevations provided by the NPS conversion program will be used in the modeling.

All receptors will be included in a single CALPUFF simulation. To calculate the visibility impacts in CALPOST for each Class I area, the NCRECP parameter can be used. It specifies the receptor range to be processed in CALPOST.

*6.1.2.2. CALPUFF Meteorology*

Refer to the CALMET section of the report for details.

*6.1.2.3. CALPUFF Modeling Domain*

The CALPUFF modeling domain is identical to the CALMET modeling domain.

*6.1.2.4. CALPUFF Parameter Summary.*

Table 3 summarizes some of the key CALPUFF settings.

| Variable | | EPA Default | Our Values |
|---|---|---|---|
| METDAT | CALMET input data filename | CALMET.DAT | CALMET.DAT |
| PUFLST | Filename for general output from CALPUFF | CALPUFF.LST | CALPUFF.LST |
| CONDAT | Filename for output concentration data | CONC.DAT | CONC.DAT |
| DFDAT | Filename for output dry deposition fluxes | DFLX.DAT | DFLX.DAT |
| WFDAT | Filename for output wet deposition fluxes | WFLX.DAT | WFLX.DAT |
| VISDAT | Filename for output relative humidities (for | VISB.DAT | VISB.DAT |

| Variable | | | Our Values |
|---|---|---|---|
| | visibility) | | |
| METRUN | Do we run all periods (1) or a subset (O)? | 0 | 0 |
| IBYR | Beginning year | User Defined | User Defined |
| IBMO | Beginning month | User Defined | User Defined |
| IBDY | Beginning day | User Defined | User Defined |
| IBHR | Beginning hour | User Defined | User Defined |
| IRIG | length of runS (hours) | User Defined | User Defined |
| NSPEC | Number of species modeled (for MESOPUFFII chemistry) | 5 | 6 |
| NSE | Number of species emitted | 3 | 3 |
| MRESTART | Restart options (0 =no restart), allows splitting runs into smaller segments | 0 | 1 |
| METFM | Format of input meteorology (1 = CAIMET) | 1 | ·1 |
| AVET | Averaging time lateral dispersion parameters (minutes) | 60 | 60 |
| MGAUSS | Near-field vertical distribution (1 = Gaussian) | 1 | 1 |
| MCTADJ | Terrain adjustments to plume path (3 = Plume path) | 3 | 3 |
| MCTSG | Do we have subgrid hills? (0 =No), allows CTDM-like treatment for subgrid scale hills | 0 | 0 |
| MSIUG | Near-field puff treatment (0 =No slugs) | 0 | 0 |
| MTRANS | Model transitional plume rise? (1 =Yes) | 1 | 1 |
| MTIP | Treat stack tip downwash? (1 =Yes) | 1 | 1 |
| MSHEAR | Treat vertical wind shear? (0 =No) | 0 | 0 |
| MSPLIT | Allow puffs' to split? (0 =No) | 0 | 0 |
| MCHEM | MESOPUFF-JI Chemistry? (1 =Yes) | 1 | 1 |
| MWET | Model wet deposition? (1 =Yes) | 1 | 1 |
| MDRY | Model dry deposition? (1 =Yes) | 1 | 1 |
| MDISP | Method for dispersion coefficients (3 =PG &MP) | 3 | 3 |
| MTURBVW | Turbulence characterization? (Only if MDISP =1 or 5) | 3 | 3 |
| MDISP2 | Backup coefficients (Only if MDISP =1 or 5) | 3 | 3 |
| MROUGH | Adjust PG for surface roughness? (0 = No) | 0 | 0 |
| MPARTI | Model partial plume penetration? (0 =No) | 1 | 1 |
| MTINV | Elevated inversion strength (0 =compute from data) | 0 | 0 |
| MPDF | Use PDF for convective dispersion? (0 = No) | 0 | 'O |
| MSGTIBI | Use TIBI module? (0 =No) allows treatment of subgrid scale coastal areas | 0 | 0 |
| MREG | Regulatory default checks? (1 =Yes) | 1 | 1 |
| CSPECn | Names of species modeled (for MESOPUFF II, must be S02, S04, NOx, HN03, N03) | User Defined | S02, S04, NOX, HN03, N03 and PM10 |
| NX | Number of east-west grids of input meteorologv | User Defined | 333 |

| Variable | | EPA Default | Our Values |
|---|---|---|---|
| NY | Number of north-south grids of input meteoroloav | User Defined | 333 |
| NZ | Number of vertical layers of input meteoroloav | User Defined | 12 |
| DGRIDKM | Meteoroloav.arid spacina (km) | User Defined | 4 |
| ZFACE | Vertical cell face heights of input meteoroloav | User Defined | Same as Table 2 |
| XORIGKM | Southwest corner (east-west) of input meteoroloav | User Defined | -497.152 |
| YORIGIM | Southwest corner (north-south) of input meteoroloav | User Defined | -544.910 |
| IUTMZN | UTM zone | User Defined | NA |
| XLAT | Latitude of center of meteorology domain | User Defined | 37 |
| XLONG | Longitude of center of meteorology domain | User Defined | 120.50 |
| XTZ | Base time zone of input meteoroloqv | User Defined | PST |
| IBCOMP | Southwest of Xindex of computational domain | User Defined | 1 |
| JBCOMP | Southwest of Y-index of computational domain | User Defined | 1 |
| IECOMP | Northeast of Xindex of computational domain | User Defined | 333 |
| JECOMp | Northeast of Y- index of computational domain | User Defined | 333 |
| LSAMP | Use aridded receptors (T -= Yes) | F | F |
| IBSAMP | Southwest of Xindex of receptor grid | User Defined | 1 |
| JBSAMP | Southwest of Y-index of receptor grid | User Defined | 1 |
| IESAMP | Northeast of Xindex of receptor grid | User Defined | 333 |
| JESAMP | Northeast of Y-index of receptor grid | User Defined | 333 |
| MESHON | Gridded receptor spacing = DGRIDKM/MESHDN | 1 | 1 |
| ICON | Output concentrations? (1 = Yes) | 1 | 1 |
| IORY | Output drv deposition flux? (1 = Yes) | 1 | 1 |
| IWET | Output wet deposition flux? (1 = Yes) | 1 | 1 |
| IVIS | Output RH for visibility calculations (1 = Yes) | 1 | 1 |
| LCOMPRS | Use compression option in output? (T = Yes)" | T | T |
| ICPRT | Print concentrations? (0 = No) | 0 | 0 |
| IDPRT | Print dry deposition fluxes (0 = No) | 0 | 0 |
| IWPRT | Print wet deposition fluxes (0 = No) | 0 | 0 |
| ICFRQ | Concentration print interval (1 = hourly) | 1 | 1 |
| IDFRQ | Dry deposition flux print interval (1 = hourly) | 1 | 1 |
| IWFRQ | Wet deposition flux print interval (1 = hourly). | 1 | 1 |
| IPRTU' | Print output units (1 = g/m**3; g/m**2/s) | 1 | 1 |
| IMESG | Status messaoes to screen? (1 = Yes) | 1 | 1 |
| Output Species | Where to output various species | User Defined | All modeled species |
| LDEBUG | Turn on debug tracking? (F = No) | F | F |
| Dry Gas Dep | Chemical parameters of gaseous deposition species | User Defined | S02,NOx,HN O3 |

| | | | |
|---|---|---|---|
| Dry Part. Dep | 'Chemical parameters of particulate deposition species | User Defined | S04,N03,PM10 |
| RCUTR | Reference cuticle resistance (s/cm) | 30. | 30. |
| RGR | Reference ground resistance (s/cm) | 10. | 10. |
| REACTR | Reference reactivity | 8 | 8 |
| NINT | Number of particle-size'intervals | 9 | 9 |
| IVEG | Vegetative state (1 =active and unstressed) | 1 | 1 |
| Wet Dep | Wet deposition parameters | User Defined | HN03,S04,N03, PM10 |
| MOZ | Ozone background? (1 =read from ozone.dat) | 1 | 1 |
| BCK03 | Ozone default (ppb) (Use only for missing data) | 80 | 80 |
| BCKNH3 | Ammonia backQround (ppb) | 10 | 10 |
| RNITE1 | Nighttime S02 loss rate %/hr) | 0.2 | 0.2 |
| RNITE2 | Nighttime NOx loss rate %/hr) | 2 | 2 |
| RNITE3 | Nighttime HN03 loss rate (%/hr) | 2 | 2 |
| SYTDEP | Horizontal size (m) to switch. to time dependence | 550. | 550. |
| MHFTSE | Use Heffler for vertical dispersion? (0 = No) | 1 | 1 |
| JSUP | PG Stability class above mixed layer | 5 | 5 |
| CONK1 | Stable dispersion constant (EQ. 2.7-3) | 0.01 | 0.01 |
| CONK2 | Neutral dispersion constant (EQ. 2.7-4) | 0.1 | 0.1 |
| TBD | Transition for downwash algorithms (0.5 = ISC) | 0.5 | 0.5 |
| IURB1 | Beginning urban landuse type | 10 | 10 |
| IURB2 | Ending urban landuse type | 19 | 19 |

Table 3. CALPUFF parameter summary.

### *6.1.2.5.* ***Chemical Mechanism***

The MESOPUFF II pseudo-first-order chemical reaction mechanism (MCHEM=1) is used for the conversio.n of S02 to sulfate ($04) and $NO_x$ to nitrate ($NO_3$). Refer to the CALPUFF User's Guide for a description of the mechanism (Scire, 2000). Further discussion about the chemical mechanism is presented in Appendix_.

Ammonia-limiting methods will be used for repartitioning nitric acid and nitrate on a receptor-by-receptor and hour-by-hour basis to account for over prediction due to overlapping puffs in CALPUFF. Specifically, the use of the MNIRATE=1 option in POSTUTIL is recommended. At this time, other ammonia-limiting methods, including iterative techniques that use observational data to resolve backward the thermodynamic equilibrium equation between $NO_3/HNO_3$ for each hour to minimize available ammonia, are not acceptable. Generally, for regulatory CALPUFF modeling in California, techniques that assume the atmosphere is always ammonia poor are not acceptable.

### 6.1.2.6. ***Chemical Mechanism - Ammonia Sensitivity Tests***

A sensitivity test of the effect of background ammonia was conducted by the Air Pollution Control Division of the Colorado Department of Public Health & Environment. Details, are presented in Appendix _. ,

### 6.1.2.7. ***Ammonia Assumptions - Discussion***

In CALPUFF, as used in this application, the background ammonia **concentration** is temporally and spatially uniform. It is likely that some portions of the modeling domain are ammonia poor and some are ammonia rich. Thus, setting a domain-wide background is problematic. As discussed in the previous section, when modeling a single large source with high 802 emission rates relative to $NO_x$, the assumed background ammonia concentration is not a critical parameter for determining visibility impacts.

According to the IWAQM Phase 2 Report,

> A *further complication is that the formation* of *particulate nitrate is dependent on the ambient concentration* of *ammonia, which preferentially reacts with sulfate. The ambient ammonia concentration is an input to the model. Accurate specification* of *this parameter is critical to the accurate estimation* of *particulate nitrate concentrations. Based on* a *review* of *available data, Langford et al. (1992) suggest that typical (within* a *factor* of 2) *background values* of *ammonia are:* 10 *ppb for grasslands, 0.5 ppb for forest, and 1 ppb fQr arid lands at* 20 C. *Langford et al.* (1992) *provide strong evidence that background levels* of *ammonia show strong dependence with ambient'temperature (variations* of a *factor* of 3 *or .4). and* a *strong dependence on the soil pH. However, given all the uncertainties in ammonia data, IWAQM recommends use* of *the background levels provided above, unless specific data are available for the modeling domain that would discredit the values cited. It should be noted, however, that in areas where' there are high ambient levels* of *sulfate, values such* as 10 *ppb might overestimate the formation* of *particulate nitrate from* a *given source, for these polluted conditions. Furthermore, areas in the Vicinity* of *strong point sources* of *ammonia, such* as *feedlots or other agricultural areas, may experience locally high levels* of *background ammonia.*

Ideally a background ammonia input to CALPUFF needs to characterize spatial and temporal variations. However ammonia data obtained from the existing air quality monitoring network are not adequate to develop a characterization of those variations. Ammonia concentrations collected in special studies are not adequate either to fulfill the need.

#### 6.1.2.8. *Ammonia Assumptions*

Because of the lack of a comprehensive ammonia data set, it is impossible in this study to develop a background ammonia input to CALPUFF that can reliably represent the temporal and spatial variations in the modeling domain. Domain-' wide ammonia background concentrations will be set to 10 ppb which is recommended by the CALPUFF developer as the default value.

#### 6.1.2.9. **Ozone *Assumptions***

According to the IWAQM Phase 2 Report,

> *CALPUFF provides two options for providing the ozone background data:* (1) a *single, typical bae,kground value appropriate for the modeling region, or* (2) *hourly ozone data from one or more ozone monitoring stations. The second and preferred option requires the creation* of *the OZONE.DA T file containing the necessary data. For the Demonstration Assessment, the domain was large (700 km by 1000 km) such that the second option was necessary. The IWAQM does not anticipate such large domains as being the typical application. Rather, it is anticipated that the more typical application will involve domains* of *order 400 km by 400 km or smaller. But even for smaller domains, the ability to provide at least monthly background values* of *ozone is deemed desirable. The problem in developing time (and perhaps spatial) varying background ozone values is having access to representative background ozone data. Ozone data are available from EPA's Aerometric Information Retrieval System (AIRS); however, AIRS data must be used with caution. Many ozone sites are located in urban and suburban centers and are not representative* of *oxidant levels experienced by plumes undergoing long range transport.*

Hourly ozone values from ARB's ozone monitoring network will be used as input to CALPUFF.

### 6.1.3. CALPOST Settings and Visibility Post-Processing

The CALPUFF results will be post-processed with a version of CALPOST (version 5.6393 level 060202) that contains a postprocessor for visibility , impairment calculations. POSTUTIL or its functional equivalents may also be used. These programs may be modified to output the correct values needed for BART analysis.

For the initial modeling analysis, all $PM_{10}$ may be assumed to have a extinction efficiency of 1.0 since the contribution of direct PM1Q emissions is expected to be relatively small compared to Visibility impairment caused by S02 and $NO_x$ emissions. However, if modeled impacts are below the contribution threshold, condensable and filterable PM10 emissions should be quantified and speciated. Alternatively, a sensitivity test could be performed to determine if speciation would change the outcome of the subject-to-BART demonstration. For example, if all PM10 is modeled as PMF in CALPOST, the extinction efficiency for PMF could be changed from 1.0 to 10.0 to simulate a worst-case speciation scenario. If this type'ofsensitivity test or another analysis suggests that PM10 speciation could change the outcome of the analysis,.then speciation should be performed. If speciated PM10 emissions are modeled, the following species should be considered: fine particulates (PMF), coarse particulates (PMC), elemental carbon (EC), organic carbon (SOA), and sulfate (S04)'

To calculate background light extinction, MVISBK should be set to 6. That is, monthly RH adjustment factors are applied directly to the background and . modeled sulfate and nitrate concentrations, as recommended by the BART guideline. The RHMAX parameter, which is the maximum relative humidity factor used in the particle growth equation for visibility processing, is not used when method 6 is selected. Similarly, the relative humidity adjustment factor (f(RH» curves in CALPOST (e.g., IWAQM growth curve and the 1996 IMPROVE curve) are not used when MVISBK is equal to 6.

f(RH) values listed in Table A-20f US EPA's 'Guidance for Tracking Progress Under the Regional Haze Rule (EPA, 2003a)' will be used in the modeling. These values are site-specific for each Federal Class I area.

EPA lists three types of Natural Conditions (natural background) in their guidance document, annual average, Best 20% Days and Worst 20% Days (EPA, 2003a). The EPA BART Guidance recommends that the Natural Conditions .' corresponding to the Best 20% Days be used. However, this issue was challenged by the Utility Air Regulatory Group (UARG) and in a settlement EPA agreed that States could use Annual Average Natural Conditions (Paise, 2006a,b). In BART modeling analyses, the visibility impacts will be calculated using annual average of Natural Conditions and provided to the ARB to make the subject to BART determinations. The Natural Conditions are available on website (http://vista.cira.colostate.edu/improve/DataIIMPROVE/summarydata.htm).

Based on the latest three years' (2001, 2002 and 2003) background concentration measurements, domain wide averaged background concentrations have been calculated from data collected at all Class I areas located in California and will be used in the post-processing for Visibility impairment analysis. The . background concentrations to be used are listed as follows: BKS04 = 1.168235 $\mu g/m^3$, BKN03 = 1.05942 $\mu g/m^3$, BKPMC = 5.713125 $\mu g/m^3$, BKOC' = 1.846471 $\mu g/m^3$, BKSOIL =0.664706 $\mu g/m^3$, BKEC =0.216471 $\mu g/m^3$.

### 6.1.3.1. 98th *Percentile. Methods*

According to the BART guideline:

> *...you should compare your "contribution" threshold against the 98th percentile of values. If the 98th percentile value from your modeling is less than your contribution threshold; then you may conclude that the source does not contribute to visibility impairment and is not sUbject to BART.* (70 FR 39162)

The U.S.EPA recommends uSing the 98th percentile value from the distribution of values containing the highest modeled delta-deciview value for each day of the simulation from all modeled receptors at a given Class I area. The 98th percentile delta-deciview value should be determined as the highest of the 8th highest values for each year modeled among all three modeled years.

The 98th percentile value at each Class I area should be compared to the contribution threshold. The contribution threshold has an implied level of precision equal to the level of precision reported from CALPOST. Specifically, the 98th percentile results should be reported to three decimal places.

The U.S. EPA recommended method is referred to as the "day-specific method" or "method 1." The first step in the method is to find the highest modeled delta-deciview value for each" day of the simulation from all modeled receptors for the selected time period. Next, daily delta-deciview maxima are ranked in descending order for the number of days processed in CALPOST. Then, the 98th percentile value is determined from the distribution of ranked modeled daily maximum \falues, irrespective of receptor location. For both a 365-day and a 366-day simulations, the 98th percentile value would be the 8th highest modeled delta-deciview value from the list of ranked delta-deciview values. That is, the top 7 days are ignored, even though the values being ignored may be at different receptors.

A different method, referred to as "receptor-specific method" or "method 2" can also be used to calculate 98th percentile values. The 8th high (for one year) and 22nd high (for 3 years) values recommended by U.S. EPA are consistent with the values that would be generated from the equations in 40 CFR 50 Appendix N - "Interpretation of the National Ambient Air Quality Standards for $PM_{2.5}$" - for determining 98th percentile values for $PM_{2.5}$ monitoring.

# ,7. Results

The CALPUFF modeling results will be reported in a separate document. The results will include 29 Class I federal areas in California and 7 Class I federal areas outside California. '

The results forsource-to-receptor distances beyond 300 kilometers may be used, but they may overestimate impacts because puff splitting is not used. The model setup used here should provide reasonable estimates for source-to-receptor distances up to 300 kilometers.

# 8. References


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# Appendix - The BART Guidelines From 40 CFR Part 51, Appendix Y

*III. HOW TO IDENTIFY SOURCES "SUBJECT TO BART"*

*Once you have compiled your list of BART-eligible sources, you need to determine whether (1) to make BART determinations for all of them or (2) to consider exempting some of them from BART because they may not reasonably be anticipated to cause or contribute to any visibility impairment in a Class I area. If you decide to make BARt determinations for all the BART-eligible sources on ' your list; you should work with your regional planning organization (RPO) to show that, COllectively, they cause or contribute to visibility impairment in at least one Class I area. You should then make individual BART determinations by applying the five statutory factors discuss,ed in Section IV below.*

*On the other hand, you also may choose to perform an initial examination to determine whether a particular BART-eligible source or group of sources cause,s or contributes to visibility impairment in nearby Class I areas. If your analysis, or 'information submitted by the source, shows that an individual source or group of sources (or certain pollutants from those sources) is not reasonably anticipated to cause or contribute to any visibility impairment in a Class I area, then you do not need to make BART determinations for that source or group of sources (or for certain pollutants from those sources). In such a case, the source is not "subject to BART" and you do not need to apply the five statutory factors to make a BART determination. This section of the Guideline discusses several approaches that you can use to exempt sources from the BART determination process. '*

*A. What Steps Do I Follow to Determine Whether A Source or Group of Sources Cause or Contribute to Visibility Impairment for Purposes of BART?*

*1. How Do I Establish a Threshold?*

*One of the first steps in determining whether sources cause or contribute to visibility impairment for purposes of BART is to establish a threshold (measured in deciviews) against which to measure the visibility impact of one or more sources. A single source that is responsible for a 1.0 deciView change or more. should'be considered to "cause" visibility impairment; a source that causes less than a1.0 deciview change may still contribute to visibility impairment and thus be subject to BART.*

*Because of varying circumstances affecting different Class I areas, the appropriate threshold for determining whether a source "contributes to any* *visibility impairment" for the purposes of BART may reasonably differ across States. As a general matter, any threshold that you use for determining whether a source "contributes" to visibility impairment should not be higher than 0.5 deciviews.*

*Insetting a threshold for "contribution," you should consider the number of emissions sources affecting the Class I areas at issue and the magnitude of the individual sources' impacts[2] In general, a larger number of sources causing impacts in a Class I area may warrant a lower contribution threshold. States remain free to use a threshold lower than 0.5 deciviews if they conclude that the location of a large number of BART eligible sources within the State and in prOXimity to a Class I areajustify this approach.[3]*

### *2. What Pollutants Do I Need to Consider?*

*You must look at S02, $NO_x$, and direct particulate matter (PM) emissions in determining whether sources cause or contribute to visibility impairment, including both PM10 and PM2.S. Consistent with the approach for identifying your BART-eligible sources, you do not need to consider less than de minimis emissions of these pollutants from a source.*

*As explained in section II, you must use your bestjudgement to determine whether VOC or ammonia emissions are likely to have an impact on visibility in an area. In addition, although as explained in Section II, you may use PM10 an indicator for particulate matter in determining whether a source is BART eligible, in determining whether a source contributes to visibility impairment, you should distinguish between the fine and coarse particle components of direct particulate emissions. Although both fine and coarse particulate matter contribute to visibility impairment, the long-range transport of fine particles is of particular concern in the formation of regional haze. Air quality modeling results used in the BART determination will provide a more accurate prediction of a source's impact on visibility if the inputs into the model account for the relative particle size of any d}rectly emitted particulate matter (i.e. PM10 vs. PM2.5).*

### *3. What Kind of Modeling Should I Use to Determine Which Sources and Pollutants Need Not Be SUbject to BART?*

*This section presents several options for determining that certain sources need not be subject to BART. These options rely on different modeling and/or emissions analysis approaches. They are provided for your guidance. You may*

2 *We expect that regional planning organizations will have modeling information that identifies sources affecting visibility in individual class I areas.*

3 *Note that the contribution threshold should be used to determine whether an individual source is reasonably anticipated to contribute to visibility impairment. You should not aggregate the visibility effects of multiple sources and compare their collective effects against your contribution threshold because this would inappropriately create a "contribute to contribution" test.*

*also use other reasonable approaches for analyzing the visibility impacts of an individual source or group of sources.*

***Option 1: Individual Source Attribution Approach (Dispersion Modeling)***

*You can use dispersion modeling to determine that an individual source cannot reasonably be anticipated to cause or contribute to visibility impairment in a Glass I area and thus is not subject to BART. Under this option, you can analyze an individual source's impact on visibility as a result of its emissions of S02, NOx and direct PM emissions. Dispersion modeling cannot currently be used to estimate the predicted impacts on visibility from an individual source's emissions of VOG or ammonia. You may use a more qualitative assessment to determine on a case-by-case basis which sources of VOG or ammonia emissions may be likely to impair visibility and should therefore be subject to BART review, as explained in section 1I.A.3. above.*

*You can use CALPUFF[4] or other appropriate model to predict the visibility impacts from a single source at a Glass I area. GALPUFF is the best regulatory modeling application currently available for predicting a single source's contribution to visibility impairment and is currently the only EPA-approved model for use in estimating single source pollutant concentrations resulting from the long range transport of primary pollutants.* 5.[8] *It can also be used for some other purposes, such as the visibility assessments addressed in today's rule, to account for the chemical transformation of S02 and $NO_x$•*

*There are several steps for making an individual source attribution using a dispersion model:*

***1. Develop a modeling protocol.***

*Some critical items to include in the protocol are the meteorological and terrain data that will be used, as well as the source-specific information (stack height, temperature, exit velocity, elevation, and emission rates of applicable pollutants) and receptor data from appropriate Glass I areas. We recommend follOWing EPA's Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 Summary Report and Recommendations for Modeling Long Range Transport Impacts[6] for parameter settings and meteorological data inputs. You may use*

4 *The model code and its documentation are available at no cost for download from http://www.epa.qov/scram001/tt22.htm#Calpuff.*

5 *The Guideline on Air Quality Models, 40 CFR part 51, appendix W; addresses the regulatory application ofair quality models for. assessing criteria pollutants under the CM, and describes further the procedures for using the CALPUFF model, as well as for obtaining approval for the use ofother, nonguideline models.*
6 *Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 Summary Report and Recommendationsfor Modeling Long Range Transport Impacts*, U.S. Environmental Protection Agency, EPA454YR-98-019, December 1998.

*other settings from those in IWAQM, but you should identify these settings and explain your selection* of *these settings.*

*One important element* of *the protocol is in establishing the receptors that will be used in the model. The receptors that you use should be located in the nearest* Class *I area with sufficient density to identify the likely visibility effects* of *the source. For other* Class *I areas in relatively close proximity to* a *BART-eligible source, you may model* a *few strategic receptors to determine whether effects at those areas may be greater than at the nearest* Class *I area. For example, you might chose to locate receptors at these areas at the closest point to the source, at the highest and lowest elevation in the* Class *I area, at the IMPROVE monitor, and at the approximate expected plume release height. If the highest modeled effects are observed at the nearest ClasS I area, you may choose not to analyze the other* Class *I areas any further* as *additional analyses might be unwarranted.*

*You should bear in mind that* some *receptors within the relevant* Class *Iarea may be* less *than 50km from the source while other receptors within that* same Class *I area may be greater than* 50 *km from the* same *source.* As *indicated by the Guideline on Air Quality Models,* 40 *CFR part* 51, *appendix W, this situation may call Jor the use of two different modeling approaches for the* same Crass *I area and source, depending upon the State's chosen method for modeling sources* less *than* 50 *km. In situations where you are* assessing *visibility impacts for source-receptor distances* less *than* 50 *km, you should use expert modeling judgment in determining visibility impacts, giving consideration to both CALPUFF and other appropriate methods.*

*In developing your modeling protocol, you may want to consult with EPA and your regional planning organization (RPO). Up-front consultation will ensure that key technical issues are addressed before you conduct your modeling.*

***2. [Run model in accordance] with the accepted protocol and compare the predicted visibility impacts with your threshold for "contribution."***

*You should calculate daily visibility values for each receptor* as *the change in deciviews compared against natural visibility conditions. You can use EPA's "Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule," £PA-454/B-03-005 (September 2003) in making this calculation. To determine whether* a *source may reasonably be anticipated to cause or contribute to visibility impairment at* Class *I area, you then compare the impacts predicted by the model against the threshold that you have selected.*

*The emissions estimates used in the models are intended to reflect steady-state operating conditions during periods* of *high capacity utilization.* We *do not generally recommend that emissions reflecting periods* of *start-up, shutdown, and malfunction be used,* as *such emission rates could produce higher than normal effects than would be typical* of most *facilities.* We *recommend that States* *use the 24 hour average actual emission rate from the highest emitting day of the meteorological period modeled, unless this rate reflects periods start-up, shutdown, or malfunction. In addition, the monthly average relative humidity is used, rather than the daily average humidity - an approach that effectively lowers the peak values in daily model averages.*

*For these reasons, if you use the modeling approach we recommend, you should compare your "contribution" threshold against the 98th percentile of values. If the 98th percentile value from your modeling is less than your contribution threshold, then you may conclude that the source does not contribute to visibility impairment and is not sUbject to BART.*

# Appendix - The MESOPUFF, II Mechanism

In the MESOPUFF II mechanism, the ammonia background concentration affects the eq'uilibrium between nitric acid, ammonia, and ammonium nitrate. The equilibrium constant for the reaction is a non-linear function of temperature and relative humidity (Scire, 2000). Unlike sulfate, the calculated nitrate concentration is limited by the amount of available ammonia, which is preferentially scavenged by sulfate (Scire, 2000). In particular, the amount of ammonia available for the nitric acid, ammonium nitrate, and ammonia reactions is determined by subtracting sulfate ,from total ammonia.

While the chemical mechanism simulates both the gas phase and aqueous phase conversion of S02to sulfate, the aqueous phase method, which is important when the plume interacts with clouds and fog, can significantly underestimate sulfate formation. In this report, as recommended by the IWAQM Phase 2 report, the "nighttime S0210ss rate (RNITE1)" is set to 0.2 percent per hour. The "nighttime NOx loss rate (RNITE2)" is set to 2.0 percent per hour and the "nighttime HN03formation rate (RNITE3)" is set to 2.0 percent per hour.

According to the 1996 "Mt. Zirkel Wilderness Area Reasonable Attribution Study of Visibility Impairment. Volume II: Results of Data Analysis and Modeling - Final Report,"

*The CALPUFF chemical module is formulated around linear transformation rates for* S02 *to sulfate and* $NO_x$ *to total nitrate. There are two options for specifying these transformation rates:*

*Option'* 1: *An internal calculation* of *rates based on local values for several controlling variables (e.g., solat radiation, background ozone, relative humidity, and plume* $NO_x$*)* as *used in MESOPUFF-II. The parametric transformation rate relationships employed were derived from box model calculations using the mechanism* of *Atkinson et al.* (1982).

*Option* **2:** A *user-specified input file* of *diurnally varying but spatially uniform conversion rates.*

*Morris' et al.* (1987) *reviewed the MESOPUFF-II mechanism* as *part* of *the U.S. EPA Rocky Mountain Acid Deposition Model Assessment study. They found that it prOVided physically plausible responses to many* of *the controlling envir:onmental parameters. However, the mechanism had no temperature dependence, which is an important factor in the Rocky Mountain region where there are wide variations in temperature. 'Furthermore, the*

*MESOPUFF-II transformation scheme was based on box model simulations for conditions more representative of the Eastern U.S. than of the Rocky Mountains.*

*The largest deficiency in the MESOPUFF-II chemical transformation algorithm is the lack of explicit treatment for in-cloud (aqueous-phase) enhanced oxidation of S02 (0 sulfate. The MESOPUFF-II chemical transformation algorithm includes a surrogate reaction rate to account for aqueous-phase oxidation of S02 to sulfate as follows:*

$$K_{aq} = 3 \times 10^{-8} \times RH^{4} \text{ (\%/hr)} \quad \text{(B.2-1)}$$

*Thus, at 100% relative humidity (RH), the MESOPUFF-II aqueous-phase surrogate S02 oxidation rate will be 3% per hour. Measurements in generating station plumes suggest spatially-and temporally-integrated S02 oxidation rates due to oxidants in clouds to be 10 times this value.*

Another issue is the amount of ammonia available for nitrate chemistry. According to a paper by Escoffier-Czaja and Scire (2002),

*"In the CALPUFF model, total nitrate (TN03 = HN03 + N03) is partitioned into. each species according to the equilibrium relationship between HN03 and N03. This equilibrium varies as a function of time and space, in response to both the ambient temperature and relative humidity. "In addition, the formation of nitrate is subject to the availability of NH3 to form ammonium nitrate (NH4N03), the assumed form of nitrate in the model. In CALPUFF, a continuous plume is simulated as a series of puffs, or discrete plume elements. The total concentration at any point in the model is the sum of the contribution of all nearby puffs from each source. Because CALPUFF allows the full amount of the specified background concentration of ammonia to be available to each pUff for forming nitrate, the same ammonia may be used multiple times in forming nitrate, resulting in an overestimate of nitrate formation. In order to properly account for: ammonia consumption, a program called POSTUTIL was introduced into the CALPUFF modeling system in 1999. POSTUTIL allows total nitrate to be repartitioned in a post-processing step to account for the total amount of sulfate scavenging ammonia from. all sources (both project and background sources) a.nd the total amount of TN03 competing for the remaining ammonia. In POSTUTIL, ammonia availability is computed based on recepiorconcentrations of total sulfate and TN03 not on a puff-by-puff basis. "*

# Appendix. Sensitivity test of the effect of ammonia background

To better understand the response of the modeling system to background ammonia when a single point source with significant emissions of $SO_2$ and $NO_x$ is modeled, the Air Pollution Control Division of the Colorado Department of Public Health & Environment (hereafter in this appendix referred to as the Division) performed sensitivity tests for a source in northeast Colorado and a source in northwest Colorado using the 2002 MM5/CALMET meteorology. In the test case, $SO_2$, $NO_x$, and filterable PM10 emissions were modeled. The ammonia background value was varied from 0 to 100 ppb. In the northeast Colorado test case, the $SO_2$ emission rate is about 3 times higher than the $NO_x$ emission rate. In the northwest Colorado test case, the modeled $NO_x$ emission rate is about 4.4 times higher than the $SO_2$ rate.

In both cases, when the background ammonia concentration is zero, the model produces no nitrate, as expected; however, it produces sulfate.

For the northeast Colorado sensitivity test, where the modeled $SO_2$ emission rate is significantly higher than the $NO_x$ emission rate, the change in visibility (delta-deciview) is not very sensitive to the background ammonia concentration across the range from 1.0 ppb to 100.0 ppb because of the high $SO_2$ emission rates relative to $NO_x$ and the way sulfate is produced in the MESOPUFF II chemical mechanism. Visibility impacts drop significantly when the ammonia background is less than 1.0 ppb, but even at 0.0 ppb of ammonia, sulfate impacts remain relative high.

For the northeast Colorado case, on days with the highest visibility impacts, the relative contribution of nitrate and sulfate vary, but most of the modeled visibility impairment is due to sulfate.

For the northwest Colorado sensitivity test, where the modeled $NO_x$ emission rate is significantly higher than the $SO_2$ emission rate, the change in visibility (delta-deciview) is not sensitive to the background ammonia concentration across the range from 10 ppb to 100 ppb. While there is a moderate drop in impacts when ammonia is dropped from 10 ppb to 1.0 ppb, the model is very sensitive to ammonia when the background ammonia level is less than 1.0 ppb.

For the northwest Colorado test case, according to CALPUFF implemented by the Division, impairment is primarily due to nitrate, but the contribution due to nitrate varies significantly depending on the assumed ammonia background level. For the 100 ppb background case, the nitrate contribution is greater than

90% for the top 20 days. However, for the 0.1 ppb case, the nitrate contribution varies from 43% to 81% for the top 20 days.

Caution should be used when extrapolating the results of these tests to other CALPUFF applications.

Since the MESOPUFF II chemical mechanism used in this analysis depends on several parameters, including ozone and ammonia background concentrations, the methods for determining the background ozone and ammonia concentration fields are discussed in more detail in sections 3.1.2.7 and 3.1.2.8

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# APPENDIX D

## District BART Determination

November 6, 2008

Ms. Lynn Terry
Deputy Executive Officer
California Air Resources Board
lOot "P' Street
P.O. Box 2815
Sacramento, California 95812

Dear Ms. Terry:

As you know, Bay Area Air Quality Management District staffhas been working on addressing the requirement ofBest Available Retrofit Technology (BART) for certain existing sources within our jurisdiction. BART is one ofthe principle elements of federal regional haze regulations, and your staffwill be including the necessary BART determinations in the State Implementation Plan (SIP) that addresses visibility protection requirements..

We have enclosed our BART determination for the Bay Area sources that your staff indicates are subject to these requirements, based on the results ofyour visibility modeling analyses. We understand that the SIP-approval process involves the opportunity for review and comment from Federal Land Managers, other interested stakeholders, and the public, and we may subsequently.revise the write-up based on comments received before the SIP is submitted to EPA.

Finally, we would like to express our appreciation to your staff for working with us on this project. In particular, we would like to acknowledge the assistance of Christine Suarez-Murias. We look forward to continuing to work together as the SIP process is finalized.

If you have any questions regarding this letter, please contact Brian Bateman, the District's Director ofEngineering, at (415) 749-4653.

Sincerely,

Jack P. Broadbent
Executive Officer/APCO

Enclosure

.cc: Karen Magliano, CARB Air Quality Data Branch Chief

# Summary of Bay Area Air Quality Management District Best Available Retrofit Technology Determinations

By:

Brenda Cabral

Bay Area Air Quality Management District

December 2,2008

Modeling was performed for the Best Available Retrofit Technology (BART)-eligible sources by the California Air Resources Board (CARB) at the following six facilities in the San Francisco Bay Area:

Chevron Richmond Refin.ery
ConocoPhillips Rodeo Refinery
Rhodia Martinez Sulfuric Acid Plant
Shell-Martinez Refinery
Tesoro-Avon Refinery
.Valero-Benicia Refinery

Of these, only the Valero Benicia Refinery (Valero) had an impact on visibility that was over 0.5 deciview and therefore high enough pursuant to the Regional Haze regulations in 40 CFR 51, Subpart P, Protection of Visibility, to require a BART determination.

The following BART-eligible sources at Valero were included in the modeling: the "Main Stack," a hydrogen plant reformer furnace, four turbine/boiler sets, two Claus units, and aco'oling tower. The refinery flares were not included in the modeling because refinery flares in the Bay Area are used only for startup, shutdown, upset and malfunction.

The table below summarizes the BART determinations for the Valero sources.

Proposed BART Determinations for Valero

| Unit | NOxControl Type | NOx Emission Limit | S02 Control Type | S02 Emission Limit | Particulate Type and Limit |
|---|---|---|---|---|---|
| "Main Stack:" Valero Coker, FCCU, CO Boilers (Units S3, S4, S5, S6) | SCR | 50 ppm on 365-day basis (est. annual emissions: 611 tpy) | CANSOLV regenerative amine scrubber (502 removal) with BELCO pre-scrubber (PM10 and 503 removal) | 50 ppm S02 @ 0% 02 on a 7-day average basis, 25 ppm S02 @ 0% 02 on a 365 day basis (est. annual emissions; 416 tpy) | Scrubber: 116 tpy |
| Valero Reformer Furnace (S21); (S21 or S22 may be replaced with S1061) | LowNOx burners | 0.033 lb/MMbtu on a refinery-wide basis; 60ppmdv@3% 02, 24-hr average | Sulfur removal from fuel gas using amine stripping | 51 ppm total reduced sulfur (TRS) in refinery fuel gas on a rolling consecutive 365-day average, 100 ppmTRS on a rolling 24-hr average | Use of gaseous fuel |

Preposed BART Determmatlons for Valero

| Unit | NOxControl Type | NOx Emission Limit | S02 Control Type | S02 Emission Limit | Particulate Type and Limit |
|---|---|---|---|---|---|
| Valero Reformer Furnace (S22); S21 or S22 may be replaced with S1061 | 'LowNOx burners | 0.033 lb/MMbtu on a refinery-wide basis; 60ppmdv@3% 02, 24-hr average | ,Sulfur removal from fuel gas using amine stripping | 51 ppmTRS in refinery fuel gas on a rolling consecutive 365-day average, 100 ppm TRS on a rolling 24-hr average | Use of gaseous fuel |
| Valero S43, Turbine (associated *w/S56,* Waste Heat Boiler) | Water iniection | 55 ppm@ 15% 02 (no additional control) | Sulfur removal from fuel gas using amine strippinQ | 51 ppmTRSin refinery fuel gas on a rolling 4 quarter basis | Use of gaseous fuel; 7 tpy |
| Valero S44, Turbine (Associated with S36, waste Heat Boiler) | Water iniection | 55 ppm@ 15% 02 (no additional control) | Sulfur removal from fuel gas using amine stripping | 51 ppm TRS in refinery fuel gason a rolling 4 quarter basis | Use of gaseous fuel; 8 tpy |
| Valero S45, Turbine, S37, Waste Heat Boiler | SCR | 9 ppm @ 15% 02; 28 tpy (no additional control) | Sulfur removal from fuel gas using amine stripping | 51 ppm TRS in refinery fuel gas on a rolling 4 quarter basis | Use of gaseous fuel; 12 tpy |
| Valero S46; Irurbine (Associated w/S48, Waste Heat Boiler) | Water iniection | 55 ppm@ 15%·02 (no additional control) | Sulfur removal from fuel gas using amine stripping | 51 ppmTRS in refinery fuel gas on a rolling 4 quarter basis | Use of gaseous fuel; 5 tpy |

Proposed BART Determinations for Valero

| Unit | NOx Control Type | NOx Emission Limit | S02 Control Type | S02 Emission Limit | Particulate Type and Limit |
|---|---|---|---|---|---|
| Valero S56, Waste Heat Boiler (associated *w/S43,* Turbine) | No additional controls | 55 ppm @ 15% 02 | Sulfur removal from fuel gas using amine stripping | 51 ppmTRSin refinery fuel gas on a rolling 4 quarter basis | Use of gaseous fuel; 2 tpv |
| Valero S36, Waste Heat Boiler (associated w/S44, Turbine) | No additional controls | 55 ppm @ 15% 02 | Sulfur removal from fuel gas using amine stripping | 51 ppmTRS in refinery fuel gas on a rolling4 quarter basis | Use of gaseous fuel; 3 tpy |
| Valero S48, Waste Heat Boiler (associated w/S46, Turbine) | No additional controls | 55 ppm @ 15% 02 | Sulfur removal from fuel gas using amine stripping | 51 ppmTRS in refinery fuel gas on a rolling 4 quarter basis | Use of gaseous fuel; 3 tpy |
| S1, S2, Claus Units | No additional controls | | No additional controls | | No additional controls |
| S29, Cobling Tower | | | | | No additional controls |

A diseussion of the technological feasibility and cost effectiveness of the controls, and other considerations required by 40 CFR 51,. Subpart P, is presented below, organized by source.

**1. "Main Stack"**

A. Discussion of controls and technological feasibility

The fluidized coker, the fluidized catalytic cracker unit or FCCU, and two CO boilers are vented to the "Main Stack." The current potential to emit for the Main Stack is:

S02: 6,222 tons per year (tpy)
NOx: 756 tpy
PM10: 179 tpy

Valero is under a consent decree that requires control of 802 from the main stack. This reduction will be completed by the 2012 BART deadline. Valero has submitted Application No. 16937 to incorporate this (equirement into .its District permit. The District's evaluation of this application is close to completion·as of November 5, 2008. The consent decree also specifies that the requirement for .control has to be incorporated into Valero's Title V permit. The requirement is expected to be incorporated into the Title V permit during the renewal, which should be issued by December 1, 2009. .

In order to install the 802 control, Valero had to replace the eXisting CO boilers (85 and 86). The new CO boilers are subject to Best Available Control Technology for NOx.

After the controls are installed, the emissions will be:

802: 416 tpy
NOx: 611 tpy
PM10: 106.5 tpy

802 will be controlled by use of a regenerative amine scrubber for 802 removal and a BELCO pre-scrubber for PM10 and 803 removal. The 802 will be sent to a sulfur recoveryunit, resulting in about 2,900 tpy of additional sulfur recovery.

The use of a regenerative amine scrubber is preferable to a caustic scrubber for 802 control because a caustic scrubber would use a large amount of water and generate an additional waste stream.

PM10 is currently controlled with an electrostatic precipitator. Use of the scrubber will result in lower PM10 emissions than use of the electrostatic precipitator in this case. The annual emission rate will be limited by a permit condition and monitored with an annual source test.

NOx is currently controlled with non-selective catalytic reduction (N8CR). After the 802 scrubber is installed, NOx will be controlled by use of selective catalytic reduction (8CR) at the main stack and by use of low NOx burners at the CO boilers. Additional control of NOx by 8CR is not feasible because the stream contains a high concentration of sulfur at the point where the 8CR will be installed. The 8CR cannot be installed downstream of the 802 scrubber because the 8CR must run at a higher temperature than the 802 scrubber.

The improvements at the Main 8tack will result in a 0.476 deciview improvement at Point Reyes on the eighth highest day per CalPuff modeling by CARB. The cost of the improvement is $202 million/deciview/yr.

Use of scrubbers for S02 and PM10 and SCR for NOx is considered to be the highest practical level of control available. Therefore, lesser controls were not evaluated. This level of control will be far superior to the NSCR 'and electrostatic precipitator that are currently installed.

B. Costs of compliance

The capital cost for the scrubbers is estimated to be $413 million, and the annual operating costs will be $7 million, for a total annual cost of $80 million. Based on reductions of 5806 tpy S02 and 72.5 tpy PM10, the cost/ton of reductions is $11,780, which is above any reasonable BART threshold for .cost-effectiveness.

NOx will be controlled by use of SCR at the Main Stack and by use of low NOx burners at the CO boilers.

The capital cost for the SCR will be approximately $110 million, and the annual operating costs will be $1.5 million, for a total annual cost of $16.5 million.

NOx is currently controlled by NSCR. The amount of NOx currently generated before control is estimated at 1,466 tpy. The limit after installation of the SCR will be 600 tpy. Using a reduction of 866 tpy NOx to calculate cost-effectiveness, the' cost/ton is $20,760. Using the incremental reduction of 156 tpyNOx, the incrementa.l'cost-effectiveness is $115, 240. The costs of NOx control at this stack are above any reasonable BART threshold for cost-effectiveness.

These estimates are based on an interest rate of 7% and an equipment life of 15 years, as suggested by the EPAConcost manual.

C. Energy and non-air quality environmental impacts of compliance

A non-air quality related impact of SCR is the risk associated with the transport of ammonia for use in the SCR. The cost of ammonia for SCR is included in the cost estimate. In this case, the amount of ammonia emitted will go down by approximately 346 *tons/yr* because the ammonia slip will be more tightly controlled. Therefore, the number of ammonia shipments to the facility will be' reduced.

The use of a regenerative amine scrubber is preferable to a caustic scrubber for S02 control because a caustic scrubber would use a large amount of water and generate an additional waste stream.

The CO boilers will have to be replaced due to the installation of the 802 scrubber because the system will operate at a higher pressure than the CO boilers' design pressure.

D. Any existing pollution control technology in use at the source
NSCR currently controls an estimated 1,022 tons NOxlyr at the Main Stack. An electrostatic precipitator controls particulate matter. There are no existing S02 controls. The proposed controls will be superior to the existing.controls.

E. The remaining useful life of the source
None of Bay Area BART-eligible. sources are expected to be retired over the next twenty years. Therefore, this factor did not affect any of the District's BART determinations. The cost-effectiveness calculations were based on a 15-year amortization period, as suggested by the. EPA OAQPS Control Cost Manual.

F. The degree of visibilitv improvement that may reasonably be anticipated from the use of BART -
The visibility improvement that will result from the proposed reductions in S02, NOx, and PM10 at the Main Stack will be 0.476 deciview at Point Reyes on the eighth highest day per CalPuff modeling by CARB. The modeling for the BART-eligible. sources at this facility originally showed a maximum visibility impact of 0.758 deciview. The resulting visioility impairment is 0.282 deciview.

This improvement would drop the facility below the 0.5 deciview threshold in Appendix Y to 40 CFR 51, Subpart P, where a source is considered to contribute significantly to visibility impairment.

G. Conclusion
The controls on the "Main Stack" sources that are included in the consent decree are considered to be the highest practical level that is technologically achievable. Although the controls exceed reasonable thresholds for BART cost effectiveness, the resulting emission reductions are significant, as is the potential improvement in visibility at Point Reyes. These controls are therefore deemed to be adequate for meeting BART requirements. .

2. Hydrogen Plant Reformer Furnaces (S21 and 822)

The capacity of the reformer furnaces is 614 MMbtu/hr furnaces each. S21 or S22 may be replaced in the next four years with a 984 MMbtu/hr furnace, depending on the economics of the project. The new furnace would be SUbject to BACT for NOx, PM10, and S02. If the furnace were replaced, reductions of NOx and PM10 of 70 tpy and 9 tpy, and an increase of 10 tpy S02 would be anticipated. An application has been submitted to replace one of the reformer furnaces, but the project may not be built.

The BART discussion below is based on the existing equipment and assumes that one of the furnaces will not be replaced.

A. Discussion of controls and technological feasibilitv
PM10 is controlled by the use of gaseous fuel.

$SO_2$ is controlled by the use of low-sulfur refinery fuel gas. Hydrogen sulfide in the gas is scrubbed by amine stripping and converted to elemental sulfur in the sulfur recovery units. The furnaces have a limit of TRS in fuel of 51 ppm on a rolling consecutive 365-day average'and 100 ppm TRS ona rolling 24-hr average. This limit is close to the 45-ppm BACT limit that is imposed on new sources.

NOx at the reformer furnaces is controlled by low NOx burners. Valero operates under a federal consent decree that requires control of NOx from most boilers and furnaces at the facility, including the reformer furnaces. The limit is 0.033 lb NOx/MMbtu on a refinery-wide basis. The reformer furnaces also have a short-term limit of 60 ppmv NOx @ 3% $O_2$ averaged over 24 hours, which is roughly equivalent to 0.076 lb/MMbtu. The actual emissions are about 0.036 lb NOx/MMbtu on an annual basis.

The controls above are existing controls. No further reductions are planned.

It is feasible to control additional NOx at the furnaces with SCR, but additional control would not necessarily result in facility-wide NOx emission reductions, because the consent decree limit is on a refinery-wide basis. Additional control at the reformer furnaces would allow higher emissions at other refinery heaters or boilers. The refinery generally emits most of the NOx allowed on a daily basis. Any excess emissions are managed with the use of interchangeable emission reduction credits (IERC), which is allowed by the consent decree.

If controlled with SCR, concentrations of 10 ppmv NOx @ 3% $O_2$ (equivalent to 0.012 lb/MMbtu) might be achievable.

B. Costs of compliance
No additional costs will be incurred for the existing controls.

If SCR were required for the furnaces, the cost/ton can be estimated at *$14,000/ton.* This estimate is derived from Table 13, "Cost Effectiveness Data for Boilers Rated at 200 MMbtu/hr" in the California Air Resources Board's (CARB!s) "Report to the Legislature: Implications of Future Oxides of Nitrogen Controls From Seasonal Sources in the San Joaquin Valley."

During the years 2005-2008, the actual emissions were about 126 tons NOx/yr total. A reduction of 56 tpy NOx could cost about $784,000 per year.

C. Energy and non-air quality environmental impacts of compliance
A non-air quality related impact of SCR would be the risk associated With the transport of ammonia for use in the SCR. The risk would be considered insignificant because the refinery already imports ammonia for use in other SCR units at the facility.

D. Any existing pollution control technology in use at the source

As described above, the furnaces are currently controlled with 10w-NOx burners, use of gaseous fLiel, and use of low-sulfur refinery fuel gas.

E. The remaining useful life of the source

According to the plant contacts, none of Valero BART sources are expected to retire over the next twenty years. Therefore, this factor did not affect any of the District's BART determinations.

F. The. degree of visibility improvement that may reasonably be anticipated from the use of BART

No additional visibility improvement is expected from the existing controls.

No additional visibility improvement would be anticipated from additional control of NOx at the furnaces because a decrease in NOx at the furnaces could be offsets by an increase at another source.

The actual emissions are about 63 tons NOXlyr each (based on a 3-year baseline calculated for Application 16937) fot a total of 126 tpy NOx. If the sources were controlled by SCR, a reasonable concentration limit would be 10 ppmv @ 3% O2 or 0.013 lb/MMbtu. The furnaces would be allowed to emit about 70 ton NOxlyr total, for a reduction of 56 tpy NOx.

A hypothetical reduction of 268 tons NOxlyr was modeled by CARB for the turbine/boiler sets. The hypothetical improvement in visibility would have been 0.091 deciview. If the improvement in visibility were proportional, the improvement obtained by further controlling the furnaces would be 0.019 deciview, which is too small to make these controls reasonable.

A 56-tpy reduction in NOx at the reformer furnaces has not been included in the model as of December 2, 2009, so the above estimate of the visibility improvement is an approximation. The stack. heights for the reformer furnaces are about 250 feet and the stack heights for the turbine/boiler sets are between 60 and 80 feet. The exit velocities for the boiler/turbine sets are about twice as high as the exit velocities for the furnaces. The exit temperatures are similar. Modeling would have to be performed to determine the magnitude of an improvement achievable by a 56-tpy reduction in NOx, but it is likely to be insignificant.

G. Conclusion

No further controls are proposed because additional controls would provide an insignificant amount of visibility improvement.

### 3. Turbine/Boiler Sets

A. Discussion of controls and technological feasibility

Valero has four turbine/boiler sets that were installed in 1969. The emissions of 502 are low because the sources use low-sulfur fuel. Theywill be subject to a 51-ppm limit on TR5in fuel. The combined potential to emit for 502 is 15 tpy. NOx at the largest set is controlled by 5CR to 9 ppmv @ 15% 02. The combined NOx emissions of the remaining three sets are about 341 tpy.

These turbine/boiler sets are different than most turbine/duct burner sets because the boilers have their own air source and can be fired separately from the turbines. Duct burners cannot be fired when the turbines are not operated.

CARB modeled a hypothetical reduction for these sources to 73 tpy NOx, which is equivalent to a 10 ppmv NOx concentration achievable by 5CR. The modeling result for the hypothetical reduction was 0.091 deciview, which is an insignificant improvement. BAAQMD is not proposing 5CR because it is not cost-effective.

N5CR is not feasible due to the cycling nature of the operation. Valero uses other more efficient sources of steam first, then these sources, so these sources are not always in use and the load is variable when they are in use. The operation is not stable enough to ensure that the temperature at an ammonia or urea injection site will be in the right range for N5CR to operate.

Low NOx burners were also considered, but low NOx burners are not available for turbines in this size range (8.9 MW), and are not feasible at the boilers because they operate at a very high turndown (the boilers are used at about 25% of capacity). The refinery operates more efficient sources of steam at the facility whenever possible.

Even if low NOx burners were feasible at the boilers, the visibility improvement at Point Reyes would be extremely low. The boilers use only about 38% of the fuel burned by the system, based on.2007 data. Assuming that 130 tpy NOx is attributable to the boilers, and that the low NOx burners would reduce emissions . from 40 ppmv to 30 ppmv, a reduction of only 32 tpy would result, which would be roughly equivalent to 0.01 deciview, an insignificant reduction.

Water injection is already being used at the turbines to lower NOx. The turbine/boiler sets are subject to BAAQMD Regulation 9, Rule 9, which imposes a 55 ppniv@ 15% 02 limit for NOx. The sources currently operate at around 40 ppmv NOx @ 15% 02, which is about 0.15 lb NOxlMMbtu.

B. Costs of compliance

BAAQMD proposes no additional control for the three turbine/boiler sets (543/556,544/536,546/548).

BAAQMD determined the cost-effectiveness for SCR based on recent rule development data and determined that the estimated cost is between \$5000 and \$7000/ton, which is above reasonable thresholds for BART cost-effectiveness. The energy usage is included in this estimate

NSCR and 10w-NOx burners were determined not to be feasible at these sources because no 10w-NOx burners are available for the Frame Size 3 turbines.

NOx emissions at the turbines are controlled by water injection.

C. Energy and non-air quality environmental impacts of compliance
A non-air quality related impact of SCR or NSCR would be the risk associated with the transport of ammonia for use in the SCR or NSCR. The risk would be considered insignificant because the refinery already imports ammonia for use in other SCRs at the facility.

D. Any existing pollution control technology in use at the source
NOx is controlled at one turbine/boiler set (S37/S45) with SCR.

NOx is controlled at the other three turbine/boiler sets by use of water injection. The existing NOx limit in BAAQMD Regulation 9, Rule 9, for these turbines is 55 ppmvd@ 15% 02. In 2010, the limits will be to 50 ppmvd @ 15% 02. The turbine/boiler sets currently operate between 40 and 46 ppmvd @ 15% 02.

S02 and PM10 emissions are controlled at all four turbine/boiler sets by use of low-sulfur refinery fuel gas. The TRS limit for the refinery fuel gas will be 51 ppm on an annual basis.

E. The remaining useful life of the source
According to the plant contacts, none of Bay Area BART sources are expected to retire over the next twenty years. Therefore, this factor did not affect any of the District's BART determinations. The cost-effectiveness calculations were based on a 15-year amortization period, as suggested by the EPA OAQPS Control Cost Manual.

F. The degree of visibility improvement that may reasonably be anticipated from the use of BART
CARB modeled a hypothetical reduction for these sources from 503 to 73 tpy NOx, which is equivalent to a 10 ppmv NOx concentration achievable by SCR. The modeling result for the hypothetical reduction was 0.091 deciview, which is an insignificant improvement.

G: Conclusion
No further controls are proposed because additional controls are either not cost-effective or would provide an insignificant amount of visibility improvement.

4. Claus Units

A. Discussion of controls and technological feasibility
The potential to emit for the Claus units is about 1 tpy NOx. They have no 802 or PM10 emissions.

B. Any existing pollution control technology in use at the source
The Glaus units are controlled by use of a reduction control system, which results in a very low potential to emit for 802.

C. Conclusion
No further controls are proposed because the emissions are very low.

5. Cooling Tower

A. Discussion of controls and technological feasibility
The calculated potential to emit for the cooling tower based on Ap-42 chapter 13.4 is about 41 tpy PM10. The calculation method has an "E" rating. It is estimated that the PM10 emissions may be overstated by an order of magnitude.

B. Conclusion
No further controls are proposed since the emissions are very low.

# APPENDIX E

Report from

WRAP Regional Modeling Center

for Air Quality Modeling

## Overview

Visibility impairment occurs when fme particulate matter (PM2.5) in the atmosphere scatters and absorbs light, thereby creating haze. PM2.5 can be emitted into the atmosphere directly as primary particulates, or it can be produced in the atmosphere from photochemical reactions of gas-phase precursors and subsequent condensation to form secondary particulates. Examples of primary PM2.5 include crustal materials and elemental carbon; examples of secondary PM include ammonium nitrate, ammonium sulfates, and secondary organic aerosols (SOA). Secondary PM2.5 is generally smaller than primary PM2.5, and because the ability of PM2.5 to scatter light depends on particle size, with light scattering for fme particles being greater than for coarse particles, secondary PM2.5 plays an especially important role in visibility impainnent. Moreover, 'the smaller secondary PM2.5 can remain suspended in the atmosphere for longer periods and is transported long distances, thereby contributing to regional-scale impacts of pollutant emissions on visibility.

The sources of PM2.5 are difficult to quantify because of the complex nature of their formation, transport, and removal from the. atmosphere. This makes it difficult to simply use emissions data to determine which pollutants should be controlled to most effectively improve visibility. Photochemical air quality models offer opportunity to better understand the sources of PM2.5 by simulating the emissions of pollutants and the formation, transport, and deposition of PM2.5' If an air quality model performs well for a historical episode, the model may then be useful for identifying the SQurces of PM2.5 and helping to select the most effective emissions reduction strategies for attaining visibility goals. Although several types of air quality modeling systems are available, the gridded, three-dimensional, Eulerian models provide the most complete spatial representation and the most comprehensive representation of processes affecting PM2.5, especially for situations in which multiple pollutant sources interact to form PM2.5. For less complex situations in which a few large point sources of emissions are the dominant source of PM2.5, trajectory models (such as the California Puff Model [CALPUFF]) may also be useful for simulating PM2.5.

## Air OualityModels

The WRAP RMC utilized two regulatory air quality modeling systems to conduct all regional haze modeling. A brief discussion of each of these models is provided below.

### *Community Multi-Scale Air Quality Model*

EPA initially developed the Community Multi-Scale Air Quality (CMAQ) modeling system in the late 1990s. The model source code and supporting data can be downloaded from the Community Modeling and Analysis System (CMAS) Center (http://www.cmascenter.orgD, which is funded by EPA to distribute and provide limited support for CMAQ users. CMAQ was designed as' a "one atmosphere" modeling system to encompass modeling of multiple pollutants and issues, including ozone, PM, visibility, and air toxics. This is in contrast to many earlier air quality models that focused on single-pollutant issues (e.g., ozone modeling by the Urban ' Airshed Model). CMAQ is an Eulerian model-that is, it is a grid-based model in which the frame of reference is a fixed, three-dimensional (3-D) grid with uniformly sized horizontal grid cells and variable vertical layer thicknesses. Thenumber and size of grid cells and the number and thicknesses of layers are defined by the user, based in part on the size of the modeling domain to be used for each modeling project. The key science processes included in CMAQ are emissions, advection and dispersion, photochemical transformation, aerosol thermodynamics and phase transfer, aqueous chemistry, and wet and dry deposition of trace species. CMAQ offers a variety of choices in the numerical algorithms for treating many of these processes, and it is designed so that new algorithms can be included in the modeL CMAQ offers a choice of three photochemical mechanisms for solving gas-phase chemistry: the Regional Acid Deposition Mechanism version 2 (RADM2), a fixed coefficient version of the SAPRC90 mechanism, and the Carbon Bond IV mechanism *(CB-N).*

*Comprehensive Air Quality Model with Extensions*

The Comprehensive Air Quality Model with extensions (CAMx) model was initially developed by ENVIRON in the late 1990s as a nested-grid, gas-phase, Eulerian photochemical grid model. ENVIRON later revised CAMx to treat PM, visibility, and air toxics. While there are many similarities between the CMAQ and CAMx systems, there are also some significant differences in their treatment of advection, dispersion, aerosol formation, and dry and wet deposition.

*Model Versions*

Both EPA and ENVIRON periodically update and revise their models as new science or other improvements to the models are developed. For CMAQ, EPA typically provides a new release about once per year. The initial 2002 MPE for WRAP used CMAQ version 4.4, which was released in October 2004. In October 2005 EPA released CMAQ version 4.5, which includes the following updates and improvements to the modeling system:

- A new vertical advection algorithm with improved mass conservation
- Changes in deposition velocities for some PM species
- A new sea-salt emissions model and inclusion of sea salt in the aerosol thermodynamics
- An option to make vertical mixing parameters vary as a function of land use type

The RMC completed the initial CMAQ MPE using CMAQ v.4.4. When version 4.5 was released in October, the modeling was revised and a comparison of the model performance using the two versions was compared. Note that some of the new features in CMAQ v4.5 (e.g., sea salt in the AE4 aerosol dynamics module, and percent urban minimum vertical diffusivity) require the reprocessing of the MM5 data using the new version of MCIP (MCIP v3.0). However, because such reprocessing could potentially jeopardize the WRAP modeling schedule, WRAP elected to operate CMAQ v4.5 using the MM5 data processed using a previous MCIP version, MCIP v2.3, and the AE3 aerosol module that does not include active sea salt chemistry.

ENVIRON releases updated versions of CAMx approximately every two years, or as new features become available. The version used for'the comparison of CMAQ and CAMx was CAMx v4.3. There are many similarities between CMAQ and CAMx regarding the science algorithms and chemical mechanisms used, including the CB-N gas-phase and RADM aqueous-phase chemistries, ISORROPIA aerosol thermodynamics, and PPM horizontal advection scheme.

In the past, the treatment of vertical advection was a major difference between the two models; however, the incorporation of the new mass conserVation scheme in CMAQ v4.5 makes its vertical advection algorithm much more similar to that of CAMx.

Major differences between the two models thatstill exist are in the basic model code, in the treatment of horizontal diffusion SOA formation mechanisms, and in grid nesting (CAMx supports one-way and two-way nesting, whereas CMAQ supports just one-way grid nesting). Both models include process analysis for the gas-phase portions of the model. The publicly released version of CAMx supports ozone and PM source apportionment through its Ozone and PM Source Apportionment Technology (OSATIPSAT) probing tools, while for CMAQ there are research versions of the model that include Tagged Species Source Apportionment (TSSA) for sollie PM species (e.g., sulfate and nitrate). There are also research versions of CMAQ and CAMx that support the Decoupled Direct Method (DDM) sensitivity tool for PM and ozone.

The CAMxmode1 is computationally more efficient than CMAQ. However, CAMx is currently supported for use on only a single central processing unit (CPU) and, can perform multiprocessing using Open Multi-Processing (OMP) paralle1ization (i.e., shared memory multiprocessors). CMAQ paralle1ization, on the other hand, is implemented using Message Passing Interface (MPI) multiprocessing and therefore can be run using any number of CPUs. Depending on the number of model simulations to be perforined and the manner in which they are set up, there can be a slight advantage either to CAMx or to CMAQ in regard to computational efficiency.

Model Simulations

In support of the WRAP Regional Haze air quality modeling efforts, the RMC developed air quality modeling inputs including annual meteorology and emissions inventories for a 2002 actual emissions base case, a planning case to represent the 2000-04 regional haze baseline period using averages for key emissions categories, and a 2018 base case ofprojected emissions determined using factors known at the end of 2005. All emission inventories were developed using the Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system. Each of these inventories has undergone a number of revisions throughout the development process to arrive at the fma1 versions used in CMAQ and CAMx air quality modeling. The development of each of these emission scenarios is documented under the emissions inventory sections of the TSS. In addition to various sensitivities scenarios, the WRAP performed air quality model simulations for each of the emissions scenarios as follows:

- The 2002 base case emissions scenario, referred to as "2002 Base Case" or "Base02". The purpose of the Base02 inventory is to represent the actual conditions in calendar year 2002 with respect to ambient air quality and the associated sources of criteria and particulate matter air pollutants. The Base02 emissions inventories are used to validate the air quality model and associated databases and to demonstrate acceptable model performance with respect to replicating observed particulate matter air quality.
- The 2000-04 baseline period planning case emissions scenario is referred to as "P1an02". The purpose of the P1an02 inventory is to represent baseline emission patterns based on average, or "typical", conditions. This inventory provides a basis for comparison with the

future year 2018 projected emissions, as well as to gauge reasonable progress with respect to future year visibility.

- The 2018 future-year base case emissions scenario, referred to as "2018 Base Case" or "Base18". These emissions are used to represent conditions in future year 2018 with respect to sources of criteria and particulate matter air pollutants, taking into consideration growth and controls. Modeling results based on this emission inventory are used to defme the future year ambient air quality and visibility metrics.

Data Sources

The CMAQ model requires inputs of three-dimensional gridded wind, temperature, humidity, cloud/precipitation, and boundary layer parameters. The current version of CMAQ can only utilize output fields from the PSU/NCAR MM5 meteorological model. MM5 is a state-of-the-science atmosphere model that has proven useful for air quality applications and has been used extensively in past local, state, regional, and national modeling efforts. MM5 has undergone extensive peer-review, with all of its components continually undergoing development and scrutiny by the modeling community. In-depth descriptions of MM5 can be found in Dudhia (1993) and Grell et al. (1994), and at http://www.mmm.ucar.edu/mm5. All meteorological data used for the WRAP air quality modeling efforts are derived from MM5 model simulations. The development of these data is documented in (Kemball-Cook, S. et al., 2005)

Emission inventories for all WRAP air quality simulations were developed using the Matrix Operator Kernel Emissions (SMOKE) modeling system. The development of these data has been discussed and documented elsewhere (Tonnesen, G. et al., 2006)

Initial conditions (ICs) are specified by the user for the first day of a model simulation. For continental scale modeling using the RPO Unified 36-km domain, the ICs can affect model results for as many as 15 days, although the effect typically becomes very small after about 7 days. A model spin-up period is included in each simulation to eliminate any effects from the ICs. For the WRAP modeling, the annual simulation is divided into four quarters, and included a 15-day spin-up period for the quarters beginning in April, July, and October. For the quarter beginning in January 2002, a spin-up period covering December 16-31,2001, using meteorology and emissions data developed for CENRAP were used..

Boundary conditions (BCs) specify the concentrations of gas and PM species at the four lateral boundaries of the model domain. BCs determine the amounts of gas and PM species that are transported into the model domain when winds flow is into the domain. Boundary conditions have a much larger effect on model simulations than do ICs. For some areas in the WRAP region and for clean conditions, the BCs can be a substantial contributor to visibility impairment.

For this study BC data generated in an annual simulation of the global-scale GEOS-Chem model that was completed by Jacob et al. (http://www-as.harvard.edu/chemistry/trop/geosD for calendar year 2002 were applied. Additional data processing of the GEOS-Chem data was required before using them in CMAQ and CAMx. The data first had to be mapped to the boundaries of the WRAP domain, and the gas and PM species had to be remapped to a set of species used in the CMAQ and CAMx models. This work was completed by Byun and coworkers 01ttp://WWW-as.harvard.edu/chemistry!trop/geos/meetings/2005/ppt/Expanding Model Capabilities/GEOS-CMAQ april 4 Byun.ppt

The CMAQ model options and configuration used for the WRAP 36-krn model simulations are described in Tonnesen, G.et aI., 2006.

Model Run Specification Sheets

In order to provide documentation for each of the CMAQ and CAMx air quality model simulations conducted by the WRAP RMC during Calendar year 2006, a series of Model Run Specification Sheets were developed. These "Spec Sheets" provide a description of each simulation, the various air quality model options and configurations used and detailed listing and description of the meteorological data and emission inventories for each scenario. These Spec Sheets also provide a means .for the RMC to track the development of each of the input data sets and defmed the modeling schedule, The purpose of each simulation, and expected results, including their implications, are also included. A link to each of the individual Specification Sheets for the model simulations can be found on the RMC web site at: http://pah.cert.ucr.edu/agm/308/cmag.shtrnI.

**2002 Base Case Modeling**

Base02 Sensitivity Simulations

The purpose of the 2002 Base Case modeling efforts was to evaluate air -quality/visibility modeling systems for a historical episode-in this case, for calendar year 2002-to demonstrate the suitability of the modeling systems for subsequent planning, sensitivity, and emissions -control strategy modeling. Model performance evaluation is performed by comparing output from model simulations with ambient air quality data for the same time period. After creating emissions and meteorology inputs for the two air quality models, CMAQ and CAMx, the next step was to perform the visibility modeling and the model performance evaluations; which are described below. A detailed discussion of the results of the CMAQ and CAMx model simulations can be found in Tonnesen, G. et aI., 2006. Also documented in Tonnesen, G. et aI., 2006 are the results of the model performance evaluation, a model mter-comparison and discussion of various-sensitivity simulations. This information was used as the basis for recommending the selection of CMAQ and/or CAMx to complete the remaining modeling efforts in RMC's support of WRAP. '

Model Performance Evaluation

The' objective of a model performance evaluation (MPE) is to compare model-simulated concentrations with observed data to determine whether the model's performance is sufficiently accurate to justify using the model for simulating future conditions. There are a number of challenges in completing an annual MPE for regional haze. The model must be compared to ambient data from several different monitoring networks for both ,PM and gaseous species, for an annual time period, and for a large number of sites. The model must be evaluated for both the worst visibility conditions and for very clean conditions. Finally, [mal guidance on how to perform an MPE for [me-particulate models is not yet available from EPA. Therefore, the RMC experimented with many different approaches for showing model performance results. The plot types that were found to be the most useful are the following:

- Time-series plots comparing the measured and model-predicted species concentrations
- Scatter plots showing model predictions on the y-axis and ambient data on the x-axis
- Spatial analysis plots with ambient data overlaid on model predictions
- Bar plots comparing the mean fractional bias (MFB) or mean fractional 'error (MFE) performance metrics
- "Bugle plots" showing how model performance varies as a function of the PM species concentration
- Stacked-bar plots of contributions to light extinction for the' average of the best-20% visibility days or the worst-20% visibility days at each site; the higher the light extinction, the lower the visibility

Examples of each of these MPE metrics and analysis products can be found in Tonnesen, G. et aI.,2006. The results of the MPE are available from the WRAP RMC website (http://pah.cert.ucr.edu/aqm/308/evaI.shtml)

## 2002 Planning Scenario

The 2000-04 baseline period planning case scenario is referred to as "Plan02". The purpose of the Plan02 scenario is to simulation the air quality representative of baseline emission patterns based on average, or "typical", conditions. This scenario provides a basis for comparison with the future year 2018 scenario based on projected emissions, as well as to gauge reasonable progress with respect to future year visibility.

### Plan02 Simulations Input Data

Input data used for the 2002 Planning model simulations consisted of the same meteorology as for the 2002 Base Case and the Plan02 emission inventories described under the Emissions Modeling section of the TSS.,

The setup of the CMAQ model (including science options, run scripts, simulation periods,and ancillary data) for the Plan02 cases was identical to that used in the Base02 modeling, as described in the 2002 MPE report (Tonnesen et aI., 2006). In summary, CMAQ v4.5 (released by EPA in October 2005) was used on the RPO Unified 36-km domain. The Carbon Bond Mechanism version 4 (CB4) with RADM aqueous chemistry, the SORGAM organic aerosol algorithm, and all other science algorithms detailed in Tonnesen et aI., 2006 were used. Initial condition (Ie) data for January 1, 2002, were developed using a 15-day spin-up period (December 16-31, 200I). Boundary condition (BC) data were generated in an annual simulation of the global-scale GEOS-Chem model that was completed by Jacob et al. (http://www-as.harvard.edu/chemistry/trop/geos/) for calendar year 2002.

Comparison With Base02 Simulations

For each of the three Plan02 emissions datasets, annual visibility modeling was performed using the CMAQ model. This was a key aspect of the QA procedure, since errors in the emissions inventories that might not be apparent during the emissions QA steps might be more readily detected in the results from the CMAQ modeling.

In our initial analysis of the Plan02 scenario, plots were prepared for QA purposes that compared the Plan02a CMAQ results with the Base02a CMAQ results for daily and monthly averages. After revising Piari02a to create Plan02b and Plan02c, additional QA plots were prepared to compare the CMAQ results of each revised Plan02 case to the previous iteration. These were prepared as Program for the Analysis and Visualization of Environmental data (PAVB) spatial plots showing the change in individual PM2.5 species concentrations as daily, monthly, and annual averages. The final set of analysis products, available on the RMC web site, include PAVB difference plots comparing the CMAQ-predicted annual average species concentrations from the Plan02c case with those from the Base02b case. Note that these plots are not useful for visibility planning purposes, but are being provided to show the magnitudes of changes when moving from the 2002 Base Case to the 2002 Planning Case-in other words, from the actual emissions for the year 2002 to the "typical-year" emissions created for the fmal Plan02 scenario. The primary analysis "product" from the Plan02 CMAQ modeling is the use of its output in combination with the CMAQ output from the 2018 modeling to develop the visibility progress calculations and glide path plots, described below.

**2018 Model Simulations**

The 2018 future-year base case scenario is referred to as "2018 Base Case" or "Base18". The purpose of the Base18 scenario is to simulation the air quality representative of conditions in future'year 2018 with respect to sources of criteria and particulate matter air pollutants, taking into consideration growth and controls. Modeling results based on this emission inventory are used to define the future year ambient air quality and visibility metrics.

Base18 Simulation Input Data

Input data used for the 2018 Base Case model simulations consisted of the same meteorology as for the 2002 Base Case and the Base18 emission inventories described under the Emissions Modeling section of the TSS.

The setup of the CMAQ model (including science options, run scripts, simulation periods, and ancillary data) for the Base18 cases was identical to that used in the Base02 modeling, as described in the 2002 MPE report (Tonnesen et aI., 2006). In summary, CMAQ v4.5 (released by EPA in October 2005) was used on the RPO Unified 36-km domain. The Carbon Bond Mechanism version 4 (CB4) with RADM aqueous chemistry, the SORGAM organic aerosol algorithm, and all other science algorithms detailed in Tonnesen et aI., 2006 were used. Initial condition (Ie) data for January·l, 2002, were developed using a IS-day spin-up period (December 16,.31, 2001). Boundary condition (BC) data were generated in an annual simulation of the global-scale GEOS-Chem model that was completed by Jacob etaI. (http://www-as.harvard.edu/chemistry/trop/geosl) for calendar year 2002.

BaselS Simulation Results

The purpose of modeling 2018 visibility is to compare the 2018 visibility predictions to the 2002 typical-year visibility modeling results, as discussed below. Some improvements in visibility by 2018 are expected because of reductions in emissions due to currently planned regulations and technology improvements. A brief summary is provided here of the comparison between the 2018 and 2002 results using annual average PAVB spatial plots. The goal of this summary is to convey the scale and spatial extent of changes in key $PM_{2.5}$ species from 2002 to 2018. For planning purposes, on the other hand, states and tribes should focus on the visibility projections and glide path calculations at individual Class I Areas.

Figures 1 through 4 show the annual average concentrations for sulfate, nitrate, PM2.5 and model-reconstructed visibility (in deciviews), respectively. In each figure, the bottom two plots show the modeled concentration or deciviews for the Plan02b and Base18b cases, while the top plot shows the change in visibility calculated as Base18b minus Plan02b. The Plan02b results are presented here instead of Plan02c results because these plots had previously been prepared with version B. As the differences between Plan02b and Plan02c are extremely small, new plots prepared using Plan02c would be essentially identical to the results in Figure 1 through 4.

In each of the top plots in the four figures, cool colors indicate areas in which model-predicted visibility improved from 2002 to 2018, while warm colors indicate areas where modeled visibility became worse over that period. Figure 1 shows that reductions in sulfate were largest in the southwest comer ofllie WRAP region and in Texas and Oklahoma. This results' from planned *SOx* emissions reductions in the CENRAP region. There were smaller reductions in sulfate.in the Los Angeles area, western Washington state, and southern Nevada. There were small increases of sulfate, mostly in Wyoming, due to growth in SOx emissions. Most regions of the WRAP domain had low concentrations of sulfate in 2002 and little change in sulfate by 2018,

Figure 2 shows the results for nitrate. In the both 2002 and 2018, the modeled nitrate was greatest in California, and there were reduction in nitrate in that state in 2018 because of reductions in mobile-source $NO_x$ emissions. There were small reductions in the Phoenix area as well, also from reductions in mobile-source $NO_x$ emissions.

Figure 3 shows the comparison of $PM_{2.5}$ for 2002 and 2018. In most areas of the WRAP region, changes in $PM_{2.5}$ were less than 1 $\mu g/m^3$. Locations with increases in $PM_{2.5}$ correspond to areas of increased sulfate (see Figure 3-1). Areas with the largest reductions in PM2.5 were the areas in California that had large reductions in modeled nitrate in 2018 (see Figure 3-2). Results for other species that contribute to $PM_{2.5}$ are available on the RMC web site at http://pah.cert.ucr.edu/agm/308/cmag.shtml#basel8bvsplanO2b.

Figure 4 compares model-reconstructed visibility for 2002 and 2018. Note that these results are calculated using the modeled relative humidity (RH), so they differ from the results that use site-specific monthly average RH. Nonetheless, the results in Figure 4 are indicative of the direction and magnitude of visibility changes in from 2002 to 2018. Although the largest improvements are in California and the Pacific Northwest, there were improvements throughout the WRAP region. The change in deciviews is more dramatic than the change in $PM_{2.5}$ mass (Figure 3) because the visibility in deciviews is a relative metric, so small mass changes in $PM_{2.5}$ in good visibility areas can result in large relative improvements in visibility.

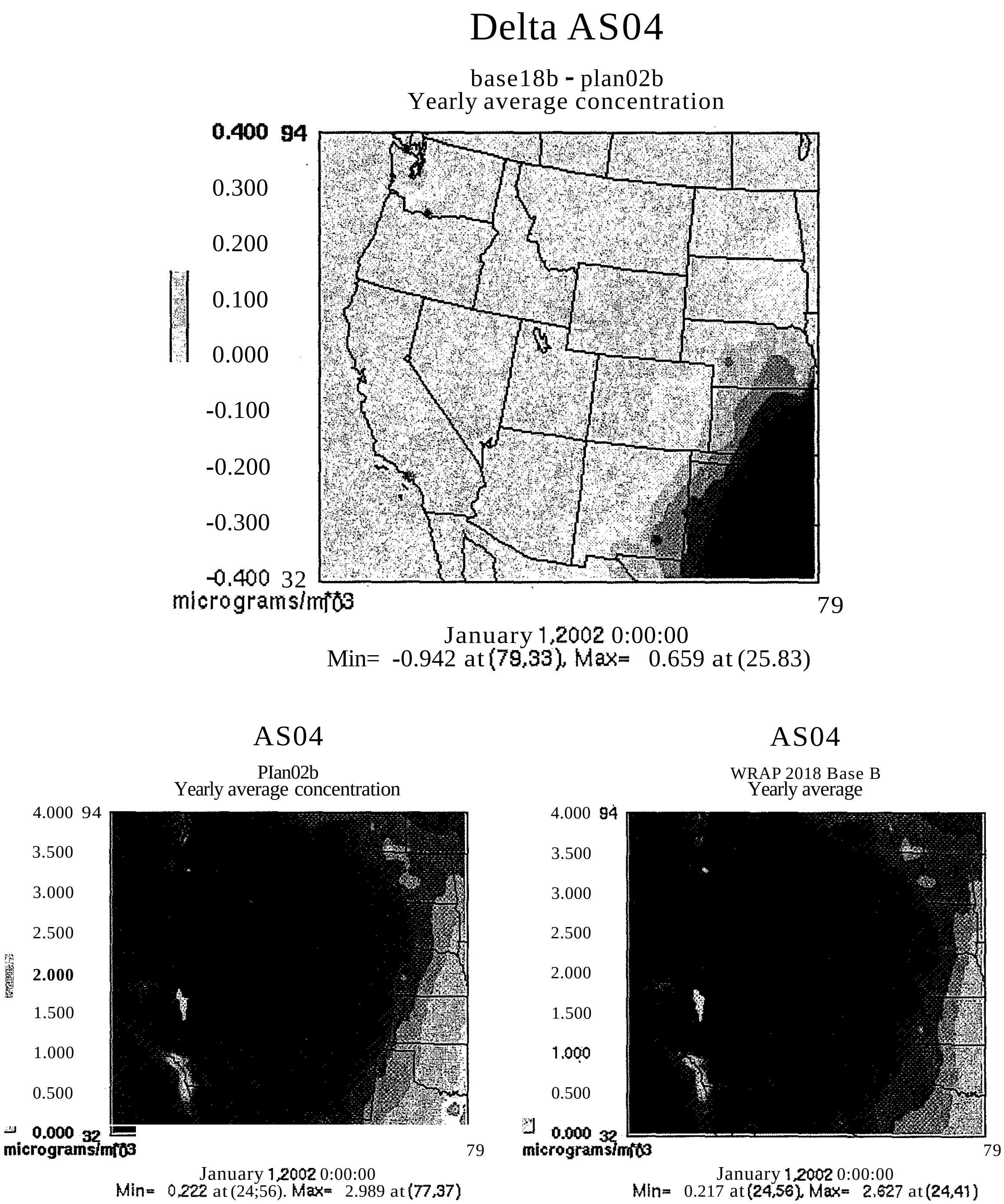



Figure 1. Annual average aerosol sulfate (AS04) concentration comparisons between Base18b and Plan02b. Top plot: difference between the two (Basel8b - Plan02b); bottom left-plot: Plan02b results; bottom right plot: Base18b results.

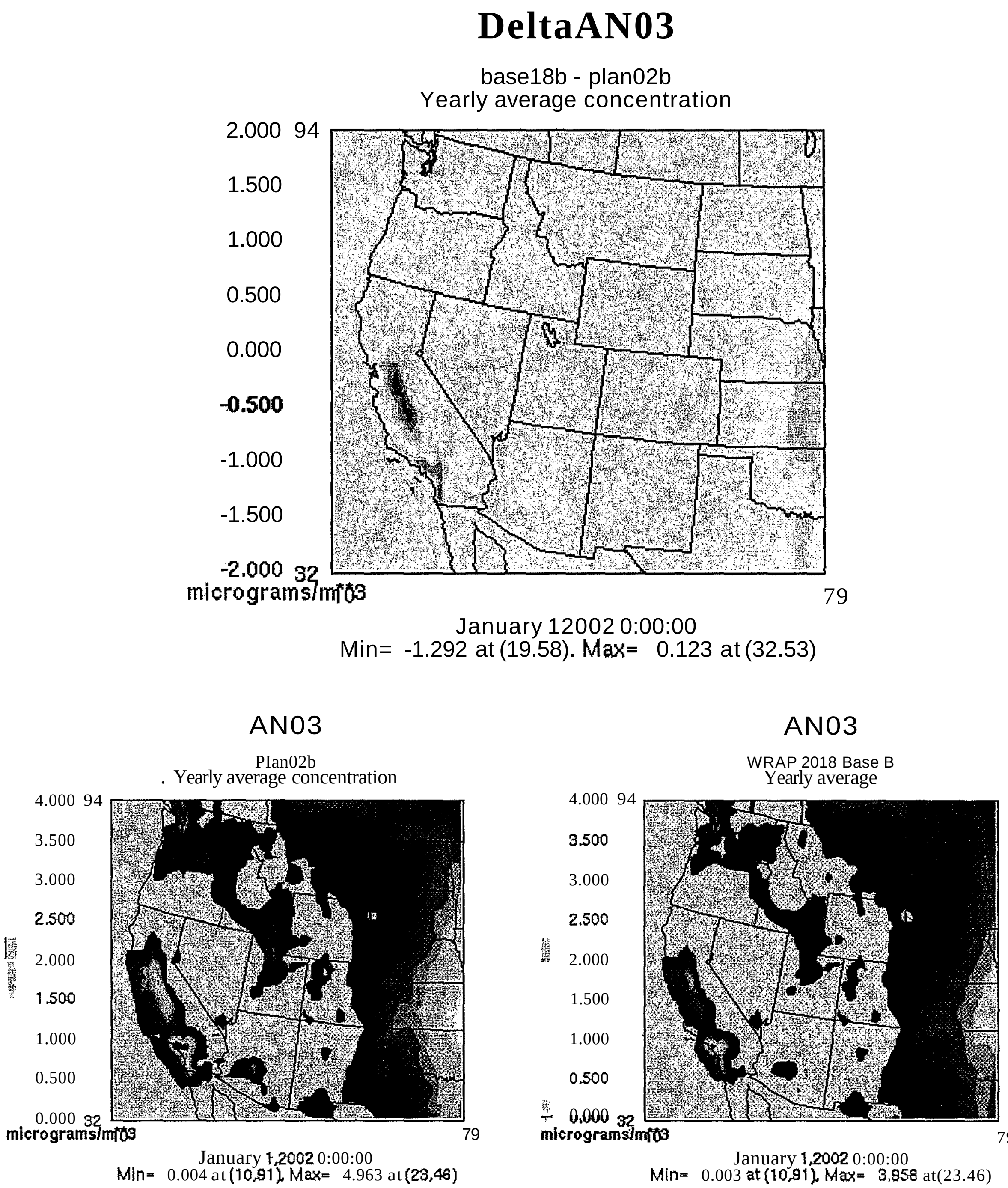



Figure 2. Annual average aerosol nitrate (AN03) concentration comparisons "between Base18b and Plan02b. Top plot: difference between the two (Base18b -Plan02b); bottom left'plot: Plan02b results; bottom right plot: Base18b results.

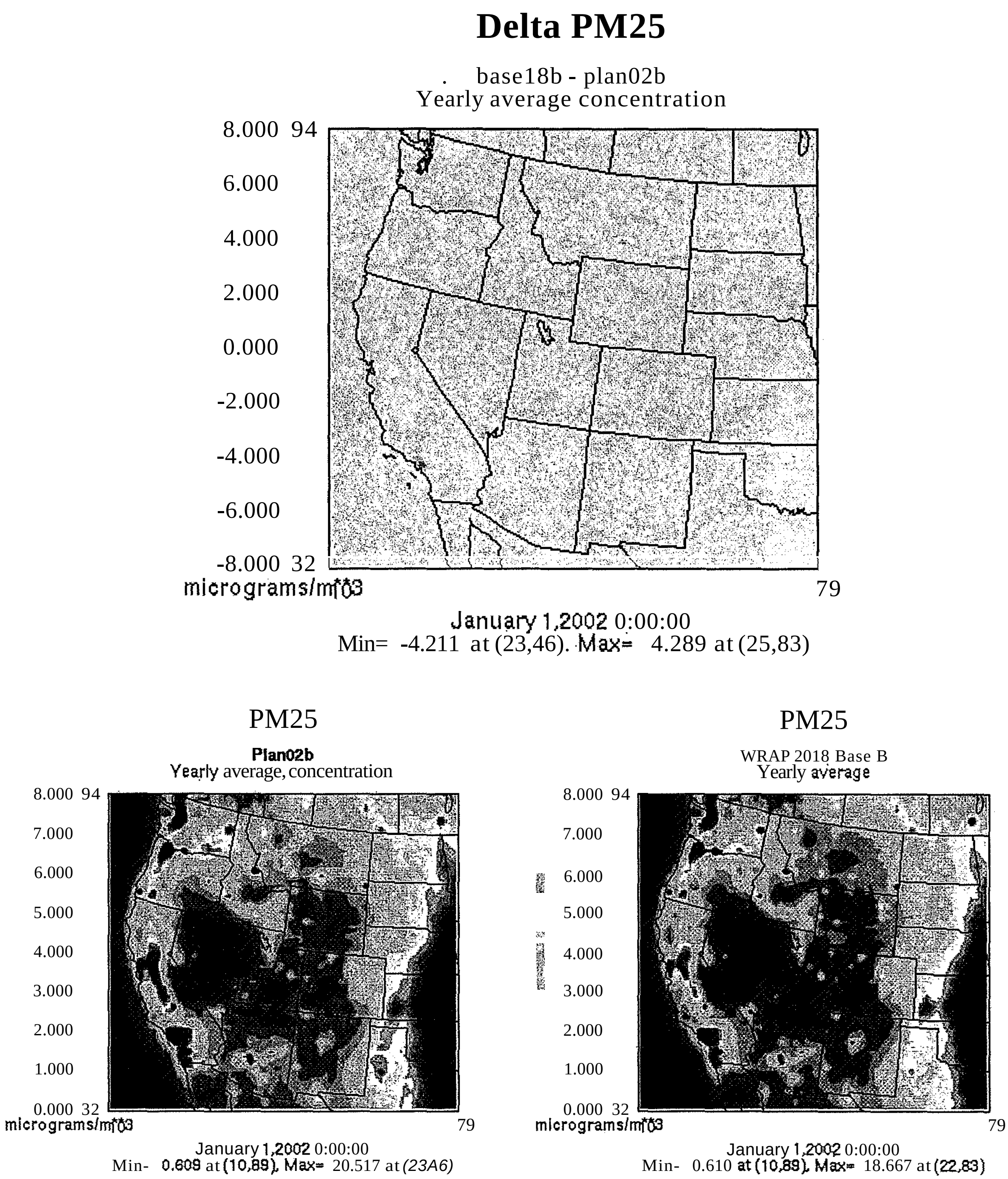



Figure 3. Annual average PM2.5 concentration comparisons between Base18b and Plan02b. Top plot: difference between the two (Base18b - Plan02b); bottom left plot: Plan02b results; bottom right plot: Base18b results.

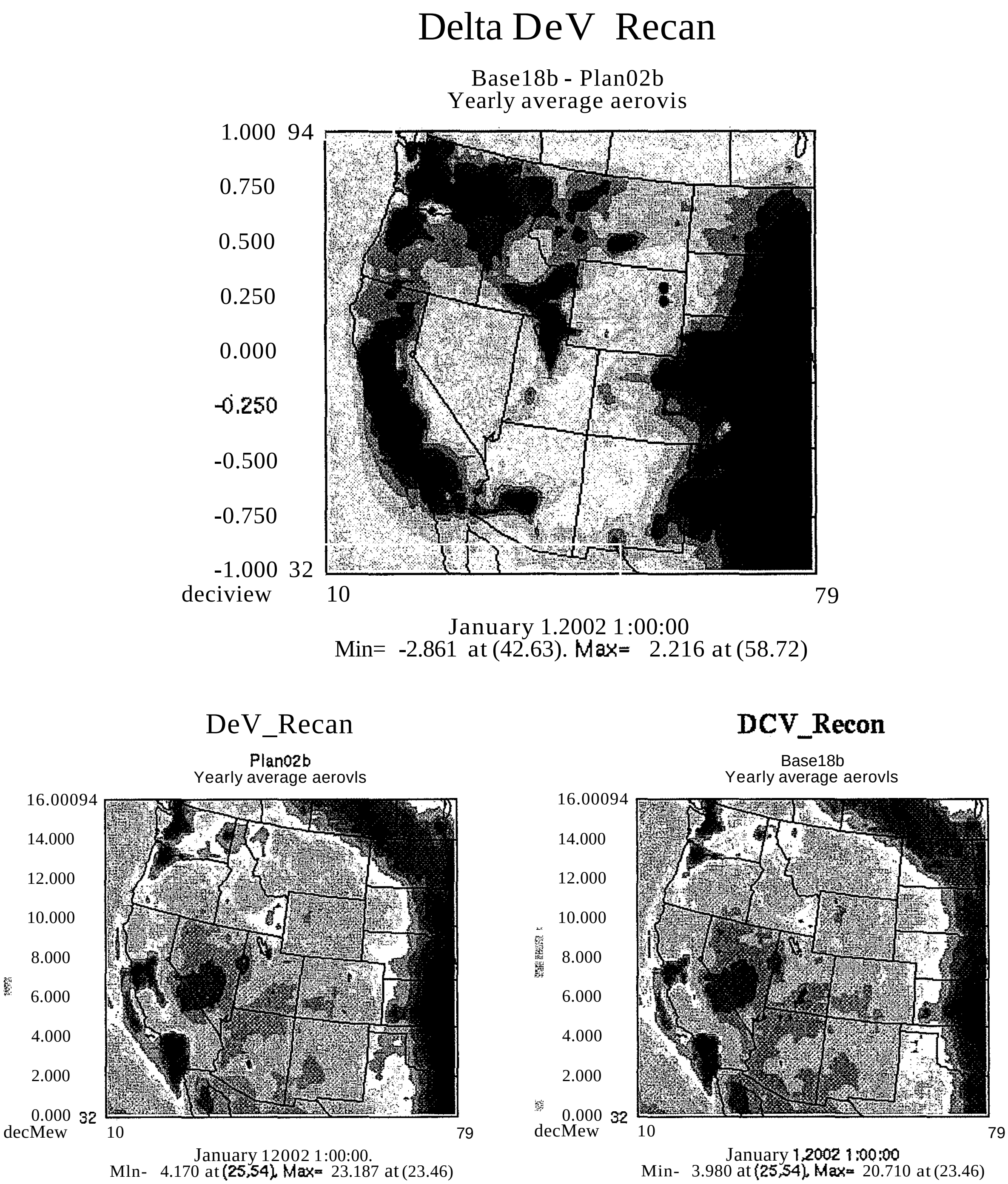



Figure 4. Annual average deciview comparisons between Base18b and Plan02b. Top plot: difference between the two (Base18b - Plan02b); bottom left plot: Plan02b results; bottom right plot: Base18b results.

## Visibility Projections

The Regional Haze Rule (RHR) goals include achieving natural visibility conditions at 156 Federally mandated Class I areas by 2064. In more specific terms, that RHR goal is defmed as (1) visibility improvement toward natural conditions for the 20% of days that have the worst visibility (termed "20% worst," or W20%, visibility days) and (2) no worsening in visibility for the 20% of days that have the best visibility ("20% best," or B20%, visibility days). One component of the states' demonstration to EPA that they are making reasonable progress toward this 2064 goal is the comparison of modeled visibility projections for the first milestone year of 2018 with what is termed a uniform rate of progress (URP) goal. As explained in detail below, the 2018 URP goal is obtained by constructing a "linear glide path" (in deciviews) that has at one end the observed visibility conditions during the mandated five-year (2000-2004) baseline period and at the other end natural visibility conditions in 2064; the visibility value that occurs on the glide path at year 2018 is the URP goal.

Preliminary WRAP 2018 visibility projections have been made using the Plan02c and Base18b CMAQ 36-km modeling results, following EPA guidance that recommends applying the modeling results in a relative sense to project future-year visibility conditions (U.S. EPA, 2001, 2003a, 2006). Projections are made using relative response factors (RRFs), which are defined as the ratio of the future-year modeling results to the current-year modeling results. The calculated RRFs are applied to the baseline observed visibility conditions to project future-year observed visibility. These projections can then be used to assess the effectiveness of the simulated emission control strategies that were included in the future-year modeling. The major features of EPA's recommended visibility projections are as follows (U.S. EPA, 2003a,b, 2006):

- Monitoring data should be used to defme current air quality.
- Monitored concentrations of $PM_{10}$ are divided into six major components; the first five are assumed to be $PM_{2.5}$ and the sixth is $PM_{2.5-10}$:
    - S04 (sulfate)
    - N03 (particulate nitrate)
    - OC (organic carbon)
    - EC (elemental carbon)
    - OF (other fine particulate or soil)
    - CM (coarse matter).
- Models are used in a relative sense to develop RRFs between future and current predicted concentrations of each component.
- Component-specific RRFs are multiplied by current monitored values to estimate future component concentrations.
- Estimates of future component concentrations are consolidated to provide an estimate of future air quality.

- Future estimated air quality is compared with the goal for regional haze to see whether the simulated control strategy would result in the goal being met.
- It is ,acceptable to assume that all measured sulfate is in the form of ammonium sulfate [$(NH_4)_2SO_4$] and all particulate nitrate is in the form of ammonium nitrate [$NH_4NO_3$].

To facilitate tracking the progress toward visibility goals, two important visibility parameters are required for each Class I area:

- *Baseline Conditions:* "Baseline Conditions" represent visibility for the B20% and W20% days for the initial five-year baseline period offue regional haze program. Baseline Conditions are calculated using monitoring data collected during the 2000-2004 five-year period and are the starting point in 2004. for the uniform rate of progress (URP) glide path to Natural Conditions in 2064 (U.S. EPA, 2003a).
- *NatitralConditions:* "Natural Conditions," the RHR goal for 2064 for the Federally mandated Class I areas, represent estimates of natural visibility conditions for the B20% and W20% days at a given Class I area.

Baseline Conditions

Baseline Conditions for Class I areas are calculated using fme and coarse PM concentrations measured at Interagency Monitoring of Protected Visual Environments (IMPROVE) monitors (MaIm et aI., 2000). Each Class I area in the WRAP domain has an associated IMPROVE PM monitor. The IMPROVE monitors do not measure visibility directly, but instead measure speciated fine particulate (pM2.5) and total PM2.5 and $PM_{IO}$ mass concentrations from which visibility is calculated using the IMPROVE aerosol extinction equation, discussed later.

Visibility conditions are estimated starting with the IMPROVE 24-h average PM mass measurements related to six PM components of light extinction:

- Sulfate [$(NH_4)_2SO_4$]
- Particulate nitrate [($NH_4NO_3$]
- Organic matter [OMC]
- Light-absorbing carbon [LAC] or elemental carbon [EC]
- Soil
- Coarse matter [CM]

The IMPROVE monitors do not directly measure some of these species, so assumptions are made as to how the IMPROVE measurements can be adjusted and combined to obtain these six components. For example, sulfate and particulate nitrate are assumed to be completely neutralized by ammonium and only the fme mode (PM2.s) is speciated to obtain sulfate and nitrate measurements (that is, any coarse-mode sulfate and nitrate in the real atmosphere may be present in the IMPROVE CM measurement). Concentrations for the above six components of .

light extinction in the IMPROVE aerosol extinction equation are obtained from the IMPROVE measured species using the formulas 'shown in Table 1.

Table 1. Definition of IMPROVE components from measured species.

| IMPROVE Component | Calculation of Component from IMPROVE Measured Species |
|---|---|
| Sulfate | 1.375 x (3 x S) |
| Nitrate | 1.29 x $NO_3^-$ |
| OMC | 1.4xOC |
| LAC | EC |
| Soil | (2.2 x AI) + (2.49 x Si) + (1.63 x Ca) + (2.42 x Fe) + (1.94 x Ti) |
| CM | MT-MF |

where

- S is elemental sulfur as determined from proton-induced x-ray emissions (PIXE) analysis of the IMPROVE Module A. To estimate the mass of the sulfate ion (S04), S is multiplied by 3 to account for the presence of oxygen. If S is missing then the sulfate (S04) measured by ion chromatography analysis of Module B is used to replace (3 x S). For the IMPROVE aerosol extinction calculation, sulfate is assumed to be completely neutralized by ammonium (1.375 x S04).
- $NO_3^-$ is the particulate nitrate measured by ion chromatography analysis of Module B. For the IMPROVE aerosol extinction calculation, it is assumed to be completely neutralized by ammonium (1.29 x N03).
- The IMPROVE organic carbon (OC) measurements are multiplied by 1.4 to obtain organic matter (OMC), which adjusts the OC mass for other elements assumed to be associated with OC.
- Elemental carbon (BC) is also referred to as light-absorbing carbon (LAC).
- Soil is determined as a sum of the masses of those elements (measured by PIXE) predominantly associated with soil (AI, Si, Ca, Fe, K, and Ti), adjusted to account for oxygen associated with the common oxide forms. Because K is also a product of the combustion of vegetation, it is represented in the formula by 0.6 x Fe and is not shown explicitly.
- MT and MF are total $PM_{10}$ and $PM_{2.5}$ mass, respectively.

Associated with each PM species is an extinction efficiency that converts concentrations (in Jlg/$m^3$) to light extinction (in inverse megameters, $Mm^{-1}$), as listed below. Sulfate and nitrate are hygroscopic, so relative humidity (RH) adjustment factors, f(RH), are used to increase the particles' extinction efficiency with increasing RH; this accounts for the particles' taking on water and having greater light scattering. Note that some organic matter (OMC) compounds may also have hygroscopic properties, but the IMPROVE aerosol extinction equation assumes OMC is nonhygroscopic.

$$\beta_{Sulfate} = 3 \times f(RH) \times [sulfate]$$
$$\beta_{Nitrate} = 3 \times f(RH) \times [nitrate]$$
$$\beta_{OM} = 4 \times [OMC]$$
$$\beta_{EC} = 10 \times [EC]$$
$$\beta_{Soil} = 1 \times [soil]$$
$$\beta_{CM} = 0.6 \times [CM]$$

The total light extinction ($\beta_{ext}$) is assumed to be the sum of the light extinctions due to the six PM species listed above plus Rayleigh (blue sky) background extinction ($\beta_{Ray}$), which is assumed to be 10 $Mm^{-1}$. This is reflected in the IMPROVE extinction equation:

$$\beta_{ext} = \beta_{Ray} + b\text{Sulfate} + \beta_{Nitrate} + \beta_{EC} + \beta_{OMC} + \beta_{Soil} + \beta_{CM}$$

The total light extinction ($\beta_{ext}$) in $Mm^{-1}$ is related to visual range (VR) in kilometers using the following relationship:

$$VR = 3912 / \beta_{ext}$$

The RHR requires that visibility be expressed in terms of a haze index (HI) in units of deciview (dv), which is calculated as follows:

$$HI = 10 \ln(\beta_{ext}/10)$$

The equations above, with measurements from the associated IMPROVE monitor, are used to estimate the daily average visibility at each Class I area for each IMPROVE monitored day. For each year from the 2000-2004 baseline period, these daily average visibility values are then ranked from highest to lowest. The "worst days" visibility for each of the five years in the baseline period is defmed as the average visibility across the 20% worst-visibility days (highest deciview values); similarly, the "best days" visibility is defined as the average visibility across the 20% best-visibility days (lowest deciview values) for each year. The Baseline Conditions for the best and worst days are defmed as the five-year average of the B20% visibility days and of the W20% visibility days, respectively, across the five-year baseline period.

The set of equations given above for relating measured PM species to visibility (light extinction) are referred to as the "Old IMPROVE" equation. The IMPROVE Steering Committee has developed a "New IMPROVE" equation that they believe better represents the fit between measured PM species concentrations and visibility impairment. Although conceptually similar to the Old IMPROVE equation, the New IMPROVE equation includes updates to many of the parameters and the addition of extinctions due to N02 absorption and sea salt. 2018 visibility projections and comparisons with the URP glide path goals were performed using both the New and Old IMPROVE equations. The reader is referred elsewhere for details on the New IMPROVE extinction equation (e.g., EPA, 2006a,b).

Mapping Model Resultsto IMPROVE Measurements

As noted above, future-year visibility at Class I areas is projected by using modeling results in a relative senSe to scale current observed visibility for the B20% and W20% visibility days. This scaling is done using RRFs, the ratios of future-year modeling results to current-year results. Each of the six components of light extinction in the IMPROVE reconstructed mass extinction equation is scaled separately. Because the modeled species do not exactly match up with the IMPROVE measured PM species,. assumptions must be made to map the modeled PM species to the IMPROVE measured species for the purpose of projecting visibility improvements. For example, in the model's chemistry (which explicitly simulates ammonium), sulfate mayor may not be fully neutralized; the IMPROVE extinction equation, on the other hand, assumes that observed sulfate is fully neutralized by ammonium. For the CMAQ v4.5 model (September 2005 release) used in the WRAP RMC modeling, the mapping of modeled species to IMPROVE measured PM species is listed in Table 2.

**Table 2. Mapping of CMAQ v4.5 modeled. species cC)Dcentrations to IMPROVE measured components.**

| IMPROVE Component | CMAQ V4.3 Species |
|---|---|
| Sulfate | 1.375 x (AS04J + AS04I) |
| Nitrate | 1.29 x (AN03J + AN03I) |
| OMC | AORGAJ + AORGAI + AORGPAJ + AORGPAI + AORGBJ + AORGBI |
| LAC | AECJ+ AECI |
| Soil | A25J+A251 |
| CM | ACORS + ASEAS + ASOIL |

Projecting Visibility Changes UsingModeling Results

RRFs calculated from modeling results can be used to project future-year visibility. For the urrent modeling efforts, RRFs are the ratio of the 2018 modeling results to the 2002 modeling results, and are specific to each Class I area and each PM species. RRFs are applied to the Baseline Condition observed PM species levels to project future-year PM levels, which are then used with the IMPROVE extinction equation listed above to assess visibility. The following six steps are used to project future-year visibility for the B20% and W20% visibility days (the discussion below is for W20% days but also applies to B20% days):

1. For each Class I area and each monitored day, dailyvisibility is ranked using IMPROVE. data and IMPROVE extinction equation for each year from the five-year baseline period (2000-2004) to identify the W20% visibility days for each year.
2. Use an air quality model to simulate a base-year period (ideally 2000-2004; but in reality just 2002) an.d a future year (e.g., 2018), then apply the resulting information to develop

Class-I-area-specific RRFs for each of the six components of light extinction in the IMPROVE aerosol extinction equation.

3. Multiply the RRFs by the measured 24-h PM data for each day from the W20% days for each year from the five-year baseline period to obtain projected future-year (2018) 24-h PM concentrations for the W20% days.

4. Compute the future-year daily extinction using the IMPROVE aerosol extinction equation and the projected PM concentrations for each of the W20% days in the five-year baseline from Step 3.

5. For each of the W20% days within each year of the five-year baseline, convert the future-year daily extinction to units of deciview and average the daily deciview values within each of the five years separately to obtain five years of average deciview visibility for the W20%days.

6. Average the five years of average deciview visibility to obtain the future-year visibility Haze Index estimate that is compared with the 2018 progress goal.

In calculating the RRFs, EPA draft guidance (U.S. EPA, 2001, 2006a) recommends selecting modeled PM species concentrations "near" the monitor by taking a spatial average of PM concentrations across a grid-cell-resolution-dependent NX by NY array of cells centered on the grid containing the monitor. For the WRAP 36-km CMAQ modeling, the model estimates for just the grid cell containing the monitor are used (i.e., NX=NY=I).

For the preliminary 2018 visibility projections, results are presented only for "Method 1," which is the recommended approach in EPA's draft modeling guidance documents (U.S. EPA, 2001, 2006a). In the Method 1 Average RRF Approach, an average RRF for the W20% days from 2002 (Modeled Worst Days) is obtained for the Plan02c and the BaseI8b CMAQ simulations by averaging the PM concentration components across the Modeled Worst Days and then calculating the (future year):(base year) ratio of the average PM concentrations. For example, if $S04_{jJ}$ is the measured sulfate concentrations at Class I area $j$ for the $i=1,\ldots,N$ 20% worst visibility days in 2002, then the RRF for sulfate on the W20% days would be obtained as:

$$RRF_j(SO4) = \frac{\frac{1}{N}\sum_{i=1}^{N} 804ij(2018)}{\frac{1}{N}\sum_{i=1}^{N} 804ij(2002)} = \frac{\sum_{i=1}^{N} SO4_{ij}(2018)}{\sum_{i=1}^{N} 804ij(2002)}$$

For each Class I area and each of the W20% days, the average RRF for each PM component would be applied to concentrations for the W20% days from the 2000-2004 baseline period to estimate future-year PM concentrations for each of the W20% days. Extinction and ill would then be calculated to obtain the projected future-year visibility conditions using the procedures given previously.

Glide Path to Natural Conditions

The presumptive visibility target for 2018 is the URP goal that is obtained by constructing a linear glide path from the current Baseline Conditions to Natural Conditions in 2064 (both expressed in deciviews). For instance, Figure 5 displays an example visibility glide path for the Grand Canyon National Park (GRCA) Class I area. EPA's default Natural Conditions value for the W20% days (U.S. EPA, 2003b), shown as the green line, is the 2064 visibility goal at GRCA of 6.95 dv. The blue diamonds at the left of the plot are the annual average current conditions, based on IMPROVE observations for the W20% days as obtained from the Visibility Infonnation Exchange Web System (VIEWS) web site (http://vista.cira.colostate.edu/viewsQ. These annual average visibility values for the 20% worst days allow an assessment of trends and the year-to-year variation in visibility. The Baseline Conditions are the average of the W20% visibility from 2000-2004, which is the starting point for the glide path in 2004 (12.04 dv for GRCA). A linear URP from the Baseline Conditions in 2004 to Natural Conditions in 2064 (sloping pink line with triangles) is assumed, and the value on the glide path at 2018 is the presumptive URP visibility target that the modeled 2018 projections are compared against to judge progress. In this example, the visibility progress goal in 2018 would be 10.85 dv. Meeting this would require a 1.19. dv reduction in visibility by 2018 to meet that milestone year's visibility progress target at the Grand Canyon National Park.

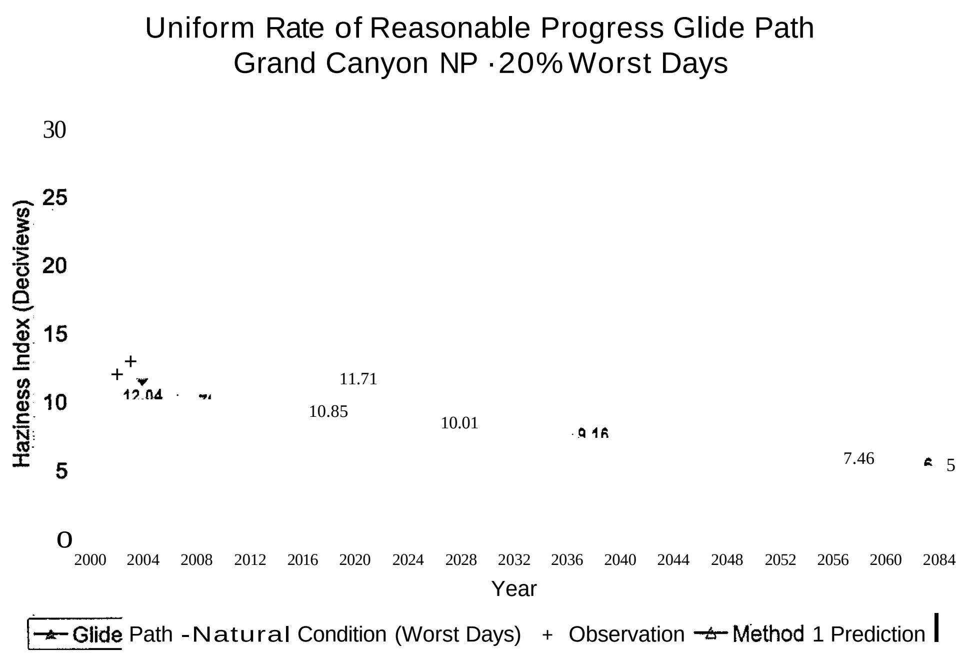



Figure 5. Example of URP glide path using IMPROVE data from the Grand Canyon Nationai Park for the W200/0 days and comparison with Base18b visibility projections.

Preliminary Visibility Projection Results

For all of the WRAP Class I areas, the RMC perfonned preliminary 2018 visibility projections and compared them to the 2018 URP goals using the Plan02c and Base18b CMAQ modeling results and the Old and New IMPROVE equations. As an example, Figure 5 above compares the Base18b visibility projections with the URP goal based on the glide path for ORCA and the Old IMPROVE equation. To achieve the 2018 URP goal, the modeled 2018 visibility projection would have to show a 1.19 dv (=12.04-10.85) reduction. However, the modeled 2018 visibility projection shows only a 0.33 dv (=12.04-11.71) reduction by 2018, which indicates that the emission controls simulated in case Base18b would not achieve the modeled URP goal; the 2018 visibility projection achieves only 28% of the goal (28% = 100 x 0.33/1.19). Figure 6 displays the 2018 visibility projections for all WRAP Class I areas, using both the Old and New IMPROVE equations, expressed as a percentage of achieving the URP goal, with values of 100% or greater achieving the goal. Using the procedures outlined above, none of the WRAP Class I areas are projected to achieve their URP goals. There are various reasons for this, such as the presence of W20% days that are dominated by emissions from sources that are not controllable, such as wildfires, dust, and/or international transport. Additional analysis of these results and alternative projection techniques are currently under study.

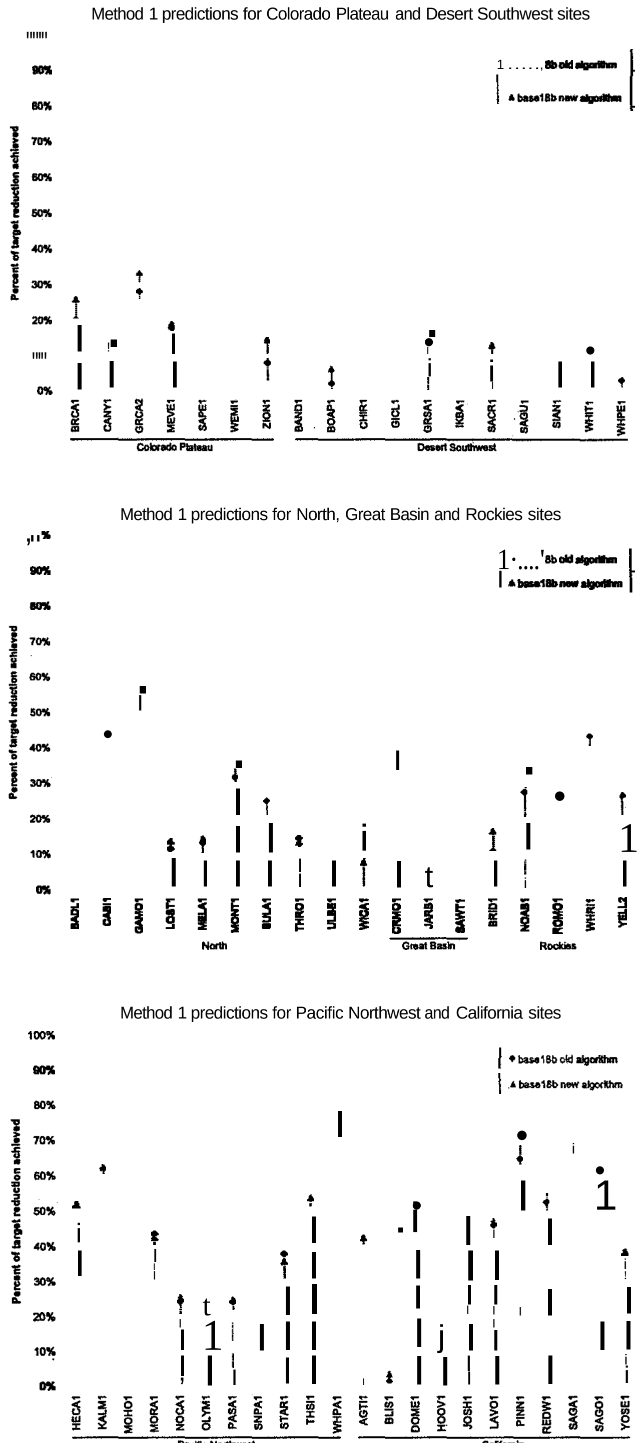



**Figure 6. 2018 visibility projections at WRAP Class I areas expressed as a percent of achieving the 2018 URP goal using the Old and New IMPROVE equation and the WRAP Base18c CMAQ 36-km modeling results.**

**PM Source Apportionment**

hnpainnent of visibility in Class I areas is caused by a combination of local air pollutants and regional pollutants that are transported long distances. To develop effective visibility improvement strategies, the WRAP member states and tribes need to know the relative contributions of local and transported pollutants, and which emissions sources are significant contributors to visibility impainnent at a given Class I area. "

A variety of modeling and data analysis methods can be used to perform source apportionment of the PM observed at a given receptor site. Model sensitivity simulations have been used in which a "base case" model simulation is performed and then a particular source is "zeroed out" of the emissions. The importance of that source is assessed by evaluating the change in pollutants at the receptor site, calculated as pollutant concentration in the sensitivity case minus that in the base case. This approach is known as a "brute force" sensitivity because a 'separate model run is required for each sensitivity.

An alternative approach is to implement a mass-tracking algorithm in" the air quality model to explicitly track for a given emissions source the chemical transformations, transport, and removal of the PM that was formed from that source. Mass tracking methods have been implemented in both the CMAQ and CAMx air quality models. Initial work completed by the RMC during 2004 used the CMAQ Tagged Species Source Apportionment (TSSA) method. Unfortunately, there were problems with mass conservation in the version of CMAQ used in that study, and these affected the TSSA results, A siinilar algorithm has been implemented in CAMx, the PM Source Apportionment Technology (PSAT). Comparisons of TSSA and PSAT showed that the results were qualitatively similar, that is, the relative ranking of the most significant source contributors were similar for the two methods. However, the total mass contributions differed. With separate funding from EPA, UCR has implemented a version of TSSA in the new CMAQ release (v4.5) that corrects the mass conservation error, but given the uncertainty of the availability of this update, the CAMxlPSAT source apportionment method was used for the WRAP modeling analysis.

The main objective of applying CAMxIPSAT is to evaluate the regional haze air quality for typical 2002 (plan02c) and future-year 2018 (Base18b) conditions. These results are used

- to assess.the contributions of different geographic source regions (e.g., states) and source categories to current (2002) and future (2018) visibility impainnent at Class I areas, to obtain improved understanding of (1) the causes of the impainnent and (2) which states are included in the area of influence (ADI) of a given Class I area; and "

- to identify the source regions and emissions categories that, if controlled, would produce the greatest visibility improvements at a Class I area.

CAMxIPSAT

The PM Source ApportiOIiment Technology performs source apportionment based on user-defmed source groups. A source group is the combination of a geographic source region and an emissions source category. Examples of source regions include states, nonattainment areas, and counties. Examples of source categories include mobile sources, biogenic sources, and elevated point sources; PSAT can even focus on individual sources. The user defines a geographic source region map to specify the source. regions of interest. He or she then inputs each source category as separate, gridded low-level emissions and/or elevated-point-source emissions. The model then determines each source group by overlaying the source categories on the source region map. For further information, please refer to the white paper on the features and capabilities of PSAT (http://pah.cert.ucr.edu/agm/308/reports/PSAT .White Paper 111405 final draftI.pdf), with additional details available in the CAMx user's guide (ENVIRON, 2005; http://www.camx.com).

PM source apportionment modeling was performed for aerosol sulfate (S04) and aerosol nitrate (N03) and their related species (e.g., S02, NO, N02, HN03, $NH_3$, and $NH_4$). The PSAT simulations include 9 tracers, 18 source regions, and 6 source groups. The computational cost for each of these species differs because additional tracers must be used to track chemical conversions of precursors to the secondary PM species S04, N03, $NH_4$, and secondary organic aerosols (SOA). Table3 summarizes the computer run time required for each species. The practical implication of this table for WRAP is that it is much more expensive to perform PSAT simulations. for N03 and especially for SOA than it is to perform simulations for other species.

Table 3. Benchmarks for PSAT computational costs for each PM species. **Run** time is for one day (01/02/2002) on the WRAP 36-km domain.

| Species | No. of Species Tracers | RAM Memory | Disk Storage per Day | Run Time with 1 CPU |
|---|---|---|---|---|
| S04 | 2 | 1.6GB | 1.1 GB | 4.7h1day |
| $N0_3$ | 7 | 1.7GB | 2.6GB | 13.2h1day |
| 804andN$0_3$ combined | 9 | 1.9GB | 303GB | 16.8 hlday |
| SOA | 14 | 6.8GB | Not tested | Not tested. |
| Primary PM species | 6 | 1.5 GB | 3.0GB. | 10.8 hlday |

Two annual 36-km CAMx/PSAT model simulations were performed: one with the Plan02c typical-year baseline case and the other with the BaseI8b future-year case. It is expected that the states and tribes will use these results to assess the sources that contribute to visibility impairment at each Class I Area, and to guide the choice of emission control strategies. The RMC web site includes a full set of source apportionment spatial plots and receptor bar plots for both Plan02b and BaseI8b. These graphical displays of the PSAT results, as well as additional analyses of these results are available on the TSS under http://vista.cira.colostate.edu/tss/TooIslResultsSA:aspx

CAMx/PSAT 2002 and 2018 Setup

PSAT source apportionment simulations for 2002 and 2018 were performed using CAMx v4.30. ° Table 4lists overall specifications for the 2002 PSAT simulations. The domain setup was identical to°the standard WRAP CMAQmodelingodomain. The CAMx/PSAT"run-time options are shown in TableS. The CAMx/PSAT computational cost for one simulation day with source tracking for sulfate (S04) and nitrate (N03) is approximately 14.5 CPU hours with an AMD . Opteron CPU. The source regions used in the PSAT simUlations are shown in Figure 7 and Table 4. The six emissions source groups are described in Table 6. Theo development of these emissions data are described in more detail below.

The annualPSAT run was divided into four seasons for. modeling. The initial conditions for the first season (January 1 toMarch 31, 2002) came from a CENRAP annual simulation. °For the other three seasons, we allowed 15 model spin-up days prior to the beginning of each season. Based on the chosen set of source regions and groups, with nine tracers, and with a minimum requirement of 87,000 p<>int sources and a horizontal domain of 148 by 112 grid cells with 19 vertical layers, the run-time memory requirement is 1.9 GB. Total disk storage per day is approximately 3.3 GB. Although the RMC's computation nodes are equipped with dual Opteron CPUs with 2 GB of RAM and 1 GB of swap space, the high run-time memory requirements prevented running PSAT simulations using the OpenMP shared memory multiprocessing capability implemented in CAMx.

Table 4. WRAP 2002 CAMx/PSAT specifications.

| WRAP PSAT Specs | Description |
|---|---|
| Model | CAMxv4.30 |
| OS/compiler | Linux, pgf90 v.6.0-5 |
| CPU type | AMD Opteron with 2 GB of RAM |
| Source region | 18 source regions; see Figure 4.1 and Table 4.4 |
| Emissions source groups | Plan02b, 6 source groups; see Table 4.5 |
| Initial cOl:iditions | FromCENRAP (camx.v4.30.cenrap36.omp.2001365.inst.2) |
| Boundary conditions | 3-h BC from GEOS-Chem v2 |

Table 5. WRAP CAMxIPSAT run-time options.

| WRAP PSAT specs | Description |
|---|---|
| Advection solver | PPM |
| Chemistry parameters | CAMx4.3.chemparam.4_CF |
| Chemistry solver | CMC |
| Plume-in-grid | Not used |

| WRAP PSAT specs | Description |
|---|---|
| Probing tool | PSAT |
| Dry/wet deposition | TRUE (turned on) |
| Staggered winds | TRUE (turned on) |

**Table 6. WRAP CAMx/PSAT source regions cross-reference table.**

| Source Region ID | Source Region Description[1] | Source Region ID | Source Region Description[1] |
|---|---|---|---|
| 1 | Arizona (AZ) | 10 | South Dakota (SD) |
| 2 | California (CA) | 11 | Utah{UT) |
| 3 | Colorado (CO) | 12 | Washington (WA) |
| 4 | Idaho (ID) | 13 | Wyoming (WY) |
| 5 | Montana (MT) | 14 | Pacific off-shore & Sea of Cortez (OF) |
| 6 | Nevada(NV) | 15 | CENRAP states (CE) |
| 7 | New Mexico (NM) | 16 | Eastern U.S., Gulf of Mexico, & Atlantic Ocean (EA) |
| 8 | North Dakota (ND) | 17 | Mexico (MX) |
| 9 | Oregon (OR) | 18 | Canada(CN) |

'The abbreviations in parentheses are used to identify source regions in PSAT receptor bar plots.

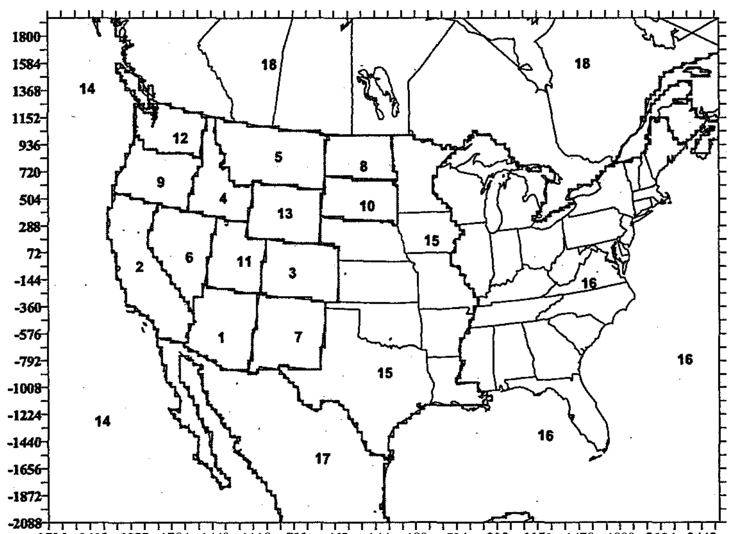



**Figure** 7. WRAP **CAMx/PSAT source region map. Table 6 defmes the source region IDs.**

**Table 7.** WRAP **CAMx/PSAT emissions source groups.**

| Emissions Source Groups | Low-level Sources | Elevated Sources |
|---|---|---|
| I | Low-level point sources (including stationary off-shore) | Elevated point sources (including stationary off-shore) |
| 2 | Anthropogenic wildfires (WRAP only) | AnthropQgenic wild frres (WRAP only) |
| 3 | Total mobile (on-road, off-road, including planes, trains, ships in/near port, off-shore shipping) | |
| 4 | Natural emissions (natural fire, WRAP only, biogenics) | Natural emissions (natural fire, WRAP only, biogenics) |
| 5 | Non-WRAP wildfires (elevated frre sources in otherRPOs) | Non-WRAP wild fires (elevated fire sources in other RPOs) |
| 6 | Everything else (area sources, all dust, fugitive ammonia, non-elevated fire sources in other RPOs) | |

PSAT Results·

The source apportionment algorithms implemented in CAMx generate output files in the same format as the standard modeled species concentrations files. This typically consists of a two-dimensional, gridded dataset of hourly-average surface concentrations for each source group tracer that gives the contribution of the tracer to all the surface grid cells in the model domain for each hour of the simulation. Three-dimensional instantaneous concentrations are also output for the last two hours of the simulation, which are used to restart the model. Although there are options to output hourly 3-D average tracer concentrations, the model is usually configures to output only the model's surface layer concentrations because of the vast disk storage space needed for the 3-D file output for all the source group contributions.

The source apportionment model results are typically presented in two ways :

- *Spatial plots* showing the area of influence of a source group's PM species contributions throughout the model domain, either at a given hourly-average point in time or averaged over some time interval (e.g., monthly average).

- *Receptor bar plots* showing the rank order of source groupings that contribute to PM species at any given receptor site. These plots also can be at a particular point in time or averaged over selected time intervals-for example, the average source contributions for the 20% worst visibility days.

If the 3-D tracer output files are saved, it is also possible to prepare animations of PM species plumes from each of the source groups. However, these plots are less useful than the others for quantitative analysis, are expensive to produce, and require saving 3-D hourly output, which is disk-space intensive. The primary products of the WRAP PSAT modeling were receptor bar plots showing the emission source groups that contribute the most to the model grid cells containing each IMPROVE monitoring site and other receptor sites identified by WRAP.

**Model Sensitivity Simulations**

A variety of sensitivity simulations were conducted by the RMC as part of their modeling efforts to support the WRAP in addressing the Regional Haze Rule requirements. These sensitivity simulations are described below.

2002 Clean Case

There are many natural sources of ambient PM2.5, both direct emissions of primary PM2.5 (such as windblown dust) and emissions of gaseous species that undergo photochemical transformation or condensation to form secondary PM2.5. Natural sources of PM2.5 are of concern because they represent sources that cannot be controlled. Estimates of natural haze levels have been developed by EPA for visibility planning purposes and are described in *Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule* (U.S. EPA, 2003a). These are the natural haze levels to be used in glide path calculations, such as those we performed as part of the visibility projections for 2018. However, the natural haze levels developed by EPA for glide path calculations were based on ambient data analysis, not on visibility modeling. This question thus arises: Would modeled levels of natural haze be consistent with the values estimated by EPA for visibility planning? If the natural haze levels calculated by the model were substantially higher than the levels used for planning purposes, this would make it more difficult for modeling studies to demonstrate progress in attaining visibility goals, because the model would predict haze levels that exceeded EPA's natural haze levels even if all anthropogenic sources of PM2.5 were removed from the modeling. The RMC explored this issue by conducting a CMAQ sensitivity "clean conditions" simulation

There are many uncertainties and unknowns regarding natural emissions. There have been only limited studies of natural emissions conditions. It is known that there are very large uncertainties in the categories of natural emissions included in the WRAP emissions inventories, and that some categories of natural emissions are not included at all. Also, it is difficult to know what truly natural emissions would have been like in the absence of human modifications of the environment. For example, wildfire emissions are a large source of natural emissions in our modeling, but how much larger might that source be in the absence of fire suppression efforts? For all of these reasons, it was decided to describe this sensitivity simulation as a "clean conditions" scenario rather than a "natural conditions" scenario. In this simulation, all anthropogenic emissions were removed from the inventory and only those emissions that were defined as biogenic in the 2002 base case (Base02) were included. Thus, this model simulation does not represent true natural conditions. It indicates instead the lowest haze levels that could be achieved in the model if all anthropogenic emissions were zeroed out.

*Emission Inventories*

The emissions for the clean 2002 sensitivity case were derived from case Base02a. Because it was a sensitivity analysis to test the impacts of natural emissions sources on visibility, it is referred to it as scenario Base02nt, where "nt" refers to natural. The following emissions categories in Base02nt were included:

- *Biogenics:* Generated in case Base02a by BEIS3.12 using SMOKE.

- *WRAP Ammonia:* The Base02a ammonia emissions for the WRAP region were·developed with a GIS by ENVIRON. The five emissions category modeled included three anthropogenic sources (domestic animals, livestock, and fertilizer application) and two natural sources (soils and wildlife). Only the two natural sources in scenario Base02nt were used.'
- *CENRAP and MRPO Ammonia:* To create ammonia inventory files for only natural sources, we used a list of SCCs representing natural sources to extract the emissions records of these sources from the monthly inventory files that were used in Base02a. it was. found that there were no natural ammonia sources in the MRPO monthly inventory files.
- *Natural Area Sources:* The Base02a area-source inventory files included natural sources, such as wildfires and wild animals. These records were extracted from the stationary-area-source inventories. Note that the WRAP area-source files did not include any natural sources.
- *Natural Fires:,* Of the five fire categories modeled in Base02a (wildfires, wildland fire use, non-Federal rangeland prescribed fires, prescribed fires [which were split into natural and anthropogenic prescribed for this purpose of this sensitivity], and agricultural fires), only the categories that represent natural fires (wildfires, wildland fire use, and natural prescribed fires) were included.
- *Windblown Dust:* We used the windblown dust inventory that ENVIRON and the RMC developed for use in case Base02a. Additional details on this dust inventory are available at http://www.cert.ucr.eduJagm/308/wb dust2002/wb dust ii 36k.shtml.

The biogenic and windblown dust emissions from the Base02a SMOKE outputs that are stored at the RMC were used directly. For the fire (including both point and area fires), natural area, and ammonia emissions, these data were reprocessed specifically for scenario Base02nt using the same ancillary data (temporal, chemical, and spatial allocation data) used in case Base02a. QA plots and documentation for scenario Base02nt are posted on the RMC web site at http://pah.cert.ucr.eduJagm/308/ga Base02nt36.shtml.

*Modeling Results*

Figure 8 shows the model-reconstructed light extinction in the clean emissions model simulation. Because the natural fire emissions in the WRAP states were a major component of the clean emissions, the largest visibility impairment is in the regions with natural fire emissions. Contributions to light extinction from natural sources were small in regions without large fire emissions, as evidenced in the eastern U.S., where the extinction was only slightly larger (about 2 $Mm^{-1}$) than'perfectly clean Rayleigh conditions of 10 $Mm^{-1}$.

Although there are large uncertainties in the natural emissions, and it is known that there are missing types of natural emissions, the components of the natural inventory used in this sensitivity simulation did contribute to relatively large visibility impairment in regions where there were large wildfires. Extinction coefficients as large as 90 $Mm^{-1}$ were simulated in the southern Oregon and northern California regions; this was most likely a result of the large Biscuit fire in Oregon, plus contributions from smaller fires and other natural emissions. These visibility impainnent levels exceed the natural visibility levels specified in the EPA regional haze natural visibility guidance document. It will thus be more difficult for the modeling to demonstrate attainment of progress goals in areas of the country subject to wildfires because of their large contribution to visibility impairment that is not controllable. In other regions of the country for which the inventories lacked large natural fire emissions, the modeled clean visibility was only slightly greater than clean Rayleigh conditions. Note the model results may be overly optimistic in these regions because we lack a complete, accurate,natural emissions inventory.

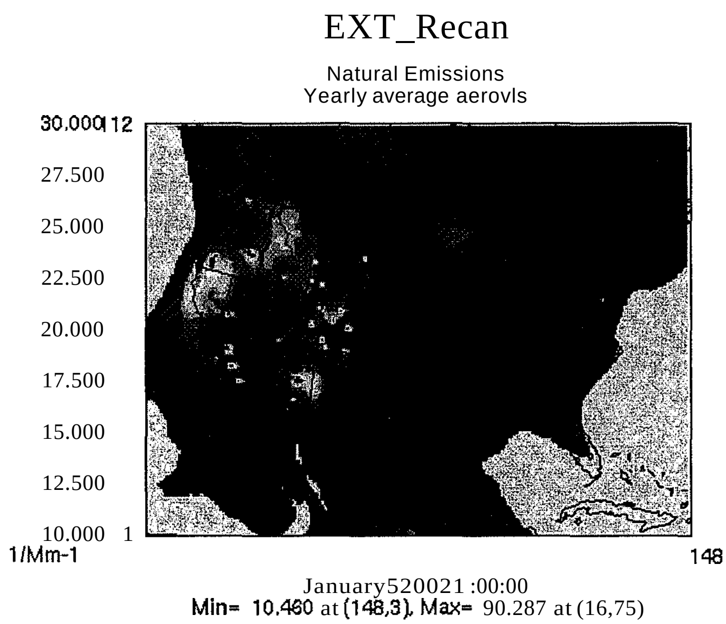



Figure 8. Annual average model-reconstructed "clean conditions" visibility as extinction coefficient.

These results are all very tentative because of the large uncertainties in natural emissions. Considerable effort would be needed to more fully investigate natural conditions in future modeling studies. It will always be difficult to determine and quantify "clean conditions" based on observations because of the pervasive influence ofanthr<?pogenic emissions.

Also as part of this sensitivity analysis, the contributors to organic carbon aerosols (OC).for the clean conditions scenario wer4e evaluated. The CMAQ model represents explicitly three classes of organic carbon aerosols:

- *AORGPA:* Primary anthropogenic OC resulting from direct organic mass emissions, such as primary organic aerosol (POA).
- *AORGA:* Secondary anthropogenic OC resulting from aromatic VOCs, such as xylene, toluene, and cresols.

- *AORGB:* Secondary biogenic OC resulting from biogenic VOCs, such as terpenes.

Because it was not cost effective to carry out CAMx/PSAT simulations with OC, the explicit OC results for the clean conditions case were analyzed, and then compared'those results to the Base02b case in an attempt to infer the relative contributions of biogenic and anthropogenic VOCs to OC. These results are difficult to interpret for at least two reasons:

- Because of the simplified approach used by CMAQ and the Carbon,Bond Mechanism version 4 (CB4) to represent these species, it is not possible to accurately classify all einissions into the CMAQ model as either biogenic or anthropogenic based simply on the species name. Thus, some biogenic OC might be included with AORGA, and some anthropogenic OC might be included in AORB.

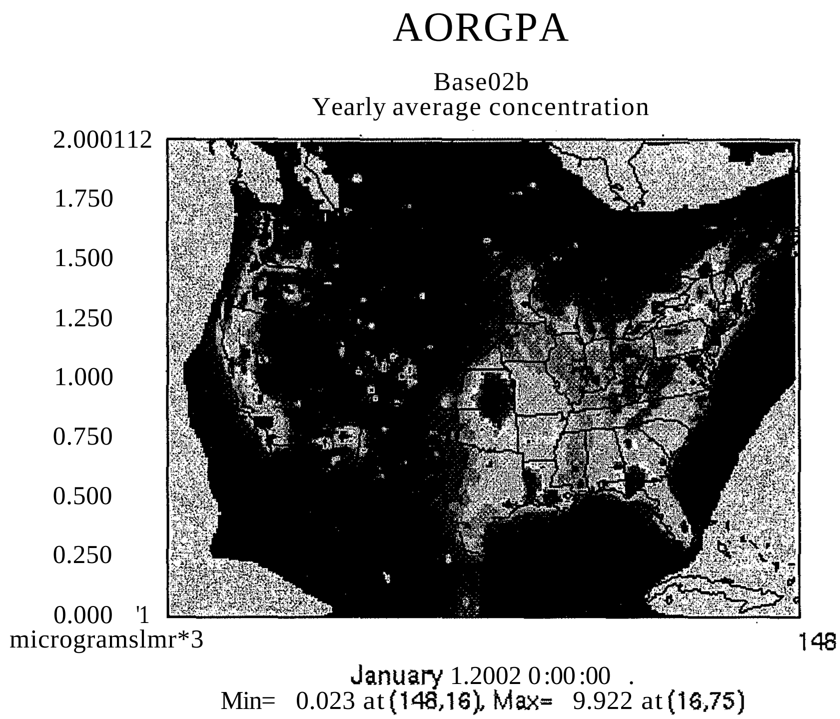
- , Some fire emissions are classified as anthropogenic, but these emissions might include species such as terpenes that are typically considered biogenic. Using the analysis' approach in which all terpenes are assumed biogenic then mcorrectly causes some anthropogenic emissions to be labeled biogenic when we use the simplified approach of analyzing OC in terms of AORGPA, AORGA and AORGB.

In spite of these difficulties, however, the results should classify the majority of the emissions correctly as either biogenic or anthropogenic.

For each of the above three components of OC, plots of the annual average mass in the Base02b case were prepared, and then the controllable mass was estimated as the difference between the Base02b case the Base02nt clean emissions scenario. Figure 9 shows the annual average mass of OC contributed from AORGPA in case Base02b (top) and the portion of that mass attributed to controllable emissions (bottom). Comparing these two plots indicates that in the western U.S. there is considerable AORGPA mass that is not controllable. It is likely that much of this mass is from fires, since uncontrollable AORGPA mass is present at the site of large fires in southern Oregon and north of Tucson, AZ.

Figure 10 shows the annual average mass of secondary OC contributed from AORGA in the Base02b case (top) and the portion of that mass attributed to controllable emissions (bottom). These plots indicate that virtually all of the AORGA mass is controllable, since the bottom plot is almost identical to the top plot.

Figure 11 shows the annual average mass of OC contributed from AORGPA in the Base02b case (top) and the portion of that mass attributed to controllable emissions (bottom). These plots indicate that although most of the AORGB mass is not controllable, a significant amount of mass is controllable. It is likely that the controllable AORGB mass results from VOC oxidation . chemistry and the larger amount of biogenic mass that is oxidized and subsequently condenses to form OC in the Base02b case. These results indicate that controlling $O_3$ precursor emissions is effective at reducing a small but significant fraction.of the biogenic OC.



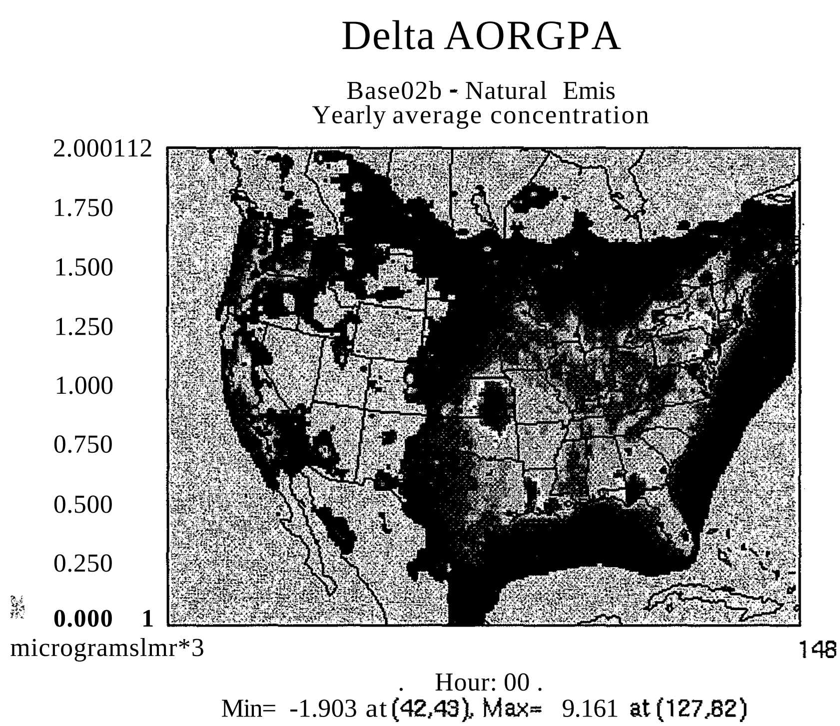




Figure 9. Annual average modeled primary anthropogenic OC (AORGPA) in Base02b (top) and the portion that is "controllable" primary anthropogenic OC (bottom).

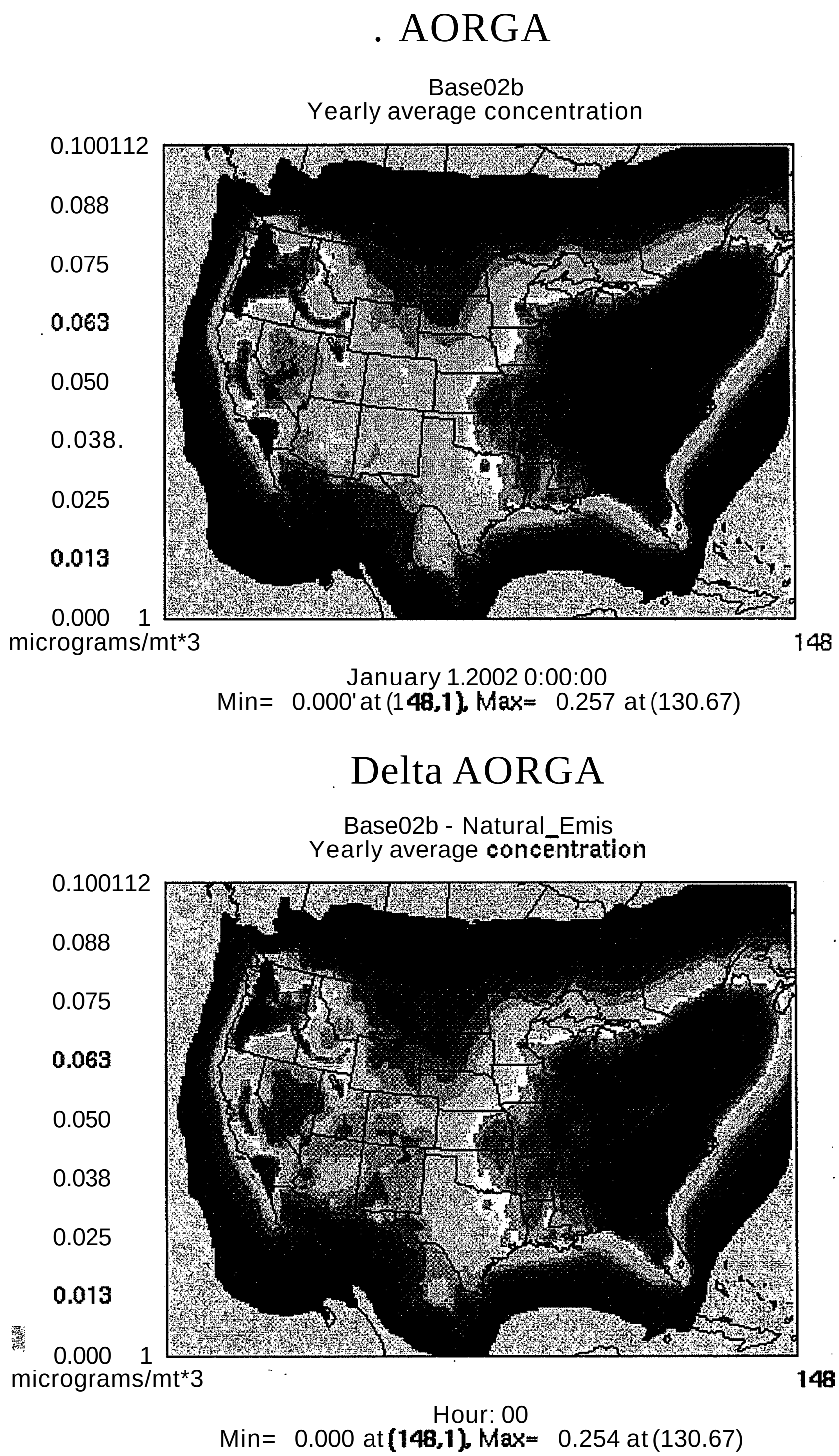



Figure 10. Annual average modeled secondary anthropogenic OC ·(AORGA) in Base02b (top) and the portion that is "controllable" secondary anthropogenic OC (bottom).

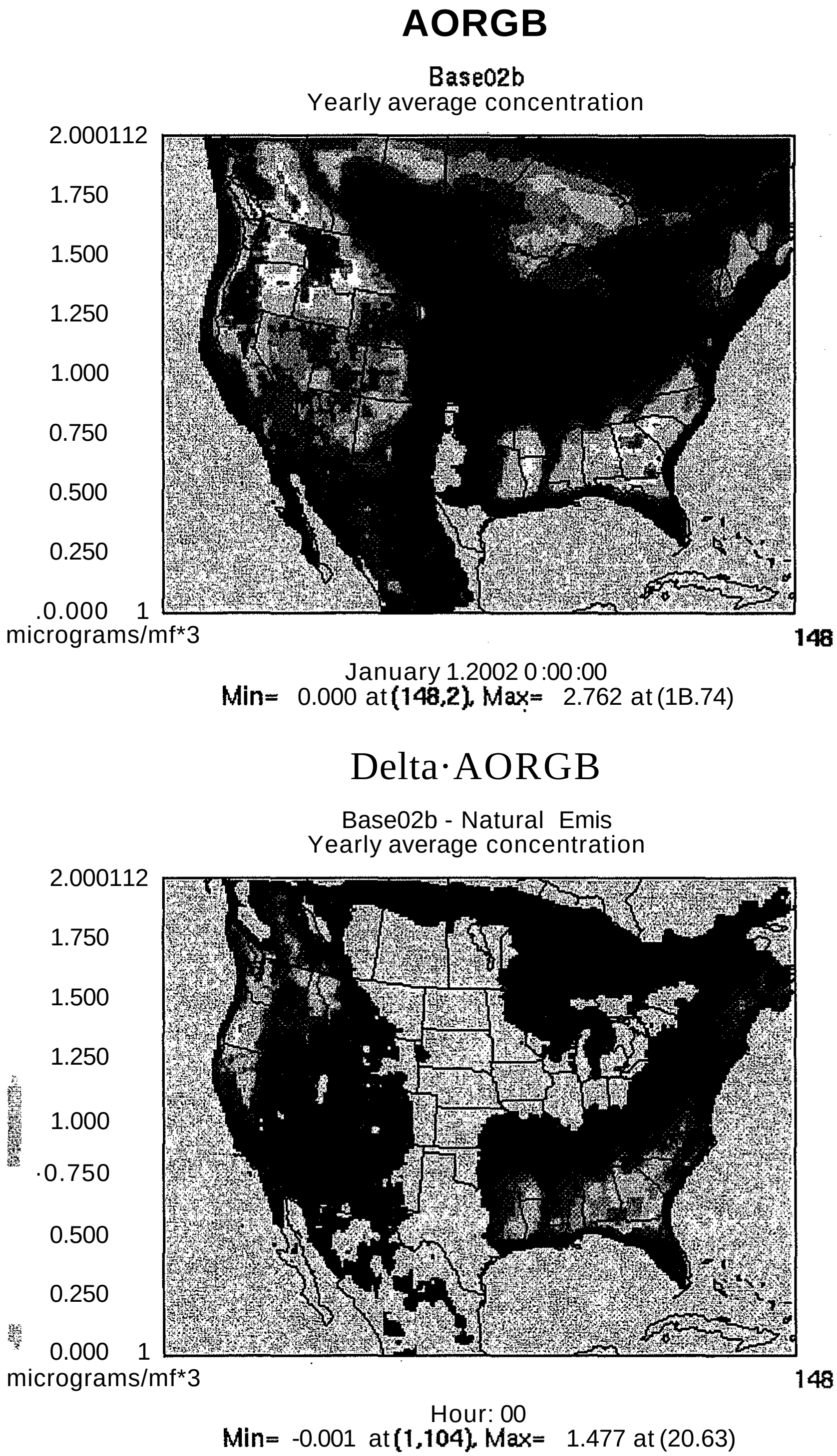



Figure 11. Annual average modeled primary biogenic OC (AORGB) in Base02b (top) and the portion that is "controllable" primary biogenic OC (bottom).

It might be difficult for the WRAP states and tribes to use these results quantitatively in developing emissions control strategies for visibility SIPs and TIPs. However, the results do provide some insight into the relative contributions of biogenic and anthropogenic OC as well as the amount of each that is controllable in the model simulations.

Finally, it is noted that there are uncertainties in the modeled emissions of anthropogenic VOCs, and larger uncertainties in the modeled emissions of biogenic VOCs. It is not possible to evaluate the model performance. individually for biogenic and anthropogenic OC because the OC measurements do not distinguish between those two forms. Instead, only comparisons of total modeled OC to total measured OC can be made. Therefore, even when the model achieves good performance for total OC, it is possible that the model may be overpredicting one component of total OC and underpredicting the other. The inability to evaluate model performance for each component of OC increases the uncertainty of the results described here and illustrated in Figures 9 through II, so caution should be used when drawing conclusions about the sources of OC based on these results.

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# APPENDIX F

Federal Land Management Agency Letters and
California's Response

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# APPENDIX G

Web links

**Web links containing information used in the California Regional Haze Plan**

General Western Regional Air Partnership (WRAP)
http://www.wrapair.org/

Air Quality Data: Visibility Information Exchange Web System (VIEWS)
http://vista.cira.colostate.edu/views/

Air Quality Data: Interagency Monitoring of Protected Visual Environments (IMPROVE) . .
http://vista.cira.colostate.edu/improve/Default.htm

Data Analysis and Technical Support: Technical Support System (TSS)
http://vista.cira.colostate.edu/tss/

Emission Inventory·Information: WRAP Emissions Data Management System
http://www.wrapedms.org

Carl Moyer Program
http://www.arb.ca.gov/msprog/moyer/moyer.htm

Climate Change Program
http://www.arb.ca.gov/cc/cc.htm

Diesel Risk Reduction Plan
http://www.arb:ca.gov/diesel/documents/rrpapp.htm

District Rules Database
http://www:arb.ca.gov/drdb/drdb.htm

Goods Movement Program
http://www.arb.ca.gov/htmllgmpr.htm

New Source Review Permitting Programs
·http://www.arb.ca.gov/nsr/nsr.htm

Senate Bill 656 Implementation
http://www.arb.ca.gov/pm/pmmeasures/pmmeasures.htm#sb656

Smoke Management Program
http://www.arb.ca.gov/smp/smp.htrri

State Strategy for California's 2007 State Implementation Plan
http://www.arb.ca.gov/planning/sip/2007sip/2007sip.htm

Vehicle Retirement Program
http://www.arb.ca.gov/msprog/avrp/avrp.htm

# APPENDIX H

## ARB BART Regulation· Comment Letter

# Air Resources Board

**Alan C. Lloyd, Ph.D.**
**Chairman**
1001 I Street · P.O. Box 2815
Sacramento, California 95812' www.arb.ca.gov

**Terry Tamininen**
*Agency Secretary*

**Arnold Schwarzenegger**
*Governor*


July 2,2004

Mr. Michael O. Leavitt
Administrator
United States Environmental Protection Agency
c/o OAR Docket
Mailcode: B102
1200 Pennsylvania Avenue, N.W.
Washington, D.C. 20460

RE: Docket ID No. OAR-2002-0076
Regional Haze Regulations and Guidelines for Best Available Retrofit Technology (BART) Determinations

Dear Administrator Leavitt:

The California Air Resources Board (ARB) appreciates the opportunity to review and comment on the United States Environmental Protection Agency (D. S. EPA) Proposed Rule for Regional Haze Regulations and Guidelines for Best Available Retrofit (BART) Detenninations. We commend U. S. EPA on harmonizing the regional haze and PM2.5 State Implementation Plan (SIP) submittal schedules. California's strategy for meeting the health-based National Ambient Air Quality Standards will be a key component in reducing regional haze in our Class 1 areas. .The common regional haze and PM2;5 SIP submittal date of January 31, 2008 allows an improved and coordinated planning process for these closely linked programs.

We also appreciate the additional flexibility provided in the revised BART Guidelines. Maintaining flexibility in measures to achieve reasonable progress goals allows states to develop appropriate strategies according to the contributions to regional haze at each Class 1 area. The proposed rule and Guidelines support state discretion in the process for determining BART-eligible sources, evaluating whether BART is required, and determining which BART controls will be most effective in each of the respective source categories.

Many California air districts have already adopted and implemented rules requiring best available retrofit control technology (BARCT) as part of planning requirements for meeting both' the federal and California health-based air quality standards. California is prepared to demonstrate that specific air district BARCT rules meet the BART-level requirements of the regional haze rule on a source category basis. This ensures that sources will have installed BART equipment and practices by the required deadline of the regional haze rule.

Given the large number of BART-eligible sources in California, this rule-based approach. provides a more efficient process, while still ensuring that the regional haze rule BART control requirements are met. It will enable the ARB and the air districts to focus more effectively on air district rules or Title V permits that must be upgraded to BART level. ARB believes that this rule-based alternative approach meets the intent of 40 CFR 51.308(e) and the BART Guidelines, and achieves the same results as a case-by-case BART determination.

Thank you for this opportunity to comment on the proposal. If you have further questions, you may contact Lynn Terry, Deputy Executive Officer at (916) 322-2739.

Sincerely,

*Signed by LMT for*

Catherine Witherspoon
Executive Officer

cc: Ms. Deborah,Jordan, Director
Air Division (AIR-I)
U.S. EPA, Region IX
75 Hawthorne Street
San Francisco, California 94105

Mr. Patrick Cummins
Western Governors Association
1515 Cleveland Place, Suite 200
Denver, Colorado 80202-5114

Lynn Terry
Deputy Executive Officer

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# APPENDIX I

SUb-Regional Emissions **Inventory**

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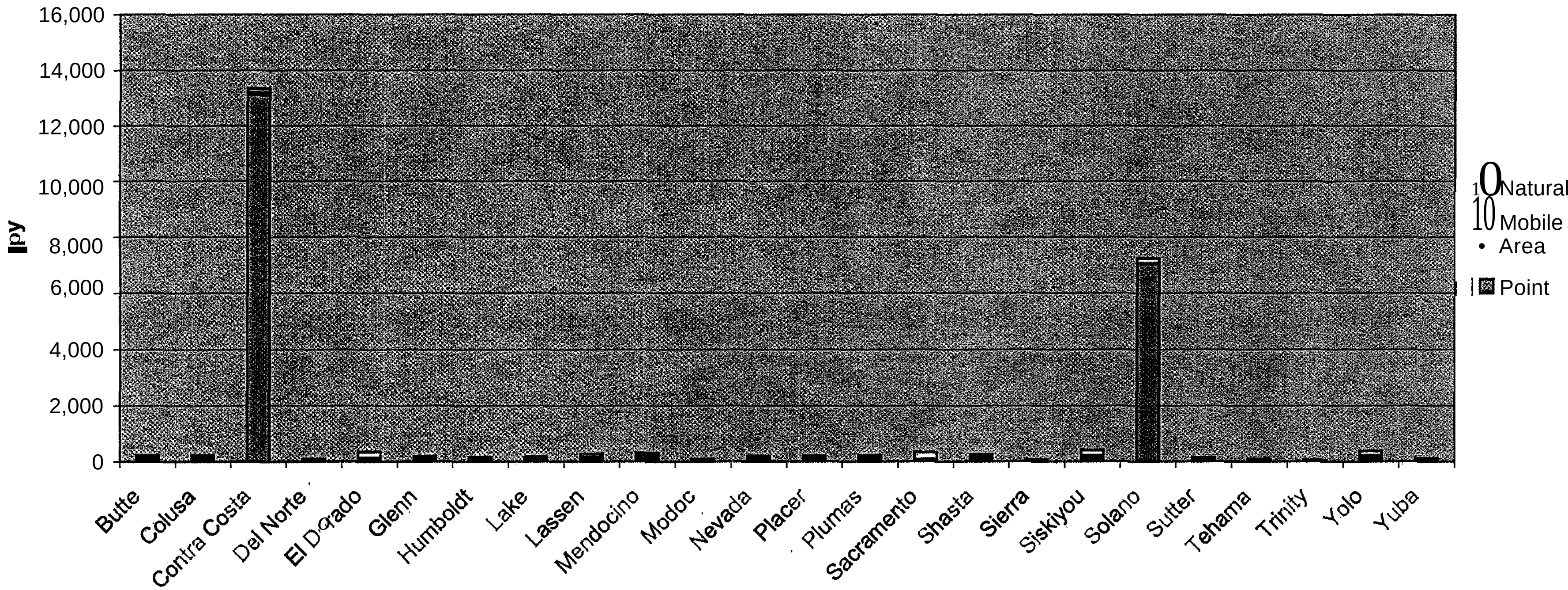
Sulfur Oxides-Northern California Region

| County | Bulte | Colusa | Contra Costa | Del Norte | EI Dorado | Glenn | Humboldt | Lake | Lassen | Mendocino | Modoc | Nevada | Placer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Poinl | 5 | 83 | 13,103 | 48 | 11 | 56 | 49 | 30 | 45 | 28 | 0 | ' 7 | 10 |
| Area | 100 | 121 | 94 | 28 | 77 | 94 | 59 | 132 | 68 | 208 | 29 | 149 | 86 |
| Mobile | 98 | 23 | 138 | 1 | 32 | 31 | 15 | 9 | 61 | 16 | 48 | 25 | 97 |
| Natural | 21 | 1 | 4 | 16 | 230 | 6 | 32 | 10 | 114 | 76 | 17 | 31 | 14 |
| County Total | 224 | 228 | 13,339 | 94 | 351 | 187 | 156 | 181 | 288 | 328 | 95 | 212 | 206 |

| County | Plumas | Sacramento | Shasta | Sierra | Siskiyou | Solano | Suiter. | Tehama | Trinity | Yolo | Yuba |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Poinl | 66 | 22 | 65 | 52 | 0 | 7,042 | 33 | 16 | 0 | 61 | 12 |
| Area | 98 | 61 | 89 | 14 | 123 | 23 | 66 | 23 | 10 | ,90 | 51 |
| Mobile | 48 | 259 | 98 | 4 | 101 | 168 | 40 | 53 | 4 | 73 | 48 |
| Natural | 27 | 1 | 23 | 1 | 193 | 6 | 0 | 2 | 33 | 168 | 1 |
| County Total | 239 | 342 | 275 | 71 | 417 | 7,239 | 139 | 94 | 47 | 392 | 112 |

## 2002 Northern California Region SOx Inventory

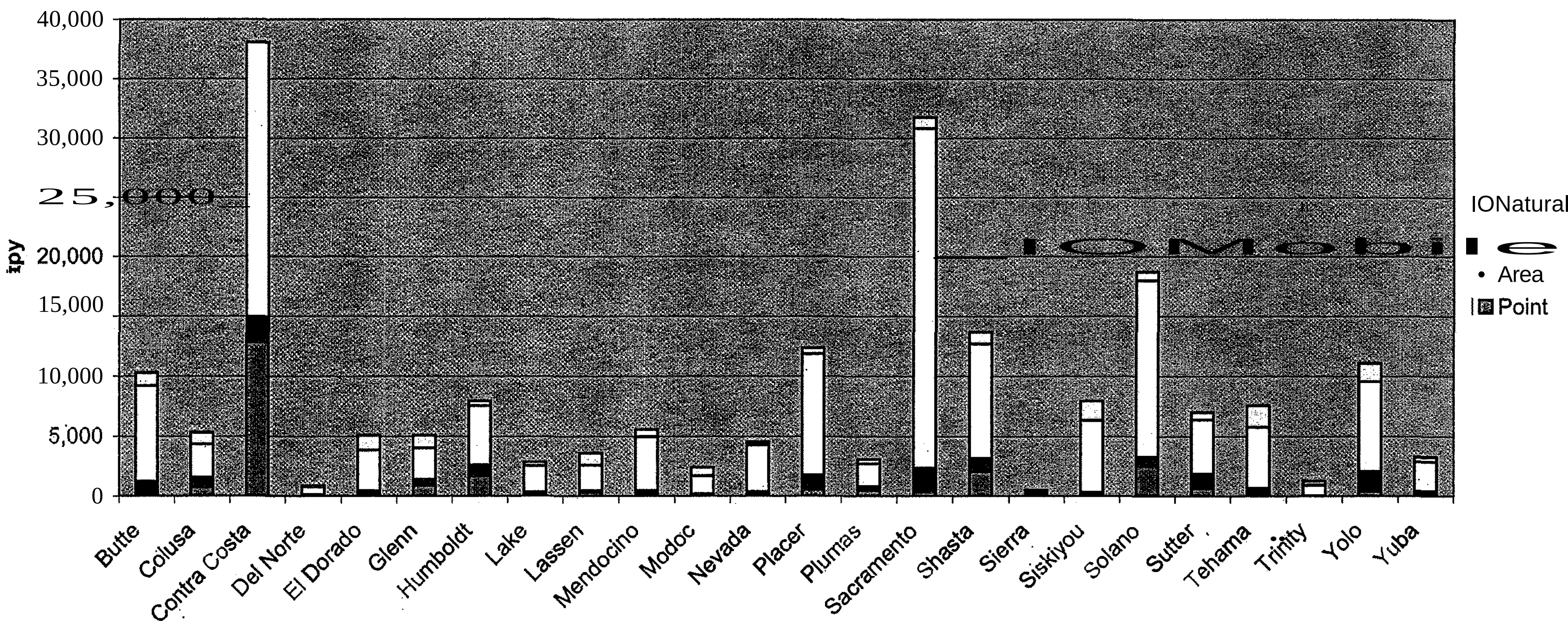


Nox-Northern California Region

| County | Bulle | Colusa | Contra Costa | Del Norte | El Dorado | Glenn | Humboldt | lake | lassen | Mendocino | Modoc | Nevada |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 220 | 751 | 12,846 | 22 | . 61 | 916 | 1,700 | 95 | 311173 | | 100 | 63 |
| Area | 1,006 | 841 | 2,125 | 64 | 385 | 500 | 911 | 257 | 155 | 328 | 81 | 315 |
| Mobile | 8,005 | 2,774 | 23,097 | 693 | 3,429 | 2,630 | 4,929 | 2,207 | 2,143 | 4,481 | 1,536 | 3,902 |
| Natural | 1,063 | 979 | 16 | 124 | 1,209 | 1,043 | 405 | 319 | 1,013 | 609 | 728 | 278 |
| Total | 10,294 | 5,344 | 38,084 | 903 | 5,084 | 5,087 | 7,945 | 2,879 | 3,622 | 5,591 | 2,445 | 4,558' |

| County | Placer | Plumas | Sacramento | Shasta | Sierra | Siskiyou | Solano | Suller | Tehama | Trinity | Yolo | Yuba |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 568· | 483 | 339 | 2,106 | 18231 | | 2;536 | 674 | 266 | 1 | 407222 | |
| Area | 1,209 | 335 | 2,022 | 1,096 | 45 | 299 | 768 | 1,195 | 427 | 51 | 1,686 | 201 |
| Mobile | 10,109 | 1,926 | 28,459 | 9,515 | 210 | 6,012 | 14,696 | 4,529 | 5,099 | 888 | 7,4792,459 | |
| Natural | 515 | 372 | 913. | 977 | 98 | 1,603 | 711 | 621 | 1,776 | 352 | 1,534 | 433 |
| Total | 12,401 | 3,116 | 31,732 | 13,694 | 535 | 7,945 | 18,711 | 7,019 | 7,567 | 1,292 | 11,107 | 3,315. |

## 2002 Northern California Region NOx Inventory



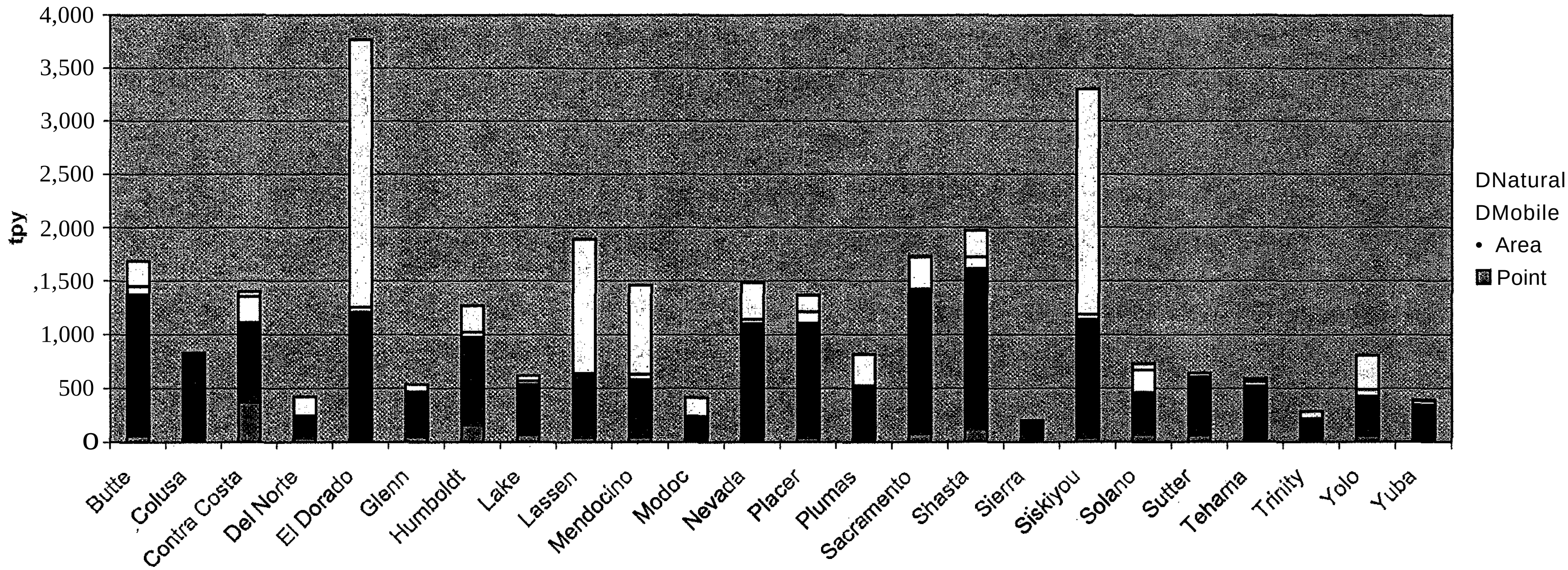

762

Organic Carbon-Northern California Region

| County | Butte | Colusa | Contra Costa | Del Norte | El Dorado | Glenn | Humboldt | Lake | Lassen | Mendocino | Modoc | Nevada | Placer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 61 | 28 | 370 | 37 | 29 | 50 | 156 | 64 | 43 | 43 | 0 | 3 | 38 |
| Area | 1,313 | 767 | ,743 | 201 | 1,180 | 393 | 818 | 470 | 576 | 538 | 229 | 1,099 | 1,070 |
| Mobile | 77 | 21 | 242 | 4 | 47 | 23 | 47 | 34 | 19 | 49 | 8 | 41 | 103 |
| Natural | 234 | 13 | 47 | 179 | 2,513 | 71 | 248 | 51 | 1,254 | 830 | 178 | 340 | 154 |
| Total | 1,684 | 830 | 1,401 | 422 | 3,768 | 536 | 1,270 | 619 | 1,891 | 1,460 | 415 | 1,483 | 1,365 |

| County | Plumas | Sacramento | Shasta | Sierra | Siskiyou | Solano | Sutter | Tehama | Trinity | Yolo | 'Yuba |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 28 | 74 | 117 | 6' | 41 | 70 | 63 | 19 | 0 | 58 | 13 |
| Area | 478 | 1,350 | 1,493 | 174 | 1,099 | 389 | 543 | 499 | 200 | 365 | 331 |
| Mobile | 19 | 296 | 108 | 7 | 49 | 211 | 37 | 43 | 16 | 64 | 36 |
| Natural | 292 | 9 | 252 | 12 | 2,112 | 62 | 0 | 27 | 68 | 321 | 11 |
| Total | 817 | 1,729 | 1,970 | 200 | 3,301 | 732 | 643 | 588 | 284 | 808 | 392 |

## 2002 Northern California Region Organic Carbon Inventory ,



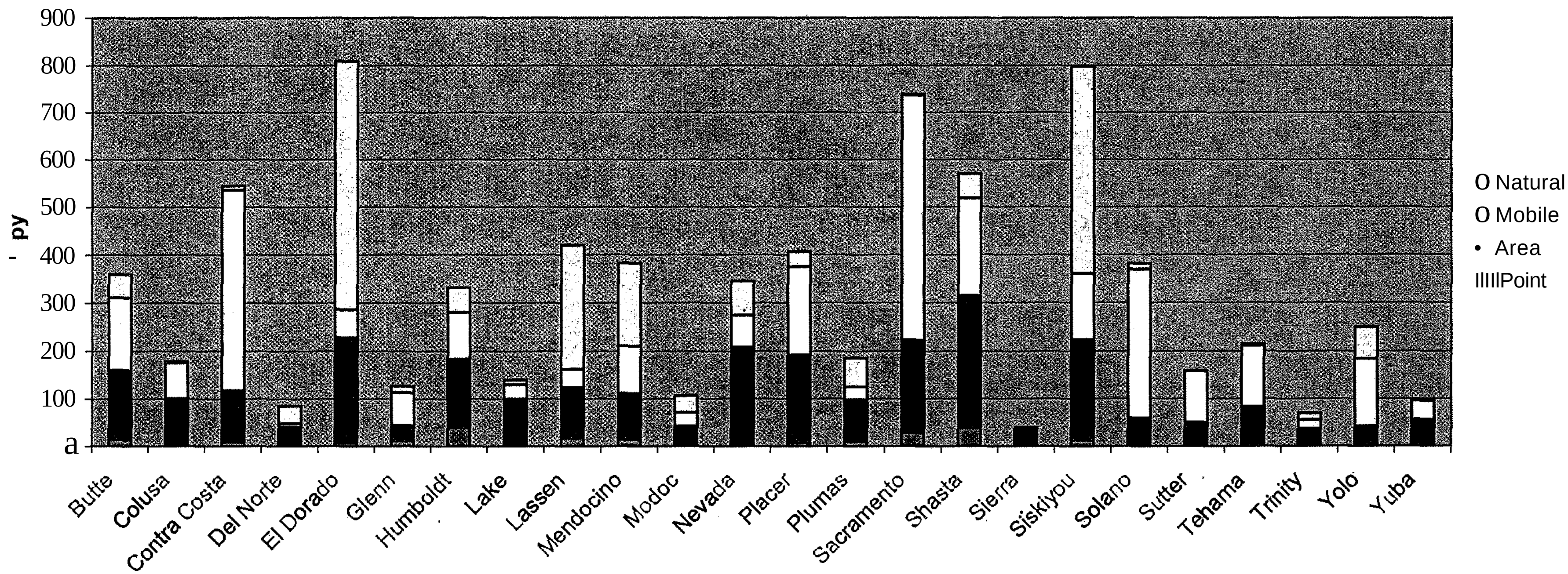

763

Elemental Carbon-Northern California Region

| County | Butte | Colusa | Contra Costa | Del Norte | El Dorado | Glenn | Humboldt | Lake | Lassen | Mendocino | Modoc | Nevada | Placer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 14 | 1 | 9 | 2 | 8 | 12 | 39 | 2 | 11 | 14 | 0 | 2 | 7 |
| Area | 146 | 101 | 108 | 39 | 221 | 33 | 144 | 98 | 107 | 97 | 43 | 207 | 185 |
| Mobile | 1'51 | 74 | 418 | 7 | 58 | 68 | 97 | 30 | 38 | 99 | 29 | 66 | 183 |
| Natural | 48 | 2 | 9 | 37 | 522 | 14 | 51 | 10 | 258 | 172 | 35 | 71 | 32 |
| Total | 359 | 178 | 545 | 85 | 809 | 127 | 332 | 140 | 420 | 383 | 107 | 345 | 407 |

| County | Plumas | Sacramento | Shasta | Sierra | Siskiyou | Solano | Sutter | Tehama | Trinity | Yolo | Yuba |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 9 | 28 | 38 | 2 | 12 | 4 | 1 | 3 | 0 | 7 | 3 |
| Area | 88 | 194 | 276 | 32 | 211 | 55 | 49 | 81 | 37 | 36 | 53 |
| Mobile | 27 | 514 | 204 | 3 | 137 | 310 | 108 | 128 | 19 | 141 | 40 |
| Natural | 60 | 1 | 51 | 2 | 438 | 12 | 0 | 3 | 14 | 66 | 2 |
| Total | 185' | 738 | 570 | 39 | 798 | 382 | 158 | 215 | 70 | 250 | 98 |

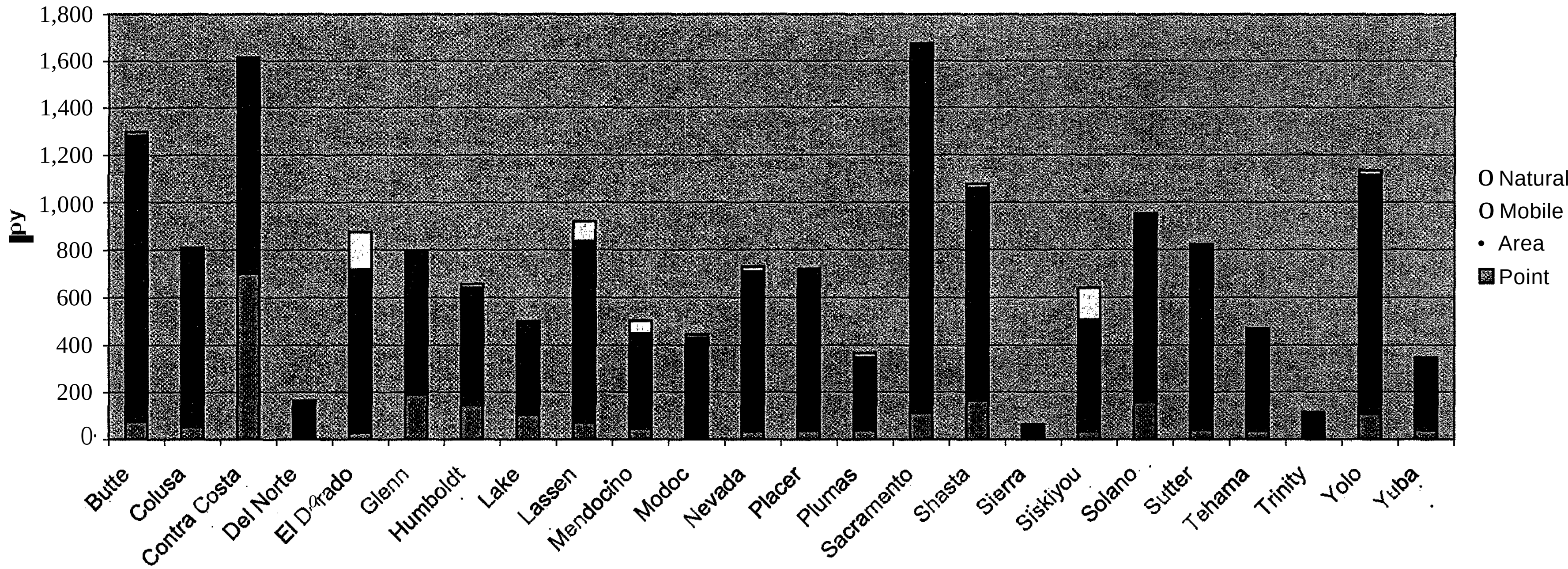
## 2002 Northern California Region Elemental Carbon Inventory



Fine Particulate Matter-Northern California Region

| County | Butte | Colusa | Contra Costa | Del Norte | El Dorado | Glenn | Humboldt | Lake | Lassen | Mendocino | Modoc | Nevada | Placer | Plumas | Sacramento | Shasta | Sierra | Siskiyou | Solano | Sutter | Tehama | Trinity | Yolo | Yuba |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 75 | 53 | 700 | 6 | 28 | 189 | 145 | 105 | 71 | 45 | 0 | 35 | 37 | 39 | 113 | 165 | 6 | 35 | 159 | 40 | 38 | 0 | 109 | 40 |
| Area | 1,208 | 755 | 910 | 148 | 690 | 604 | 495 | 391 | 766 | 404 | 429 | 673 | 672 | 308 | 1,560 | 895 | 57 | 472 | 789 | 783 | 425 | 111 | 1,005 | 306 |
| Mobile | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Natural | 15 | 2 | 4 | 11 | 157 | 6 | 16 | 4 | 83 | 53 | 15 | 22 | 11 | 18 | 2 | 18 | 1 | 134 | 5 | 0 | 7 | 4 | 21 | 1 |
| Total | 1,298 | 809 | 1,614 | 165 | 874 | 799 | 657 | 500 | 920 | 502 | 445 | 729 | 720 | 366 | 1,675 | 1,079 | 64 | 640 | 953 | 823 | 470 | 116 | 1,135 | 347 |

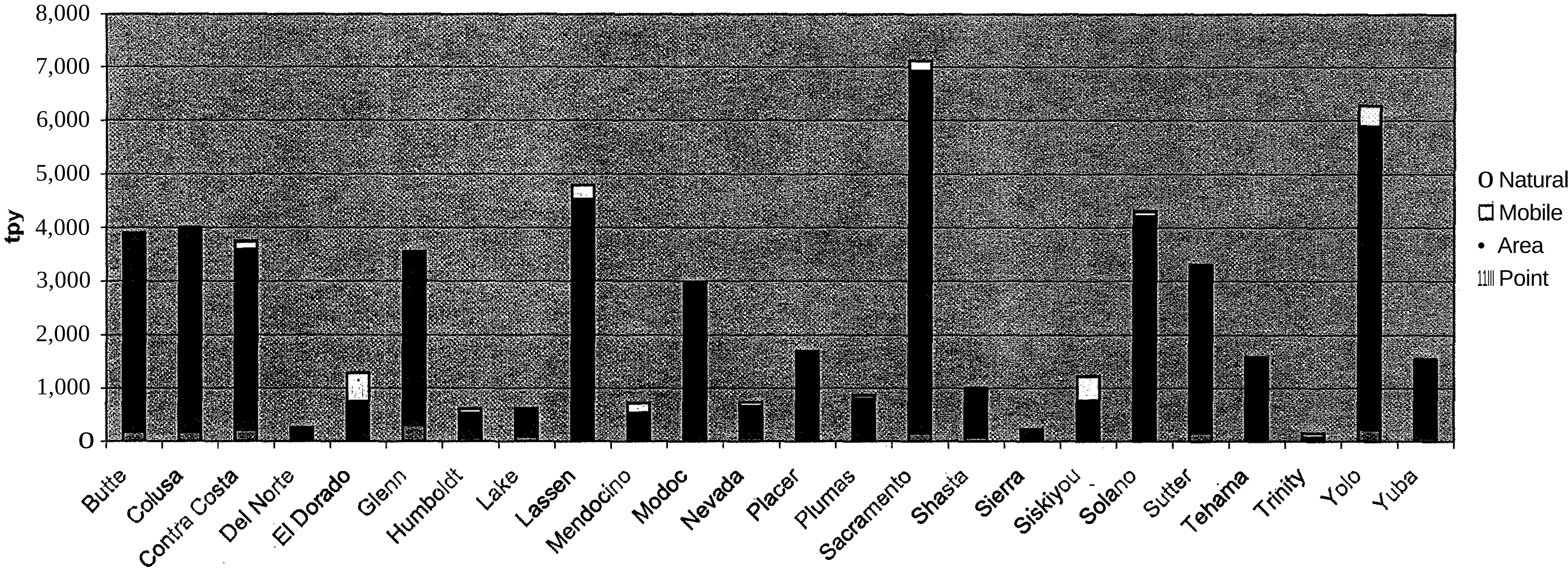
## .2002 Northern California Region Fine Particulate Matter Inventory



Coarse Particulate Matter-Northern California Region

| County | Butte | Colusa | Contra Costa | Del Norte | El Dorado | Glenn | Humboldt | Lake | Lassen | Mendocino | Modoc | Nevada | Placer | Plumas | Sacramento | Shasta | Sierra | Siskiyou | Solano | Sutter | Tehama | Trinity | Yolo | Yuba |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 173 | 168 | 217 | 22 | 12 | 304 | 66 | 88 | 14 | 14 | 0 | 72 | 31 | 30 | 153 | 80 | 1 | 10 | 42 | 165 | 42 | 0 | 226 | 65 |
| Area | 3,634 | 3,823 | 3,367 | 197 | 710 | 3,228 | 450 | 504 | 4,503 | 508 | 2,933 | 566 | 1,571 | 774 | 6,776 | 844 | 229 | 739 | 4,171 | 3,125 | 1,523 | 75 | 5,627 | 1,480 |
| Mobile | 35 | 8 | 150 | 2 | 21 | 8 | 22 | 9 | 5 | 19 | 2 | 21 | 59 | 3 | 185 | 41 | 0 | 23 | 89 | 18 | 22 | 4 | 37 | 8 |
| Natural | 50 | 2 | 10 | 39 | 541 | 15 | 76 | 23 | 266 | 178 | 39 | 73 | 33 | 63 | 1 | 53 | 2 | 454 | 13 | 0 | 4 | 77 | 394 | 2 |
| Total | 3,892 | 4,001 | 3,744 | 259 | 1,285 | 3,554 | 614 | 624 | 4,788 | 720 | 2,974 | 733 | 1,695 | 870 | 7,116 | 1,018 | 233 | 1,225 | 4,314 | 3,307 | 1,590 | 156 | 6,284 | 1,556 |

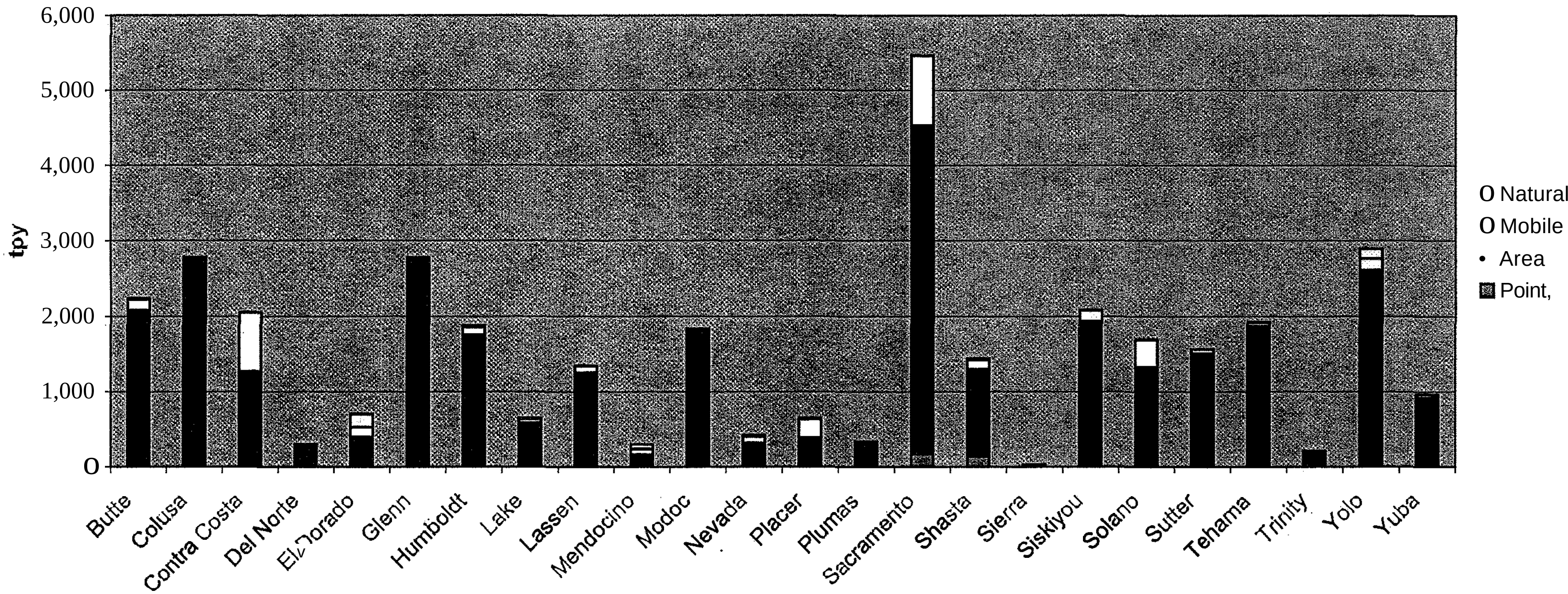
## 2002 Northern California Region Coarse Particulate Matter Inventory



Ammonia-Northern California Region

| County | Butte | Colusa | Contra C | Del Nor | El Dorad. | Glenn | Humboldt | Lake | Lassen | Mendocino | Modoc | Nevada | Placer | Plumas | Sacramento | Shasta | Sierra | Siskiyou | Solano | Sutter | Tehama | Trinity | Yolo | Yuba |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 174 | 137 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Area | 2;077 | 2,766 | 1;266 | 270 | 391 | 2,751 | 1,752 | 583 | 1,226 | 161 | 1,810 | 316 | 381 | 294 | 4,357 | 1,159' | 21 | 1,892 | 1,321 | 1,504 | 1,870 | 177 | 2,612 | 914 |
| Mobile | 145 | 15 | 782 | 18 | 134 | 22 | 102 | 55 | 26 | 76 | 7 | 82 | 251 | 24 | 931 | 126 | 7 | 39 | 364 | 59 | 47 | 11 | 152 | 43 |
| Natural | 17 | 2 | 4 | 13 | 176 | 6 | 25 | 8 | 90 | 59 | 15 | 24 | 11 | 21 | 1 | 19 | 1 | 149 | 5 | 0 | 4 | 25 | 128 | 1 |
| Total | 2,238 | 2,782 | 2,052 | 300 | 701 | 2,779 | 1,880 | 646 | 1,341 | 296 | 1,832 | 422 | 643 | 339 | 5,463 | 1,440 | 29 | 2,080 | 1,690 | 1,563 | 1,921 | 213 | 2,893 | 957 |

## 2002 Northern California Region Ammonia Inventory

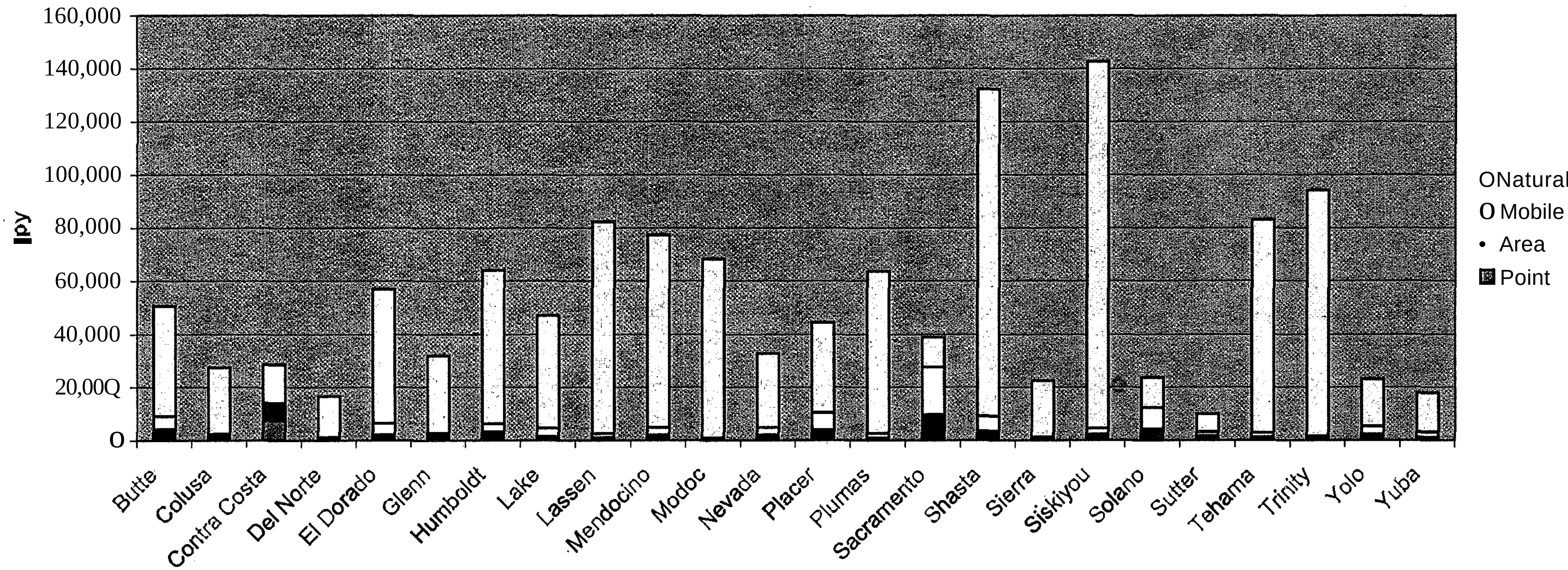



767

Volatile Organic Compounds-Northern California Region

| County | Butte | Colusa | Contra Costa | Del Norte | El Dorado | Glenn | Humboldt | Lake | Lassen | Mendocino | Modoc | Nevada | Placer | Plumas | Sacramento | Shasta | Sierra | Siskiyou | Solano | Sutter | Tehama | Trinity | Yolo | Yuba |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 23 | 257 | .7,534 | 53 | 16 | 554 | 407 | 110 | 19 | 70 | 0 | 23 | 111 | 73 | 492 | 103 | 12 | 78 | 1,222 | 50 | 45 | 0 | 291 | 65 |
| Area | 4,283 | 1,472 | 6,563 | 590 | 2,186 | 1,433 | 2,886 | 1,399 | 1,102 | 1,928 | 627 | 1,999 | 3,939 | 889 | 9,255 | 3,379 | 267 | 2,251 | 3,097 | 1,601 | .1,116 | 510 | 1,966 | 1,044 |
| Mobile | 4,868 | 783 | 14,546 | 513 | 4,274 | 840 | 3,012 | 3,061 | 1,440 | 2,763 | 398 | 2,752 | 6,450 | 1,751 | 17,836 | 5,636 | 971 | 2,195 | 7,967 | 1,592 | 1,665 | 949 | 3,051 | 1,999 |
| Natural | 41,431 | 25,018 | 35 | 15,586 | 50,608 | 29,053 | 57,743 | 42,593 | 79,673 | 72,519 | 67,274 | 28,003 | 33,995 | 60,878 | 11,301 | 122,926 | 21,122 | 138,184 | 11,302 | 6,751 | 80,136 | 92,653 | 17,749 | 14,682 |
| Total | 50,605 | 27,530 | 28,678 | 16,743 | 57,084 | 31,881 | 64,049 | 47,163 | 82,234 | 77,280 | 68,298 | 32,777 | 44,495 | 63,591 | 38,885 | 132,045 | 22,371 | 142,708 | 23,589 | 9,995 | ·82,962 | 94,112 | 23,057 | 17,790 |

## 2002 Northern California Region Volatile Organic Compound Inventory



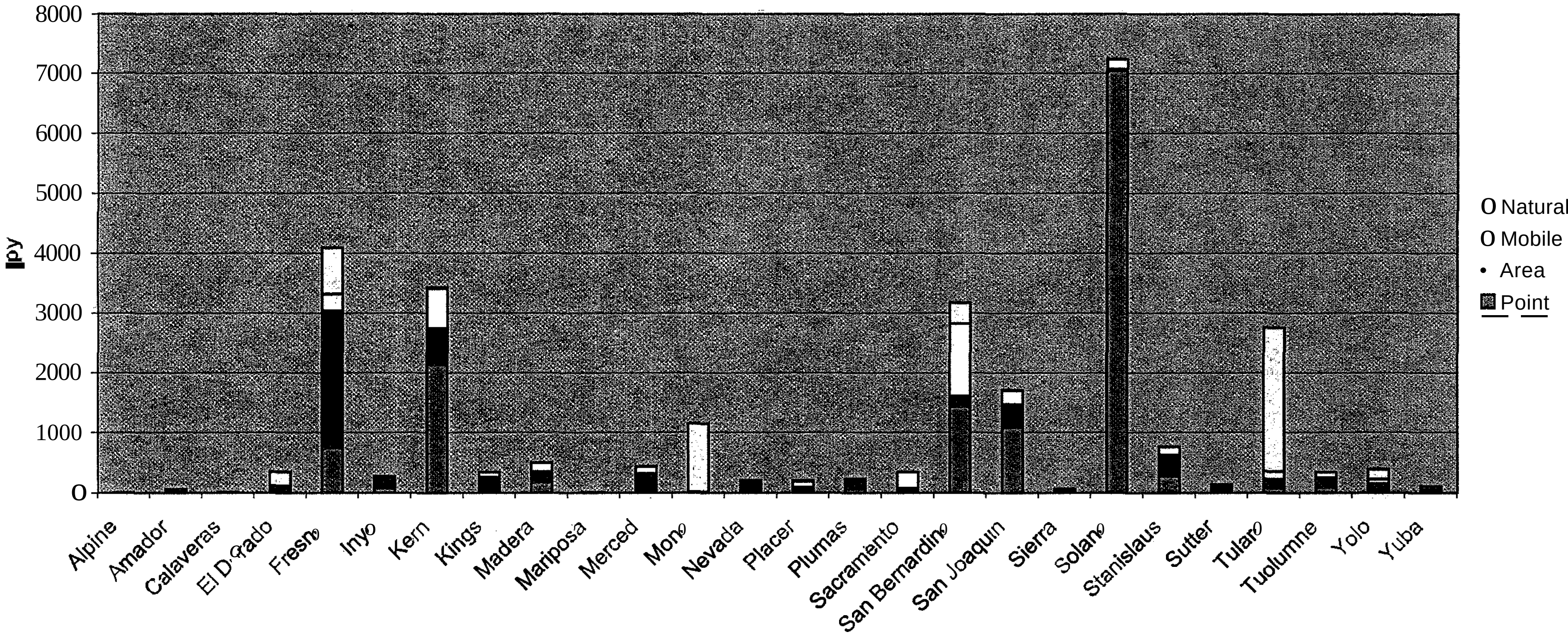

768

Sulfur Dioxide-Sierra Region

| County | Alpine | Amador | Calaveras | El Dorado | Fresno | Inyo | Kern | Kings | Madera | Meriposa | Merced | Mono | Nevada | Placer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 0 | 29 | 0 | 11 | 744 | 76 | 2126 | 47 | 176 | 0 | 11 | 6 | 7 | 10 |
| Area | 7 | 17 | 13 | 77 | 2288 | 146 | 618 | 214 | 125 | 13 | 312 | 11 | 149 | 86 |
| Mobile | 1 | 7 | 5 | 32 | 285 | 13 | 663 | 82 | 52 | 1 | 114 | 3 | 25 | 97 |
| Natural | 3 | 12 | 1 | 230 | 773 | 44 | 20 | 1 | 147 | 3 | 2 | 1129 | 31 | 14 |
| Total | 11 | 65 | 18 | 351 | 4090 | 279 | 3427 | 344 | 499 | 17 | 439 | 1149 | 212 | 206 |

| County | Plumas | Sacramento | San Bernardino | San Joaquin | Sierra | Solano | Stanislaus | Sutter | Tulare | Tuolumne | Yolo | Yuba |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 66 | 22 | 1437 | 1084 | 52 | 7042 | 277 | 33 | 88 | 96 | 61 | 12 |
| Area | 98 | 61 | 170 | 383 | 14 | 23 | 356 | 66 | 147 | 136 | 90 | 51 |
| Mobile | 48 | 259 | 1215 | 236 | 4 | 168 | 134 | 40 | 126 | 21 | 73 | 48 |
| Natural | 27 | 1 | 344 | 4 | 1 | 6 | 0 | 0 | 2394 | 96 | 168 | 1 |
| Total | 239 | 342 | 3166 | 1708 | 71 | 7239 | 768 | 139 | 2755 | 348 | 392 | 112 |

## 2002 Sierra Region SOx Inventory

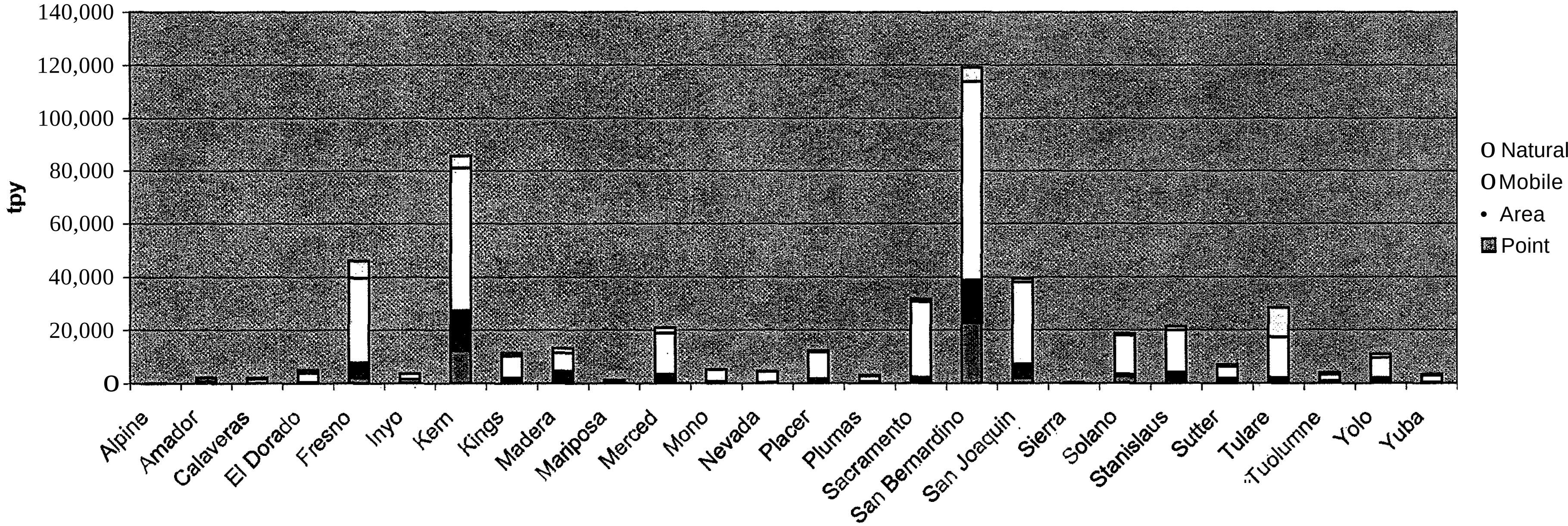


Nox-Sierra Region

| County | Alpine | Amador | Calaveras | El Dorado | Fresno | Inyo | Kern | Kings | Madera | Mariposa | Merced | Mono | Nevada | Placer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 0 | 299 | 0 | 61 | 2,159 | 211 | 12,262 | 316 | 822 | 0 | 809 | 1 | 63 | 568 |
| Area | 25 | 529 | 101 | 385 | 5,825 | 84 | 15,161 | 1,806 | 3,918 | 74 | 2,658 | 52 | 315 | 1,209 |
| Mobile | 138 | 1,164 | 1,548 | 3,429 | 31 ,703 | 1,301 | 53,609 | 8,221 | 6,725 | 594 | 15,455 | 842 | 3,902 | 10,109 |
| Natural | 75 | 330 | 572 | 1,209 | 6,420 | 2,098 | 4,674 | 1,268 | 1,909 | 622 | 2,018 | 4,410 | 278 | 515 |
| Total | 238 | 2,322 | 2,222 | 5,084 | 46,107 | 3,693 | 85,705 | 11,612 | 13,373 | .1,289 | 20,940 | 5,304 | 4,558 | 12,401 |

| County | Plumas | Sacramento | San Bernardino | san Joaquin | Sierra | Solano | Stanislaus | SUiter | Tulare | Tuolumne | Yolo | Yuba |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 483 | 339 | 22,769 | 2,030 . | 182 | . 2,536·· | 951. | 674 | 372 | 344 | 407 | 222 |
| Area | 335 | 2,022 | 15,971 | 5,180 | 45 | 768 | 3,121 | 1,195 | 1,823 | 550 | 1,686 | 201 |
| Mobile | 1,926 | 28,459 | 75,108 | 30,813 | 210 | 14,696 | 15,783 | 4,529 | 15,234 | 2,299 | 7,479 | 2,459 |
| Natural | .372 | 913 | 5,208 | 1,356 | 98 | 711 | 1,471 | 621 | 11,122 | 860 | 1,534 | 433 |
| Total | 3,116 | 31,732 | 119,055 | 39,379 | 535 | 18,711 | 21,325 | 7,019 | 28,552 | 4,054 | 11,107 | 3,315 |

## 2002 Sierra Region NOx Inventory



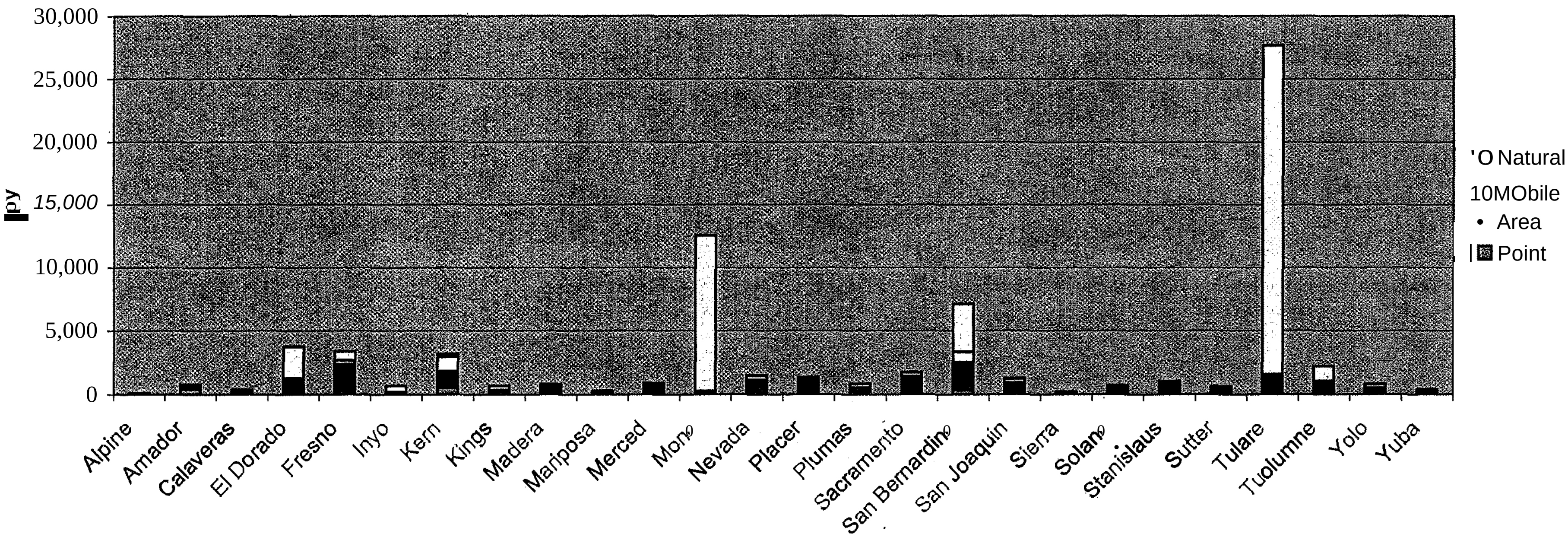

770

Organic Carbon-Sierra Region

| County | Alpine | Amador | Calaveras | El Dorado | **Fresno** | Inyo | Kern | Kings | Madera | Mariposa | Merced | Mono | Navada |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 0 | 434 | 0 | 29 | 135 | 10 | 530 | 39· | 24 | 0 | 20 | 0 | 3 |
| Area | 67 | 230 | 340 | 1,180 | 2,218 | 177 | 1,280 | 313 | 599 | 261 | .696 | 267 | 1,099 |
| Mobile | 1 | 13 | 40 | 47 | 323 | 10 | 1,136 | 331 | 74 | 20 | 148 | 7 | 41 |
| Natural | 32 | 127 | 8 | 2,513 | 707 | 480 | 216 | 9 | 111 | 32 | 23 | 12,279 | 340 |
| Total | 99 | 803 | 389 | 3,768 | 3,384 | 677 | 3,162 | 692 | 808 | 314 | 886 | 12,554 | 1,483 |

| County | Placer | Plumas | Sacramento | San Bernardino | San Joaquin | Sierra | Solano | Stanislaus | Sutler | Tulare | Tuolumne | Yolo | Yuba |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 38 | 28 | 74 | 324 | 44 | 6 | ·70 | 30 | 63 | 30 | 36 | 58 | 13 |
| Area | 1,070 | 478 | 1,350 | 2,206 | 884 . | 174 | 389 | 838 | 543 | 1,379 | 979 | 365 | 331 |
| Mobile | 103 | 19 | 296 | 805 | 298 | 7 | 211 | 155 | 37 | 135 | 34 | 64 | 36 |
| Natural | 154 | 292 | 9 | 3,768 | 46 | 12 | 62 | 8 | 0 | 26,138 | 1,154 | 321 | 11 |
| Total | 1.365 | 817 | 1,729 | 7,104 | 1,271 | 200 | 732 | 1,032 | 643 | 27,682 | 2,201 | 808 | 392 |

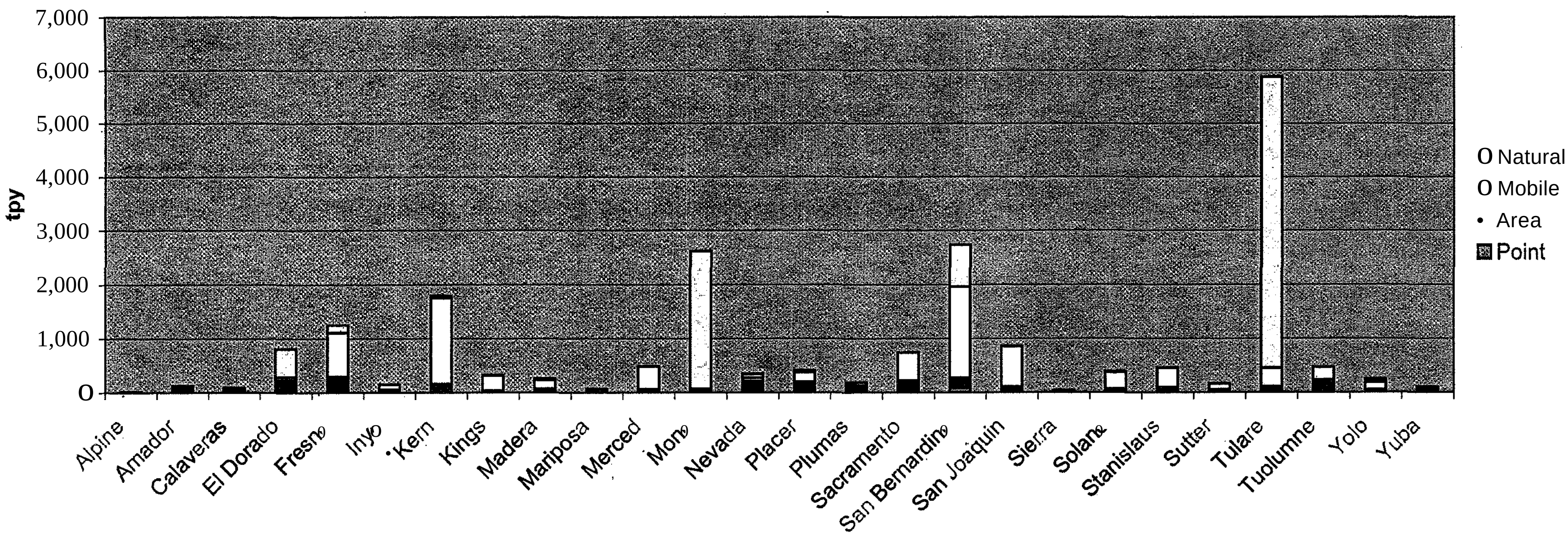
## 2002 Sierra Region Organic Carbon Inventory



Elemental Carbon-Sierra Region

| County | Alplna | Amador | Calavaras | EJ Dorado | Fresno | Inyo | Kern | Kings | Madara | Mariposa | Merced | Mono | Nevada | Placer | Plumas | Sacramento | San Bernerdlno | San Joaquin | Sierra | Solano | Stanlsleus | Sutter | Tulare | Tuolumne | Yolo | Yuba |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 0 | 53 | 0 | 8 | 12 | 3 | 30 | 7 | 4 | 0 | 0 | 0 | 2 | 7 | 9 | 28 | 85 | 9 | 2 | 4 | 2 | 1 | 4 | 11 | 7 | 3 |
| Area | 13 | 40 | 64 | 221 | 284 | 29 | 123 | 29 | 64 | 50 | 58 | 47 | 207 | 185 | 88 | 194 | 184 | 100 | 32 | 55 | 88 | 49 | 102 | 190 | 36 | 53 |
| Mobile | 3 | 14 | 27 | 58 | 811 | 22 | 1,601 | 286 | '166 | 11 | 423 | 16 | 66 | 183 | ' 27 | 514 | 1,689 | 745 | 3 | 310 | 364 | 108 | 343 | 27 | 141 | 40 |
| Natural | 7 | 26 | 1 | 522 | 146 | 99 | 37 | 1 | 22 | 6 | 3 | 2,551 | 71 | 32 | 60 | 1 | 777 | 9 | 2 | 12 | 0 | 0 | 5,430 | 239 | 66 | 2 |
| Total | 23 | 132 | 92 | 809 | 1,253 | 153 | 1,792 | 323 | 256 | 67 | 485 | 2,615 | 345 | 407 | 185 | 738 | 2,736 | 862 | 39 | 382 | 454 | 158 | 5,879 | 467 | 250 | 98 |

## 2002 Sierra Region Elemental Carbon Inventory





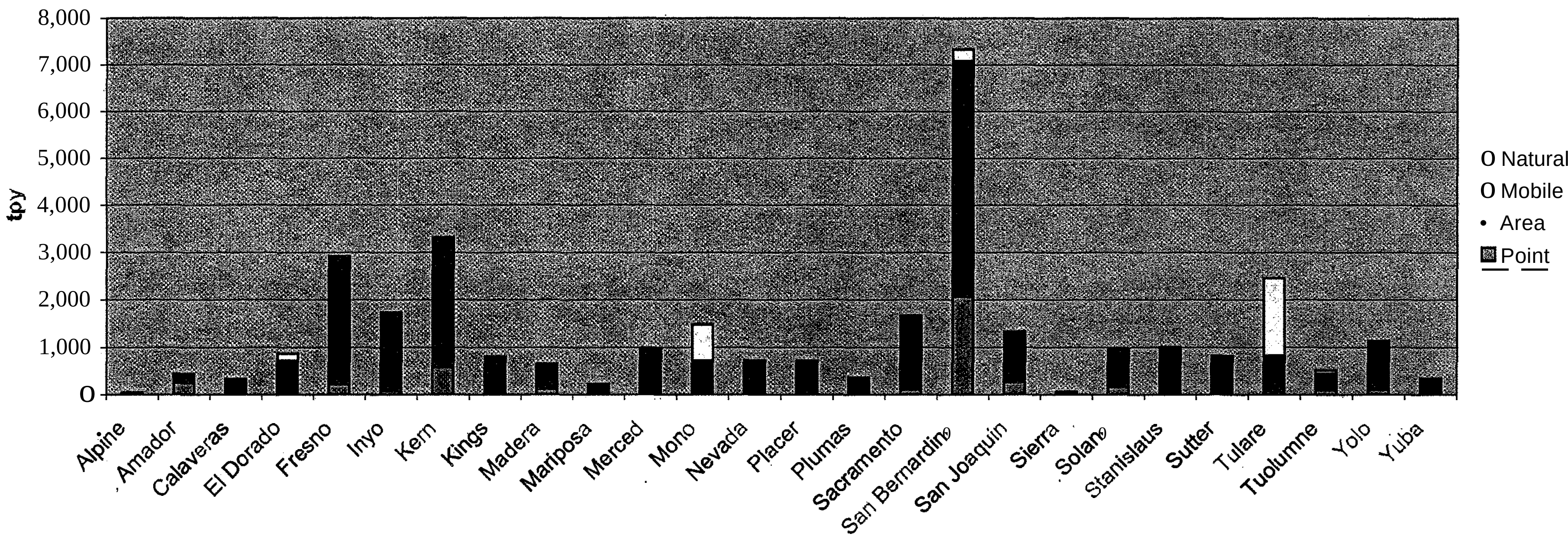

772

Fine Particulate Matter-Sierra Region

| County | Alpine | Amador | Calaveras | El Dorado | **Fresno** | Inyo | Kern | Kings | Madera | Mariposa | Merced | Mono | Nevada |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 0 | 252 | 0 | 28 | 224 | 70 | . 577- | 55, | 124 | 3 | 32 | 10 | 35 |
| Area· | 38 | 180 | 325 | 690 | 2,644 | 1,633 | 2,711 | 752 | 522 | 220 | 950 | 706 | 673 |
| Mobile | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Natural | 2 | 9 | 2 | 157 | 47 | 32 | 31 | 2 | 9 | '4 | 4 | 766 | 22 |
| Total | 40 | 441 | 327 | 874 | 2,915 | 1,735 | 3,319 | 810 | 655 | 227 | 987 | 1,482 | 729 |

| County | Placer | Plumas | Sacramento | San Bernardino | San Joaquin | Sierra | Solano | Slanlslaus | Sutler | Tulare | Tuolumne | Yolo | Yuba . |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 37 | 39 | 113 | 2,068 | 266 | 6 | 159 | 51 | 40 | 74 | 103 | 109 | 40 |
| Area· | 672 | 308 | 1,560 | 5,015 | 1,064 | 57 | 789 | 951 | 783 | 749 | 349 | 1,005 | 306 |
| Mobile | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Natural | 11 | 18 | 2 | 248 | 4 | ' 1 | 5 | 3 | 0 | 1,633 | 73 | 21 | 1 |
| Total | 720 | 366 | 1,675 | 7,331 | 1,335 | 64 | 953 | 1,005 | 823 | 2,456 | 525 | 1,135 | 347 |

## 2002 Sierra Region Fine Particulate Matter'lnventory

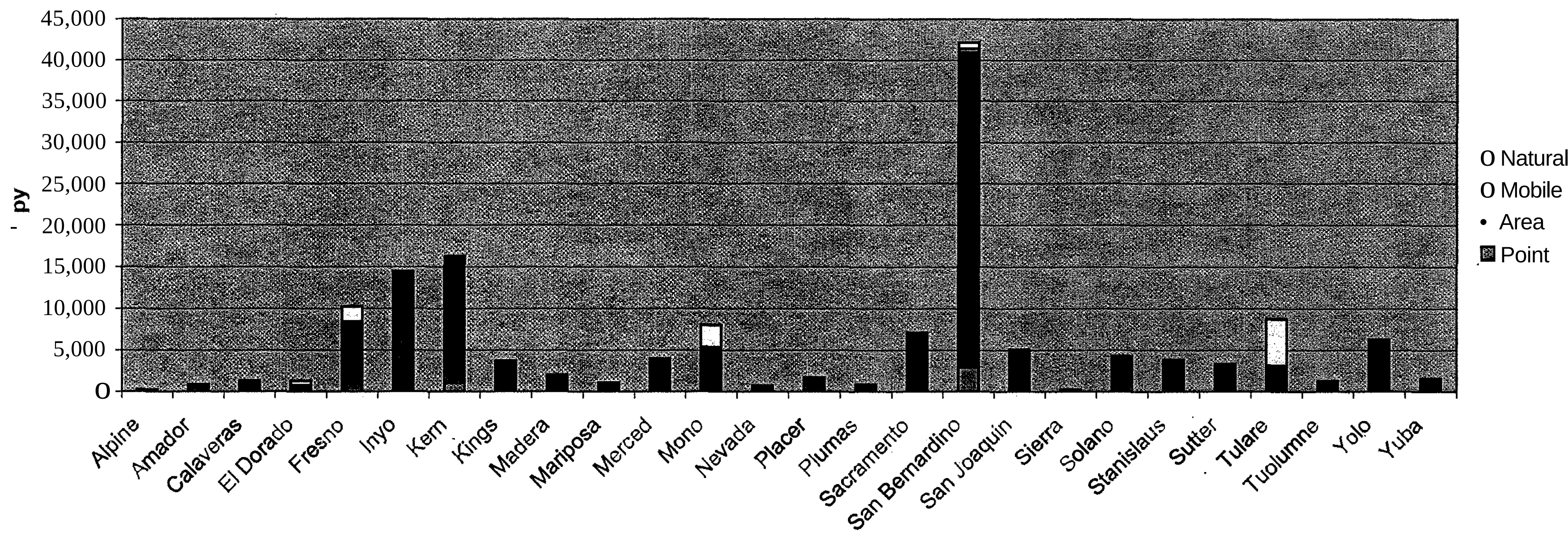


Coarse Particulate Matter-Sierra Region

| County | Alpine | Amador | Calaveras | El Dorado | Fresno | Inyo | Kern | Kings | Madera | Mariposa | Merced | Mono | Nevada |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 0 | 233 | 0 | 12 | 404 | 124 | 995 | 161 | 48 | 7 | 68 | 23 | 72 |
| Area | 216 | 604 | 1,274 | 710 | 7,880 | 14,263 | 15,027 | 3,488 | 1,593 | 1,046 | 3,814 | 5,350 | 566 |
| Mobile | 0 | .6 | 7 | 21 | 164 | 7 | 255 | 40 | 34 | 4 | 83 | 5 | 21 |
| Natural | 7 | 27 | 1 | 541 | 1,818 | 103 | 43 | 1 | 345 | 6 | 4 | 2,656 | 73 |
| Total· | 223 | 871 | 1,282 | 1,28.5 | 10,266 | 14,497 | 16,321 | 3,690 | 2,020 | 1,063 | ·3,969 | 8,033 | 733 |

| County | Placer | Plumas | Sacramento | San Bernardino | San Joaquin | Sierra | Solano | Stanislaus | SUller | Tulare | Tuolumne | Yolo | Yuba |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 31 | 30 | 163 | 2,877 | 271 | 1· | 42 | 88 | 165 | 138 | 111 | 226 | 65 |
| Area | 1,571 | 774 | 6,776 | 38,094 | 4,693 | 229 | 4,171 | 3,651 | 3,125 | 2,903 | 913 | 5,627 | 1,480 |
| Mobile | 59 | 3 | 185 | ·406 | 123 | 0 | 89 | 83 | 18 | 66 | 8 | 37 | 8 |
| Natural | 33 | 63 | 1 | 807 | 9 | 2 | 13 | 1 | 0 | 5,633 | 225 | 394 | 2 |
| Total· | 1,695 | 870 | 7,116 | 42,184 | 5,097 | 233 | 4,314 | 3,823 | 3,307 | 8,739 | 1,257 | 6,284 | 1,556 |

## 2002 Sierra Region Coarse Particulate Matter Inventory

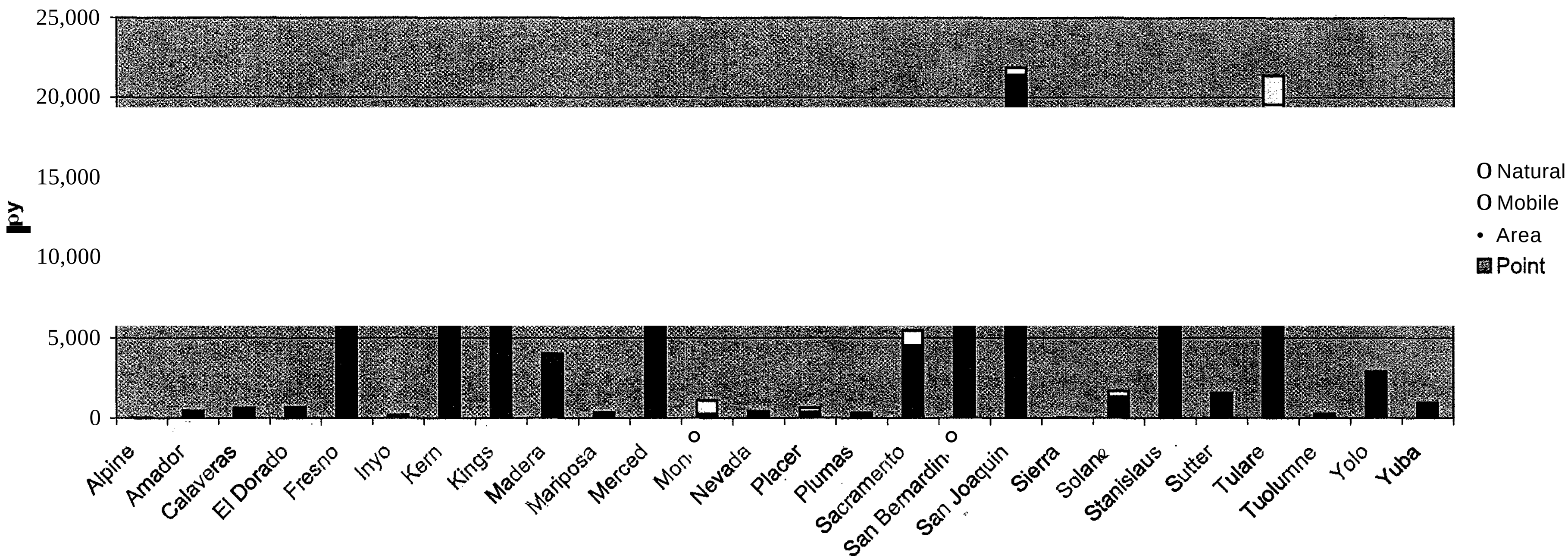


. Ammonia-Sierra Region

| County | Alpine | Amador | Calaveras | El Dorado | Fresno | Inyo | Kern | Kings | Madera | Mariposa | Merced | Mono | Nevada |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 0 | 0 | 0 | 0 | 0 | 0 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| Area | 38 | 416 | 591 | 391 | 14,259 | 136 | 10,492 | 8,585 | 3,816 | 361 | 12,959 | 228 | 316 |
| MObile | 1 | 34 | 41 | 134 | 561 | 27 | 543 | 90 | 105 | 16 | 198 | 11 | 82 |
| Natural | 2 | 9 | 1 | 176 | 592 | 35 | 24 | 1 | 113 | 3 | 3 | 864 | 24 |
| Total | 41 | 459 | 634 | 701 | 15,412 | 197 | 11,077 | 8,677 | 4,034 | 380 | 13,160 | 1,103 | 422 |

| County | Placer | Plumas | Sacramento | San Bernardino | San Joaquin | Sierra | Solano | Slanlslaus | Sutter | Tulare | Tuolumne | Yolo | Yuba |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | O- | 0 | 174 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Area | 381 | 294 | 4,357 | 10,602 | 21,410 | 21 | 1,321 | 12,546 | 1,504 | 19,291 | 131 | 2,612 | 914 |
| MObile | 251 | 24 | 931 | 1,490 | 474 | 7 | 364 | 326 | 59 | 261 | 59 | 152 | 43 |
| Natural | 11 | 21 | 1 | 270 | 4 | 1 | 5 | 2 | 0 | 1,833 | 74 | 128 | 1 |
| Total | 643 | 339 | 5,463 | 12,361 | 21,887 | 29 | 1,690 | 12,873 | 1,563 | 21,385 | 264 | 2,893 | 957 |

## 2002 Sierra Region Ammonia Inventory

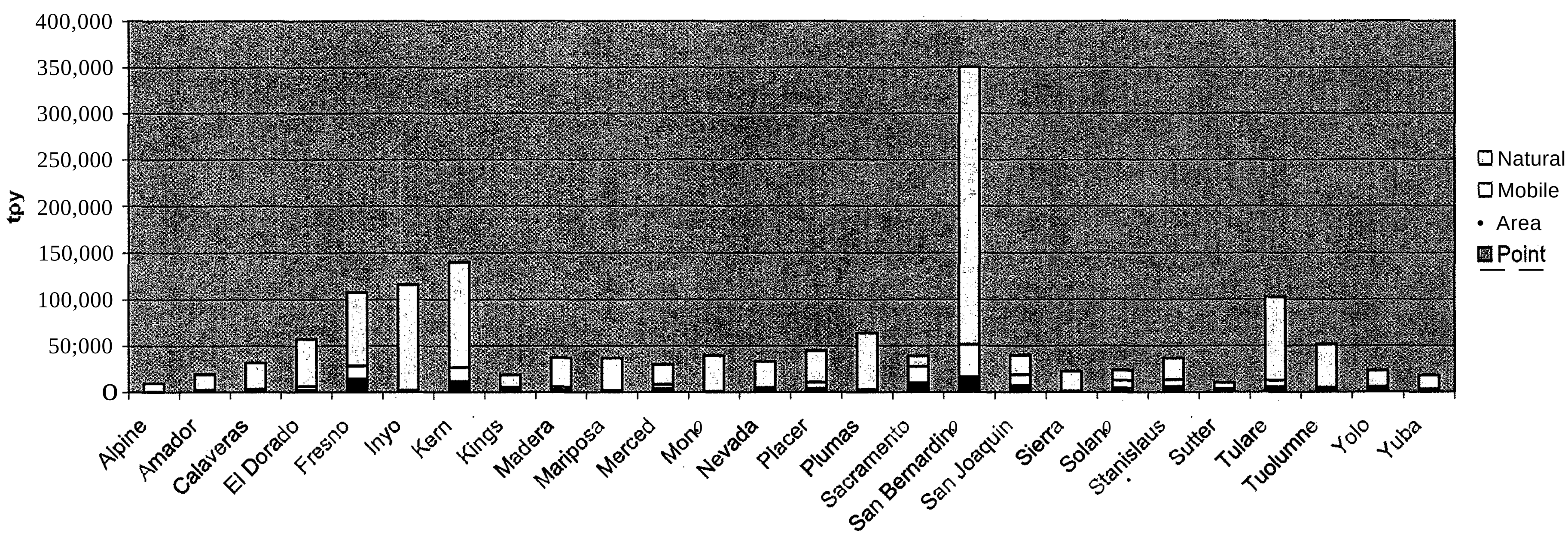


Volatile Organic Compounds-Sierra Region

| County | Alpine | Amador | Calavaras | El Dorado | Fresno | Inyo | Kern | Kings | Madera | Mariposa | Merced | Mono | Nevada | Placer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 0 | 316 | 0 | 16 | 498 | 0 | 2,278, · | 232 | 87 | 0 | 222, | 8 | 23 | 111 |
| Area | 98 | 822 | 820 | 2,186 | 13,759 | 733 | 9,427 | 1,942 | 2,518 | 549 | 3,566 | 536 | 1,999 | 3,939 |
| Mobile | 152 | 1,208 | 2,552 | 4,274 | 13,931 | 1,231 | 14,770 | 3,149 | 3,160 | 1,444 | 4,524 | 494 | 2,752 | 6,450 |
| Natural | 9,529 | 17,032 | 28,271 | 50,608 | 79,780 | ##### | ###### | 13,582 | 31,562 | 34,564 | 21,427 | 38,388 | 28,003 | 33,995 |
| Total | 9,780 | 19,379 | 31,642 | 57,084 | 107,96!! | ##### | ###### | 18,906 | 37,328' | ,36,557 | 29,739 | 39,425 | 32,777 | 44,495 |

| County | Plumas | Sacramento | San Bernardino | San Joaquin | Sierra | Solano | Stanislaus | Sutter | Tulare | Tuolumne | Yolo | Yuba |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 73 | 492 | 2,469 | 624 | 12 | 1;222 | 465 | 50 | 402 | 9 | 291 | 65 |
| Area | 889 | 9,255 | 13,789 | 6,338 | 267 | 3,097 | 5,092 | 1,601 | 4,989 | 1,558 | 1,966 | 1,044 |
| Mobile | 1,751 | 17,836 | 34,807 | 11,668 | 971 | 7,967 | 7,558 | 1,592 | 7,351 | 3,267 | 3,051 | 1,999 |
| Natural | 60,878 | 11,301 | 299,007 | 20,878 | 21,122 | 11,302 | 23,274 | 6,751 | 90,128 | 46,439 | 17,749 | 14,682 |
| Total | 63,591 | 38,885 | 350,072 | 39,508 | 22,371 | 23,589 | 36,389 | 9,995 | 102,870 | 51,273 | 23,057 | 17,790 |

## ·2002 Sierra Region Volatile Organic Compounds Inventory



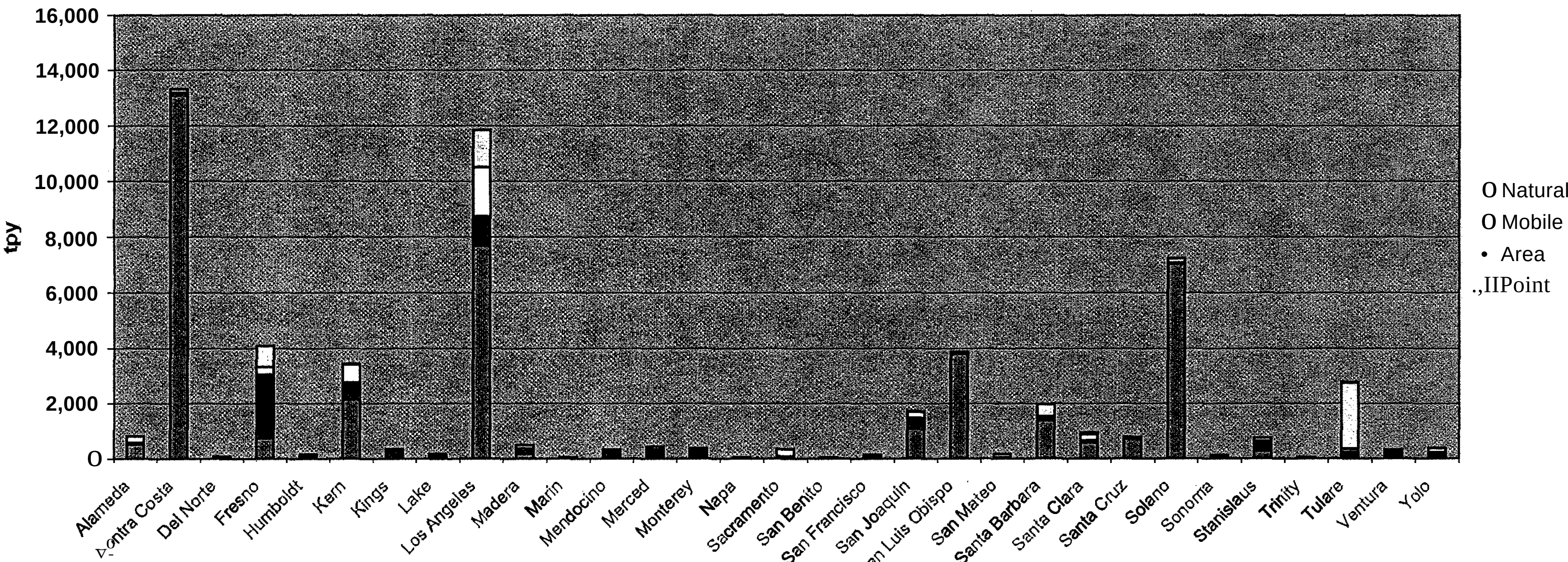

776

**Sulfur Dioxide-Coastal Region**

| County | Alameda | Conlra Costa | Del Norte | Fresno | Humboldt | Kam | Kings | Lake | Los Angeles | Madera | Marln | Mendocino | Merced | Monterey | Napa |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 526 | 13,103 | 48 | 744 | 49 | 2,126 | 47 | 30 | 7,674 | 176 | 3 | 28 | 11 | 38 | 4 |
| Area | 47 | 94 | 28 | 2,288 | 59 | 618 | 214 | 132 | 1;050 | 125 | 16 | 208 | 312 | 220· | 7 |
| Mobile | 243 | 138 | 1 | 285 | 15 | 863 | 82 | 9 | 1,779 | 52 | 25 | 16 | 114 | 76 | 22 |
| Natural | 1 | 4 | 16 | 773 | 32 | 20 | 1 | 10 | 1,344 | 147 | 0 | 76 | 2 | 37 | 12 |
| Total | 816 | 13,339 | 94 | 4,090 | 156 | 3,427 | 344 | 181 | 11,848 | 499 | 44 | 328 | 439 | 371 | 45 |

| County | Sacramento | San Benito | San Francisco | San Joaquin | San Luis Obispo | San Mateo | Santa Barbara | Santa Clara | Santa Cruz | Solano | Sonoma | Stanislaus | Trinity | Tulare | Ventura | Yolo |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 22 | 1 | 24 | 1,084 | 3,786 | 11 | 1,373 | 590 | .725 | 7,042 | 19 | 277 | 0 | 88 | 100 | 61 |
| Area | 61 | 12 | 41 | 383 | 24 | 28 | 84 | 76 | 50 | 23 | 47 | 356 | 10 | 147 | 61 | 90 |
| Mobile | 259 | 19 | 72 | 236 | 43 | 131 | 67 | 217 | 21 | 168 | 60 | 134 | 4 | 126 | 92 | 73 |
| Natural | 1 | 2 | 0 | 4 | 18 | 0 | 432 | 66 | 0 | 6 | 2 | 0 | 33 | 2,394 | 76 | 168 |
| Total | 342 | 35 | 137 | 1,708 | 3,871 | 170 | 1,956 | 949 | 796 | 7,239 | 129 | 768 | 47 | 2,755 | 328 | 392 |

## 2002 Coastal Region SOx Inventory

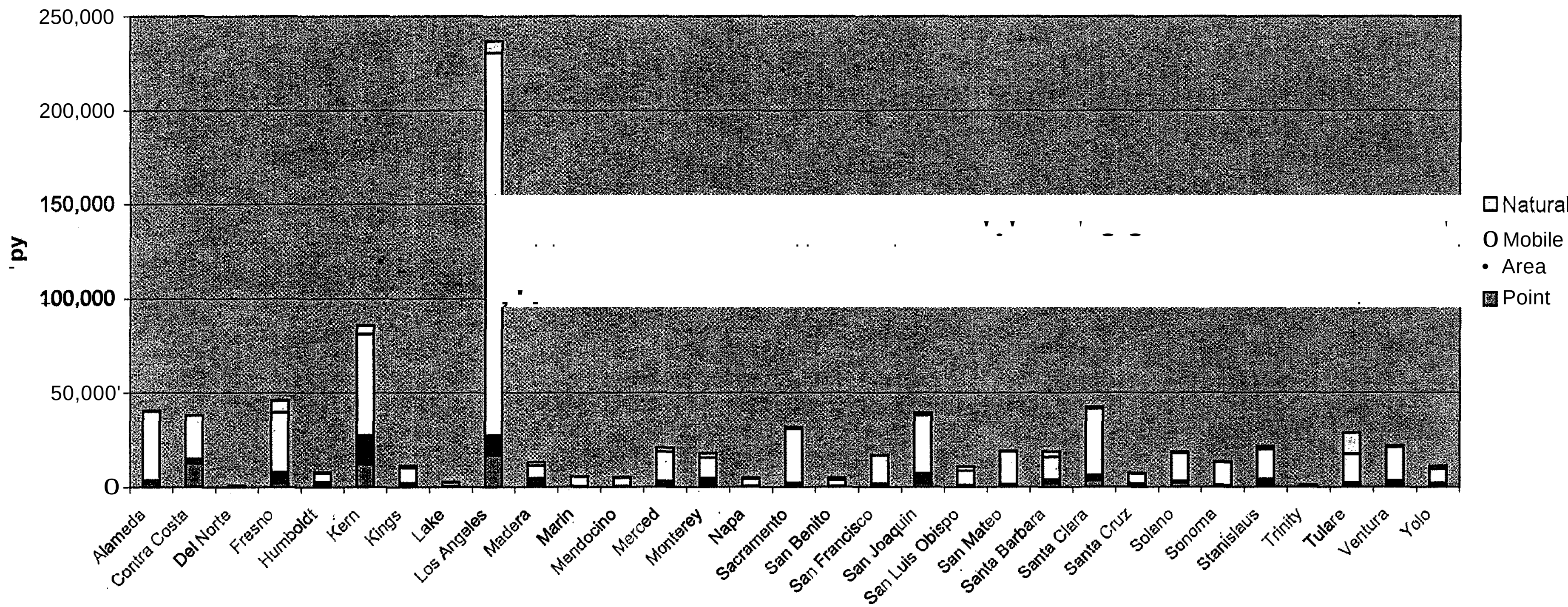



777

Nox-Coastal Region

| County | Alameda | Contra Costa | Del Norte | Fresno | Humboldt | Kern | Kings | lake | Los Angeles | Madera | Marin | Mendocino | Merced | Monterey | Napa | Sacramento | San Benito | San Francisco | San Joaquin | San Luis Obispo | San Mateo | Santa Barbara | Santa Clara | Santa Cruz | Solano | Sonoma | Stanislaus | Trinity | Tulare | Ventura | Yol. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 1,645 | 12,846 | 22 | 2,159 | 1,700 | 12,262 | 316 | 95 | 17.008 | 822 | 71 | 173 | B09 | 708 | 113 | 339 | 42 | 651 | 2,030 | 573 | 332 | 2,198 | 3,618 | 888. | 2.536 | 193 | 951 | 1 | 3.72 | 1.179 | 407 |
| Area | 2.039 | 2.125 | 64 | 5.825 | 911 | 15.161 | 1,806 | 257 | 10.521 | 3.918 | 461 | 328' | 2.658 | 4,008 | 240 | 2,022 | 304 | 1.236 | 5.180 | 664 | 1,143 | 1,904 | 2.663 | 978 | 768 | 768 | 3.121 | 51 | 1.823 | 2,081 | 1.686 |
| Mobile | 36.509 | 29,097 | 693 | 31,703 | 4.929 | 53.809 | 8.221 | 2.207 | 202,861 | 8.725 | 5.139 | 4.481 | 15,455 | 11.013 | 4.144 | 28,459 | 3,427 | 15.052 | 30.813 | 7,484 | 17,484 | 11.802 | 35,331 | 5,371 | 14.696 | 12.123 | 15,789 | 888 | 15.234 | 17,694 | 7,479 |
| Natural | 400 | 16 ' | 124 | 6,420 | 405 | 4.674 | 1,288 | 319 | 6.155 | 1.809 | 224 | 609 | 2,018 | 2,278 | 440 | 913 | 1,142 | 20 | 1.356 | 2.307 | 91 | 2.758 | 800 | 83 | 711 | 445 | 1,471 | 352 | 11.122 | 821 | '1.534 |
| Total | 40,594 | 38.084 | 903 | 46.107 | 7.945 | 65.705 | 11.612 | 2.879 | 236,545 | 13,373 | 5.914 | 5.591 | 20.940 | 18,007 | 4.937 | 31,732 | 4.914 | 16;959 | 39.379 | 11,028 | 19.030 | 18.762 | 42,511 | 7.320 | 18.711 | 13.528 | 21,325 | 1,292 | 28.552 | 21,776 | 11.107 |

## 2002 Coastal Region NOx Inventory

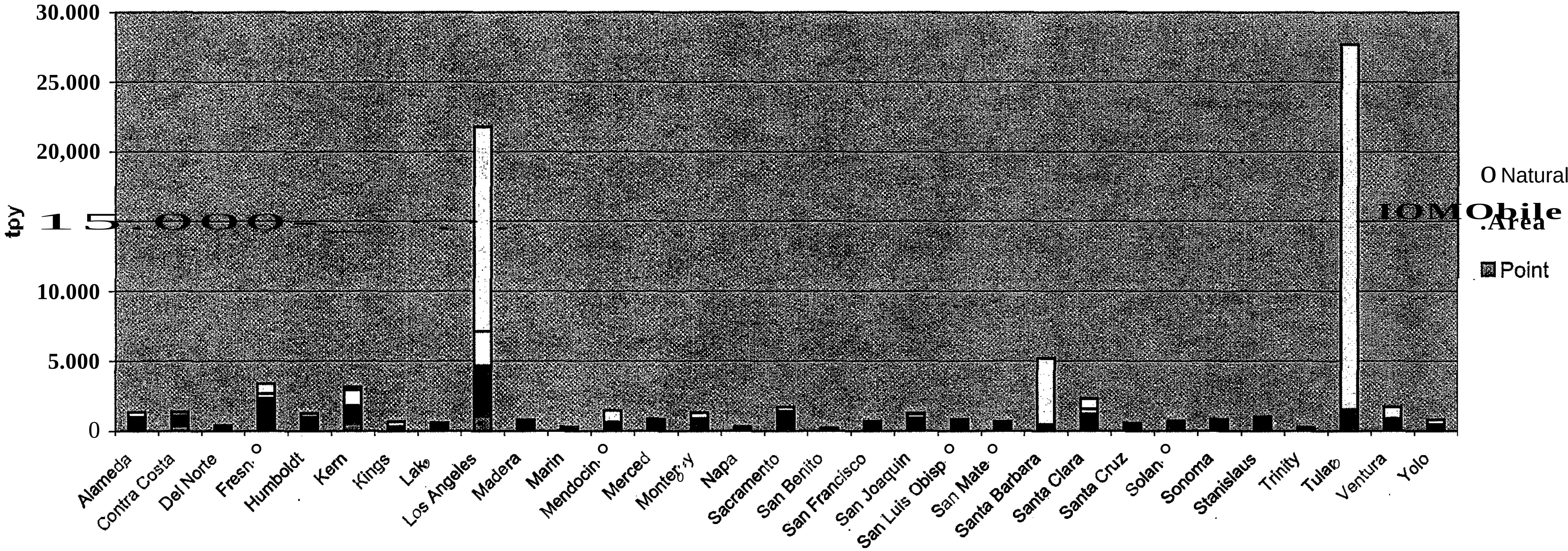


## Organic Carbon-Coastal Region

| County | Alameda | Contra Costa | Del Norte | Fresno | Humboldt | Kern | Kings | Laka | Los Angeles | Madera | Marin | Mendocino | Merced | Monterey | Napa | Sacramento | San Benito |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 65 | 370 | 37 | 135 | 156 | 530· | 39 | ·64 | ·1,051 | 24· | 7 | 43 | 20· | 119 | 11 | 74 | 4 |
| Ara. | 841 | 743 | 201 | 2,218 | 818 | 1,280 | 313 | 470 | 3,637 | 599 | 238 | 538 | 896 | 643 | 131 | 1,350 | 189 |
| Moblla | 358 | 242 | 4 | 323 | 47 | 1,136 | 331 | 34 | 2,449 | 74 | 71 | 49 | 148 | 143 | 45 | 296 | 30 |
| Natural | 7 | 47 | 179 | 707 | 248 | 216 | 9 | 51 | 14,666 | 111 | 3 | 830 | 23 | 405 | 135 | 9 | 25 |
| Tolal | 1,371 | 1,401 | 422 | 3,384 | 1,270 | 3,162 | 692 | 619 | 21,803 | 808 | 320 | 1,460 | 886 | 1,310 | 321 | 1,729 | 228 |

| County | San Francisco | San Joaquin | San Luis Obispo | San Mateo | Santa Barbara | Santa Clara | Santa Cruz | Solano | Sonoma | Stanislaus | Trinity | Tulare | Ventura | Yolo |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 26 | 44 | 46 | ·33 | 69 | 103 | 10 | 70 | 76 | 30 | 0 | 30 | 82 | 58 |
| Ara. | 548 | 864 | 532 | 503 | 314 | 1,127 | 523 | 389 | 817 | 638 | 200 | 1,378 | 588 | 385 |
| Moblla | 150 | 298 | 80 | 156 | 102 | 370 | 4B | 211 | 127 | 155 | 16 | 135 | 228 | 64 |
| Natural | 0 | 46 | 202 | 2 | 4,722 | 720 | 0 | 62 | 24 | 8 | 68 | 28,138 | 830 | 321 |
| Tolal | 724 | 1,271 | 859 | 893 | 5,208 | 2,320 | 582 | 732 | 844 | 1,032 | 284 | 27,682 | 1,727 | 808 |

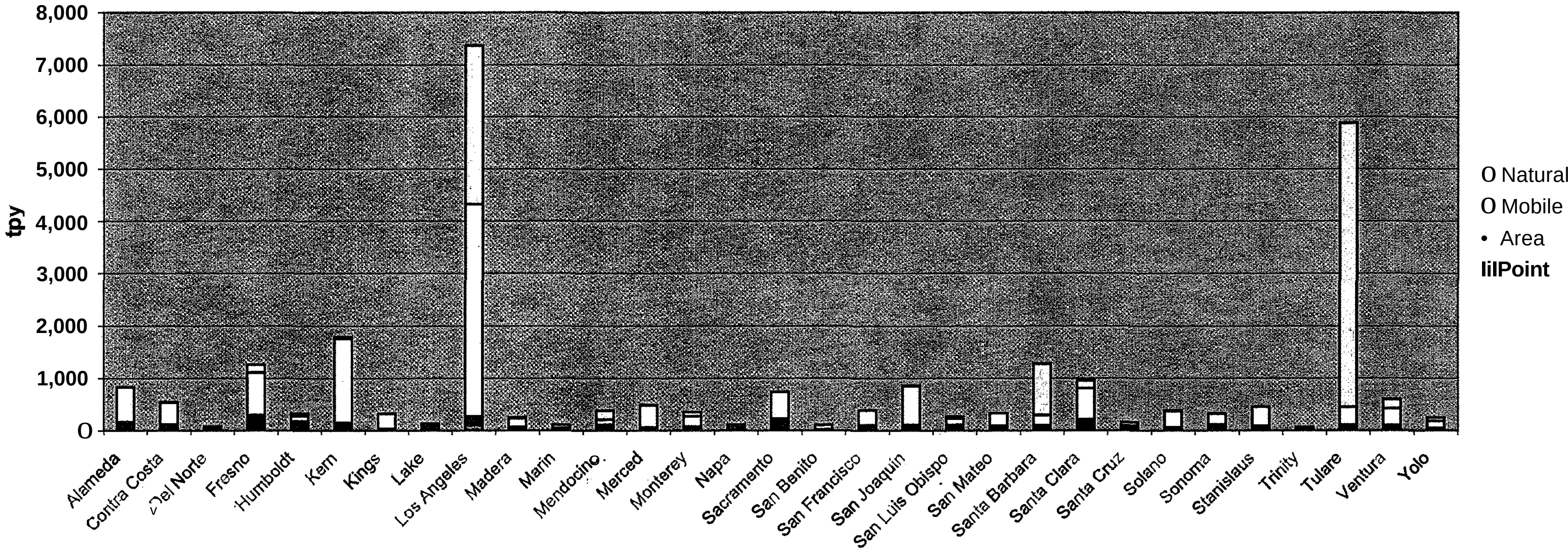
**2002 Coastal Region Organic Carbon Inventory**



## Elemental Carbon-Coastal Region

| County | Alameda | Contra Costa | Del Norta | Fresno | Humboldt | Kern | KIng. | Lake | Lo. Angeles | Madera | Martn | Mendocino | Marced | Monterey | Napa | Sacramento | san Benito | San Francisco | San Joaquin | San Luis Obispo | san Mateo | Santa Barbara | Santa Clara | santa Cruz | Solano | Sonoma | Stanislaus | Trinity | Tulare | Ventura | Yolo |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 11 | 9 | 2 | 12 | 39 | 30 | 7 | 2 | .. 104 | 4 | 1 | 14 | 0 | 1 | 2 | 28 | 0 | 10 | 9 | 3 | 9· | 42 | 18 | 4 | 4 | 3 | 2 | 0· | 4 | 13 | |
| Area | 159 | 108 | 39 | '284 | 144 | 123 | 29 | 98 | 167 | 84 | 42 | 97 | 58 | 75 | 23 | 194 | 18 | 92 | 100 | 103 | 84 | 57 | 191 | 88 | 55 | 108 | 88 | 37 | 102 | 83 | 36 |
| Mobile | 662 | 418 | 7 | 811 | 97 | 1.601 | 286 | 30 | 4.053 | 166 | 70 | 99 | 423 | 197 | 60 | 514 | 88 | 287 | 745 | 124 | 242 | 194 | 595 | 64 | 310 | 208 | 364 | 19 | 343 | 327 | 141 |
| Nalum! | 1 | 9 | 37 | 146 | 51 | 37 | 1 | 10 | 3.045. | 22 | 0 | 172 | 3 | 82 | 28 | 1 | 3 | 0 | 9 | 39 | 0 | 980 | 149 | 0 | 12 | 4· | 0 | 14 | 5.430 | 171 | 66 |
| Total | 832 | 545 | 85 | 1,253 | 332 | 1.792 | 323 | 140 | 7.389 | 258 | 114 | 383 | 485 | 354 | 113 | 738 | 110 | 389 | 862 | 270 | 335 | 1.273 | 954 | 156 | 382 | 324 | 454 | 70 | 5.879 | 594 | 250 |

## 2002 Coastal Region Elemental Carbon Inventory



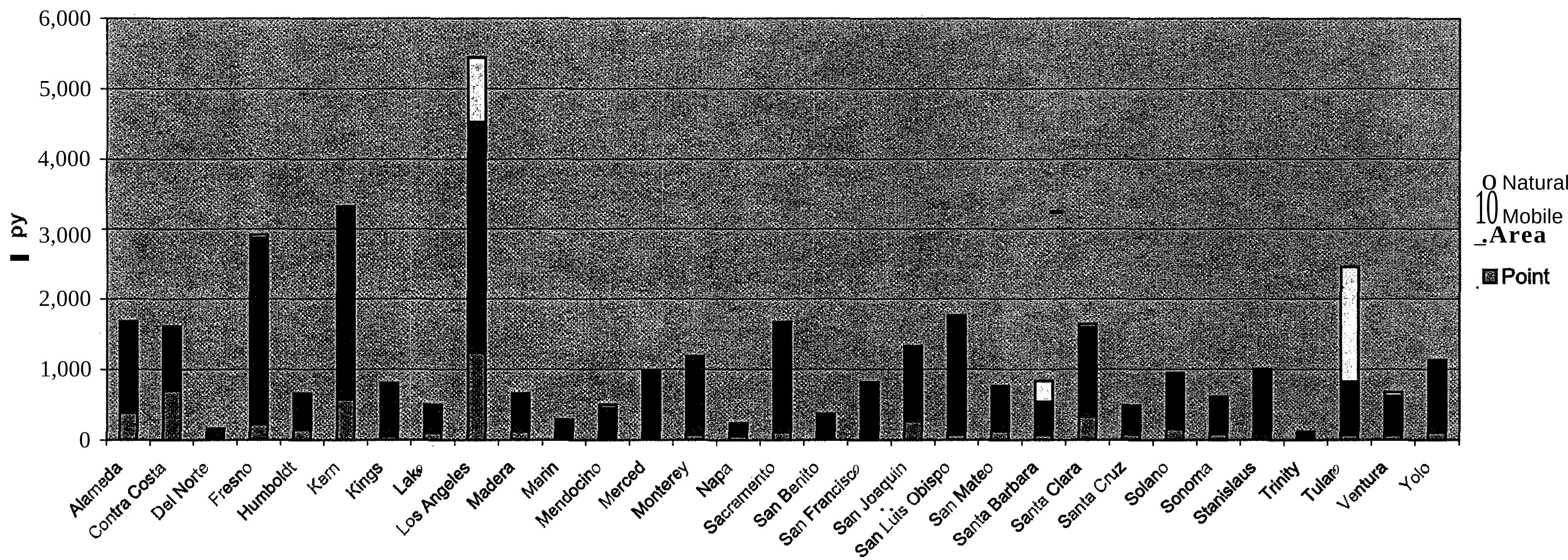

780

Fine Particulate Matter-Coastal Region

| County | Alameda | Contra Costa | Del Norte | Fresno | Humboldt | Kem | Kings | Lake | Los Angeles | Madera | Marin | Mendocino | Merced | Monterey | Nape |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 388 | 700 | 6 | 224 | 145 | 577 | 55- | - -105 | 1;238 | 124 | 39 | 45 | 32 | 77 | 60 |
| Area | 1,292 | 910 | 148 | 2,644 | 495 | 2,711 | 752 | 391 | 3,284 | 522 | 253 | 404 | 950 | 1,079 | 171 |
| Moblle | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Natural | 1 | 4 | 11 | 47 | 16 | 31 | 2 | 4 | 920 | 9 | 1 | 53 | 4 | 32 | 9 |
| Toial | 1,682 | 1,614 | 165 | 2,915. | 857 | 3,319 | 810 | 500 | 5,442 | 655 | 293 | 502 | 987 | 1,188 | 240 |

| County | Sacramento | San Benito | san Francisco | San Joaquin | San luis Obispo | 5an Mateo | Santa Barbara | Santa Clara | Santa Cruz | Soleno | Sonoma | Stanislaus | Trinity | Tulara | Ventura | Yolo |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 113 | -9 | 47 | 266 | 78 | 130 | 71 | 328 | 81 | 159 | 83 | 51 | 0-- | 74 | ·66 | 109 |
| Area | 1,560 | 354 | 775 | 1,084 | 1,669 | 635 | 467 | 1,268 | 408 | 789 | 525 | 951 | 111 | 749 | 555 | 1,005 |
| Moblle | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -0 | | | | | | |
| Natural | 2 | 6 | 0 | 4 | 19 | 1 | 298 | 47 | 0 | 5 | 3 | 3 | 4 | 1,633 | 54 | 21 |
| Toial | 1,675 | 369 | 822 | 1,335 | 1,766 | 766 | 836 | 1,843 | 489 | 953 | 610 | 1,005 | 118 | 2,456 | 675 | 1,135 |

## 2002 Coastal Region Fine Particulate Matter Inventory

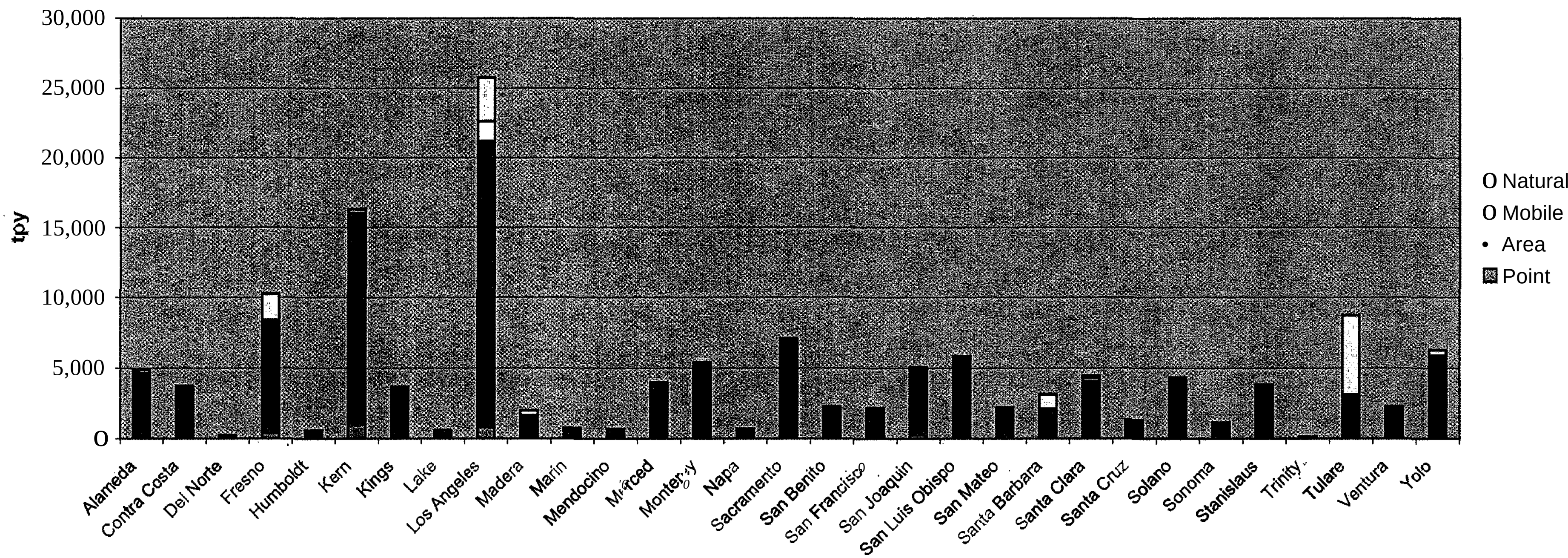


Coarse Particulate Matter-Coastal Region

| County | Alameda | Contra Cosla | Del Norte | Fresno | Humboldt | Kern | Kings | Lake | Los Angeles | Madera | Marin | Mendocino | Merced | Monterey | Napa | Sacramento |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Polnt | 237 | 217 | 22 | 404 | 66 | 995' | 161 | '66 | 624' | 46 | 10 | 14 | 66 | '94 | 19 | 153 |
| Area | 4,409 | 3,367 | 197 | 7,660 | 450 | 15,027 | 3,466 | 504 | 20,367 | 1,593 | 746 | 506 | 3,614 | 5,169 | 661 | 6,776 |
| Mobile | 233 | 150 | 2 | 164 | 22 | 255 | 40 | 9 | 1,407 | 34 | 36 | 19 | 63 | 76 | 24 | 185 |
| Natural | 1 | 10 | 39 | 1,816 | 76 | 43 | 1 | 23 | 3,162 | 345 | 0 | 176 | 4 | 67 | 29 | 1 |
| Total | 4,879 | 3,744 | 259 | 10,266 | 614 | 16,321 | 3,690 | 624 | 25,759 | 2,020 | 794 | 720 | .3,969 | 5,428 | 733 | 7,116 |

| County | San Benito | San Francisco | San Joaquin | Ssn Luis Obispo | San Mateo | sanla Barbara | Santa Clara | Santa Cruz | Solano | Sonoma | Stanislaus | Trinity | Tulare | Ventura | Yolo |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Polnt | 14 | 35 | 271 | 113 | 40 | 130 | 244· | 91 | 42 | 156 | 66 | 0 | 136 | 26 | 226 |
| Area | 2,252 | 2,060 | 4,693 | 5,659 | 2,074 | 1,919 | 3,621 | 1,192 | 4,171 | 936 | 3,651 | 75 | 2,903 | 1,986 | 5,627 |
| Mobile | 18 | 80 | 123 | 41 | 114 | 61 | 246 | 36 | 69 | 71 | 83 | 4 | 66 | 109 | 37 |
| Natural | 4 | 0 | 9 | 41 | 0 | 1,016 | 154 | 0 | 13 | 5 | 1 | 77 | 5,633 | 178 | 394 |
| Total | 2,288 | 2,194 | 5,097 | 5,854 | 2,228 | 3,126 | 4,467 | 1,319 | 4,314 | 1,168 | 3,623 | ,56 | 8,739 | 2,280 | 6,294 |

## 2002 Coastal Region Coarse Particulate Matter Inventory ,



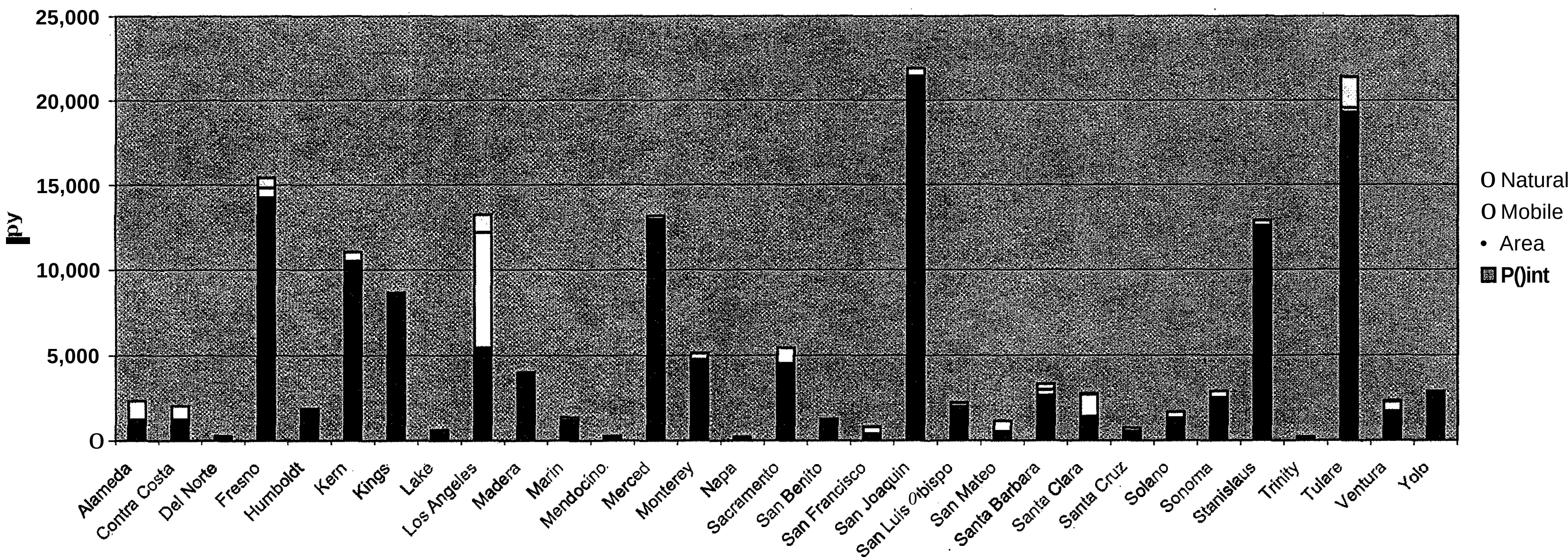

782

## Ammonia-Coastal Region

| County | Alameda | Contra Costa | Del Norte | Fresno | Humboldt | Kern | Kings | Lake | Los Angeles | Madera | Marin | Mendocino | Merced | Monterey | Napa | Sacramento |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 0 | 0 | 0 | 0 | 0 | 18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ·0 | 0 | 174 |
| Area | 1,254 | 1,288 | 270 | 14,259 | 1,752 | 10,492 | 8,585 | 583 | 5,458 | 3,818 | 1,194 | 181 | 12,959 | 4,780 | 108 | 4,357 |
| Mobile | 1,087 | 782 | 18 | 581 | 102 | 543 | 90 | 55 | 6,731 | 105 | 195 | 76 | 198 | 350 | 123 | 931 |
| Natural | 1 | 4 | 13 | 592 | 25 | 24 | 1 | 8 | 1,031 | 113 | 1 | 59 | 3 | 32 | 10 | 1 |
| Tolal | 2,342 | 2,052 | 300 | 15,412 | 1,880 | 11,077 | 8,877 | 648 | 13,218 | 4,034 | 1,391 | 296 | 13,160 | 5,162 | 239 | 5,483 |

| County | San Benito | San Francisco | San JoaqUin | San Luis Obispo | San Mateo | Santa Barbara | Santa Clara | Santa Cruz | Solano | Sonoma | Stanislaus | Trinity | Tulare | Ventura | Yolo |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 0 | 0 | 0 | 0 | 0· | 78 | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| Area | ,1,228 | 408 | 21,410 | 2,017 | 539 | 2,592 | 1,411 | 551 . | 1,321 | 2,532 | 12,548 | 177 | 19,291 | 1,718 | 2,812 |
| Mobile | 49 | 411 | 474 | 214 | 623 | 327 | 1,308 | 198 | 364 | 368 | 326 | 11 | 261 | 565 | 152 |
| Natural | 4 | 0 | 4 | 17 | 0 | 333 | 51 | 0 | 5 | 2 | 2 | 25 | 1,833 | 59 | 128 |
| Tolal | 1,280 | 817 | 21,887 | 2,248 | 1,182 | 3,330 | 2,770 | 749 | 1,890 | 2,902 | 12,873 | 213 | 21,385 | 2,343 | 2,893 |

## 2002 Coastal Region Ammonia Inventory

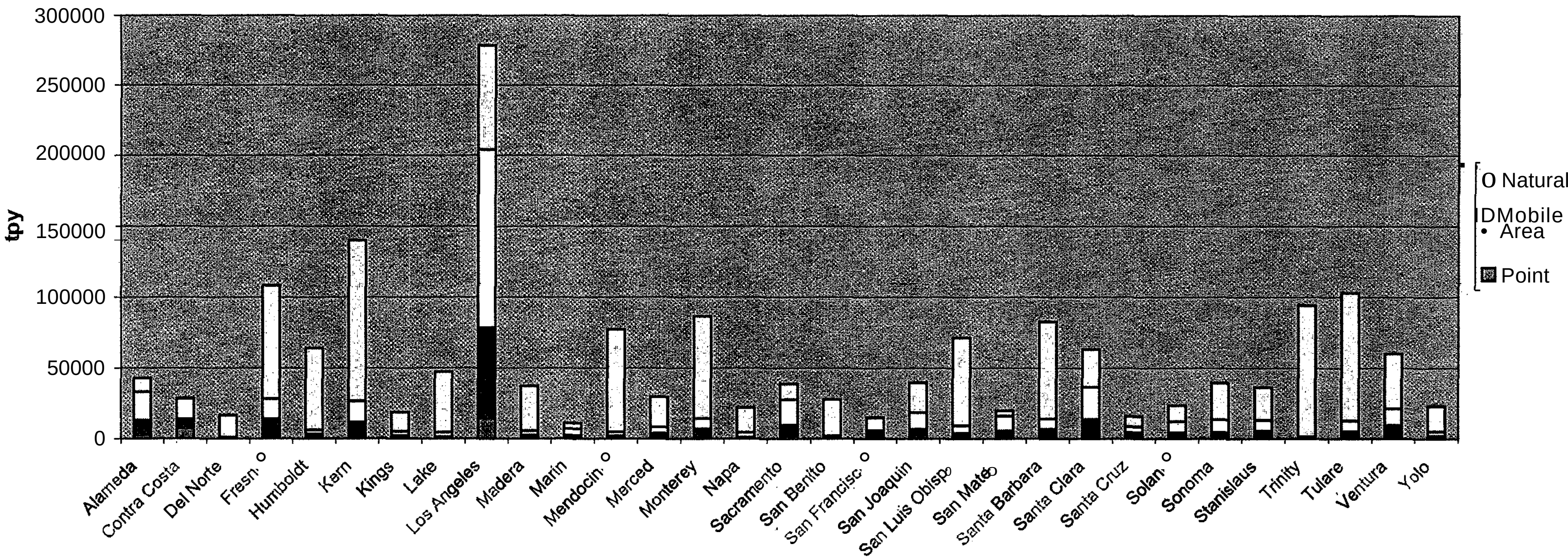


Volatile Organic Compounds-Coastal Region

| County | Alameda | Contra Costa | Del Norta | Frasno | Humboldt | Kam | KIngs | Lake | Los Angeles | Madera | Marin | Mendocino | Merced | Monterey | Napa |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 2826 " | 7534 | 53 | 498 | 407 | 2278 | 232 | 110 | 14550 | 87 | 613 | 70 | 222' | 291 | 106 |
| Area | 10292 | 6563 | 590 | 13759 | 2866 | 9427 | 1942 | 1399 | 64048 | 2518 | 1637 | 1928 | 3566 | 6808, | 1075 |
| Moblla | 20122 | 14546 | 513 | 13931 | 3012 | 14770 | 3149 | 3061 | 125470 | 3160 | 4886 | 2763 | 4524 | 7410 | 3357 |
| Natural | 9638 | 35 | 15566 | 79780 | 57743 | 113538 | 13562 | 42593 | 74564 | 31562 | 4015 | 72519 | 21427 | 71864 | 17825 |
| Total | 42878 | 28878 | 18743 | 107988 | 64049 | 140013 | 18908, | 47183 | 278832 | 37328 | 11151 | 77280 | 29739 | 86372 | 22383 |

| County | Sacramento | San Benito | San Francisco | San Joaquin | Sari Luis Obispo | San Mateo | Santa Barbara | Santa Clara | Santa Cruz | Solano | Sonoma | Stanislaus | Trinity | Tulara | Ventura | Yolo |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point | 492 | '87 | 511 | 624 | 309 | 736 | 1898 | 2120' , | 20 | 1222 | 395 | 465 | O,' | '402 | 1121 | 291 |
| Area | 9255 | 843 | 5309 | 633B | 3806 | 4934 | 5313 | 11787 | 4512 | 3097 | 4212 | 5092 | 510 | 4989 | 6654 | 1968 |
| Moblla | 17836 | 1011 | 9009 | 11668 | 5402 | 10513 | 7154 | 22789 | 4199 | 7967 | 9078 | 7556 | 949 | 7351 | 11686 | 3051 |
| Natural | 11301 | 25885 | 601 | 20878 | 61902 | 3768 | 68488 | 26574 | 7227 | 11302 | 25951 | 23274 | 92653 | 90128 | 3B847 | 17749 |
| Total | 38885 | 27825 | 15431 | 39508 | 71419 | 19951 | 82854 | 83270 | 15958 | 23589 | 39636 | 38389 | 94112 | 102870 | 80308 | 23057 |

## 2002 Coastal Region Volatile Organic Compounds Inventory



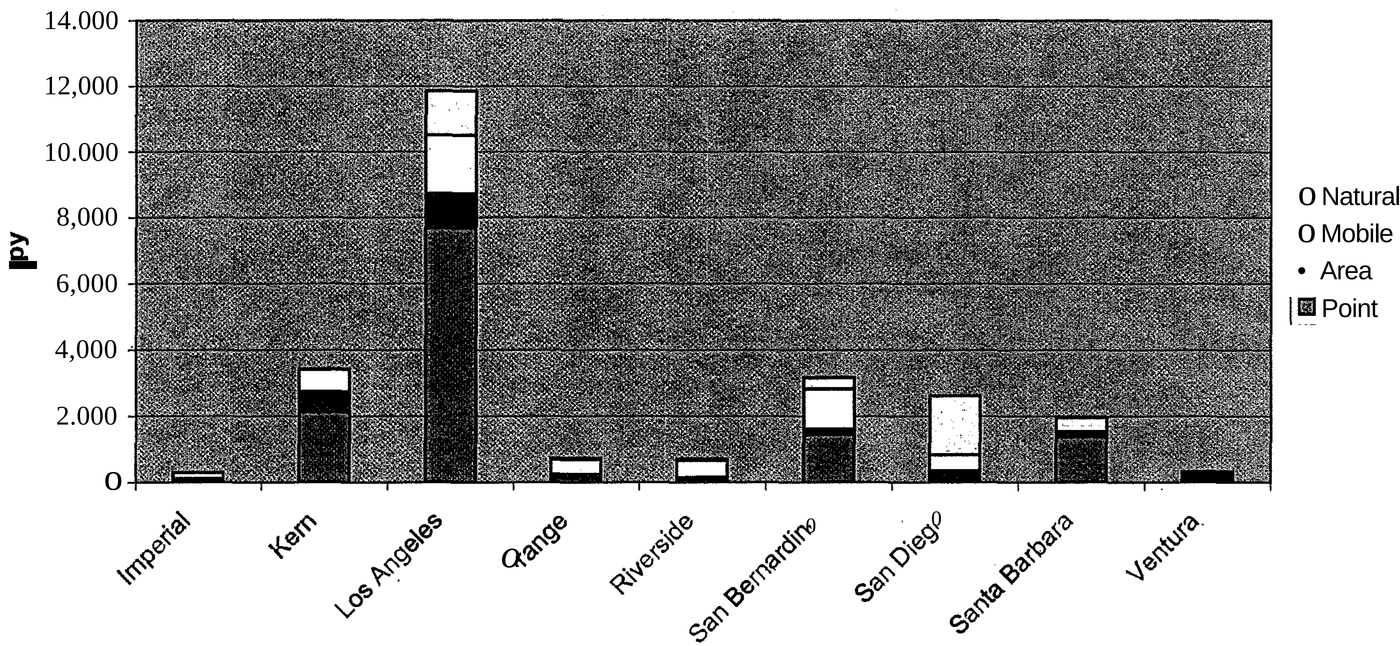



784

Sulfur Dioxide-Southern California Region

| County | Imperial | Kern | Los Angeles | Orange | Riverside | San Bernardino | San Diego | Santa Barbara | Ventura |
|---|---|---|---|---|---|---|---|---|---|
| Point | | 442.126 | | 7.674123 | 34 | 1,437 | 107 | 1.373 | 100 |
| Area | 65 | 618 | 1,050 | 116 | 112 | 170 | 237 | 84 | 61 |
| Mobile | 189 | 663 | 1.779 | 448 | 508 | 1,215 | 484 | 67 | 92 |
| Natural | O | 20 | ",344 | 27 | 43 | 344 | 1,781 | 432 | 76 |
| Total | 298 | 3,427 | 11,848 | 714 | 698 | 3.166 | 2,609 | 1.956 | 328 |

## 2002 Southern-California Region SOx Inventory

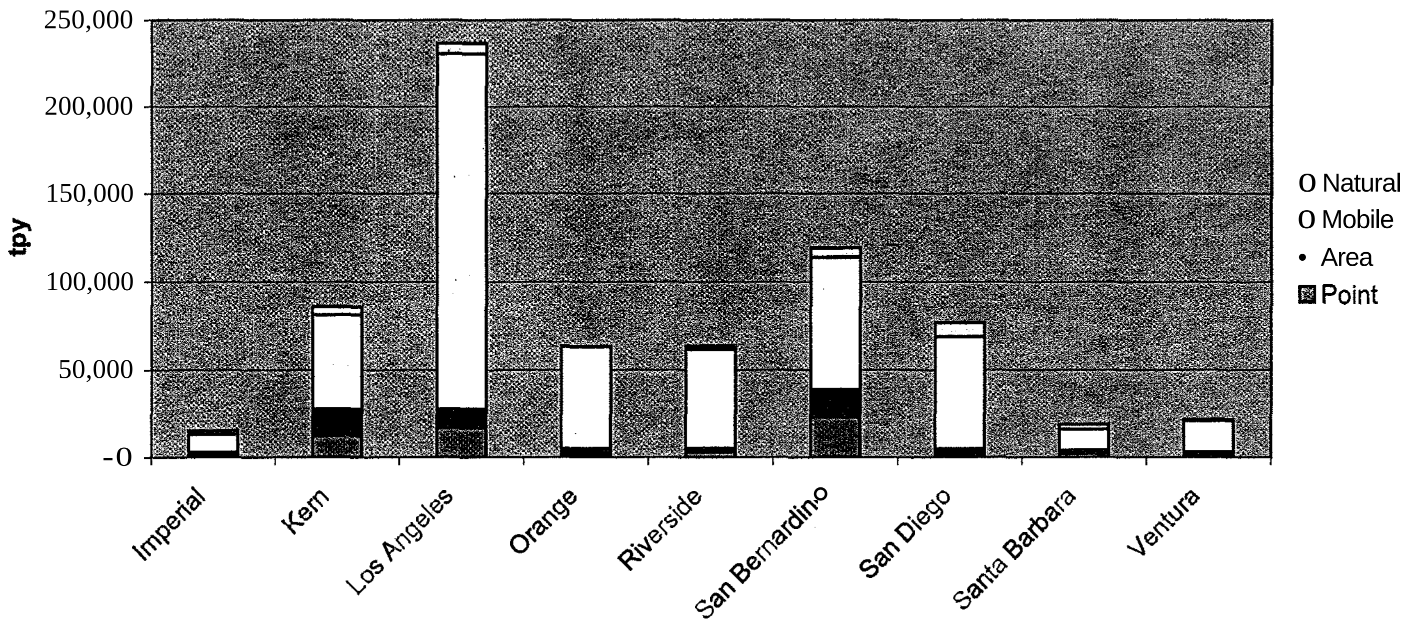


,

NOx-Southern California Region

| -County | Imperial | Kern | Los Angeles | Orange | Riverside | San Bernardino | San Diego | Santa Barbara | Ventura |
|---|---|---|---|---|---|---|---|---|---|
| Point | 762 | 12,262 | 17,008 | '1,896 | 2,867 | 22,769 | 1,832 | 2,198 | 1,179 |
| Area | 2,128 | 15,161 | 10,521 | 3,192 | 2,364 | 15,971 | 3,094 | 1,904 | 2,081 |
| Mobile | 10,258 | 53,609 | 202,861 | 58,096 | 56,241 | 75,108 | 63,888 | 11,902 | 17,694 |
| Natural | 2,004 | 4,674 | 6,155 | 347 | 2,204 | 5,208 | 7,790 | 2,758 | 821 |
| Total | 15,152 | 85,705 | 236,545 | 63,532 | 63,676 | 119,055 | 76,604 | 18,762 | 21,776 |

## 2002 Southern California Region NOx Inventory

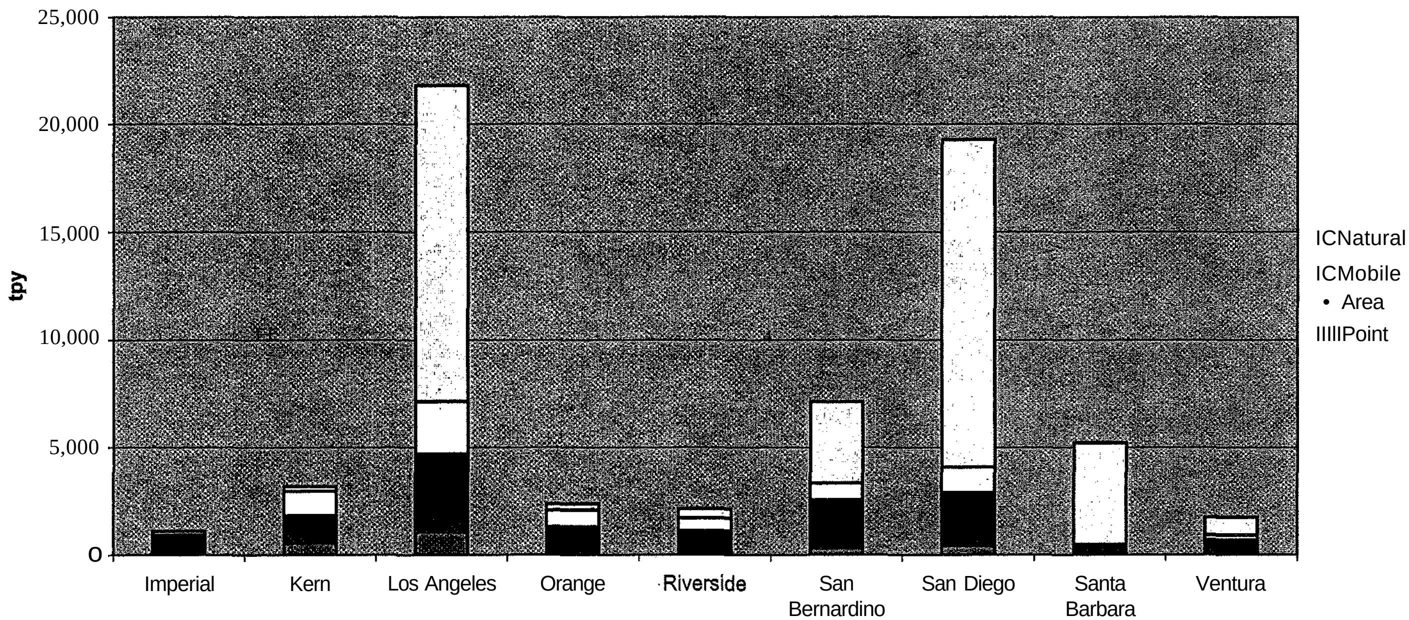



786

Organic Carbon-Southern California Regibn

| County | Imperial | Kern | Los Angeles | Orange | Riverside | San Bernardino | San Diego | Santa Barbara | Ventura |
|---|---|---|---|---|---|---|---|---|---|
| Point | 25. | 530 | 1,051 | 147 | 144 | 324 | 427 | 69 | 82 |
| Area | 880 | 1,280 | 3,637 | 1,141 | 948 | 2,206 | 2,436 | 314 | 588 |
| Mobile | 195 | 1,136 | 2,449 | 775 | 617 | 805 | 1,204 | 102 | 228 |
| Natural | 2 | 216 | 14,666 | 295 | 420 | 3,768 | 15,222 | 4,722 | 830 |
| Total | 1,102 | 3,162 | 21,803 | 2,359 | 2,129 | 7,104 | 19,289 | 5,206 | 1,727 |

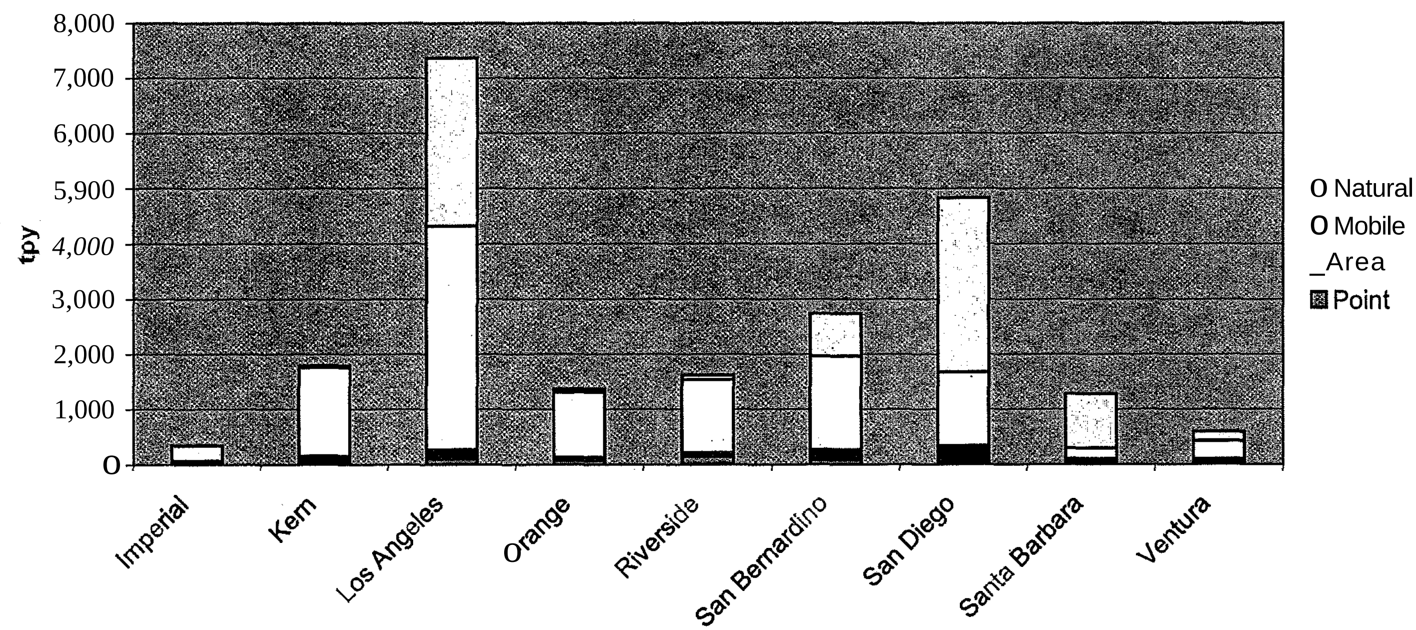
## 2002 Southern California Region Organic Carbon Inventory



Elemental Carbon-Southern California Region

| County | Imperial | Kern | Los Angeles | Orange | Riverside | San Bernardino | San Diego | Santa Barbara | Ventura |
|---|---|---|---|---|---|---|---|---|---|
| Point | 13 | 30 | 104 | 77 | 148 | 85 | 19 | 42 | 13 |
| Area | 58 | 123 | 167 | 50 | 65 | 184 | 313 | 57 | 83 |
| Mobile | 275 | 1,601 | 4,053 | 1,179 | 1,325 | 1,689 | 1,339 | 194 | 327 |
| Natural | 0 | 37 | 3,045 | 61 | 85 | 777 | 3,160 | 980 | 171 |
| Total | 347 | 1,792 | 7,369 | 1,367 | 1,622 | 2,736 | 4,832 | 1,273 | 594 |

## 2002 Southern California Region Elemental Carbon Inventory



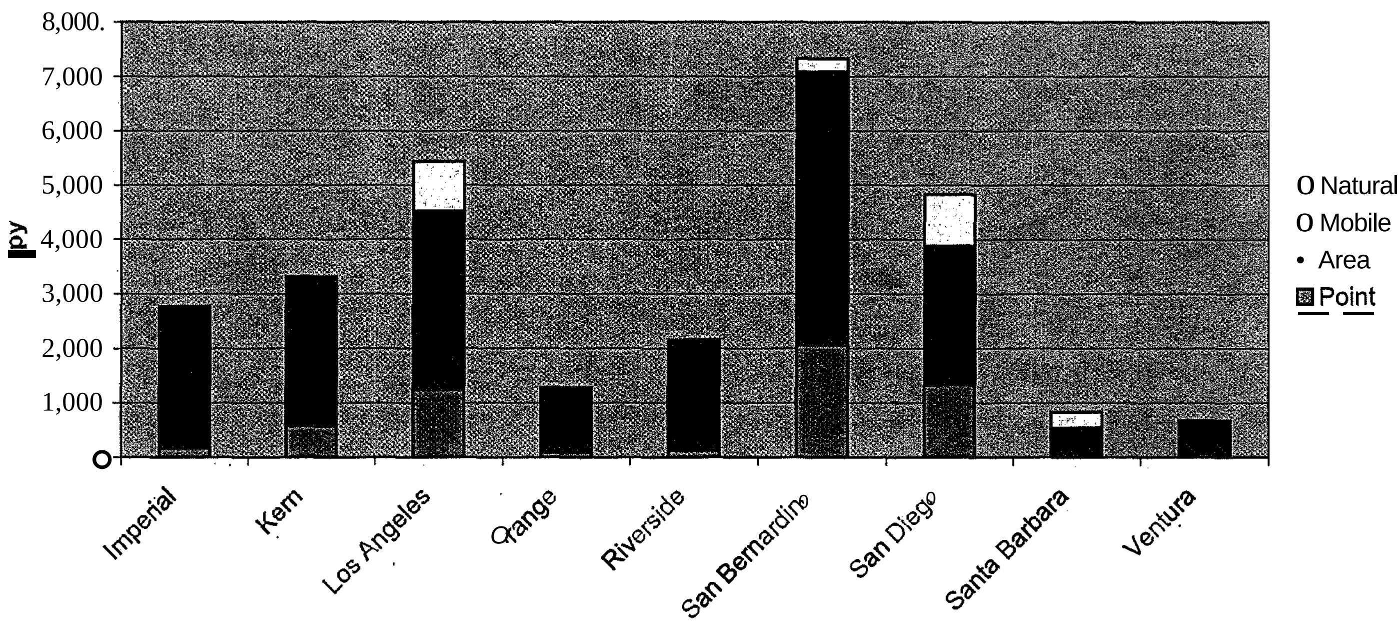



788

Fine Particulate Matter-Southern California Region

| -County | Imperial | Kern | Los Angeles | Orange | Riverside | San Bernardino | San Diego | Santa Barbara | Ventura |
|---|---|---|---|---|---|---|---|---|---|
| Point | 162 | 577 | 1,238 | 91 | 122 | 2,068 | 1,336 | 71 | 66 |
| Area | 2,612 | 2,711 | 3,284 | 1,174 | 2,001 | 5,015 | 2,540 | 467 | 555 |
| Mobile | O | O | O | O | O | O | O | O | O |
| Natural | O | 31 | 920 | 19, | 32 | 248 | 956 | 298 | 54 |
| Total | 2,774 | 3,319 | 5,4421,284 | | 2,154 | 7,331 | 4,831 | 836 | 675 |

**2002 Southern California Region Fine Particulate Matter Inventory'**



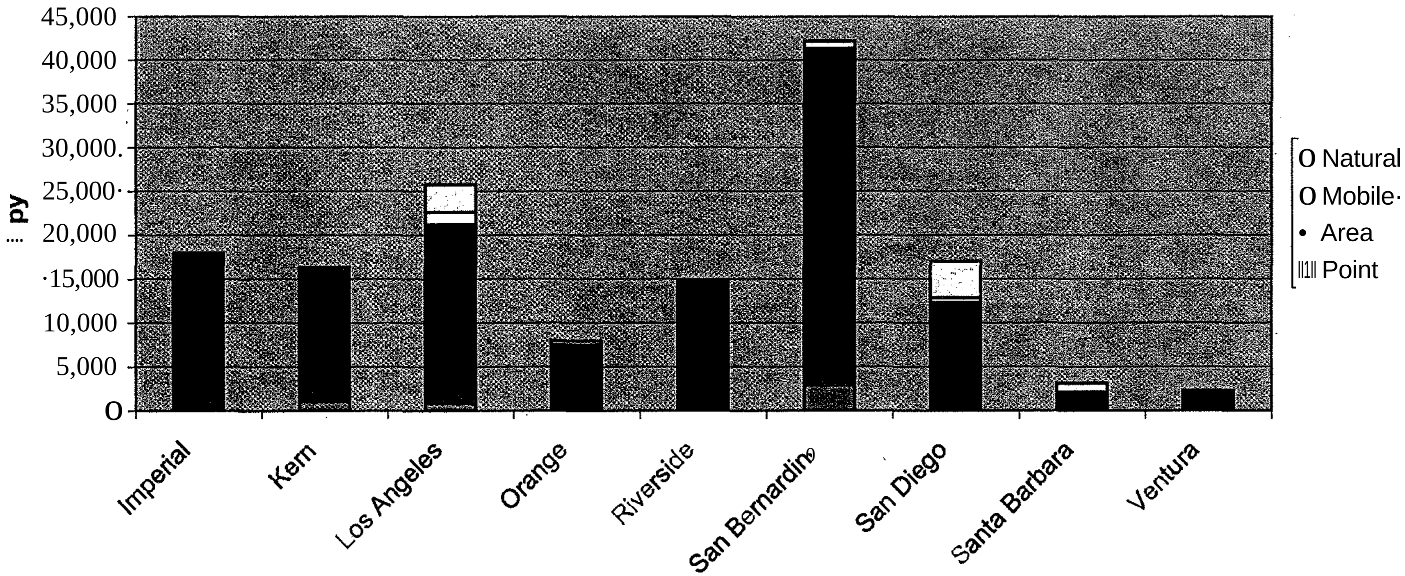



789

Coarse Particulate Matter-Southern California Region

| County | Imperial | Kern | Los Angeles | Orange | Riverside | San Bernardino | San Diego | Santa Barbara | Ventura |
|---|---|---|---|---|---|---|---|---|---|
| Point | 235 | 995 | 824 | 15 | 42 | 2,877 | 302 | 130 | 28 |
| Area | 17,684 | 15,027 | 20,367 | 7,431 | 14,312 | 38,094 | 1'2,020 | 1,919 | 1,966 |
| Mobile | 44 | 255 | 1,407 | 430 | 384 | 406 | 508 | 61 | 109 |
| Natural | 0 | 43 | 3,162 | 63 | 101 | 807 | 4,189 | 1,016 | 178 |
| Total | 17,963 | 16,321 | 25,759 | 7,939 | 14,839 | 42,184 | 17,020 | 3,.126 | 2,280 |

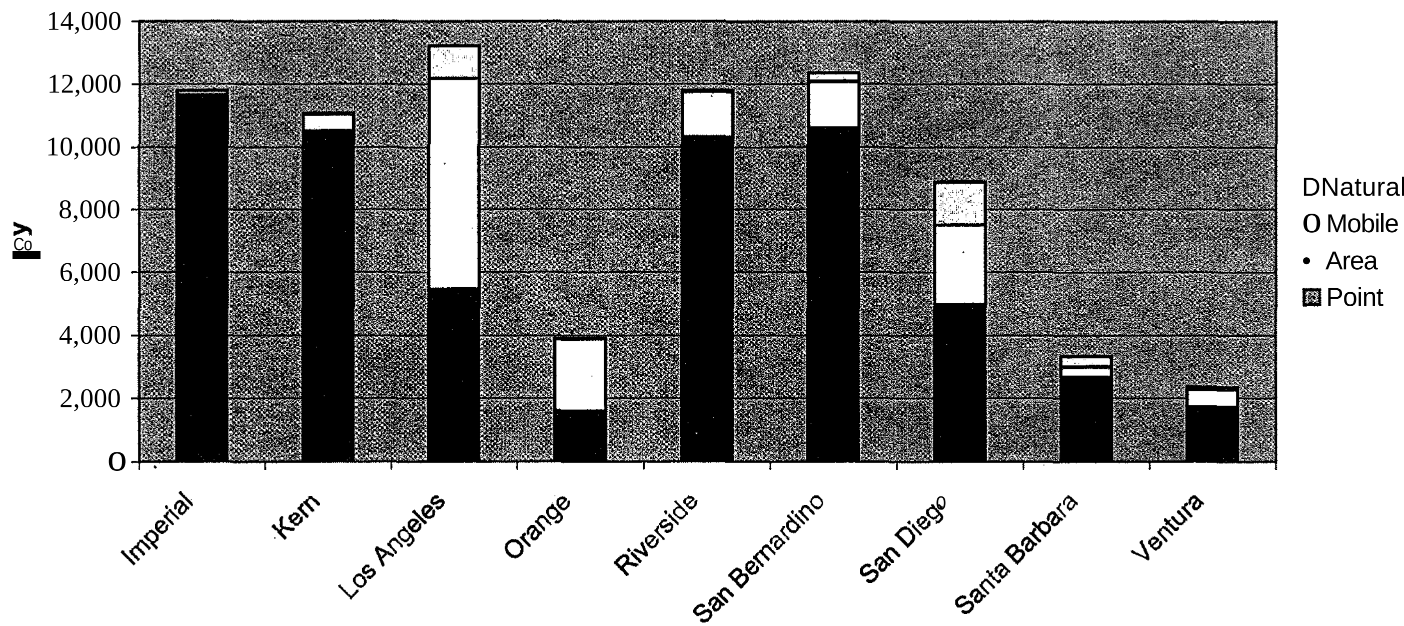
## 2002 Southern California Region Coarse Particulate Matter Inventory



Ammonia-Southern California Region

| County | Imperial·· | Kern | ·· | Orange | Riverside | San Bernardino | San Diego | Santa Barbara | Ventura |
|---|---|---|---|---|---|---|---|---|---|
| Point | 14 | | O | O | 0 | 0 | 12 | .78 | O |
| Area | 11,652 | | 5,456 | 1,599 | 10,319 | 10,602 | 4,952 | 2,592 | 1,718 |
| Mobile | 131 | | 6,731 | 2,285 | 1,445 | 1,490 | 2,548 | 327 | 565 |
| Natural | O | | 1,031 | 21 | 36 | 270 | 1,365 | 333 | 59 |
| Total' | 11,797 | | 13,218 | 3,905 | 11,800 | 12,361 | 8,877 | 3,330 | 2,343 |

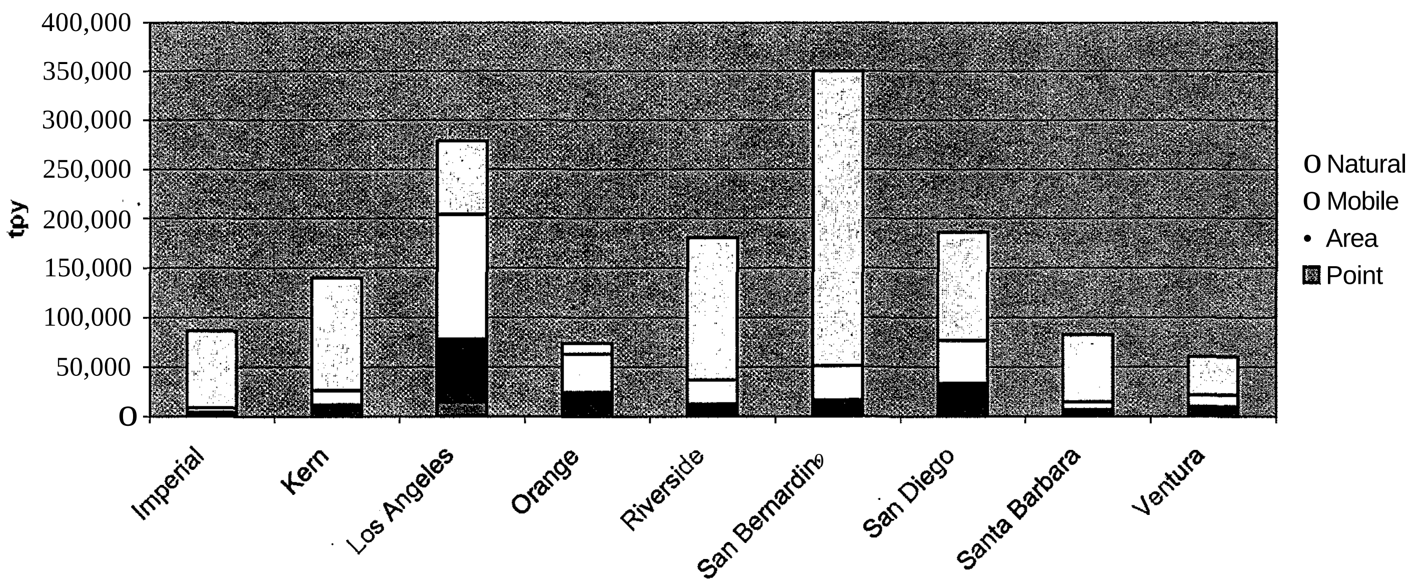
## 2002 Southern California Region Ammonia Inventory



Volatile Organic Compounds-Southern California Region

| County | Imperial | Kem | Los Angeles | Orange | Riverside | San Bernardino | San Diego | Santa Barbara | Ventura |
|---|---|---|---|---|---|---|---|---|---|
| Point | 117 | 2,278 | 14,550 | 3,846 | 2,261 | 2,469 | 3,605 | 1,898 | 1,121 |
| Area | 4,079 | 9,427 | 64,048 | 20,851 | 10,445 | 13,789 | 29,606 | 5,313 | 8,654 |
| Mobile | 4,629 | 14,770 | 125,470 | 38,336 | 24,071 | 34,807 | 43,752 | 7,154 | 11,686 |
| Natural | 78,052 | 113,538 | 74,564 | 11,267 | 143,762 | 299,007 | 109,095 | 68,488 | 38,847 |
| Total | 86,877 | 140,013 | 278,632 | 74,300 | 180,539 | 350,072 | 186,059 | 82,854 | 60,308 |

**2002 Southern California Region Volatile Organic Compounds Inventory**



# APPENDIXJ

## Regional Haze Plan Check List

| CITATION | REQUIREMENT | LOCATION IN PLAN |
|---|---|---|
| Clean Air Act 110(a)(2)(D)(II) | SIP contains adequate provisions not to interfere with measure included in any other State to protect visibility. | Section 8.2 |
| 51.308(d)(1) | RPGs for each Class I area that provide for an improvement in visibility on worst days and no degradation in visibility for the best days. | Table 7.2 |
| 51.308(d)(1)(i)(A) | Consider the costs of compliance, time necessary for compliance, energy and non-air quality environmental impacts of compliance, and remaining useful life of affected sources, and demonstrate how these factors were taken into consideration in selecting the RPG. | Documented in Sections 4.6 and 4.7 of the .2018 Progress Strategy Chapter. |
| 51.308(d)(1)(i)(B) | Analyze and determine the uniform rate of progress needed to attain natural conditions by 2064. | Documented in Section 7.3 and AppendiX B. |
| 51.308(d)('1)(i)(B) | In establishing the RPG for each Class I area, consider the emission reductions measure needed to achieve the uniform rate of progress. | Appendix B |
| 51.308(d)(1)(ii) | If RPG is higher than uniform rate of progress, demonstrate based on the four factors that attaining natural conditions by 2064 is unreasonable and assess when the area would reach natural conditions based on the RPG. | Table 7.2 |
| 51.308(d)(1)(iv) | When developing the RPG, consult with other States which may reasonably be anticipated to cause or contribute to visibility impairment in the Class 1 Area. | Section 8.2 |
| .51.308(d)(2) | Determine baseline and natural visibility conditions for best and worst days at all Class 1 Areas. Determine the difference between baseline and natural visibility for best and worst days. | Table 2-1 |

| CITATION | REQUIREMENT | LOCATION IN PLAN |
|---|---|---|
| 51.308(d)(3) | Submit a long-term strategy that addresses visibility impairment for each Class. I area, inside and outside the State, which may be affected by the State's emissions and include enforceable emissions limitations, compliance schedules, and other measures as necessary to achieve the RPGs. | Chapter 4 |
| 51.308(d)(3)(i) | Consult with other states regarding inter-state transport of emissions and their impact on Class I Areas in or out of state. | Section 8.2 |
| 51.308(d)(3)(ii) | Demonstrate that the long-term strategy includes all measures necessary to reduce its share of the emission reductions needed to meet the RPG for an out-of-state Class 1 Area. | Section 8.2 |
| 51.308(d)(3)(iii) | Document the technical basis, including modeling, monitoring and emissions information, on which·it is relying to determine its apportionment of emission reduction obligations necessary for achieving reasonable progress in each Class I area it affects. The State may meet this requirement by relying on technical analysis developed by the regional planninQ orQanization. | Section 1.1 |
| 51:308(d)(3)(iii) | Identify the baseline emissions inventory on which its strategies are based. | Section 3.3 |
| 51.308(d)(3)(iv) | Identify all anthropogenic sources considered in developing the l.ong-term strategy. | Appendix B |
| 51.308(d)(3)(v)(A) | In developing the long-term strategy, consider emission reductions due to ongoing air pollution control programs, including measures to address reasonably attributable visibility impairment. | Chapter 4 |

| CITATION | REQUIREMENT | LOCATION IN PLAN |
|---|---|---|
| 51.308(d)(3)(v)(B) | In developing the long-term strategy, consider measures to mitigate construction activity impacts. | Section 4.5 |
| 51.308(d)(3)(v)(C) | In developing the long-term strategy, consider emission emissions limitations and schedules for compliance to achieve the RPG. | Chapter 4 |
| 51.308(d)(3)(v)(D) | In developing the long-term strategy, consider source retirement and replacement schedules. | Section 4.5 |
| 51.308(d)(3)(v)(E) | In developing the long-term strategy; consider smoke management techniques for agriculture and forest management purposes. | Section 4.5 |
| 51.308(d)(3)(v)(F) | In developing the long-term strategy, consider enforceability of emissions limitations and control measures. | Chapter 4 |
| 51.308(d)(3)(v)(G) | In developing the long-term strategy, consider the change in visibility due to changes in point, area, and mobile sources. | Chapter 4 and Appendix B |
| 51.308(d)(4) | Submit a monitoring strategy for measuring, characterizing, and reporting of regional haze visibility impairment representative of all Class I areas within the State. The requirement can be met throuQh participation in IMPROVE. | Section 9.2 |
| 51.308(d)(4)(i) | If needed; establish additional monitoring sites to assess whether RPGs are being achieved. | Section 9.2 |
| 51.308(d)(4)(ii) | Include procedures by which monitoring data and other information are used to determine the contribution of emissions from within the State to regional haze visibility impairment at Class I Areas both within and outside the State. | Section 9.2 |
| 51.308(d)(4)(iv) | Provide for reporting all visibility monitoring data annually to the Administrator. | Section 9.2 |

| CITATION | REQUIREMENT | LOCATION IN PLAN |
|---|---|---|
| 51.308(d)(4)(v) | Include baseline and future.emission inventories for visibility impairment pollutants and a commitment to update the inventory periodically. | Chapter 3 and Sections 9.3 and 9.4 |
| 51.308(d)(4)(vi) | Include reporting, recordkeeping, and other measures, necessary to assess and report on visibility. | Section 9.2 |
| 51.308(e) | Include emission limitations representing BART and schedules for compliance with BART for each BART-eligible source that contributes to Visibility impairment at a Class 1 Area. | Section 5.9 and Table 5-4 |
| 51.308(e)(1) | Include a list of all BART-eligible sources, BART determination for any source that contributes to visibility impairment, and documentation for these analyses. | Table 5-2 and Appendix D |
| 51.308(e)(1)(iv) | Sources subject to BART must install and operate BART as expeditiously as practicable, but no later than 5 years after SIP approval. | Section 5.9 |
| 51.308(e)(1)(v) | Sources subject to BART must maintain the control equipment required and ensure it is properly operated and maintained. | Appendix D |
| 51.308(i)(2) | Provide the FLMs With an opportunity for consultation at least 60 days prior to holding any public hearing. | Section. 8.3 |
| 51.308(i)(3) | Describe how the FLM comments will be addressed. | Section 8.3 |
| 51.308(i)(4) | Provide procedures for continuing consultation between the State and the FLMs. | Section 8.4 |

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# TITLE 13. CALIFORNIA AIR RESOURCES BOARD

## NOTICE OF PUBLIC HEARING TO CONSIDER PLUG-IN HYBRID ELECTRIC VEHICLE TEST PROCEDURE AMENDMENTS AND AFTERMARKET PARTS CERTIFICATION REQUIREMENTS ADOPTION

The Air Resources Board (the Board or ARB) will conduct a public hearing at the time and place noted below to consider amendments to motor vehicle test procedures for exhaust emissions, evaporative emissions, and refueling emissions, and new requirements for certification of aftermarket conversion systems for plug-in hybrid electric vehicles.

DATE: January 22, 2009

TIME: 9:00 a.m.

PLACE: California Environmental Protection Agency
Air Resources Board
Byron Sher Auditorium
1001 I Street
Sacramento, CA 95814

This item will be considered at a two-day meeting of the Board, whichwill commence at 9:00 a.m., January 22,2009, and may continue at 8:30 a.m., January 23,2009. This item may not be considered until January 23, 2009. Please consult the agenda for the meeting, which will be available at least ten days before January 22,2009, to determine the day on which this item will be considered.

For individuals with sensory disabilities,this document and other related material can be made available in Braille, large print, audiocassette, or computer disk. For assistance, please contact ARB's Reasonable Accommodations/Disability Coordinator at (916) 323-4916 by voice or through the California Relay Services at 711, to place your request for disability services, or go to http://www.arb.ca.gov/html/ada/ada.htm.

If you are a person with limited English and would like to request interpreter services to be available at the Board meeting, please contact ARB's Bilingual Manager at (916) 323-7053.

## INFORMATIVE DIGEST OF PROPOSED ACTION AND POLICY STATEMENT OVERVIEW

**Sections Affected:** Proposed amendments to California Code of Regulations, title 13, section 1961, and the following test procedure incorporated by reference: "California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles," adopted

August 5, 1999, as last amended Máy 2,2008; section 1962 and the following test procedure as renamed and incorporated by reference: "California Exhaust Emission Standards and Test Procedures for 2005 through 2008 Model Zero-Emission Vehicles, and 2001 through 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes," adopted August 5, 1999, as last amended December 19, 2003; section 1962.1 and the following test procedure as renamed and incorporated by reference: "California Exhaust Emission Standards and Test Procedures for 2009 and SUbsequent Model Zero-Emission Vehicles, and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes,"; section 1976 and the following test pro"cedure incorporated by reference: "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles," adopted August 5, 1999, as last amended May 2,2008; and section 1978 and the following test procedure incorporated by reference: "California Refueling Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles," adopted August 5, 1999, as last amended May 2, 2008; and the adoption of a new section 2032, title 13, California Code of Regulations, and the incorporated "California Certification and Installation Procedures for Off-Vehicle Charge Capable Conversion Systems for 2000 and Subsequent Model Year Hybrid Electric Vehicles."

**Background:**

In 1990, the California Air Resources Board (ARB or the Board) adopted an ambitious regulation to significantly reduce the environmental impact of light-duty vehicles through the commercial introduction of zero emission vehicles (ZEV) into the California fleet. Over the years, the ZEV program has evolved to include hybrid electric vehicle (HEV) technologies among compliance options. The regulation includes certification standards and test procedures for HEV and ZEV technologies. The most recent changes to the ZEV regulation, considered in March 2008 included provisions that strongly encourage commercialization of plug-in HEVs (PHEV) or off vehicle charge capable (OVCC) HEVs. OVCC HEVs may charge on or off the electric power grid. In this hearing notice and the staff report, the term PHEV is used to refer to OVCC HEVs, that is, vehicles capable of charging on or off the grid.

This rulemaking focuses on adapting the current test procedures to address new configurations ofPHEVs. Additional amendments in this rulemaking address HEV conversions and ZEV range testing. Aftermarket PHEV conversion system manufacturers (Conversion System Manufacturers) have developed products to convert existing HEVs to PHEVs. Certification requirements for PHEV conversion systems are proposed, as is an alternative all electric range (AER) determination for fuel cell vehicles (ZEV Range Test Procedures for Fuel Cell Electric Vehicles), based on fuel consumption.

**Proposed Amendments and Adoptions:**

**Amend the Exhaust Test Procedures for Hybrid Electric Vehicles:** To specifically address PHEVs, a new section is being included in the renamed "California Exhaust

Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes" (Exhaust Test Procedures). This section includes a determination of an equivalent all electric range (EAER) and provides test procedures for more adv'anced PHEVs.

While the current Exhaust Test Procedures are appropriate for testing current HEVs and battery electric vehicles (EV), additional amendments are needed to clarify requirements for conventional HEVs and to provide for equivalency in results from EV and PHEV AER tests. In addition, current procedures are not adequate for testing PHEVs. The proposed changes. more accurately determine the contribution of the electric drive and vehicle emissions from PHEVs.

Allow Alternative AER Test Procedures for Fuel Cell EVs: Staff proposes to supplement the current AER test for electric vehicles, which was designed for battery EVs, with a procedure more appropriate for fuel cell EVs. Staff's proposal incorporates the newly revised Society of Automotive Engineers (SAE) J2572 "Recommended Practice for Measuring Fuel Consumption and Range of Fuel Cell and Hybrid Fuel Cell Vehicles Fueled by Compressed Gaseous Hydrogen." This SAE Recommended Practice addresses both hydrogen measurement challenges and decreases. the duration of the current AER Test Procedures by calculating the vehicle range based on fuel consumption.

Amend the Evaporative Emission and Refueling Related Test Procedures for PHEVs: HEVs are currently certified to comply with ARB's evaporative emission standards according to the "California Evaporative Emission Standards and Test Procedures For 2001 and Subsequent Model Motor Vehicles" (Evap Test Procedures), and the "California Refueling Emission Standards and Test Procedures For 2001 and Subsequent Model Motor Vehicles" (ORVR Test Procedures). Much like the Exhaust Test Procedures, these procedures are adequate for testing current HEVs, but do not address the unique characteristics of PHEV technologies. The ability to recharge batteries without internal combustion (IC) engine operation offers exhaust emission benefits; however, the accurate determination of evaporative emissions decreases with decreased IC engine use. Accordingly, staff is proposing amendments to the current Evap and ORVRTest Procedures to ensure that the evaporative emissions of PHEVs are reasonably characterized for certification purposes to demonstrate compliance with the applicable evaporative emission standards.

Create a New Set of Certification Procedures for PHEV Conversion Systems: Staff is proposing to create a separate set of certification procedures to address conversions of HEVs to PHEVs. Certification of PHEV conversion systems will follow the same Exhaust, ORVR and Evap Test Procedures as described above. The addition of PHEV conversion requirements will ensure that the converted vehicle continues to meet the original emission standards under the warranty prOVided to the consumers.

## COMPARABLE FEDERAL REGULATIONS

Currently, there are no comparable federal test procedures for PHEVs. There are no federal certification procedures for aftermarket PHEV conversion systems. There are no federal test procedures specific to fuel celi EV range.

## AVAILABILITY OF DOCUMENTS AND AGENCY CONTACT PERSONS

The Board staff has prepared a Staff Report: Initial Statement of Reasons (ISOR) for the proposed regulatory action, which includes a summary of the economic and environmental impacts of the proposal. The report is entitled: "Initial Statement of Reasons for Proposed Rulemaking for Off-Vehicle Charge Capable Hybrid Electric Vehicles: Modifications to Test Procedures and Aftermarket Parts Certification Requirements."

Copies of the ISOR and the full text of the proposed regulatory language, in underline and strikeout format to allow for comparison with the existing regulations, may be accessed on the ARB's web site listed below, or may be obtained from the Public Information Office, Air Resources Board, 1001 I Street, Visitors and Environmental Services Center, 1st Floor, Sacramento, CA 95814, (916) 322-2990 at least 45 days prior to the scheduled hearing on January 22,2009.

Upon its completion, the Final Statement of Reasons (FSOR) will be available and copies may be requested from the agency contact persons in this notice, or may be accessed on the ARB's web site listed below.

Inquiries concerning the substance of the proposed regulation may be directed to the designated agency contact persons, Ms. Lesley Crowell, Air Resources Engineer, by email tolcrowell@arb.ca.gov or by phone at (916) 323-2913, or to Ms. Elise Keddie, Manager, ZEV Implementation Section, by email toekeddie@arb.ca.gov or by phone at (916) 323-8974.

Further, the agency representative and designated back-up contact persons to whom nonsubstantive inquiries concerning the proposed administrative action may be directed are Ms. Lori Andreoni, Manager, Board Administration & Regulatory Coordination Unit, (916) 322-4011, or Ms. Amy Whiting, Regulations Coordinator, (916) 322-6533. The Board has compiled a record for this rulemaking action, which includes all the information upon which the proposal is based. This material is available for inspection upon request to the contact perso,ns.

This notice, the ISOR and all subsequent regulatory documents, including the FSOR, when completed, are available on the ARB Internet site for this rulemaking at www.arb.ca.gov/regact/2008/phev09/phev09.htm

**COSTS TO PUBLIC AGENCIES AND TO BUSINESSES AND PERSONS AFFECTED**

The determinations of the Board's Executive Officer concerning the costs or savings necessarily incurred by public agencies and private persons and businesses in reasonable compliance with the proposed regulations are presented below.

Pursuant to Government Code sections 11346.5(a)(5) and 11346.5(a)(6), the Executive Officer has determined that the proposed regulatory action would create costs or savings to any state agency or in federal funding to the state, costs or mandate to any local agency or school district whether or not reimbursable by the state pursuant to part 7 (commencing with section 17500), division 4, title 2 of the Government Code, or other nondiscretionary cost or savings to state or local agencies. Under the proposal, ARB will incur costs for conducting the Exhaust and Evap Test Procedures for compliance testing of PHEVs. A detailed assessment of the cost impacts of the proposed regulatory action can be found in the ISOR.

In developing this regulatory proposal, the ARB staff evaluated the potential economic impacts on representative private persons or businesses. The ARB is not aware of any cost impacts that a representative private person or business would necessarily incur in reasonable compliance with the proposed action.

The Executive Officer has made an initial determination that the propos,ed regulatory action would not have a significant statewide adverse economic impact directly affecting businesses, including the ability of California businesses to compete with businesses in other states, or on representative private persons.

In accordance with Government Code section 11346.3, the Executive Officer has determined that the proposed regulatory action would not affect the creation or elimination of jobs within the State of California, the creation of new businesses or elimination of existing businesses within the State of California, or the expansion of businesses currently doing business within the State of California. A detailed assessment of the economic impacts of the proposed regulatory action can be found in the ISOR.

The Executive Officer has also determined, pursuant to title 1, CCR, section 4, that the proposed regulatory action may affect small businesses. Independent testing facilities may need to upgrade equipment to perform additional testing. However, the costs associated with any upgrades would be passed along to manufacturers using the facilities.

The incremental costs associated with producing and certifying PHEVs is likely to be passed on to the consumer. Staff estimates the incremental cost to be less than $5 to $10 per vehicle.

Conversion System Manufacturers modifying vehicles outside of the original equipment manufacturer's (OEM) warranty will see a marginal increase in current costs of about $200 for additional application costs. However, Conversion System Manufacturers modifying vehicles still under OEM warranty will be allowed to use the aftermarket certification process instead of recertifying the vehicle as a small volume manufacturer as currently required. As recertification costs are considerable, the proposed certification· process will provide Conversion System Manufacturers with a substantial cost savings.

Cost savings are also anticipated for OEMs producing Fuel Cell EVs due to the reduction of required test cycles. The cost savings are difficult to calculate as they depend on the range of the vehicle: longer range vehicles will see larger cost savings as the number of test cycles is proportional to the range of the vehicle.

Before taking final action on the proposed regulatory action, the" Board must determine that no reasonable alternative considered by the board or that has otherwise been identified and brought to the attention of the board would be more effective in carrying out the purpose for which the action is proposed or would be as effective and less burdensome to affected private persons than the proposed action.

SUBMITTAL OF COMMENTS

The pUblic may present comments orally or in writing at the meeting, and in writing or by e-mail before the meeting. To be considered by the Board, written submissions not physically submitted at the meeting must be received no later than 12:00 noon, January 21, 2009, and addressed to the following:

| | |
|---|---|
| Postal mail: | Clerk of the Board, Air Resources Board<br>1001 I Street, Sacramento,California 95814 |
| Electronic submittal: | http://www.arb.ca.gov/lispub/comm/bclist.php |
| Facsimile submittal: | (916) 322-3928 |

Please note that under the California Public Records Act (Government Code section 6250 et seq.), your written and oral comments, attachments, and associated "contact information (e.g., your address, phone, email, etc.) become part of the public record and can be released to the public upon request. Additionally, this information may become available via Google, Yahoo, and any other search engines.

The Board requests but does not require that 30 copies of any written statement be submitted and that all written statements be filed at least 10 days prior to the hearing so that ARB staff and Board Members have time to fully consider each comment. The board encourages members of the public to bring to the attention of staff in advance of the hearing any suggestions for modification of the proposed regulatory action.

## STATUTORY AUTHORITY AND REFERENCES

This regulatory action is proposed under the authority granted sections 39500, 39515, 39600,39600,39601,39667,43000,43006,43013, 43018, 43101, 43104,·and 43105, and 42107, Health and Safety Code. The action is proposed to implement, interpret, and make specific sections 39002, 39003, 39500, 39667,43000,43006,43008.6, 43009.5,43013,43018,43100,43101,43101.5,43102,43104,43105,43106,43107, 43108,43204,43205, and 43205.5, Health and Safety Code; and sections 27156 and 39391, Vehicle Code.

## HEARING PROCEDURES

The public hearing will be conducted in accordance with the California Administrative Procedure Act, title 2, division 3, part 1, chapter 3.5 (commencing with section 11340) of the Government Code.

Following the public hearing, the Board may adopt the regulatory language as originally proposed, or with non substantial or grammatical modifications. The Board may also adopt the proposed regulatory language with other modifications if the text as modified is sufficiently related to the originally proposed text that the public was adequately placed on notice that the regulatory language as modified could result from the proposed regulatory action; in such event the full regulatory text, with the modifications clearly indicated, will be made available to the public, for written comment, at least 15 days before it isadopted.

The public may request a copy of the modified regulatory text from the ARB's Public Information Office, Air Resources Board, 1001 I Street, Visitors and Environmental Services Center, 1st Floor, Sacramento, CA 95814, (916) 322-2990.

CALIFORNIA AIR RESOURCES BOARD

J mes N. Goldstene
Executive Officer

Date: November 25, 2008.

*The energy challenge facing Califomia is real. Every Califomian needs to take immediate action to reduce energy consumption. For a list of simple ways you can reduce demand and cut your energy costs see our Web -site at www.arb.ca.gov.*

**CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY**
**. AIR RESOURCES BOARD**

# STAFF REPORT: INITIAL STATEMENT OF REASONS FOR PROPOSED RULEMAKING FOR PLUG-IN HYBRID-ELECTRIC VEHICLES:

## AMENDMENTS TO TEST PROCEDURES AND AFTERMARKET PARTS CERTIFICATION REQUIREMENTS

Location:
Byron Sher Auditorium
Air Resources Board, Cal/EPA Headquarters
1001 I Street
Sacramento, CA 95812
Air Resources Board
P.O. Box 2815
Sacramento, CA 95812

Date of Release: December 5, 2008
Scheduled for Consideration: January 22-23, 2008

This report has been reviewed by the staff of the California Air Resources Board and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Air Resources Board, nor does the mention of trade names or commercial products constitute endorsement or recommendation for use.

# TABLE OF CONTENTS



Date of Release: December 5, 2008
Date of Hearing: January 22-23, 2008

TABLE OF TABLES



TABLE OF APPENDICES

## TABLE OF ACRONYMS

| | |
|---|---|
| 2D+HS | Supplemental Two-Day Diurnal pius Hot Soak |
| 3D+HS | Three-Day Diurnal plus High-Temperature Hot Soak and Running Loss |
| AER | All-Electric Range |
| ARB | California Air Resources Board |
| AT PZEV | Advanced Technology Partial ZEV Allowance Vehicle |
| CCR | California Code of Regulations |
| $CO_2$ | Carbon Dioxide |
| CNG | Compressed Natural Gas |
| EAER | Equivalent All-Electric Range |
| EV | Electric Vehicle |
| Evap | Evaporative Emission |
| Exhaust. | Exhaust Emission |
| GVWR | Gross Vehicle Weight Rating |
| HEV | Hybrid-Electric Vehicle |
| HFEDS | Highway Fuel Economy Driving Schedule |
| IC engine | Internal Combustion Engine |
| ISOR | Initial Statement of Reasons |
| LDT1 | Light-Duty Truck with a loaded vehicle weight of 0-3750 pounds |
| LDT2 | Light-Duty Truck with a loaded vehicle weight of 3751 pounds to a gross vehicle weight of 8500 pounds, or a "LEV I" light-duty truck with a loaded vehicle weight of 3751-5750 pounds |
| LEV I | First generation Low-Emission Vehicle program, adopted in a 1990-1991 rulemaking, and generally applicable in the 1994-2003 model-years |
| LEV II | Second generation Low-Emission Vehicle program, adopted in a 1998-1999 rulemaking, and generally applicable in the 2004 and subsequent model-years |
| LEV II Evap | Evaporative emission standards adopted in LEV II Rulemaking |
| MIL | Malfunction Indicator Light |
| MY | Model-Year |
| OBD | On Board Diagnostic |
| ORVR | Onboard Refueling Vapor Recovery |
| OVCC HEV | Off-Vehicle Charge Capable Hybrid-Electric Vehicle |
| PHEV | Plug-in Hybrid-Electric Vehicle |
| PZEV | Partial ZEV Allowance Vehicle |
| Rcda | Actual charge depleting range |
| SAE | Society of Automotive Engineers |
| SC03 | SC03 Driving Schedule |
| SHED | Sealed Housing for Evaporative Determination |
| SOC | State of Charge |
| Type F | Enhanced AT PZEV vehicle category within the ZEV Regulation |

| | |
|---|---|
| **Type G** | **Enhanced AT PZEV vehicle category w.ithin the ZEV Regulation** |
| **UF** | **Utility Factor** |
| **UD"DS** | **Urban Dynamometer Driving Schedule** |
| **US06** | **US06 Driving Schedule** |
| U.S. **EPA** | **United States Environmental Protection Agency** |
| **VMT** | Vehicle **MilesTraveled** |
| **ZEV** | **Zero-Emission Vehicle** |

# 1. EXECUTIVE SUMMARY

In 1990, the California Air Resources Board (ARB or the Board) adopted an ambitious regulation to significantly reduce the environmental impact of light-duty vehicles through the commercial introduction of zero emission vehicles (IEV) into the California fleet. Over the years, the IEV program has evolved to include hybrid electric vehicle (HEV) technologies among compliance options. The regulation includes certification standards and test procedures for HEV and ZEV technologies. The most recent changes to the ZEV regulation, considered inMarch 2008 included provisions that strongly encourage commercialization of plug-in HEVs (PHEV) or off vehicle charge capable (OVCC) HEVs. OVCC HEVs may charge on or off the electric power grid. In the staff report, the term PHEV is used to refer to OVCC HEVs, that is; vehicles capable of charging on or off the grid.

This rulemaking focuses on adapting the current hybrid exhaust, evaporative emission and onboard refueling vapor recovery (ORVR) test procedures to address new configurations of PHEVs. The proposed changes to the exhaust test procedures more accurately determine the contribution of the electric drive and vehicle exhaust emissions for PHEVs, include a determination of an equivalent all-electric range, and provide test procedures for more advanced PHEVs. Staff is proposing amendments to the current evaporative and ORVR test procedures to ensure that the evaporative emissions of PHEVs are reasonably characterized for testing purposes when demonstrating compliancewith the applicable evaporative-related emission standards.

Additional amendments in this rulemaking address PHEV conversions and IEV range testing. Aftermarket PHEV conversion system manufacturers have developed"products to convert existing HEVs to PHEVs. Staff proposes new certification requirements for PHEV conversion systems, which will include the proposed exhaust, ORVR and evaporative test procedures and will ensure that the converted vehicle continues to meet the original emission standards under the warranty provided to the consumers. Staff proposes to supplement the current all-electric range test with a procedure more appropriate for range determination of fuel cell electric vehicles, based on fuel consumption.

A more detailed description of the proposed amendments is in section four of the staff report.'

The ARB staff recommends that the Board adopt the amendments as proposed in appendices A through G of this Initial Statement of Reasons (ISOR or staff report).



Date of Release: December 5, 2008
Date of Hearing: January 22-23, 2008

## 2. INTRODUCTION

Plug-in hybrid-electriC vehicles (PHEVs, also known asoff:.vehicle·charge capable hybrid-electric vehicles or av.cc HEVs) utilize motive power supplied by an internal combustion engine (IC engine) and off-vehicle electricity stored in batteries or other energy storage systems. Electricity may be combined with motive power from the IC engine (conventional hybrid operation), provide exclusive vehicle propulsion until additionalIC engine power is needed (all-electric range operation, or AER operation), or a combination of both of these operations (blended operation). Throughout this staff report we will refer to these vehicles by their more common name, PHEV. The use of this terminology should not imply that the charging sources are limited to the grid, as with the PHEV definition used in Pavely. Since the Pavely definition of PHEV cannot be changed in this rulemaking and for c1arifi.cation on this point, the test procedures and regulation language will utilize the more inclusive terminology of avcc HEVs. The avcc terminology includes non-grid battery charging sources such as solar panels.

This staff report presentstechnical amendments to the EXhaust, Evap, and aRVR Test Procedures, and presents certification requirements for PHEV conversion kits. These amendments reflect the unique operating characteristics of PHEVs and are designed to more accurately measure exhaust and evaporative emissions. The proposed conversion kit certification requirements provide an opportunity for the aftermarket conversion of vehicles to PHEV operation, while ensuring that emissions post-conversion do not increase. An optional range test for fuel cell electric vehicles is also presented.

This report addresses the need for the proposed changes, presents a summary of the amendments or new requirements, discusses alternatives to the proposal, and presents the environmental and economic impacts of the proposal. Appendix A shows the proposed regulatory text. Appendices B through F contain the proposed amendments to the current exhaust, .evaporative emission, and refueling test procedures. Appendix G contains the proposed new certification requirements for aftermarket PHEV conversion systems. Appendices H and I contain technical support documents for the proposed amendments to the exhaust and evaporative-related test procedures. Appendix J contains information about Onboard Diagnostics and the relation to aftermarket PHEV conversion systems. Appendix K contains additional information on the Economic Impact of the proposed exhaust and evaporative-related test procedure amendments.

# 3. BACKGROUND

## 3.1 Air Quality in California

Air quality in California has improved dramatically over the past 30 years, largely due to continued progress in controlling pollution from motor vehicles. Faced with ever more" stringent regLilations, vehicle manufacturers have made remarkable progress in advancing vehicle technology. Vehicles meeting the Air Resources Board's (ARB) most stringent emission certification standards achieve emission levels that seemed impossible when the ZEV program was adopted in 1990.

Despite this progress, air quality in many areas of the state still does not meet federal or state health-based ambient air quality standards. Mobile sources stiil are responsible for well Over half of the ozone-forming emissions in California. The relative contribution of passenge"r cars and small trucks is expected to decline overtime as new standards "phase in, but in 2020 such vehicles will still be responsible for approximately 10 percent of total emissions based on the ARB emissions inventory.[1] State and federal law requires the implementation of control strategies to attain ambient air quality standards as quickly as practicable.

In 2004, the ARB adopted the first greenhouse gas (GHG) emission reduction measure in the nation, applicable to light-duty vehicles. The California Global Warming Solutions "Act of 2006, Assembly Bill 32 (AB 32) gave ARB the responsibility for monitoring and reducing GHG emissions. AB 32 also established requirements for a comprehensive program of regulatory and market mechanisms to achieve real, quantifiable, and cost effective GHG emission reductions. It requires ARB and other state agencies to adopt regulations and other requirements that reduce GHG emissions to 1990 levels by 2020. In addition, Governor Schwarzenegger set a goal of an 80 percent reduction from 1990 GHG emission levels by 2050[2]. The transportation-sector is the largest contributor of human caused GHG emissions in California: 38 percent of total carbon dioxide equivalent emissions in 2004; Seventy-four percent of the transportation emissions are contributed by passenger vehicles. Other programs and legislation, including Assembly Bill 1007 (State Alternative Fuels Plan), require the state to prepare new plans to increase the use of alternative fuels in California. These other programs indicate the need for significant use of the electric drive train as well as other actions to meet California's air quality, emission reduction, and climate change goals. Off-vehicle charge capable vehicles can help play an important role in redLicing both GHG and criteria pollutant emissions.

## 3.2 PHEV Technology

In 2003, staff envisioned two types of hybrid vehicle operation: AER PHEVs (sometimes called series hybrids) and conventional hybrids. An AER PHEV utilizes an electric

1 ARB 2007a.
2 Executive Order S-03-05

motor exclusively for a period oftime, thereby allowing the vehicle to have an all-electric range. These vehicles operate the electric motor utilizing the electricity in the battery until the charge is depleted and then switch to using the IC engine. The AER has been defined as the total miles driven electrically before the IC engine turns on for the first time. During AER operation the vehicle is operating in a charge depleting mode. When the battery state of charge (SOC) can no longer' sustain the vehicle's requirements to solely operate on the electric motor, the vehicle will then transition to a combined IC engine and electric motor hybrid operation.

The Chevrolet Volt is one example of an AER PHEV. This vehicle relies exclusively on its battery to power an electric motor to drive the wheels in charge depleting operation. When the battery state-of-charge (SOC) drops to a charge-sustaining level, generally after about 40 miles of all-electric operation, the IC engine starts in order to sustain the battery's SOC, like today's conventional HEVs. The Chevrolet Volt relies only on the electric motor to drive the wheels - the IC engine does not directly drive the wheels.

The conventional HEV utilizes an operating mode where both the electric motor and IC engine operate either simultaneously or independently to provide motive power. They do not plug in; their batteries are recharged by the IC engine and by recapturing energy while braking. In conventional hybrids the IC engine operates most of the time, thereby keeping the catalyst warm and operating more effectively. Examples of conventional HEVs include the Nissan Altima Hybrid, Toyota Prius, and Ford Escape Hybrid. The current Exhaust Test Procedures provide an accurate all-electric range determination from AER PHEVs such as the Chevrolet Volt and an accurate measurement of emissions from conventional HEVs.

Since 2003, the concept of a "blended PHEV" has emerged as an intermediate step between conventional HEVs and AER PHEVs. It is anticipated that conventional HEV models may evolve into blended PHEVs with the addition of extra battery capacity and the ability to charge from an external source. Blended' PHEVs differ from an AER PHEVs in electric range because the IC engine may start anytime during operation, and usually before the off-vehicle charge energy has reached a charge-sustaining level. Blended PHEVsmay operate the IC engine intermittently, either to provide more electrical power to the electric motor or to actually provide torque directly to the wheels. [4] Therefore, it is possible to have many IC engine starts within one trip. Proponents of blended PHEVs claim that these vehicles provide nearly the same reductions in green house gas (GHG) emissions and petroleum dependency as AER PHEVs with a less powerful, and less expensive electric drive system.

## 3.3 ZEV Program

In preparation for the recent ZEV program amendments, an independent panel of experts (Panel) reported on the status of ZEV technologies and their readiness for

3 General Motors 2008

4 During the predominantly all-electric operating mode, engine operation should be infrequent and called for only under conditions of heavy load or acceleration requirements from the driver

commercialization prior to 2009 to the Board in May 2007. The Panel's report[5] identified the potential of PHEVs for commercialization. However, the Panel also concluded that a'mendments to current test procedures must be made to adequately address emissions and electric range from PHEVs.

The most recent amendments to the ZEV regulation classify PHEVs as enhanced advanced technology partial allowance zero-emission vehicles (enhanced AT PIEV). Manufacturers can produce enhanced AT PIEVs in combination with pure IEVs to meet their ZEV requirement. To qualify as PIEVs, vehicles have additional requirements, including a warranty requirement of 15 years or 150,000 miles on all emission related components. To qualify for ATPIEVs, an additional warrarity requirement on all zero-emission energy storage of 10 years or 150,000 miles devices must be met.

PHEVs may be certified at any number of emission categories. However only those PHEVs that meet super ultra low-emission vehicle (SULEV)6 emission levels with zero evaporative emissions? can qualify for credit including specific advanced componentry allowances under the IEV regulation. PHEVs may also qualify fora zero-emission vehicle miles traveled (VMT) allowance based on an AER or equivalent all-electric range (EAER) with specific driving schedules.

## 3.4 Emission Test Procedures

### Exhaust Test Procedures

Exhaust emissions testing quantifies and evaluates criteria emissions underworst-case operating scenarios. Most emissions from vehicles occur at the start of IC engine operation,known as a "cold start." Emissions are controlled with catalysts which operate most efficiently when warm. The current "California Exhaust Emission Standards and Test Procedures for 2005 and Subsequent Model Zero-Emission Vehicles and 2001 and Subsequent Model Hybrid-Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes" (Exhaust Test Procedures) measure emissions produced from cold starts and "hot starts" (Ie engine at optimal operating temperature) using driving schedules that simulate a range of low and high speed vehicle operation.

For both conventional HEVs and conventional vehicles, the engine operates most of the time and typically there is only one cold start. PHEVs can cycle the IC engine on and off several times throughout the operation. Depending on the operating conditions, these vehicles are capable of multiple cold starts throughout a test drive cycle. For these vehicles, the current test procedure does not evaluate the worst-case operating scenario. The proposal contains a series of tests to address the unique operating

5 Kalhammer, et al. 2007
6 ARB 2008c, Section E.1.1.2
7 CCR title 13 Section 1978 E.1.(c)

characteristics of these vehicles to determine a procedure that evaluates the emissions under the worst-case operating scenarios.

The development of this test series is the result of a collaborative effort through the Society of Automotive Engineers (SAE) technical committee that is presently developing revisions to "Recommended Practice for Measuring the Exhaust Emissions and Fuel Economy of Hybrid-Electric Vehicles" (SAE J1711). SAE J1711 includes procedures for determining emissions and all-electric range of PHEVs. Whenever possible, ARB works closely with the SAE in the development of emissions-related test procedures. The technical committee included members from the automotive industry, environmental groups, ARB, and the U.S. EPA ARB's proposed Exhaust Test Procedures and the next revision of SAE J1711 are expected to be similar, and in some regards, identical. The SAE J1711 revisions will not be completed in time for ARB regulatory requirements. Consequently, this parallel SAE-ARB Exhaust Test Procedures development effort was required. Several auto manufacturers are urgently working towards near-term deployment of PHEVs, and therefore it was necessary for all parties to come to an agreement as to how to determine the emissions performance and EAER of these new vehicles. The SAE J1711 must also cover additional procedures that the currentand proposed ARB Exhaust Test Procedures do not, for example, the development of fuel economy test procedures for hybrids. This challenging aspect of PHEV performance assessment may take substantial additional time in order for the SAE J1711 Technical Committee to reach agreement.

All-Electric Range Determination Test Procedures for Fuel Cell EVs

Testing requirements are relatively straightforward for IEVs as they do not have IC engine- or fuel-associated emissions. These vehicles are tested to determine the range of the vehicle. Range testing is required for IEVs intending to receive credit for IEV program compliance. In the current AER Test Procedures, a IEV is driven over the urban test cycle and the highway test cycle on a dynamometer until it is no longer able to meet the vehicle speed called for in the test. The distance driven up to that point is its AER. Fuel cell EVs and battery EVs can have significant ranges, which are proportional to dynamometer time. The test can be time and resource consuming for hydrogen fuel cell EVs that may attain ranges of 300 miles or greater. For example, a hydrogen fuel cell EV with a range of 300 miles would require performing forty 7.45 mile-long UDDS at an average speed of approximately 20 miles per hour with 10-minute cold soaks in between cycles, resulting in21 hours of total dynamometer time.

As with the Exhaust Test Procedures, ARB staff worked with the SAE on the newly revised "Recommended Practice for Measuring Fuel Consumption and Range of Fuel Cell and Hybrid Fuel Cell Vehicles Fuelled by Compressed Gaseous Hydrogen," SAE J2572.[8] SAE J2572 addre'sses both the hydrogen measurement challenges and the duration of the current AER Test Procedures. The proposed procedures shorten the testing time for fuel cell EVs.

SAE may develop a similar abbreviated procedure for high range battery EVs. ARB will continue to follow the development of the potential Recommended Practice, and may consider inclusion of an abbreviated battery EV range test at a future date. In the meantime, the current AER test will be used.

Evaporative Emission and ORVR Test Procedures

Motor vehicle gasoline or other hydrocarbon evaporative emissions are classified into four types: running loss, hot soak, diurnal, and refueling. Running loss emissions occur when the vehicle is driven and originate from numerous sources within the fuel system. Hot soak emissions occur immediately after a vehicle is parked with its IC engine turned off and are due to the latent IC engine heat vaporizing residual fuel in the le engine system. Diurnal emissions occur when a vehicle is parked and subjected to daily, summertime ambient temperature changes that cause an expansion of vapors in the fuel tank. Refueling emissions are fuel tank vapors that are volumetrically displaced from the tank as the tank is replenished with new fuel.

The evaporative emission control systems of modern gasoline vehicles limit emissions by using components made from advanced, non-permeable materials, and by capturing and holding vapors in an on-board carbon canister. This canister, which contains actiVated carbon material that collects hydrocarbon vapors, is the prime evaporative emissions control device. Vapors that form inside the fuel tank are routed to the canister for storage. These captured vapors are later routed or "purged" to the IC engine system to be combusted when the vehicle is driven. However, if a vehicle's ,evaporative emission control system is not properly designed, some vapors may escape to the atmosphere when the amount of tank vapors routed to the canister is greater than its storage capacity, or ifthe canister has not been purged adequately, "breakthrough" can occur.'

There are two types of evaporative emission control systems. The first is an "integrated" system which uses a single canister to store the vapors produced by both the evaporative and refueling ,processes. The second is a "non-integrated" system which uses a separate canister to store vapors for each process. Until recently, the integrated evaporative emission control system was the only type used. Toyota Motors Corporation introduced a variation of the non-integrated system beginning with a 2005 model-year HEV. That system uses a single canister for storing only the refueling vapors while the other evaporative diurnal vapors remain stored inside the fuel tank

8 SAE 2008a,

(Le., "non-integrated refueling canister-only" system). As with an integrated system, all vapors are eventually routed to the IC engine for combustion once the vehicle is driven.

The .current evaporative emission requirements were formally adopted by ARB in 1999 as part of the second generation of California's LEV regulations (LEV II evap). Manufacturers demonstrate compliance with the LEV II evap standards for each of the four types of evaporative emissions using simulated "real-world" conditions. Determination of a vehicle's evaporative emissions relies on two specific test sequences that are contained in the "California Evaporative Emission Standards and Test Procedures For 2001 and Subsequent Model Motor Vehicles" (hereinafter referred to as "Evap Test Procedures"). The first test sequence is the 'Three-Day Diurnal plus High-Temperature Hot Soak and Running Loss" (3D+HS) procedure. The second test sequence is the "Supplemental Two-Day Diurnal plus Hot Soak" (2D+HS) procedure. Manufacturers are also required to demonstrate compliance with the applicable ORVR emission standards using another test sequence contained in the ORVR Test Procedures. . .

The current Evap and ORVR Test Procedures do not test PHEVs under theworst case scenario. As with the Exhaust Test Procedures, the Evap and ORVR Test Procedures need to be modified to 'account for the unique operating characteristics of PHEVs.

## 3.5 Aftermarket Parts

California Vehicle Code section 27156 prohibits sale, offer for sale, advertisement, or installation of any aftermarket parts that alter the design or performance of any required motor vehicle pollution control device or system. The same section authorizes ARB to exempt such parts from the prohibition if it finds that the parts do not reduce the effectiveness of any required pollution control device or do not cause vehicle emissions to exceed applicable standards. To allow evaluation and legal use of aftermarket parts, ARB adopted exemption procedures in 1977 with subsequent amendments in 1981 and 1990. Aftermarket parts exempted under these procedures are generally add-on parts or parts that modify the original parts they replace. The exemption procedures ensure that the aftermarket. parts do not adversely affect vehicle emissions or On-Board Diagnostic (OBD) systems.[9] Aftermarket parts evaluated under these procedures typically do not require significant changes to the original vehicle. Examples of exempted aftermarket parts include air intake systems, superchargers, and controllers.

For parts that require more extensive changes to allow use of fuel other than gasoline and diesel, California Health and Safety Code section 43006 authorizes ARB to certify the fuel systems. To allow evaluation and legal use of fuel systems, ARB adopted certification procedures in 1975, 1983, and 1993. These procedures allow certification of alternative fuel conversion systems designed to convert gasoline or diesel vehicles to operate on liquefied petroleum gas, natural gas, or alcohol fuels. The certification procedures ensure that vehicles modified with alternative fuel conversion systems continue to meet emission standards throughout their useful life. This is accomplished through emission testing and demonstration of conversion system durability.

9 Appendix J has more detailed information on the implications of aBD to aftermarket conversions.

Certification also requires demonstration of compliance with aBD requirements, conversion system and installation warrantY,and in-use testing.

PHEVs are similar to fuel conversions, in that the addition of off-vehicle charge capability effectively converts the vehicle to allow another source of energy to provide motive power. As with OEM PHEVs these vehicles have unique operating characteristics, which need to be evaluated differently. The current certification procedures do not address these issues. As with other fuel conversions, additional test procedures and provisions are necessary to determine if the vehicle meets the applicable emission standards over the useful life of the vehicle.

## 4. Staff's Proposed' Amendments

Staff's proposed amendments are designed to reflect the state of technology and provide appropriate emission test procedures for PHEV technologies. Other proposed changes are intended to clarify and simplify specific program requirements. The areas identified in this section represent the most significant changes being proposed.,

### 4.1 Objectives

The following are the main objectives of this rulemaking and staff's proposed changes:

- Ensure test procedures adequately measure emissions from blended PHEVs, AER PHEVs, and conventional HEVs;
- Ensure Exhaust Test Procedures adequately determine an equivalent all-electric range for blended PHEVs to determine the zero-emission VMT'allowance; [10]
- Determine the advanced componentry allowance[11] under both the Urban Dynamometer Driving Schedule (UDDS) and US06 driving schedules;
- Provide a mechanism for certifying conversions of HEVs, while ensuring emissions are not increased throughout the original equipment manufacturer warranty period; .and
- Provide a condensed testing option for fuel cell EVs to determine the AER of the vehicle.

### 4.2 Hybrid Exhaust Test Procedures.

The proposed Exhaust Test Procedures incorporate an accurate method for testing all types of PHEVsto determine the vehicle's electric range contribution, to accurately quantify exhaust emissions, and determine if vehicles qualify for the zero-emission VMT or advanced componentry allowances described in the ZEV regulation. ARB has worked closely with the SAE J1711 committee to develop Exhaust Test Procedures in ordertoprovide a consistent approach for testing these vehicles. The proposed Exhaust Test Procedures will be required for the 2011 model-year. However, manufacturers may optto use the proposed Exhaust Test Proce'dures for model-years priorto 2011.

In the current Exhaust Test Procedures, staff assumed that the electric motor would be used exclusively during the charge depletion mode, and thus the current Exhaust Test Procedures start 'collecting emissions after the battery's charge is depleted. The AER occurs during the charge depleting mode and is defined as operation that occurs prior to the start of the le engine. Blended PHEVs oper,ate differently. While blended PHEVs

10 ARB 2008e, title 13 section 1962.1 (c) (3)
11 ARB 2008e,title 13 section 1962.1 (c) (4) (B) 7 for UDDS and title section 1962.1 (c) (4)(B) 8 for US06,

can operate in an electric mode, the IC engine may start at any time to meet the driving condition demanded by the driver. For example, a blended PHEV may operate in an all-electric mode for 1a miles in a 25 mile trip. However, if the trip began with a hard acceleration, the IC engine would likely start to provide needed power. In this example, the AER as determined by the current procedure would be much less than 1a miles. Using the current AER definition, the electric contribution for the rest of the trip does not currently count toward the AER and is therefore not recognized for its benefit. The proposed Exhaust Test Procedures include an EAER determination, which. is used to calculate the electric driving range during blended operation over an entire trip. This determination will allow blended PHEVs to qualify for a zero-emission VMT allowance in the IEV regulation. Since electric range during blended operation cannot be directly measured, a method was developed to calculate EAER based on the amount of $CO_2$ emitted during vehicle testing.

Additionally, the current Exhaust Test Procedures do not accurately capture tailpipe emissions from blended and AER PHEVs. The current Exhaust Test Procedures are based on the premise that the IC engine does not operate in charge depleting mode, therefore emissions are not collected during this time. For instance, if the IC engine cycles on and off throughout charge depleting mode, the exhaust emissions could not be sampled under the current Exhaust Test Procedures. Likewise, for AER PHEVs the IC engine can start in the middle ota driving schedule, when the vehicle demands are different than at the start of a driving schedule. The current Exhaust Test Procedures will not capture the emissions from either of these situations. In the proposed Exhaust Test Procedures, emission sampling during charge depleting operation will now be required for all PHEVs. Emissions will continue to be captured until the battery SOC is depleted to the point where the IC engine operates more frequently to sustain a minimum battery SOC.

Staff proposes to split the Exhaust Test Procedures, including the AER determination, into two sections: 1) applicable for PHEVS,[12] and 2) applicable for conventional HEVs and IEVs.[13] Appendix H contains a complete detailed explanation of all the proposed changes to the ExhaustTest Procedures.

The following amendments address changes for PHEVs.

Urban Charge Depleting Range Test

For a PHEV which has two distinct modes otoperation, one using battery power alone and another in which motive power is derived from the engine only, the current procedure for the urban charge depleting range test to determine AER is accurate. For the urban charge depleting range test, continuous urban dynamometer driving schedule (UDDS) test cycles with a 1a-minute soak period between each UDDS are conducted until charge-sustaining operation is achieved for two consecutive UDDS cycles (the second UDDS may be omitted if data is provided showing charge-sustaining operation

12 Section F in the proposed Exhaust Test Procedures (Appendix D)
13 Section E in the proposed ExhaustTest Procedures (Appendix D)

can be determined from one UDDS). For labs unable to perform this sequence, an alternative procedure is described in Appendix H. Appendix D contains the specific test procedure language relating to this alternative.

Highway Charge Depleting Range Test

Similarly, for the highway'charge depleting range test, four continuous highway fuel economy driving schedule (HFEDS) test cycles are conducted. After every fourth HFEDS, an optional key-off soak period is provided to reset test cell equipment. The test sequence is continued until the vehicle achieves charge-sustaining operation for one highway cycle. As with the UDDS procedure, an alternative procedure is allowed for labs unable to perform this sequence. This procedure is in Appendix D and described in AppendixH.

Equivalent All-Electric Range (EAER)

Testing for equivalent all-electric range (EAER) is a new procedure designed to quantify the electric driving range provided by the battery-powered electric motor during blended operation mode of a PHEV. The procedure is based on comparing the propulsion energy contributed by the fuel-powered IC engine during charge-sustaining mode (when net energy is supplied by the engine only) to the proportion of propulsion energy contributed by the engine during charge depleting mode (when net energy is supplied by either the IC engine, the electric motor, or a combination of both.). EAER along with a utility factor (UF)[14] correction is used to determine the zero-emission VMT allowance. The UF is the estimation of the percentage of driving in the charge depleting mode.

Advanced Componentry Allowances

The proposed Exhaust Test Procedures also include two methods to determine if a PHEV qualifies for a Type F or Type G HEV advanced componentry allowances under the ZEV regulation. The proposed methods require that a vehicle be driven utilizing a specified drive cycle and ends when the IC engine first starts or when the vehicle fails to meet the speed tolerance of the drive schedule. Descriptions of the two proposed methods follows:

- the UDDS AER determination: the UDDS charge depleting range test consists of a repeated series of UDDS driving cycles. As discussed in the March 2008 ZEV program amendments, to qualify for a Type F advanced componentry allowance, the vehicle must be capable of achieving a 10-mile AER on this driving schedule.
- the US06 AER determination: the US06 charge depleting range test consists of a repeated series of US06 driving cycles. To qualify for a Type G advanced componentry allowance, the vehicle must be capable of achieving a 1O-mile AER on the more aggressive US06 driving schedule.[15]

14 SAE 2008b.

15 Code of Federal Regulations title 40 volume 18 chapter'1part 86 SUbpart B §86.164-08

Other Amendments to the Exhaust Test Procedures

Staff is also proposing amendments to the Exhaust Test Procedures for conventional HEVs and ZEVs. In general, these amendments align the procedures with those for PHEVs and provide clarification. Most of the changes occur in the charge-sustaining emission tests,[16] or relate to battery charging operations. A more comprehensive discussion is provided in Appendix H.

The proposed amendments to the "California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles,"[17] amendments incorporate the proposed amendments to the hybrid Exhaust Test Procedures.[18]

## 4.3 All-Electric Range Determination Test Procedures for Fuel Cell EVs within the Hybrid Exhaust Test Procedures

There are three challenges with testing hydrogen fuel cell EVs in accordance with the current AER Test Procedures:

(1) The current AER Test Procedures were developed based on battery EVs and do not specifically address hydrogen fuel capacity or consumption measurements.

(2) The current AER Test Procedures require a complete range test of the fuel cell EV. The test can be time and resource consuming for hydrogen fuel cell EVs that may attain ranges of 300 miles or greater. For example, a hydrogen fuel cell EV with a range of 300 miles would require performing forty 7.45 mile-long UDDS at an average speed of approximately 20 miles per hour with 10-minute cold soaks in between cycles, resulting in 21 hours of total dynamometer time.

(3) A third challenge with the current AER Test Procedures for fuel cell EVs is related to the duration of the test. The extended duration of the current AER Test Procedure increases the possibility that the operator fails to meet the speed trace tolerance specifications of a single test cycle due to fatigue. If an error is made in a test cycle near the end of the vehicle range, a great deal of time is required to refill, stabilize, and retest the fuel cell EV.

ARB staff proposes to supplement the current AER Test Procedures for fuel cells by incorporating the newly revised SAE J2572 "Recommended Practice for Measuring Fuel Consumption and Range of Fuel Cell and Hybrid Fuel Cell Vehicles Fuelled by Compressed Gaseous Hydrogen". This SAE Recommended Practice addresses both the hydrogen measurement challenges and the impractical duration of the current AER Test for fuel cell EVs by reducing actual dynamometer testing to only two UDDS cycles (about 15 miles) with one 10-minute soak. Hydrogen consumption during this reduced

16 The following four tests are all run in charge-sustaining mode: UDDS, HFEDS, SC03, and US06.
17 Appendix 8
18 Appendix C and Appendix D

duration test is measured to within one percent accuracy, and usable hydrogen storage capacity is also calculated. Instead of direct measurementof the vehicle's full range, these values are used to' determine the range as follows:

Range (km) = Usable fuel amount (kg) / Fue,1 consumption (kg/km)

For a 300-niile hydrogen ZEV, this revised procedure would result in a reduction in dynamometer test time from 21 hours to 54 minutes. The proposed AER Test Procedures provide a method for calculating theAERof a fuel cell vehicle based on the fuel consumed overthe UOOS and the highway driving ·schedule and the amount of usable hydrogen in the fuel tank.

Although the testing time challenge also exists for high range battery EVs, these abbreviated ZEV AER Test Procedures are not applicable to battery EVs because of additional challenges in consumption and capacity measurements for batteries. In addition, battery depletion may not be linear with mileage. SAE may develop a similar abbreviated procedure for high range battery EVs. ARB will continue to follow the development of the potential Recommended Practice, and may consider inclusion of an abbreviated battery EV range test at a future date. In the meantime, the currentAER test will be used.

## 4.4 Evaporative Emissions Test Procedures.

Some vehicles are exempted from the evaporative emission standards and test procedures, such as diesel- and compressed natural gas- (CNG) fueled vehicles, as well as HEVs with sealed fuel systems that have no evaporative emissions. However, the exemption for HEVs with sealed fuel systems has caused some confusion because the current evaporative regulations do not contain a definition of a "sealed fuel system." Staff's proposal addresses this issue.

For demonstrating compliance, a PHEV presents a challenge for accurately simulating real-world in-use testing conditions using the current Evap Test Procedures. This difficulty is due to the HEV's potential to be "always plugged-in" by an owner. In other words, the vehicle's battery could always be at a fully charged level, or at a high battery SOC, before any commute, which means that the vehicle could operate for a long time, perhaps for weeks, without ever operating its IG engine. This is a concern because without IC engine operation, the evaporative canister cannot purge its stored vapors, yet new evaporative emissions will be generated during each day's temperature diurnal. This will ultimately result in a release, or breakthrough, of vapors to the atmosphere.

Manufacturers are exploring various evaporative emission system designs for controlling evaporative diurnal and ORVR emissions in response to the evaporative control challenges presented by PHEVs. Staff believes that manufacturers will ultimately select designs that use a "non-integrated refueling canister-only" system because this design provides some technological advantages over conventional systems for effectively managing the real-world evaporative emission conditions created by the "always plugged-in" potential operation of these HEVs.

A brief description. of the proposal follows. Refer to Appendix I for a complete detailed explanation of all the proposed changesto the Evap and ORVR Test Procedures.

Definition of a "Sealed Fuel System"

Staff proposes that the curren't Evap and ORVR Test Procedures be amended to include a definition of a "sealed fuel system." The current Evap regulations and Evap Test Procedures apply to HEVs with "sealed fuel systems" which can demonstrate no emissions. However, the current Evap Test Procedures do not include a definition of a "sealed fuel system and this causes confusion of the applicability of the Evap standards and Test Procedures.[19] Specifically, staff recommends that a "sealed fuel system" be defined as a system that uses non-liquid fuels that are under very high pressures and has no evaporative emissions, by virtue of its design specifications. Accordingly, non-integrated refueling canister-only systems do not qualify as a sealed fuel system.

Preconditioning and Revisions to Test Procedures

The Evap and ORVR Test Procedures require a ve.ry detailed method for preparing or "preconditioning" a test vehicle and its evaporative control system before any emission testing is conducted. The currenttest procedures need to be modified to address the unique operating characteristics of PHEVs. Listed below are the major proposed revisions. Other relatively minor revisions (not listed below) are also proposed and are described in Appendix I. . .

- When conducting the sequences of the Evap and ORVR Test Procedures, staff proposes that the vehicle-preconditioning step be performed. entirely with the vehicle's le engine operating in a "charge-sustaining mode".[20] This will ensure that the test vehicle is properly conditioned with the certification test fuel.

- Staff proposes that the SOC of the testvehicle's battery be set at appropriate levels in both of the sequences for the Evap and ORVR Test Procedures, so that the evaporative emissions are reasonably characterized with respect to the potential in-use "always plugged-in" condition for evaporative emissions testing.

- Staff proposes that a new "fuel-tank-refill" canister-loading preconditioning method for non-integrated refueling canister-only systems be added to the Evap and ORVR Test Procedures. This new method is necessary because the existing canister preconditioning methods do not apply to non-integrated systems that use a canister for controlling only refueling vapors. The new method is more appropriate because it represents "real-world" conditions.

19 Appendix E, section 1.A.1 . '

20 "Charge-sustaining" mode means that the vehicle is propelled only by power'from the engine.

- Because it is an additional technology to control evaporative emissions, staff proposes that a definition for a "non-integrated refueling canister-only system" be added to the Evap Test Procedures.

Revisions to the 20+HS Test Sequence

In order to demonstrate that the evaporative emission control system of a PHEV has the capability for sufficiently purging a canister during a short driving event, staff proposes a revision to the 20+HS test sequence. Specifically, the test would be performed with the vehicle's battery set at a low SOC level, thereby forcing the IC engine to operate, which in turn would force a demonstration of the IC engine's purge capability. To reduce the burden of actually performing this demonstration, manufacturers will have the option to conduct an alternative engineering evaluation demonstrating the evaporative emission control system's capability.

## 4.5 Aftermarket Parts Program

With increased numbers of HEVs on the road and growing interest in reducing gasoline consumption, maximizing electric-only drive, and concern about climate change, a number of Conversion System Manufacturers have developed PHEV conversion systems to provide extended electric driving range for HEV drivers. Many of the HEVs being targeted for PHEV conversion are some of the cleanest vehicles operating in California. With their California introduction in 2000, HEVs have become increasingly cleaner, with many HEVs now meeting the most stringent PZEV standards. PZEVs are warranted for emissions by the vehicle manufacturers for 15 years or 150,000 miles. The battery is considered an emission control part and is considered a zero-emission energy storage device used for traction power. As such, the battery is warranted for 10 years or 150,000 miles.[21] The battery on non-PZEV HEVs, which may also be converted, is warranted by the vehicle manufacturer for 7 years or 70,000 miles.

A typical PHEV conversion system adds a rechargeable battery to provide supplemental electrical energy and acontroller to determine when to supply electrical energy from the add-on battery. Other PHEV conversion systems may involve more substantial changes like replacing the existing OEM battery with a larger capacity battery. These conversions impact the way the original vehicle was designed to operate. More electrical energy means less internal combustion engine operation with potential for higher cold start emissions, reduced emission canister purges causing higher evaporative emissions, and higher loading on existing electrical components, such as an electric motor, possibly leading to faster component wear and tear. Conversions also impact operation of the aBO system.[22]

There are current procedures for approving aftermarket parts and alternative fuel conversions systems, but neither procedure applies to PHEV conversions. Therefore, staff is proposing a new procedure to address PHEV conversions. The proposed

21 ARB 2008f. CCR title 13 section1962 (c) (2) (D) and ARB 2008e title 13 section 1962.1 (c) (2) (D).
22 Additional information on aBD is in Appendix J.

procedures establish a certification process very similar to that already used by alternative fuel Conversion System Manufacturers. They would require Conversion System Manufacturers to submit an application package to initiate the certification process, perform emission, durability, and in-use testing, and provide documentation of consumer warranty. These new procedures also require that Conversion System Manufacturers meet aBO requirements. In the certification application, Conversion System Manufacturers must identify the vehicles to be converted, describe their PHEV conversion system and explain how it operates, describe their aBO system; and provide appropriate system labels and warranty. Conversion System Manufacturers must also provide a plan to demonstrate compliance with the emission and durability requirements in the application.

The PHEV conversion system must be tested and shown to be durable for the useful life of the vehicle. Durability testing can be carried out by installing the PHEV conversion system on a vehicle and accumulating mileage on the vehicle using an approved method for the vehicle's useful life. In lieu of whole vehicle aging, Conversion System Manufacturers have the option to age individual components or systems on a bench using an approved method. Once mileage accumulation or bench aging is complete, Conversion System Manufacturers must test the aged vehicle or vehicle with the aged components for emissions. Emission testing would be performed following the test procedures proposed in this rulemaking. To be eligible for certification, the vehicle must meet all the original certification standards. The procedures allow for Conversion System Manufacturers to propose alternative durability- and emission-testing methods that would effectively predict the deterioration of the PHEV converted vehicle as well as predict the useful life emissions of the converted vehicle.

The proposed procedures are written to provide flexibility depending on the .extent of the amendments made. Staff envisions a typical PHEV conversion system to consist ofa battery pack, sensors, and a controller. This would not alter the original engine or any of the original emission control parts. For such conversion, Conversion System Manufacturers may request use of OEM deterioration factors to estimate the useful life emissions of the converted vehicle. For PHEV conversion system durability, Conversion System Manufacturers may propose cycling of the battery fora period equivalent to the vehicle's useful life. It may entail charging and depleting of the battery under conditions that simulate in-use conditions. EAER or SOC data of the new system and the cycled system may be compared. Acceptance criteria may be proposed by Conversion System. Manufacturers. Data or information on other electrical components may also be required to ensure durability.

For more extensive conversions, the use of OEM deterioration factors may not be appropriate. Such conversions would require more extensive testing, including emission-control-part aging and/or vehicle-mileage accumulation. Carry-over and carry-across of emission and durability data will be allowed upon demonstration that existing data adequately represent the emission and deterioration characteristics of the conversion system and vehicle to be certified. The proposed procedures would require

Conversion System Manufacturers to demonstrate that the converted vehicle has a fully compliant OBD system. Additional information on OBO is in Appendix J.
The proposed certification procedures would require Conversion System Manufacturers and installers of PHEV conversion systems to provide consumer warranties. The required warranty is similar to the warranty required for alternative fuel conversion systems and their installers, except for warranty periods for PZEVs. Conversion System Manufacturers would be required to warrant to the person having the vehicle converted and to each subsequent purchaser of the vehicle that the PHEV conversion system meets the following requirements:

- is designed and manufactured to conform with the applicable requirements of the certification procedures,
- is free from defects in materials and workmanship which cause the PHEV conversion system to fail to conform with the applicable requirements of the procedures or cause damage to any part on the converted vehicle.

For example, if the OEM designed an electrical part for regular hybrid operation, and the conversion required the part to be used more often, this could contribute to early failure. If the vehicle is still under the Conversion Warranty, the Conversion System Manufacturer would be responsible for replacement or repair of the part.

The warranty period begins from the date of installation and covers customer service· and the full repair or replacement costS.[23] Table 4-1 shows the warranty requirements for conversions. The length of warranty is determined by the age of the vehicle, the emission category, and the cost to replace or repair the damaged parts.

23 This includes the costs of diagnosiS, labor, and parts, and any part on the converted vehicle that is damaged due to a defect in the conversion system.

**Table 4-1: Conversion System Manufacturer** Warranty Requirements

| Type of vehicle | Time of conversion from vehicle's initial purchase | Type of Part | Length of. Conversion Warranty |
|---|---|---|---|
| Non PZEV | Within 4 years[24] | Low cost parts | 3 years or 50,000 miles |
| | | High cost parts | 7 years or 70,000 miles |
| | After 4 years[25] | Low cost parts | 3 years or 25,000 miles |
| | | High cost parts | 3 years or 35,000 miles |
| PZEV | Within 6 years[26] | Zero emission energy storage devices used for traction power | 10 years or 150,000 miles |
| | | All other parts | 15 years or 150,000 miles |
| | After 6 years[27] | All parts | 5 years or 75,000 miles |

Installers of PHEV conversion systems would be required to warrant to the vehicle owner and subsequent vehicle owners that conversion system will not fail to meet the certification procedure requirements due to incorrect installation, and that no part on the vehicle will be damaged due to incorrect installation. Installers of PHEV conversion systems shall install only those systems of a certified configuration and shall agree to cover the cost of repair of any vehicle upon which a noncertified configuration was installed. In additio'n, the installer shall agree to be responsible for any tampering fines that may be imposed as a result of improper installation of the PHEV conversion system. The warranties and agreements shall begin on the date of installation and be effective for 3 years or 50,000 miles, whichever occurs first. This warranty shall cover customer service and the full repair or replacement costs including the cost of diagnosis, labor; and parts, including any part on the converted vehicle that is damaged due to incorrect installation of the conversion system.

To ensure that the PHEV converted vehicles continue to operate as presented during certificatiqn, the proposed procedures contain in-use testing requirements for Conversion System Manufacturers. Upon request by ARB, a Conversion System

24 This warranty period is the same as the warranty period specified for OEMs in section 2037.(b), title 13, California Code of Regulations (CCR).

25 The warranty period is three years or half the .applicable warranty period mileage specified in section 2037(b), title 13, CCR, whichever occurs first from the date of installation.

26 This warranty period is same as the warranty period specified for OEMs in section 1962(c), title 13, CCR.

27 The warranty period is five years or half the applicable warranty period mileage specified in section 1962(c), title 13, CCR, whichever occurs first from the date' of installation.

Manufacturer would be required to test a maximum of five PHEV conversion systems per year. Testing costs will be borne by ARB, except for those PHEV conversion systems that do not comply with the applicable emission standards. Conversion System Manufacturers would also be required to properly label the converted vehicle as a PHEV and maintain records of the conversions. Similar record keeping requirement$ would apply to installers of the PHEV conversion systems.

Table 4-2 summarizes the changes from what is currently required. The first column identifies the main requirements for conversions, while the second through fourth columns address the proposal and the current procedures available.

**Table 4-2: Comparison of Staff's Proposal to Current PHEV Conversion Options**

| | **Staff's Proposal** | **Current Requirements** | |
|---|---|---|---|
| | | **Small Volume Manufacturer requirements** | **Vehicle Code section 27156 exemption** |
| Vehicles that can be converted to PHEVs | HEVs | All vehicles | Only vehicles outside OEM warranty |
| Certification applicability | IC engine family/test group | IC engine family/test group | Similar model-years |
| Emission Standards | Must meet original certification standards | Treated as a new vehicle, therefore can choose certification standards | Must meet original certification standards |
| Durability | Demonstrate or if applicable apply OEM deterioration factor | Demonstrate full compliance | Apply OEM deterioration factor |
| OBDII | Demonstrate full compliance | Demonstrate full compliance | Demonstrate no degradation |
| Warranty requirements | Conversion system, unless system causes OEM part failure | Whole vehicle | N/A |
| Subject to in-use testing, warranty reporting, etc | In-use testing only, cost to ARB if compliant | Must meet all OEM requirements | N/A |

Potential impacts to OBD

Today's vehicles are incredibly complex; therefore, it is difficult to accurately predict the full impact of aftermarket conversion systems to the OBD system until specifics are known about the base vehicle and about the hybrid modification itself. However, based on staffs experience, there are several areas where added hybrid functionality will likely require aBO revision or further development. These include extended idle-off which may disable other monitors that only function at idle. Monitors that fail to run because ·IC engine operation is too short or infrequent and development of monitoring strategies for newly added components such as switches and controllers.

Staff understands that most Conversion System Manufacturers will need some time to revise. monitoring strategies and develop new solutions to bring a compliant product to the marketplace. Accordingly, staff is proposing to use the existing deficiency provisions in the OBD regulation that allow certification of systems that fall short of fully meeting all of the OBD system requirements. Deficiencies can be awarded in most cases where the manufacturer has made a good faith effort to comply and has a plan to come into full compliance as expeditiously as possible. Using this mechanism, staff could certify systems that fall short in one or more areas as long as the; manufacturer had attempted to comply and had a valid plan to address the shortcomings in a reasonable timeframe.[28] Conversion System Manufacturers will still need to meet the vast majority of the aBO requirements and relief is expected to primarily be needed in the area of minimum monitoring frequency. Further, such relief could only be granted for short term relief and only in cases where the Conversion System Manufacturer has' determined what is needed to come into full compliance and has a plan to do so in an expeditious manner. Staff's proposal should allow Conversion System Manufacturers to gain necessary in-use experience and to use that information to refine the system.

## 4.6 Additional Amendments

Non-Substantive Changes

Staff proposes minor non-substantive amendments to the Exhaust, Evap, and ORVR Test Procedures. In particu.lar, staff proposes to add a Terminology section to the Exhaust Test Procedures. Staff also proposes to revise Figures 2, 3A, and 3B in the Evap Test Procedures to improve their clarity and to make the applicable terminology consistent with the language in the test procedures themselves, as well as with the federal versions of the test procedures. Also, the existing canister-loading-related definition of a "2-gram breakthrough," contained within the body of the Evap Test Procedures, is relocated to the "Definitions, Acronyms, Terminology" section of those same test procedures. Other proposed changes include revisions to the formats of some of the section indicators to make them consistent throughout the test procedures, corrections to current text, and other miscellaneous grammatical corrections.

28 ARB will not approve systems with such reduced monitoring frequency that any monitors are effectively disabled or the vehicle is otherwise incompatible with the Smog Check inspection process.

# 5. REGULATORY ALTERNATIVES

Staff evaluated alternatives for each of the three main proposed amendments separately: Exhaust Test Procedures, Emission Test Procedures related to evaporative emissions, and Aftermarket Conversion System Certifications.

## 5.1 Exhaust Test Procedures

Do Not Amend

The alternative of keeping the current procedure is not reasonable because it does not adequately assess exhaust emissions, or the contribution of the electric motor to blended PHEVs. The current Exhaust Test Procedures underestimate the contribution of electric energy to vehicle operation for blended PHEVs during normal driving. conditions. Only PHEVs with a significant all-electric range would qualify for ZEV advanced componentry and zero-emission VMT allowance credits using the current procedures. Additionally, the current Exhaust Test Procedures do not accurately assess emissions during charge depleting operation for blended and non-blended PHEVs. As a result, staff rejected this alternative.

Wait for SAE 1711 to be Adopted

New procedures are needed for expected introduction of PHEVs for ZEV regulation compliance before projected completion of the SAE process. ARB's proposed Exhaust Test Procedures closely follow the Draft SAE J1711 Procedure. Therefore, this is not a viable option.

## 5.2 Evaporative Test Procedures

Do Not Amend

The alternative of not amending the current California Evap Test Procedures is not reasonable because it would prevent specific technical revisions to these test procedures that are necessary in order to certify PHEVs. Thus, this alternative would impede the commercial. introduction of these vehicles within the timeframes required under the ZEV regulations. Therefore, staff rejected this alternative.

Wait for the adoption of federal PHEV Evap and ORVR Test Procedures.

Current federal regulations do not provide any measures to certify PHEVs. Indeed, as the United States Environmental Protection Agency (U.S. EPA) indicated when the federal National Low-Emission Vehicle rulemaking was proposed in 1997, U.S. EPA planned to rely on California's lead in emission control rulemaking to address HEV technological advances. In addition, the National Highway Traffic Safety Administration's recent rulemaking discussion of plug-in hybrids in its proposed fuel economy standards for 2011 - 2015 model-year passenger cars and light-duty trucks involves exhaust emissions and not evaporative emissions. Accordingly, relying on the adoption of any federal regulations that address PHEV evaporative emission controls is not a viable alternative.

### 5.3 Aftermarket Conversion System Certification

ARB currently does not have certification procedures that are directly applicable to the sale of PHEV conversion systems. Given the absence of such procedures, staff considered two alternatives.

Require Certification as a New Vehicle

The first alternative would require a Conversion System Manufacturer to essentially recertify a vehicle with a PHEV conversion system installed as a new vehicle and be issued a new vehicle Executive Order for the combination of the vehicle and the PHEV conversion system. Under this alternative, a Conversion System Manufacturer would have to procure a vehicle then fully emission test that vehicle with the PHEV conversion system installed. This would subject Conversion System Manufacturers to all of ARB's current new vehicle certification provisions and require certification fee payment as new vehicle manufacturers. Conversion System Manufacturers would alsobe required to . warrant the entire vehicle with the PHEV conversion system instead of only the PHEV conversion system. This'would impose very significant costs to Conversion System Manufacturers that essentially would make it infeasible. It would also mean that owners of HEVs would not be able to get their cars converted because the kits would only be allowed on essentially new vehicles.

Use Existing Vehicle Code Section 27156 Exemption Requirements

Under the second alternative, ARB would evaluate PHEV conversion systems using the existing Vehicle Code section 27156 exemption procedures. The exemption procedures do not contain any warranty provisions. Because PHEV conversion systems impact emission control parts like the battery, ARB would only consider systems for vehicles no longer covered by their original warranty. This alternative was rejected because it would prevent Conversion System Manufacturers from legally selling PHEV conversion systems for vehicles less than 10 years old (the battery warranty period for many OEM HEVs).

## 6. ECONOMIC IMPACTS

There are three main sections to consider the proposed amendments: costs associated with"theproposed conversion certification procedures, capital costs and testing costs associated with the proposed PHEV related test procedures, and costs associated with the fuel cell range test.

The proposed certification PHEV conversion system procedures open an opportunity for Conversion System Manufacturers to enter the in-use vehicle market. In addition, the proposed certification procedures prevent the illegal sale of converted vehicles. Conversion System Manufacturers will not incu'r any additional costs over what is expected for OEMs. Therefore, the economic impacts associated with aftermarket certification of PHEV conversion" systems will be similar to those economic impacts discussed below relating to the Exhaust and Evap Test Procedures. In addition, the cost to test PHEV conversion systems will be on the lower end of the cost range, as these conversion systems are not.eligible for zero-emission VMT or advanced componentry allowances and therefore do not need to conduct as many tests. Conversion System Manufacturers modifying vehicles outside of the OEM warranty will see a marginal increase in costs of about $200 for additional application costs, Conversion System Manufacturers modifying vehicles still under OEM warranty will be allowed to use the aftermarket certification process instead of recertifying the vehicle as a small volume manufacturer. The recertification costs for certifying as a small volume manufacturer are considerable and therefore the proposed certification process will provide these Conversion System Manufacturers a substantial cost savings.

The proposed test procedure amendments will be required for both OEMs and Conversion Systems Manufacturers producing PHEVs. As with Conversion System Manufacturers, OEMs are not required to produce PHEVs. PHEVs are an optional vehicle technology strategy that OEMs can use to meet their regulatory requirements in the IEV regulation. For those manufacturers choosing to produce PHEVs and PHEV conversion systems, the proposed PHEV exhaust, evaporative-related, and aftermarket regulatory amendments are expected to result in a net cost increase above the current regulatory cost for certifying PHEVs. Staff anticipated that 150,000 enhanced AT PZEVs would be producedin the 2012 through 2017 model-years.[29] Assuming 10 OEMs produce enhanced AT PIEVs with each manufacturer producing two models, staff estimates that the incremental cost to be less $15 per vehicle. Staff does not expect any additional costs for certifying conventional HEVs. The incremental cost for OEMs producing an enhanced AT PIEV PHEV is $25,000 over the cost to produce a conventional HEV.[30] The incremental cost of this rulemaking is not noticeable compared to the incremental cost to produce these vehicles.

29 ARB 2008a, This estimate is based on manufacturers complying with the ZEV regulation through the production of ZEVs and enhanced AT PZEVs. Enhanced AT PZEVs may be used to meet up to 70% of the requirement during Phase III (2012 - 2014) and up to 50% during Phase IV (2015 - 2017).
30 ARB 2008d. Table 6.1

No cost will be incurred from the optional fuel cell range test. The proposed amendments reduce the number of test cycles required for range determination. The cost savings to manufacturers is proportional to the range of the fuel cell EV.

Therefore, the proposed amendments are expected to have minimal to no adverse impacts on business competitiveness, California employment, or on business creation, elimination, and expansion. The remaining sections focus on the minimal cost of the proposed test procedures related to PHEVs.

## 6.1 Legal Requirement

Sections 11346.3 and 11346,5 of the Government Code require State agencies to assess the potential for adverse economic' impacts on California business enterprises and individuals when proposing to adopt or amend any administrative regulation. The assessment shall include a consideration of the impact of the proposed regulation on California jobs, business expansion, elimination, or creation, and the ability of California business to compete. State agencies are required to estimate the cost or savings to any state or local agency, and school districts. The estimate is to include any nondiscretionary cost or savings to local agencies and the cost or savings in federal funding to the state.

## 6.2 Potential Impacts on Business

The proposed amendments are expected to benefit Conversion System Manufacturers. However, some businesses conducting Exhaust and Evap Test Procedures may be adversely affected by the proposed amendments to the' regulation. As mentioned above, the amendments increase the cost of performing exhaust and evaporative emission tests of PHEVs.

Potential Impacts for PHEV Conversion Systems

Conversion System Manufacturers will not incur any additional costs beyond what the OEMs would see. Some cost savings may be seen by Conversion System Manufacturers modifying vehicles still under OEM warranty. Currently, these manufacturers must certify the entire converted vehicle as a small volume manufacturer. The cost of recertifying vehicles as a small volume manufacturer is considerable and therefore the proposed aftermarket certification process will provide- these Conversion System Manufacturers a substantial cost savings.

Estimated Costs to OEMs and Independent Laboratories

Using independent laboratories able to conduct SULEV tests as a baseline, staff assessed the ability of these laboratories to conduct the proposed procedures. These costs are broken down into two main componentsand are discussed in separate subsections: capital costs and testing costs.

### Capital Costs

Staff does not believe revisions to software or hardware are necessary to conduct the JProposed, Evap Test Procedures. However, testing facilities may need to make modifications to address the proposed amendments to the Exhaust Test Procedures. To accommodate the new test cycles in the proposed procedure, such as the continuous urban test, continuous highway test, and continuous US06, some test facilities may require hardware and software upgrades. These upgrades are estimated to cost from $20,000-$100,000 depending on what is necessary. This would be a one-time additional cost. Laboratories needing to Lipgrade their software will see costs on the lower end of the spectrum. Other laboratories may need to make both software and hardware amendments, which cost as much as $100,000. Staff anticipated that 150,000 enhanced AT PZEVs would be produced in the 2012 through 2017 model-years.[31] Assuming 10 OEMs produce enhanced AT PZEV PHEVs and that OEMs pass the capital costs on to the consumers of just these vehicles, staff estimates that the incremental cost to be less than $5 per vehicle. The increased testing costs will not impact manufacturers of conventional HEVs. It is important to note that some of these laboratories will be able to conduct the tests without any amendments. The proposed procedures are not expected to significantly change facility maintenance costs. Staff believes that all Conversion System Manufacturers will utilize independent laboratories to test their PHEV conversion systems. Although independent laboratories may need to make modifications, these costs will be passed on to the manufacturers as consumers of the laboratories.

### Testing Costs

These amendments will increase the cost of testing a PHEV, because more test cycles and additional test procedures will be required. Most OEMs have testing facilities and will conduct their own testing. Costs to these OEMs will include test facility amendments and labor. For those OEMs that utilize independent labs to conduct tests, staff does not anticipate that the individual cost of each required test will increase. However, due to the additional tests and test cycles needed, additional testing time will increase dynamometer demand. Staff believes that the laboratories have adequate capacity to address the assessed increase in testing. However, if outside testing demand increases beyond the independent laboratories available capacity, market forces may temporarily increase the cost of individual tests. The increased testing costs will not impact manufacturers of conventional HEVs.

Costs to conduct the tests already include the additional labor costs and dynamometer time associated. While the incremental cost increase is diffic,ult to calculate without knowing the number ottests needed to complete the Charge Depleting portion of tests, staff anticipates that the incremental cost increase to certify most HEVs will range between $6,050 and $7,450 per engine family for both the Evap and Exhaust Test

[31] ARB 2008a, This estimate is based on manufacturers complying with the ZEV regUlation through the production of ZEVs and enhanced AT PZEVs, Enhanced AT PZEVs may be used to meet up to 70% of the requirement during Phase III (2012 - 2014) and up to 50% during Phase IV (2015 - 2017),

Procedures as currently proposed. The OEM may incur an additional testin'g cost of $2,OOO,.if a TypeG advanced componentry allowance is desired. Additional details on this analysis are in Appendix K. These costs will likely be passed on to consumers.

*Costs Associated with the Proposed Exhaust Test Procedures*

In comparing the current Exhaust Test Procedures with the proposed Exhaust Test Procedures, an analysis was made for a PHEV that has only AER during charge depleting operation since it can be fully tested by both procedures. A hypothetical PHEV with a 40-mile AER was chosen as the additional electric operation would increase total testing costs. The increased cost to test these vehicles would be around $4,800. OEMs choosing to certify their vehicles for Type G advanced componentry allowance would incur additional costs' of approximately $2,000, bringing the total to around $6,800.

The typical overall costs of testing a blended PHEV are expected be less than that of testing a PHEV with significant all-electric range for the proposed procedure. The smaller battery size of anticipated blended PHEV will provide less electric range and require fewer test cycles to deplete the battery, resulting in reduced testing costs. In addition, blended PHEVs are unlikely to undergo additional testing for Type G credit, reducing testing costs. Therefore, the increased cost to test most PHEVs would be around $3,400. Staff anticipates that the majority of vehicles produced 'in the early' years will be blended. As battery technology improves, staff anticipates more vehicles moving towards AER PHEV technology. Additional details on this analysis are in Appendix K.

*Costs Associated with the Proposed Evaporative Test Procedures*

An additional cost to a manufacturer would involve the possible increase in the amount of vehicle-preconditioning UDDS cycles performed in the Evap and ORVRTest Procedures. Since the proposal requires that the vehicle-preconditioning be conducted in a charge-sustaining mode of Ie engine operation, some amount of vehicle driving in a charge-depleting mode may be necessary to decrease the battery energy level in order to reach the required charge-sustaining mode. However, this charge-depleting mode of driving can be done over an off-road test track course, thereby relieving a manufacturer of the additional expense of conducting actual UDDS cycles in a laboratory. Although the number of extra charge-depleting UDDS cycles that are necessary may va'ry depending on a particular HEV's design, staff used two charge-depleting UDDS cycles for estimation purposes. Thus, staff estimates that the incremental cost associated with performing the vehicle-preconditioning step for PHEVs would be $1,250 per evaporative test.

In addition, a PHEV that is equipped with a non-integrated refueling canister-only system must load its refueling canister using the new method as specified in the proposal. Staff estimates that the incremental cost of using that new method is $1,400 per evaporative test. Accordingly, the total incremental cost is estimated to be $2,650 per evaporative test for a PHEV equipped with a non-integrated refueling canister-only system. The number of evaporative tests that would be conducted by a manufacturer in order to certify an evaporative family is unknown by staff because that information is proprietary to the manufacturer. However, these additional costs are expected to be passed on to the manufacturers as customers of the laboratories. Additional details on this analysis are in Appendix K.

## 6.3 Potential Impact on Business Competitiveness

The proposed amendments to the Exhaust and Evap Test Procedures are not expected to have a significant impact on the ability of California businesses to compete with businesses in other states. For any California-certified PHEV, a manufacturer must comply with the proposed Exhaust Test Procedures requirements. In addition, for any California-certified PHEV that is equipped with a non-integrated refueling canister-only system, the manufacturer must comply with the proposed requirements in the Evap Test Procedures. There are no manufacturers that currently certify light-duty vehicles that are headquartered in California.

## 6.4 Potential Impact on Employment

The proposed amendments to the Exhaust and Evap Test Procedures are not expected to cause a change in California employrnent. Additional exhaust and evaporative testing may result in creation of some additional jobs as demand for testing rises.

## 6.5 Potential Impact on Business Creation, Elimination, or Expansion

The proposed amendments to the Exhaust and Evap Test Procedures are not expected to have a noticeable impact on the status of California business creation, elimination, or expansion. Additional testing can be handled with the existing labs. However, if demand for testing rises above the capacity currently available, market forces will' indicate the need for expansion or the creation of additional laboratories.

## 6.6 Potential Impacton Small Businesses

The proposed amendments to the Exhaust and Evap Test Procedures for PHEVs are not expected to have a noticeable impact on the status of California businesses . including small businesses. The OEMs that would benefit most by this regulation are .not small businesses. Most laboratories and Conversion System Manufacturers would qualify as small businesses. The proposed amendments provide additional business opportunities for these businesses. Therefpre these companies will likely pass any increased costs on to the consumer, as staff expects these businesses to experience an increase in demand for their services and products.

## 6.7 Potential Costs to Local and State Agencies

Staff believes the proposed Exhaust and Evap Test Procedures are the most cost-effective means of achieving exhaust emissions control for PHEVs. The proposed amendments have no fiscal impacts on local agencies. The only costs to state government, as a ,result of the proposed amendments, would be to ARB for conducting Exhaust and Evap Test Procedures for compliance testing of PHEVs. This is estimated to be around $240,000 dollars in fiscal year *2009/2010.* For clarification of these costs they are broken out individually in the Exhaust and Evap Test Procedures sections below.

Potential Costs Related to Exhaust Test Procedures

These additional costs would be associated with the increase in performing additional UDDS and HFEDS tests to comply with the proposed Exhaust Test Procedures. There is additional cost associated with creating new test cell software to run the newly created continuous highway and city test schedules resulting in a one-time cost of $40,000 in *2009/2010.* Any certification confirmatory and in-use compliance testing of these HEVs will likely not be conducted by ARB until after the 2011 model-year introduction. Beyond the costs addressed above, the proposed amendments are not expected to result in any other increases in costs for local agencies.

Potential Costs Related to Evaporative Test Procedures

As with the Exhaust Test Procedures, additional costs would be associated with the possible -increase in performing extra UDDS cycles when preconditioning test vehicles, as well as when using the new canister-loading method when testing PHEVs that are equipped with non-integrated refueling canister-only systems. Specifically, using this new canister-loading method would require the modification of one of ARB's current Haagen-Smit laboratory evaporative emission testing chambers (Sealed Housing for Evaporative Determination, or SHED) to accommodate performing the ORVR Test Procedures. Furthermore, additional SHED staff would be required in order to perform the new canister-loading method. Any certification confirmatory and in-use compliance testing of these HEVs will likely not be conducted by ARB until after the 2011 model-year introduction. Thus, the proposed SHED modification, and additional staff, would not be necessary until that time. The one-time cost to modify one of the existing SHEDs is estimated at $200,000 in *2009/2010.* The proposed amendments are not expected to result in an overall increase in costs for local agencies.

# 7. ENVIRONMENTAL IMPACTS

While these procedures do not specifically reduce or increase emissions, the amendments that staff is proposing in this rulemaking ensure that the emissions from PHEVS are characterized appropriately. This then allows staff to determine if OEM PHEVs qualify for ZEV credit, and ensure that PHEV conversion systems will not increase emissions.

## 7.1 Program Benefits

The amendments to the test procedures will ensure that the expected emission benefits from PHEVs identified in the Zero-Emission Vehicle Program are realized. The ZEV and Aftermarket Parts programs encourage manufacturers to design and build robust electric motors, IC engines and emission control systems to comply with the emission requirements during their useful life.

## 7.2 Energy Diversity and Energy Demand

The PHEV and fuel cell EV technologies expected to benefit from these amendments typically use fuel more efficiently, and thus when fully commercialized will reduce demand for petroleum fuels. These technologies also use non-petroleum fuels, such as electricity and hydrogen, which help diversify the transportation fuel market. The proposed amendments are consistent with recent reports that recommend increased vehicle efficiency and increased use of alternative fuels.

## 7.3 Environmental Justice

State law defines environmental justice as the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies. The Board has established a framework for incorporating environmental justice into ARB's programs consistent with the directives of State law. The proposed regulation would benefit all Californians by ensuring that PHEVs comply with certification emission standards throughout their useful life.

Staff's proposed changes provide a mechanism to determine compliance with all light-duty and medium-duty mobile source regulations. ARB's environmental justice policy calls for reduction in health risks from criteria pollutants in all communities, including low-income and minority communities. While staff's proposed changes do not directly affect low-income and minority communities, they do provide a mechanism to measure emissions from vehicles. This allows ARB staff to independently assess these vehicles, which in turn helps ensure ARB's environmental justice policy. Many low-income and minority communities are located near heavily traveled freeways. By measuring the emissions of air pollutants from light-duty and medium-dutyvehicles, the proposed regulation will provide data for enforcement programs to assess compliance with the exhaust and evaporative emission standards. Several ARB programs set these standards and these standards provide air quality benefits by reducing exposure to, and. associated health risk from, these pollutants.

# 8. CONCLUSION AND STAFF RECOMMENDATION

## 8.1 Summary of Staff Proposal

Staffs proposed amendments accommodate revisions needed to address PHEV technologies. These amendments provide greater flexibility in manufacturer compliance with theZEV Program and assess emissions issues related to this PHEV technology. The staff proposal contains the following specific amendments:

Table 8-1: Summary of Proposed Amendments

| Goal | Solution |
|---|---|
| Determine PHEVexhaust and evaporative emissions | Amend Exhaust, Evap; and ORVR Test Procedures to address IC engine cold start issues |
| Determine if vehicles qualify for Advanced Com onent allowance | Incorporate 'US06 and UDDS AER tests into Exhaust Test Procedures |
| Determine if vehicles qualify for zero-emission Vehicle Miles Travelled allowance | Define EAER and incorporate into calculations for zero-emission VMT allowance |
| Reduce testing burden for Fuel Cell EV Ran e Test | Utilize procedures to determine range based on fuel consum tion |
| Evaluate aftermarket PHEV conversion s stems | Design certification requirements to address issues associated with PHEVs |

## 8.2 Staff Recommendation

ARB staff recommends that the Board approve this proposal.

# 9. REFERENCES


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ARB 2008d. California Air Resources Board, Staff Report: Initial Statement of Reasons 2008 Proposed Amendments to the California Zero Emission Vehicle Program Regulations http://www.arb;ca.gov/regact/2008/zev2008/zevisor.pdf

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California Code of Regulations, Title 13, Section 1978. Standards and Test Procedures for Vehicle Refueling Emissions http://www.calregs.com/linkedslice/default.asp?SP=CCR-1 OOO&Action=Welcome

Code of Federal Regulations, "Highway Fuel Economy Driving Schedule (HFEDS)." Title 40, Part 600 http://www.epa.gov/lawsregs/search/40cfr.html

Code of Federal Regulations, "Exhaust emission test procedure for SC03 emissions." Title 40, Part 86. Section 86.160-00. December 8,2005. http://www.epa.gov/lawsregs/search/40cfr.html

Code of Federal Regulations Title 40, Volume 18, Chapter 1, Part 86 Subpart B §86.164-08. "Part 86: Control of Emission from New and In-use Highway Vehicles and Engines; Subpart 164-08: Supplemental Federal Test Procedure Calculations" http://www.epa.gov/lawsregs/search/40cfr.html

Code of Federal Regulations Title 40, Chapter 1, Part 86 Subpart B §86 Appendix I (g) US06 Supplemental FTP Driving Schedule http://www.epa.gov/lawsregs/search/40cfr.html

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# APPENDICES

## TABLE OF APPENDICES




Date of Release: December 5, 2008
Board Hearing: January 22-23, 2008

# APPENDIX A

## PROPOSED REGULATION'ORDER

# PROPOSED REGULATION ORDER - Part 1

Set forth below are the proposed amendments to title 13 of the California Code of Regulations. Proposed amendments are shown in underline to indicate additions and strikeout to indicate deletions. Amendments to these regulations that were adopted by the Board on March 27, 2007 as part of a rulemaking for zero-emission vehicles, but which have not yet been approved by the Office of Administrative Law are indicated in double underline to indicate additions and ~~double strikeout~~ to indicate deletions.

## § 1961. Exhaust Emission Standards and Test Procedures - 2004 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles.

*Introduction.* [No change.]

(a) *Exhaust Emission Standards.* [No change.]

(b) *Emission Standards Phase-In Requirements for Manufacturers.*

(1) *Fleet Average NMOG Requirements for Passenger Cars and Light-Duty Trucks.*

(A) through (D) [No change.]

(E) *Treatment of ZEVs.* ZEVs classified as LOTs (>3750Ibs. LVW) that have been counted toward the ZEV requirement for pes and LOTs (0-3750 Ibs. LVW) as specified in sections 1962 and 1962.1 shall be included as LDT1s in the calculation of a fleet average NMOG value.

(2) through (3) [No change.]

(c) *Calculation of NMOG Credits for Passenger Cars and Light-Duty Trucks.* [No change.]

(d) *Test Procedures.* The certification requirements and test procedures for determining compliance with the emission standards in this section are set forth in the "California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles," as amended May 2,2008 [insert date of amendment for this rulemaking], and the "California Non-Methane Organic Gas Test Procedures," as amended July 30, 2002, which are incorporated herein by reference. In the *case* of hybrid electric vehicles and on-board fuel-fired heaters, the certification requirements and test procedures for determining compliance with the emission standards in this section are set forth in the "California Exhaust Emission Standards and Test Procedures for 2005 ~~and~~ Subsequent through 2008 Model Zero-Emission Vehicles, and 2001 and Subsequent through 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes," incorporated by reference in section 1962 and the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the

Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes," incorporated by reference in section 1962.1.

(e) *Abbreviations.* [No change.]

Note: Authority cited: Sections 39500,39600,39601,43013,43018,43101,43104 and 43105, Health and Safety Code. Reference: Sections 39002,39003,39667,43000,43009.5,43013, 43018,43100,43101,43101.5,43102,43104,43105, 43106, 43204, and 43205, Health and Safety Code.

**§ 1962. Zero-Emission Vehicle Standards for 2005 ~~and Subsequent~~ throuah 2008 Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles.**

Sections (a) through (g). [No change.]

(h) *Test Procedures.* The certification requirements and test procedures for determining compliance with this section 1962 are set forth in "California Exhaust Emission Standards and Test Procedures for 2005 and ~~Subsequent~~ through 2008 Model Zero-Emission Vehicles, and 2001 and Subsequent through 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes," adopted by the state board on August 5, 1999, and last amended ~~December 19, 2003~~ !insert date ~~of~~ amendment ~~for~~ the ~~zero~~ emission vehicle rulemakingl [insert date of amendment for this rulemaking], which is incorporated herein by reference.

Section (i) through (k). [No change.]

Note: Authority cited: Sections 39600,39601,43013,43018,43101,43104 and 43105, Health and Safety Code. Reference: Sections 39002, 39003, 39667,43000,43009.5,43013,43018, 43100,43101,43101.5,43102,43104,43105,43106,43204, and 43205.5, Health and Safety Code.

§ 1962.1. **Zero-Emission** Vehicle Standards for 2009 and Subsequent Model Year Passenger Cars. **Light-Duty** Trucks. and **Medium-Dutv** Vehicles.

Sections (a) through (g). [No change.]

(h) Test Procedures.

(1) Determining Compliance. The certification requirements and test procedures for determining compliance with this section 1962.1 are set forth in "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and 2001 and Subsequent Model Hybrid Electric Vehicles, in the Passenger Car. Light-Duty Truck and Medium-Duty Vehicle Classes." adopted by the state board on ~~August~~ ~~5,~~ ~~1999.~~ ~~and~~ last ~~amended~~ [insert date of amendments for the zero-emission vehicle rulemakingl and last amended [insert date of amendment for this rulemaking], which is incorporated herein by reference.

Sections (h)(2) through (I). [No change.]

Note: Authority cited: Sections 39600. 39601.43013,43018 43101 43104 and 43105, Health and Safety Code. Reference: Sections 39002.39003 39667,43000,43009.5 43013 43018,43100, 43101.43101.5.43102,43104,43105 43106 43107 43204 and 43205.5 Health and Safety Code,

**§ 1976. Standards and Test Procedures for Motor Vehicle Fuel Evaporative Emissions.**

Sections (a) and (b). [No change.]

(c) The test procedures for determining compliance with the standards in subsection (b) above applicable to 1978 through 2000 model year vehicles are set forth in "California Evaporative Emission Standards and Test Procedures for 1978-2000 Model Motor Vehicles," adopted by the state board on April 16,1975, as last amended August 5, 1999, which is incorporated herein by reference. The test procedures for determining compliance with standards applicable to 2001 and sUbsequent model year vehicles are set forth in the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles," adopted by the state board on August 5, 1999, and as last amended ~~October~~ 17,2007 [insert date of amendment for this rulemaking], which is incorporated herein by reference.

Sections (d) through (t). [No change.]

Note: Authoritycited: Sections 39600, 39601, 39667, 43013, 43018, 43101, 43104 and 43107, Health and Safety Code. Reference: Sections 39003,39500,39667,43000,43013,43018, 43100,43101,43102,43104 and 43107, Health and Safety Code.

**§ 1978. Standards and Test Procedures for Vehicle Refueling Emissions.**

Section (a). [No change.]

(b) . The test procedures for determining compliance with standards applicable to 1998 through 2000 gasoline, alcohol, diesel, and hybrid electric passenger cars, light-duty trucks, and medium-duty vehicles are set forth in the "California Refueling Emission Standards and Test Procedures for 1998-2000 Model Motor Vehicles," as amended August 5, 1999, which is incorporated herein by reference. The test procedures for determining compliance with standards applicable to 2001 and subsequent gasoline, alcohol, diesel, and hybrid electric passenger cars, light-duty trucks, and medium-duty vehicles are set forth in the "California Refueling Emission Standards and Test Procedures for 2001 and SUbsequent Model Motor Vehicles," adopted August 5, 1999, and last amended October 17, 2007 [insert date of amendment for this rulemakingl, which is incorporated herein by reference.

Note: Authority cited: Sections 39600,39667,43013,43018,43101, and 43104, Health and Safety Code. Reference: Sections 39003,39500, 39667, 43000, 43013, 43018, 43101, 43102, and 43104, Health and Safety Code.

## Proposed Regulation Order - Part 2

.Note: The regulation text is shown in underline to indicate additions to and strikeout to . indicate deletions from the current regulations. For ease of review, the text of section 2032, which is proposed for adoption as a new regulation, is shown without underline as permitted by section 8, title 2, California Code of Regulations.

Amend the title of article 5, chapter 1, division 3, title 13, California Code of Regulations and adopt section 2032, title 13, California Code of Regulations to read:

Article 5. Approval of Systems Designed to Convert Motor Vehicles to Use Fuels Other . Than the Original Certification Fuel or to Convert Motor Vehicles for Emission Reduction Credit or to Convert Hybrid Electric Vehicles to Off-Vehicle Charge Capable Hybrid Electric Vehicles

§ 2032. Off-Vehicle Charge Capable Hybrid Electric Vehicle Conversion Systems

(a) Applicable Standards.

Hybrid electric vehicles for the 2000 and later model years in the passenger car, light-duty truck, and medium-duty vehicle classes, converted to incorporate off-vehicle charging capability shall meet the California emission standards for the model year of original manufacture and certification.

(b) Applicable Test Procedures.

The certification and installation procedures that shall apply for approval of systems that convert 2000 and later model-year hybrid electric vehicles in the passenger car, light-duty truck, and medium-duty vehicle classes to use off-vehicle charging are contained in the "California Certification and Installation Procedures for Off-Vehicle Charge Capable Conversion Systems for 2000 and Subsequent Model Year Hybrid Electric Vehicles," adopted by the state board on [INSERT DATE OF ADOPTION], which are incorporated herein by reference.

(c) Definitions.

The definitions that apply to section 2032, title 13, CCR, are contained in sections 1900, 1962, and 1962.1, title 13, CCR, and the test procedures incorporated by reference in paragraph (b), section 2032, title 13, CCR.

NOTE: Authority cited: Sections 39515, 39600, 39601, 43000, 43006, and 43013, Health and Safety Code. Reference: Sections 43000, 43004, 43006, 43008.6, and 43013, Health and Safety Code; and Sections 27156 and 38391, Vehicle Code.

# APPENDIX B

## PROPOSED AMENDMENTS TO THE PASSENGER CAR EXHAUST EMISSION TEST PROCEDURES

Date of Release: December 5 2008; 45-Day Notice version
Date of Hearing: January 22-23, 2009

California Environmental Protection Agency
AIR RESOURCES BOARD

# CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 2001 AND SUBSEQUENT MODEL PASSENGER CARS, LIGHT-DUTY TRUCKS, AND MEDIUM-DUTY VEHICLES

| | |
|---|---|
| Adopted: | August 5, 1999 |
| Amended: | December 27, 2000 |
| Amended: | July 30, 2002 |
| Amended: | September 5, 2003 (corrected February 20,2004) |
| Amended: | May 28, 2004 |
| Amended: | August 4, 2005 |
| Amended: | June 22, 2006 |
| Amended: | October 17, 2007 |
| Amended: | May 2, 2008 |
| Amended: | [INSERT DATE OF AMENDMENT] |

Note: The proposed amendments to this document are shown in underline to indicate additions and strikeout to indicate deletions compared to the test procedures as amended May 2, 2008. Existing intervening text that is not amended is indicated by ,,** * *".

Date of Release: December 5, 2008; 45-Day Notice version
Date of Hearing: January 22-23, 2009

NOTE: This document is incorporated by reference in sections 1960.1(k) and 1961(d), title 13, California Code of Regulations (CCR). It contains the majority of the requirements necessary for certification of a passenger car, light-duty truck or medium-duty vehicle for sale in California, in addition to containing the exhaust emission standards and test procedures for these motor vehicles. However, reference is made in these test procedures to other ARB documents that contain additional requirements necessary to complete an application for certification. These other documents are designed to be used in conjunction with this document. They include:

1. "California Exhaust Emission Standards and Test Procedures for 2005 ~~and~~ Subsequent through 2008Model Zero-Emission Vehicles, and 2001 and Subsequent through 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes" (incorporated by reference in section 1962, title 13, CCR);

2. "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes" (incorporated by reference in section 1962.1, title 13, CCR);

~~2~~3. "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles" (incorporated by reference in section 1976(c), title 13, CCR);

~~3~~4. "California Refueling Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles" (incorporated by reference in section 1978(b), title 13, CCR);

~~4~~5. OBD II (section 1968, et seq. title 13, CCR, as applicable);

~~5~~6. "California Smog Index Label Specifications for 2004 through 2009 Model Year Passenger Cars and Light-Duty Trucks" (incorporated by reference in section 1965, title 13, CCR);

~~6~~7. "California Environmental Performance Label Specifications for 2009 and Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Passenger Vehicles"" (incorporated by reference in section 1965, title 13, CCR);

~~7~~8. Warranty Requirements (sections 2037 and 2038, title 13, CCR);

~~8~~9. "Specifications for Fill Pipes and Openings of Motor Vehicle Fuel Tanks" (incorporated by reference in section 2235, title 13, CCR);

~~9~~10. Guidelines for Certification of Federally Certified Light-Duty Motor Vehicles for Sale in California (incorporated by section 1960.5, title 13, CCR); and

~~10~~11. "California Non-MethaneOrgariic Gas Test Procedures," (incorporated by reference in section ,1961 (d), title 13, CCR).

The section numbering conventions for this document are set forth in Part I, section A.3 on page A-2.

# CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 2001 AND SUBSEQUENT MODEL PASSENGER CARS, LIGHT-DUTY TRUCKS AND MEDIUM-DUTY VEHICLES

The provisions of Subparts B, C, and S, Part 86, Title 40, Code of Federal Regulations, as adopted or amended on May 4, 1999 or as last amended on such other date set forth next to the 40 CFR Part 86 section title listed below, and to the extent they pertain to exhaust emission standards and test procedures, are hereby adopted as the "California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars,-Light-Duty Trucks, and Medium-Duty Vehicles," with the following exceptions and additions.

## PART I: GENERAL PROVISIONS FOR CERTIFICATION AND IN-USE VERIFICATION OF EMISSIONS

* * * *

### B. Definitions, Acronyms and **Abbreviations**

* * * *

2. California Definitions.

* '* * *

"All-Electric Range Test" means a test sequence used to determine the range of an electric or hybrid electric vehicle without the use of its auxiliary power unit. The All-Electric Range Test is described in the "California Exhaust Emission Standards and Test Procedures for 2005 and Subsequent through 2008 Model Zero-Emission Vehicles, and 2001 ~~and~~ Subsequent through 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes-;" as incorporated by ~~reference~~ in ~~section~~ 1962(e) and the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes.", title 13, GCR.

* * * *

"Zero-emission vehicle" or "ZEV" means any vehicle certified to the zero-emission standards set forth in the "California Exhaust Emission Standards and Test Procedures for 2005 and Subsequent through 2008 Model Zero-Emission Vehicles, and 2001 and Subsequent through 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes~~,~~" as incorporated by reference in section 1962 and the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes." , title 13, CCR.

* * *

**E. California Exhaust Emission Standards.**

Delete 40 CFR §§86.1811 through 86.1819.

**Introduction.** The following Section E. contains the exhaust emission standards, phase-in requirements and reactivity adjustment factors applicable to California passenger cars, light-duty trucks and medium-duty vehicles. A manufacturer must demonstrate compliance with the exhaust standards applicable to specific test groups, and with the composite phase-in requirements applicable to the manufacturer's entire fleet.

A manufacturer has the option of certifying engines used in incomplete and diesel MDVs with a gross vehicle weight rating of greater than 8,500 lbs. to the heavy-duty engine standards and test procedures set forth in sections 1956.8(g) and(h), title 13, CCR, except when the federal vehicle is chassis-certified. If a federal vehicle with a gross vehicle weight rating of greater than 8,500 lbs. is certified to chassis standards, then the equivalent California vehicle must either be certified to the exhaust emission standards applicable to medium-duty vehicles as set forth in section 1961, title 13, CCR or to the federal Tier 2 standards, as per the requirements of section *R.1A* of these test procedures.

The procedures for meeting the ZEV phase-in requirements and for earning ZEV credits are contained in the "California Exhaust Emission Standards and Test Procedures for 2005 ~~and~~ Subsequent through 2008 Model Zero-Emission Vehicles, and 2001 and Subsequent through 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes~~,~~" as incorporated ~~by reference~~ in ~~section~~ 1962 and the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes.", title 13, GGR.

**1. Exhaust Emission Standards.**

* * *- *

1.7 **Requirem.ents for Vehicles Certified to the** Optional 150,000 **Mile Standards.**

* * * *

(b) **Requirement to Generate a Partial ZEV Allowance.** A manufacturer that certifies to the 150,000 mile SULEV standards shall also generate a partial ZEV allocation according to the criteria set forth in section C.3 of the "California Exhaust Emission Standards and TestProcedures for 2005 and Subsequent through 2008 Model Zero-Emission Vehicles, and 2001 and Subsequent through 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes~~,~~" ~~as~~ incorporated by reference in section 1962 and the "California Exhaust Emission

Standards.and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes.", title 13, GGR.

* * * *

**1.13 Emission Standard for Fuel-Fired Heaters.** Whenever a manufacturer elects to utilize an on-board fuel-fired heater on any passenger car, light-duty truck or medium-duty vehicle, the heater must meet the LEV II ULEV standards for passenger cars and light-duty trucks less than 8,500 pounds GVW set forth'in Section E.1.1.2 of these test procedures. The exhaust emissions from the fuel-fired heater shall be determined in accordance with the "California Exhaust Emission Standards and Test Procedures for 2005 and Subsequent through 2008 Model Zero-Emission Vehicles, and 2001 ~~and~~ Subsequent through 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes" and the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes.". On-board fuel-fired heaters may not be operable at ambient temperatures above 40°F.

* * * *

**2. Emission Standards Phase-In Requirements for Manufacturers**

**2.1 Fleet Average NMOG Requirements for Passenger Cars and Light-Duty Trucks.**

* * * *

2.1.2 **Calculation of Fleet Average** .NMOG **Value.**

* * * *

2.1.2.2 **HEV NMOG Factor.** The HEV NMOG factor for light-duty vehicles is calcuhited as follows:

LEV HEV Contribution Factor = 0.075 -,[(Zero-emission VMT Factor) x 0.035]
ULEV HEV Contribution Factor = 0.040 - [(Zero-emission VMT Factor) x 0.030]

where Zero-emission VMTFactor for HEVs is determined in accordance with Section C.3ofthe "California Exhaust Emission Standards and Test Procedures for 2005 ~~and~~ Subsequent through 2008 Model Zero-Emission Vehicles, and 2001 ~~and~~ Subsequent through 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes," as incorporated ~~by~~ reference in section 1962 and the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and

Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes.", title 13, CCR.

* * * *

2.1.5 **Treatment of ZEVs.** ZEVs classified as LDTs (>3750 lbs. LVW) that have been counted toward the ZEV requirement for PCs and LDTs (0-3750 lbs. LVW) as specified in Section C of the "California Exhaust Emission Standards and Test Procedures for 2005 and ~~Subsequent~~ through 2008 Model Zero-Emission Vehicles, and 2001 and Subsequent through 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes," as incorporated by reference in section 1962, title 13, CCR and the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes," shall be included in this equation.

* * * *

## 3. Calculation of CreditslDebits

### 3.1 Calculation of NMOG CreditslDebits

* * * *

3.1.2.1 The MDV HEV VEC allowance is calculated as follows:

1 + [(LEV standard - ULEV standard) x (Zero-emission VMT Allowance) ÷ LEV standard] for LEVs;
1 + [(ULEV standard - SULEV standard) x (Zero-emission VMT Allowance) ÷ ULEV standard] for ULEVs;
1 + [(SULEV standard - ZEV standard) x (Zero-emission VMT Allowance) ÷ SULEV standard] for SULEVs;

where "Zero-emission VMT Allowance" for an HEV is determined in accordance with Section C.3 of the "California Exhaust Emission Standards and Test Procedures for 2005 and Subsequent through 2008 Model Zero-Emission Vehicles, and 2001 and Subsequent through 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes:, as incorporated in section ~~1962,~~ title 13, CCR and the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes."

* * * *

## G. Procedures for Demonstration of Compliance with Emission Standards

* * * *

**8. §86.1834 Allowable maintenance.**

* * * *

8.2 HEVs.

* * * *

(b) The manufacturer shall equip "off-vehicle charge capable HEVs" with a useful life indicator for the battery system consisting of a light that shall.iIluminate the first time the battery system is unable to achieve an all-electric operating range (starting from a full state-of-charge) which is at least 75% of the range determined for the vehicle in the Urban Driving Schedule portion of the All-Electric Range Test (see the "California Exhaust Emission Standards and Test Procedures for 2005 and Subsequent through 2008 Model Zero-Emission Vehicles, and 2001 and Subsequent through 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes,' as incorporated by reference in section 1962, title 13, CCR and the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes").

* * * *

**H. Certification, Information and Reporting Requirements.**

* * * *

**4. §86.1844 Information Requirements: Application for Certification and Submittal of Information Upon Request.**

* * * *

4.3 **HEVs.**

For HEVs, the information required in the "California Exhaust Emission Standards andTest Procedures for 2005 and Subsequent through 2008 Model Zero-Emission Vehicles, and 2001 and Subsequent through 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes," as incorporated by reference in section 1962, title 13, CCR and the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, inthe Passenger Car, Light-DutyTruck and Medium-Duty Vehicle Classes,: must be supplied with the Part I application for certification.'

* * * *

# APPENDIXC

## PROPOSED AMENDMENTS TO THE HYBRID EXHAUST EMISSION TEST PROCEDURES, MODEL YEAR 2005 THROUGH 2008

Date of Release: December 5, 2008; 45-Day Noticeversion
Date of Hearing January 22-23, 2009

California Environmental Protection Agency
AIR RESOURCES BOARD

# CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 2005 ~~AND SUBSEQUENT~~ THROUGH 2008 MODEL ZERO-EMISSION VEHICLES, AND 2001 AND SUBSEQUENT THROUGH 2008 MODEL HYBRID ELECTRIC VEHICLES, IN THE PASSENGER CAR, LIGHT-DUTY TRUCK AND MEDIUM-DUTY VEHICLE CLASSES

Adopted: August 5, 1999
Amended: Apri/12, 2002
Amended: July 30,2002
Amended: December 19, 2003
Amended: [Insert date of amendment]
Amended: [Insert date of amendment]

Note: The proposed amendments to this document are shown in underline to indicate additions and strikeout to indicate deletions compared to the test procedures as last amended December 19,2003. The document in which the amendments are being shown is a version that was initially approved by the Board on March 27,2008 for adoption as part'of the "Rulemaking to Consider Adoption of the 2008 Amendments to the California Zero-Emission Vehicle Regulation." That rulemaking is not yet final. For that reason, the document also includes two sets of proposed changes that the Board authorized staff to offer for public comment as part of the March 27, 2008 rulemaking. The amendments considered by the Board on March 27, 2008 are iridicatedby double underline to indicate additions and ~~double strikeout~~ to indicate deletions compared to the December 19, 2003 version. The first set of changes to this document for the March 27, 2008 rulemaking. are indicated by dotted underline to indicate additions and ~~*italics double strikeout*~~ to indicate deletions compared to the test procedures issued with the 45-day notice for the Board hearing. The second set of changes to this document for the March 27,2008 rulemaking are indicated by **bold dotted underline** to indicate additions and ~~***bold italics double strikeout***~~ to indicate deletions compared to

**the test procedures issued with the first 15-day notice for the Board hearing. Existing intervening text that is not amended is indicated by** "* * * *".

# CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 2005 ~~AND SUBSEQUENT~~ THROUGH 2008 MODEL ZERO-EMISSION VEHICLES, AND 2001 AND SUBSEQUENT THROUGH 2008 MODEL HYBRID ELECTRIC VEHICLES, IN THE PASSENGER CAR,L1GHT-DUTY TRUCK AND MEDIUM-DUTY VEHICLE CLASSES

, A. Applicability

The emission standards and test procedures in this document are applicable to 2005 ~~and subsequent~~ through 2008 model-year zero-emission passenger cars,light-duty trucks and medium-duty vehicles, and 2001 and subsequent through 2008 model-year hybrid electric passenger cars, light-duty trucks and medium-duty vehicles. The, general procedures and requirements necessary to certify a vehicle for sale in California are contained in the "California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles" (hereinafter "LDV/MDV TPs"), and apply except as amended herein. A manufacturer may elect to certify a 2000 model-year hybrid electric vehicle under these standards and test procedures and the LDV/MDV TPs. .

* * * *

C. Zero-Emission Vehicle Standards.

* * * *

2. Percentage ZEV Requirements

* * * *

2.2 Requirements for Large Volume Manufacturers.

* * * *

(b) *Alternative Requirements for Large Volume Manufacturers.*

*(1) Minimum Floor for Production* of *Type 11/ ZEVs.*

* * * *

(G) *Carry-over* of Excess *Credits.* ~~Where~~ a ~~manufacturer generates more qualifying ZEV credits than are needed to meet the minimum floor requirement for the production of Type~~ III ~~ZEVs in one of the periods identified in section C.2.2(b)(1)(A) (C), the qualifying ZEV credits may be used towards meeting the minimum floor requirement for the production of Type~~ III ~~ZEVs in a subsequent period, provided that the value of these carryover credits shall be based on the model year in which the credits are used.~~

=ZEV credits generated from excess production in model years 2005 through 2008 may be carried forward and applied to the 2009 through 2011 minimum floor requirement specified in ~~1962.1(b)(2)(B)~~ ~~1.b.~~ the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles, ~~and 2001 and Subsequent Model~~ Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes," section C.2.2(b)(1)(B) provided that the value of these carryover 'creditsshall be based on the model year in which the cre.dits are used.

* * * *

# APPENDIXD

# PROPOSED AMENDMENTS to THE HYBRID EXHAUST EMISSION TEST PROCEDURES, MODEL YEAR 2009 AND SUBSEQUENT

Date .of Release: December 5, 2008; 45-Day Notice version
· Date of Hearing: January 22-23, 2009

California Environmental Protection Agency
AIR RESOURCES BOARD

# CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 2009 AND SUBSEQUENT MODEL ZERO-EMISSION VEHICLES, ~~AND 2001~~ AND SUBSEQUENT MODEL HYBRID ELECTRIC VEHICLES, IN THE PASSENGER CAR, LIGHT-DUTY TRUCK AND MEDIUM-DUTY VEHICLE CLASSES

Adopted: [Insert date of adoption]
Amended: [Insert date of amendment]

Note:The proposed amendments to this document are shown in underline to indicate additions and strikeout to indicate deletions proposed by staff in the Notice of Public Hearing released December 5,2008. The document inwhich the amendments are being shown is a version that was initially approved by the Board on March 27,2008 for adoption as part of the "Rulemakiilg to Consider Adoption of the 2008 Amendments to the California Zero-Emission Vehicle Regulation." That rulemaking is not yet final: For that reason, the document text also. includes two sets of proposed changes that the Board authorized staff to offer for public comment as part of the March 27, 2008 rulemaking. The first set of changes noticed as I5-day changes to the March 27,2008 rulemaking version are indicated by double underline to indicate additions and ~~double strikeout~~ to indicate deletions compared to the test procedures issued with the 45-day notice for the Board hearing. The second set of I5-.day changes to the March 27,2008 rulemaking version are indicated by dotted underline to indicate additions and ~~*italics double strikeout*~~ to indicate deletions. Existing intervening text that is not amended is indicated by "* * * *". Page numbers in the table of contents will be amended in the final rulemaking if the proposal is approved by the Board.

Date of Release: December 5, 2008; 45-day Notice version
Date of Hearing: January 22-23, 2009

NOTE: This document is incorporated by reference in section 1962.1, title 13, California Code of Regulations (CCR). Additional requirements necessary to complete an application for certification of zero-emission vehicles and hybrid electric vehicles are contained in other documents that are designed to be used in conjunction with this document. These other documents include:

1. "California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles" (incorporated by reference in section 1961Cd), title 13, CCR);

2. "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles" (incorporated by reference in section 1976(c), title 13, CCR);

3. "California Refueling Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles" (incorporated by reference in section 1978(b), title 13, CCR);

4. OBD II (section 1968, et seq. title 13, CCR, as applicable);

5. "California Environmental Performance Label Specifications for 2009 and Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Passenger Vehicles" (incorporated by reference in 1965, title 13, CCR);

6. Warranty Requirements (sections 2037 and 2038, title 13, CCR);

7. "Specifications for Fill Pipes and Openings of Motor Vehicle Fuel Tanks" (incorporated by reference in section 2235, title 13, CCR);

8. '. Guidelines for Certification of Federally Certified Light-Duty Motor Vehicles for Sale in California (incorporated by section 1960.5, title 13, CCR); and

9. "California Non-Methane Organic' Gas Test Procedures," (incorporated by reference in section 1961(d), title 13, CCR).

TABLE OF CONTENTS

# CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 2009 AND SUBSEQUENT MODEL ZERO-EMISSION VEHICLES, ~~AND 2001~~ AND ~~SUBSEQUENT~~ MODEL HYBRID ELECTRIC VEHICLES, IN THE PASSENGER CAR, LIGHT-DUTY TRUCK AND MEDIUM-DUTY VEHICLE CLASSES

## A. Applicability

The emission standards and test procedures in this document are applicable to 2009 and subsequent model-year zero-emission passenger cars, light-duty trucks and medium-duty vehicles, and ~~2001~~ 2009 and subsequent model-year hybrid electricpassenger cars, light-duty trucks and medium-duty vehicles. The general procedures and requirements necessary to certify a vehicle for sale in California are contained in the "California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles" (hereinafter "LDVIMDV TPs"), and apply except as amended herein. /\.. manufacturer may elect to certify a 2000 model year ~~hybrid~~ electric vehicle under these standards and test procedures ~~and~~ the LDV/MDV TPs.

## B. Definitions and Terminology.

### 1. Definitions.

In addition to the following, these test procedures incorporate by reference the definitions and abbreviations set forth in the Title 40 Code of Federal Regulations (CFR) §86.l803-01, the definitions and abbreviations set forth in the LDVIMDV TPs, and the definitions set forth in section 1900, title 13, CCR.

**"Advanced technology PZEV" or "AT PZEV"** means any PZEV with an allowance greater than 0.2 before application of the PZEV early introduction phase-in multiplier.

**"All-Electric Range"** means the total miles driven electrically (with the engine off) before the engine turns on for the first time, after the battery has been fully charged. For a blended off-vehicle charge capable hybrid electric vehicle, the equivalent all-electric range shall be considered the "all-electric range" of the vehicle.

**"All-Electric Range Test"** means a test sequence used to determine the range of an electric vehicle or of a hybrid electric vehicle without the use of its auxiliary power unit. The All-Electric Range Test cycle consists of the Highway Fuel Economy Schedule and the Urban Dynamometer Driving Schedule (see section E of these test procedures).

**"Alternate Continuous Urban Test Schedule"** means a repeated series of the following sequence: UDDS, 10 minute key-off hot soak, UDDS, and 10-20 minute key-off hot soak. This alternate procedure may be substituted for the Continuous Urban Test Schedule when the Continuous Urban Test Schedule cannot be performed.

**"Alternate Continuous Highway Test Schedule"** means a repeated series of the following sequence: HFEDS, 15 second key-on pause, HFEDS, and 10-20 minute key-off hot soak. This alternate procedure may be substituted for the Continuous Highway Test Schedule when the Continuous Highway Test Schedule cannot be performed.

"Auxiliary power unit" means a device that converts consumable fuel energy into mechanicai or electrical energy. Some examples of auxiliary power units are internal combustion engines, gas turbines, or fuel cells.

"Battery electric vehicle" or "BEV" means any vehicle that operates solely by use of a battery or battery pack, or that is powered primarily through the use of an electric battery or battery pack but uses a flywheel or capacitor that stores energy produced by the electric motor or through regenerative braking to assist in vehicle operation.

"Battery or Battery pack" means any electrical energy storage device consisting of any number of individual battery modules or cells that is used to propel a battery'electric or hybrid electric vehicle. These terms may also generically refer to capacitor and flywheel energy storage devices in the 'context of hybrid electric vehicles.

"Battery state-of-charge" means the quantity of electrical energy remaining in the battery relative to the maximum rated capacity of the battery expressed in percent.

"Blended off-vehicle charge capable hybrid electric vehicle" means an off-vehicle charge capable hybrid electric vehicle that uses the engine to supplement battery/electric motor, power during charge depleting operation.

"Blended operation mode" means an operating mode in which the energy storage state-of-charge decreases, on average, while the vehicle is driven and the engine is used occasionally to support'power requests.

"ChaFge ~~depleting~~" means that the battery of a hybrid electric vehicle ultimately fully discharges and impairs vehicle operation as the vehicle continuously operates over a given driving cycle when no off vehicle charging is performed and the consumable fuel is regularly replenished. Hybrid electric vehicles are required to be classified as either charge sustaining or charge depleting ~~over~~ each driving cycle (i.e. UDDS, HFEDS, ~~US06,~~ or ~~SC03).~~

"Charge-depleting net energy consumption" means the net electrical energy, $\underline{E}_{cd}$, measured in watt-hours consumed by vehicle over the charge depleting cycle range, $\underline{R}_{cdc}$. $\underline{E}_{cd}$ can be expressed as AC or DC watt hours, where appropriate.

"Charge-depleting (CD) mode" means an operating mode in which the energy storage state-of-charge (SOC) may fluctuate but, on average, decreases while the vehicle is driven. Hybrid electric vehicles are required tobe classified as either charge.:.sustaining or charge-depleting over each driving cycle (i.e. UDDS, HFEDS, US06, or SC03).

"Charge depleting actual range or $\underline{R}_{cda}$" means the distance traveled on the Urban Charge Depleting Test Procedure at which the state-of-charge is'first equal to the average state-of-charge of the two consecutive UDDS used to end the Urban Charge Depleting Test Procedure. This range must be accurate to the nearest 0.1 miles. (See section F.11.9.)

"Charge depleting actual range, highway or $R_{cdah}$" means the distance traveled on the Highway Charge Depleting Test Procedure at which the state-oi-charge is first equal to the average state-of-charge of the HFEDS used to end the Highway Charge Depleting Test Procedure. This range must be accurate tothe nearest 0.1 miles.

"Charge depleting cycle range or $\underline{R}_{cdc}$" means the distance traveled on the Urban or Highway Charge Depleting Procedure up to the test cycle prior to where the state-of-charge is above the lower bound state-of-charge tolerance for one test cycle. This range will appear as the sum of a discrete number of test cycle distances. This range shall be accurate to the nearest 0.1 miles. (See section F.11.8.)

"ChaFge ~~depletion range actual or $R_{cdq}$"~~ means the distance ~~achieved by~~ a hybrid electric ~~vehicle~~ on a specified driving cycle at the point when the ~~zero~~ emission energy storage ~~device~~ is depleted of off ~~vehicle~~ charge and regenerative braking ~~derived~~ energy.

~~"Charge~~ sustaining" ~~means~~ that the battery of a hybrid electric ~~vehicle~~ ultimately does not funy discharge and impair ~~vehicle~~ operation as the ~~vehicle~~ continuously operates ~~over~~ a ~~given driving cycle~~ \vhen no off ~~vehicle~~ charging is performed and the consumable fuel is regularly replenished. Hybrid electric vehicles are required to be olassified as either charge sustaining or charge depleting ~~over each driving cycle~~ (i.e. ~~UDDS, HFEDS, US06,~~ or ~~SC03).~~

"Charge-sustaining net energy consumption" means the net electrical energy, Ecs, measured in watt-hours consumed by vehicle during charge sustaining ope.ration: For charge sustaining operation, this number should be ~ O.

"Charge-sustaining (CS) mode" means an operating mode in which the energy storage SOC may fluctuate but, on average, is maintained at a certain level while the vehicle is driven. Hybrid electric vehicles are required to be classified as either charge-sustaining or charge-depleting over each driving cycle (i.e. UDDS, HFEDS, US06, or SC03).

"Consumable fuel" ·means any solid, liquid, or gaseous matter that releases energy when consumed by an auxiliary power unit.

"Continuous Urban Test Schedule" means a repeated series comprised of an Urban Dynamometer Driving Schedules (UDDS), 40 CFR, Part 86, Appendix 1, which is incorporated herein by reference; each test is followed by a 10 minute key-off soak period.

"Continuous Highway Test Schedule" means a repeated series comprised of four consecutive key-on Highway Fuel Economy Driving Schedules (HFEDS) with a 15 second key-on pause in-between each HFEDS. If this schedule cannot be performed continuously, a key-off soak up to 30 minutes is permitted after every fourth HFEDS.

"Continuous US06 Test Schedule" means a repeated series ofUS06 driving schedules (US06) with a key-on idle period of not less than one minute and not greater than two minutes between each US06.

"Electric drive system" means an electric motor and associated power electronics" which provide acceleration torque to the drive wheels sometime during normal vehicle operation. This does not include components that could act as a motor, but are configured to act only as a generator or engine starter in a particular vehicle application.

"Electric range fraction" means the fraction of electrical energy derived from off-vehicle charging and regenerative braking energy relative to total traction energy used over the charge depletion range on a specified drive cycle.

"Enhanced AT PZEV" means any PZEV that has an allowance of 1.0 or greater per vehicle without multipliers and makes use of a ZEV fuel.

"Equivalent all:electric range" means the oharge depletion range multiplied by the electric range fraction (EAER ~~$R_{cd}$ x~~ ERF) the portion of the total charge depleting range attributable to the use of electricity from the battery over the charge depleting range test.

"Fuel cell vehicle" or "FCV" means any vehicle that receives propulsion solely from an onboard fuel cell power system.

"Fuel-fired heater" means a fuel burning device that creates heat for the purpose of warming the passenger compartment of a vehicle but does not contribute to the propulsion of the vehicle.

"Grid-connected hybrid electric vehicle" means a hybrid electric vehicle that has the capacity for the battery to be recharged from an off-board source of electricity and has some all-electric range.

"Highway Fuel Economy Driving Schedule" or "HFEDS" means highway fuel economy driving schedule. See 40 CFR Part 600 §600.1 09(b).

"Hybrid electric vehicle" or "HEV" means any vehicle that can draw propulsion energy from both of the following on-vehicle sources of stored energy: 1) a consumable fuel and 2) an energy storage device such as a battery, capacitor, or flywheeL

"Hybrid fuel cell vehicle" or "HFCV" means any vehicle that receives propulsion energy from both an onboard fuel cell power system and either a battery or a capacitor.

"Neighborhood Electric Vehicle" or "NEV" means a motor vehicle that meets the definition of "low-speed vehicle" either in section 385.5 of the Vehicle Code or in 49 CFR §.571.500 (as it existed on July 1,2000), and is certified to zero-emission vehicle standards.

"NIST" means the National Institute of Standards and Technology.

"Off-vehicle charge capable" means having the capability to charge a battery from an off-vehicle electric energy source that cannot be connected or coupled to the vehicle in any manner while the vehicle is being driven. A grid-connected hybrid electric vehicle is one example of an off-vehicle charge capable hybrid electric vehicle.

"Placed in service" means having been sold or leased to an end-user and not just to a dealer or other distribution chain entity, and having been individually registered for on-road use by the California Department of Motor Vehicles.

"PZEV" means any vehicle that is delivered for sale in California and that qualifies for a partial ZEV allowance of at least 0.2.

"Regenerative braking" means the partial recovery of the energy normally dissipated into friction braking that is returned as electrical current to an energy storage device.

"SAR J2572" means the "Recommended Practice for Measuring Fuel Consumption and Range of Fuel Cell and Hybrid Fuel Cell Vehicles Fuelled by Compressed Gaseous Hydrogen" as published by the Society of Automotive Engineers in October, 2008.

**"Section 177 State"** means a state that is administering the California ZEV requirements pursuant to section 177 of the federal Clean Air Act (42 U.S.C. § 7507).

"SC03" means the U.S. EPA SC03 driving schedule representing vehicle operation with air conditioning, as set forth in Appendix I of 40 CFR Part 86.

"SOC Net Change Tolerance" means the state-of-charge net change tolerance that is applied to the SOC Criterion for charge-sustaining hybrid electric vehicles when validating an emission test. See section ~~D.8~~ E.9 and F.10 of these procedures for tolerance specifications.

"SOC Criterion" means the state-of-charge criterion that is applied to a charge-sustaining hybrid electric vehicle to validate an emission test. The SOC Criterion requires that no net change in battery energy occurs over a given test cycle, i.e. the final battery state-of-charge that is recorded at the end of the emission test must be equivalent to the initial battery state-of-charge that is set at the beginning of the emission test. The SOC Net Change Tolerance shall be applied to the SOC Criterion.

"Type 0, I, 1.5, II, **III,** ~~and~~ IV. and V ZEV" all have the meanings set forth in section C.4.4(a).

"US06" means the US06 driving schedule for aggressive driving as set forth in Appendix I of 40 CFR Part 86.

"UDDS" means urban dynamometer driving schedule as set forth Appendix I of 40 CFR Part 86.

"Zero-emission vehicle" or "ZEV" means any vehicle certified to zero-emission standards.

"Zero-emission VMT" means the vehicle miles traveled with zero exhaust emissions of any criteria pollutant (or precursor pollutant).

"ZEV fuel" means a fuel that provides traction energy in on-road ZEVs. Examples of current technology ZEV fuels include electricity, hydrogen, and compressed air.

2. Terminology.

| | Abbreviation | Units |
|---|---|---|
| Charge Depleting Actual Range | $R_{cda}$ | ml |
| Charge Depleting to Charge Sustaining Range | Rcdcs | ml |
| Charge Depleting Net Energy Consumption | $E_{cd}$ | wh |
| Charge Depleting $CO_2$ Produced | $M_{cd}$ | g/mi |
| Charge Sustaining $CO_2$ Produced | $M_{cs}$ | g/mi |
| Highway Charge Depleting Cycle Range | $R_{cdch}$ | ml |
| Highway Electric Range Fraction. | $ERF_h$ | % |
| Highway Equivalent All-Electric Range | $EAER_h$ | ml |
| Highway Equivalent All-Electric Range Energy Consumption | EAERECh | wh/mi |
| Urban Charge Depleting Cycle Range | $R_{cdcu}$ | ml |
| Urban Electric Range Fraction . | $ERF_y$ | % |
| Urban Equivalent All-Electric Range | $EAER_u$ | ml |
| Urban Equivalent All-Electric Range Energy Consumption | $EAEREC_u$ | wh/mi |

**C. Zero-Emission Vehicle Standards.**

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**3. Partial ZEV Allowance Vehicles (PZEVs).**

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**3.3 Zero-Emission VMT PZEV Allowance.**

(a) *Calculation o/Zero Emission VMT Allowance.* A vehicle that meets the requirements of section C.3.2 and has zero-emission vehicle miles traveled ("VMT") capability will generate an additional zero emission VMT PZEV allowance, calculated as follows:

| *~~Urban~~ ~~Equivalent~~ ~~All~~ ~~Electric~~ Range (EAER)* | *Zero-emission VMT Allowance* |
|---|---|
| $EAER_u$ < 10 miles | 0.0 |
| $EAER_u$ ~~>=~~ ≥ 10 miles and $R_{cda}$ = 10 miles to ~~100~~ 40 miles | $EAER_y$ x (1 – $UF_{Rcda}$)/~~14.6~~ 11.028 |
| $R_{cda}$ > ~~100~~ 40 miles | ~~1.58~~ $EAER_{u40}$/29.63 |

The urban equivalent all-electric range ($EAER_u$) and ~~urban~~ charge depletion depleting actual range ~~actual~~ ($R_{cda}$) shall be determined in accordance with sections F.11 and ~~E.3.2.1(2)(a)~~ F.5.5, respectively, of these test procedures. The ~~U~~utility Factor (UF) based on the charge depletion depleting actual range actual ($R_{cda}$) shall be determined according to ~~the~~ ~~0~~ 1~~00~~ ~~mile~~ ~~4th~~ ~~order~~ ~~curve~~ ~~fit~~ ~~from~~ SAE ~~J1711~~ J2841 PropDft 2008., ~~issued~~ ~~March~~ 1999, ~~p52.~~

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**D. Certification Requirements.**

**1. Durability and Emission Testing Requirements.** All ZEVs are exempt from all mileage and service accumulation, durability-data vehicle, and emission-data vehicle testing requirements.

**2. Information Requirements: Application for Certification.** Except as noted below, the Part 1(40 CFR §86.1843-01(c)) certification application shall include the following:

2.1 Identification and description of the vehicle(s) covered by the application.

2.2 Identification of the vehicle weight category to which the vehicle is certifying: PC, LDT 0-3750 lbs. LVW, LDT 3751-5750 lbs. LVW, LDT 3751lbs; LVW - 8500 lbs. GVW, or MDV (state test weight range), and the curb weight and gross vehicle weight rating of the vehicle.

2.3 Identification and description of the propulsion system for the vehicle.

2.4 Identification and description of the climate control system used on the vehicle.

2.5 Projected number of vehicles produced and delivered for sale in California, and projected California sales.

2.6 Identification of the energy usage in kilowatt-hours per mile from:

(a) the battery output (DC energy) (to be submitted with the Part II certification application (40 CFR §86.1843-01(d));

(b) the point when electricity is introduced from the electrical outlet (AC energy); and

(c) the operating range in miles of the vehicle when tested in accordance with the All-Electric Range Test set forth in section E, below. For off-vehicle charge capable hybrid electric vehicles certifying to section F, the manufacturer shall provide the energy usage in kilowatt hours per mile from the Urban Equivalent All-Electric Range and the Highway Equivalent All-Electric Range.

2.7 For those ~~ZEVs~~ and HEVs vehicles that use fuel-fired heaters, the manufacturer shall provide:

(a) a description of the control system logic of the fuel-fired heater, including an evaluation of the conditions under which the fuel-fired heater can be operated and an evaluation of the possible operational modes and conditions under which evaporative emissions can exist;

(b) the exhaust emissions value per mile produced by the auxiliary fuel-fired heater operated between 68°F and 86°F; and

(c) the test plan which describes the procedure used to determine the mass emissions of the fuel-fired heater.

2.8 All information necessary for proper and safe operation of the vehicle, including information on the safe handling of the battery system, emergency procedures to follow in the event of battery leakage or other malfunctions that may affect the safety of the vehicle operator or laboratory personnel.

2.9 Method for determining battery state-of-charge, battery charging capacity and recharging procedures, and any other relevant information as determined by the Executive Officer.

2.10 Battery specific energy data and calculations as specified in section E.4 of these procedures including the weight of the battery system and the three hour discharge rate *(C/3)* energy capacity.

2.11 Vehicle and battery break-in period as specified in section E.2 of these test procedures.

2.12 Labeling shall conform with the requirements specified in section 1965, title 13, CCR and the ~~California~~ Motor Vehicle Emission Control and Smog Index Label Specifications "California Environmental Performance Label Specifications for 2009 and Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Passenger Vehicles" (incorporated by reference therein).

2.13 For a ZEV, extended range HEV or PZEV that qualifies to receive one or more multipliers under sections C.3 - C.7, the manufacturer shall provide all information relevant to the vehicle's qualification for, and the estimated value of, the multiplier(s). The Executive Officer may request additional information needed to appropriately characterize the vehicle. Based on the submitted information and other relevant data, the Executive Officer shall assign to the vehicle the highest multiplier(s) for which the manufacturer has demonstrated the vehicle qualifies at that time.

2.14 Where When a manufacturer plans to require any scheduled maintenance for a PZEV before 150,000 miles, the manufacturer must submit information demonstrating the need for each scheduled maintenance item before 150,000 miles, including actual in-use data, engineering evaluation of the durability of the part, or other relevant information. The manufacturer may require such maintenance for a PZEV only upon the Executive Officer's determination, prior to certification, the manufacturer has demonstrated the need for the scheduled maintenance; this determination may not unreasonably be denied.

2.15 For off-vehicle charge capable hybrid electric vehicles certifying to section F, the manufacturer shall provide the Urban Charge Depleting Cycle Range, the Urban Charge Depleting Actual Range, the Charge Depleting to Charge Sustaining Urban Range, the Highway Charge Depleting Cycle Range, the Highway Charge Depleting Actual Range, the Charge

Depleting to' Charge Sustaining Highway Range, the Urban Equivalent All-Electric Range, the Highway Equivalent All-Electric Range, the Urban Electric Range Fraction, and the Highway Electric Range Fraction.'

3. ZEV **Reporting Requirements.** In order to verify the status of each manufacturer's compliance with the ZEV requirements for a given calendar year, each manufacturer shall submit a report to the Executive Officer at least annually, by May 1 of the calendar year following the close of the model year, that identifies the necessary delivery and placement data of all vehicles generating ZEV credits or allowances, and all transfers and acquisitions of ZEV credits. The manufacturer may update the report by September 1 to cover activities occurring between April 1 and June 30.

**E. Test Procedures for 2011 and Subsequent Model Zero-Emission Vehicles (including Fuel Cell Vehicles and Hybrid Fuel Cell Vehicles) and All 2011 and Subsequent Model Hybrid-Electric Vehicles, Except Off-Vehicle Charge Capable Hybrid Electric Vehicles.**

The "as adopted or amended dates" of the 40 CFR Part 86 regulations referenced by this document are the dates identified in the "California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles." Unless otherwise noted, these requirements shall apply to all ZEVs (including fuel cell vehicles and hybrid fuel cell vehicles) and all HEVs, except off-vehicle charge capable HEVs. A manufacturer may elect to certify a 2009 or a 2010 model-year zero-emission vehicle or hybrid electric vehicle, except an off-vehicle charge capable hybrid electric vehicle, using this section E.

**1. Electric Dynamometer.** All ZEVs and HEVs must be tested using a 48-inch single roll electric dynamometer meeting the requirements of 40 CFR Subpart B, &86.108-00(b)(2) [October 22, 1996].

**2. Vehicle and Battery Break-In Period.** A manufacturer shall use good engineering judgment in determining the proper stabilized emissions mileage test point and report same according to the requirements of section D.2.11 above.

**3. All-Electric Range Test for Zero-Emission Vehicles (including Fuel Cell Vehicles and Hybrid Fuel Cell Vehicles).** All 2011 and subsequent ZEVs shall be subject to the All-Electric Range Testspecified below for the purpose of determining the energy efficiency and operating range of the ZEV.

3.1 **Determination of Urban All-Electric Range for Zero-Emission Vehicles.**

3.1.1 **Determination of Urban All-Electric Range for Battery Electric Vehicles.**

(a) **Cold soak.** The vehicle shall be stored at an ambient temperature not less than 68°F (20°C) and not more than 86°F OO°C) for 12 to 36 hours. During this time, the vehicle's battery shall be charged to a full state-of-charge. Charge time shall not exceed soak time.

(b) At the end of the cold soak period, the vehicle shall be placed or pushed, onto a dynamometer and operated through successive Urban Dynamometer Driving Schedules (DDDS), 40 CFR, Part 86, Appendix I [July 13,2005], which is incorporated herein by reference. A lO-minute soak shall follow each UDDS.

(c) For vehicles with a maximum speed greater than or equal to the maximum speed on the UDDS, this test sequence shall be repeated imtil the vehicle is no longer able to maintain either the speed or time tolerances in 40 CFR §86.115-00 (b)(l) and (2) [October 22, 1996], or the manufacturer determines that the test should be terminated for safety reasons, e.g. excessively high battery temperature, abnoimally low battery voltage, etc.

(d) For vehicles with a maximum speed less than the maximum speed on the UDDS, the vehicle shall be operated at maximum available power (or full throttle) when the vehicle cannot achieve the speed trace within the speed and" time tolerances specified in 40 CFR §86.115-OO(b)(l) and (2) [October 22,1996]. The test shall be terminated when the vehicle speed when operated at maximum available power (or full throttle) falls below 95 percent of the maximum speed initially achieved on the UDDS or when the battery state-of-charge is depleted to the lowest level allowed by the manufacturer, or the manufacturer determines that the test should be terminated for safety reasons, e.g. excessively high battery temperature, abnormally low battery voltage, etc., whichever occurs first. For off':vehicle charge capable hybrid electric vehicles, this determination shall be performed without the use of the auxiliary power unit.

3.1.2 **Determination** of Urban **All-Electric Range for Fuel Cell Vehicles and Hybrid Fuel Cell Vehicles.**

(a) . The urban all-electric range for a fuel cell vehicle and. a hybrid fuel cell vehicle shall be determined in accordance with SAE J2572.

3.2 **Determination** of Highway All-Electric Range **for Zero-Emission Vehicles and Range for Fuel Cell Vehicles and Hybrid Fuel Cell Vehicles.**

3.2.1 **Determination** of Highway **All-Electric Range for Battery Electric Vehicles.**

(a) **Cold soak** The vehicle shall be stored at an ambient temperature not less than 68°F (20°e) and not more than 86°F OO°e) for 12 to 36 hours. During this time, the vehicle's battery shall be charged to a full state-of-charge. Charge time shall not exceed soak time.

(b) At the end of the cold soak period, the vehicle shall be placed, either driven or pushed, onto a dynamometer and operated through two Continuous Highway Test Schedules of the Highway Fuel Economy Driving Schedule (HFEDS). "

(c) For vehicles with a maximum speed greater than or equal to the maximum speed on the HFEDS, this test sequence shall be repeated until the vehicle is no longer able to maintain either the speed or time tolerances in 40 CFR §86.115-00 (b)(l) and (2) [October 22, 1996], or the manufacturer determines that the test should be terminated for safety reasons, e.g. excessively high battery temperature, abnormally low battery voltage, etc.

(d) For vehicles with a maximum speed less than the maximum speed on the HFEDS, the vehicle shall be operated at maximum available power (or.full throttle) when the vehicle cannot achieve the speed trace within the speed and time tolerances specified in 40 CFR §86.115-00Cb)(l) and (2) [October 22, 1996]. The test shall be terminated when the vehicle speed when operated at maximum available power (or full throttle) falls below 95 percent of the maximum speed initially achieved on the HFEDS or when the battery state-of-charge is depleted to the lowest level allowed by the manufacturer, or the manufacturer determines that the test should be terminated for safety reasons, e.g. excessively high battery temperature, abnormally low battery voltage, etc., whichever occurs first.

(e) NEVs are exempt from the all-electric range highway test.

3.2.2 **Determination** of Highway **All-Electric Range for Fuel Cell Vehicles and Hybrid Fuel Cell Vehicles.**

(a) The highway all-electric range for a fuel cell vehicle and a hybrid fuel cell vehicle shall be determined in accordance withSAE J2572.

3.3 **Recording requirements.**

*For all battery electric vehicles and hybrid electric vehicles. except o[fvehicle charge capable hybrid electric vehicles:* Once the vehicle is no longer able to maintain the speed and time requirements specified in E.3.1 or E.3.2 above, the vehicle shall be· brought to an immediate stop and the following data shall be recorded:

(a) mileage accumulated during the All-Electric Range Test;

(b) Net DC energy from the battery that was expended during the All-Electric Range Test (may be reported as the total DC battery energy output and the total DC battery energy input during the All-Electric Range Test);

(c) AC energy required to fully charge the battery after the All-Electric Range Test from the point where electricity is introduced from the electric outlet to the battery charger; and

(d) DC energy required to fully charge the battery after the All-Electric Range Test from the point where electricity is introduced from the battery charger to the battery.

Battery charging shall begin within 1 hour after terminating the All-Electric Range Test.

3.4 **Regenerative braking.** Regenerative braking systems may be utilized during the range test. The braking level, if adjustable, shall be set according to the manufacturer's specifications for normal driving conditions prior to the commencement of the test. The driving schedule speed and time tolerances specified in E.3.1 or E.3.2 shall not be exceeded due to the operation of the regenerative braking system.

3.5 **Measurement Accuracy.** For battery electric vehicles, the overall errorin voltage and current recording instruments shall be NIST traceable and accurate to ± 1% of the maximum value of the variable being measured. Suggested equipment: amp meter/power meter capable of sampling voltage and current. Voltage and current shall be sampled at a minimum rate of 20 hz.

3.6 **Watt Hour Calculation for Battery Ele.ctric** Vehicles.

DC energy (watt hours) shall be calculated as follows

DC energy = $\int v(t) * i(t)\, dt$
Where v = vehicle DC main battery pack voltage
i = vehicle DC main battery pack current

3.7 Charger Requirements for Battery Electric Vehicles.

The standard charging apparatus (or equivalent) nonnally furnished with or specified for the vehicle shall be used for charging during vehicle testing.

4. Determination of Battery Specific Energy for ZEVs.

Determine the specific energy of batteries used to power a ZEV in accordance with the U.S. Advanced Battery Consortium's Electric Vehicle Battery Procedure Manual (January 1996), Procedure No. 2, "Constant Current Discharge Test Series," using the C/3 rate. The weight calculation must reflect a completely functional.battery system as defined in the Appendix of the Manual, including pack(s), required support ancillaries (e.g., thermal management), and electronic controller.

5. Determination of the Emissions of the Fuel-fired Heater for Vehicles Other Than ZEVs.

The exhaust emissions result of the fuel-fired heater shall be determined by operating at a maximum heating capacity with a cold start between 68°F and 86°F for a period of 20 minutes and dividing the grams of emissions by 20. The resulting grams perminute shall be multiplied by 3.0 minutes per mile to obtain a grams per mile value.

6. Urban Emission Test Provisions for All Hybrid Electric Vehicles, Except Hybrid Fuel Cell Vehicles and Off-Vehicle Charge Capable Hybrid Electric Vehicles.

Alternative procedures may be used if shown to yield equivalent results and if approved in advance by the. Executive Officer of the Air Resources Board.

6.1 Vehicle Preconditioning.

To be conducted pursuant to the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model MotorVehicles" with the following supplemental requirements:

6.1.1 For hybrid electric vehicles that do not allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at a level that causes the hybrid electric vehicle to operate the auxiliary power unit for the maximum possible cumulative amount of time during the preconditioning drive.

6.1.2 For hybrid electric vehicles that allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at a level that satisfies one of the following conditions:

(i) If the hybrid electric vehicle is charge-sustaining over the UDDS, battery state-of-charge shall be set at the lowest level allowed by the manufacturer.

(ii) If the hybrid electric vehicle is charge-depleting over the UDDS, battery state-of-charge shall be set at the level recommended by the manufacturer for activating the auxiliary power unit when operating in urban driving conditions.

6.1.3 After setting battery state-of-charge, the hybrid electric vehicle shall be pushed or towed to a work area for the initial fuel drain and fill according to section IIID.1.4. of the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles."

6.1.4 Following the initial fuel drain and fill, the vehicle shall complete an initial soak period of a minimum of 6 hours. After completing the soak period, the vehicle shall be pushed or towed into position on a dynamometer and preconditioned. If the auxiliary power unit is capable of being manually activated, the auxiliary power unit shall be manually activated at the beginning of and operated throughout the preconditioning drive.

6.1.5 Within five minutes of completing preconditioning drive, battery state-of-charge shall be set at a level that satisfies one of the following conditions:

(i) If the hybrid electric vehicle does not allow manual activation of the auxiliary power unit and is charge-sustaining over the UDDS, then set battery state-of-charge to a level such that the SOC criterion in section F.10 would be satisfied for the dynamometer procedure (section E.6.2 of these procedures). If off-vehicle charging is required to increase battery state-of-charge for proper setting, off-vehicle charging shall occur during the second soak period of 12 to 36 hours.

(ii) If the hybrid electric vehicle does not allow manual activation of the auxiliary power unit and is charge-depleting over the UDDS, then no battery state-of-charge adjustment is permissible.

(iii) If the hybrid electric vehicle does allow manual activation of the auxiliary power unit, then set battery state-of-charge to manufacturer recommended level for activating the auxiliary power unit when the hybrid electric vehicle is operating in urban driving conditions.

**6.2 Urban Dynamometer Procedure for All Hybrid Electric Vehicles, Except Hybrid Fuel Cell Vehicles and Off-Vehicle Charge Capable Hybrid Electric Vehicles.**

To be conducted pursuant to 40 CFR §86.135-00 [October 22, 1996] with the following revisions. References to §86.110-94 shall mean §86.110-94 as last amended June 30, 1995.

6.2.1 Amend subparagraph (a).

*Overview.* The dynamometer run shall consist of two tests, a "cold" start test, after a second fuel drain and fill and a 12 to 36 hour soak period performed pursuant to the provisions of the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles" and a "hot" start test following the "cold" start test by 10 minutes. Vehicle startup (with all accessories turned off), operation over the UDDS and vehicle shutdown make a complete cold start test. Vehicle startup and operation over the UDDS and vehicle shutdown make a complete hot start test.

For all UDDS tests, the exhaust emissions are diluted with ambient air in the dilution tunnel as shown in Figure B94-5 and Figure B94-6 (§86.110-94). A dilution tunnel is not required for testing vehicles waived from the requirement to measure particulates. Four particulate samples are collected on filters for weighing; the first sample plus backup is collected during the cold start test (including shutdown); the second sample plus backup is collected during the hot start test (including shutdown). Continuous proportional samples of gaseous emissions are collected for analysis during each test. For hybrid electric vehicles with Otto-cycle auxiliary power units, the composite samples collected in bags are analyzed for THC, CO, $CO_2$, $CH_4$ and $NO_x$. For hybrid electric vehicles that are not "off-vehicle charge capable," and are equipped with petroleum-fueled diesel-cycle auxiliary power units (optional for natural gas-fueled, liquefied petroleum gas-fueled, and alcohol-fueled diesel-cycle vehicles), THC is sampled and analyzed continuously pursuant to the provisions of §86.110-94. Parallel samples of the dilution air are similarly analyzed for THC, CO, $CO_2$, $CH_4$ and $NO_x$. For hybrid electric vehicles with natural gas-fueled, liquefied petroleum gas-fueled, and alcohol-fueled auxiliary power units, bag samples are collected and analyzed for THC (if not sampled continuously), CO, $CO_2$, $CH_4$ and $NO_x$. For hybrid electric vehicles with alcohol-fueled auxiliary power units, alcohol and formaldehyde samples are taken for both exhaust emissions and dilution air (a single dilution air formaldehyde sample, covering the total test period may be collected). Parallel bag samples of dilution air are analyzed for THC, CO, $CO_2$, $CH_4$ and $NO_x$.

6.2.2 Subparagraphs (b)-through (c). [No change.]

6.2.3 Delete subparagraph (d).

6.2.4 Subparagraphs (e) through (g). [No change.]

6.2.5 Amend subparagraph Ch): The driving distance, as measured by counting the number of dynamometer roll or shaft revolutions, shall be determined for the cold start test and hot start test. The revolutions shall be measured on the same roll or shaft used for measuring the vehicle's speed.

6.2.6 Subparagraph (i). [No change.]

**6.3 Urban Dynamometer Test Run, Gaseous and Particulate Emissions for All Hybrid Electric Vehicles, Except Hybrid Fuel Cell Vehicles and Off-Vehicle Charge Capable Hybrid Electric Vehicles.**

To be conducted pursuant to 40 CFR §86.137-96 [March 24, 1993] with the following revisions:

6.3.1 Amend subparagraph (a): *General.* The dynamometer run shall consist of two tests, a "cold" start test, after a second fuel drain and fill and a 12 to 36 hour soak period performed pursuant to the provisions of the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles" and a "hot" start test following the cold start test by 10 minutes. The complete dynamometer test consists of a cold start drive of 7.5 miles (12.1 kIn) and a hot start drive of 7.5 miles (12.1 kni). The vehicle shall be stored prior to the emission test in such a manner that precipitation (e.g., rain or dew) does not occur on the vehicle. The vehicle is allowed to stand on the dynamometer during the 10 minute time period between each test.

6.3.2 Amend subparagraph (b) as follows.

6.3.2.1 Amend subparagraph (b)(9): Start the gas flow measuring device, position the sample selector valves to direct the sample flow into the exhaust sample bag, the alcohol exhaust sample, the formaldehyde exhaust sample, the dilution air sample bag, the alcohol dilution air sample and the formaldehyde dilution air sample (turn on the petroleum-fueled diesel-cycle THC analyzer system integrator, mark the recorder chart, start particulate sample pump No.1, and record both gas meter or flow measurement instrument readings, if applicable), and turn the key on. If the auxiliary power unit is capable of being manually activated, the auxiliary power unit shall be activated at the beginning of and operated throughout the UDDS.

6.3.2.2 Delete subparagraph (b)(l3).

6.3.2.3 Amend subparagraph (b)(14): Turn the vehicle off 2 seconds after the end of the last deceleration (at 1,369 seconds).

6.3.2.4 Amend subparagraph (b)(15): Five seconds after the vehicle is shutdown, simultaneously turn off gas flow measuring device No.1 and if applicable, turn off the hydrocarbon integrator No. 1, mark the hydrocarbon recorder chart, turn off the No.1 particulate sample pump and close the valves isolating particulate filter No.1, and position the sample selector valves to the "standby" position. Record the measured roll or shaft revolutions (both gas meter or flow measurement instrumentation readings), and reset the counter. As soon as possible, transfer the exhaust and dilution air samples to the analytical system and process the samples pursuant to &86.140, obtaining a stabilized reading of the exhaust bag sample on all analyzers within 20 minutes of the end of the sample collection phase of the test. Obtain alcohol and formaldehyde sample analyses, if applicable, within 24 hours of the end of the sample period. (If it is not possible to perform analysis on the alcohol and formaldehyde samples within 24 hours, the samples should be stored in a dark cold (4°C to 1a°C) environment until analysis. The samples should be analyzed within fourteen days.) If applicable, carefully remove both pairs of particulate sample filters from their respective holders, and place each in a separate petri dish, and cover.

6.3.2.5 Amend subparagraph (b)08): Repeat the steps in paragraphs (b)(2) through (b)07) of this section for the hot start test. The step in paragraph (b)(9) of this section shall begin between 9 and 11 minutes after the end of the sample period for the cold start test.

6.3.2.6 Delete subparagraph (b)(19).

6.3.2.7 Delete subparagraph (b)(20).

6.3.2.8 Amend subparagraph (b)(21): As soon as possible, and in no case longer than one hour after the end of the hot start phase of the test, transfer the four particulate filters to the weighing chamber for post-test conditioning, if applicable. For hybrid electric vehicles that do not allow manual activation of the auxiliary power unit and are charge-sustaining over the UDDS, a valid test shall satisfy the SOC criterion in section F.10.

6.3.2.9 Amend subparagraph (b)(24): Vehicles to be tested for evaporative emissions will proceed pursuant to the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles."

**6.4 Calculations - Exhaust Emissions for All Hybrid Electric Vehicles, Except Hybrid Fuel Cell Vehicles and Off-Vehicle Charge Capable Hybrid Electric Vehicles.**

To be conducted pursuant to 40 CFR §86.144-94 [July 13,2005] with the following revisions:

6.4.1 Amend subparagraph (a): For light-duty vehicles and light duty trucks:

$$Y_{wm} = 0.43 * \left(\frac{Y_c}{D_c}\right) + 0.57 * \left(\frac{Y_h}{D_h}\right)$$

Where:

(1) $Y_{wm}$ = Weighted mass emissions of each pollutant, Le., THC, CO, *THCE*, NMOG, NMHCE, $CH_4$, $NO_x$, or C02, in grams per vehicle mile.

(2) $Y_c$ = Mass emissions as calculated from the cold start test, in grams per test.

(3) $Y_h$ = Mass emissions as calculated from the hot start test, in grams per

(4) $D_c$ = The measured driving distance'fromthe cold start test, in miles.

(5) $D_h$ = The measured driving distance from the hot start test, in miles.

6.4.2 Subparagraphs (b) through (e). [No change.]

**6.5 Calculations - Particulate Emissions for All Hybrid Electric Vehicles, Except Hybrid Fuel Cell Vehicles and Off-Vehicle Charge Capable Hybrid Electric Vehicles.**

To be conducted pursuant to 40 CFR §86.145-82 [November 2,1982] with the following revisions. References to §86.110-94 shall mean §86.110-94 as last amended June 30, 1995.

6.5.1 Amend" subparagraph (a): The final reported test results for the mass particulate ($M_p$) in grams/mile shall be computed as follows:

$$M_p = 0.43 * \left(\frac{M_{pc}}{D_c}\right) + 0.57 * \left(\frac{M_{ph}}{D_h}\right)$$

Where:

(1) $M_{pc}$ = Mass of particulate determined from the cold start test, in grams per vehicle mile. (See §86.110-94 for determination.)

(2) $M_{ph}$ = Mass of particulate determined from the hot start test, in grams per vehicle mile. (See §86.110-94 for determination.)

(3) $D_c$ = The measured driving distance from the cold start test, in miles.

(4) $D_h$ ="The measured driving distance from the hot start test,' in miles.

6.5.2 Subparagraph (b)." [No change.]

**7. Highway Emission Test Provisions for All Hybrid Electric Vehicles, Except Hybrid Fuel Cell Vehicles and Off-Vehicle Charge Capable Hybrid Electric Vehicles.**

To be conducted pursuant to 40 CFR §600.111-08 [December 27,2006] withthe following revisions.

7.1 Subparagraph (a). [not applicable - delete]

7.2 Amend subparagraph (b) as follows:

7.2.1 Amend subparagraph (b)(2): The highway fuel economy test is designated to simulate non-metropolitan driving with an average speed of 48.6 mph and a maximum speed of 60 mph. The cycle is 10.2 miles long with 0.2 stop per mile and consists of warmed-up vehicle operation on a chassis dynamometer through a specified driving cycle. A proportional part of the diluted exhaust emission is collected continuous'ly for subsequent analysis of THC, CO, C02, and $NO_x$ using a constant volume (variable dilution) sampler. Diesel dilute exhaust is continuously analyzed for hydrocarbons using a heated sample line and analyzer. Alcohol and formaldehyde samples are collected and individually analyzed for alcohol-fueled vehicles.

7.2.2 Amend subparagraph (b)(7)(i): The dynamometer procedure shall consist of two cycles of the Highway Fuel Economy Driving Schedule (§600;109(b)) separated by 15 seconds of idle. The first cycle of the Highway Fuel Economy Driving Schedule is driven to precondition the test vehicle and the second is driven for the fuel economy measurement.

7.2.3 Amend subparagraph (b)(7)(iii): Only one exhaust sample and one background sample shall be collected and analyzed for THC (except diesel hydrocarbons which are analyzed continuously), CO, $CO_2$, and $NO_x$. Alcohol and formaldehyde samples (exhaust and dilution air) are collected and analyzed for alcohol-fueled vehicles.

7.2.4 Add subparagraph(b)(7)(v): For hybrid electric vehicles that do not allow nianual·activation of the auxiliary power unit, battery state-of-charge shall be set at a level that causes the hybrid electric vehicle to operate the auxiliary power unit for the maximum possible cumulative amount of time during the HFEDS preconditioning cycle. For hybrid electric vehicles that allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at a level that satisfies one of the following conditions:

(i) If the hybrid electric vehicle is charge-sustaining over the HFEDS, battery state-of-charge shall be set at the lowest level allowed by the manufacturer.

(m If the hybrid electric vehicle is charge-depleting over the HFEDs, battery state-of-charge shall be set at 'the level recommended by the manufacturer for activating the auxiliary power unit when operating in highway driving conditions.

7.2.5 Amend subparagraph (b)(9)(v): Operate the vehicle overoue HFEDS preconditioning cycle according to the dynamometer driving schedule specified in §600;109-08(b) [December 27,2006]. If the auxiliary power unit is capable of being manually activated, the auxiliary power unit shall be manually activated at the beginning of and operated throughout the HFEDS preconditioning cycle.

7.2.6 Amend subparagraphCb)(9)(vi): When the vehicle reaches zero speed at the end of the HFEDS preconditioning cycle, the driver has 17 seconds to prepare for the HFEDS emission measurement cycle of the test.' Reset and enable the roll revolution counter. During ,the idle period, one of the following conditions shall apply:

(i) For hybrid electric vehicles that do not allow the auxiliary power unit to be manually activated and are charge-sustaining over the HFEDS, the vehicle shall be momentarily turned off for 5 seconds and turned back on during , the idle period. The battery state-of-charge shall be recorded after the hybrid electric vehicle has fully turned on.

(ii) For hybrid electric vehicles that do not allow the auxiliary power unit to be manually activated and are charge-depleting over the HFEDS, the vehicle shall remain turned on during the idle period.

(iii) For hybrid electric vehicles that allow the auxiliary power unit to be manually activated, the vehicle shall remain turned on with the auxiliary power unit operating during the idle period.

7.2.7 Add subparagraph (b)(9)(viii): At the conClusion of the HFEDS emission test; one of the following conditions shall apply:

(i) For hybrid eiectric vehicles that do not allow the auxiliary power unit to be manually activated and are charge-sustaining over the HFEDS, record the battery state-of-charge to determine if the SOC criterion in section F.10 is satisfied. If the SOC criterion is not satisfied, then repeat dynamometer test run from subparagraph (h)(6). Atotal of three highway emission tests shall be allowed to satisfy the SOC criterion.

(ii) For hybrid electric vehicles that do not allow the auxiliary power unit to be manually activated and are charge-depleting over the HFEDS, the emission test is completed.

(iii) For hybrid electric vehicles that allow the auxiliary power unit to be manually activated, the emission test is completed.

7.2.8 Delete subparagraph (b)(10).

7.3 Delete sUbparagraphs (c) through (e).

8. SFTP Emission Test Provisio,ns for All Hybrid Electric Vehicles, Except Hybrid Fuel Cell Vehicles and Off-Vehicle Charge Capable Hybrid Electric Vehicles.

8.1 US06 Vehicle Preconditioning

To be conducted pursuant to 40 CFR §86.132-00 [October 22, 1996] with the following revisions.

8.1.1 Subparagraphs (a) through (m). [No change.]

8.1.2 Amend subparagraph (n): Aggressive Driving Test (US06) Preconditioning.

8.1.2.1 Amend subparagraph (1) as follows: If the US06 test follows the exhaust emission FTP or evaporative testing, the refueling step may be deleted and the vehicle may be precoriditioned using the fuel remaining in the tank (see paragraph (c)(2)(ii) of this section). The test vehicle may be pushed or driven onto the test dynamometer. For hybrid electric vehicles that allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at a level that satisfies one of the following conditions:

8.1.2.1.1 Delete subparagraph (i), and replace with: If the hybrid electric vehicle is charge-sustaining over the US06, battery state-of-charge shall be set at the lowest level allowed by the manufacturer. The auxiliary power unit shall be manually activated at the beginning of and operated throughout the US06 preconditioning cycle.

8.1.2.1.2 Delete subparagraph (ii), and replace with: If the hybrid electric vehicle is charge-depleting over the US06, battery state-of-charge shall be set at the level recommended by the manufacturer for activating the auxiliary power unit when operating in highway driving conditions. The auxiliary power unit shall be manually activated at the beginning of and operated throughout the US06 preconditioning cycle.

8.1,2.1.3 Subparagraphs (iii) through (iv). [No change.]

8.1.2.2 Subparagraph (2). [No change.]

8.1.3 Subparagraph (0). [No change.]

8.2 US06 Emission Test.

To be conducted pursuant to 40 CFR §86.159-08 [December27, 2006] with the following revisions.

8.2.1 Amend subparagraph Cal: *Overview.* The dynamometer operation consists of a single, 600 second test on the US06 driving schedule, as described in appendix 1, paragraph (g), of this part. The hybrid electric vehicle is preconditioned in accordance with §86.132-00, to bring it to a warmed-up stabilized condition.· This preconditioning is followed by a 1 to 2 minute idle period that proceeds directly into the US06 driving schedule during which continuous proportional samples of gaseous emissions are collected for analysis. If engine stallin'g should occur during testing, follow the provisions of §86.136-90 (engine starting andrestarting). For hybrid electric vehicles with Otto-cycle auxiliary power units, the composite samples collected in bags are analyzed for THC, CO, C02, $CH_4$ and $NO_x$. For hybrid electric vehicles with diesel-cycle auxiliary power units, THC is sampled and analyzed continuously according to the provisions of §86.110. Parallel bag samples of dilution air are analyzed for THC, CO, $CO_2$, $CH_4$ and $NO_x$.

8.2.2 . Amend subparagraph (b) as follows.

8.2.2.1 Amend subparagraph (b)(2): Position the test vehicle on the dynamometer and restrain.·

8.2.3 Subparagraph (c). [No change.]

8.2.4 Amend subparagraph (d): Practice runs over the prescribed driving schedule may be performed at test point to permit sampiing system adjustment.

8.2.5 Subparagraph (e). [No change.]

8.2.6 . Amend subparagraph (f) as follows.

8.2.6.1 Amend subparagraph (0(2)0): Immediately after completion of the US06 preconditioning cycle, idle the vehicle. The idle period is not to be less than one minute or not greater than two minutes. During the idle period, one of the following conditions shall apply:

en For hybrid electric vehicles that do not allow the auxiliary power unit to be manually activated and are charge-sustaining over the US06, the vehicle shall be momentarily turned off for 5 seconds and turned back on during the idie period. The battery state-of-charge shall be recorded after the hybrid electric vehicle has fully turned on.

(ii) For hybrid electric vehicles that do not allow the auxiliary power unit to be manually activated and are charge-depleting over the US06, the vehicle shall remain turned on during the idle period.

(iii) For hybrid electric vehicles that allow the auxiliary power unit to be manually activated, the vehicle shall remain turned on with the auxiliary power unit operating during the idle period:

8.2.6.2 Amend subparagraph (f)(2)(ix): At the conclusion of the US06 emission test, one of the following conditions shall apply:

(i) For hybrid electric vehicles that do not allow manual activation of the auxiliary power unit and are charge-sustaining over the US06, record the battery state-of-charge to determine if the SOC criterion in section F.10 is satisfied. If the SOC criterion is not satisfied, then repeat dynamometer test run from subparagraph (f)(2)(i). A total of three US06 emission tests shall be allowed to satisfy the SOC criterion.

(ii) For hybrid electric vehicles that do not allow the auxiliary power unit to be manually activated and are charge-depleting over the US06, turn off vehicle 2 seconds after the end of the last deceleration.

(iii) For hybrid electric vehicles that allow the auxiliary power unit to be manually activated, turn off vehicle 2 seconds after the end of the last deceleration.

**8.3 SC03 Vehicle Preconditioning.**

To be conducted pursuant to 40 CFR §86.132-00 [October 22, 1996] with the following revisions.

8.3.1 Subparagraphs (a) through (n). [No change.]

8.3.2 Amend subparagraph (0): *Air Conditioning Test (SeD]) Preconditioning.*

8.3.2.1 Amend subparagraph (1) as follows: If the SC03 test follows the exhaust emission FTP or evaporative testing, therefueling step may be deleted and the vehicle may be preconditioned using the fuel remaining in the tank (see paragraph (c)(2)(ii) of this section). The test vehicle may be pushed or driven onto the test dynamometer. For hybrid electric vehicles that allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at a level that satisfies one of the following conditions:

8.3.2.1.1 Delete subparagraph (i), and replace with: If the hybrid electric vehicle is charge-sustaining over the SC03, 'battery state-of-charge shall be set at the lowest level allowed by the manufacturer. The auxiliary power unit shall be manually activated at the beginning of and operated throughout the SC03 preconditioning cycle.

8.3.2.1.2 Delete subparagraph Oi), and replace with: If the hybrid electric vehicle is charge-depleting over the SC03, battery state-of-charge shall be set at the level recommended by the manufacturer for activating the auxiliary power unit when operating in highway driving conditions. The auxiliary power unit shall be manually activated at the beginning of and operated throughout the SC03 preconditioning cycle.

8.3.2.2 Subparagraphs (2) through (3). [No change.]

**8.4 SC03 Emission Test.**

To be conducted pursuant to 40 CFR §86.160-00 [December 8, 2005] with the following revisions.

8.4.1 Amend subparagraph (a): *Overview.* The dynamometer operation consists of a single, 594 second test on the SC03 driving schedule, as described in appendix 1, paragraph (h), of this part. The hybrid electric vehicle is preconditioned in accordance with §86.132-00 of this subpart, to bring the vehicle to a warmed-up stabilized condition. This preconditioning is followed by a 10 minute vehicle soak (vehicle turned off) that proceeds directly into the SC03 driving schedule, during which continuous proportional samples of gaseous emissions are collected for analysis. The entire test, including the SC03 preconditioning cycle, vehicle soak, and SC03 emission test, is either conducted in an environmental test facility or under test conditions that simulate testing in an environmental test cell (see §86.162-00 (a) for a discussion of simulation procedure approvals). The environmental test facility must be capable of providing the following nominal ambient test conditions of: 95°F air temperature, 100 grains of water/pound of dry air (approximately 40 percent relative humidity), a solar heat load intensity of 850 $W/m^2$, and vehicle cooling air flow proportional to vehicle speed. Section 86.161-00 discusses the minimum facility requirements and corresponding control tolerances for air conditioning ambient test conditions. The vehicle's air conditioner is operated or appropriately simulated for the duration of the test procedure (except for the 10 minute vehicle soak), including the preconditioning. If engine stalling should occur during testing, follow the provisions of §86.136-90 (engine starting and restarting). For hybrid electric vehicles with Otto-cycle auxiliary power units, the composite samples collected in bags areLanalyzed for THC, CO, C02, $CH_4$ and $NO_x$. For hybrid electric vehicles with diesel-cycle auxiliary power units, THC is sampled and analyzed continuously according to the provisions of §86.110. Parallel bag samples of dilution air are analyzed for THC, CO, $CO_2$, $CH_4$ and $NO_x$.

8.4.2 Amend subparagraph (b) as follows.

8.4.2.1 Amend subparagraph (b)(2): Position the test vehicle on the dynamometer and restrain.

8.4.3 Amend subparagraph (c) as follows.

8.4.3.1 Amend subparagraph (c)C9): Start vehicle (with air conditioning system also running). If the auxiliary power unit of the hybrid electric vehicle is capable of being manually activated, the auxiliary power unit shall be manually activated at the beginning of and operated throughout the SCm emission test. Fifteen seconds after the vehicle starts, begin the initial vehicle acceleration of the driving schedule.

8.4.4 Amend subparagraph Cd) as follows.

8.4.4.1 Amend subparagraph (d)CI0): At the conclusion of the SC03 emission test, one of the following conditions shall apply:'

0) For hybrid electric vehicles that do not allow the auxiliary power. unit to be manually activated and are charge-sustaining over the SCm, record the battery state-of-charge to determine if the SOC criterion in section F.10 is satisfied. If the SOC criterion is not satisfied, then turn off cooling fanes), allow vehicle to soak in the ambient conditions of paragraph Cc)(5) of this section for 10 minutes, and repeat dynamometer test run from subparagraph (d). A total of three SCm emission tests shall be attempted to satisfy the SOC criterion.

(ii) For hybrid electric vehicles that do not allow the auxiliary power unit to be manually activated and are charge-depleting over the SC03, tum off. vehicle 2 seconds after the end of the last deceleration.

(iii) For hybrid electric vehicles that allow the auxiliary power unit to be manually activated, tum off vehicle 2 seconds after the end of the last deceleration.

8.4.5 Subparagraph (e). [No change.]

**9. State-of-Charge Net Change Tolerances for All Hybrid Electric Vehicles, Except Hybrid Fuel Cell Vehicles and Off-Vehicle Capable Hybrid Electric Vehicles.**

9.1 For hybrid electric vehicles that use a battery as an energy storage device, the following state-of-charge net change tolerance shall apply:

$$(\text{Amp-hr}_{final})_{max} = (\text{Amp-hr}_{initial}) + 0.01 * \left( \frac{NHV_{fuel} * m_{fuel}}{V_{system} * K} \right)$$

$$(\text{Amp-hr}_{final})_{min} = (\text{Amp-hr}_{initial}) - 0.01 * \left( \frac{NHV_{fuel} * m_{fuel}}{V_{system} * K} \right)$$

Where:

| | | |
|---|---|---|
| $(Amp\text{-}hr_{final})_{max}$ | = | Maximum allowed Amp-hr stored in battery at the end of the test |
| $(Amp\text{-}hr_{final})_{min}$ | | Minimum allowed Amp-hr stored in battery at the end of the test |
| (Amp-hrinitiaU | | Battery Amp-hr stored at the beginning of the test |
| $NHV_{fuel}$ | | Net heating value of consumable fuel, in Joules/kg |
| $m_{fuel}$ | = | Total mass of fuel consumed during test, in kg |
| K, | | Conversion factor, 3600 seconds/hour |
| $V_{system}$ | = | Average charge sustaining battery DC bus voltage (open circuit) during charge sustaining operation. This value shall be submitted for testing purposes, and it shall be subject to confirmation by the Air Resources Board. |

9.2 For hybrid electric vehicles that use a capacitor as an energy storage device, the following state-of-charge net change tolerance shall apply:

$$(V_{final})_{max} = \sqrt{V^2_{initial} + 0.01 * \frac{2 * NHV_{fuel} * m_{fuel}}{C}}$$

$$(V_{final})_{min} = \sqrt{V^2_{initial} - 0.01 * \frac{2 * NHV_{fuel} * m_{fuel}}{C}}$$

Where:

| | | |
|---|---|---|
| $(V_{final})_{max}$ | | The stored capacitor voltage allowed at the end of the test |
| $(V_{final})_{min}$ | = | The stored capacitor voltage allowed at the end of the test |
| $V^2_{initial}$ | | The square of the capacitor voltage stored at the beginning of the test |
| $NHV_{fuel}$ | = | Net heating value of consumable fuel, in Joules/kg |
| $m_{fuel}$ | | Total mass of fuel consumed during test, in kg |
| C | | Rated capacitance of the capacitor, in Farads |

9.3 For hybrid electric vehicles that use an electro-mechanical flywheel as an energy storage device, the following state-of-charge net change tolerance shall apply:

$$(rpm_{final})_{max} = \sqrt{rpm^2_{initial} + 0.01 * \frac{(2 * NHV_{fuel} * m_{fuel})}{I * K_3}}$$

$$(rpm_{final})_{min} = \sqrt{rpm^2_{initial} - 0.01 * \frac{2 * NHV_{fuel} * m_{fuel}}{I * K_3}}$$

Where:

| | | |
|---|---|---|
| $(rpm_{final})_{max}$ | = | The maximum flywheel rotational speed allowed at the end of the test |

| | | |
|---|---|---|
| $(rpm_{final})_{min}$ | = | The minimum flywheel rotational speed allowed at the end of the test |
| $rpm^2_{initial}$ | | The squared flywheel rotational speed at the beginning of the test |
| $NHV_{fuel}$!- | | Net heating value of consumable fuel, in Joules/kg |
| $m_{fuel}$ | | Total mass of fuel consumed during test, in kg |
| | = | Conversion factor, $\frac{4\pi^2}{3600\sec^2 \cdot rpm^2}$ |
| I | | Rated moment of inertia of the flywheel, **in** kg_m$^2$ |

**F. Test Procedures for 2011 and Subsequent Model Off-Vehicle Charge Capable Hybrid Electric Vehicles.**

The "as adopted or amended dates" of the 40 CFR Part 86 regulations referenced by this document are the dates identified in the "California Exhaust Emission Standards and Test Procedures for 200t'and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles," unless otherwise noted. A manufacturer may elect to certify a 2009 or a 2010 model-year off-vehicle charge capable hybrid electric vehicle using this section F.

**1. Electric Dynamometer.**

All off-vehicle charge capable HEVs must be tested using a 48-inch single roll electric dynamometer meeting the requirements of 40 CFR Subpart B, §86.108-00(b)(2) [October 22, 1996].

**2. Vehicle and Battery** Break-In Period.

A manufacturer shall use good engineering judgment in determining the proper stabilized emissions mileage test point and report same according to the requirements of section D.2.11 above.

**3. General Testing Requirements.**

3.1 **Recording requirements.**

*For off-vehicle charge capable hybrid electric vehicles:* The following data shall be recorded for all charge depleting range and exhaust tests and for each individual test cycle therein:

(a) mileage accumulated during the All-Electric Range portion of the test, where applicable;
(b) Net DC energy from the battery that was expended during the test (may be reported as the total DC battery energy output and the total DC battery energy input);
(c) AC energy required to fully charge the battery after a charge depleting or charge sustaining test from the point where electricity is introduced from the electric outlet to the battery charger;
(d) DC energy required to fully charge the battery after a charge depleting or charge sustaining test from the point where electricity is introduced from the battery charger to the battery; and
(e) Net DC amp-ills from the battery that was expended during the test (may be reported as the total DC amp-ills output and the total DC amp-ills input)

3.2 **Regenerative braking.** Regenerative braking systems may be utilized during the range test. The braking level, if adjustable, shall be set according to the manufacturer's specifications for normal driving conditions prior to the commencement of the test. The driving schedule speed and time tolerances specified in F.3.1 or F.3.2 shall not be exceeded due to the operation of the regenerative braking system.

3.3 **Measurement Accuracy.** The overall error in voltage and current recording instruments shall be NIST traceable and accurate to ± 1% of the maximum value of the variable being measured. Suggested equipment: amp meter/power meter capable of sampling voltage and current. Voltage and current shall be sampled at a minimum rate of 20 hz.

3.4 **Watt Hour Calculation.**

DC energy (watt hours) shall be calculated as follows

DC energy = ∫v(t) *i(t) dt
Where v = vehicle DC main battery pack voltage
i = vehicle DC main battery pack current

3.5 **Charger Requirements**

The standard charging apparatus (or equivalent) normally furnished with or specified for the vehicle shall be used for charging during vehicle testing.

**4. Determination of the Emissions of the Fuel-fired Heater.**

The exhaust emissions result of the fuel-fired heater shall be determined by operating at a maximum heating capacity with a cold start between 68°F and 86°F for a period of 20 minutes and dividing the grams of emissions by 20. The resulting grams per minute shall be multiplied by 3.0 minutes per mile to obtain a grams per mile value.

**5. Urban Test Provisions for Off-Vehicle Charge Capable Hybrid Electric Vehicles.**

Alternative procedures may be used if shown to yield equivalent results and if approved in advance by the Executive Officer of the Air Resources Board.

The criteria certification emissions for the Urban test shall be the worst case emissions of NMOG, CO, NOx, and PM from either the charge depleting or charge sustaining tests. The sum of NMOG + NOx emissions shall constitute the worst case for the charge sustaining or charge depleting modes of operation and determine the operation mode for US06 and SC03 emission tests.

Vehicles with more than one mode of operation for a given charge depleting or charge sustaining test cycle must be tested in the mode(s) which represents maximum operation of the auxiliary power unit. Confirmatory testing may also be performed in any mode of operation to ensure compliance with emission standards.

**5.1** Vehicle Preconditioning.

To be conducted pursuant to the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles" with the following supplemental. requirements:

5.1.1 For vehicles that do not allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at a level that causes the vehicle to operate the auxiliary power unit for the maximum possible cumulative amount of time during the preconditioning drive.

5.1.2 For vehicles that allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at the lowest level allowed by the manufacturer.

5.1.3 After setting battery state-of-charge, the vehicle shall be pushed or towed to a work area for the initial fuel drain and fill according to section III.D.l.4 of the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles."

5.1.4 Following the initial fuel drain and fill, the vehicle shall complete an initial soak period of a minimum of 6 hours. After completing the soak period, the vehicle shall be pushed or towed into position on a dynamometer and preconditioned. If the auxiliary power unit is capable of being manually activated, the auxiliary power unit shall be manually activated at the beginning of and operated throughout the preconditioning drive.

**5.2 Urban Dynamometer Procedure for Off-Vehicle Charge Capable Hybrid Electric Vehicles.**

To be conducted pursuant to 40 CFR &86.135-00 [October 22, 1996] with the following revisions. References to §86.11O-94 shall mean §86.11 0-94 as last amended June 30, 1995.

5.2.1 Amend subparagraph (a).

*Overview.* The dynamometer run shall consist of a series of charge depleting tests, after a second fuel drain and fill and a 12 to 36 hour soak period performed pursuant to the provisions of the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles." Each charge depleting test shall consist of one UDDS followed by a 10 minute hot soak period until charge sustaining operation is achieved for two consecutive UDDSs. Once charge sustaining operation is achieved over two consecutive UDDSs, or a single UDDS if data is provided showing that charge sustaining operation can consistently be maintained over one UDDS, the vehicle shall be turned off and stored at an ambienUemperature not less than 68°F (20°C) and not more than 86°F (30°C) for 12 to 36 houts. If the energy required to charge the vehicle from urban charge sustaining operation to full charge is not equivalent (within ± 1% of the AC energy) to the energy required to charge the vehicle from highway charge sustaining operation to full charge, the vehicle must be recharged. If the energy required to charge' the vehicle from urban charge sustaining operation to full charge is equivalent (within ± 1% of the AC energy) to the energy required to charge the vehicle from highway charge sustaining operation to full charge, the vehicle may be recharged. The vehicle must be turned off during recharging. At the end of this cold soak period, the vehicle shall be placed or pushed onto a dynamometer. Vehicle emissions shall be measured over two UDDSs during charge sustaining operation, each separated by a 10 minute key-off hot soak period. The vehicle must meet SOC criterion in section F.lO from the start of the first UDDS until the end of the second UDDS.

For all exhaust emission tests, the exhaust emissions are diluted with ambient air in the dilution tunnel as shown in Figure B94-5 and Figure B94-6 (§86.110-94). A dilution tunnel is not required for testing vehicles waived from the requirement to measure particulates. For UDDSs, particulate samples are collected on filters for weighing during each UDDS. Each sample plus backup is collected during each UDDS (including shutdown). Continuous proportional samples of gaseous emissions are collected for analysis during each UDDS. For vehicles with Otto-cycle auxiliary power units, the composite samples collected in bags are analyzed for THC, CO, $CO_2$, CH4 and $NO_x$. For vehicles with petroleum-fueled diesel-cycle auxiliary power units (optional for natural gas-fueled, liquefied petroleum gas-fueled, and alcohol-fueled diesel-cycle vehicles), THC is sampled and analyzed continuously pursuant to the provisions of §86.110-94. Parallel samples of the dilution air are similarly analyzed for THC, CO, $CO_2$, $CH_4$ and $NO_x$. For vehicles with natural.gas-fueled, liquefied petroleum gas-fueled, and alcohol-fueled auxiliary power units, bag samples are collected and analyzed for THC (if not sampled continuously), CO, $CO_2$, CH4 and $NO_x$. For vehicles with alcohol-fueled auxiliary power units, alcohol and formaldehyde samples are taken for both exhaust emissions and dilution air (a single dilution air formaldehyde sample, covering the total test period may be collected). Parallel bag samples of dilution air are analyzed for THC, CO, $CO_2$, CH4 and $NO_x$.

5.2.2 Subparagraphs (b) through (c). [No change.]

5.2.3 Delete subparagraph (d).

5.2.4 Subparagraphs (e) through (g). [No change.]

5.2.5 Amend subparagraph (h): The driving distance, as measured by counting the number of dynamometer roll or shaftrevolutions, shall be determined for all charge depleting and exhaust emission tests. The revolutions shall be measured on the same roll or shaft used for measuring the vehicle's speed.

5.2.6 Subparagraph en. [No change.]

**5.3 Urban Dynamometer Test Run, Gaseous and Particulate Emis'sions for Off-Vehicle Charge Capable Hybrid Electric Vehicles.**

To be conducted pursuant to 40 CFR &86.137-96 [March 24,1993] with the following revisions:

5.3.1 Amend subparagraph (a): *General.* The dynamometer run shall consist of a series ofUDDSs, after a second fuel drain and fill and a 12 to 36 hour soak period performed pursuant to the provisions of the "California Evaporative Emission Standards .and Test Procedures for 2001 and Subsequent Model Motor Vehicles." The vehicle shall be stored prior to the emission test in such a manner that precipitation (e.g., rain or dew) does not occur on the vehicle. The vehicle is allowed to stand on the dynamometer during the 10 minute time period between each UDDS.

5.3.2 Amend subparagraph (b) as follows.

5.3.2.1 Amend subparagraph (bX9): Start the gas flow measuring device, direct the sample flow into the exhaust sample bag, the alcohol exhaust sample, the formaldehyde exhaust sample, the dilution air sample bag, the alcohol dilution air sample and the formaldehyde dilution air sample, and turn the key on. If the auxiliary power unit is capable of being manually activated, the auxiliary power unit shall be activated at the beginning of and operated throughout the UDDS.

5.3.2.2 Delete subparagraph (b)(13).

5.3.2.3 Subparagraph (bX14). [No change.]

5.3.2.4 Amend subparagraph (b)05): Five seconds after the' vehicle is shutdown, simultaneously turn offthe gas flow measuring device and particulate sample pump. Record the measured roll or shaft revolutions (both gas meter or flow measurement instrumentation readings), and reset the counter. As soon as possible, transfer the exhaust and dilution air samples to the analytical system and process the samples pursuantto &86.140, obtaining a stabilized reading of the exhaust bag sample on all analyzers within 20 minutes of the end of the sample collection phase of the UDDS. Obtain alcohol and formaldehyde sample analyses, if applicable, within 24 hours of the end of the sample period. (If it is not possible to perform analysis on the alcohol and formaldehyde samples within 24 hours, the samples should be stored in a dark cold (4DC to lODC) environment until analysis. The samples should be analyzed within fourteen days.) If applicable, carefully remove both pairs of particulate sample filters from their respective holders, and place each in a separate petri dish, and cover.

5.3.2.5 Amend subparagraph (b)(18): Repeat the steps in paragraphs (b)(2) through (b)07) of this section for the hot start UDDS. The



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steps in paragraph (b)(9) of this section shall begin between 9 and 11 minutes after the end of the sample period for the cold start UDDS.

5.3.2.6 Delete subparagraph (b)(19).

5.3.2.7 Delete subparagraph (b)(20).

5.3.2.8 Amend subparagraph (b)(2l): As soon as possible, transfer the particulate filters to the weighing chamber for post-test conditioning, if applicable; For vehicles undergoing a cold start charge sustaining test, a valid test shall satisfy the SOC criterion in section F.lO.

5.3.2.9 Amend subparagraph (b)(24): Vehicles to be tested for evaporative emissions will proceed pursuant to the "California Evaporative Emission Standards and Test Procedures for 200I and Subsequent Model Motor Vehicles."

**5.4 Determination of Urban All-Electric Range and Urban Equivalent AlI-Electric Range for Off-Vehicle Charge Capable Hybrid Electric Vehicles.**

5.4.1 The **Urban All-Electric Range** shall be shall be defined as the distance that the vehicle is driven from the start of Urban Charge Depleting Range Test until the internal combustion engine first starts.

5.4.2 **Cold soak and vehicle charging.** The vehicle shall be stored at an ambient temperature not less than 68°F (20°C) and not more than 86°F (30°C) for 12 to 36 hours. During this time, the vehicle's battery shall be charged toa full state-of-charge. The vehicle must be turned off during charging. Charge time shall not exceed soak time.

5.4.3 **Urban Charge Depleting Range Test.** At the end of the coldsoak period, the vehicle shall be placed or pushed, onto a dynamometer and operated through the Continuous Urban Test Schedule until the SOC Net Change Tolerances (specified in section F.lO of these test procedures) that indicate charge sustaining operation are met for two consecutive UDDSs, or a single UDnS if data is provided showing that charge sustaining operation can consistently be maintained in one UDDS. The Alternative Continuous Urban Test Schedule may be substituted for the Continuous Urban Test Schedule if the test facility is unable to perform the Continuous Urban Test Schedule. Refer to sections F.5.5, F.5.6, and F.1l, for calculations of urban exhaust emissions, urban particulate emissions, and equivalent all-electric range, respectively.

5.4.4 **Urban Charge Sustaining Emission Test.** The Urban Charge Sustaining Emission Test is conducted cold, and after charge sustaining operation has been reached, or an optional charge sustaining test mode has been activated, and no subsequent charge has been performed.

0) Cold soak: The vehicle shall be stored at an ambient temperature not less than 68 °F (20 °C) and not more than 86°F OOGC) for 12 to 36 hours.

(m At the end of the cold soak period, the vehicle shall be placed or pushed onto a dynamometer, and two UDDSs shall be performed during charge sustaining operation, each separated by a 10 minute key-off hot soak period. The vehicle must meet the SOC criterion in section P.1 0 from the start of the first UDDS until the end of the second UDDS. If the SOC criterion is not satisfied, the test shall be stopped, the vehicle cold soak shall be conducted again, and the dynamometer test .run shall be conducted again.

**5.5 Calculations - Urban Exhaust Emissions for** Off-Vehicle Charge **Capable Hybrid Electric Vehicles.**

To be conducted pursuant to 40 CPR §86.144-94 [July 13, 2005J with the following revisions:

5.5.1 Amend subparagraph (a):

Gaseous Emissions - Urban Charge Depleting Range Test.

For light-duty vehicles and light duty trucks:

$$Y_{wm} = 0.43*\left(\frac{Y_c}{D_c}\right) + 0.57*\left(\frac{\Sigma Y_n}{\Sigma D_n}\right)$$

Where:

$Y_{wm}$ = Weighted mass emissions of each pollutant, i.e., THC, CO, THCE, NMOG, NMHCE, $CH_4$, NOx, or C02, in grams per vehicle mile.

$Y_c$ = Mass emissions as calculated from the cold start UDDS, in grams per test.

Dc = The measUred driving distance from the cold start UDDS, in miles.

n number of hot start UDDSs in Charge Depleting operation

Gaseous Emissions -Urban Charge Sustaining Emission Test.

For light-duty vehicles and light-duty trucks:

$$Y_{wm} = 0.43 * \left(\frac{Y_c}{D_c}\right) + 0.57 * \left(\frac{Y_h}{D_h}\right)$$

Where:

$Y_{wm}$ = Weighted mass emissions of each pollutant, i.e., THC, CO, THCE, NMOG, NMHCE, $CH_4$, $NO_x$, orCO?, in grams per vehicle mile.

$Y_c$ Mass emissions as calculated from the cold start UDDS, in grams per test.

$Y_h$ = Mass emissions as calculated from the hot start UDDS, in grams pertest.
$D_c$ = The measured driving distance from the cold start UDDS, in miles.
$D_h$ The measured driving distance from the hot start UDDS, in miles.

5.5.2 Subparagraphs (b) through (e). [No change.)

**5.6 Calculations - Urban Particulate Emissions for Off-Vehicle. Charge Capable Hybrid.Electric Vehicles.**

To be conducted pursuant to 40 CFR §86.145-82 [November 2, 1982] with the following revisions. References to &86.110-94 shall mean &86.110-94 as last amended June 30, 1995.

5.6.1 Amend subparagraph (a):

Particulate Emissions - Urban Charge Depleting Range Test.

The final reported test results for the mass particulate ($M_p$) in grams/mile shall be computed as follows:

$$M_p = 0.43 * \left[\frac{M_{pc}}{D_c}\right] + 0.57 * \left(\frac{\Sigma M_{pn}}{\Sigma D_n}\right]$$

Where:
$M_{pc}$ = Mass of particulate determined from the cold start UDDS, in grams per vehicle mile. (See §86.110-94 for determination.)
Dc: The measured driving distance from the cold start UDDS, in miles.
n number of hot start UDDSs in Charge Depleting operation

Particufate Emissions - Urban Charge Sustaining Emission Test.

The final reported test results for the mass particulate ($M_p$) in grams/mile shall be computed as follows:

$$M_p = 0.43 * \left(\frac{M_{pc}}{D_c}\right) \pm 0.57 * \left(\frac{M_{ph}}{D_h}\right)$$

Where:
$M_{pc}$ = Mass of particulate determined from the cold start UDDS, in grams per vehicle mile. (See §86.11 0-94 for determination.)
$M_{ph}$ Mass of particulate determined from the hot start UDDS, in grams per vehicle mile. (See §86.11 0-94 for determination.)
Dc = The measured driving distance from the cold start UDDS, in miles.

$\underline{D}_h$ The measured driving distance from the hot start UDDS, in miles.

5.6.2 Subparagraph (b). [No change.]

5.6.3 **Equivalent All-Electric Range** shall be calculated in accordance with section P.11 of these test procedures.

**6. Highway Test Provisions for Off-Vehicle Charge Capable Hybrid Electric Vehicles.**

The third HPEDS of the Highway Charge Sustaining Test shall be used to calculate highway NOx emissions and must be within the SOC criterion in section *P.10.* As an option, the Highway Charge Sustaining Test may be performed with two HPEDS provided that the second HFEDS meets the SOCcriterion in section *P.10.* In this case, the second HPEDS shall be used to calculate emissions.

Vehicles with more than one mode of operation for a given charge depleting or charge sustaining test cycle must be tested in the mode(s) which represents maximum operation of the auxiliary power unit. Confirmatory testing may also be performed in any mode of operation to ensure compliance with emission standards.

**6.1 Vehicle Preconditioning.**

If the Highway Charge Depleting Range Test is performed within 36 hours after completion of either the Urban Charge Depleting Range Test or the Urban Charge Sustaining Range Test, no preconditioning is necessary. If the Highway Charge Depleting Range Test is performed more than 36 hours after completion of either the Urban Charge Depleting Range Test or the Urban Charge Sustaining Range Test, the manufacturer shall precondition the vehicle pursuant to section F.5.1 of these test procedures, without loading the evaporative canister.

**6.2 Highway <u>Dynamometer</u> Procedure for <u>Off-</u>Vehicle Charge Capable Hybrid· Electric Vehicles;**

To be conducted pursuant to 40 CPR §600.111-08 [December 27,2006] with the following revisions. This section *P.6.2* shall apply during both charge sustaining and charge depleting operation.

6.2.1 Subparagraph (a). [n/a]

6.2.2 Amend subparagraph (b) as follows: .

6.2.2.1 Amend subparagraph (b)(2): The highway fuel economy test is designated to simulate non-metropolitan driving with an average speed of 48.6 mph and a maximum speed of 60 mph. The cycle is 10.2 miles long with 0.2 stop per mile and consists of warmed-up vehicle operation on a chassis dynamometer through a specified driving cycle. A proportional part ofthe diluted exhaust emission is collected continuously for subsequent analysis ofTHC, CO, $CO_2$, and $NO_x$ using a constant volume (variable dilution) sampler. Diesel dilute exhaust is continuously analyzed for hydrocarbons using a heated sample line and analyzer. Alcohol and formaldehyde samples are collected and individually analyzed for alcohol-fueled vehicles.

6.2.2.2 Replace subparagraph (b)(6) with: Cold soak: The vehicle shall be stored at an ambient temperature not less than 68°F (20°C) and not more than 86°F (30°C) for 12 to 36 hours. At the end of the cold soak period, the vehicle shall be placed, either driven or pushed onto a dynamometer.

6.2.2.3 Amend subparagraph (b)(7)(i): The Highway Charge Sustaining Emission Test is conducted cold, and after charge sustaining operation has been reached, or an optional charge sustaining test mode has been activated, and no subsequent charge has been performed.

Three HFEDSs, separated by a 15 second key-on hot soak period, shall be performed. The vehicle must meet the SOC criterion in section F.10 for the third HFEDS. If the SOC criterion is not satisfied, the test shall be stopped, and sections F.6.2.2.2 and this section F.6.2.2.3 shall be repeated. As an option, two HFEDSs may be performed in lieu of three HFEDSs if the SOC criterion is satisfied for the second HFEDS. Emissions shall be measured for all HFEDSs.

6.2.2.4 Amend subparagraph (b)(7)(iii): One exhaust sample and one background sample per each HFEDS shall be collected and analyzed for THC (except diesel hydrocarbons which are analyzed continuously), CO, $CO_2$, and $NO_x$. Alcohol and formaldehyde samples (exhaust and dilution air) are collected and analyzed for alcohol-fueled vehicles.

6.2.2.5 Add subparagraph (b)(7)(v):For vehicles that do not allow manual activation of the auxiliary power unit, battery-state-of-charge shall be set at a level that causes the vehicle to operate the auxiliary power unit for the maximum possible cumulative amount oftime during the HFEDS preconditioning cycle. For vehicles that_ allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at the lowest level allowed by the manufacturer.

6.2.2.6 Amend subparagraph (b)(9)(v): Operate the vehicle over the continuous highway test schedule, consisting of repeated HFEDSs according to the dynamometer driving schedule specified in §600.109-08(b) [December 27,20061. If the auxiliary power unit is capable of being manually activated, the auxiliary power unit shall be manually activated at the beginning of and operated throughout the HFEDS preconditioning cycle.

6.2.2.7 Amend subparagraph (b)(9)(vi): When the vehicle reaches zero speed between each HFEDS, the driver has 17 seconds to prepare for the HFEDS emission measurement cycle of the test. During the idle period, one of the following conditions shall apply:

(a) For vehicles that do not allow the auxiliary power unit to be manually activated, the vehicle shall remain turned on during the idle period.

(b) For vehicles that allow the auxiliary power unit to be manually activated, the vehicle shall remain turned on with the auxiliary power unit operating during the idle period.

6.2.2.8 Add subparagraph (b)(9)(viii): At the conclusion of the HFEDS emission test, the following conditions shall apply: For vehicles that do not allow the auxiliary power unit to be manually activated and are charge-sustaining over the HFEDS, record the battery state-of-charge to determine if the SOC criterion in section F.10 is satisfied. If the SOC criterion is not satisfied, then repeat dynamometer test run from subparagraph (h)(6). Up to two highway emission tests shall be allowed to satisfy the SOC criterion.

6.2.2.9 Delete subparagraph (b)(10).

6.2.3 Delete subparagraphs (c) through (e).

**6.3 Determination of Highway All-Electric Range and Highway Equivalent All-Electric Range for Off-Vehicle Charge Capable Hybrid Electric Vehicles.**

6.3.1 The **Highway All-Electric Range** shall be defined as the distance that the vehicle is driven from the start of test until the internal combustion engine starts.

6.3.2 **Cold soak and vehicle charging.** The vehicle shall be stored at an ambient temperature not less than 68°F (20°C) and not more than 86°F (30°C) for 12 to 36 hours. During this time, the vehicle's battery shall be charged to a full state-of-charge. Charge time shall not exceed soak time.

6.3.3 **Highway Charge Depleting Range Test.** At the end of the cold soak period, the vehicle shall be placed or pushed, onto a dynamometer and operated through the Continuous Highway Test Schedule until the State-of-Charge Net Change Tolerances (specified in section F.10 of these test procedures) that indicate charge sustaining operation is met for one HFEDS. The Alternative Continuous Highway Test Schedule may be substituted for the Continuous Highway Test Schedule if the test facility is unable to perform the Continuous Highway Test Schedule. Refer to sections F.6.3.4, and F.11, for calculations of highway exhaust emissions and equivalent all-electric range, respectively.

If the energy required to charge the vehicle from highway charge sustaining operation to full charge is not equivalent (within ± 1% of the AC energy) to the energy required to charge the vehicle from urban charge sustaining operation to full charge, repeat subparagraphs F.6.2.2 and

F.6.2.3. Battery charging in F.6.3.2 shall by begin within one hour of the end of the Highway Charge Depleting Range Test.

6.3.4 **Highway Charge Sustaining Emission Test.** The Highway Charge Sustaining Emission Test is conducted cold, and after charge sustaining operation has been reached, or an optional charge sustaining test mode has been activated, and no subsequent charge has been performed:

(i) **Cold soak:** The vehicle shall be stored at an ambient temperature not less than 68°F (20°C) and not more than 86°F (30°C) for 12 to 36 hours.

(ii) At the end of the cold soak period, the vehicle shall be placed or pushed onto a dynamometer. Three HFEDSs, separated by a 15 second key-on hot soak period, shall be performed. The vehicle must meet the SOC criterion in section F.10 for the third HFEDS. If the SOC criterion is not satisfied, the test shall be stopped, and sections F.6.3.2, F.6.3.3, and this section F.6.3.4 shall be repeated. As an option, two HFEDSs may be performed in lieu of three HFEDSs if the SOC criterion is satisfied for the second HFEDS. Emissions shall be measured for all HFEDSs.

6.3.5 **Equivalent All-Electric Range** shall be calculated in accordance with section F.11 of these test procedures.

## 7. SFTP Emission Test Provisions for Off-Vehicle Charge Capable Hybrid Electric Vehicles.

Hybrid electric vehicles with more than one mode of operation for a given charge depleting or charge sustaining test cycle must be tested in the mode(s) which represents maximum operation of the auxiliary power unit. Confirmatory testing may also be performed in any mode of operation to ensure compliance with emission standards.

### 7.1 US06 Vehicle Preconditioning.

To be conducted pursuant to 40 CFR §86.132-00 [October 22, 1996] with the following revisions. This section 7.1 shall apply during charge sustaining operation or at an optional charge sustaining test mode that has been activated, if no subsequent charge has been performed.

7.1.1 Subparagraphs (a) through (m). [No change.]

7.1.2 Amend subparagraph (n) *Aggressive Driving Test (US06) Preconditioning.* as follows:

7.1.2.1 Amend subparagraph (1) as follows: If the US06 test follows the exhaust emission urban, highway, or evaporative testing, the refueling step may be deleted and the vehicle may be preconditioned using the fuel remaining in the tank (see paragraph (c)(2)(ii) of this section). The test vehicle may be pushed or driven onto the test dynamometer. For vehicles that allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at the lowest level allowed by the manufacturer. The auxiliary power unit shall be manually activated at the beginning of and operated throughout the US06 preconditioning cycle.

7.1.2.1.1 Delete subparagraphs (i) and (ii).

7.1.2.1.2 Subparagraphs (iii) through (iv). [No change.]

7.1.2.2 Subparagraph (2). [No change.]

7.1.3 Subparagraph (0). [No change.]

**7.2 US06 Emission Test.**

To be conducted pursuant to 40 CFR §86.159-08 [December 27,2006] with the following revisions. This section 7.2 shall apply during charge sustaining operation or at an optional charge sustaining test mode that has been activated, if no subsequent charge has been performed.

7.2.1 Amend subparagraph (a): *Overview.* The dynamometer operation consists of a single, 600 second test on the US06 driving schedule, as described in appendix 1, paragraph (g), or this part. The vehicle is preconditioned in accordance with §86.132-00, to bring it to a warmed-up stabilized condition. This preconditioning is followed by a 1 to 2 minute idle period that proceeds directly into the US06 driving schedule during which continuous proportional samples of gaseous emissions are collected for analysis. If engine stalling should occur during testing, follow the provisions of §86.136-90 (engine starting and restarting). For vehicles with Otto-cycle auxiliary power units, the composite samples collected in bags are analyzed for THC, CO, $CO_2$, $CH_4$ and $NO_x$. For vehicles with diesel-cycle auxiliary power units, THC is sampled and analyzed continuously according to the provisions of §86.110. Parallel bag samples of dilution air are analyzed for THC, CO, $CO_2$, $CH_4$ and $NO_x$. The second US06 (the cycle after preconditioning) shall be used to calculate emissions and shall be within the state-or-charge net tolerances as calculated in section F.10.

7.2.2 Amend subparagraph (b) as follows.

7.2.2.1 Amend subparagraph (b)(2): Position the test vehicle on the dynamometer and restrain.

7.2.3 Subparagraph (c). [No change.]

7.2.4 Amend subparagraph Cd): Practice runs over the prescribed driving schedule may be performed at test point to permit sampling system adjustment.

7.2.5 Subparagraph Ce). [Nochange.1

7.2.6 Amend subparagraph CD as follows.

7.2.6.1 Amend subparagraph (f)C2)Ci): Immediately after completion of the US06 preconditioning cycle, idle the vehicle. The idle period is not to be less than one minute or not greater than two minutes. During the idle period, one of the following conditions shall apply:

(i) For vehicles that do not allow the auxiliary power unit to be manually activated and are charge-sustaining over the US06, the vehicle shall remain on during the idle period. The battery state-of-charge shall be recorded after the vehicle has started idle.

(ii)· For vehicles that allow the auxiliary power unit to be manually activated, the vehicle shall remain turned on with the auxiliary power unit operating during the idle period.

7.2.6.2 Amend subparagraph (D(2)(ix): For vehicles that do not allow manual activation of the auxiliary power unit and are charge-sustaining over the US06, determine if the SOC criterion in section F.1 0 is satisfied at the end of the US06 emission test. If the SOC criterion is not satisfied, then repeat dynamometer test run from subparagraph (D(2)(i). Up to two US06 emission tests shall be allowed to satisfy the SOC criterion.

**7.3 Se03 Vehicle Preconditioning.**

To be conducted pursuant to 40 CFR §86.132-00 [October 22, 19961 with the following revisions. This section 7.3 shall apply during charge sustaining operation or at an optional charge sustaining test mode that has been activated, if no subsequent charge has been performed.

7.3.1 Subparagraphs (a)through (n). [No change.]

7.3.2 Amend subparagraph (0): *Air Conditioning Test (Sea3) Preconditioning.*

7.3.2.1 Amend subparagraph (1) as follows: If the SCm test follows the exhaust emission urban, highway, or evaporative testing, the refueling step may be deleted and the vehicle may be preconditioned using the fuel remaining in the tank (see paragraph (c)(2)(ii) of this section). The test vehicle may be pushed or driven onto the test dynamometer. For vehicles that allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at the lowest level allowed by the manufacturer. The auxiliary power unit shall be manually activated at the beginning of and operated throughout the SCM preconditioning cycle.

7.3.2.1 J Delete subparagraphs (i) and (ii).

7.3.2.2 Subparagraphs (2) through (3). INo change.]

**7.4 SC03.Emission·Test.**

To be conducted pursuant to 40 CFR §86.160-00 [December 8, 2005] with the following revisions. This section 7.4 shall apply during charge sustaining operation or at an optional charge sustaining test mode that has been activated, if no subsequent charge has been performed. References to §86.162-03 shall mean §86.162-03 as adopted October 22, 1996.

7.4.1 Amend subparagraph (a): *Overview."* The dynamometer operation consists of a single, 594 second test on the Se03 driving schedule, as described in appendix 1, paragraph (h), of this part. The vehicle is preconditioned in accordance with §86.132-00 of this subpart, to bring the vehicle to a warmed-up stabilized condition. This preconditioning is followed by a 10 minute vehicle soak (vehicle turned off) that proceeds directly into the SCM driving schedule, during which continuous proportional samples of gaseous emissions are collected for analysis. The entire test, including the SC03 preconditioning cycle, vehicle soak, and SC03 emission test, is either conducted in an environmental test facility or under test conditions that simulate testing in an environmental test cell (see §86.162-03 (a) for a discussion of simulation procedure approvals). The environmental test facility must be capable of providing the following nominal ambient test conditions of: 95°F air temperature, 100 grains of water/pound of dry air (approximately 40 percent relative humidity), a solar heat load intensity of 850 $W/m^2$, and vehicle cooling air flow proportional to vehicle speed. Section 86.161-00 discusses the minimum facility requirements and corresponding control tolerances for air conditioning ambient test conditions. The vehicle's air conditioner is operated or appropriately simulated for the duration of the test procedure (except for the 10 minute vehicle soak), including the preconditioning. If engine stalling should occur during testing, follow the provisions of §86.136-90 (engine starting and restarting). For vehicles with Otto-cycle auxiliary power units, the composite samples collected in bags'are analyzed for THC, CO, $CO_2$, $CH_4$ and $NO_x$. For vehicles with diesel-cycle auxiliary power units, THC is sampled and analyzed continuously according to the provisions of §86.l10. Parallel bag samples of dilution "air are analyzed for THC, CO, C02, $CH_4$ and $NO_x$. The second SC03 (the cycle after preconditioning) shall be used to'calculate emissions and shall be within the state'-of-charge net tolerances as calculated in section F.10.

7.4.2 Amend subparagraph (b) as follows.

7.4.2.1 Amend subparagraph (b)(2): Position the test vehicle on the dynamometer and restrain.

7.4.3 Amend subparagraph (c) as follows.

7.4.3.1 Amend subparagraph (c)(8): Add the following: Immediately after completion of the SC03 preconditioning cycle, idle the vehicle. The idle period shall not be less than one minute and not greater than two minutes. During the idle period, one of the following conditions shall apply:

(i) For vehicles that do not allow the auxiliary power unit to be manually activated and are charge-sustaining over the SC03, the vehicle shall remain on during the idle period. The battery state-of-charge shall be recorded after the vehicle has started idle.

(m For vehicles that allow the auxiliary power unit to be manually activated, the vehicle shall remain turned on with the auxiliary power unit operating during the idle period.

7.4.3.2 Amend subparagraph (c)(9): Start vehicle (with air conditioning system also running). If the auxiliary power unit of the vehicle is capable of being manually activated, the auxiliary power unit shall be manually activated at the beginning of and operated throughout the SC03 emission test. Fifteen seconds after the vehicle starts, begin the initiaJ vehicle acceleration of the driving schedule.

7.4.4 Amend subparagraph (d) as follows.

7.4.4.1 Amend subparagraph (d)(lO): For vehicles that do not allow the auxiliary power unit to be manually activated and are charge-sustaining over the SC03, determine if the SOC criterion in section *P.1* 0 is satisfied at the end of the SC03 emission test If the sOC criterion is not satisfied, then turn off cooling fanes), aliowvehicle to soak in the ambient conditions of paragraph (c)(5) of this section for 10 minutes, and repeat dynamometer test run from subparagraph (d). A total of two SC03 emission tests shall be attempted to satisfy the SOC criterion.

7.4.5 Subparagraph (e). [No change.]

**7.5 Optional Cold Start US06 Range Test.**

7.5.1 **Cold soak and vehicle charging.** The vehicle shall be stored at an ambient temperature not less than 68°p (20°C) and not more than 86°p (30°C) for 12 to 36 hours. During this time, the vehicle battery shall be charged to a full state-of-charge. The vehicle must be turned off during charging. Charge time shall not exceed soak time.

7.5.2 At the end of the cold soak period, the vehicle shall be placed or pushed onto a dynamometer, and shall be driven on a continuous US06 test cycle until either:

(a) the auxiliary power unit starts, or

(b) the vehicle can no longer meet the speed trace limits of the US06 driving schedule as specified in CFR 86 Appendix I to within 2 mph higher than the highest point on the trace within 1 second for the upper limit or within 2 mph higher than the lowest point on the trace within 1 second for the lower limit.

The instant either of these conditions are met the test shall be ended. The range for this test, in miles, shall be the distant driven from the start of the test to when condition fa) or fb) is met. Emission sampling is not required for this test.

**8. 50°F and 20°F Test Provision for Off.Vehicle Charge Capable Hybrid Electric Vehicles.**

8.1 To satisfy test requirements for the 50°F emission test, the vehicle shall be tested in the worst case (NMHC + NOx) of the urban charge sustaining range test or urban charge sustaining test as defined in section F.5. To satisfy test requirements for the 20°F emission test, the vehicle shall be tested in the worst case (CO) of the urban charge sustaining range test or urban charge sustaining test as defined in section F.5. For the 20°F and 50°F emission tests, the vehicle is not required to meet SOC net tolerances.

8.2 If the worst case for emissions is charge sustaining operation, the vehicle shall be preconditioned according to section F.5.1. There are two emission test options.

en A three phase test that includes phase one as the first 505 seconds of the UDDS, phase two as 506 seconds to the end of the UDDS, a 10 minute key-off soak period, and phase three the first 505 seconds of the UDDS. The first two phases test shall be counted as the first UDDS and the second and third phases will constitute the second UDDS. Emission weighting is as follows:

$$Y_{wm} = 0.43 * \left( \frac{Y_1 + Y_2}{D_1 + D_2} \right) + 0.57 * \left( \frac{Y_2 + Y_3}{D_2 + D_3} \right)$$

Where:

$Y_{wm}$ = Weighted mass emissions of each pollutant, i.e., THC, CO, THCE, NMOG, NMHCE, $CH_4$, $NO_x$, or C02, in grams per vehicle mile.

$Y_1$ = Mass emissions as calculated from phase one of the three phase test.

$Y_2$ = Mass emissions as calculated from phase two of the three phase test.

$Y_3$ = Mass emissions as calculated from phase three of the three phase test.



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$D_1$ = The measured driving distance from phase one of the three phase tests, in miles.

$D_2$ = The measured driving distance from phase two of the three phase testS, in miles.

$D_3$ = The measured driving distance from phase three of the three phase tests, in miles.

(ii) A two phase test that includes phase one as a UDDS, a 10 minute key-off soak period, and phase two as a UDDS. Emission weighting for the four phase test will follow the procedure outlined in section F.5.5.1.

8.3 If measurement of worst case emissions requires the urban charge depleting range test to be performed, the vehicle shall be preconditioned according to section F.5.1 and fully charged. The continuous urban test schedule shall then be performed. The UDDS, in which the auxiliary power unit first starts, shall be the cold UDDS. Emissions shall be sampled according to one of the options in section F.8.2. For the three phase test option, if the auxiliary power unit starts in phase two of the UDDS, phase one emissions are considered zero for emission calculation purposes. Emissions are weighted according to section F.8.2.

**9. AdditionarProvisions.**

9.1 Confirmatory testing may be performed on all tests to establish if higher emissions occur at different states-of-charge in charge depleting mode. This is to ensure that cold start and other emissions standards are not exceeded at other operating sacs.

9.2 Confirmatory testing may be performed on the US06 test or the manufacturer may provide data to show that potential cold start off-cycle emissions are controlled to the extent that they are controlled for the UDDS.

9.3 Confirmatory testing may be performed on vehicles equipped with an optional charge sustaining operation mode selector with selector set to simulate charge sustaining operation or in actual charge sustaining operation in accordance with section F of these test procedures.

9.4 A period of up to'three hours may be used to initiate charge on the vehicle after either the urban or highway charge depleting range tests are completed.

9.5 Highway NOx emissions may be determined from the HFEDS in the Highway Charge Depleting Range Test that demonstrates charge sustaining operation.

9.6 If data can be provided to show that the AC energy required to fully charge the vehicle following the urban charge depleting range test is greater than the AC energy required to recharge the vehicle after the highway charge depleting range test, then the measured AC energy required to recharge the vehicle following the urban charge depleting range test may be used to calculate the Highway Equivalent All-Electric Range Energy Consumption, in section F.11.7.

9.7 For an example of an off-vehicle charge capable hybtidelectric vehicle with all-electric range and blended operation that has charge depleting actual range and charge depleting cycle range, please see section H, Figure 1.

9.8 For an example of charge depleting to charge sustaining range with and without transitional range and end of test conditions, please see section H, Figure 2.

**10. State-or-Charge Net Change Tolerances.**

10.1 For vehicles that use a battery as an energy storage device, the following state-of-charge net change tolerance shall apply:

$$(\text{Amp-hr}_{final})_{max} = (\text{Amp-hr}_{initial}) + 0.01 * \frac{(NHV_{fuel} * m_{fuel})}{V_{system} * K1}$$

$$(\text{Amp-hr}_{final})_{min} = (\text{Amp-hr}_{initial}) - 0.01 * \frac{(NHV_{fuel} * m_{fuel})}{V_{system} * K1}$$

Where:

| | | |
|---|---|---|
| $(\text{Amp-hr}_{final})_{max}$ | = | Maximum allowed Amp-hr stored in battery at the end of the test |
| $(\text{Amp-hr}_{final})_{min}$ | = | Minimum allowed Amp-hr stored in battery at the end of the test |
| $(\text{Amp-hr}_{initial})$ | | Battery Amp-hr stored at the beginning of the test |
| $NHV_{fuel}$ | = | Net heating value of consumable fuel, in Joules/kg |
| $m_{fuel}$ | | Total mass of fuel consumed during test, in kg |
| K1 | = | Conversion factor, 3600 seconds/hour |
| $V_{system}$ | = | Average charge sustaining battery DC bus voltage (open circuit) during charge sustaining operation. This value shall be submitted for testing purposes, and it shall be subject to confirmation by the Air Resources Board. |

An alternate state-of-charge net tolerance may be used if shown to be technically necessary and if approved in advance by the Executive Officer of the Air Resources Board.

10.2 For vehicles that use a capacitor as an energy storage.device, the following state-of-charge net change tolerance shall apply:

$$(V_{final})_{max} = \sqrt{V_{initial}^2 + 0.01 * \frac{2 * NHV_{fuel} * m_{fuel}}{C}}$$

$$(V_{final})_{min} = V_{initial}^2 - 0.01 * \frac{2 * NHV_{fuel} * m_{fuel}}{C}$$

Where:

| | | |
|---|---|---|
| $(V_{final})_{max}$ | = | The stored capacitor voltage allowed at the end of the test |
| $(V_{final})_{min}$ | = | The stored capacitor voltage allowed at the end of the test |
| $V_{initial}^2$ | = | The sguare of the capacitor voltage stored at the beginning of the test |
| NHVfuel-I | | Net heating value of consumable fuel, in Joules/kg |
| mfuel!- | = | Total mass of fuel consumed during test, in kg |
| C | | Rated capacitance of the capacitor, in Farads |

10.3 For vehicles that use an electro-mechanical flywheel as an energy storage device, the following state-of-charge net cliange tolerance shall apply:

$$(rpm_{final})_{max} = \sqrt{rpm_{initial}^2 + 0.01 * \frac{(2 * NHV_{fuel} * m_{fuel})}{I * K_3}}$$

$$(rpm_{final})_{min} = rpm_{initial}^2 - 0.01 * \frac{2 * NHV_{fuel} * m_{fuel}}{I * K_3}$$

Where:

| | | |
|---|---|---|
| $(rpm_{final})_{max}$ | = | The maximum flywheel rotational speed allowed at the end of the test |
| $(rpm_{final})_{min}$ | | The minimum flywheel rotational speed allowed at the end of the test |
| $rpm_{initial}^2$ | = | The squared flywheel rotational speed at the beginning of the test. |
| NHVfuel-I | | Net heating value of consumable fuel, in Joules/kg |
| $m_{fuel}$ | | Total mass of fuel consumed during test, in kg |
| $K_3$ | | Conversion factor, $\frac{4\pi^2}{3600 \sec^2 - rpm^2}$ |
| I | | Rated moment of inertia of the flywheel, in kg_m$^2$ |

**11. Calculations - Equivalent All-Electric Range for Off-Vehicle Charge Capable Hybrid Electric Vehicles.**

11.1 Charge Depleting $CO_2$ Produced means the cumulative tailpipe CO2 emissions produced, Merl, in grams per mile during the charge depleting cycle range.

$$M_{cd} = \Sigma Y_i$$

where:

Vi = The sum of the C02 grams per mile in the charge depleting mode from each test cycle (UDDS or HFEDS)

i Number (UDDS or HFEDS) of the test over the charge depleting cycle ninge, $R_{cdc}$

11.2 Charge Sustaining CO2 Produced - urban means the cumulative tailpipe CO2 emissions produced, $M_{es}$, in grams per mile, during the cold start charge sustaining urban test.

$$M_{cs} = Y_c + Y_h * [(R_{CdCU} - D_c) / D_c]$$

11.3 Charge Sustaining CO2 Produced - highway means the grams per mile tailpipe CO2·emissions produced, $M_{es}$, during the cold start charge sustaining highway test.

$$M_{cs} = (R_{CdCh} / D_h) * y_h$$

where:

$R_{cdch}$ = Highway Charge Depleting Cycle Range, in miles

$D_h$ = The measured driving distance from the hot start HFEDS, in miles

$Y_h$ Grams per mile emissions as calculated from the hot start HFEDS

11.4 Urban Equivalent All-Electric Range ($EAER_u$) Shall be calculated as follows:

$$EAER_u = ((Mcs - Mcd) / M_{cs}) * R_{cdcu}$$

where:
$M_{cs}$ and $M_{cd}$ are the sum of the grams per mile of tailpipe $CO_2$ emissions accumulated over the urban charge depleting cycle range, $R_{cdcu}$ (mi).

11.5 Highway Equivalent All-Electric Range (EAERh) shall be calculated as follows:

$$EAER_h = \left[\frac{M_{cs} - M_{cd}}{M_{cs}}\right] * R_{cdch}$$

where:

$M_{cs}$ and $M_{cd}$ are the grams per mile of $CO_2$ emissions accumulated over the highway charge depleting cycle range, $R_{cdch}$ (mi).

$$M_{cd} = \Sigma Y_i$$

Vi = The sum of the $CO_2$ grams per mile in the charge depleting mode from each test cycle (UDDS or HFEDS)

i = Number HFEDS tests in charge depleting operation

$$M_{cs} = \left(\frac{R_{cdC}}{D_h}\right) * Y_h$$

$Y_h$, and $D_h$ are the $CO_2$ grams per mile and distance traveled, respectively, from the final charge sustaining (hot) test HFEDS (either the third or the second HFEDS, per section F.6.2.2.3).

11.6 Electric Range Fraction (%).

The Electric Range Fraction means fraction of the total miles driven electrically (with the engine off) for blended operation hybrid electric vehicles.

The Urban Electric Range Fraction ($ERF_u$) is calculated as follows:

$$ERF_u\ (\%) = \left(\frac{EAER_u}{R_{cdo}}\right) * 100$$

The Highway Electric Range Fraction (ERFh) is.calculated as follows:

$$ERF_h\ (\%) = \left(\frac{EAER_h}{R_{cdah}}\right) * 100$$

11.7 Eguivalent All-Electric Range Energy Consumption.

The Urban Equivalent All-Electric Range Energy Consumption ($EAEREC_u$) shall be calculated as follows:

$$EAEREC_u \text{ (wh/mi)} = \frac{E_{cd}}{EAER_u}$$

The Highway Equivalent All-Electric Range Energy Consumption ($EAEREC_h$) shall be calculated as follows:

$$EAEREC_h \text{ (wh/mi)} = \frac{E_{cd}}{EAER_h}$$

11.8 The Urban Charge Depleting Cycle Range, Redell' (see section H for an illustration of Redell) shall be defined as the distance traveled on the Urban Charge Depleting Procedure up to the UDDS prior to where the state-of-charge is above the lower bound state-of-charge tolerance for one test cycle given by:

$$(Amp\text{-}hr_{final})_{min} = (Amp\text{-}hr_{initial}) - 0.01 * \frac{(NHV_{fuel} * m_{fuel})}{V_{system} * K_1}$$

Where:

| | | |
|---|---|---|
| $(Amp\text{-}hr_{final})_{min}$ | | Minimum allowed Amp-hr stored in battery at the end ofthe test |
| $(Amp\text{-}hr_{initial})$ | | Battery Amp-hr stored at the beginning of the test |
| $NHV_{fuel}$ | = | Net heating value of consumable fuel, in Joules/kg |
| $m_{fuel}$ | = | Total mass of fuel consumed during test, in kg |
| $K_1$ | = | Conversion factor, 3600 seconds/hour |
| $V_{system}$ | = | Average charge sustaining battery DC bus voltage (open circuit) during charge sustaining operation; This value shall be submitted for testing purposes, and it shall be subject to confirmation by the Air Resources Board. |

11.9· The Charge Depleting Actual Range, $R_{cda}$, shall be defined as the range at which the state-or-charge is first equal to the average state-of-charge of the one or two UDDSs used to end the Urban Charge Depleting Test. This range must be accurate to the nearest 0.1 miles. For an illustration of $R_{cda}$ see section H.

11.10 The Charge Depleting to Charge Sustaining Urban Range shall be defined as the distance driven in miles from the start of the Urban Charge Depleting Test through the UDDS preceding the one or two UDDSs used to end the Urban Charge Depleting Test.

11.11 The Highway Charge Depleting Cycle Range, $R_{cdch}$, shall be defined as the sum of the distance traveled on the Highway Charge Depleting Test up to the HFEDS prior to where the state-of-charge is above the lower bound state-or-charge tolerance for one test cycle given by:

$$(Amp\text{-}hr_{final})_{min} = (Amp\text{-}hr_{initial}) - 0.01 * \frac{[NHV_{fuel} * m_{fuel}]}{V_{system} * K_1}$$

Where:

| | | |
|---|---|---|
| $(Amp\text{-}hr_{final})_{min}$ | = | Minimum allowed Amp-hr stored in battery at the end of the test |
| $(Amp\text{-}hr_{initial})$ | | Battery Amp-hr stored at the beginning of the test |
| $NHV_{fuel}$ | = | Net heating value of consumable fuel, in Joules/kg |
| $m_{fuel}$ | | Total mass of fuel consumed during test, in kg |
| $K_1$ | = | Conversion factor, 3600 seconds/hour |
| $V_{system}$ | = | Average charge sustaining battery DC bus voltage (open circuit) during charge sustaining operation. This value shall be submitted for testing purposes, and it shall be subject to confirmation by the Air Resources Board. |

11.12 The Charge Depleting to Charge Sustaining Highway Range shall be defined as the distance driven in miles from the start of the Highway Charge Depleting Test through the HFEDS preceding the final HFEDS.

**G. Off-Vehicle Charge Capable Hybrid Electric Vehicle Emission Test Sequence.**

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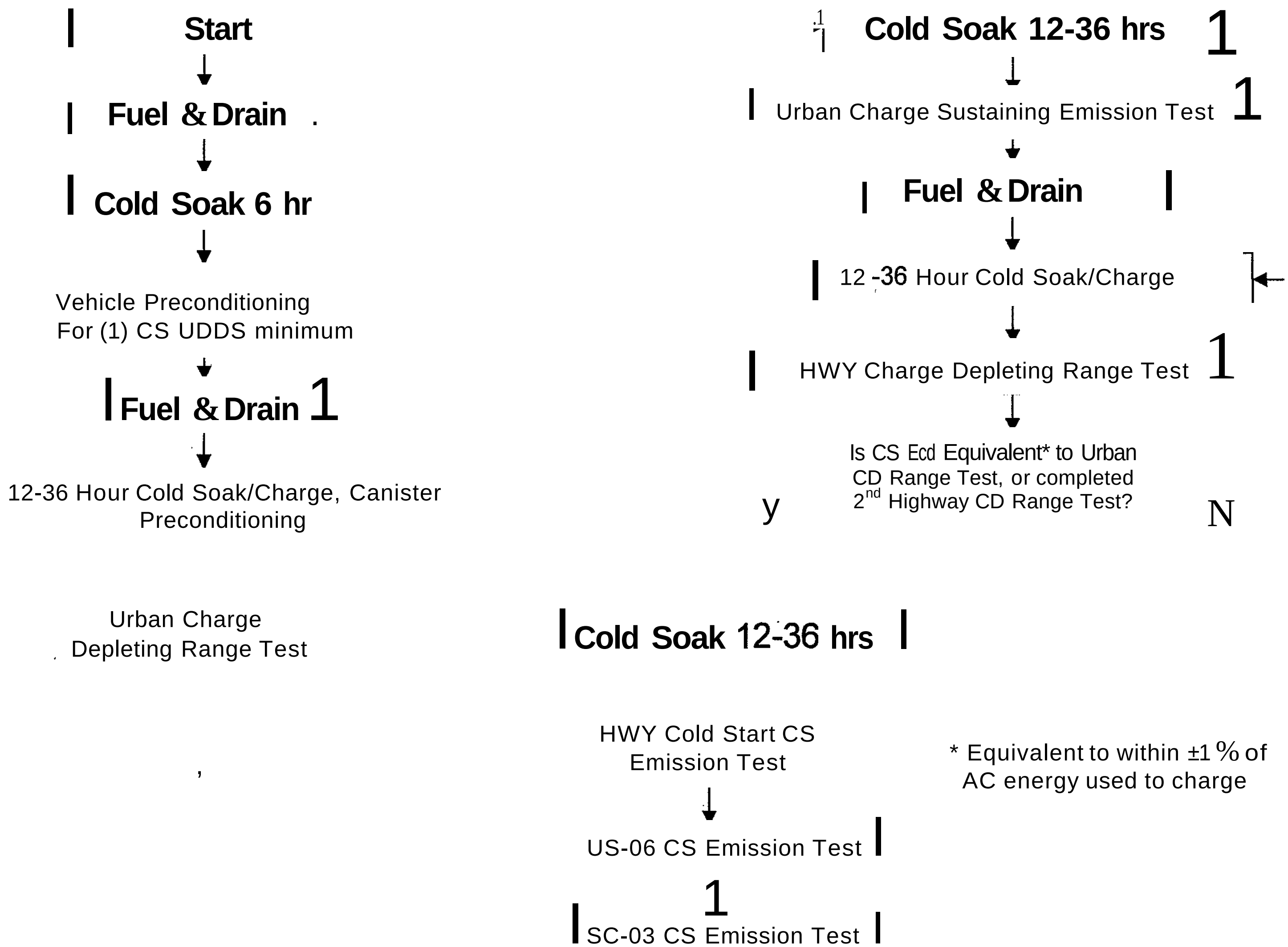
*[The diagram on the next page is proposedfor addition.}*

# Proposed Off-Vehicle Charge Capable HEV Exhaust Emissions Test Sequence



**H.** **Examples** of Off-Vehicle **Charge Capable Hybrid Electric Vehicle Terminology,**

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*[Figures 1 and 2 below are proposed for addition.]*

937

## Example of an Off-Vehicle. Charge Capable HEV with AER and Blended Operation .Undergoing the Urban Charge Depleting Range Test

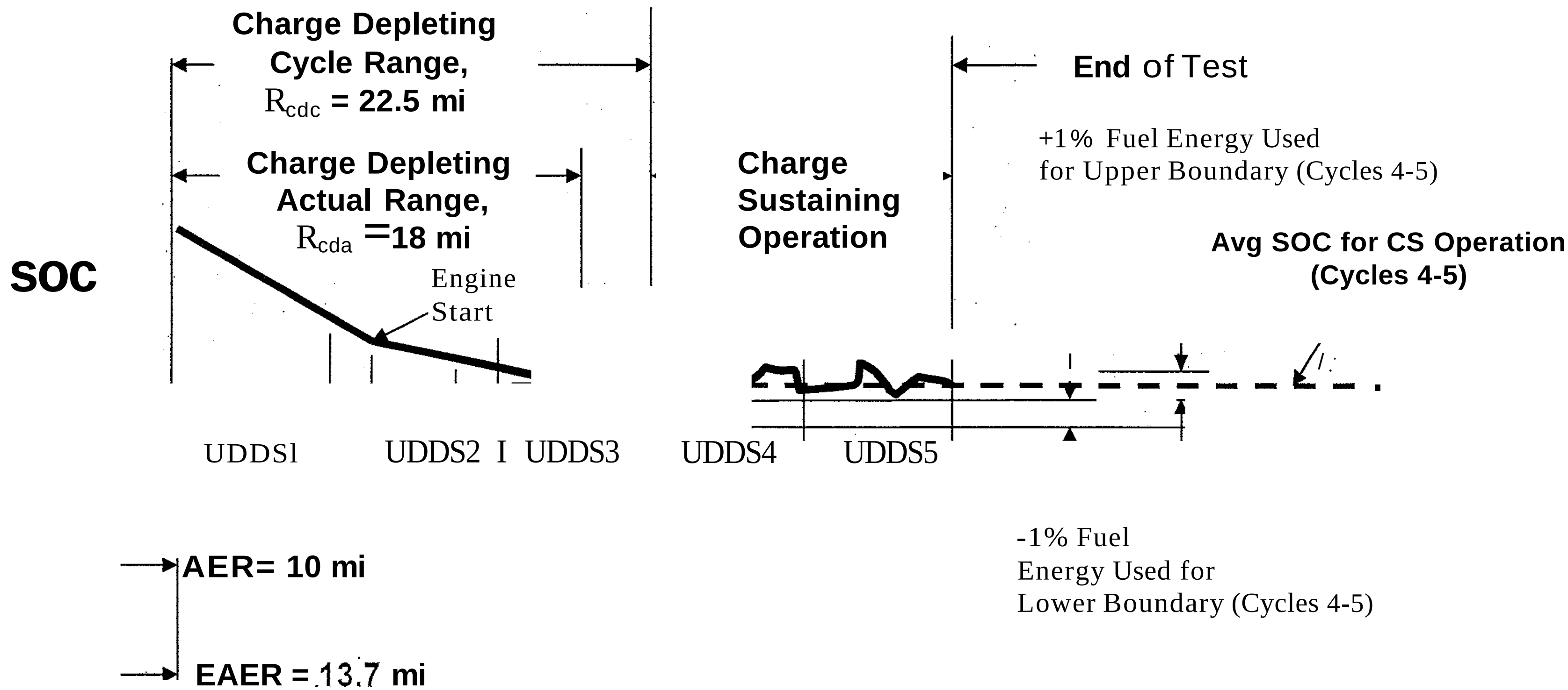
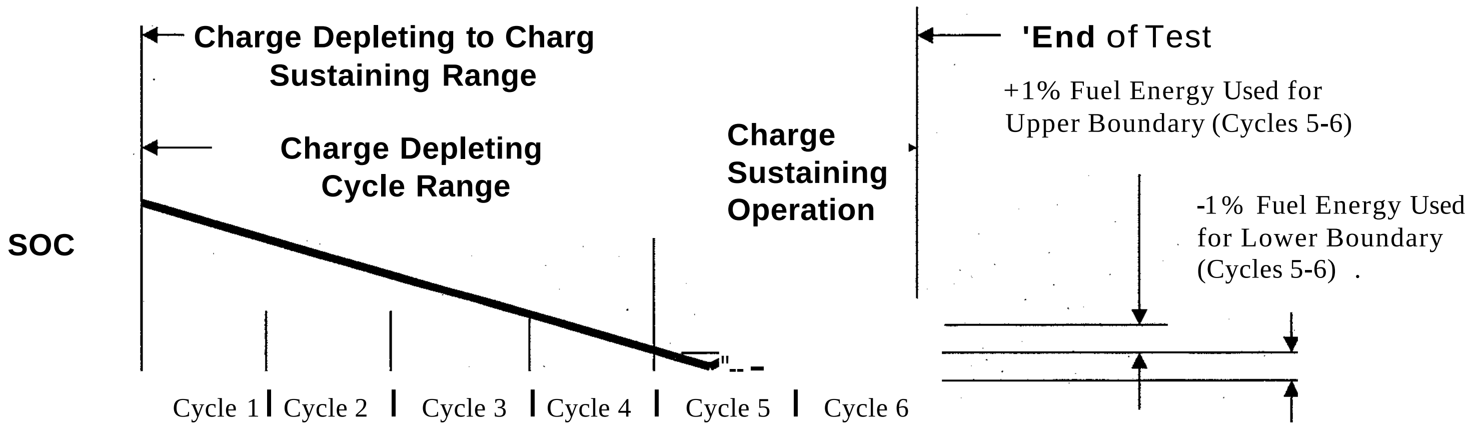



**Figure 1**

938

## Example of Urban End of Test Conditions for Off-Vehicle Charge Capable HEV




## Example of Urban End of Test Conditions for Off-Vehicle Charge Capable HEV with Transitional Range

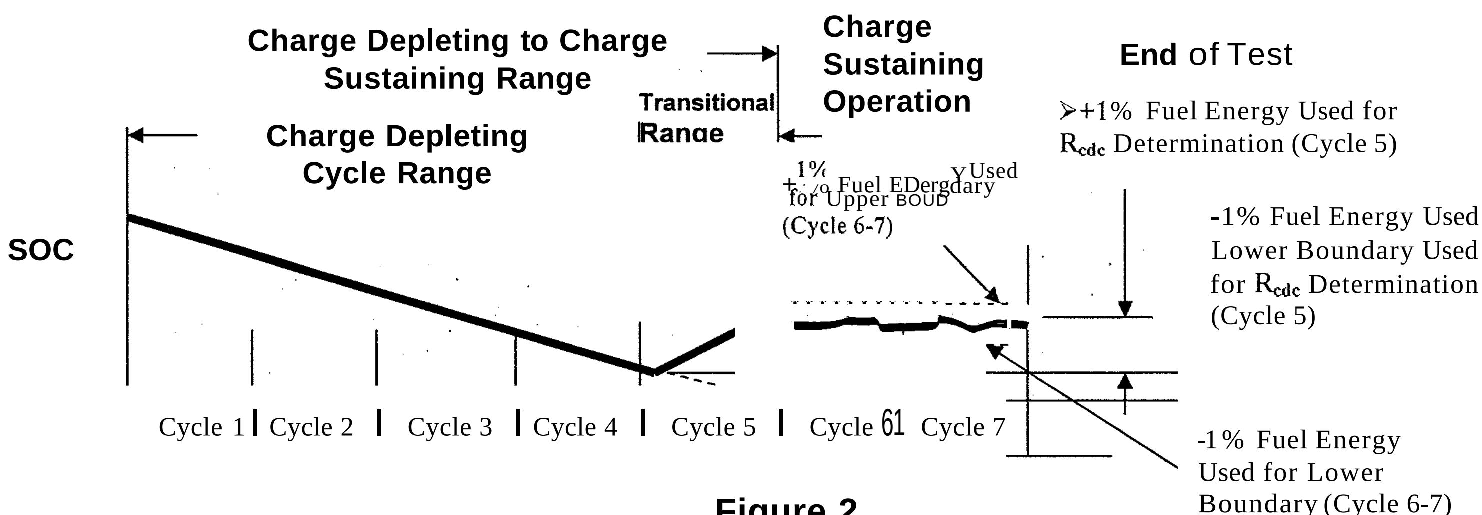



**Figure 2**

**EI. Test Procedures for 2009 and 2010 Model Zero-Emission Vehicles and Hybrid-Electric Vehicles.**

The "as adopted or amended dates" of the 40 CFR Part 86 regulations referenced by this document are the dates identified in the '"California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles." incorporated by reference in section 1961 (d), ~~title~~ 13, CCR.

**1. Electric Dynamometer.** All ZEVs must be tested using a 48-inch single roll electric dynamometer meeting the requirements of 40 CFR Subpart B, §86.108-00(b)(2).

**2. Vehicle and** Battery Break-In **Period.** A manufacturer shall use good engineering judgment in determining the proper stabilized emissions mileage test point and report same according to the requirements of section D.2.11 above:

**3. All-Electric Range Test.** All ~~2001~~ 2009 and subsequent ZEVs and only off-vehicle charge capable hybrid electric vehicles shall be subject to the All-Electric Range Test specified below for the purpose of determining the energy efficiency and operating range of a ZEV or of an off-vehicle charge capable hybrid electric vehicle operating without the use of its auxiliary power unit. For hybrid electric vehicles, the manufacturer may elect to conduct the All-Electric Range Test prior to vehicle preconditioning in the exhaust and evaporative emission test sequence specified in the "California Evaporative Emission Standards and Test Procedures 'for 2001 and Subsequent Model Motor Vehicles" as incorporated by reference in section 1976, Title 13, CCR.

3.1 **Cold soak.** The vehicle shall be stored at an ambient temperature not less than 68°F (20°C) and not more than 86°F (30°C) for 12 to 36 hours. During this time, the vehicle's battery shall be charged to a full state-of-charge.

3.2 **Driving schedule.**

3.2.1 **Determination** of Urban **All-Electric Range UrbaB.**

(a) At the end of the cold soak period, the vehicle shall be placed, either driven or pushed, onto a dynamometer and operated through successive Urban Dynamometer Driving Schedules (UDDS), 40 CFR, Part 86, Appendix **I,** which is incorporated herein by reference. A 10-minute soak shall follow each UDDS cycle.

(b) For vehicleswith a maximum speedgreater than or equal to the maximum speed on the UDDS cycle, this test sequence shall be repeated until the vehicle is no longer able to maintain either the speed or.time tolerances in 40 CFR §86.115-00 (b)(1) and (2), or the manufacturer determines that the test should be terminated for safety reasons, e.g. excessively high battery temperature, abnormally low battery voltage, etc. For off-vehicle charge capable hybrid electric vehicles, this determination shall be performed without the use of the auxiliary power unit.

(c) For vehicles with a maximum speed less than the maximum speed on the UDDS cycle, the vehicle shall be operated at maximum available power (or full throttle) when the vehicle cannot achieve the speed trace within the speed and time tolerances specified in 40 CFR § 86.115-00(b)(1) and (2). The test shall be terminated when the vehicle speed when operated at maximum available power (or full throttle) falls below 95 percent of the maximum speed initially achieved on the UDDS cycle or when the battery state-of-charge is depleted to the lowest level allowed by the manufacturer, or the manufacturer determines thatthe test should be terminated for safety reasons, e.g. excessively high battery temperature, abnormally 16wbattery voltage, etc., whichever occurs first.. For off-vehicle charge capable hybrid electric vehicles, this determination shall be performed without the use of the auxiliary power unit.

3.2.2 Determination of Highway **All-Electric** Range Highway.

(a) At the end of the cold soak period, the vehicle shall be placed, either driven or . pushed, onto a dynamometer and operated through two successive Highway Fuel Economy Driving Schedules (HFEDS), 40 CFR, Part 600, Appendix I, which is incorporated herein by reference. There shall be a 15 second zero speed with key on and brake depressed between two cycles and a 10-minute soak following the two HFEDS cycles.

(b) For vehicles with a maximum speed greater than or equal to the maximum speed on the HFEDS cycle, this test sequence shall be repeated until the vehicle is no longer able to maintain either the speed or time tolerances in 40 CFR § 86.115-00 (b)(1) and (2), or the manufacturer determines that the test should be terminated for safety reasons, e.g. excessively high battery temperature, abnormally low battery voltage, etc. For off-vehicle charge capable hybrid electric vehicles, this determination is optional and shall be performed without the use of the auxiliary power unit.

(c) For vehicles with a maximum speed less than the maximum speed on the HFEDS cycle, the vehicle shall be operated at maximum available power (or full throttle) when the vehicle cannot achieve the speed trace within the speed and time tolerances specified in 40 CFR § 86.115-00(b)(1) and (2). The test shall be terminated when the vehicle speed when operated at maximum available power (or full throttle) falls below 95 percent of the maximum speed initially achieved on the HFEDS cycle or when the battery state-of-charge is depleted to the lowest level allowed by the manufacturer, or the manufacturer determines that the test should be terminated for safety reasons, e.g. excessively high battery temperature, abnormally low battery voltage, etc., whichever occurs first. For off-vehicle charge capaple hybrid electric vehicles, this determination shall be performed without the use of the auxiliary power unit.

(d) NEVs are exempt from the highway all-electric range ~~highway~~ test.

3.2.3 Recording requirements. Once the vehicle is no longer able to maintain the speed and time requirements specified in (2) above, or once the auxiliary power unit turns on, in the case of an off-vehicle charge capable hybrid electric vehicle, the vehicle shall be brought to an immediate stop and the following data recorded:

(a) mileage accumulated during the All-Electric Range Test;

(h) Net DC energy from the battery that was expended during the All-Electric Range Test (may be reported as the total DC battery energy output and the total DC battery energy input during the All-Electric Range Test);

(c) AC energy required to fully charge the battery afterthe All-Electric Range Test from the point where electricity is introduced from the electric outlet to the battery charger; and

(d) DC energy required to fully charge the battery after the All-Electric Range Test from the point where electricity is introduced from the battery charger to the battery.

Battery charging shall begin within 1 hour after terminating the All-Electric Range Test.

3.2.4 **Regenerative braking.** Regenerative braking systems may be utilized during the range test. The braking level, if adjustable, shall be set according tothe manufacturer's specifications prior to the commencement of the test. The driving schedule speed and,time tolerances specified in (2) shall not be exceeded due to the operation of the regenerative braking system.

**4. Determination** of Battery **Specific Energy for** ZEVs:.

Determine the specific energy of batteries used to power a ZEV in accordance with the U.S. Advanced Battery Consortium's Electric Vehicle Battery Procedure Manual (January 1996), Procedure No.2, "Constant Current Discharge Test Series," using the C/3 rate. The weight calculation must reflect a completely functional battery system as defined in the Appendix of the Manual, including pack(s), required support ancillaries (e.g., thermal management), and electronic controller.

**5. Determination of the Emissions of the Fuel-fired Heater for Vehicles Other ThanZEVs.**

The exhaust emissions result of the fuel-fired heater shall be determined by operating at a maximum heating capacity with a cold start between 68°F and 86°F for a period of 20 minutes and dividing the grams of emissions by 20. The resulting grams per minute shall be multiplied by 3.0 minutes per mile for a grams per mile value.

**6. Hybrid Electric Vehicle FTP Emission Test Provisions:.**

Alternative procedures may be used if shown to yield equivalent results and if approved in advance by the Executive Officer of the Air Resources Board.

**6.1 Vehicle Preconditioning.**

To be conducted pursuant to the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles" as incorporated by reference herein with the following supplemental requirements:

6.1.1 Battery state-of-charge shall be set prior to initial fuel drain and fill before vehicle preconditioning.

6.1.2 For hybrid electric vehicles that do not allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at a level that causes the hybrid electric vehicle to operate the auxiliary power unit for the maximum possible cumulative amount of time during the preconditioning drive.

6.1.3 For hybrid electric vehicles that allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at a level that satisfies one of the following conditions:

(i) If the hybrid electric vehicle is charge-sustaining over the UDDS, battery state-of-charge shall be set at the lowest level allowed by the manufacturer.

(ii) If the hybrid electric vehicle is charge-depleting over the UDDS, battery state-of-charge shall be set at the level recommended by the manufacturer for activating the auxiliary power unit when operating in urban driving conditions.

6.1.4 After setting battery state-of-charge, the hybrid electric vehicle shall be pushed or towed to a work area for fuel drain and fill according to sections D.1.1. and D.1.2. of the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles" as incorporated by reference herein.

6.1.5 Following fuel drain and fill, the vehicle shall be pushed or towed into position on a dynamometer and preconditioned. If the auxiliary power unit is capable of being manually activated, the auxiliary power unit shall be manually activated at the beginning of and operated throughout the preconditioning drive.

6.1.6 Within five minutes of completing preconditioning drive, battery state-of-charge shall be set at a level that satisfies one of the following conditions:

(i) If the hybrid electric vehicle does not allow manual activation of the auxiliary power unit and is charge-sustaining over the UDDS, then set battery state-of-charge to a level such that the SOC Criterion (see section B., Definitions, of these procedures) would be satisfied for the dynamometer procedure (section 6.2 of these procedures). If off-vehicle charging is required to increase battery state-of-charge for proper setting, off-vehicle charging shall occur during 12 to 36 hour soak period.

(ii) If the hybrid electric vehicle does not allow manual activation of the auxiliary power unit and is charge-depleting over the UDDS, then no battery state-of-charge adjustment is permissible..

(iii) If the hybrid electric vehicle does allow manual·activation of the auxiliary power unit, then set battery state-of-charge to manufacturer recommended level for activating the auxiliary power unit when the hybrid electric vehicle is operating in urban driving conditions.

## 6.2 Dynamometer Procedure

To be conducted pursuant to 40 CFR § 86.135-00 with the following revisions:

6.2.1 Amend subparagraph (a): Overview. The dynamometer run consists of two tests, a "cold" start test, after a minimum 12-hour and a maximum 36-hoursoak pursuant to the provisions of the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles" as ~~incorporated~~ by reference herein, and a "hot" start test following the "cold" start test by 10 minutes. Vehicle startup (with all accessories turned off), operation over the UDDS and vehicle shutdown make a complete cold start test. Vehicle startup and operation over the UDDS and vehicle shutdown make a complete hot start test. The exhaust emissions are diluted with ambient air inthe dilution tunnel as shown in Figure B94-5 and Figure B94-6. A dilution tunnel is not required for testing vehicles waived from the requirement to measure particulates. Four particulate samples are collected on filters for weighing; the first sample plus backup is collected during the cold start test (including shutdown); the second sample plus backup is collected during the hot start test (including shutdown). Continuous proportional samples of gaseous emissions are collecfed for analysis during each test. For hybrid electric vehicles with gasoline-fueled, natural gas-fueled and liquefied petroleum gas-fueled Otto-cycle auxiliary power units, the composite samples collected in bags are analyzed for THC, CO, $CO_2$, CH4 and $NO_x$. For hybrid electric vehicles with petroleum-fueled diesel-cycle auxiliary power units (optional for natural gas-fueled, liquefied petroleum gas-fueled and methanol-fueled diesel-cycle vehicles), THC is sampled and analyzed continuously pursuant to the provisions of § 86.11 O.Parallel samples of the dilution air are similarly analyzed forTHC, CO, $CO_2$, CH4 and $NO_x$. For hybrid electric vehicles with natural gas-fueled, liquefied petroleum gas-fueled and methanol-fueled auxiliary power units, bag samples are collected and analyzed for THC (if not sampled continuously), CO, C02, $CH_4$ and $NO_x$. For hybrid electric vehicles with methanol-fueled auxiliary power units, methanol and formaldehyde samples are taken for both exhaust emissions and dilution air (a single dilution air formaldehyde sample, covering the total test period may be collected). Parallel bag samples of dilution air are analyzed for THC, CO, $CO_2$, CH4 and $NO_x$.

6.2.2 Delete subparagraph (d).

6.2.3 Amend subparagraph (h): The driving distance, as measured by counting the number of dynamometer roll or shaft revolutions, shall be determined for the cold start test and hot start test. The revolutions shall be measured on the same roll or shaft used for measuring the vehicle's speed.

### 6.3 Dynamometer Test Run, Gaseous and Particulate Emissions

To be conducted pursuant to 40 CFR § 86.137-96 with the following revisions:

6.3.1 Amend subparagraph (a): General. The dynamometer run consists of two tests, a cold start test, after a minimum 12-hour and a maximum 36-hour soak pursuant to the provisions of the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles" as incorporated by reference herein, and a hot start test following the cold start test by 10 minutes. The vehicle shall be stored prior to the emission test in such a manner that precipitation (e.g., rain or dew) does not occur on the vehicle. The complete dynamometer test consists of a cold start drive of 7.5 miles (12.1 km) and a hot start drive of7.5 miles (12.1 km). The vehicleis allowed to stand on the dynamometer during the 10 minute time period between the cold and hot start tests.

6.3.2 Amend subparagraph (b)(9): Start the gas flow measuring device, position the sample selector valves to direct the sample flow into the exhaust sample bag, the methanol exhaust sample, the formaldehyde exhaust sample, the dilution air sample bag, the methanol dilution air sample and the formaldehyde dilution air sample (turn on the petroleum':'fueled diesel-cycle THC analyzer system integrator, mark the recorder chart, start particulate sample pump No.1, and record both gas meter or flow measurement instrument readings, if applicable), and tum the key on. If the auxiliary power unit is capable of being manually activated, the auxiliary power unit shall be activated at the beginning of and operated throughout the UDDS.

6.3.2 Delete subparagraph (13).

6.3.3 Amend subparagraph (14): Tum the vehicle off 2 seconds after the end of the last deceleration (at 1,369 seconds).

6.3.4 Amend subparagraph (15): Five seconds after the vehicle is shutdown, simultaneously turn off gas flow measuring device No.1 and if applicable, tum off the hydrocarbon integrator No.1, mark the hydrocarbon recorder chart, turn off the No.1 particulate sample pump and close the valves isolating particulate filter No.1, and position the sample selector valves to the "standby" position. Record the measured roll or shaft revolutions (both gas meter or flow measurement instrumentation readings), and reset the counter. As soon as possible, transfer the exhaust and dilution air samples to the analytical system and process the samples pursuant to § 86.140, obtaining a stabilized reading of the exhaust bag sample on all analyzers within 20 minutes of the end of the sample collection phase of the test. Obtain methanol and formaldehyde sample analyses, if applicable, within 24 hours of the end of the sample period. (If it is not possible to perform analysis on the methanol and formaldehyde samples within24 hours, the samples should be stored in a dark cold (4°C to lOOC) environment until analysis. The samples should be analyzed within fourteen days.) If applicable, carefully remove both pairs of particulate sample filters from their respective holders, and place each in a separate petri dish, and cover.

6.3.3 Amend subparagraph (18): Repeat the steps in paragraphs (b)(2) through (b)(17) of this section for the hot start test. The step in paragraph (b)(9) of this section shall begin between 9 and 11 minutes after the end of the sample period for the cold start test.

6.3.4 Delete subparagraph (19).

6.3.5 Delete subparagraph (20).

6.3.6 Amend subparagraph (21): As soon as possible, and in no case longer than one hour after the end of the hot start phase of the test, transfer the four particulate filters to the weighing chamber for post-test conditioning, if applicable. For hybrid electric vehicles that do not allow manual activation of the auxiliary power unit and are charge-sustaining over the UDDS, a valid test shall satisfy the SOC Criterion (see Definitions, section B of these procedures).

6.3.7 Amend subparagraph (24): Vehicles to be tested for evaporative emissions will proceed pursuant to the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles" as incorporated by reference herein.

## 6.4 Calculations - Exhaust Emissions

To be conducted pursuant to 40 CFR §86.144-94 with the following revisions:

6.4.1 Amend subparagraph (a): For light-duty vehicles and light duty trucks:

$$Y_{wm} = 0.43 * \frac{Y_c}{D_c} + 0.57 * \frac{Y_h}{D_h}$$

Where:

(1) $Y_{wm}$ = Weighted mass emissions of each pollutant, i.e., THC, CO, THCE, NMHC, NMHCE, $CH_4$, $NO_x$, or C02, in grams per vehicle mile.

(2) $Y_c$ = Mass emissions as calculated from the cold start test, in grams per test.

(3) $Y_h$ = Mass emissions as calculated from the hot start test, in grams per test.

(4) $D_c$ = The measured driving distance from the cold start test, in miles.

(5) $D_h$ = The measured driving distance from the hot start test, in miles.

## 6.5 Calculations - Particulate Emissions

To be conducted pursuant to 40 CFR §86.145-82 with the following revisions:

6.5.1 Amend subparagraph (a): The final reported test results for the mass particulate ($M_p$) in grams/mile shall be computed as follows:

$$M_p = 0.43 * \frac{M_{pc}}{D_c} + 0.57 * \frac{M_{ph}}{D_h}$$

Where:

(1) $M_{pc}$ = Mass of particulate determined from the cold start test, in grams per vehicle mile. (See § 86.110-94 for determination.)

(2) $M_{ph}$ = Mass of particulate determined from the hot start test, in grams per vehicle mile. (See § 86.110-94 for determination.)

(3) $D_c$ = The measured driving distance from the cold start test, in miles.

(4) $D_h$ = The measured driving distance from the hot start test, in miles.

**7. Hybrid** Electric Vehicle **Highway Emission Test Provisions**

To be conducted pursuant to 40 CFR § 600.111-93 with the following revisions:

7.1 Amend subparagraph (b)(2): The highway fuel economy test is designated to simulate non-metropolitan driving with an average speed of 48.6 mph and a maximum speed of 60 mph. The cycle is 10.2 miles long with 0.2 stop per mile and consists of warmed-up vehicle operation on a chassis dynamometer through a specified driving cycle. A proportional part of the diluted exhaust emission is collected continuously for subsequent analysis of THC, CO, $CO_2$, and NOx using a constant volume (variable dilution) sampler. Diesel dilute exhaust is continuously analyzed for hydrocarbons using a heated sample line and analyzer. Methanol and formaldehyde samples are collected and individually analyzed for methanol-fueled vehicles.

7.2 Amend subparagraph (f)(3): Only one exhaust sample and one background sample are collected and analyzed for THC (except diesel hydrocarbons which are analyzed continuously), CO, $CO_2$, and $NO_X$. Methanol and formaldehyde samples (exhaust and dilution air) are collected and analyzed for methanol-fueled vehicles.

7.3 Add subparagraph (f)(5): Battery state-of-charge shall be set prior to performing the HFEDS preconditioning cycle. For hybrid electric vehicles that do not allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at a level that causes the hybrid electric vehicle to operate the auxiliary power unit for the maximum possible cumulative amount of time during the HFEDS preconditioning cycle. For hybrid electric vehicles that allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at a level that satisfies one of the following conditions:

(i) If the hybrid electric vehicle is charge-sustaining over the HFEDS, battery state-of-charge shall be set at the lowest level allowed by the manufacturer.

(ii) If the hybrid electric vehicle is charge-depleting over the HFEDs, battery state-of-charge shall be set at the level recommended by the manufacturer for activating the auxiliary power unit when operating in highway driving conditions.

7.4 Amend subparagraph (h)(5): Operate the vehicle over one HFEDS preconditioning cycle according to the dynamometer driving schedule specified in . 600.1 09(b). If the auxiliary power unit is capable of being manually activated, the auxiliary power unit shall be manually activated at the beginning of and operated throughout the HFEDS 'preconditioning cycle.

7.5 Amend subparagraph (h)(6): When the vehicle reaches zero speed at the end of the HFEDS preconditioning cycle, the driver has 17 seconds to prepare for the HFEDS emission measurement cycle of the test. Reset and enable the roll revolution counter. During the idle period, one of the following conditions shall apply:

(i) For hybrid electric vehicles that do not allow the auxiliary power unit to be manually activated and are charge.:.sustaining over the HFEDS, the vehicle shall be momentarily turned off for 5 seconds and turned back on during the idle period. The. battery'state-of-charge shall be recorded after the hybrid electric vehicle has fully turned on.

(ii) For hybrid electric vehicles that do not allow the auxiliary power unit to be manually activated and are charge-depleting over the HFEDS, the vehicle shall remain turned on during the idle period.

(iii) For hybrid electric vehicles that allow the auxiliary power unit to be manually activated, the vehicle shall remain turned on with the auxiliary power unit operating during the idle period.

7.6 Add subparagraph (h)(9): At the conclusion of the HFEDS emission test, one of the following conditions shall apply:

(i) For hybrid electric vehicles that do not allow the auxiliary power unit to be manually activated and are charge-sustaining over the HFEDS, record the battery state-of-charge to determine if the SOC Criterion (see Definitions, section B of these procedures) is satisfied. If the SOC Criterion is not satisfied, then repeat dynamometer test run from subparagraph (h)(6). A total of three highway emission tests shall be allowed to satisfy the SOC Criterion. Manufacturers may elect to repeat dynamometer test run from . subparagraph (h)(6) if battery energy level increased significantly relative to the initial battery state-of-charge set at the beginning of the HFEDS emission test.

(ii) For hybrid electric vehicles that do not allow the auxiliary power unit to be manually activated and are charge-depleting over the HFEDS, the emission test is completed.

(iii) For hybrid electric vehicles that allow the auxiliary power unit to be manually activated, the emission test is completed..

## 8. Hybrid Electric Vehicle SFTP Emission Test Provisions

### 8.1 US06 Vehicle Preconditioning

To be conducted pursuant to'40 CFR § 86.132-00 with the following revisions:

8.1.1 Amend subparagraph (n): Aggressive Driving Test (US06) Preconditioning. (1) If the US06 test follows the exhaust emission FTP or evaporative testing, the refueling step may be deleted and the vehicle may be preconditioned using the fuel remaining in the tank (see paragraph (c)(2)(ii) of this section). The test vehicle may be pushed or driven onto the test dynamometer provided that battery state-of-chargehas not been set; otherwise, if battery state-of-charge is set prior to securing vehicle on dynamometer, vehicle shall be pushed or towed into position on dymimometer. Battery state-of-charge shall be set prior to performing the US06 preconditioning cycle. For hybrid electric vehicles thatdo not allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at a level that causes the hybrid electric vehicle to operate the auxiliary power unit for the maximum possible cumulative amount of time during the US06 preconditioning drive. For hybrid electric vehicles that allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at a level that satisfies one of the following conditions:

(i) If the hybrid electric vehicle is charge-sustaining over the US06, battery state-of-charge shall be set at the lowest level allowed by the manufacturer. The auxiliary power unit shall be manually activated at the beginning of and operated throughout the US06 preconditioning cycle.

(ii) If the hybrid electric vehicle is charge-depleting over the US06, battery state-of-charge shall be set at the level recommended by the manufacturer for activating the auxiliary power unit when operating in highway driving conditions. The auxiliary power unit shall be manually activated at the beginning of and operated throughout the US06 preconditioning cycle.

8.1.2 Delete subparagraphs (n)(1)(i) and (n)(1)(ii).

**8.2 US06 Emission Test**

To be conducted pursuant to 40 CFR §86.159-00 with the following revisions:

8.2.1 Amend subparagraph (a): Overview. The dynamometer operation consists of a single, 600 second test on the US06 driving schedule, as described in appendix I, paragraph (g), of this part. The hybrid electric vehicle is preconditioned in accordance with § 86.132-00, to bring it to a warmed-up stabilized condition. This preconditioning is followed by a 1 to 2 minute idle period that proceeds directly into the US06 driving schedule during which continuous proportional samples of gaseous emissions are collected for analysis. If engine stalling should occur during testing, follow the provisions of § 86.136-90 (engine starting and restarting). For hybrid electric vehicles with gasoline-fueled Otto-cycle auxiliary power units, the composite samples collected in bags are analyzed for THC, CO, $CO_2$, $CH_4$ and $NO_x$. For hybrid electric vehicles with petroleum-fueled diesel-cycle auxiliary power units, THC is sampled and analyzed continuously according to the provisions of § 86.110. Parallel bag samples of dilution air are analyzed for THC, CO, C02, $CH_4$ and $NO_x$.

8.2.2 Amend subparagraph (b)(2): Position (vehicle shall be pushed or towed if battery state-of-charge is set prior to securing to dynamometer otherwise vehicle may be driven as well) the test vehicle on the dynamometer and restrain.

8.2.3 Amend subparagraph (d): Practice runs over the prescribed driving schedule may be performed at test point, provided that battery state-of-charge setting is conducted after practice and an emission sample is not taken, for the purpose of finding the appropriate throttle action to maintain the proper speed-time relationship, or to permit sampling system adjustment.

8.2.4 Amend subparagraph (f)(2)(i): Immediately after completion of the US06 preconditioning cycle, idle the vehicle. The idle period is not to be less than one minute or not greater than two minutes. During the idle period, one of the following conditions shall apply:

(i) For hybrid electric vehicles that do not allow the auxiliary power unit to be manually activated and are charge-sustaining over the US06, the vehicle shall be momentarily turned off for 5 seconds and turned back on during the idle period. The battery state-of-charge shall be recorded after the hybrid electric vehicle has fully turned on.

(ii) For hybrid electric vehicles that do not allow the auxiliary power unit to be manually activated and are charge-depleting over the US06, the vehicle shall remain turned on during the idle period.

(iii) For hybrid electric vehicles that allow the auxiliary power unit to be manually activated, the vehicle shall remain turned on with the auxiliary power unit operating during the idle period.

8.2.5 Amend subparagraph (f)(2)(ix): At the conclusion of the US06 emission test, one of the foliowing conditions shall apply:

(i) For hybrid electric vehicles that do not allow manual activation of . the auxiliary power unit and are charge-sustaining over the US06, r.ecord the battery state-of-charge to determine if the SOC Criterion (see Definitions, section B ofthese procedures) is satisfied. If the SOC Criterion is not satisfied, then repeat dynamometer test run from subparagraph (f)(2)(i).. A total ofthreeUS06 emission tests shall-be allowed to satisfy the SOC Criterion. Manufacturers may elect to repeat dynamometer test run from subparagraph (f)(2)(i) if battery energy level increased significantly relative to the initial battery state-of-charge set at the beginning of US06 emission test.

(ii) For hybrid electric vehicles that do not allow the auxiliary power . unit to be manually activated and are charge-depleting over the US06, turn off vehicle 2 seconds after the end of the last deceleration.

(iii) For hybrid electric vehicles that allow the auxiliary power unit to be manually activated, turn off vehicle 2 seconds after the end of the last . deceleration.

## 8.3 SC03 Vehicle Preconditioning

To be conducted pursuant to 40 CFR §86.132-00 with the following revisions:

. 8.3.1 Amend subparagraph (0): Air Conditioning Test (SC03) Preconditioning. (1) If the SC03 test follows the exhaust emission FTP or evaporative testing, the refueling step may be deleted and the vehicle may be preconditioned using the fuel remaining in the tank (see paragraph (c)(2)(ii) of this section). The test vehicle may.be pushed or driven onto the test dynamometer provided that battery state-of-charge has not been set; otherwise, if battery state-of-charge is set prior to securing vehicle on dynamometer, vehicle shall be pushed or towed into position on dynamometer: Battery state-of-charge shall be set prior to performing the SC03 preconditioning cycle. For hybrid electric vehicles that do not allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at a level that causes the hybrid electric vehicle to operate the auxiliary power unit for the maximum possible cumulative amount of time during the SC03 prec'onditioning drive. For hybrid electric vehicles that allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at a level that satisfies one of the following conditions:

(i) If the hybrid electric vehicle ischarge-su·staining over the SC03, battery state-of-charge shall be set at the lowest level allowed by the manufacturer. The auxiliary power unit shall be manually activated .at the beginning of and operated throughout the SC03 preconditioning cycle.

(ii) If the hybrid electric vehicle is charge-depleting over the SC03, battery state-of-charge shall be set at the level recommended by the manufacturer for activating the auxiliary power unit when operating in highway driving conditions. The auxiliary power unit shall be manually activated at the beginning of and operated throughout the SC03 preconditioning cycle.

8.3.2 Delete subparagraphs (0)(1)(i) and (o)(l)(ii).

**8.4 SC03 Emission Test**

To be conducted pursuant to 40 CFR § 86.160-00 with the following revisions:

8.4.1 Amend subparagraph (a): Overview. The dynamometer operation consists of a single, 594 second test on the SC03 driving schedule, as described. in appendix I, paragraph (h), of this part. The hybrid electric vehicle is preconditioned in accordance with §86.132-00 of this subpart, to bring the vehicle to a warmed.,up stabilized condition. This preconditioning is followed by a 10 minute vehicle soak (vehicle turned off) that proceeds directly into the SC03 driving schedule, during which continuous proportional samples of gaseous emissions are collected for analysis. The entire test, including the SC03 preconditioning cycle, vehicle soak, and SC03 emission test, is either conducted in an ·environmental test facility or under test conditions that simulates testing in an environmental test cell (see Sec. 86.162-00 (a) for a discussion of simulation procedure approvals). The environmental test facility must be capable of providing the following nominal ambient test conditions of: 95°F air temperature, 100 grains o(water/pound of dry air (approximately 40 percent relative humidity), a solar heat load intensity of 850 $W/m^2$, and vehicle cooling air flow proportional to vehicle speed. Section 86.161-00 discusses the minimum facility requirements and corresponding control tolerances for air conditioning ambient test conditions. The vehicle's air conditioner is operated or appropriately simulated for the duration of the test procedure (except for the 10 minute vehicle soak), including the preconditioning. If engine stalling should occur during testing, follow the provisions of §86.136-90 (engine starting and restarting). For hybrid electric vehicles with gasoline-fueled Otto-cycle auxiliary power units, the composite samples collected in bags are analyzed for THC, CO, $CO_2$, CH4 and $NO_x$. For hybrid electric vehicles with petroleum-fueled diesel-cycle auxiliary power units, THC is sampled and analyzed continuously according to the provisions of § 86.110. Parallel bag samples of dilution air are analyzed for THC, CO, $CO_2$, CH4 and $NO_x$.

8.4.2 Amend subparagraph (b)(2): Position (vehicle shall be pushed or towed if battery state-of-charge is set prior to securing to dynamometer otherwise vehicle may be driven as well) the test vehicle on the dynamometer and restrain.

8.4.3 Amend subparagraph (c)(9): Start vehicle (with air conditioning system also running). If the auxiliary power unit of the hybrid electric vehicle is capable of being manually activated, the auxiliary power unit shall be manually activated at the beginning of and operated throughout the SC03 emission test. Fifteen seconds after the vehicle starts, begin the initial vehicle acceleration of the driving, schedule.

8.4.4 Amend subparagraph (c)(12): Turn the vehicle off 2 seconds after the end of the last deceleration.

8.4.5 Amend subparagraph (d)(7): Start vehicle (with air conditioning system also running). If the auxiliary power unit of the hybrid electric vehicle is capable of being manually activated, the auxiliary power unit shall be manually activated at the beginning of and operated throughout the SC03 emission test. Fifteen seconds after the vehicle starts, begin the initial vehicle acceleration of the driving schedule.

8.4.6 Amend subparagraph (d)(10): At the conclusion of the US06 emission test, one of the following conditions shall apply:

(i) For hybrid electric vehicles that do not allow the auxiliary power unit to be manually activated and are charge-sustaining over the SC03, record the battery state-of-charge to determine if the SOC Criterion (see Definitions, section B of these procedures) is satisfied. If the SOC Criterion is not satisfied, then tum off cooling fane s), allow vehicle to soak in the ambient conditions of paragraph (c)(5) of this section for 10 minutes, and repeat dynamometer test run from supparagraph (d). A total of three SC03 emission tests shall be attempted to satisfy the SOC Criterion. Manufacturers may elect to repeat dynamometer test run from subparagraph (d) following a 10 minute soak in the ambient conditions of paragraph (c)(5) of this section if battery energy level increased significantly relative to the initial battery state-of-charge set at the beginning of SC03 emission test.

(ii) For hybrid electric vehicles that do not allow the auxiliary power unit to be manually activated and are charge-depleting over the SC03, turn off vehicle 2 seconds after the end of the last deceleration.

(iii) For hybrid electric vehicles that allow the auxiliary power unit to be manually activated, tum off vehicle 2 seconds after the end of the last deceleration.

## 9. State-of-Charge Net Change Tolerances

9.1 For hybrid electric vehicles that use a battery as an energy storage device, the following state-of-charge net change tolerance shall apply:

$$(Amp\text{-}hr_{final})_{max} = (Amp\text{-}hr_{initial}) + 0.01 * \frac{(NHV_{fuel} * m_{fuel})}{(V_{system} * K_1)}$$

$$(Amp\text{-}hr_{final})_{min} = (Amp\text{-}hr_{initial}) - 0.01 * \frac{(NVH_{fuel} * m_{fuel})}{(V_{system} * K_1)}$$

Where:

| | | |
|---|---|---|
| $(Amp\text{-}hr_{final})_{max}$ | = | Maximum allowed Amp-hr stored in battery at the end of the test |
| $(Amp\text{-}hr_{final})_{min}$ | | Minimum allowed Amp-hr stored in battery at the end of the test |
| $(Amp\text{-}hr_{initial})$ | | Battery Amp-hr stored at the beginning of the test |
| $NHV_{fuel}$ | = | Net heating value of consumable fuel, in Jouleslkg |
| $m_{fuel}$ | | Total mass of fuel consumed during test, in kg |
| $K_1$ | | Conversion factor, 3600 secondslhour |
| $V_{system}$ | | Battery DC bus voltage (open circuit) |

9.2 For hybrid electric vehicles that use a capacitor as an energy storage device, the following state-of-charge net change tolerance shall apply:

$$(V_{final})_{max} = \sqrt{(V_{initial})^2 + 0.01 * \frac{(2 * NHV_{fuel} * m_{fuel})}{C}}$$

$$(V_{final})_{min} = (V_{initial})^2 - 0.01 * \frac{(2 * NHV_{fuel} * m_{fuel})}{C}$$

Where:

| | | |
|---|---|---|
| $(V_{final})_{max}$ | | The stored capacitor voltage allowed at the end of the test |
| $(V_{final})_{min}$ | = | The stored capacitor voltage allowed at the end of the test |
| $(V_{initial})^2$ | = | The square of the capacitor voltage stored at the beginning of the test |
| $NHV_{fuel}$ | = | Net heating value of consumable fuel, in Jouleslkg |
| $m_{fuel}$ | | Total mass of fuel consumed during test, in kg |
| C | = | Rated capacitance of the capacitor, in Farads |

9.3 For hybrid electric vehicles that use an electro-mechanical flywheel as an·energy storage device, the following state-of-charge net change tolerance shall apply:

$$(rpm_{final})_{max} = (rpm_{initial})^2 + 0.01 * \frac{(2 * NVH_{fuel} * m_{fuel})}{(1 * K_3)}$$

$$(rpm_{final})_{min} = \sqrt{(rpm_{initial})^2 - 0.01 * \frac{(2 * NVH_{fuel} * m_{fuel})}{(1 * K_3)}}$$

Where:

| | | |
|---|---|---|
| $(rpm_{finat})_{max}$ | = | The maximum flywheel rotational speed allowed at the end of the test |
| $(rpm_{finat})_{min}$ | | The minimum flywheel rotational speed allowed at the end of the test |
| $(rpm_{initiat})^2$ | = | The squared flywheel rotational speed at the beginning of the test |
| $NHV_{fuel}$ | | Net heating value of consumable fuel, in Joules/kg . |
| $m_{fuet}$ | = | Total mass of fuel consumed during test, in kg |
| $K_3$ | = | Conversion factor, $41t^2j(3600\ sec^2\_rpm^2)$ |
| I | = | Rated moment of inertia of the flywheel, in $kg\_m^2$ |

# APPENDIX E

# PROPOSED AMENDMENTS TO THE EVAPORATIVE EMISSION TEST PROCEDURES

Date of Release: Oecember 5, 2008; 45-Day Notice version
Date of Hearing: January 22-23, 2009

State of California
AIR RESOURCES BOARD

# CALIFORNIA EVAPORATIVE EMISSION STANDARDS AND TEST PROCEDURES FOR 2001 AND SUBSEQUENT MODEL MOTOR VEHICLES

Adopted: August 5, 1999
Amended: June 22, 2006
Amended: October 17,2007
Amended: [insert amended date]

Note: Proposed amendments to this document are shown in underline to indicate additions and strikeouts to indicate deletions compared to the test procedures as last amended October 17,2007. Existing intervening text that is not amended is indicated by a row of asterisks ( * * * * ).

Date of Release: December 5, 2008; 45-Day Notice version
Date of Hearing: January 22-23, 2009

NOTE: This document is incorporated by reference in section 1976(c), title 13, California Code of Regulations (CCR). Additional requirements necessary to complete an application for certificatioFl of motor vehicles are contained in other documents that are designed to be used in conjunction with this document. These other documents include:

1. "California Exhaust Emission Standards and Test Procedures for 2001 and . Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Dutv Vehicles" (incorporated by reference in section 1961(d), title 13, CCR);

2. "California Exhaust Emission Standards and Test Procedures for 2005 - 2008 Zero-Emission Vehicles, and 2001 - 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes" (incorporated by reference in section 1962(6), title 13, CCR);

3. "California Exhaust Emission Standards and Test Procedures for 2009 and. Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes" (incorporated by reference in section 1962.1 (h), title 13, CCR);

4. "California Refueling Emission Standards and Test Procedures for 2001 and' Subsequent Model Motor Vehicles" (incorporated by reference in section 1978(b), title 13, CCR);·

5. "California Exhaust Emission Standards and Test Procedures for 1987 through 2003 Modei Heavy-Duty Otto-Cycle Engines and Vehicles," as incorporated by reference in section 1956.8(d), title 13, 'CCR;

6. "California Exhaust Emission Standards and Test Procedures for 2004 and Subsequent Model Heavy-Duty Otto-Cycle Engines," as incorporated by reference in section 1956.8(d), title 13, CCR.

## TABLE OF CONTENTS

# CALIFORNIA EVAPORATIVE EMISSION STANDARDS AND TEST PROCEDURES FOR 2001 AND SUBSEQUENT MODEL MOTOR VEHICLES

The provisions of Title 40, Code of Federal Regulations (CFR), Part 86; Subparts A and B (as adopted or amended as of July 1, 1989); Subpart S (as adopted or amended on May 4,1999); and, such sections of these Subparts as last amended on such other date set forth next to the 40 CFR Part 86 section title listed below, insofar as those subparts pertain to evaporative emission standards and test procedures, are hereby adopted as the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Years," with the following exceptions, and additions:

## PART I. GENERAL CERTIFICATION REQUIREMENTS FOR EVAPORATIVE EMISSIONS

### A. 40 CFR §86.1801-01 Applicability.

Engines and Vehicles," as incorporated by reference in section 1956.8(d), title 13, GGR, and the "California Exhaust Emission Standards and Test Procedures for 2004 and Subsequent Model HeaVY-Duty Otto-Cycle Engines," shall apply to heavy-d,uty vehicles; andJ, section 1958, title 13, CCR shall apply to motorcycles, except as otherwise noted in these test procedures.

1.3.:. Approval of vehicles that are not exhaust emission tested using a chassis dynamometer pursuant to section 1961, title 13, CCR shall be based on .an engineering evaluation of the system and data submitted by the applicant.

1.4. Reference to light-duty trucks in the federal CFR shall mean light-duty trucks and medium-duty vehicles. Regulations concerning methanol in the Title 40, CFR Part 86, shall mean methanol and ethanol, except as otherwise indicated in these test procedures.

1.5.:. The term "[no change]" means that these test procedures do not modify the applicable federal requirement. . .

1.6.:. . In those instances. where the testing conditions or parameters are not practical or feasible for vehicles operating on LPG fuel, the manufacturer shall provide a test plan that provides equal or greater confidence in comparison to these test procedures. The test plan must be approved in advance by the Execl:ltive Officer.

B. Definitions, Acronyms, Terminology

1. These test procedures incorporate by reference the definitions set forth in the "California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles;" and, the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles. in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes," as incorporated by reference in section 1961 (d), title 13, GGR, including the incorporated definitions from the Code of Federal Regulations.. In addition, the following definitions apply:

1.1. "Non-integrated refueling canister-only system" means a subclass of a non-integrated refueling emission control system, where other non-refueling related evaporative emissions from the vehicle are stored in the fuel tank, instead of in a vapor storage unit(s).

1.2. "Sealed fuel system" means a non-liq'uid phase fuel system, on-board a vehicle, that stores, delivers, and meters the fuel under a very high pressure, and which inherently has no evaporative-related emissions. due to design specifications that eliminate the escape of any fuel vapors, under normal vehicle operations. , -

1.3. "2-gram breakthrough" means the point at which the cumulative quantity of hydrocarbons emitted from a stabilized canister vapor storage unit, during the loading process of the unit, is equal to 2 grams.

C. Useful life

1. §86.1805-01. Delete. For vehicles certified to the emission standards in section I.E.1.(a}, "useful life" shall have the same meaning as provided in section 2112, title 13, CCR. For vehicles certified to the emission standards in sections I.E.1:(c) and (d), the "useful life" shall be 15 years or 150,000 miles, whichever first occurs.

D. General Standards; increase in emissions; unsafe conditions; waivers

1. light- and Medium-Duty Vehicles.

1.1. Amend §86.1810-01 (December 8,2005) as follows:

(a) through (g). [The provisions of these paragraphs are contained in the "California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles." adopted ~~August~~ 5, ~~1999,~~ as last amended June 22, 2006.]

(h) For alcohol vehicles, hydrocarbon evaporative emissions shall be expressed as OMHCE.

(i) [No change.]

(j) Evaporative Emissions general provisions.

(1) The evaporative standards in section E. of this part apply equally to certification and in-use vehicles and trucks.

(2) For certification testing only, a manufacturer may conduct testing to quantify a level of stabilized non-fuel evaporative emissions for an individual certification test vehicle. Testing may be conducted on a representative vehicle to determine the non-fuel evaporative emission characteristics of the certification test vehicle. The demonstration must be submitted for advance approval by the Executive Officer and include a description of the sources of vehicle hon-fuel evaporative emissions, the methodology for the quantification of the non-fuel emissions, an estimated non-fuel emission decay rate, and the stabilized non-fuel emission level. The demonstrated stabilized level of nOn-fuel evaporative emissions may be used in place of the test vehicle non-fuel evaporative emissions and be combined with the vehicle fuel evaporative emissions to determine compliance with the evaporative emission standard.

(3) [No change.]

(4) [No change.]

(k) through (n) [The provisions of these paragraphs are contained in the "California Refueling Emission Standards and Test Procedures for 2001 and Subsequent Model Year Motor Vehicles,.:." adopted ~~August~~ 5, ~~1999,~~ as last amended Gctober 17, 2007.]

(0) through (p). [The provisions of these paragraphs are contained in the "California Exhaust Emission Standards and Test Procedures for2001 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehides,.:." adopted ~~August~~ 5, 1999, as last amended June 22,2006.]

**2. Heavy-Duty Vehicles.** Approval ofheavy-duty vehicles over 14,000 Ibs. GVWR and incomplete medium-duty vehicles shall be based on an engineering evaluation of the system and data submitted by the applicant. Such evaluation may include successful public usage on light-duty or medium-duty vehicles, adequate capacity of storage containers, routing of lines to prevent siphoning, and other emissions-related factors deemed appropriate by the Executive Officer. For LPG systems, this engineering evaluation shall include: emissions from pressure relief valves, carburetion systems and other sources of leakage; emissions due to fuel system wear and aging, and evaporative emission test data from light-duty or medium-duty vehicles with comparable systems.

## E. Emission Standards

### 1. Evaporative Emission Standards for 2001 .and Subsequent Model Year Vehicles Other Than Motorcycles.

(a) For the 2001 through 2005 model year vehicles identified below, tested in accordance with the test procedure sequence set forth in Part III, the maximum projected total hydrocarbon evaporative emissions are:

| Class of Vehicle | Running Loss (grams per mile) | Three-Day Diurnal + HofSoak (grams per test) | Two-Day Diurnal + Hot Soak (grams per test) |
|---|---|---|---|
| Passenger Cars, Light-Duty Trucks | 0.05 | 2.0 | 2.5 |
| Medium-Duty Vehicles (6,001 - 8,500 lbs. GVWR) | | | |
| with fuel tanks < 30 | | | |

| Class of Vehicle | Running Loss (grams per mile) | Three-Day Diurnal + Hot Soak (grams per test) | Two-Day Diurnal + Hot Soak (grams per test) |
|---|---|---|---|
| gallons | 0.05 | 2.0 | 2.5 |
| with fuel tanks ≥ 30 gallons | 0.05 | 2.5 | 3.0 |
| Medium-Duty Vehicles (8,501 -14,000 lbs. GVWR) | 0:05 | 3.0 (1) | 3.5 |
| | 0.05 | 2.0 (2) | 3.5 |
| Heavy-Duty Vehicles (over 14,000 lbs. GVWR) | 0.05 | 2.0 | 4.5 |
| Hybrid Electric PCs, LDTs and MDVs | 0.05 | 2.0 | 2.5 |

(1) The standards in this row apply to medium-duty vehicles certified according to the exhaust standards in section 1961, title 13, CCR.

(2) The standards in this row apply to incomplete medium-duty vehicles certifying to the exhaust standards in section 1956.8, title 13, CCR.

(b) Zero emission vehicles shall produce zero fuel evaporative emissions under any and all possible operational modes and conditions.

(c) The optional zero-fuel evaporative emission standards for the three-day and two-day diurnal-plus-hot-soak tests are 0.35 grams per test for passenger cars, 0.50 grams per test for light-duty trucks 6,000 lbs. GVWR and under, and 0.75 grams per test for light-duty trucks from 6,001 to 8,500 lbs. GVWR, to account for vehicle non-fuel evaporative emissions (resulting from paints, upholstery, tires, and other vehicle sources). Vehicles demonstrating compliance with these evaporative emission standards shall also have zero (0.0) grams of fuel evaporative emissions per test for the three-day and two-day diurnal-plus-hot-soak tests. The "useful life" shall be 15 years or 150,000 miles, whichever occurs first. In lieu of demonstrating compliance with the zero (0.0) grams of fuel evaporative emissions per test over the three-qay and two-day diurnal-plus-'hot-soak tests, the manufacturer may submit for advance Executive Officer approval a test plan to demonstrate that the vehicle has zero (0.0) grams of fuel evaporative emissions throughout its useful life.

Additionally, in the case of a SULEV vehicle for which a manufacturer is seeking a partial ZEV credit, the manufacturer may prior to certification elect to have measured fuel evaporative emissions reduced by a specified value in all certification and in-use testing of the vehicle as long as measured mass exhaust emissions ofNMOG for the vehicle are increased in all certification and in-use testing. The measured fuel , evaporative emissions shall be reduced .in increments of 0.1 gram per test, and the measured mass exhaust emissions of NMOG from the vehicle shall be increased by a. gram per mile factor, to be determined by t,he Executive Officer, for every 0.1.gram per test by which the measured fuel evaporative emissions are reduced. For the purpc>se of this calculation, the evaporative emissions shall be measured, in grams 'per test, to a minimum of three significant figures.

(d) For the 2004 and subsequent model motor vehicles identified "below, tested in accordance with the test procedure sequence set forth in Part III, the maximum projected total hydrocarbon evaporative emissions are:

| Vehicle Type | Hydrocarbon Standards(1)(2) | | |
|---|---|---|---|
| | Running Loss (grams per mile) | Three-Day Diurnal + Hot Soak (grams per test) | Two-Day Diurnal . + Hot Soak (grams per test) |
| Passenger Cars | 0.05 | 0.50 | 0.65 |
| Light-Duty Trucks (under 8,501 lbs. GVWR) | | | |
| 6,000 lbs. GVWR and under | 0.05 | 0.65 | 0.85 |
| 6,001 - 8,500 lbs. GVWR | 0.05 | 0.90 | 1.15 |
| Medium-Duty Vehicles (8,501 - 14,000 lbs. GVWR) | 0.05 | 1.00 | 1.25 |
| Heavy-Duty Vehicles (over 14,000 lbs. GVWR) | 0.05 | 1.00 | 1.25 |

(1) (a) These evaporative emission standards shall be phased-in beginning with the 2004 model year. Each manufacturer, except small volume manufacturers, shall certify at a minimum the specified percentage of its vehicle fleet to the evaporative emission standards in this table or the optional zero-evaporative emission standards in section LE.1.(c) according to the schedule set forth below. For purposes of this paragraph (a), each manufacturer's vehicle fleet consists of the total projected California sales of the manufacturer's gasoline-fueled, liquefied petroleum-fueled and alcohol-fueled passenger cars; light-duty trucks, medium-duty vehicles, and heavy-duty vehicles.

*Minimum Percentage* of *Vehicles Certified to the*

| *Model Year* | *Standards in Sections LE.1.(c) and LE.1.(d)* |
|---|---|
| 2004 | 40 |
| 2005 | 80 |
| 2006 and subsequent | 100 |

A small volume manufacturer shall certify 100 percent of its 2006 and subsequent model vehicle fleet to the evaporative emission standards in the" table or the optional zere evaporative emission standards in sectionLE.1.(c).

All 2004 through 2005 model-year motor vehicles which are not subject to these standards or the standards in section E.1.(c) pursuant to the phase-in schedule shall comply with the requirements of sections section LE.1.(a).

(b) A manufacturer may use an "Alternative or Equivalent Phasein Schedule" to comply with the phase-in requirements. An "Alternative Phase-in" is one that achieves at least equivalent emission reductions by the end of the last model year of the scheduled phase in. Model-year emission reductions shall be calculated by mUltiplying the percent of vehicles (based on the manufacturer's projected Calibrnia sales volume of the applicable vehicle fleet) meeting the new requirements per model year by the number of model years implemented prior to and including the last model year of the scheduled phase-in. The "cumulative total" is the summation of the model-year emission reduc;tions (e.g., the three model-year *40/80/100* percent phase-in schedule would be calculated as: (40%*3 years) + (80%*2 years) + (100%*1 year) =380). The required cumulative total for the phase-in of these standards is 380 emission reductions. Any alternative phase-in that results in an equal or larger cumulative total than the required cumulative total by the end of the last model year of the scheduled phase-in shall be considered acceptable by the Executive Officer only if all vehicles subject to the phase-in comply with the respective requirements in the last model year of the required phasein schedule. A manufacturer shall be allowed to include vehicles introduced before the first model year of the scheduled phase-in (e.g., in the previous example, 10 percent introduced one year before the scheduled phase-in begins would be calculated as: (10%*4 yearsl=_40) and added to the cumulative total.

(c) These evaporative emission standards do not apply to zero-emission vehicles.

(2) In-use compliance whole vehicle testing shall not begin until the motor vehicle.is at least one year frOm the production date and has accumulated a minimum of 10,000 miles. For vehicles introduced prior to the 2007 model year, in-use compliance standards of 1.75 times the "Three-Day Diurnal + Hot-Soak" and "Two-Day Diurnal + Hot-Soak" gram per test standards shall apply for only the first three model years of an evaporative family certified to a new standard.

2. . **Evaporative Emission Standards for 2001 and Subsequent Model Year Motorcycles.** The maximum projected evaporative emission standards for 2001 and subsequent model gasoline-fueled motorcycles are:

| Motorcycle Class | Hydrocarbons (grams per test) |
|---|---|
| **Class I and Class II (50-279 cc)** | **2.0** |
| **Class III (280 cc and greater)** | **2.0** |

PART II. DURABILITY DEMONSTRATION

A. Light- and Medium-Duty Vehicles

1. Evaporative/refueling emission family determination. §86.1821-01 [No change.] ,

2. Durability Demonstration Procedures for Evaporative Emissions

2.0. Beginning with 2010 model-year vehicles or engines, at the time of certific,ation manufacturers shall state, based on good engineering judgment and available information, that the emission control devices on their vehicles or engines are durable and are designed and will be manufactured to operate properly and in compliance with all applicable requirements for the full useful life (or allowable maintenance interval) of the vehicles or engines. Also, vehicles and engines tested for certification shall be, in all material respects, substantially the same as production vehicles and engines. If it is determined pursuant to title 13 CCR, Division 3, Chapter 2, Article 5, sections 2166 through 2174 that any emission controlcomponent or device experiences a systemic failure because valid failures for that component or device meet or exceed four percent or 50 vehicles (whichever is greater) in a California-certified engine family or test group, it constitutes a violation of the foregoing test procedures and the Executive Officer of the Air Resources Board may require that the vehicles or engines be recalled or subjected to corrective action as set forth in title 13 CCR, Division 3, Chapter 2, Article 5, sections 2166 through 2174. Certification applications may not be denied based on the foregoing information provided that the manufacturer commits to correct the violation.

2.1. §86.1824-01 Amend as follows:

(a) and (b) Delete.
(c) [No change.]
(d) Delete.
*(e)* [No change.]

2.2. For all passenger cars, light-duty trucks and chassis-certified medium-duty vehicles subject to the standards specified in section I.E.:. of these test procedures, demonstration of system durability and determination of three-day diurnal plus hot soak, twO-day diurnal plus hot soak, and running loss emission deterioration factors ("evaporative DFs") for each evaporative/refueling family shall be based on tests of . representative vehicles and/or systems. For purposes of evaporative emission durability testing, a representative vehicle is one which, with the possible exception of the engine and drive train, was builtat least three months prior to the commencement of evaporative emission testing, or is one which the manufacturer demonstrates has stabilized non-fuel-related evaporative emissions.

2.3. Prior to commencement of a durability program, the manufacturer shall propose a method for durability testing and-for determination of evaporative DFs for each evaporative/refueling family. The 4,000 and full useful life mile test points (or their equivalent) used in determining a OF must be within the standards of section I.E. or data will not be acceptable for use in the calculation of a DF. A manufacturer is not required to obtain a new approval to use a previously approved evaporative emission durability procedure. The Executive Officer shall review the method, and shall approve it if it meets the following requirements:

2.3.1. The method must cycle and test the complete evaporative emission control system for the equivalent of the applicable vehicle useful life (i.e., 100,000 'or 120,000 miles) of typical customer use.

2.3.2. The method must reflect the· flow of liquid and gaseous fuel through the evaporative emission control system, and the exposure (both peak and cyclical) to heat, vibration, and ozone expected based on typical customer use through the applicable useful life.

2.3.3. The method must have the specifications for acceptable system performance, including maximum allowable leakage based on typical customer use through the applicable vehicle useful life.

2.4. (a) In addition to the requirements of subparagraphsection 11.A.2.3. above, for evaporative/refueling families subject to testing for exhaust emission durability, at least one evaporative emission test shall be conducted at 5,000, 40,000, 70,000, and 100,000 mile test points for all passenger car, and light-duty truck durability vehicles and at 5,000,40,000,70,000,90,000, and 120,000 mile test points for all medium-duty durability vehicles. With prior written approval from the Executive Officer, manufacturers may. terminate evaporative emissions testing at the mileage corresponding to 75 percent of the vehicle's useful life if no significant vehicle maintenance or emissions change are observed. Testing may be performed at different intervals as determined by the manufacturer using good engineering judgment. Evaporative emission testing may be performed at corresponding exhaust emission mileage points as set forth in Ssection F.4. (40 CFR§86.1823) of the "California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles,." as inoorporated by referenoe in §1961(d), title 13, CCR. The 4,000 and full useful life mile test points (or their equivalent) used in determining a DFmust be within the standards of section I.E. or data will not be acceptable for use in the calculation of a OF.

(b) For evaporative families subject to the requirements of subparagraphsection II.A.2.4.(a), manufacturers may demonstrate compliance by conducting an exhaust and evaporative emission test sequence at the end of the useful life of the exhaust durability data vehicle if the procedure set forth in subparagraphsection II.A.2.3. includes on-road, useful life deterioration on the evaporative test vehicle. The evaporative test vehicle used to meet the criteria in subparagraphsection 11.A.2.3.:. must be deteriorated based on typical customer use throughout the applicable useful life. The manufacturer may perform unscheduled maintenance on the evaporative test vehicle at the final test point only upon prior' Executive Officer approval, which shall be granted if the Executive Officer determines that the exhaust emission control system will not be affe'cted, and the manufacturer demonstrates that the effectiveness of the evaporative emission control system is not diminished. The unscheduled maintenance must be conducted in accordance with 40 CFR §86.1834-01 as amended by the "California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles,.:." as'inoorporated by referenoe in §1961(d), title 13, CCR.

2.5.:. The evaporative DFs determined under subparagraptlsection II.A. 2.4.:., if any, shall be averaged with the evaporative DFs determined under sUbparagraphsection 11.A.2.3.:. to determine a single evaporative OF for each evaporative/refueling family. Evaporative DFs shall be generated for the running loss test and for the hot soak and the diurnal test in the three-day diurnal sequence, and for the hot soak and the diurnal test in the two-day diurnal sequence. The manufacturer may carry-across the OF generated in the three-day diurnal sequence to the two-day diurnal sequence if the manufacturer can demonstrate that the DF generated in the three-day diurnal sequence is at least as great as the OF generated in the two-day diurnal sequence.

3. **Assigned DFs**

3.1. §86.1826-01. [No change.]

3.2.:. Any manufacturer may request to certify evaporative/refueling families using assigned DFs for a combined tot.al of 4,500 projected annual Californ'ia sales of passenger cars, light-duty trucks, medium-duty vehicles, and heavy-duty engines per manufacturer regardless of total sales.

3.3.:. Assigned DFs shall be used only where specific evaporative durability data do not exist. Assigned DFs shall be used in lieu of data from durability vehicle(s) only when a manufacturer demonstrates that it has control over design specifications, can provide development data, has in-house testing capabilities including accelerated aging of components/systems, and has evaluation criteria to ,ensure emission control system (ECS) durability for the vehicle's useful life. The applying manufacturer must demonstrate that evaporative emission control system(s) developed or adapted for the particular vehicle will be durable and comply with the applicable emission standards for the vehicle's useful life. In evaluating any information provided, all relevant test data and design factors shall be considered, including but not limited to: canister nominal working capacity and location, purge strategy, method of purge control, fuel tank capacity, variables affecting fuel temperature (use of fuel return, material, shape of fuel tank, distance of fuel tank from road surface and distance from exhaust pipe, total underbody airflow), fuel and vapor hose materials, use of sensors and auxiliary control devices, technical comparison to an evaporative emission control system and the durability of any evaporative emission control system components that may have been used in other vehicle applications. The assigned DFs shall be applied only to entire evaporative/refueling families.

3.3.1. If emission control parts from other certified vehicles are utilized, then. parameter comparisons of the above data must also be provided including part numbers where applicable. Evaporative emission control durability may include special in-house specifications.

3.4.:. The criteria for evaluating assigned DFs for evaporative/refueling families are the same as those for exhaust families. However, in determining evaporative/refueling family DFs these test procedures require that an evaporative family OF be determined by averaging DFs obtained from durability vehicle testing and from bench testing. Therefore, if a manufacturer meets the criteria as specified above, the Executive Officer may grant assigned DFs for either (or both) the durability vehicle OF or the bench DF.

3.5.:. Assigned DFs for bench test requirements do not depend upon the 4,500 maximum sales limit. The assigned bench OF is applicable on'ly to evaporative emission control systems which are similar to those used by the manufacturer for 1998 or later model-year vehicles and where.an evaporative OF was determined.

4. Emission Data Vehicle Selection

4.1. §86.1828-01 [No change.]

4.2. In selecting medium-duty test vehicles, the Executive Officer shall consider the availability of test data from comparably equipped light-duty vehicles and the size of medium-duty vehicles as it relates to the practicability of evaporative emission testing.

5. Durability and Emission Testing Requirements; waivers

5.1. §86.1829-01 (December 8,2005). [No change, except as otherwise noted.]

5.2. References to the "EPA" shall mean the Executive Officer of the Air Resources Board.

. 5.3. The optional provision for a manufacturer to provide a statement of compliance in lieu of a demonstration of compliance with the supplemental two-day diurnal plus hot soak 'emission standard for certification purposes, as contained in §86.1829-01 (b)(2)(iii), shall be applicable to gasoline- and ethanol-fueled passenger cars, light-duty trucks, and medium-duty vehicles, including hybrid electric, fuel-flexible, dual fuel, and bi-fuel vehicles. Heavy-duty vehicles over 14,000Ibs. GVWR and. incomplete medium-duty vehicles shall comply with the requirements of section 1.0.2.

5.4. For purposes of certification, a 2011 and subsequent off-vehicle charge capable hybrid electric vehicle shall demonstrate the capability to sufficiently purge its evaporative canister(s} during the exhaust emission test of the supplemental two-day diurnal plus hot soak emission test sequence.

5.4.1. This capability shall be demonstrated through compliance with the supplemental two-day diurnal plus hot soak emission standard. using the test sequence as specified in section 111.0.3.1.18.. except that the battery state-of-charge setting prior to the standard three-phase exhaust test shall be at the lowest level allowed by the manufacturer in order to maximize the cumulative amount of the auxiliary power unit activation during the three-phase exhaust test. Performance of this demonstration shall be in addition to the demonstration of compliance with the supplemental two-day diurnal plus hot soak emission standard required under section I.E.1., using the test sequence specified in section 111.0.3.1.18.

5.4.2. In lieu of conducting the demonstration described in section 11.A.5.4.1., a manufacturer may optionally conduct an engineering evaluation that demonstrates the evaporative emission control system's capability to sufficiently purge its evaporative canister(s} during the exhaust emission test of the supplemental two-day diurnal plus hot soak emission test sequence. Such an evaluation shall be submitted to the Executive Officer. if requested. The manufacturershall provide a statement of compliance in the certification application to indicate that the evaporative emission control system will sufficiently purge the system's evaporative canister(s} during the supplemental two-day diurnal plus hot-soak test sequence. The evaluation would include. but not be limited to, canister type, canister volume. canister working capacity, fuel tank volume, fuel tank geometry, fuel delivery system, description of the input parameters and software strategy used to control canister purge. and nominal purge flow volume (i.e.! amount of bed volumes) achieved by a test vehicle after completing the exhausttest of a supplemental two-day diurnal plus hot soak emission test sequence.

B. Motorcycles

1. Durability Requirements. Certification of a motorcycle evaporative emission control system reqLiires that the manufacturer demonstrate the durability of each evaporative emission control system family.

1.1. The motorcycle manufaCturer can satisfy the vehicle durability testing requirements by performing an evaporative emission test at each scheduled exhaust emission test (40 CFR §86.427-78) during the motorcycle exhaust emission certification test (40 CFR §86.425-78) for each evaporative emission family. The minimum mileage accumulated shall be the total distance (one-half the useful life distance), although the

manufacturer may choose to extend the durability test to the useful life distance .
(40 CFR §86.436-78). The displacement classes and test distances are shown below:

| Displacement Class | Engine Displacement Range (cc) | Total Test Distance (km) | Useful Life Distance (km) |
|---|---|---|---|
| | 50-169 | 6,000 | 12,000 |
| II | 170-279 | 9,000 | 18,000 |
| III | 280 and greater | 15,000 | 30,000 |

(i) All durability vehicles shall be built at least one month before the evaporative emissions test, or the manufacturer must demonstrate that the non-fuel related evaporative emissions have stabilized.

(ii) Testing at more frequent intervals than the scheduled exhaust· emissions tests may be performed only when authorized in writing by the Executive Officer.

(iii) The OF shall be determined by calculating a least-squares linear. regression of the evaporative emissions data with respect to mileage. The DF is defined as the extrapolated (from the regression) value at the useful life distance minus the interpolated value at the total test distance, where these distances are taken from the table in paragraphsection II.B.1.1.:., above.

(iv) The extrapolated useful life and total test distance emissions shall be less than the applicable evaporative emission standards of section 1.E.2.:. or the data will not be acceptable for use in the calculation of a OF and demonstration of compliance.

(v) Motorcycle manufacturers may use the ARB Component Bench Test Procedures or propose in their application a method for durability bench testing and determination of a OF foreach evaporative family. The Executive Officer shall review the method, and shall approve it if it is similar to the requirements specified below. Any reference to 4,000 miles and 50,000 miles shall mean total test distance and useful life distance, respectively, as defined in paragraphsection II.B.1.1.:. for the appropriate engine displacement class.

The manufacturer shall propose in its preliminary' application for certification a method for durability testing and for determination of a OF for each evaporative family. The 4,000 and 50,000 mile test points (or their equivalent) used in determining the OF must be within the standards of sectionII.B1.1. or data will not be acceptable for use in the calculation of a OF. The Executive Officer shall review the method, and shall approve it if it meets the following requirements:

(A) The method must cycle and test the complete evaporative emission control system for the equivalent of at least 50,000 miles of typical customer use.

(8) The method must reflect the flow of liquid and gaseous fuel through the evaporative emission control system, and the exposure (both peak and cyclical) to heat, vibration, and ozone expectedthrough 50,000 miles.of typical customer use.

(C) The method must have the specifications for acceptable. system performance, including maximum allowable leakage after 50,000 miles of typical customer use.

(vi) The OF determined under paragraphsection II.B.1.1jiii) shall be averaged with the OF determined under paragraphsection II.B.1.1.(v) to determine a single evaporative emission OF for each evaporative family. For those motorcycles that do not require exhaust emission control system durability testing; the evaporative emission control system OF shall be determined under paragraphsection II.B.1.1jv)· only. Compliance with the standard shall be demonstrated by performing an evaporative emission test on a stabilized motorcycle. The motorcycle shall have accumulated at least the minimum test distance. The extrapolated useful life dfstance. emissions after applying the bench test-derived DF shall be less than the applicable evaporative emission standards of paragraphsection 1.E.2.

(vii) (A) Manufacturers of Class III motorcycles may elect to use an assigned evaporative emission control system DF, provided they meet the following requirements:

- Annual California motorcycle sales do not exceed 500 units, and .

- The evaporative emission control system has been previously certified to meet the emission standards specified in these procedures, or the manufacturer provides test data from previous certification demonstrating that the system complies with the' durability requirements set forth in this paragraphsection.

(8) Manufacturers of Class III motorcycles using an assigned evaporative emission control system DF pursuant to paragraphsection II.B.1.1jvii)(A) may submit a written request for a waiver of evaporative. emission testing. The waiver shall be granted if the Executive Officer determines that the motorcycles will comply

with the evaporative emission standard. The determination shall be based on the performance of the evaporative emission control system on' other motorcycles, the capacity of vapor storage containers, the routing of lin.es to prevent siphoning, and other emission-related factors determined by the Executive Officer to be relevant to evaluation of the waiver request.

(C) Nothing in this paragraphsection shall be construed as an exemption from the exhaust emission standards and test procedures applicable pursuant to section 1958, title 13, CCR or paragraphsection IV.4.(ii) of these test procedures.

(viii) The emission label (40 CFR §86.413-78) shall identify the evaporative emission family.

1.2. Motorcycle manufacturers with annual sales of less than 2,000 units for the three displacement classes in California are not required to submit the information specified by these test procedures to the Executive Officer. However, all information required by these test procedures must be retained on file and be made available on request to the Executive Officer for inspection. These manufacturers shall submit the following information for evaporative emission certification:

(i) A brief description of the vehicles to be covered by the Executive Order. (The manufacturer's sales data book or advertising, including specifications, will satisfy this requirement for most manufacturers.)

(ii) A statement signed by an authorized representative of the manufacturer stating "The vehicles described herein have been tested in accordance , with the provisions of the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles," and on the basis of those tests, are in conformance with the aforementioned standards and test procedures."

1.3. The definitions for motorcycle evaporative emission families as set forth in EPA's MSAPC Advisory Circular No. 59, section D shall apply. '

# PART III. EVAPORATIVE EMISSION TEST PROCEDURES FOR L1GHT- AND MEDIUM-DUTY VEHICLES

## A. Instrumentation

The instrumentation necessary to perform evaporative emission testing is described in 40 CFR 86.107-90. The following language is applicable in lieu of 40 CFR §86.107-90(a)(1):

### 1. Diurnal Evaporative Emission Measurement Enclosure

1.1.:. The diurnal evaporative emissions measurement enclosure shall be equipped with an internal blower or blowers coupled with an air temperature management system (typically air to water heat exchangers and associated programmable temperature controls) to provide for air mixing and temperature control. The blower(s) shall provide a nominal total flow rate of 0.8 ± 0.2 $ft^3$/min per $ft^3$ of the nominal enclosure volume, $V_n$. The inlets and outlets of the air circulation blower(s) shall be configured to provide a well dispersed air circulation pattern that produces effective internal mixing and avoids significant temperature or hydrocarbon and alcohol stratification. The discharge and intake air diffusers in the enclosure shall be configured and adjusted to eliminate localized high air velocities which could produce non-representative heat transfer rates between the vehicle fuel tank(s) and the air in the enclosure. The air circulation blower(s), plus any additional blowers if needed, shall also maintain a minimum wind speed of 5 mph under-the fuel tank of the test vehicle. The Executive Officer may adjust wind speed and location to ensure sufficient air circulation around the fuel tank. The wind speed requirement may be satisfied by consistently using a blower configuration that has been demonstrated to meet a broad 5-mph air flow in the vicinity of the vehicle's fuel tank, subject to verification by the Executive Officer.

1.1.1. The enclosure temperature shall be taken with thermocouples located 3 feet above the floor of the approximate mid-length of each side wall of the enclosure and within 3 to 12 inches of each side wall and with a thermocouple located underneath the vehicle where it would provide a temperature measurement representative of the temperature of the air under the fuel tank. The temperature conditioning system shall be capable of controlling the internal enclosure air temperature to follow the prescribed temperature versus time cycle as specified in 40 CFR §86.133-90 as modified by paragraphsection 111.0.10.:. (diurnal breathing loss test) of these procedures within an instantaneous tolerance of ± 3.0°F and an average tolerance of ± 2.0°F as measured by' the vehicle underbody thermocouple, and within an instantaneous tolerance of ± 5.0°F as measured by the side wall thermocouples. The control system shall be tuned to provide a smooth temperature pattern which has a minimum of overshoot, hunting, and instability about the desired long term temperature profile.



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1.2.:. The enclosure shall be of sufficient size to contain the test vehicle with personnel access space. It shall use materials on its interior surfaces which do not adsorb or desorb hydrocarbons, or alcohols (if the enclosure is used for alcohol-fueled vehicles). The enclosure shall be insulated to enable the test temperature profile to be achieved with a heating/cooling system which has minimum surface temp.eratures in the enclosure no less than 25.0°F below the minimum diurnal temperature specification. The enclosure shall be equipped with a pressure transducer with an accuracy and precision of ± 0.1 inches $H_2O$. The enclosure shall be constructed with a minimum number of seams and joints which provide potential leakage paths. Particular attention shall be given to sealing and gasketingof such seams and joints to prevent leakage.

1.3.:. The enclosure shall be equipped with features which provide for the' effective enclosure volume to expand and contract in response to both the temperature changes of the air mass in the enclosure, and any fluctuations in the ambient barometric pressure durihgthe duration of the test. Either a variable volume enclosure or a fixed volume enclosure may be used for diurnal emission testing.

1.3.1. The variable volume enclosure shall have the capability of latching or otherwise constraining the enclosed volume to a known, fixed value, $V_n$. The $V_n$ shall . be determined by measuring all pertinent dimensions of the enclosure in its latched configuration, including internal fixtures, based on a temperature of 84°F, to an accuracy of ± 1/8 inch (0.5 cm) and calculating the net $V_n$ to the nearest 1 ft3. In addition, $V_n$ shall be measured based on a temperature of 65°F and 105°F. The latching system shall provide a fixed volume with an accuracy and repeatability of $0.005xV_n$. Two potential means of providing the volume accommodation capabilities are a moveable ceiling which is joined to the enclosure walls with a flexure; or a flexible bag or bags of Tedlar or other suitable materials which are installed in the enclosure and provided with flowpaths which communicate with the ambient air outside the enclosure. By moving air into and out of the bag(s), the contained volume can be adjusted dynamically. The total enclosure volume accommodation shall be sufficient to balance the volume changes produced by the difference between the extreme enclosure temperatures and the ambient laboratory temperature with the addition of a superimposed barometric pressure change of 0.8 in. Hg. A minimum total volume. accommodation range of $\pm 0.07xV_n$ shall be used. The action of the enclosure volume accommodation system shall limit the differential between the enclosure internal pressure and the external ambient barometric pressure to a maximum value of ± 2.0 inches $H_2O$.

1.3.2.:. The fixed volume enclosure shall be.constructed with rigid panels that maintain a fixed enclosure volume, which shall be referred to as $V_n$. $V_n$ shall be determined by measuring all pertinent dimensions of the enclosure including internal fixtures to an accuracy of ± 1/8 inch (0.5 cm) and calculating the net $V_n$ to the nearest 1 ft3. The enclosure shall be equipped with an outlet flow stream that withdraws air at a low, constant rate and provides makeup air as needed, or by reversing the flow of air into and out of the enclosure in response to rising or falling temperatures. If inlet air is added continuously throughout the test, it must be filtered with activated carbonto provide a relatively constant hydrocarbon and alcohol level. Any method of volume accommodation shall maintain the differential between the enclosure internal pressure and the barometric pressure to a maximum value of ±2.0 inches of water. The equipment shall be capable of measuring the mass of hydrocarbon, and alcohol (if the enclosure is used for alcohol-fueled vehicles) in the inlet and outlet flow streams with a resolution of 0.01 gram. A bag sampling system may be used to collect a proportional sample of the air withdrawn from and admitted to the enclosure. Alternatively, the inlet and outlet flow streams may be continuously analyzed using an on-line Flame Ionization Detector (FIO) analyzer and integrated with the flow measurements to provide a continuous record of the mass hydrocarbon and alcohol removal.

1.4. An online computer system or stripchart recorder shall be used to record the following parameters during the diurnal evaporative emissions test sequence:

-Enclosure internal airtemperature
-Diurnal ambient air temperature specified profile as defined in 40 CFR §86.133-90 as modified in paragraphsection III.D.10.:. (diurnal breathing loss test).
-Vehicle fuel tank liquid temperature
-Enclosure internal pressure
-Enclosure temperature control system surface temperature(s)
-FIO output voltage recording the following parameters for each sample analysis:

-zero gas and span gas adjustments
-zero gas- reading .
-enclosure sample reading .
-zero gas and span gas readings

1.4.1. The data recording system shall have a time resolution of 30 seconds and' shall provide a permanent record in either magnetic, electronic or paper media of the above parameters for the duration of the test.

1.5. Other equipment configurations may be used if approved.in advance by the Executive Officer. The Executive Officer shall approve alternative equipment configurations if the manufacturer demonstrates that the equipment will yield test results equivalent to those resulting from use of the specified equipment.

2. Running Loss Measurement Facility

2.1. For all types of running loss measurement test facilities, the following shall apply:

2.1.1. The measurement of vehicle running loss fuel vapor emissions shall be conducted in a test facility which is maintained at a nominal ambient temperature of 105.0°F. Manufacturers have the option to perform running loss testing in either an enclosure incorporating atmospheric sampling equipment, or in a cell utilizing point source sampling equipment. Confirmatory testing or in-use compliance testing may be conducted by the Executive Officer using either sampling procedure. The test facility shall have space for personnel access to all sides of the vehicle arid shall be equipped with the following test equipment:

-A chassis dynamometer which meets the requirements of 40 CFR §86.108-00 with the following addition to §86.1 08-00(d):

Another dynamometer configuration may be used for running loss testing if approved in advance by the Executive Officer based on a demonstration that measured running loss emissions are equivalent to the emissions using the single-roll electric dynamometer described in 86.108-00(b)(2).

-A fuel tank temperature management system which meets the requirements specified in section 1I1.A.2.1.3:. of this paragraph.

-A running loss fuel vapor hydrocarbon analyzer which meets the requirements specified in 40 CFR §86.1 07-90(a)(2)(i) and a running loss fuel vapor alcohol analyzer which meets the requirements specified in 40 CFR §86.107-90(a)(2)(ii).

-A running loss test data recording system which meets the requirements specified in section III.A.2.1.4:. of this paragraph.

2.1.2. All types of running loss test facilities shall be configured to provide an internal ambient temperature of 105°F ± 5°F maximum and ± 2°F on average throughout the running loss test sequence. This shall be accomplished by anyone or combination of the following techniques:

-Using the test facility without artificial cooling and relying on the residual heat in the test vehicle for temperature achievement.

-Adding insulation to the test facility walls.

-Using the test facility artificial cooling system (if so equipped) with the setpoint of the cooling system adjusted to a value not lower than 105.0°F, where the cooling system set point refers to the internal test facility air temperature..

-Using a full range test facility temperature management system with heating and cooling capabilities.

2.1.3. Cell/enciosuretemperature management shall be measured at the inlet of the vehicle cooling fan. The vehicle cooling fan shall be a road speed modulated fan which is controlled to a discharge velocity which matches the dynamometer roll speed at least up to 30 mph throughout the driving .cycle. The fan outlet may discharge airflow to both the vehicle radiator air inlet(s) and the vehicle underbody. An additional fan, not to exceed 8,000 cfm, may be used to discharge airflow from the front of the vehicle directly to the vehicle underbody to control fuel temperatures.

2.1.3.1. The fuel tank temperature management system shall be configured and operated to control the fuel tank temperature profile of the test vehicle during the running loss test sequence.' The use of a discrete fuel tank temperature management system is not required provided that the existing temperature and airflow conditions in the test facility are sufficient to match the on-road fuel tank liquid (Tliq) temperature. profile of the test vehicle within a tolerance of ± 3.0°F throughout the running loss driving cycle, and, if applicable, the fuel tank vapor ($T_{vap}$) temperature profile of the test vehicle within a tolerance of ± SOF throughout the running loss driving cycle and ± 3.0°F during the final 120 second idle period of the test. The system shall provide a ducted air flow directed at the vehicle fuel tank which can be. adjusted in flow rate and/or temperature of the discharge air to manage the fuel tank temperature. The system shall monitor the vehicle fuel tank temperature sensors located in the tank according to the specifications in paragraphsection III.C.1.:. (40 CFR §86.129-80) during the running loss drive cycle. The measured temperature shall be compared to a reference on-road profile for the same platform/powertrain/fuel tank combination developed according to the procedures in section III.C.1.:. (40 CFR §86.129-80). The system shall adjust the discharge flow and/or temperature of the outlet duct to maintain the tank liquid temperature profile within ± 3.0°F of the reference on-road liquid temperature profile throughout the test. If applicable, the vapor temperature shall match the reference on-road vapor temperature profile within ± S.OoF throughout the test and ± 3.0°F during the final 120 second idle period. The system shall be designed to avoid heating or cooling of the fuel tank vapor space in a way that would cause vapor temperature behavior to be unrepresentative of the vehicle's on-road vapor profile. The system shall provide a discharge airflow up to 4,000 cfm. With advance Executive Officer approval, the system may provide a discharge airflow with a maximum of 6,000 cfm.

2.1.3.2. Blowers or fans shall be used to mix the enclosure contents during evaporative emission testing. The blowers or fans shall have a total capacity of at least 1.0 $ft^3$/min per ft3 of $V_n$. The inlets and outlets of the air circulation blower(s) shall be configured to provide a well dispersed air circulation pattern that produces effective internal mixing and avoids significant temperature or hydrocarbon and alcohol stratification.

2.1.3.3. . The temperature of the air supplied to the outlet duct shall be within a range of 90°F to 160°F for systems which utilize artificial heating and/or cooling of the air supply to the outlet duct. This requirement does not apply to systems which recirculate air from inside the test cell without temperature conditioning the airflow. The control system shall be tuned and operated to provide a smooth and continuous fuel tank temperature profile which is representative of the on-road temperature profile.

2.1.3.4. Direct fuel heating may be used to control fuel temperatures for vehicles under exceptional circumstances in which airflow alone is insufficient to control fuel temperatures. The heating system must not cause hot spots on the tank wetted surface that could cause local. overheating of the fuel. Heat must not be applied to the vapor in the tank above the liquid fuel, nor near the liquid-vapor interface.

. 2.1.4. An on-line computer system or strip-chart recorder shall be used to record the following parameters during the running. loss test sequence:

-Cell/enclosure ambient temperature
-Vehicle fuel tank liquid (Tuq) and, if applicable, vapor space ($T_{vap}$) temperatures
-Vehicle coolant temperature
-Vehicle fuel tank headspace pressure
-Reference on-road fuel tank temperature profile developed according to paragraphsection III.C.1. (40 CFR §86.129-80)
-Dynamometer rear roll speed (if applicable)
-FIO output voltage recording the following parameters for each sample analysis:
    -zero gas and span gas adjustments
    -zero gas reading
    -dilute sample bag reading (if applicable)
    -dilution air sample bag reading (if applicable)
    -zero gas and span gas readings

-methanol sampling equipment data:
    -the volumes of deionized water introduced into each impinger
    -the rate and time of sample collection
    -the volumes of each sample introduced into the gas chromatograph
    -the flow rate of carrier gas through the column
    -the column temperature
    -the chromatogram of the analyzed sample

2.2. If an enclosure, or atmospheric sampling, running loss facility is used, the following requirements (in additionto those in subaragraphsection III.A.2.1. above) shall also be applicable:

2.2.1. The enclosure shall be readily sealable and rectangular in shape. When sealed, the enclosure shall be gas tight in accordance with 40 CFR 86.117-90. Interior surfaces shall be impermeable and non-reactive to hydrocarbons, and to alcohol (if the enclosure is used for alcohol-fueled vehicles). One surface should be of flexible, impermeable, and non-reactive material to allow for minor volume changes, resulting from temperature changes.

. 2.2.2. In the event an artificial cooling or heating system is used, the surface temperature of the heat exchanging elements shall be a minimum of 70.0°F.

2.2.3. The enclosure shall be equipped to supply air to the vehicle, at a temperature of 105 ± SOF, from sources outside of the running loss enclosure directly into the operating engine's air intake system. Supplemental air requirements shall be supplied by drawing air from the engine intake source.

2.3:. If a point source running loss measurement facility (cell) is used, the· following requirements (in addition to those in subaragraphsection 1I1.A.2.1:. above) shall also be applicable:

2.3.1. The running loss vapor collection system shall be configured to collect all running loss emissions from each of the discrete emissions sources, which include vehicle fuel system vapor vents, and transport the collected vapor emissions to a CFV or PDP based dilution and measurement system. The collection system shall consist of a collector at each discrete vehicle emissions source, lengths of heated sample line connecting each collector to the inlet of the heated sample pump, and lengths of heated sample line connecting the outlet of the heated sample pump to the inlet of the running loss fuel vapor sampling system. Up to 3 feet of unheated line connecting each of the vapor collectors to the heated sample lines shall be allowed. Each heated sample pump and its associated sample lines shall be maintained at a temperature between 17S.0$^{o}$F and 200.0$^{0}$F to prevent condensation of fuel vapor in the sample lines. The heated sample pump(s) and its associated flow controls shall be configured and operated to draw a flow of ambient air into each collector at a flow rate of at least 40 standard cubic feet per hour (SCFH). The flow controls on each heated sampling system shall include an indicating flow meter which provides an alarm output to the data recording system if the flow rate drops below 40 SCFH by more than S percent. The collector inlet for each discrete emissions source shall be placed in proximity to the source as necessary to capture any fuel vapor emissions without significantly affecting flow or pressure of the normal action of the source. The collector inlets shall be designed to interface with the configuration and orientation of each specific source. For vapor vents which terminate in a tube or hose barb, a short length of tubing of an inside diameter larger throughout its length than the inside diameter of the vent outlet, may be used to extend the vent into the mouth of the collector as illustrated in Figure 1. For those vapor vent designs which are not compatible with such collector configurations and other emissions sources, the 'vehicle manufacturer shall supply a collector which is configured to interface with the vapor vent design orthe specific emissions source design, and which terminates in a fitting approved by the Executive Officer. The Executive Officer shall approve the fitting if the manufacturer demonstrates that it is capable of capturing all vapors emitted from the source.

2.3.2. The running loss fuel vapor sampling system shall bea CFV or PDP based dilution and measurement system which further dilutes therunning loss fuel vapors collected by the vapor collection system(s) with ambient air, collects continuously proportional samples of the diluted running loss vapors and dilution air in sample bags, and measures the total dilute flow through the sampling system over each test interval. In practice, the system shall be configured and operated in a manner which 'is directly analogous to an exhaust emissions constant volume sampling system, except that the input flow to the system is the flow from the running loss vapor collection system(s) instead of vehicle exhaust flow. The system shall be configured and operated to meet the following requirements:

2.3.2.1.~~(1)~~ The running loss fuel vapor sampling system shall be designed to measure the true mass of fuel vapor emissions collected by the running loss vapor collection system from the specified discrete emissions source. The total volume of the mixture of running loss emissions and dilution air shall be measured, and a continuously proportionated sample of volume shall be collected for analysis. Mass emissions shall be determined from the sample concentration and total flow over the test period.

2.3.2.2.~~(2)~~ The PDP-CVS shall consist of a dilution air filter and mixing assembly, heat exchanger, positive displacement pump, sampling system, and associated valves, pressure and temperature sensors. The PDP-CVS shall conform to the following requirements:

-The gas mixture temperature, measured at a point immediately ahead of the positive displacement pump, shall be within ±10°F of the designed operating temperature at the start of the test. The gas mixture temperature variation from its value at the start of the test shall be limited to ± 10°F during the entire test. The temperature measuring system shall.have an accuracy and precision of ± 2°F.

-The pressure gauges shall have an accuracy and precision of ± 1.6 inches of water (± 0.4 kPa).

-The flow capacity of the CVS shall not exceed 350 CFM (0.165 $m^3$/s).

- Sample collection bagsJor dilution air and running loss fuel vapor samples shall be sufficient size so as not to impede sample flow.

2.3.2.3.~~(3)~~ The CFV sample system shall consist of a dilution air filter and mixing assembly, a sampling venturi, a critical flow venturi, a sampling system and assorted valves, and pressure and temperature sensors. The CFV sample system shall conform to the following requirements:

-The temperature measuring system shall have an accuracy and precision of ± 2°F and a response time of 0.100 seconds of 62.5 percent of a temperature change (as measured in hot silicone oil).
-The pressure measuring system shall have an accuracy and precision of ± 1.6 inches of water (0.4 kPa).
-The flow capacity of the CVS shall not exceed 350 CFM (0.165 $m^3$/s).

-Sample collection bags for dilution air and running loss fuel vapor samples shall be of sufficient size so as not to impedesampl.e flow.

2.3.3. The on-line computer system or strip-chart recorder specified in section 1I1.A.2.1.4.:. of this paragraph shall be used to record the following additional parameters during the running loss test sequence, if applicable:

-CFV (if used) inlet temperature and pressure
-PDP (if used) inlet temperature and pressure and differential pressure
-Running loss vapor collection system low flow alarm events

2.4. Other equipment configurations may be used if approved in advance by the Executive Officer. The Executive Officer shall approve alternate equipment configurations if the manufacturer demonstrates that the equipment will yield test results equivalent to those resulting from use of the specified equipment.

### 3. Hot Soak Evaporative Emission Measurement Enclosure

3.1. The enclosure shall be readily sealable, rectangular in shape, with space for personnel access to all sides of the vehicle. When sealed, the enclosure shall be gas tight in accordance with §86.117-90. Interior surfaces shall be impermeable and non-reactive to hydrocarbon, and to alcohol (if the enclosure is used for alcohol-fueled vehicles). One surface shall be of flexible, impermeable and non-reactive material to allow for minor volume changes, resulting from temperature changes. The enclosure shall be configured to provide an internal enclosure ambient temperature of 105°F ± 5°F maximum and ±2°F on average during the test time interval from 5 minutes after the enclosure is closed and sealed until the end of the one hour hot soak interval. For the first 5 minutes, the ambient temperature shall be maintained at 105°F ± 10°F. The enclosure shall be equipped with an' internal air circulation blower(s). The blower(s) shall be sized to provide a nominal total flow rate within a range of 0.8 ± 0.2 ft3tmin per ft3 of $V_n$• The inlets and outlets of the blower(s) shall be configured to provide a well dispersed air circulation pattern that produces effective internal mixing and avoids significant temperature or hydrocarbon and alcohol stratification. The discharge and intake air diffusers in the enclosure shall be configured and adjusted to'eliminate localized high air velocities which could produce non-representative heat transfer rates between the vehicle fuel tank(s) and the air in the enclosure. The enclosure temperature shall be taken with thermocouples located 3 feet above the floor of the approximate mid-length of each side wall of the enclosure and within 3 to 12 inches of each side wall. This shall be accomplished by anyone or combination of the following techniques:

-Using the enclosure without artificial cooling and relying on the residual heat in the test vehicle for temperature achievement.

-Adding insulation to the enclosure walls.

-Using the enclosure artificial cooling·system (if so equipped) with the set point of the cooling system adjusted to a value not lower than 105.O°F, where the cooling system set point refers to the internal enclosure air temperature.

-Using a full range enclosure temperature management system with heating and cooling capabilities.

3.2. In the event an artificial cooling or heating system is used, the surface temperature of the heat exchanging elements shall be a minimum of 70.0°F.

3.3. The requirements in 40 CFR§86.1 07-90(a)(4) shall not apply.

**B. Calibrations**

1. Evaporative emission enclosure calibrations are specified in 40 CFR §86.117-90. Methanol measurements may be omitted when methanol-fueled vehicles will not be tested in the evaporative enclosure. Amend 40 CFR §86.117-90 to include an additional subsection III.B.1.1., to read:

1.1.:. Diurnal evaporative emission enclosure. The diurnal evaporative emission measurement enclosure calibration consists of the following parts: initial and periodic determination of enclosure background emissions, initial determination of enclosure volume, and periodic hydrocarbQn (HC) and methanol retention check and calibration. Calibration for HC and methanol may be conducted in the same test run or in sequential test runs.

1.1.1.:. The initial and periodic determination of enclosure background emissions shall be conducted according to the procedures specified in §86.117-90(a)(1) through (a)(6). The enclosure shall be maintained at a nominal temperature of 10S.0oF throughout the four hour period. Variable volume enclosures may be operated in either the latched volume configuration, or with the variable volume feature active. Fixed volume enclosures shall be operated with inlet and outlet flow streams closed. The allowable enclosure background emissions of HC and/or methanol as calculated according to 40 CFR §86.117-90(a)(7) shall not be greater than O.OS grams in 4 hours. The enclosure may be sealed and the mixing .fan operated for a period of up to 12 hours before the initial HC concentration reading ($C_{HCi}$) and the initial methanol concentration reading ($C_{CH3OHi}$) is taken and the four hour background measurement period begins.

1.1.2.:. The initial determination of enclosure internal volume shall be performed according to the procedures specified in paragraphsection 1I1.A.1.3. If the enclosure will be used for hot soak determination, the determination of enclosure internal volume shall also be performed based on 1OSoF.

1.1.3.:. The HC and methanol measurement and retention checks shall evaluate the accuracy of enclosure HC and methanol mass measurements and the ability of the enclosure to retain trapped HC and methanol. The check shall be conducted over a 24: hour period with all of the no'rmally functioning subsystems of the enclosure active. A known mass of propane and/or methanol shall be injected into the enclosure and an initial enclosure mass measurement(s) shall be made. The enclosure shall be subjected to the temperature cycling specified in paragraphsectionIII.D.1 0.31.7. of these procedures (revising 40 CFR §86.133-90(1)) for a 24 hour period. The temperature cycle shall begin at 10s°F (hour 11) and continue according to the schedule until a full 24-hour cycle is completed. A final enclosure mass measurement(s) shall be made. The following procedure shall be performed prior to the introduction of the enclosure into service and following any modifications or repairs' to the enclosure that may impact the integrity of this enclosure; otherwise, the following procedure shall be performed on a monthly basis. (If six consecutive monthly retention checks are successfully completed without corrective action, the following procedure may be determined quarterly thereafter as long as no corrective action is required.)

1.1.3.1.(a) Zero and span the HC analyzer.

1.1.3.2.(b) Purge the enclosure until a stable enclosure HC level is attained.

1.1.3.3.(c) Turn on the enclosure air mixing and temperature control system and adjust it for an initial temperature of 10S.0°F and a programmed temperature profile covering one diurnal cycle over a 24 hour period according to the profile specified in paragraphsection III.D.10.31.7. of these procedures (revising 40 CFR§86.133-90). Close the enclosure door. On variable volume enclosures, latch the enclosure to the enclosure volume measured at 10SoF. On fixed volume enclosures, close the outlet and inlet flow streams.

1.1.3.4.(d) When the enclosure temperature stabilizes at 1OS.O°F ± 3.0°F seal the enclosure; measure the enclosure background HC concentration ($C_{HCe1}$) and/or background methanol concentration ($C_{CH3OH1}$) and the temperature ($T_1$), and pressure ($P_1$) in the enclosure.

1.1.3.5.(e) Inject into the enclosure a known quantity of propane between 2 to 6 grams and/or a known quantity of methanol in gaseous form between 2 to 6 grams. For evaporative emission ,enclosures that will be used for testing motor vehicles certified to the reduced evaporative standards in Part I, sections I.E.1.(c) and (d), use a known amount of propane or gaseous methanol between O.Sto 1.0 grams. The injection method shall use a critical flow orifice to meter the propane and/or methanol at a measured temperature and pressure for a measured time period. Techniques which provide an accuracy and precision of ± O.S percent of the injected mass are also acceptable. Allow the enclosure internal HC and/or methanol_concentration to mix and stabilize for up to 300 seconds. Measure the enclosure HC concentration ($C_{HCe2}$)

and/or the enclosure methanol concentration ($C_{CH3OH2}$). For fixed volume enclosures, measure the temperature ($T_2$) and pressure in the enclosure ($P_2$). On variable volume enclosures, unlatch the enclosure. On fixed volume enclosures, open the outlet and inlet flow streams. Start the temperature cycling function of the enclosure air mixing and temperature control system. These steps shall be completed within 900 seconds of sealing the enclosure.

1.1.3.6.~~(f)~~ For fixed volume enclosures, calculate the initial recovered HC mass ($M_{HCe1}$) according to the following formula:

$$M_{HCe1} = (3.05 \times V \times 10^{-4} \times [P_2 (C_{HCe2} - rC_{CH3OH2})/T_2 - P_1 (C_{HCe1} - rC_{CH3OH1})/T_1])$$

where:

V is the enclosure volume at 105°F ($ft^3$)
$P_1$ is the enclosure initial pressure (inches Hg absolute)
$P_2$ is the enclosure final pressure (inches Hg absolute)
$C_{HCen}$ is the enclosure HC concentration at event n (ppm C)
$C_{CH3OHn}$ is the enclosure methanol concentration calculated according to 40 CFR §86.117-90 (d)(2)(iii)atevent n (ppm C)
r is the FIO response factor to methanol
$T_1$ is the enclosure initial temperature (oR)
$T_2$ is the enclosure final temperature (OR)

1.1.3.6.1. For variable volume enclosures, cal"culate the initial recovered HC mass and initial recovered methanol mass according to the equations used above. except that $P_2$ and $T_2$ shall equal $P_1$ and $T_1$.

1.1.3.6.2. Calculate the initial recovered methanol.mass ($M_{CH3OH1}$) according to 40 CFR §86.117-96(d)(1), as amended March 24,1993.

1.1.3.6.3. If the recovered HC mass agrees with the injected mass within 2.0 percent and/or the recovered methanol mass agrees with the injected mass within 6.0 percent, continue the test for the 24:hour temperature cycling period. If the recoyered mass differs from the injected mass by greater than the acceptable percentage(s) for HC and/or methanol, repeat the enclosure concentration measurement in section III.B.1.1.3.5.step(E)andrecalculate the initial recovered HC mass ($M_{HCe1}$) and/or methanol mass ($M_{CH3OH1}$). If the recovered mass based on the latest concentration measurement agrees within the acceptable percentage(s) of the injected mass, continue the test for the 24:hour temperature cycling period and substitute this second enclosure concentration measurement .for $C_{HCe2}$ and/or $C_{CH3OH2}$ in all subsequent calculations. In order to be a valid calibration, the final measurement of $C_{HCe2}$ and $C_{CH3OH2}$ shall be completed within the 900:second time limit outlined above. If the discrepancy persists, the test shall be terminated and the cause of the difference determined, followed by the correction of theproblems(s) and the restart of the test.

1.1.3.7.~~(g)~~ At the completion of the 24 hour temperature cycling period, measure the final enclosure HC concentration ($C_{HCe3}$) and/or the final enclosure methanol concentration ($C_{CH3OH3}$). For fixed-volume enclosures, measure the final pressure ($P_3$) and final temperature ($T_3$) in the enclosure.

1.1.3.7.1. For fixed volume enclosures, calculate the final recovered HC mass ($M_{HCe2}$) as follows:

$$M_{HCe2} = [3.05 \times V \times 10^{-4} \times (P_3 (C_{HCe3} - rC_{CH3OH3})/T_3 - P_1 (C_{HCe1} - rC_{CH3OH1})/T_1)] + M_{HC,out} - M_{HC,in}$$

where:

V is the enclosure vOlume at 105°F ($ft^3$)
$P_1$ is the enclosure initial pressure (inches Hg absolute)
$P_3$ is the enclosure final pressure (inches Hg absolute)
$C_{HCe3}$ is the enclosure HC concentration at the end of the 24:hour temperature cycling period (ppm C)
$C_{CH3OH3}$ is the enclosure methanol concentration at the end of the 24:hour temperature cycling period, calculated according to 40 CFR §86.117-90-(d)(2)(iii) (ppm C)
r is the FIO response factor to methanol
$T_1$ is the enclosure initial temperature.(OR)
$T_3$ is the enclosure final temperature (OR)
$M_{HC,out}$ is mass of HC exiting the enclosure, (grams)
$M_{HC,in}$ is mass of HC entering the enclosure, (grams)

1.1.3.7.2. For variable volume enclosures, calculate the final recovered HC mass and final recovered methanol mass according to the equations used above except that $P_3$ and $T_3$ shall equal $P_1$ and $T_1$, and $M_{HC,out}$ and $M_{HC,in}$ shall equal zero.

1.1.3.7.3. Calculate the final recovered methanol mass ($M_{CH3OH2}$) according to 40 CFR §86.117-96(d)(1), as amended March 24,1993.

1.1.3.8.~~(h)~~ If the calculated final recovered HC mass for the enclosures is not within 3 percent of the initial enclosure mass or the calculated final recovered methanol mass for the enclosures is not within 6 percent of the initial enclosure mass, then action shall be required to correct the error to the acceptable level.

1.2. The running loss equipment shall be calibrated as follows:

1.2.1. The chassis dynamometer shall be calibrated according to the requirements of 40 CFR §86.118-78. The ca,libration shall be conducted at a typical ambient temperature of 75°F ± 5°F.

1.2.2.:. The running loss HC analyzer shall be calibrated according to the requirementsof 40 CFR §86.121- 90.

1.2.3.:. If a point source facility is used, the running loss fuel vapor sampling system shall be calibrated according to the requirements of 40 CFR§86.119-90, with the additional requirement that the CVS System Verification in 40 CFR §86.119-90(c) be conducted by injecting the known quantity of propane into the inlet of the most frequently used fuel vapor collector configured to collect vapors from the source of the evaporative emission vapor storage canister. This procedure shall be conducted in the running loss test cell with the collector installed in a vehicle in the normal test configuration, except that the vent hose from the vehicle evaporative emission canister shall be routed to a ventilation outlet to avoid unrepresentative background HC concentration levels. The propane injection shall be _conducted by injecting approximately 4 grams of propane into the collector while the vehicle is operated over one Urban Dynamometer- Driving Schedule (UDDS) test procedure, as described in 40 CFR §86.115-78 and Appendix I. The propane injection shall be conducted at a typical ambient temperature of 75°F ± 5°F.

1.2.4.:. In the event the running loss test is conducted using the atmospheric sampling measurement technique, the following procedure shall be used for the enclosure calibration: .

1.2.4.1.~~(a)~~ The initial and periodiC determination of enclosure background emissions shall be conducted according to the -procedures specified in 40 CFR §86.117-90(a)(1) through (a)(6). The enclosure shall be maintained at a nominal temperature of 105.0°F throughout the four hour period. The allowable enclosure background_emissions as calculated according to 40 CFR §86.117-90 (a)(7) shall not be greater than 0.2 grams in 4 hours. The enclosure may be sealed and the mixing fan operated for a period of up to 12 hours before the initial HC-concentration reading is taken.

1.2.4.2.~~(b)~~ The initial determination of enclosure internal volume shall be performed according to the procedures specified in 40 CFR §86.117-90 (b).

1.2.4.3.~~(c)~~ The enclosure shall meet the calibration and retention requirements of 40 CFR §86.117-90(c). The propane injection recovery test shall be conducted with a test vehicle being driven over one UDDS cycle in the enclosure during the propane injection test. The vehicle used shall be configured and operated under conditions which ensure that its own running loss contribution is negligible, by using fuel of the lowest available volatility (7.0 psi RVP), maintaining the tank temperature at low levels «100°F), and routing the canister vent to the outside of the enclosure.

1.2.5.:. Hotsoak"enclosure. The hot. soak enclosure calibration consists of the following parts: initial and periodic determination of enclosure background emissions, initial determination of enclosure volume, and periodic HC arid methanol retention check and calibration. The hot soak enclosure calibration shall be conducted according to the method specified in section III.B.1.1.:. with a retention check of 4 hours at 105°F or the method specified in section III.B.1.2.4. If the hot soak enclosure is also for diurnal testing, the 4 hour retention check at 105°F may be replaced by the 24 hour diurnal retention check.

1.2.6.:. Diurnal and hot soak enclosure HC analyzer. The HC analyzers used for measuring the diurnal and hot soak samples shall be calibrated according to the requirements of 40 CFR §86.121-90.

1.2.7.:. Other equipment. Other test equipment including temperature and pressure sensors and the associated amplifiers and recorders, flow measurement devices, and other instruments shall be calibrated and operated according to the manufacturer's specifications and recommendations, and good engineering practice.

C. Road Load Power, Test Weight, Inertia Weight Class, and Running Loss Fuel Tank Temperature Profile Determination

Amend 40 CFR §86.129-80 to include an additional ~~subsection~~ III.C.1. to read:

1. Determination of running loss test fuel tank temperature profile. The manufacturer shall establish for each combination of vehicle platform/powertrain/fuel tank submitted for certification a representative profile of fuel tank liquid and vapor temperature versus time to be used as the target temperature profile for the running loss evaporative emissions test drive cycle. If a vehicle has more than one fuel tank, a profile shall be established for each tank. If manufacturers use a vehicle model to develop a profile to represent multiple vehicle models, the vehicle model selected must have the greatest expected fuel liquid temperature and fuel vapor temperature increase during driving of all of the vehicle models it will represent. Manufacturers must select test vehicles with any available vehicle options that could increase fuel temperature during driving, such as any feature that limits underbody air flow. The profile shall be established by driving the vehicle on-road over the same driving schedule as is used for the running loss evaporative emissions test according to the following sequence:

1.1. The vehicle to be used for the fuel tank temperature profile determination shall be equipped with at least 2 thermocouples installed so as to provide a representative bulk liquid average fuel temperature. The specific placement of the thermocouples shall take into account the tank configuration and orientation and shall be along the major axis of the tank. The thermocouples shall not be placed within internal reservoirs or other locations which are thermally isolated from the bulk volume of the fuel. The thermocouples shall be placed at a vertical depth equivalent to the mid-volume of the liquid fuel at a fill level of 40 percent of nominal tank capacity. A third thermocouple, shall be installed in the approximate center of the vapor space of the fuel tank. A pressure transducer with a minimum precision and accuracy of ± 1.0 inches

$H_2O$ shall be connected to the vapor space of the fuel tank. A means of conveniently draining the fuel tank shall be provided. The vehicle shall be equipped with a driver's aid which shall be configured to provide the test driver with the desired UDDS vehicle speed versus time trace as defined in Part 86, Appendix I and with the desired NYCC vehicle speed versus time trace as defined in Part 86, Appendix I of the CFR, amended as of March 24, 1993, and the actual vehicle speed. Vehicle coolant temperature shall be monitored to ensure adequate vehicle coolant air to the radiator intake(s). A computer, data logger, or strip chart data recorder shall record the following parameters during the test run:

- Desired speed
- Actual speed
- Average liquid fuel temperature ($T_{liq}$)
- Vapor space temperature ($T_{vap}$)
- Vapor space pressure

1.1.1. The data recording system shall provide a time resolution of 1 second, and an accuracy of ± 1 mph, ± 2.0°F, and ± 1.0 inches $H_2O$. The temperature and pressure signals may be recorded at intervals of up to 30 seconds.

1.2. The temperature profile determination shall be conducted during ambient conditions which include:

- ambient temperature above 95°F ,and increasing or stable (±2°F)
- sunny or mostly sunny with a maximum cloud cover of 25 percent
- wind conditions calm to light with maximum sustained wind speeds of 15 mph; temporary gusts of wind between 15 and 25 mph may occur up to 5 percent of the total driving time
- road surface temperature ($T_{sur}$) at least 30°F above $T_{amb}$ or at least 135°F, whichever is less

1.2.1. The track surface temperature shall be measur.ed with an embedded sensor, a portable temperature probe, or an infrared pyrometer which can provide an accuracy of ± 2.0°F. Temperatures must be measured on a surface representative of the surface where the vehicle is driven. The test shall be conducted on a track or other restricted access facility so that the speed versus time schedule can be maintained without undue safety risks.

1.2.2. Prior to the start of the profile generation, the fuel tank may be artificially heated to the ambient temperature to a maximum of 105°F. The vehicle may be soaked in a temperature-controlled enclosure. Fans blowing ambient air may be used to help control fuel temperatures. Engine idling may not be used to control fuel temperatures. If the fuel tank is artificially heated, the liquid fuel temperature and the vapor temperature must be stabilized for at least one hour at the ambient temperature within ± 2°F to a maximum of 105°F before the profile generation begins. If the allowance fora lower initial fuel temperature established in section III.D.7.:. is used, the fuel in the test vehicle may not be stabilized at a temperature higher than the established lower initial temperature.

1.2.3. Tank pressure shall not exceed 10 inches of water 30 seconds after the start of the engine until the end of engine operation during the temperature profile determination unless a pressurized system is used and the manufacturer demonstrates in a separate test that vapor would not be vented to the atmosphere if the fuel fill pipe cap was removed at the end of the running loss fuel tank temperature profile determination.

1.3. The vehicle fuel tank shall be drained and filled to 40 percent of the nominal tank capacity with fuel meeting the requirements of paragraphsection 111.0.1. of these procedures. For all hybrid electric vehicles, the battery state-of-charge shall be set at a level such that the auxiliary power unit would be activated by the vehicle's control strategy within 30 seconds of starting the first UDDS ofthe fuel tank temperature profile determination test sequ.ence. If the auxiliary power unit is capable of being manually activated, the auxiliary power unit shall be manually activated at the beginning of and operating throughout the fuel tank temperature profile determination. The vehicle shall be moved to the location where. the driving cycle is to be conducted. It may be driven a maximum distance of 5.0 miles, longer distances shall require that the vehicle be transported by other means. The vehicle shall be parked for a minimum of 12 hours in an open area on a surface that is representative of the test road. The orientation of the front of the vehicle during parking (N, SW, etc.) shall be documented. Once the 12: hour minimum parking time has been achieved and the ambient temperature and weather conditions and track surface temperature are within the allowable ranges, the vehicle engine shall be started. The vehicle air conditioning system (if so equipped) shall be set to the "NORMAL" air conditioning mode and adjusted to the minimum discharge air temperature and high fan speed. Vehicles equipped with automatic temperature controlled air conditioning systems shall be operated in "AUTOMATIC" temperature and fan modes with the system set at 72°F. The vehicle may be operated at minimum throttle for periods up to 50 seconds prior to beginning the first UDDS cycle in order to move from the parking location onto the road surface. The driver's aid shall be started and the vehicle operated over one UDDS cycle, then two NYCCs, and another UDDS cycle. The end of each UDDS cycle and the end of the two NYCCs shall be followed by an idle period of 120 seconds during which the engine shall remain on with the vehicle in the same transmission range and clutch (if so equipped) actuation mode as specified in 40 CFR §85.128-79 except for the following:

Revise sectionsubparagph (c) to include: Idle modes may be run with automatic transmission in "Neutral" and shall be placed in "Drive" with the wheels braked at least 5 seconds be.fore the end of the idle mode. Manual transmission may be in "Neutral" with the clutch engaged and shall be placed in gear with the clutch disengaged at least 5 seconds before the end of the idle mode.

1.3.1. . The data recording system shall provide a record of the required parameters over the entire sequence from the initiatiop of the first UDDS cycle to the end of the third 120 second idle period. Following the completion of the test, the data recording system and driver's aid shall be turned off.

1.4. In addition to the vehicle data recording, the following parameters shall be documented for the running loss test fuel tank temperature determination:

- Date and time of vehicle fueling
- Odometer reading at vehicle fueling
- Date and time vehicle was parked and parking location and orientation
- Odometer reading at parking
- Time and temperature of fuel tank heating, if applicable
- Date and time engine was started
- Time of initiation of first UDDS cycle
- Time of completion of third 120 second idle period
- Ambient temperature and track surface temperature at initiation of first. UDDS cycle ($T_{amb1}$ and $T_{sur1}$)
- Ambient temperature and track surface temperature at completion of third 120 second idle period ($T_{amb2}$ and $T_{sur2}$)

1.5. The two UDDS and two NYCC driving traces shall be verified to meet the speed tolerance requirements of 40 CFR 86.115-78 (b)(1), amended as follows:

1.5.1.:. Revise subparagraph (v) to read: When conducted to meet the requirements of 40 CFR §86.129, up to three additional occurrences of speed variations greater than the tolerance are acceptable, provided they occur for less than 15 seconds on any occasion. All speed variations must be clearly documented as to the time and speed at that point in relation to the driving schedule.

1.5.2.:. Add subparagraph (vi) to read: When conducted to meet the requirements of 40 CFR §86.129 and §86.132, the speed tolerance shall be as specified above, except thatthe upper and lower limits shall be 4 mph.

1.6.:. The following temperature conditions shall be verified:

$(T_{amb1}) \geq 95.0^{o}F$
$(T_{amb2}) \geq (T_{amb1} - 2.0°F)$
$(T_{sur(n)} - T_{amb(n)}) \geq 30.0^{o}F$

where n is the incremental measurements in time.

or $T_{sur} > 135^{o}F$

1.7:.. Failure to comply with any of these requirements shall result in a void test, and require that the entire test procedure be repeated beginning with the fuel drain specified in section III.C.1.3:.. of this subparagraph.

1.8:.. If all of these requirements are met, the following calculations shall be performed:·

$$T_{corr} = T(i) - T_o$$

where: T(i) is the liquid fuel temperature (oF) or vapor fuel temperature (oF) during the drive where i is the incremental measurements in time.

$T_o$ is the corresponding liquid fuel temperature (oF) or vapor fuel temperature (oF) observed at the start of the specified driving schedule

1.8.1. The individual tank liquid ($T_{liq}$) and vapor space ($T_{vap}$) temperatures recorded during the test run shall be adjusted by arithmetically adding the corresponding temperature correction ($T_{corr}$) adjustment calculated above to 105°F. If $T_o$ is higher than the corresponding ambient temperature by 2°F, the temperature correction shall be determined by the above equation plus the difference in $T_o$ and the corresponding ambient temperature.

1.9. Other methodologies for developing corrected liquid and vapor space temperature profiles are acceptable if approved in advance by the Executive Officer. The Executive Officer shall approve an alternate method if the manufacturer demonstrates equivalence to data collected at 105°F.

D. Test Procedure

The test sequence described in 40 CFR §86.130 through §86.140 shall be performed with the following modifications:

1. General Requirements

1.0. The following language shall be applicable in lieu of 40 CFR §86.130-78:

1.1. The test sequence shown in Figure 2 (Figure 3A or 38 for hybrid electric vehicles) describes the steps encountered as the vehicle undergoes the three-day diurnal sequence and the supplemental two-day diurnal sequence to determine conformity with the standards set forth. Methanol measurements may be omitted when methanol-fueled vehicles will not be tested in the evaporative enclosure. Ambient temperature levels encountered by the test vehicle throughout the entire duration of this test sequence sh.all not be less than 68°F nor more than 86°F, unless otherwise specified. The temperatures monitored during testing shall be representative of those experienced by the test vehicle. The test vehicle shall be approximately level during all phases of the test sequence to prevent abnormal fuel distribution. The temperature tolerance of a soak period may be waived for up to 10 minutes to allow purging of the enclosure or transporting the vehicle into the enclosure.

1.2. If tests are invalidated after collection of emission data from previous test segments, the test may be repeated to collect only those data points needed to complete emission measurements. Compliance with emission standards may be determined by combining emission measurements from these different test runs. If any emission measurements are repeated, the new measurements supersede previous values.

1.3. The three-day diurnal test sequence shown in Figure 2 (and Figure 3A or 38 for hybrid electric vehicles) is briefly described as follows:

~~1.1.~~1.4. The fueltank shall be initially drained and filled to the prescribed tank fuel volume of 40 percent of the manufacturer's nominal fuel tank capacity, as specified in 40 CFR §86.1803-01, in preparation for the vehicle preconditioning. ~~For hybrid electric vehicles only, the manufacturer may elect to perform the All Electric Range Test pursuant to the "California Exhaust Emission Standards and Test Procedures for 2003 and Subsequent Model Zero Emission Vehicles, and 2001 and Subsequent Model Hybrid Electric Vehicles, in the Passenger Car, Light Duty Truck, and Medium Duty Vehicle Classes,"~~ as incorporated by reference in *§1962(e),* title 13, CCR, prior to fuel drain and fill.

1.4.1. For 2001 through 2008 model-year hybrid electric vehicles, the manufacturer may elect to perform the All-Electric Range Test (as indicated in Figure 3A or 38, as applicable) pursuant to the "California Exhaust Emission Standards and Test Procedures for 2005- 2008 Model Zero-Emission Vehicles, and 2001 – 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes," prior to the initial fuel drain and fill step in this test sequence.

1.4.2. For 2009 and subsequent model-year hybrid electric vehicles, a manufacturer may elect to perform the All-Electric Range Tests separately from the test sequences specified under these evaporative emission test procedures, and pursuant to the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes,"

~~1.2.~~1.5. The vehicle preconditioning drive shall be performed in accordance with 40 CFR §86.132-90, except that following the initial fuel drain and fill step in this test sequence vehicle fueling step at , as specified in 40 CFR §86.132-90(a)(1), an initial preconditioning minimum soak period of a minimum of 6 hours shall be provided to allow the vehicle to stabilize to ambient temperature prior to the preconditioning drive. Vehicles performing consecutive tests at a test point with the Same fuel specification and while remaining under laboratory ambient temperature conditions for at least 6 hours, may eliminate both the initial fuel drain and fill and vehicle soak. In such cases, each subsequent test shall begin with the preconditioning drive.

1.5.1. For a 2011 and subsequent model-year off-vehicle charge capable hybrid electric vehicle, the vehicle preconditioning drive shall include at least one complete UDDS performed entirely under a charge-sustaining mode of operation, The battery state-of-charge net change tolerance provisions specified in section F.10., of the "California Exhaust Emission Standards and Test Procedures for. 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, In The Passenger Car, Light-Duty Truck, and Medium-"Duty Vehicle Classes" shall not apply.

~~1.4~~.1.8. The vehicle shall be ~~allowed~~ to soak ~~for~~ 12 to 36 hours prior to the exhaust emissions test.A second preconditioning soak period of not less than 12 hours and not more than 36 hours shall be performed prior to the exhaust emission test.

~~1.5.~~ 1.9. Except for 2011 and subsequent model-year off-vehicle charge capable hybrid electric vehicles that are equipped with non-integrated refueling canister-only systems, ~~D~~during the 12:to:36 hour soak specified in subparagraph ~~1.4~~section 111.0.1.8 above, the vehicle's evaporative control canister shall be purged with a volume of air equivalent to 300 carbon canister charcoal bed.volumes at a flow rate of 48 SCFH (22.7 slpm). . . .

~~1.6.~~ 1.10. Except for 2011 and subsequent model-year off-vehicle charge capable hybrid electric vehicles that are equipped with non-integrated refueling canister-only systems, ~~T~~the evaporative control canister shall then be loaded using a butane-nitrogen mixture.

~~1.7.~~ 1.11. Perform exhaust emission tests in accordance with procedures as provided in "California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles," and these procedures.

~~1.7.1.~~ 1.12. For 2001 through 2008 model-year hybrid electric vehicles, a four: phase exhaust test shall be performed as shown in Figure 3A pursuant to the "California Exhaust Emission Standards and Test Procedures for ~~2003~~2005 - 2008~~and Subsequent~~ Model Zero-Emission Vehicles, and 2001 and Subsequent 2001 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes:." as incorporated by reference in §1962(e), title 13, CCR. ~~Following~~ the four phase exhaust test, the test sequence shall repeat from step 1.3 of this section to conduct the evaporative test using the standard cold start test and hot start test (standard three phase test) without emission sampling. Battery state of charge setting prior to the standard three phase test shall be performed pursuant to section 6.1.6 of the "California Exhaust Emission Standards and Test Procedures for 2003 and Subsequent Model Zero Emission Vehicles, and 2001 and Subsequent Model Hybrid Electric Vehicles, in the Passenger Car, Light Duty Truck, and Medium Duty Vehicle Classes" as incorporated by reference in §1962(e), title 13, CCR. Four phase exhaust testing may be_performed in conjunction ~~with~~ evaporative testing as shown in Figure 3B ~~with~~ advance Executive Officer approval if the manufacturer is able to provide data demonstrating compliance with evaporative emission standards using the standard three phase test.

1.12.1. For 2009 and subsequent model-year hybrid electric vehicles, a manufacturer may elect to perform the four-phase exhaust emission test separately from the test sequence specified under these evaporative emission test procedures, and pursuant to the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes."

1.12.2. When a four-phase exhaust test is performed with the evaporative emission test sequence as shown in Figure 3A, the evaporative emission test sequence shall begin, at section 111.0.1.6., after the four-phase exhaust test is completed. The ensuing standard three-phase exhaust test shall then be performed witliout eXhaust emissio'n sampling.

1.12.3. For hybrid electric vehicles, the four-phase exhaust testing may be performed in conjunction with evaporative testing, as shown in Figure 3B, with advance Executive Officer approval if the manufacturer is able to provide data demonstrating compliance with evaporative emission standards using the standard three-phase test.

1.1.2.4. For 2001 through 2008 model-year hybrid electric vehicles, battery state-of-charge setting prior to the standard three-phase test shall be performed pursuantto the supplemental requirements specified in section E.6.1.6. of the "California Exhaust Emission Standards and Test Procedures for 200S - 2008 Model Zero-Emission Vehicles, and 2001 - 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes."

1.12.S. For 2009 and subsequent model-year hybrid electric vehicles, except for 2001 and·subsequent model-year off-vehicle charge capable hybrid electric vehicles, battery state-of-charge setting prior to the standard three-phase test shall be performed pursuant to the supplemental requirements specified in section E.6.1.S.of the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes."

1.12.6. For 2011 and subsequent model-year off-vehicle charge capable hybrid electric vehicles, battery state-of-charge setting prior to the standard three-phase test shall be at the highest level allowed by the manufacturer in order to eliminate or minimize the cumulative amount of the auxiliary power unit activation during either of the ensuing three-phase exhaust or running loss tests. This requirement shall be applicable regardless of a vehicle's abiHtv to allow, or not to allow, manual activation of the auxiliary power unit. If off-vehicle charging is required to increase the battery state-of-charge for the proper setting, then this charging shall occur during the 12-to-36 hour soak period. The battery state-of-chargenet change tolerance provisions specified in section F.10., of the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, In The Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes" shall not apply.

~~1.8.~~ 1.13. Upon completion of the hot start test, the vehicle shall be parked in a temperature controlled area between one to six hours to stabilize the fuel temperature at 10SoF for one hour. Artificial cooling or heating of the fuel tank may be induced to achieve a fuel temperature of 10SoF. The initial fuel and, if applicable, vapor temperatures for the running loss test may be less than 10SoF with advance Executive Order approval if the manufacturer is able to provide data demonstrating initial temperatures at least 3°F lower than the required 10SoF starting temperature.

~~1.9.~~1.14. A running loss test shall be performed after the fuel tank is stabilized at 105°F. The fuel tank temperature shall be controlled using a specified tank temperature profile for that vehicle during the test. The temperature profile shall be achieved either using temperature controllers or by an air management system that would simulate airflow conditions under the vehicle during driving.

. ~~1.10.~~1.15. The hot soak enclosure test shall then be performed at an enclosure ambient temperature of 105°F.

~~1.11~~.1.16. Upon completion of the hot soak enclosure test, the vehicle shall be soaked for not less than'6 hours and notf more than 36 hours. For at least the last 6 hours of this period, the vehicle shall be soaked at 65°F.

~~1.12.~~1.17. A three-day diurnal test shall be performed in a variable temperature enclosure.

1.18. The supplemental two-day diurnal sequence in Figure 2 (and Figure3A or 38 for hybrid electric vehicles) shall be conducted according to sections III. D.1.4. through III. D.1 .17., with the following exceptions:the steps desoribed in 1.1 . through 1.4, 1.6, 1.7, followed by 1.10 through 1.12 of this paragraph exoept that the ambient temperature of the hot soak test is conducted at an ambient temperature. between ~~68°F~~ and B6°F at all times and that the diurnal test will consist of a two day test. Emission sampling is not required for the standard Gold start test and hot start test (standard three phase test) in the supplemental two day diurnal sequenoe as shown in F'igure3A(.

1.18.1 Sections III.D.1.9., 111.0.1:12., III.D.1.13., and III.D.1.14., shall not apply,

1.18.2 In section III.D.1.15., the ambient temperature of the hot soak test is conducted at an ambient temperature between 68°F and 86°F at all times.

1.18.3. In section III.D.1.17" the diurnal test will consist of atwo-day test

1.18.4. For 2001 through 2008 model-year hybrid electric vehicles, battery state-of-charge setting prior to the standard three-phase exhaust test in the supplemental two-day diurnal test sequence shall be performed pursuant to the supplemental requirements specified in section E.6.1.6. of the "California Exhaust Emission Standards and Test Procedures for 2005 - 2008 Model Zero-Emission Vehicles, and 2001 – 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes."

1.18.5. For 2009 arid subsequent model-year hybrid electric vehicles, except for 2011 and subsequent model-year off-vehicle charge capable hybrid electric vehicles, battery state-of-charge setting prior to the standard three-phase test in the supplemental two-day diurnal test sequence shall be performed pursuant to the supplemental requirements specified in section E.6.1.5 of the· "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, In The Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes."

1.18.6. For 2011 and subsequent model-year off-vehicle charge capable hybrid electric vehicles, battery state-of-charge setting prior to the standard three-phase exhaust test in the supplemental two-day diurnal sequence shall be at the highest level allowed by the manufacturer in order to eliminate or minimize the cumulative amount of the auxiliary power unit activation during either of the ensuing three-phase exhaust or running loss tests. This requirement shall be applicable regardless of a vehicle's ability to allow, or not to allow, manual activation of the auxiliary power unit. If off-vehicle charging is required to increase the battery state-of-charge for the proper setting, then this charging shall occur during the 12-to-36 hour soak period. The batterystate-of-charge net change tolerance provisions specified in section F.10., of the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, In The Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes" shall not apply.

1.18.7. Emission sampling is not required for the standard three-phase exhaust test performed in the supplemental two-day diurnal test sequence shown in Figure 3A.

1.19. The Executive Officer may conduct certification confirmatory tests and in-use compliance tests of 2011 and subsequent off-vehicle charge capable hybrid electric vehicles using any of the following battery state-of-charge levels:

1.19.1. As specified in sections 111.0.1.12.6. or 111.0.1.18.6.. as applicable.

1.19.2. At the lowest level allowed by the manufacturer.

1.19.3. At any level in-between the levels indicated by sections 111.0.1.19.1. and 11.8.1.19.2., above, if applicable.

2. Vehicle Preparation

2.0. Amend 40 CFR §86.131-90 to read:

. 2.1.:. Prepare the fuel tank(s) for recording the temperature(s) of the prescribed test fuel liquid and, if applicable, fuel vapor according to the requirements of paragraphsection III.C.1.1. (40 CFR §86.129-80). Measurement of the fuel vapor temperature is optional. If vapor temperature is not measured, the measurement of the fuel tank pressure is not required.



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2.2;:. If applicable, the vehicle shall be equipped with a pressure transducer to monitor the fuel tank headspace pressure during the test. The transducer shall have an accuracy and precision of ± 1.0 inches water.

2.3;:. Provide additional fittings and adapters, as required, to accommodate a fuel drain atthe lowest point possible in the fuel tank(s) as installed on the vehicle.

2.4;:. Provide valving or other means to allow purging and loading of the evaporative emission canister(s). Special care shall be taken during this step not to alter normal functions of the fuel vapor system components.

2.5;:. For vehicles to be tested for running loss emissions, prepare the exhaust system by sealing and/or plugging all detectable sources' of exhaust gas leaks. The eXhaust system shall be tested or inspected to ensure that detectable exhaust hydrocarbons are not emitted into the running loss enclosure during the running loss test.

3. Vehicle Preconditioning

3.1.1. For supplemental vehicle preconditioning requirements for 2001 through 2008 model-year hybrid electric vehicles, refer to the "California Exhaust Emission Standards and Test Procedures for 20032005 - 2008 and Subsequent Model_Zero-Emission Vehicles, and 2001and Subsequent - 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes,:."as . inoorporated by referenoe in §1962(e), title 13, CCR.

3.1.2. For supplemental vehicle preconditioning requirements for 2009 and subsequent model-year hybrid electric vehicles, refer to the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Modei Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes."

3.2;:. The following language shall be applicable in lieu of 40 CFR §86.132-90(a)(4):

The Executive Officer may also choose to conduct or require the performance of optional or additional preconditioning to ensure that the evaporative emission control system is subjected to conditions typical of normal driving. The optional preconditioning shall consist of no less than 20 and no more than 50 miles of on-road mileage. accumulation under typical driving conditions.

3.3;:. The following language shall be applicable in lieu of 40 CFR §86.132-90(b):

3.3.1. Within five minutes of completion of preconditioning, the vehicle shall be driven off the dynamometer to a work area. For hybrid electric vehicles following battery state-of-charge setting, the vehicle shall only be pushed or towed to avoid disturbing battery state-of-charge setting.

3.3.2. Except for 2011 and subsequent model-year off-vehicle charge capable hybrid electric vehicles that are equipped with non-integrated refueling canister-only systems. Tthe fuel tank(s) of the prepared vehicle shall undergo the second fuel drain and fill step of the test sequence. be drained and refilled with the applicable test fuel, as specified in paragraphsection III.F. of these procedures, to the prescribed tank fuel volume of 40 percent oOhe manufacturer's nominal fuel tank capacity. as defined in 40 CFR §86.1803-01. The vehicle shall be refueled within 1 hour ofcompletion of the preconditioning drive. For 2011 and subsequent model-year off-vehicle charge capable hybrid electric vehicles that are equipped with non-integrated refueling canister-only systems, the second fuel drain and fill step shall be performed as specified in section 111.0.1.7., with the applicable test fuel specified in section III.F.

3.3.3. Following the second fuel drain and fill described in subparagraphsection 111.0.3.3.2. above, the test vehicle shall be allowed to soak for a period of not less than 12 orand not more than 36 hours prior to the exhaust emissions test Except for 2011 and subsequent model-year off-vehicle charge capable hybrid electric vehicles that are equipped with non-integrated refueling canister-only systems. Dduring the soak period, the canister shall be connected to a pump or compressor and loaded with butane as described in section 111.0.3.3.4. below for the three-day diurnal sequence and in section 111.0.3.3.5. below for the supplemental two-day diurnal sequence. For all vehiclessubjected to exhaust emissions testing only, the canister loading procedure as set forth in paragraphsection 111.0. 3.3.4. below shall be used. For 2011 and subsequent model-year off-vehicle charge capable hybrid electric vehicles that are equipped with non-integrated refueling canister-only systems. the canister shall be loaded according to the fuel-tank-refill canister-loading method specified in section 111.0.3.3.6., for both the three-day diurnal sequence and the supplemental two-day diurnal sequence.

3.3.3.1. For methanol-fueled and flexible-fueled vehicles, canister preconditioning shall be performed with a fuel vapor composition representative of that which the vehicle would generate with the fuel mixture used for the current test. Ma'nufacturers shall develop a procedure to precondition the canister, if the vehicle is so equipped for the different fuel. The procedure shall represent a canister loading equivalent to that specified in section III.D.3.3.4. below for the three-day diurnal sequence and in section III.D.3.3.5. below for the supplemental two-day diurnal sequence and shall be approved in advance by the Executive Officer.

3.3.4. For the three-day diurnal sequence, the evaporative emissions storage canister(s) shall be preloaded with an amount of butane equivalent to 1.5 times the nominal working capacity. For vehicles with multiple canisters in a series configuration, the set of canisters must be preconditioned as a unit. For vehicles with multiple canisters in a parallel configuration, each canister shall be preconditioned separately. For vehicles equipped with a non-integrated refueling emission control system, the non-integrated canisters shall be preconditioned for the three-day diurnal test sequence according to the procedure in section III.D.3.3.5.:..1Ja) below. All 2011 and subsequent model-year off-vehicle charge capable hybrid electric vehicles equipped with non-integrated refueling canister-only systems shall be preconditioned for the three-day diurnal test sequence according to the procedure specified in section 111.0.3.3.6. If a vehicle is designed to actively control evaporative or refueling emissions without a canister, the manufacturer shall devise an appropriate preconditioning procedure subject to the approval of the Executive Officer. If canisters on both certification and production vehicles are equipped with purge and load service ports, the service port shall be used for the canister preconditioning. The nominal working capacity of a carbon canister shall be established by determining the mass of butane required to load a stabilized canister to a two2-gram breakthrough. The 2:gram breakthrough is defined as the point at which the cumulative quantity of hydrocarbons emitted is equal to 2 grams. as defined in section 1.8.1.3. The determination of nominal capacity shall be based on the average capacity of no less than five canisters which are in a stabilized condition. For stabilization, each canister must be cycled no less than 10 times and no more than 100 times to a two2-gram breakthrough with a SO/50 mixture by volume of butane and nitrogen, at a rate of 15 ± 2 grams butane per hour. Each canister loading step must be preceded by canister purging with 300 canister bed volume exchanges at 48 SCFH. The following procedure shall be used to preload the canister:

(a)3.3.4.1. Prepare the evaporative emission canister(s) for the canister purging and loading operation. The canister shall not be removed from the vehicle, unless access to the canister in its normal location is so restricted that purging and loading can only reasonably be accomplished by removing the canister from the vehicle. Special care shall be taken during this step so that the normal functions of the fuel system components or the normal pressure relationships in the system are not disturbed. The canister purge shall be performed with ambient air of controlled humidity to 50 ± 25 grains per pound of dry air. This may be accomplished by purging the canister in a room which is conditioned to this level of absolute humidity. The flow rate of the purge air shalJ be maintained at a nominal flow rate of 48 SCFH (22.7 slpm), and the duration shall be determined to provide a total purge volume flow through the canister equivalent to 300 carbon canister charcoal bed volume exchanges.

(b)3.3.4.1.2. The evaporative emission canister(s) shall then be roaded with an amount of commercial grade butane vapors equivalent to 1.5 times the nominal working capacity. Canister loading shall not be less than 1.5 times the nominal canister capacity. The canister shall be loaded with a mixture composed of 50 percent butane and 50 percent nitrogen by volume. The butane shall be loaded into the canister at a rate of15 ± 2 grams of butane per hour. If the canister loading at this rate takes longer than 12 hours, a manufacturer may determine a new rate, based on completing the canister loading in no less than 12 hours. Either aA Critical Flow Orifice (CFO) butane injection device, a gravimetric method, or electronic mass flow controllers shall be used to fulfill the requirements of thisstep. The time of completion of the canister loading activity shall be recorded. Manufacturers shall disclose to the Executive Officer their canisterloading procedure. The protocol may not allow for the replacement of components. In addition, the Executive Officer may require that the manufacturer demonstrate that the procedure does not unduly disturb the components of the evaporative system.

~~(c)~~3.3.4.1.3. Reconnect the evaporative emission canister(s), if applicable.

3.3.5. For the supplemental two-day diurnal sequence, the evaporative emission storage canister(s) shall be loaded to the point of breakthrough using the method specific in either section 111.0.3.3.5.1. or section 1I1.0.3.3.5.2.(a) or (b) ~~below.~~ For vehicles with multiple canisters in a series configuration, the set of canisters must be preconditioned as a unit. For vehicles with multiple canisters in a parallel configuration, each canister shall be preconditioned separately. For vehicles equipped with a non,..integrated refueling emission control system, the non-integrated canisters shall be preconditioned for the supplemental two-diurnal test sequence according to the procedure in section III.D.3.3.5.1.~~(a).~~ Breakthrough may be determined by emission measurement in an enclosure or by measuring the weight gain of an auxiliary evaporative canister connected downstream of the vehicle's canister, in which case, the following references to the enclosure can be ignored. The auxiliary canister shall be well purged with ambient air of humidity controlled to 50±25 grains per pound of dry air prior to loading. Breakthrough is defined as the point at which the cumulative quantity of hydrocarbons emitted is equal to 2 grams, as defined in section I.B.1.3.

~~(a)~~3.3.5.1. The following procedure provides for loading of the canister to breakthrough with a mixture composed of 50 percent butane and 50 percent nitrogen by volume. If the canisters on both certification and production vehicles are equipped with purge and load service ports, the service port shall be used for the canister precond itioning.

3.3.5.1.1. Prepare the evaporative/refueling emission canister(s) for t.he canister loading operation. The canister shall not be removed from the vehicle, unless access to the canister in its normal location is so restricted that loading can only reasonably be accomplished by removing the canister from the vehicle. Special care shall be taken during this step to avoid damage to the components and the integrity of the fuel system. The evaporative emission enclosure shall be purged for several minutes. The FlO hydrocarbon analyzer shall be zeroed and spanned immediately prior to the canister loading procedure. If not already on, the evaporative enclosure mixing fan shall be turned on at this time. Place the vehicle in the sealed enclosure and measure emissions with the FlO.

3.3.S.1.2. Load the canister with a mixture composed of SO/SO mixture by volume of butane and nitrogen at a rate of 40 ± 2 grams butane per hour. As soon as the canister reaches breakthrough, the vapor source shall be shut off.

3.3.S.1.3. Reconnect the evaporative/refueling emission canister, if applicable.

~~(b)~~3.3.5.2. The following procedure provides for loading the canister with repeated diurnal heat builds to breakthrough.

3.3.S.2.1. The evaporative emission enclosure shall be purged for several minutes. The FlO hydrocarbon analyzer shall be zeroed and spanned immediately prior .to the diurnal heat builds. If not already on, the evaporative enclosure mixing fan shall be turned on at this time. The average temperature of the dispensed fuel shall be 60 ± 12°F. Within one hour of being refueled, the vehicle shall be placed, with the engine shut off, in the evaporative emission enclosure. The fuel tank temperature sensor shall be connected'to the temperature recording system. A heat source, specified in 40CFR §86.107-90(a)(4), shall be properly positioned with respect to the fuel tank(s) and connected to the temperature controller.

3.3.S.2.2. The fuel may be artificially heated or cooled to the starting diurnal temperature of 6SoF. Turn off purge blower (if not already off); close and seal enclosure doors; and initiate measurement of the hydrocarbon level in the enclosure. When the fuel temperature reaches 6SoF, start the diurnal heat build. The diurnal heat build should conform to the following function to within ± 4°F:

$$F = T_o \pm O.4t$$

F is the fuel temperature, OF
To is the initial temperature, OF
t is the time since beginning o!test, minutes

3.3.S.2.3. As soon as breakthrough occurs or when the fuel temperature reaches 1OSoF, whichever occurs first, the heat source shall be turned off, the enclosure doors shall be unsealed and opened. If breakthrough has not occurred by the time the fuel temperature reaches 10SoF, the heat source shall be removed from the vehicle, the vehicle shall be removed (with the engine still off) from the evaporative emission enclosure and the entire procedure outlined above shall be repeated until breakthrough occurs.

3.3.S.2.4. After breakthrough occurs, the fuel tank(s) of the prepared vehicle shall be drained and filled with test fuel, as specified in paragraphsection III.F.:. of these procedures, to the "tank fuel volume" defined in 40 CFR §86.1803-01. The fuel shall be stabilized to a temperature within ± 3°F of the lab ambient before beginning the driving cycle for the exhaust emission test.



Date of Release: December 5, 2008; 45-Day Notice version
Date of Hearing: January 22-23.2009

3.3.6. After the second fuel drain and tank refill step specified in section 111.0.1.7.. is completed. the canister for a 2011 and subsequent model-year off-vehicle charge capable hybrid electric vehicle equipped with a non-integrated refueling canister-only system shall be preconditioned and loaded according to the following steps. Prior to conducting these steps. the canister shall have already achieved a stabilized state. such as is accomplished using the stabilization method described in section 111.0.3.3.4. Good engineering practice and safety considerations. such as, but not limited to, adequate ventilation and appropriate electricalgroundings. shall apply.

3.3.6.1. Ambient temperature levels encountered by the test vehicle throughout these steps shall not be less than 68°F (20°C) or more than 86°F (30°C).

. 3.3.6.2. The test vehicle shall be approximately level. during the performance of these steps, to prevent abnormal fuel distribution.

3.3.6.3. In order to be moved. the test vehicle shall be pushed, as necessary. without starting its engine. throughout the performance of these steps.

3.3.6.4. The test vehicle shall be allowed to soak for a minimum of 6 hours and a maximum of 24 hours, at 80°F +3°F (27°C ±'1.7°C), prior to starting the fuel-tank-fill canister-loading step. The refueling canister shall remain isolated from its' system during this soak period. in order to prevent any abnormal purging or loading of it during this soak period. .

3.3.6.5. The refueling canister shall not be isolated from its system during the fuel-tank-refill canister-loading step.

3.3.6.6. The test vehicle's fuel fill pipe cap shall be removed.

3.3.6.7. The dispensed fuel temperature recording system shall be started.

3.3.6.8. The fuel nozzle shall be inserted into the fill pipe neck of the test vehicle. to its maximum penetration. and the refueling operation shall start. The plane of the nozzle's handle shall be approximately perpendicular to the floor. The fuel shall be dispensed at a temperature of 67°F+1,5°F (19.4°C ±O.BOC), and at a dispensing rate of *9.B* gal/min +0,3 gal/min (37.1 liter/min +1.1 liter/min). When this refueling operation is conducted by the Executive Officer, a dispensing rate that is not less than 4.0 gal/min (15.1 liter/min) may be used.

3.3.6.9. The fuel flow shall continue until the refueling nozzle automatic shut-off is activated. The amount of fue·1 dispensed must be at least B5 percent of the nominal fuel tank volume, determined to the nearest one-tenth of a U.S. gallon (0.38 liter). If an automatic nozzle shut-off occurs prior to this point, the dispensing shall be reactivated within 15 seconds. and fuel dispensing continued as needed. A minimum of 3 seconds shall elapse between any automatic nozzle shutoff and the subsequent resumption of fuel dispensing.

3.3.6.10. As soon as possible after completing the refilling step. remove the fuel nozzle from the fill pipe neck. and replace the test vehicle's fuel fill pipe cap.

3.3.6.11. The refueling canister shall be isolated from its system as soon as possible after completing the refilling step.

3.3.6.12. For vehicles equipped with more than one fuel tank, the steps described in this section shall be performed for each fuel tank.

3.3.6.13. After the fuel-tank-refill canister-loading process is completed. a third fuel drain and fill step shall be performed. the fuel tank shall be filled to the prescribed fuel thank volume of 40 percent of the manufacturer's nominal fuel tank capacity. as specified in 40 CFR §86.1803-01. When the refueling canister is isolated from its system, fuel vapors shall be allowed to be vented out of the fuel tank, as appropriate. during this refilling step. The required fuel tank volume of 40 percent may be accomplished by using a measured drain of the fuel tank, in place of the specified complete fuel tank drain and fill step, when prior approval is obtained from the Executive Officer.

3.3:6.14. Upon completion of the third fuel drain and fill step, the test vehicle shall proceed to the 12-to-36 hour preconditioning soak step which is performed prior to the three-phase exhaust cold start test step. The canister shall not be isolated from its system during this soak step, and shall not be isolated from its system from this point onward in the test sequence.

3.3.6.15. The Executive Officer may approve modifications to this fuel-tank-refill canister-loading method when such modifications are supported by good engineering judgment. and do not reduce the stringency of the method.

3.4. As allowed under the provisions of section III.G. of these test procedures, a manufacturer may propose, for Executive Officer approval, the use of an alternative method to precondition canisters in lieu of the methods required under sections 111.0.3.3.4.:.; III.0.3.3.5.1.~~(a)~~; and, III.D.3.3.5.2.~~(b).~~, and III.D.3.3.6. The Ex.ecutive Officer may conduct certification confirmatory tests and in-use compliance'tests with the either 'the alternative canister loading method or the methods specified in sections 111.0.3.3.4; III.D.3.3.5.1.~~(a)~~; ~~and,~~ III.D:3.3.5.2.~~(b),~~; and, III.D.3.3.6, as applicable.

**4. Dynamometer Procedure.**

4.1. To be conducted according to 40 CFR §86.135-90 (December 8,2005).

4.2. For 2001 through 2008 model-year hybrid electric vehicles, the dynamometer procedure shall beperformed pursuant to the "California Exhaust Emission Standards and Test Procedures for 20032005 - 2008 and Subsequent Model Zero-Emission Vehicles, and 2001 and Subsequent 2008 Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes.:." as ineorporated by reference in §1962(e), title 13, GGR.

4.3. For 2009 and subsequent model-year hybrid electric vehicles, the dynamometer procedure shall be performed pursuant to the "California Exhaust Emission Standards and Test Procedures for 2009 Subsequent Model Zero-Emission Vehicles and Model Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes."

5. Engine Starting and Restarting.

5.1. Amend 40 CFR §86.136-90 to read as follows:

5.1.1. Revise sectionsubparagraph (c) to read: If the vehicle does not start after the manufacturer's recommended crankingtime (or 10 continuous seconds inthe absence of a manufacturer's recommendation), cranking shall cease for the period recommended by the manufacturer (or 10 seconds in the absence of a manufacturer's recommendation). This may be repeated for up to three start attempts. If the vehicle does not start after three attempts, the reason for failure to start shall be determined. The gas flow measuring device on the CVS (usually a revolution counter) or CFV shall be turned off and the sampler selector valves, including the alcohol sampler, placed in the "standby" position during this diagnostic period. In addition, 'either the CVS should be turned off, or the exhaust tube disconnected from the tailpipe during the diagnostic period. If failure to start is an operational error, the vehicle shall be rescheduled for testing from a cold start.

6. Dynamometer Test Run, Gaseous and Particulate Emissions.

6.1. To be conducted according to 40 CFR §86.137-90.

6.2. For 2001 through 2008 model-year hybrid electric vehicles, the dynamometer test run, gaseous and particulate emissions shall be performed pursuant to the "California Exhaust Emission Standards and Test Procedures for 20032005 – 2008 and Subsequent ModetZero-Emission Vehicles, and 2001 'and Subsequent-2008 Model Hybrid Electric Vehicles, in the Passenger Car" Light-Duty Truck, and Medium-Duty Vehicle Classes.:." as incorporated by reference in§1962(e), title 13, GGR.

6.3. For 2009 and subsequent model-year hybrid electric vehicles, the dynamometer test run, gaseous and particulate emissions shall be performed pursuant to the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes."

7. Vehicle Fuel Tank Temperature Stabilization

7.1. Immediately after the hot transient exhaust emission test, the vehicle shall be soaked in a temperature controlled area between one hour to six hours, until the fuel and, if applicable, vapor temperatures are stabilized at 10SoF ± 3°F for one hour. This is a preparatory step for the funning ioss test. Cooling or heating of the fuel tank may be induced to bring the fuel to 1OSoF. The fuel heating rate shall not exceed SOF in any 1-hour interval. Higher fuel heating rates are allowed with Executive Officer approval if the SOF per hour heating rate is insufficient to heat the fuel to 10SoF in the allowed soak time. The vehicle fuel temperature stabilization step may be omitted on vehicles whose tank fuel and, if applicable, vapor temperatures are already at 10SoF upon completion of the exhaust emission test. .

7.2. The initial fuel and, if applicable, vapor temperatures for the running loss test may be less than 10SoF with advance Executive Officer approval if the manufacturer is able to provide data justifying initial temperatures at least 3°F lower than" the required 10SoF starting temperature. The test data shall include the maximum fuel temperatures experienced by the vehicle during an extended parking event and after a UDDS cycle and be conducted on a day which meets the ambient conditions specified in section III.C.1.2.:., except the ambient temperature must be at least 1OSoF. During the profile generation, the temperature offset shall apply.

7.3. The vehicle air conditioning system (if so equipped) shall be set to the "NORMAL" air conditioning mode and adjusted to the minimum discharge air temperature and high fan speed. Vehicles equipped with automatic temperature controlled air conditioning systems shall be operated in "AUTOMATIC" temperature and fan modes with the system set at 72°F.

8. Running Loss Test

8.0. After the fuel temperature is stabilized at 10SoF or at the temperature specified by the manufacturer, the running loss test shall be performed. During the test, the running loss measurement enclosure shall be maintained at 10SoF ± SOF maximum and within ± 2°F on average throughout the running loss test sequence. Control of the vapor temperature throughout the test to follow the vapor temperature profile generated according to the procedures in section III.C. is optional. In those instances where vapor temperature is not controlled to follow the profile, the measurement of the fuel tank pressure is not required, and sections III.D.8.1.10.:. andIII.D.8.2.S.:. below shall not apply. In the eventthat a vehicle exceeds the applicable emission standard during . confirmatory testing or in-use compliance testing, and the vapor temperature was not



Date of Release: December 5, 2008; 45-Day Notice version
Date of Hearing: January 22-23.2009

controlled, the manufacturer may, utilizing its own resources, test the vehicle to demonstrate if the excess emissions are attributable to inadequate control of vapor temperature. If the vehicle has more than one fuel tank, the fuel temperature in each tank shall follow the profile generated in paragraphsection III.C. If a warning light or gauge indicates that the vehicle's engine coolant has overheated, the test run may be stopped.

8.1. If funning loss testing is conducted using an enclosure which incorporates atmospheric sampling equipment, the manufacturer shall perform the following steps for each test:

8.1.1. The running loss enclosure shall be purged for several minutes immediately prior to the test.· If at any time the concentration of hydrocarbons, of alcohol, or of alcohol and hydrocarbons exceeds 15,000 ppm C, the enclosure should be immediately purged. This concentration provides at least a 4:1 safety factor against the lean flammability limit.

8.1.2. Place the drive wheels of the vehicle on the dynamometer without starting the engine.

8.1.3. Attach the exhaust tube to the vehicle tailpipe(s).

8.1.4. The test vehicle windows and the luggage compartments shall be closed.

8.1.5. The fuel tank temperature sensor and the ambient temperature sensor shall be connected to the temperature recording system and, if required, to the air management and temperature controllers. The vehicle cooling fan shall be positioned as described in 40 CFR §86.135-90(b). During the running loss test, the cover of the vehicle engine compartment shall be closed as much as possible, windows shall be closed, and air conditioning system (if so equipped) shall be operated according to the requirements of paragraphsection III.C:. (§86.129-80 (d)(3». Vehicle coolant temperature shall be monitored to ensure adequate vehicle coolant air to the radiator intake(s). The temperature recording system and the hydrocarbon and alcohol emission data recording system shall be started.

8.1.6. Close and seal enclosure doors.

8.1.7. When the ambient temperature is 105°F ± 5°F, the running loss test shall begin. Analyze enclosure atmosphere for hydrocarbons and alcohol at the beginning of each phase of the test (Le., each UDDS and 120 second idle; the two NYCCs and 120 second idle) and record. This is the background hydrocarbon concentration, herein denoted as CHCa(n) for each phase of the test and the background methanol concentration, herein denoted as CCH30Ha(n) for each phase of the test. The methanol sampling muststart simultaneously with the initiation of the hydrocarbon analysis and continue for 4.0 ± 0.5 minutes. Record the time elapsed during this analysis. If the 4 minute sample period is inadequate to collect a sample of sufficient concentration to allow accurate Gas Chromatography analysis, rapidly collect the methanol sample in a bag and then bubble the bag sample through· the impingers at the specified flow rate. The time elapsed between collection of the bag sample and flow through the impingers should be minimized to prevent any losses. .

8.1.8. The vehicle shall be driven through one UDDS, then two NYCCs and followed by one UDDS. Each UDOS and the. NYCC driving trace shall be verified to meet the speed tolerance requirements of 40 CFR §86.115-78 (b) as modified by III.C. The end of each UDDS cycle and the two NYCCs shall be followed by an idle period of 120 seconds during which the engine shall remain on with the vehicle in the same transmission range and clutch (if so equipped) actuation mode as specified in §86.128-79, modified by paragraphsection III.C.1.3.

8.1.8.1. The fuel tank liquid temperature during the dynamometer drive shall be controlled within ± 3°F of the fueltank temperature profile obtained on the road according to the procedures in paragraphsection III.C. (40 CFR §86.129-80) for the same vehicle platform/powertrain/fuel tank configuration. If applicable, the fuel tank vapor temperature throughout the running loss test shall agree with the corresponding vapor temperature with a tolerance of ± SOF. A running loss test with a fuel tank vapor temperature that exceeded the corresponding vapor temperature profile by more than· the ± SOF tolerance may be considered valid if test results comply with the applicable running loss .evaporative emission standards. In addition, the fuel tank vapor temperature during the final 120 second idle period shall agree with the corresponding vapor temperature from the on-road profile within ± 3°F. For testing conducted by the Executive Officer, vapor temperatures may be cooler than the specified tolerances without invalidating test results. The fuel tank temperatures shall be monitored at a frequency of at least once every 1S seconds.

8.1.9. For engine starting and restarting, the provisions of §86.136-90(a) and (e) shall apply. If the vehicle does not start after the manufacturer's recommended cranking time or 10 continuous seconds in the absence of a manufacturer's recommendation, cranking shall cease for the period recommended by the manufacturer or 10 seconds in the absence ofa manufacturer's recommendation. This may be repeated for up to three start attempts. If the vehicle does not start after these three attempts, cranking shall cease and the reason for failure to start shall be determined. If the failure is caused by a vehicle malfunction, corrective action of less than 30 minutes duration may be taken (according to 40 CFR §86.1830-01), and the test continued, provided that the ambient conditions to which thevehicle is exposed are m·aintained at 10SoF ± SOF. When the engine starts, the timing sequence of the driving schedule shall begin. If the yehicle cannot be started, the test shall be voided.

8.1.10. Tank pressure shall not exceed 10 inches of water during the running loss test unless a pressurized system is used and the manufacturer demonstrates in a separate test that vapor would not be vented to the atmosphere if the fuel fill pipe cap was removed at the end of the test. Transitory incidents of the pressure exceeding 10 inches of water) not greater than 10 percent of the total driving time, shall be acceptable during the running loss test if the manufacturer can demonstrate that the tank pressure does not exceed 10 inches of water during in-use operation. No pressure checks of the evaporative system shall be allowed. If the manufacturer suspects faulty or malfunctioning instrumentation, a repair of the test instrumentation may be performed. Under no circumstances will any changes/repairs to the evaporative emissions control system be allowed.

8.1.11. The FIO hydrocarbon analyzer shall be zeroed and spanned immediately prior to the end of each phase of the test.

8.1.12. ,Analyze the enclosure atmosphere for hydrocarbons and for alcohol following each phase. This is the sample hydrocarbon concentration, herein denoted as $C_{HCs(n)}$ for each phase of the test and the sample alcohol concentration, herein denoted as $C_{CH3OHs(n)}$ for each phase of the test. The sample hydrocarbon and alcohol concentration for a particular phase of the test shall serve as the background concentration for the next phase of the test. The running loss test ends with completion ofthe final 120 second idle and occurs 72 ± 2 minutes after the test begins. The elapsed time of this analysis shall be recorded.

8.1.13. Turn off the vehicle cooling fan and the vehicle underbody fan if used. The test vehicle windows and luggage compartment shall be opened. This isa preparatory step for the hot soak evaporative emission test.

8.1.14. The technician may now leave the enclosure through one of the enclosure doors.· The enclosure door shall be open no longer than necessary for the technician to leave.

8.2. If running loss testing is conducted using a cell which incorporates point source sampling equipment, the manufacturer shall perform the following steps for each test:

8.2.1. The running loss test shall be conducted in a test cell meeting the specifications of 40 CFR §86.107-90 (a)(1) as modified by paragraphsection III.A.2.:. of these procedures. Ambient temperature in the running loss test cell shall be maintained at 10S ± 5°F maximum and within ± 2°F on average throughout the running loss test sequence. The ambient test cell temperature shall be measured in the vicinity of the vehicle cooling fan, and it shall be monitored at a frequency of at least once every 1S seconds. The vehicle running loss collection system and underbody cooling apparatus (if applicable) shall be positioned and connected. The vehicle shall be allowed to re-stabilize until the liquid fuel tank temperature is within ± 3.0°F of the initial liquid fuel temperature calculated according to paragraphsection III.C.1.5. (40 CFR §86.129-80) before the running loss test may proceed.

8.2.2. The vehicle cooling fan shall be positioned as described in 40 CFR §86.135-90(b). During the running loss test, the cover of the vehicle engine compartment shall be closed as much as possible, windows shall be closed, and air conditioning system (if so equipped) shall be operated according to the requirements of paragraphsection III.C.1.3. (40 CFR §86.129-80). Vehicle coolant temperature shall be monitored to ensure adequate vehicle coolant air to the radiator intake(s).

8.2.3. The vehicle shall be operated on the dynamometer over one UDDS, two NYCCs, and one UDDS. Each UDDS and NYCC driving trace shall be verified to meet the speed tolerance requirements of 40 CFR §86.115-78 (b) as modified by paragraphsection lil.e. Idle periods of 120 seconds shall be added to the end of each of the UDDS and to the end of the two NYCCs. The transmission may be operated according to the specifications of 40 CFR §86.128-79 as modified by paragraphsection III.C.1.3. Engine starting and restarting shall be conducted according to paragraphsection 111.0.8.1.9.

8.2.4. The fuel tank liquid temperature during the dynamometer drive shall be controlled within ± 3°F of the fuel tank liquid temperature profile obtained on the road according to the procedures in paragraphsection III.C.:, (40 CFR §86.129-80) for the same vehicle platform/powertrain/fuel tank configuration. If applicable, the fuel tank vapor temperature throughout the running loss test shall ag'ree with the corresponding vapor temperature with a tolerance of ± 5°F. A running loss test with a fuel tank vapor temperature that exceeded the corresponding vapor temperature profile by more than the ± 5°F tolerance may be considered valid if test results complywith the applicable running loss evaporative emission standards. In addition, the fuel tank vapor temperature during the final 120 second idle period shall agree with the corresponding vapor temperature from the on-road profile within ± 3°F. For testing conducted by the Executive Officer, vapor temperatures may be cooler than the specified tolerances without invalidating test results. The fuel tank temperatures shall be monitored at a frequency of at least once every 15 seconds.

8.2.5. Tank pressure shall not exceed 10 inches of water during the running loss test unless a pressurized system is used and the manufacturer demonstrates in a separate test that vapor would not be vented to the atmosphere if the fuel fill pipe cap was removed at the end of the test. Transitory incidents of the pressure exceeding 10 inches of water, not greater than 10 percent of the total driving time, shall be acceptable during the running loss test if the manufacturer can demonstrate that the tank pressure does not exceed 10 inches of water during in-use operation. No pressure checks of the evaporative system shall be allowed. If the manufacturer suspects faulty or malfunctioning instrumentation, a repair of the test instrumentation may be performed. Under no circumstances will any changes/repairs to the evaporative emissions control system be allowed.

'8.2.6. After the test vehicle is positioned 'on the dynamometer, the running loss vapor collection system shall be properly positioned at the specified discrete emissions sources, which include vapor vents of the vehicle's fuel system, if not already positioned. The typical vapor vents for current fuel systems are the vents of the evaporative emission canister(s) and the tank pressure relief vent typically integrated into the fuel tank cap as depicted in fEigure 1. Other designated places, if any, where fuel vapor can escape, shall also be included.

8.2.7. The running loss vapor collection system may be connected to the POP-CVS or CFV bag collection system: Otherwise, running loss vapors shall be sampled continuously with analyzers meeting the requirements of §86.1 07-90(a)(2).

8.2.8. The temperature of the collection system until it enters the main dilution. airstream shall be maintained between 17SoF to 200°F throughout the test to prevent fuel vapor condensation.

8.2.9. The sample bags shall be analyzed within 20 minutes of their res·pective sample collection phases, as described in 40 CFR §86.137-90(b)(1S).

8.2.10. After the completion of the final 120 seconds, turn off the vehicle cooling fan and the vehicle underbody fan if used.

8.3. Manufacturers may use an alternative running loss test procedure if it provides an equivalent demonstration of compliance. The use of an alternative procedure also requires the prior approval of the Executive Officer. The Executive Officer may conduct confirmatory testing or in-use compliance testing using either the running loss measurement enclosure incorporating atmospheric sampling equipment or in a test cell utilizing point source sampling equipment, as specified in paragraphsection III.A.2.:. (40 CFR §86.1 07-90(a)(1», in conjunction with the procedures as outlined in either paragraphsection 111.0.8.1.:. or 111.0.8.2.:. ofthis test procedure, or using the manufacturer's approved alternative running loss test procedure for a specific evaporative family.

9. **Hot Soak** Test

9.1.:. Amend the first paragraph of 40 CFR §86.138-90 as follows: For the three-day diurnal sequence, the hot soak evaporative emission test shall be conducted immediately following the running loss test. The hot soak test shall be performed at an ambient temperature of 10SoF ± 1O.O°F for the first S minutes of the test. The remainder of the hot soak test shall be performed at 10SoF ± S.O°F and ± 2.0°F on average.

9.2. Revise sectionsubparagraph (a) to read: If the hot soak test is conducted in the running loss enclosure, the final hydrocarbon and alcohol concentration for the running loss test, ·calculated in paragraphsection III.D.11.3.1jb), shall be the initial hydrocarbon concentration (time_=_O minutes) CHCe1 and the initial alcohol concentration (time=O minutes) CCH30He1 for the hot soak test. If the vehicle must be transported to a different enclosure, sections III.D.9.3. through III.D.9.7., as modified below, shall be conducted.

9.3. Revise sectionsubparagraph (d) to include: Analyze the enclosure atmosphere for hydrocarbons and alcohol and record. This is the initial (time=O minutes) hydrocarbon concentration, $C_{HCe1}$ and the initial (time=O minutes) alcohol concentration, $C_{CH3OHe1}$, required in paragraphsection 1II.0.11.3.1Ja).

9.4. Revise sectionsubparagraph (e) to read: If the hot soak test is not conducted in the running loss enclosure, the vehicle engine compartment cover shall be closed, the cooling fan shall be moved, the vehicle shall be disconnected from the dynamometer and exhaust sampling system, and then driven at minimum throttle to the vehicle entrance' of the enclosure.

9.5. Revisesectionsubparagraph (i) to read: If hot soak testing is not conducted in the same enclosure as running loss testing, the hot soak enclosure doors shall be closed and sealed within two minutes of engine shutdown and within seven minutes after the end of the running loss test. If running loss and hot soak testing is conducted in the same enclosure, the hot soak test shall commence immediately after the completion of the running loss test.

9.6. Revise sectionsubparagraph (j) to read: The 60 ± 0.5 minutes hot soak begins when the enclosure door(s) are sealed or when the running loss test ends if the hot soak test is conducted in the running loss enclosure.

9.7. For the supplemental two-day diurnal test sequence, the hot soak test shall be conducted immediately following the hot start exhaust test. The hot soak test shall be performed at an ambient temperature between 68 to 86°F at all times. The hot soak test shall be conducted according to 40 CFR §86.138 90, revised by 9.2 through 9.7 of this paragraph.

9.8. The hot soak test shall be conducted according to 40 CFR §86.138-90, as revised by sections 111.0.9.2. through 111.0.9.7.

10. **Diurnal Breathing Loss Test**

10.1. A three-day diurnal test shall be performed in a variable temperature enclosure, described in .paragraphsection III.A.1. of this test procedure. The test consists of three 24-hour cycles. For purposes of this diurnal breathing loss test, all references to methanol shall be applicable to alcohol..

. 10.2. If testing indicates that a vehicle design may result in fuel temperature responses during enclosure testing that are not representative of in-use summertime conditions,. the Executive Officer may adjust air circulation and temperature during the test as needed to ensure that the test sufficiently duplicates the vehicle's in-use experience.

10.1.10.3. Revise 40 CFR §86.133-90 to read as follows:

10.1.1.10.3.1. Revise seotionsubparagraph (a)(1) to read: Upon completion of the hot soak test, the test vehicle shall be soaked for not less than 6 hours and notr more than 36 hours. For at least the last 6 hours of this period, the vehicle shall be soaked at 65°F ± 3°F. The diurnal breathing loss test shall consist of three 24-hour test cycles.

+10.1.2.10.3.2. Omit sectionsubparagraph (t).

10.1.3.10.3.3. Omit sectionsubparagraph (i).

10.1.4.10.3.4. Revisesectionsubparagraph (j) to read: Prior to initiating the emission sampling:

10.1.5.10.3.5. Revise seotionsubparagraph (k) to read: Emission sampling shall begin within 10 minutes of closing and sealing the doors, as follows:

10.1.6.10.3.6. Revise seotionsubparagraph (k)(3) to read: Start diurnal heat build and record time. This commences the 24 hour ± 2 minute test cycle.

10.1.7.10.3.7. Revise sectionsubparagraph (l) to read: For each 24-hour cycle of the diurnal breathing loss test, the ambient temperature in the enclosure shall 'be changed in real time as specified in the following table:

| Hour | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (OF) | 65.0 | 66.6 | 72.6 | 80.3 | 86.1 | 90.6 | 94.6 | 98.1 | 101.2 | 103.4 | 104.9 | 105.0 | 104.2 |
| Hour | 13 | 14 | 15 | 16 | 17 | ,18 | 19 | 20 | 21 | 22 | 23 | 24 | |
| (OF) | 101.1 | 95.3 | 88.8 | 84.4 | 80.8 | 77.8 | 75.3 | 72.0 | 70.0 | 68.2 | 66.5 | 65.0 | |

10.1.8.10.3.8. Omit seotionsubparagraph (m).

10.1.9.10.3.9. Revise sectionsubparagraph (n) to read: The end of the first 24-hour cycle of the diurnal test occurs 24 hours ± 2 minutes after the heat build begins. Ana,lyze the enclosure atmosphere for hydrocarbons and alcohol and record. This is the final hydrocarbon concentration, $C_{HCe2}$, and the final alcohol concentration, $C_{CH3OHe2}$, in paragraphsection III.D.11.3.1jc) which modifies 40 CFR §86.143-90, for this test cycle. The time (or elapsed time) of this analysis shall be recorded. The procedure, commencing with subparagraph (k)(1) shall be repeated until three consecutive 24-hour tests are completed. The data from the test cycle yielding the highest diurnal hydrocarbon mass shall be used in evaporative emissions calculations as required by paragraphsection 1I1.0.11.3.1jc). which modifies 40 CFR §86.143-90.

10.1.10.10.3.10. Revise sectionsubparagraph (q) to read: Upon completion of the final 24-hour test cycle, and after the final alcohol sample has been collected, the enclosure doors shall be unsealed and opened.

10.1.11.10.3.11. Omit sectionsubparagraph (r).

10.1.12.10.3.12. Add sectionsubparagraph (t) to read:, For hybrid electric vehicles the manufacturer shall specify the working capacity of the evaporative emission control' canister, and shall specify the number of 24-hour diurnals that can elapse before the auxiliary power unit will activate solely for the purposes of purging the canister of hydrocarbon vapor.

10.1.13.10.3.13. Add sectionsubparagraph (u) to read: In order to determine thaUheworkingcapacityof the canister is sufficient to store the hydrocarbon vapor generated oyer the manufacturer specified number of days between auxiliary power unit activaUonevents for the purposes of purging the evaporative canister, the evaporative canister shall be weighed after completion of the three-day diurnal period. The weight ofthe vapor contained in the canister shall not exceed the working capacity of the canister multiplied by three days and divided by the manufacturer specified number of days between auxiliary powerunit activation events.

10.1.14.10.3.14. Addsectionsubparagraph (v) to read: The manufacturer shall specify the time interval of auxiliary power unit operation necessary to purge the evaporative emission control canister, and shall submit an engineering analysis to demonstrate that the canister will be purged to within five percent of its working capacity over the time interval.

10.15. The two-day diurnal test shall be performed in an enclosure, described in paragraphsection liLA.1. of this testprocedure. The test consists of two 24-hour cyclesdiurnals. The test procedure shall be conducted according to 40 CFR §86.133-90, revised bysections III.D.10.3.1. through 111.0.10.3.14.,10.1.1 through 10.1.15 of this paragraph except that only two consecutive 24-hour cyclesdiurnals shallwill be performed. For the purposes of this diurnal breathing loss test, all references to methanol shall be applicable to alcohol.

11. Calculations: Evaporative Emissions

11.0. Revise 40 CFR §86.143-90 as follows:

11.1. Revise sestionsubparagraph (a) to read: The calculation of the net hydrocarbon pius methanol mass change in the enclosure is used to determine the diurnal, hot soak, and running loss mass emissions. If the emissions also include ethanol and other alcohol components, the manufacturer shall determine an appropriate calculation(s) which reflect characteristics of the alcohol component similar to the equations below, subject to the Executive Officer approval. The mass changes are calculated from initial and final hydrocarbon and methanol concentrations in ppm carbon, initial and final enclosure ambient temperatures, initial and final barometric pressures, and net enclosure volume using the following equations:

11.2. Revise sestionsubparagraph (a)(1) to read:

Methanol calculations shall be conducted according to 40 CFR §86.143-96(b)(1)(i), as amended March 24, 1993.

11.3. Revisesestionsubparagraph (a)(2) to read:

11.3.1. For hydrocarbons:

(a) Hot soak HC mass. For fixed volume enclosures, the hot soak enclosure mass is determined as:

MHchs = [2.97x $(V_n$ - 50) x1 0-4 x {Pf (CHCe2 - rCCH30He2)fTf - Pi (CHCe1 - rCCH30He1)fTi}I

where: $M_{HChs}$ is the hot soak HC mass emissions (grams)

Vn is the enclosure nominal volume if the running loss enclosure is used or the enclosure volume at 105°F if the diurnal enclosure is used. $(ft^3)$

Pi is the initial barometric pressure (inches Hg)

Pf is the final barometric pressure (inches Hg)

$C_{HCe2}$ is the final enclosure hydrocarbon concentration including FIO response to methanol in the sample (ppm C)

$C_{HCe1}$ is the initial enclosure hydrocarbon concentration including FIO response to methanol in the sample (ppm C)

CCH30He2 is the final methanol concentration calculated according to §86.143-90 (a)(2)(iii) (ppm C equivalent)

$C_{CH3OHe1}$ is the initial methanol concentration calculated according to §86.143-90 (a)(2)(iii) (ppm C equivalent)

r is the FID response factor to methanol

$T_i$ is the initial enclosure temperature (°R)

$T_f$ is the final enclosure temperature (°R)

For variable volume enclosures, calculate the hot soak enclosure mass ($M_{HChs}$) according to the equation used above except that $P_f$ and $T_f$ shall equal $P_i$ and $T_i$.

(b) Running loss HC mass. The running loss HC mass per distance traveled is defined as:

$$M_{HCrlt} = (M_{HCrl(1)} + M_{HCrl(2)} + M_{HCr1(3)})/(D_{rl(1)} + D_{rl(2)} + D_{rl(3)})$$

where: $M_{HCrlt}$ is the total running loss HC mass per distance traveled (grams HC per mile)

$M_{HCrl(n)}$ is the running loss HC mass for phase n of the test (grams HC)

$D_{rl(n)}$ is the actual distance traveled over the driving cycle for phase n of the test (miles)

For the point-source method:

where: $C_{HCs(n)}$ is the sample bag HC concentration for phase n of the test (ppm C)

$C_{HCa(n)}$ is the background bag concentration for phase n of
the test (ppm C)

16.88 is the density of pure vapor at 68°F (grams/$ft^3$)

$V_{mix}$ is the total dilute CVS volume (std. $ft^3$)



Date of Release: December 5, 2008; 45-Day Notice version
Date of Hearing: January 22-23.2009

and: $V_{mix}$ is calculated per 40 CFR §86.144-90

Methanol emissions:

$M_{CH3OHrl(n)} = (C_{CH3OHs(n)} - C_{CH3OHa(n)}) \times 37.74 \times V_{mix}$

where: $C_{CH3OHS(n)}$ is the sample bag methanol concentration for phase n of the test (ppm C equivalent)

$C_{CH3OHa(n)}$ is the background bag concentration for phase n of the test (ppm C equivalent)

37.71 is the density of pure vapor at 68°F *(grams/ft$^3$)*

$V_{mix}$ is the total dilute CVS volume (std. ft3)

and: $V_{mix}$ is calculated per 40 CFR §86.144-90

For the enclosure method:

$M_{HCrl(n)}$ shall be determined by the same method as the hot soak hydrocarbon mass emissions determination specified in paragraphsection III.D.11.3.1Ja).

(c) Diurnal mass. For fixed volume enclosures, the HC mass for each of the three diurnals is defined for an enclosure as:

$M_{HCd} = [2.97 \times (V - 50) \times 10^{-4} \times \{P_f (C_{HCe2} - rC_{CH3OHe2}) / T_f - P_i (C_{HCe1} - rC_{CH3OHe1}) / T_i\}] + M_{HC,out} - M_{HC,in}$

where: $M_{HCd}$ is the diurnal HC mass emissions (grams)

V is the enclosure volume at 65° F (ft3)

$P_i$ is the initial barometric pressure (inches Hg)

$P_f$ is the final barometric pressure (inches Hg)

$C_{HCe2}$ is the final enclosure hydrocarbon concentration including FID response to methanol in the sample (ppm C)



Date of Release: December 5, 2008; 45-Day Notice version
Date of Hearing: January 22-23.2009

$C_{HCe1}$ .is the initial enclosure hydrocarbon concentration including FID response to methanol in the sample (ppm C)

$C_{CH3OHe2}$ is the final methanol concentration calculated according to 40 CFR §86.143-90 (a)(2)(iii)

$C_{CH3OHe1}$ is the initial methanol concentration calculated according to 40 CFR §86.143-90 (a)(2)(iii)

r is the FID response factor to methanol

Tj is the initial enclosure temperature (oR)

Tf is the final enclosure temperature (oR)

$M_{HC, out}$ is the mass of hydrocarbon exiting the enclosure from the beginning of the cycle to the end of the cycle (grams)

. $M_{HC, in}$ is the mass of hydrocarbon entering the enclosure from the beginning of the cycle to the end of the cycle (grams)

For variable volume enclosures, calculate the HC mass for each of the three diurnals ($M_{HCd}$) according to the equation used above except that Pf and Tf shall equal Pi and Ti and $M_{HC, out}$ and $M_{HC, in}$ shall equal zero.

11.3.2. Revise seotionsubparagraph (a)(3) to read:

The total mass emissions shall be adjusted as follows:

(1) $M_{hs} = M_{HChs} + (14.2284/32.042) \times 10^{-6} M_{CH3OH}$

(2) $M_{di} = M_{HCd} + (14.3594/32.042) \times 10^{-6} M_{CH3OH}$

(3) $M_{rl} = M_{HCrl} + (14.2284/32.042) \times 10^{-6} M_{CH3OH}$

11.3.3. Revise sectionsubparagraph (b) to read: The final evaporative emission test results reported shall be computed by summing the adjusted evaporative emission result determined for the hot soak test ($M_{hs}$) and the highest 24-hour result determined for the diurnal breathing loss test ($M_{di}$)·. The final reported result for the running loss test shall be the adjusted emission result ($M_{rl}$), expressed on a grams per mile basis. .

E. **Liquefied Petroleum Gas-fueled Vehicles**

1. For 1983 and subsequent model-year LPG-fueled motor vehicles, the introduction of 40 percent by volume of chilled fuel and the heating of the fuel tank under the diurnal part of the evaporative test procedures shall be eliminated.

2. Calculation of LPG Emissions. The evaporative emissions for LPG systems shall be calculated in accordance with 40 CFR §86.143-78 or §86.143-90except that a *HIC* ratio of 2.658 shall be used for both the diurnal and hot soak emissions.

F. **Fuel Specifications**

1. Evaporative emission test fuel shall be the fuel specified for exhaust emission testing as specified in the "California Exhaust Emission Standards and Test Procedures for,2001 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles," except as provided in section III.G. of these test procedures.

G. **Alternative Test Procedures**

1. If a manufacturer uses for evaporative and exhaust emission testing a gasoline test fuel meeting the specifications set forth in 40 CFR §86.113-94(a)(1), the manufacturer may use the evaporative emission test procedures set forth in 40 CFR §§86.1 07-96 through 86.143-96 in place of the test procedures set forth in these test procedures.

2. Manufacturers may use an alternative set of test procedures to demonstrate compliance with the standards set forth in section I.E. of these test procedures with advance Executive Officer approval if the alternative procedure is demonstrated to yield test results equivalent to, or more stringent than, those resulting from the use of the tesLprocedures set forth in section III.D. of these test procedures.

3. If the manufacturer uses for certification a test procedure other than section 111.0:., the Executive Officer has the option to conduct confirmatory and in-use compliance testing with the test procedures set forth in section 111.0. of this California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles.

H. **Use of Comparable Federal Requirements for Carry-across Specifications and Road Profile Correction Factors**

1. Upon prior written approval of the Executive Officer, a manufacturer may use the comparable federal requirements in Title 40, CFR, Part 86 in lieu of the carry-across specifications of paragraphsection II.A. of these test procedures and the running loss road profile correction factors of paragraphsection III.C. The Executive

**Officer shall approve a manufacturer's request if the manufacturer demonstrates tothe Executive Officer that the alternative methodology will not adversely affect in-use evaporative emissions.**

# PART IV. EVAPORATIVE EMISSION TEST PROCEDURES FOR MOTORCYCLES

1. For the purposes of these procedures, the following references in 40 CFR, Part 86, Subpart B to light-duty vehicle evaporative testing shall also apply to motorcycles: 40 CFR §§86.117-78, 86.117-90, 86.121-82 and 86.121-90. In addition, 40 CFR, Part 86, Subparts E, F, and other cited sections of Subpart B are incorporated into this test procedure by reference.

2. Preconditioning shall be performed in accordance with 40 CFR . §86.532-78. The provisions of §86.132-78 which prohibit abnormal loading of the evaporative emission control system during fueling and setting the dynamometer horsepower using a test vehicle shall be observed. Additional preconditioning (40 CFR §86.132-82(a)(3) and §86.132-90(a)(3» may be allowed by the Executive Officer under unusual circumstances.

3. Instrumentation. The instrumentation necessary to perform the motorcycle evaporative emission test is described in 40 CFR §86.1 07-78 and §86.1 07-90, with the following changes:

(i) Revise seGtionsubparagraph (a)(4) to read: Tank fuel heating system. The tank fuel heating system shall consist of two separate heat sources with two temperature controllers. A typical heat source is a pair of heating strips. Other sources may be used as required by circumstances and the Executive Officer may allow manufacturers to provide the heating apparatus for compliance testing. The temperature controllers· may be manual, such as variable transformers, or they may be automated. Since vapor and fuel temperature are to be controlled independently, an automatic controller is recommended for the fuel. The heating system must not cause hot spots on the tank wetted surface which could cause local overheating of the fuel or vapor. Heating strips for the fuel, if used, should be located as low as practicable on the tank and should cover at least 10 percent of the wetted surface. The centerline of ,the fuel heating strips, if used, shall be below 30 percent of the fuel depth as measured from the bottom of the fuel tank and approximately parallel to the fuel level in the tank. The centerline of the vapor heating strips, if used, should be located at the approximate height of the center of the vapor volume. The temperature controller must be capable of controlling the fuel and vapor temperatures to the diurnal heating profile within the 'specified tolerance.

(ii) Revise sectionsubparagraph (a)(5) (Temperature Recording System) to read: In addition to the specifications in this section, the vapor temperature in the fuel tank shall be measured. When the fuel or vapor temperature sensors cannot be located in the fuel tank to measure the temperature of the prescribed test fuel or vapor at the approximate mid-volume, sensors shall be located at the approximate mid-volume of each fuel or vapor containing cavity. The average of the readings from these sensors shall constitute the fuel or vapor temperature. The fuel and vapor temperature sensors shall be located at least one inch away from any heated tank surface. The



Date of Release: December 5, 2008; 45-Day Notice version
Date of Hearing: January 22-23.2009

Executive Officer may approve alternate sensor locations where the specifications above cannot be met or where tank symmetry provides redundant measurements.

(iii) Calibration shall be performed in accordance with 40 CF-R §86.516-78 or §86.516-90.

4. Test Procedure

(i) The motorcycle exhaust emission test sequence is described in 40 CFR §86.530-78 through §86.540-78. The SHED test shall be accomplished by peiformingthe diurnal portion of the SHED test (40 CFR §86.133-78 except subseotionsubparagraphs a(1), k, and p; §86.133-90 except subseotionsubparagraphs a(1), l, and s; and neglecting references to windows and luggage compartments in these sections) after preconditioning and soak but prior to the "cold" start test. The fuel will be cooled to below 30°C after the diurnal test. The "cold" and "hot" start exhaust emission tests shall then be'run. The motorcycle will then be returned for the hot soak portion of the SHED test. This general sequence is shown in Figure E78-10, under 4- CFR §86.130-78. The specified time limits shall be followed with the exception of soak times which are specified in 40 CFR §86.532-78 for motorcycles.

Running loss tests, when necessary, will be performed in accordance with 40 CFR §86.134-78, except references to §§86.135-82 through 86.137-82 and §§86.135-90 through 86.137-90 shall mean §§86.535-78 through 86.537-78.

(ii) A manufacturer of Class III motorcycles with annual California sales of less than 500 units using an assigned evaporative emission control system OF pursuant to paragraphsection II.B.2.1.1jvii) shall measure and report to the Executive Officer exhaust emissions from the CVS test between the diurnal and the hot soak tests even if the testis being conducted for evaporative emissions only. The exhaust emission levels projected for the motorcycle's useful life utilizing the exhaust emission OF determined during previous federal or California certification testing shall not exceed the standards set forth in.section 1958, title 13, CCR.

(iii) The fuel and vapor temperatures for the diurnal portion of the evaporative emission test shall conform to the following functions within ± 1.7°C with the tank filled to 50 percent ±2.5 of its actual capacity, and with the motorcycle resting on its center kickstand (or a similar support) in the vertical position.

$$T_f = (1/3)t + 15.5°C$$

$$T_v = (1/3)t + 21.0°C$$

where Tf = fuel temperature, °c
Tv = vapor temperature, °c



Date of Release: December 5, 2008; 45-Day Notice version
Date of Hearing: January 22-23.2009

t = time since the start of the diurnal temperature rise, minutes.

The test duration shall be 60 ± 2 minutes, giving a fuel and vapor temperature rise of 20°C. The final fuel temperature shall-be 3S.SoC ± O.S °C.

An initial vapor temperature up to SoC above 21°C may be used. For this condition, the vapor shall not be heated at the beginning of the diurnal test. When the fuel temperature has been raised to S.SoC below the vapor temperature by following the Tf function, the remainder of the vapor heating profile shall be followed.

(iv) An alternate temperature rise for the diurnal test may be approved by the Executive Officer. If a manufacturer has information which shows that a particular fuel tank design will change the temperature rise significantly from the function above, the manufacturer may present the information to the Executive Officer for evaluation and c;onsideration.

(v) The hot soak evaporative emission test shall be performed immediately following the "hot" start exhaust emission test. This test is described in 40 CFR §§86.138-78 and 86.138-90, except for §§86.138-78(d) and 86.138-90(e) which are revised to require that the motorcycle be pushed with the engine off rather than driven at a minimum throttle from the dynamometer to the SHED.

(vi) Calculations shall be performed in accordance with 40 CFR §86.143-78 or 86.143-90, except the standard volume for a motorcycle shall be Sft$^3$ instead. of SO ft3.

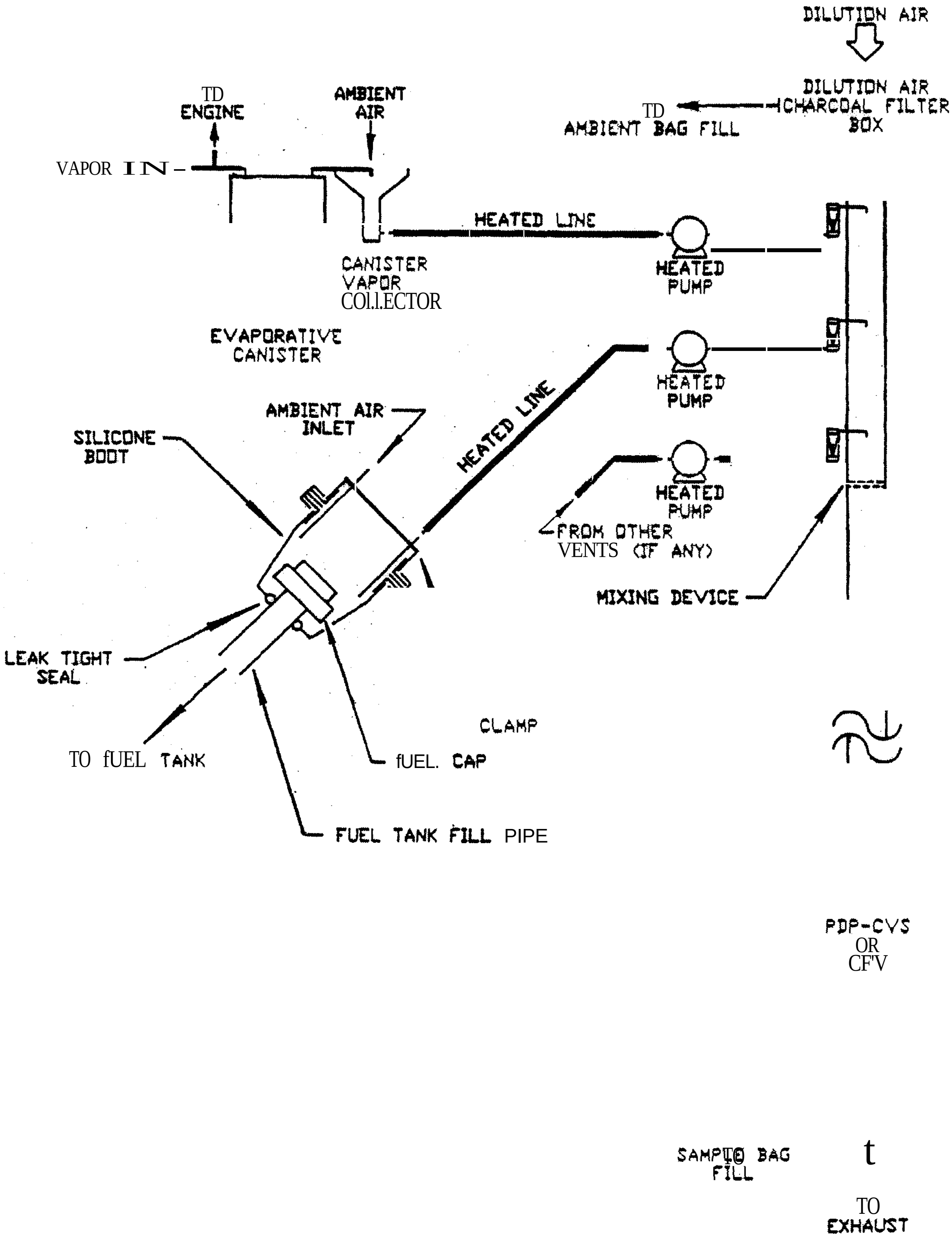


Figure 1: Running Loss Vapor Vent Collection System

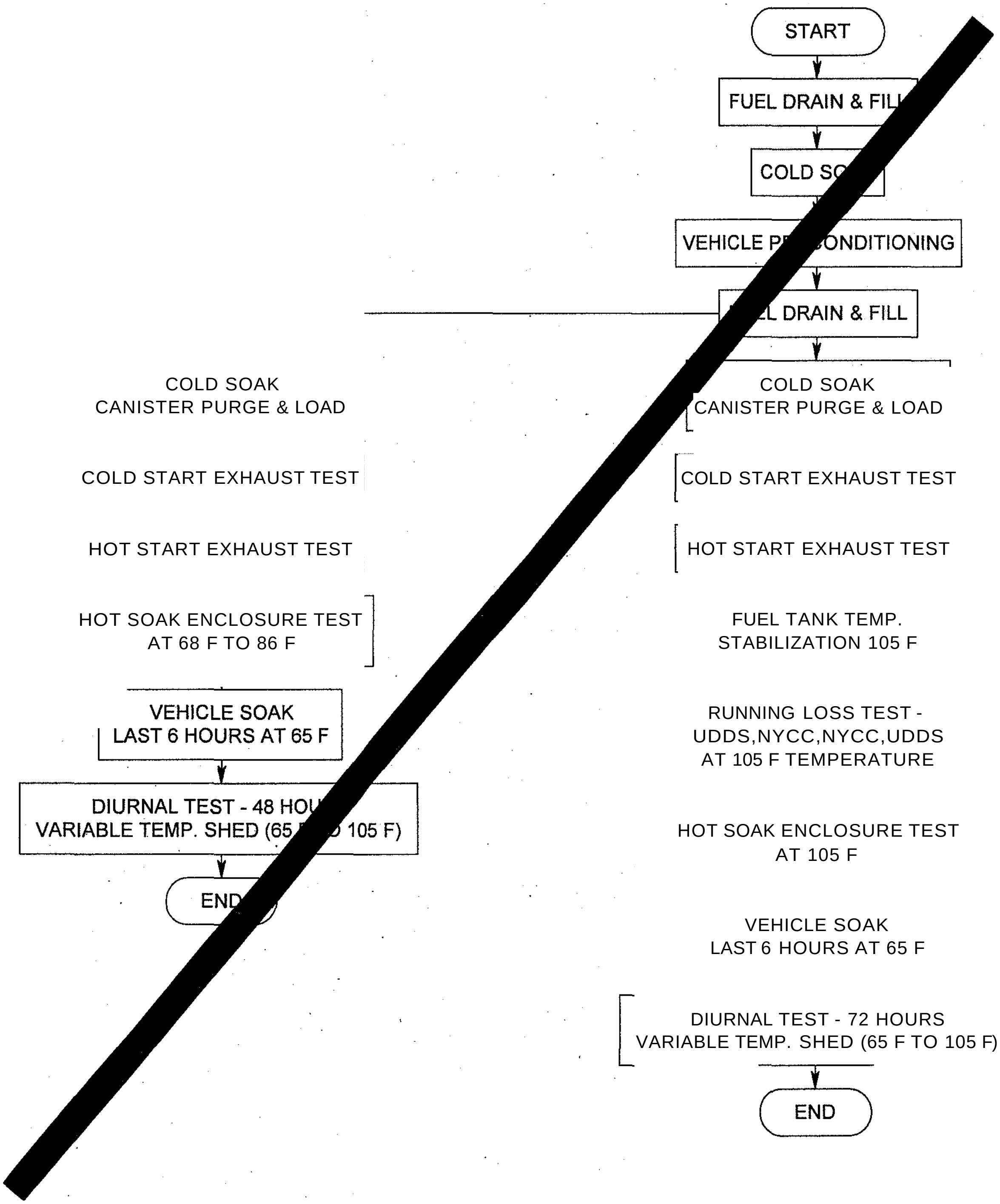


**Figure** 2:· **Test Procedure for 2001 and Subsequent Model Motor**

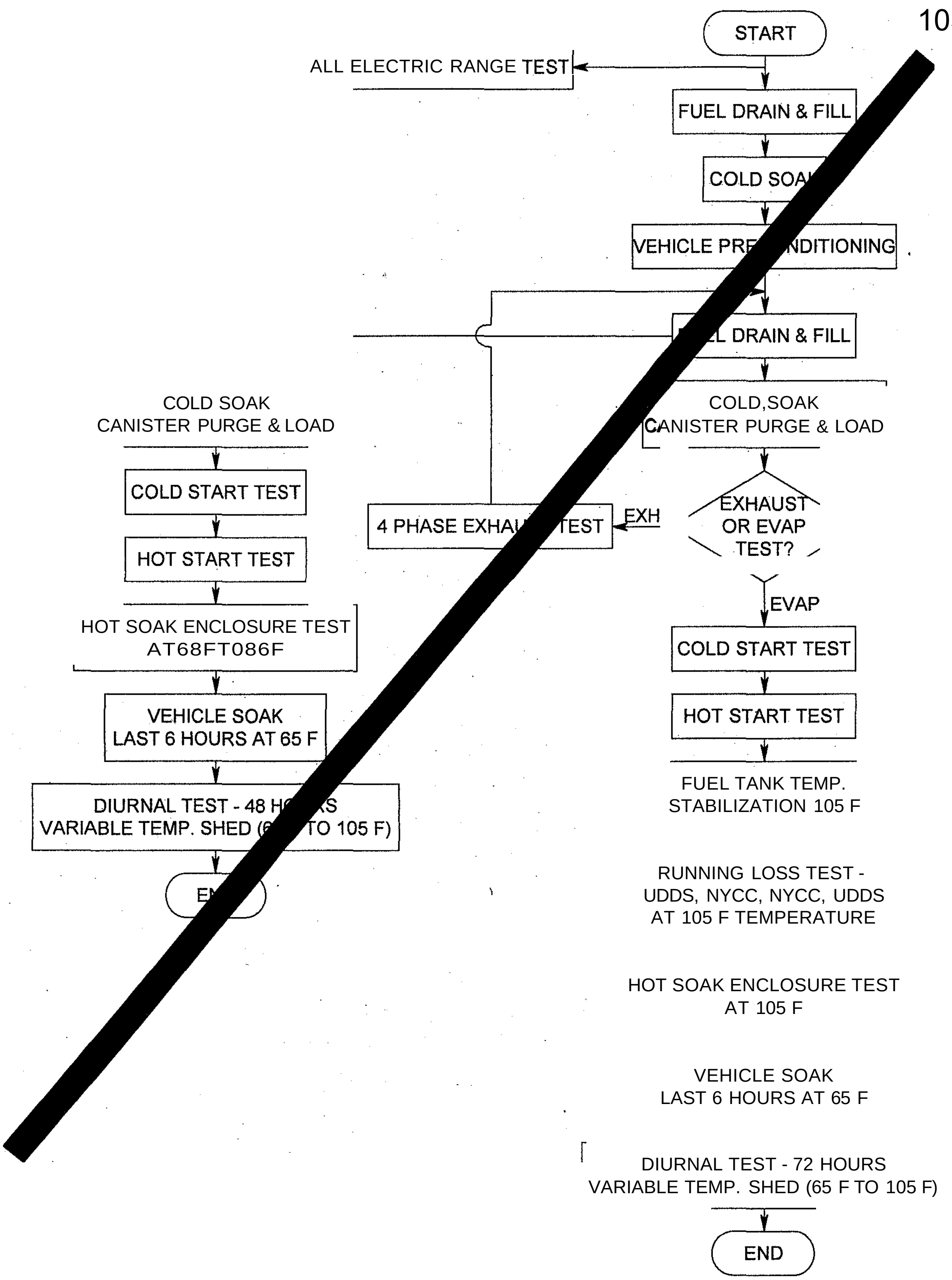


**Figure 3A: Test Procedure for 2001 and Subsequent Model Hybrid Electric Vehicles**

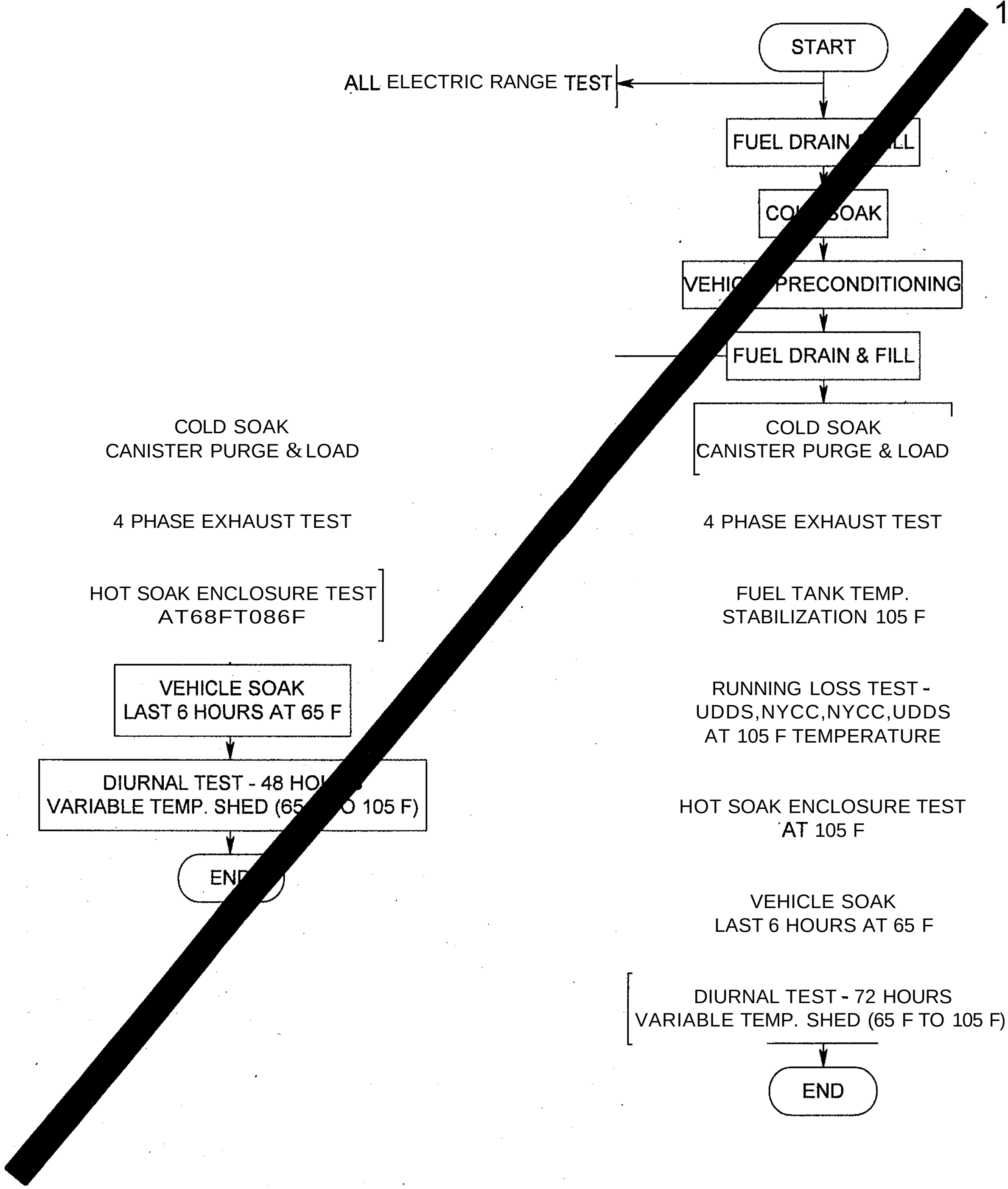


Figure 38: Test Procedure for 2001 and Subsequent Model Hybrid Electric Vehicles

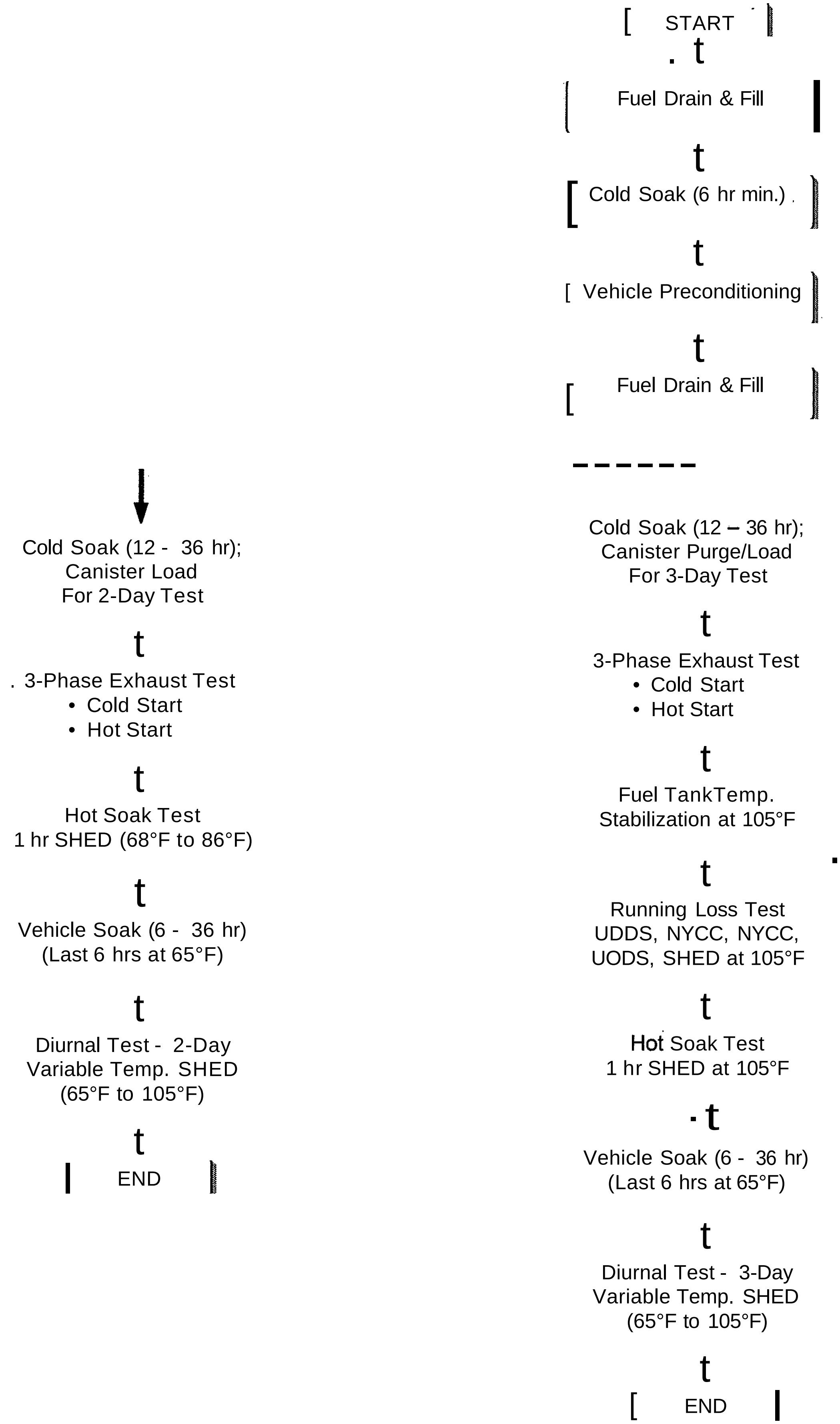


Figure 2: Test Procedure for 2001 and Subsequent Model MotorVehicles

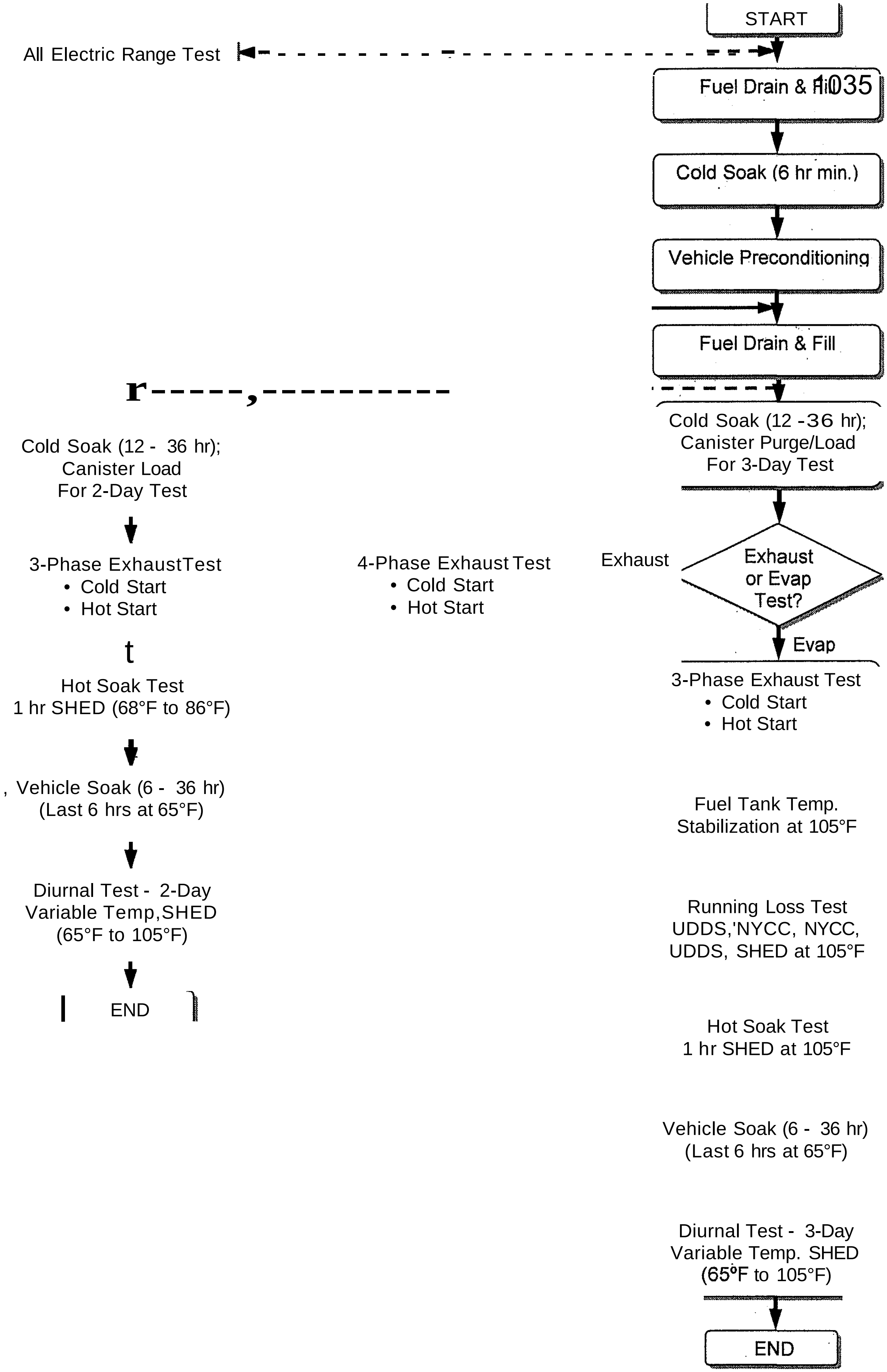


Figure 3A: Test Procedure for 2001 and Subsequent Model Hybrid Electric Vehicles

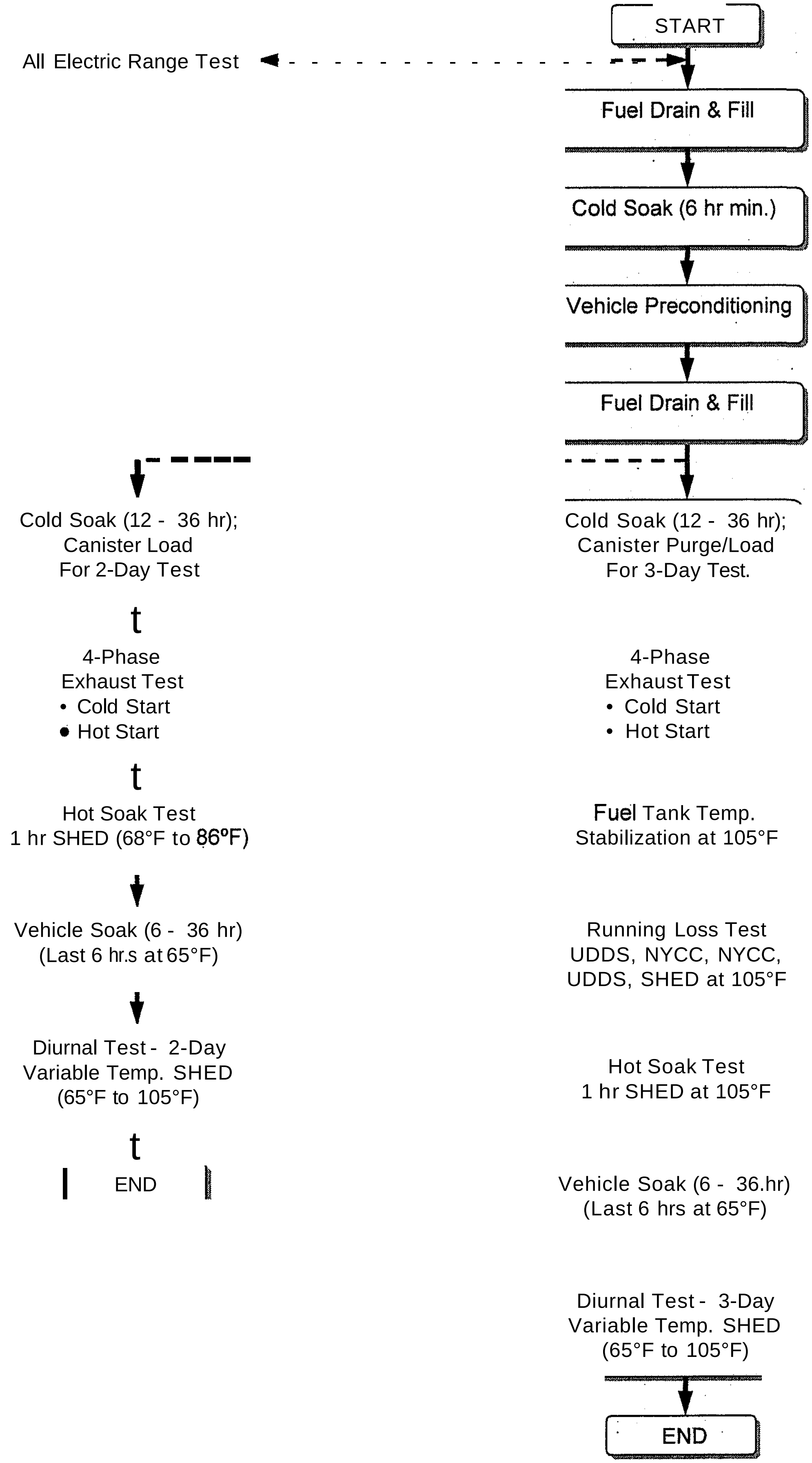


Figure 38: Test Procedure for 2001 and Subsequent Model Hybrid Electric Vehicles

# APPENDIX F

# PROPOSED AMENDMENTS TO THE
# ON ROAD VAPOR RECOVERY TEST PROCEDURES

Date of Release: December 5, 2008; 45‑Day Notice version
Date of Hearing: January 22-23, 2009

State of California
AIR RESOURCES BOARD.

# CALIFORNIA REFUEUNGEMISSION STANDARDS AND TEST PROCEDURES FOR 2001 AND SUBSEQUENT MODEL MOTOR VEHICLES

Adopted: August 5, 1999
Amended: September 5,2003
Amended: June 22, 2006
Amended:" October 17,2007
Amended: [insert amended date]

Note: PropoSed amendments to this document are shown in underline to indicate additions and strikeouts to indicate deletions compared to the test procedures as last amended October 17,2007. Existing intervening text that is not amended is indicated by a row of asterisks (* * * *)..

bate of Release: December 5, 2008; 45-Day Notice version
Date of Hearing: January 22-23, 2009

NOTE: This document is incorporated by reference in section 1978(b), title 13, California Code of Regulations (CCR). Additional requirements necessary to complete an application for certification of motor vehicles are contained in other documents that are designed to be used in conjunction with this document. These other documents include:

1. "California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles" (incorporated by reference in section 1961(d), title 13, CCR);

2. "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes" (incorporated by reference in section 1962.1(h), title 13, CCR);

3. "California Evaporative Emission Standards and Test Procedures For 2001 and Subsequent Model Motor Vehicles" (incorporated by reference in section 1976(c), title 13, CCR).

4. "Malfunction and Diagnostic System Requirements - 1994 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines" (incorporated by reference in section 1968.1, title 13, CCR).

5. "Malfunction and Diagnostic System Requirements - 2004 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines" (incorporated by reference in section 1968.2, title 13, CCR).

6. "Specifications for Fill Pipes and Openings of Motor Vehicle Fuel Tanks" (incorporated by reference in section 2235, title 13, CCR).

# CALIFORNIA REFUELING EMISSION STANDARDS AND TEST PROCEDURES FOR 2001 AND SUBSEQUENT MODEL MOTOR VEHICLES

The provisions of Title 40, Code of Federal Regulations.(CFR), Part 86, Subparts 8 (as adopted or amended by the U.S. Environmental Protection Agency (U.S. EPA) on the date listed) and S (as adopted on May 4, 1999, or as last amended on such other date set forth next to the 40 CFR Part 86 section title listed below) to the extent they pertain to the testing and compliance of vehicle refueling emissions for passenger cars, light-duty trucks and medium-duty vehicles, are hereby adopted as the "California Refueling Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles," with the following exceptions and additions.

**Subpart S Requirements**

## I. General Certification Requirements for Refueling Emissions

### A. Applicability

1. These refueling standards and test procedures are applicable to all new 2001 and subsequent model gasoline-fueled, alcohol-fueled, diesel-fueled, liquefied petroleum gas-fueled,' natural gas-fueled, and hybrid electric passenger cars (including 2011 and subsequent model-year off-vehicle charge capable hybrid electric vehicles), light-duty trucks and medium-duty vehicles with a gross vehicle weight rating of less than 8,501 lbs. A manufacturer may elect to certify a 2009 or a 2010 model-year off-vehicle charge capable hybrid electric vehicle using these provisions. In cases where a provision applies only to a certain vehicle group based on its model year, vehicle class, motor fuel, engine type, or other distinguishing characteristics, the limited applicability is cited in the appropriate.section or paragraph.

2. For general certification purposes, the requirements set forth in the "California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles;" the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes;" and the "California Evaporative Emission Standards and Test Procedures For 2001 and Subsequent Model Motor Vehicles," shall apply, except as otherwise noted in these test procedures.

3. Reference to vehicle sales throughout the United States shall mean vehicle sales in California, except when certifying to the refueling standards, in which case, vehicle sales shall mean throughout the United States.

4. A small volume manufacturer is defined as any vehicle manufacturer with . California actual sales less than or equal to 4,500 new vehicles per model year based on the average number of vehicles sold by the manufacturer in the previous three consecutive years.

5. Regulations concerning U.S. EPA hearings, inspections, specific language on the Certificate of Conformity, alternative 'useful life, and selective enforcement audit shall not be applicable to these procedures, except where specifically noted.

6. In those instances where testing conditions or parameters are not practical or feasible for vehicles certified to the refueling standards, the manufacturer shall provide a test plan that provides equal or greater confidence in comparison to these test refueling procedures. The test plan must be approved in advance by the Executive Officer.

7. The term "[no change]" means that these test procedures do not modify the applicable federal requirement.

8. The specifications for the fuel used in testing are set forth in 40 CFR §86.113-94 ([February 18, 2000]). California certification fuel is not allowed for certification or in-use testing.

B. Definitions, Acronyms, Terminology

'1. These test procedures incorporate by reference the definitions set forth in the Code of Federal Regulations; and, the definitions as set forth in the "California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles.," in the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes," and in the "California Evaporative Emission Standards and TeslProcedures For 2001 and Subsequent Model Motor Vehicles,"

C. Useful Life

1. Delete §86.1805-01; §86.1805-04 and replace with:

"Useful life" shall have the same meaning as provided in Ttitle 13, CeR, §2112.

D. On-Board Diagnostics

1. Delete §86.1806 and replace with:

The applicable sections of the "Malfunction and Diagnostic System Requirements for– 1994 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines," as set forth in Ttitle 13, CCR, Ssection 1968.1 et seq., as applioable,; and, the "Malfunction and Diagnostic System Requirements – 2004 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines," as set forth in title 13, CCR, section 1968.2, areis hereby incorporated by reference into this test procedure. For purposes of this test procedure, all references to evaporative system monitoring, malfunction criteria, and MIL illumination and fault code storage shall also apply to refueling systems.

E. General Standards, increase in emissions; unsafe conditions; waivers

1. Amend §86.1810-01 ([July 12, 2001]) asfollows:

1.1.:. (a) through (j). [See the "California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles,;" adopted August 5, 1999, as last amended June 22,2006; or the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles,." adopted Aug,ust 5, 1999, as last amended June 22, 2006.)

1.2.:. (k) [No change.) ,

1.3. (l) Substitute certification to the applicable refueling emission standards set forth in section I.I.F. of these test procedures instead of with the standards set forth in §86.1811-04(e); §86.1812-01(e); §86.1813-01(e); and, §86.1816-05(e).

1.4.:. (m) Substitute compliance with applicable refueling emission standards set forth in section I.I.F. of these test procedures instead of with the standards set forth in §86.1811-04(e); §86.1812-01(e); §86.1813-01 (e); and, §86.1816-05(e).

1.5.:. (n) [No change.)

1.6.:. (0) and (p) [See the "California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles,." adopted August 5, 1999, as last amended June 22, 2006.)

1.7.:. A manufacturer must demonstrate compliance with the fuel spillage test requirements in Title 13, California Code of Regulations, §2235, the "Specifications for Fill Pipes and Openings of Motor Vehicle Fuel Tanks," as last amended January 22, 1990, which is hereby iricorporated·by reference herein.

2: In addition to the provisions set forth in these test procedures, the ARB reserves the authority to require testing to enforce compliance and to prevent noncompliance with the refueling emission standard.

3. Vehicles certified to the refueling emission standards set forth in Section I.F.2.2,:. below, shall not be counted in the phase-in sales percentage compliance determinations.

F. **Emission Standards**

·1. Delete 40 CFR §§86,1811 through 86.1816 (all years).

2. The maximum refueling emissions for 2001 and subsequent model passenger cars, light-duty trucks and medium-duty vehicles with a gross vehicle weight rating less than 8,501 lbs. for the full useful life are:

2.1,:. For gasoline-fueled, alcohol-fueled, diesel-fueled, fuel-flexible, and hybrid electric vehicles: 0.20 grams hydrocarbons per gallon of fuel dispensed. [For purposes of these test procedures, hydrocarbons shall mean organic material hydrocarbon equivalent for alcohol-fueled vehicles.] For liquefied petroleum gas-fueled vehicles: 0.15 grams hydrocarbons per gallon of fuel dispensed.

2.2,:. Vehicles powered by diesel fuel are not required to conduct testing to demonstrate compliance with the refueling emission standards set forth above, provided that all of the following provisions are met

(A) The manufacturer can attest to the following evaluation: "Due to the low vapor pressure of diesel fuel and the vehicle tank temperatures, hydrocarbon vapor concentrations are low and the vehicle meets the 0.20 grams/gallon refueling emission standard without a control system."

(B) The certification requirement described in paragraphsection I.F.2.2.(A) is provided in writing and applies for the full useful life of the vehicle.

G. **Durability Demonstration procedures for refueling emissions.**

1. §86.1825-01 {October 6, 2000]. Amend as follows: Add the following sentences to the first paragraph:

2. Beginning with 2010 model-year vehicles or engines, at the time of certification manufacturers shall state, based on good engineering judgment and available information, that the emission control devices on their vehicles or engines are durable and are designed and will be manufactured to operate properly and in compliance with all applicable requirements for the full useful life (or allowable maintenance interval) of the vehic1es or engines. Also, vehicles and engines tested for certification shall be, in all material respects, substantially the same as production vehicles and engines. If it is determined pursuant to title 13CCR, Division 3, Chapter 2, Article 5, sections 2166 through 2174 that any emission control component or device experie.nces a systemic failure because valid failures for that component or device meet or exceed four percent or 50 vehicles (whichever is greater) in a California-certified

engine family or test group, it constitutes a violation of the foregoing test procedures and the Executive Officer of the Air Resources Board may require that the vehicles or engines be recalled or subjected to corrective action as set forth in title 13 CCR, Division 3, Chapter 2, Article 5, sections 2166 through 2174. Certification applications may not be denied based on the foregoing information provided that the manufacturer commits to correct the violation.

Subpart B - Emission Regulations for 1977 and Later Model Year New Light-Duty Vehicles and New Light-Duty Trucks; Test Procedures

40 CFR §§ 86.101 through 86.145 and Appendix I (UDDS Schedule) of this Subpart B, as incorporated by reference and amended in the "California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium·Duty Vehicles,;" the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles. in the Passenger Car. Light-Duty Truck, and Medium-Duty Vehicle Classes;" and. the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles," are hereby incorporated by reference herein.

II. Refueling Emissions Test Procedures

A. Fuel Spitback Emissions

1. §86.146-96 Fuel dispensing spitback procedure. {August 23, 1995]. [No change.]

B. Refueling Emissions

1. §86.150-98 Refueling test procedure; GQverview, refueling test. {September 21, 1994].

1.1. Revise subparagraph (a). first sentence,' as follows: The refueling emissions test procedure described in this and subsequent sections is used to determine the conformity of vehicles with the refueling emissions standards set forth in section I.F. of these test procedures for all of the vehicles types specified in section I.A.subpart A of this part for light duty vehioles and light duty truoks.

2. §86.151-98 General requirements; refueling test. {April 6, 1994].

2.1. Revise subparagraph (a), first sentence, as follows: The refueling emissions procedure, shown in Figure B98-12, starts with the stabilizing'of the vehicle and the loading of the refueling emissions canister(s) to breakthrough, and continues with the vehicle drive for purging of the canister, followed by the refueling emissions measurement.

3. §86.152-98 Vehicle preparation; refueling test. {December 8, 20051

3.1. Amend subparagraph (a) to include: For 2009 and subsequent off-vehicle charge capable hybrid electric vehicles equipped with non:' integrated refueling canister-only systems. the refueling canister shall not be removed from the vehicle.

3.2. **Subparagraph** (b) **fNochange.]**
3.3. **Subparagraph** (c) **[No change.]**

4.1.7. The test vehicle shall be allowed to soak for a minimum of 6 hours and a maximum of 24 hours, at 80°F +3°F (27°C +1.7°C), prior to starting the fuel-tank-fill canister-loading step.

4.1.8. The refueling canister shall not be 'isolated from its system during the fuel-tank-refill canister-loading step.

4.1.9. The test vehicle's fuel fill pipe cap shall be removed

4.1.10. The dispensed fuel temperature recording system shall be started.

4.1.11. The fuel nozzle shall be inserted into the fill pipe neck of the test vehicle, to its maximum penetration, and the tank refueling operation shall start. The plane of the nozzle's handle shall be approximately perpendicular to the floor. The fuel shall be dispensed at a temperature of 67°F +1.5°F (19.4°C +0.8°C), and at a dispensing rate of 9.8 gal/min +0.3 gal/min (37.1 liter/min +1.1 liter/min). When this refueling operation is conducted by the Executive Officer, a dispensing rate that is not less than 4.0 gal/min (15.1 liter/min) may be used.

4.1.12. The fuel flow shall continue' until the refueling 'nozzle automatic shut-off is activated.' The amount of fuel' dispensed must be at least 85 percent ofthe nominal fuel tank volume, determined to the nearest one-tenth of a U.S. gallon (0.38 liter). If an automatic nozzle shut-off occurs prior to this point. the dispensing shall be reactivated within 15 seconds, and fuel dispensing continued as needed. A minimum of 3 seconds shall elapse between any automatic nozzle shutoff and the subsequent resumption of fuel dispensing'.

4.1.13. As soon as possible after completing the refilling step, remove the fuel nozzle from the fill pipe neck, and replace the test vehicle's fuel fill pipe cap.

4.1.14. The refueling canister shall be isolated from its system as soon as possible after completing the refilling step.

4.1.15. For vehicles equipped with more than one fuel tank, the steps described in this section shall be performed for each fuel tank.

4.1.16. When the fuel-tank-refill canister-loading operation is completed, the test vehicle shall proceed to the non-integrated system canister purging procedures specified in section III.D.4.4. The canister shall not be isolated from its system during these canister-purging procedures, and shall not be isolated from its system from this point onward in the test sequence.

4.1.17. The Executive Officer may approve minor modifications to this canister loading method when such modifications are supported by good engineering judgment. and do not reduce the stringency of the method.

4.2. Subparagraph (b) [No change.]

4.3. Subparagraph (c), amend subparagraph (c)(1) to include: A 2011 and later model-year off-vehicle charge capable hybrid electric vehicle that is tested either for exhaust emissions only or for refueling emissions, shall be processed in accordance with the provisions of section· F. of the "Californ"ia Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles. in the Passenger Car. Light-Duty Truck, and Medium-Duty Vehicle Glasses," with the following exceptions.

4.3.1. For such vehicles. the battery state-of-charge setting prior to the cold start exhaust test shall be at the highest level allowed by the manufacturer. This requirement shall be applicable regardless of a vehicle's ability to allow. or not to allow. manual activation of the auxiliary power unit. If off-vehicle charging is required to increase the battery state-ot-charge for the proper setting. then this charging shall occur during the canister preconditioning process.

4.3.2. The battery state-of-charge net change tolerance provisions specified in section F.1 0.. of the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, In The Passenger Car. Light-Duty Truck,.and Medium-Duty Vehicle Classes" shall not apply.

4.4. Amend subparagraph (d) as follows: Canister purging: non-integrated systems. For all vehicles. except for 2011 and subsequent model-year charge capable hybrid electric vehicles equipped with non-integrated refueling canister-only systems. Wwithin one hour of completion of canister loading to breakthrough,the fuel tank(s). shall be further filled to 95 percent of nominal tank capacity determined to the nearest one-tenth of a U.S. gallon (0.38 liter) with the fue1 specified in Sec. 86.113-94. During this fueling operation, the refueling emissions canister(s) shall be disconnected, unless the manufacturer specifies that the canister(s) should not be disconnected. FollOWing' completion of refueling, the refueling emissions canister(s) shall be reconnected, if the canister was disconnected during refueling. Special care shall be taken during this step to avoid damage to the components and the integrity of the fuel system. For all vehicles, including 2011 and subsequent model-year charge capable hybrid electric vehicles equipped with non-integrated refueling canister-only systems. Vvehicle driving to purge the refueling canister(s) shall be performed using either the chassis"dynamometer procedure or the test track procedure, as described in " paragraphs.(d)(1) and (d)(2) of this section. _The Executive Officer Administrator may choose to shorten the vehicle driving for a partial refueling test as described in paragraph (d)(3) of this section. For vehicles equipped with dual fuel tanks, the required volume of fuel shall be driven out of one tank, the second tank shall be selected as the fuel source, and the required volume of fuel shall be driven out of the second tank.

4.4.1. A 2011 and subsequent model-year off-vehicle charge capable hybrid electric vehicle shall be processed in accordance with the provisions of section F of the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles. in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes." with the following exception.

4.4.2. 'For such vehicles, the battery state-of-charge setting prior to either the chassis dynamometeror the test track driving procedures. as applicable. shall be at the highestlevel allowed by the manufactureL . This, requirement shall be applicable regardless of a vehicle's ability to allow. or not to allow. manual activation of the auxiliary power unit. If off-vehicle charging is required to increase the battery state-of-charge for the proper setting, then this charging shall occur during the canister preconditioning process.

4.4.3. The battery state-of-charge net change tolerance provisions specified in section F.10.. of the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles. In the Passenger Car. Light-Duty Truck, and Medium-Duty Vehicle Classes" shall not apply. '

4.4.4. In order to reduce the amount of time required to consume 85 percent of the fuel tank capacity. as required by either subparagraph (d)(1) or (d)(2) in 40 CFR 86.154-98. as applicable, a manufacturer may. with advance approval of the Executive Officer. elect to set the battery state-of-charge at a level that is less than , specified in section 11.8.4.4.2.. prior to conducting either the chassis dynamometer or the test track driving procedure, as applicable.

4.4.5.' The Executive Officer may use any of the following battery state-of-charge levels for purposes of either certification confirmatory or in-use compliance testing of such vehicles,

4.4.6. As specified in section 11.8.4.4.2.

4.4.7. If applicable, at the level approved under section 11.8.4.4.4.

4.4.8. If applicable, at any level in-between the levels indicated by sections 11.8.4.4.2. and 11.8.4.4.4.

4.5. Subparagraph (e) [No change.]

5. §86.154-98 Measurement procedure; refueling test. {August 23, 1995]. [No change).

6. §86.155-98 Records required; refueling test. {April 6, 1994]. [No change).

7. §86.156-98 Calculations. {April 6, 1994]. [No change.)

# APPENDIXG

# PROPOSED LANGUAGE FOR AFTERMARKET PARTS CERTIFICATION OF OFF VEHICLE CHARGE CAPABLE HYBRID ELECTRIC VEHICLES

Date of Release: December 5, 2008; 45-Day Notice version
Date of Hearing: January 22-23, 2009

State of California
AIR RESOURCES BOARD

# CALIFORNIA CERTIFICATION AND INSTALLLATION PROCEDURES FOR OFF-VEHICLE CHARGE CAPABLE CONVERSION SYSTEMS FOR 2000 AND SUBSEQUENT MODEL YEAR HYBRID ELECTRIC VEHICLES

[Note: All text is proposed for adoption. As permitted by section 8, title 2, California Code of Regulations, the proposed text is not underlined for ease of review.]

Adopted: [INSERT DATE OF ADOPTION]

Note: These procedures are incorporated by reference into section 2032, title 13, California Code of Regulations (CCR).

Date of Release: December 5,2008; 45-day Notice version
Date of Hearing: January 22-23, 2009

California Certification and Installation Procedures for Off-Vehicle Charge Capable Conversion Systems for 2000· and Subsequent Model Year Hybrid Electric Vehicles.

1. APPLICABILITY

(a) "California Certification and Installation Procedures for Off-Vehicle Charge .Capable Conversion Systems for 2000 and Subsequent Model Year Hybrid Electric Vehicles" (these Procedures) apply to off-vehicle charge capable . conversion systems designed for installation on 2000 and subsequent model year hybrid electric vehicles in the passenger car, light-duty truck, and medium- .duty vehicle classes. .

(b) Hybrid electric vehicles converted to incorporate off-vehicle charging are not eligible for zero emission vehicle credits under sections 1962 and 1962.1, title 13, CCR.

(c) Certification ofoff-vehicle charge capable conversion systems issued pursuant to these Procedures shall have the effect of an exemption issued pursuant to Vehicle Code Sections 27156 and 38391.

2. DEFINITIONS

"Advanced technology partial zero emission vehicle" means any partial zero emission vehicle with an allowance greater than 0.2 before application of the partial zero emission vehicle early introduction phase-in multiplier under section 1962 or 1962.1, CCR.

"Driveability" of a vehicle means the smooth delivery of power, as demanded by the driver. Typical causes of driveability. degradation are rough idling, misfiring, surging, hesitation, or insufficient power.

"Hybrid electric vehicle" means any vehicle that can draw propulsion energy from both of the following on-vehicle sources of stored energy: 1) a consumable fuel and 2) an energy storage device such as a battery, capacitor,or flywheel.

"Installer" means a person authorized by the manufacturer to install the . manufacturer's off-vehicle charge capable conversion system on a motor vehicle.

"Off-vehicle charge capable" or "OVCC" means having the capability to charge a battery from an off.,.vehicle electric energy source that cannot be connected or coupled to the vehicle in any manner while the vehicle is being driven.

"Off-vehicle charge capable conversion system" or "conversion system" means a package of zero emission vehicle energy storage device and charger, control, modules, and any other vehicle/engine components that are modified, removed, or added during the process of modifying a' hybrid electric vehicle to an off-vehicle charge capable hybrid electric vehicle.

"Off-vehicle charge capable conversion system manufacturer" or "manufacturer" means a person who manufactures, assembles, imports, packages, orrepackages an off-vehicle charge capable conversion system for sale in California and requests or is granted the Executive Order certifying the off-vehicle charge capable conversion system.

"Partial zero emission vehicle" or "PZEV" means any vehicle that is delivered for sale in California and that qualifies for a partial zero emission vehicle allowance of at least 0.2 under sections 1962 or 1962,1, title 13, CCR.

"Useful life" for purposes of these Procedures, means the duration,expressed in miles, of the longest durability period for the new vehicle emission standards to which thehybrid electric vehicle was certified.

"Zero emission vehicle" means any vehicle certified to zero emission standards under sections 1962 or 1962.1, title 13, CCR.

"Zero emission vehicle energy storage device" means batteries and other electric energy storage devices.

3. GENERAL REQUIREMENTS

In addition to all other standards or requirements imposed, the following general requirements shall apply to all conversion systems to be certified for installation on hybrid electric vehicles:

(a) *On-Board Diagnostic (aBO) System Compatibility.*
If the vehicle to be converted was certified with an aBO system pursuant to section 1968.1, or 1968.2, title 13, CeR, the converted vehicle shall also be required to comply with and be certified to the same applicable aBO regulation. This includes, but is not limited to, ensuring the, converted vehicle robustly detects malfunctions at the required emission thresholds, meets the required minimum monitoring frequency, implements required monitors for applicable added electronic hardware or emission controls, complies with standardization requirements, and conducts required demonstration and production vehicle testing. This requirement may necessitate modification of the original vehicle aBO system and/or addition of more diagnostics to supplement the original' vehicle aBO system. All'modifications affecting aBO compliance including added, modified, or original vehicle hardware (e.g., components, wiring) or software (e.g., programming, calibration) must be fully documented as part of the conversion system application for certification.

(b) *Oriveability* :

The driveability of a vehicle equipped with a conversion system shall not be degraded in such a way as to encourage consumer tampering. To verify that the driveability of a converted vehicle is acceptable, the Executive Officer may require that an independent laboratory evaluate driveability. The Executive Officer's determination that driveability must be evaluated shall be based on an engineering evaluation of the conversion system described in the application for certification or on reports or observations that conversion systems similar in design to the system for which certification is sought have caused driveabHity degradation. The Cost of this evaluation shall be borne by the manufacturer.

(c) *Emission Control Label:*
California motor vehicle emission control label specifications, incorporated by reference in section 1965, title 13, CeR, shall apply to installations of conversion systems, with the following additions:

(i) The manufacturer 'shall provide a supplemental emission control information label, which shall be affixed in a permanent manner to each converted vehicle, in a location adjacent to the original Vehicle Emission Control Information label. If the supplemental label cannot be placed adjacent to the original label, it shall be placed in a location where it can be seen by a person viewing the original label.

(ii) The supplemental label shall show the vehicle model year; the Executive Order number certifying the conversion system; and the conversion system manufacturer's name, address, and telephone number. The label shall also list any original parts that were removed during installation of the conversion system, as well as any changes in tune-up specifications required by the.conversion system. In addition, the label shall show the installer's name, address, and telephone number; the date on which the conversion system was installed; and the mileage (vehicle odometer reading) at time of conversion; and date on which the conversion system's warranty expires. The label shall dearly state that the vehicle has been equipped with an off-vehicle charge capable conversion system and that the converted vehicle complies with California emission requirements; It is not necessary for supplemental emission control information labels installed with conversion systems to be machine readable.

(d) *Owner's Manual:*
Each conversion system installed shall include an owner's manual containing at least the following information:

(i) Description of the conversion system, including wiring diagrams and descriptions of major components and their theory of operation;

(ii) Charging procedure;

(iii) Listing of necessary service and service intervals, as well as tune-up data, which differ from the service requirements specified by the vehicle's original manufacturer;

(iv) Name, address, and phone number of the installer, as well as a list of the narnes, addresses, and phone numbers of the major dealers in California who supply parts for or service the conversion system; and

(v) Warranty information.

(e) *Manufacturer Recordkeeping Requirement:*
The manufacturer of a conversion system shall maintain a record of the vehicle identification numbers and California license plate numbers of those vehicles on which the conversion system has been installed. As part of this record, the manufacturer shall identify the installation date and the certification Executive Order number of the conversion system installed on each vehicle and shall identify the vehicles' owners at the time of installation, including the owners' current addresses and phone numbers. The manufacturer shall supply a copy of all installation information to the Executive Officer upon request.

(f) *Installer Rec ordkeeping Requirement:*
The installer of a conversion system shall maintain a record as specified in paragraph *3(e)* of these Procedures and shall provide this information to manufacturers upon request.

4. REQUEST FOR CERTIFICATION

(a) Request for certification of a conversion system shall be. submitted in writing by the manufacturer, or its authorized representative, intending to offer the conversion system for sale in California.

(b) The request shall include all the information required pursuant to these Procedures, including:

(i) Identification and description of the test groups for which the conversion system to be certified is designed;

(ii) Complete description of the conversion system, including detailed wiring diagrams and parts list; explanation on how the conversion system interacts with or integrates into the original Vehicle; all the necessary modifications to the vehicle and its OBO system; sample of the supplemental emission control information label; owner's manual; warranted parts list; and samples of warranty statements;

(iii) Procedures for installing and maintaining the conversion system, including tune-up specifications and discussion of any special tools or techniques required for proper installation, maintenance, or operation;

(iv) Agreement to supply the Air Resources Board, within 45 calendar days of the Executive Officer's request, with anyone or more of the vehicles used for certification testing or to provide Air Resources Board personnel with the equipment to inspect and test such vehicles at the manufacturer's facility, if requested by the Executive Officer;

(v) Names and addresses of the fabrication, assembly line, and test facilities where the conversion system and its major components are manufactured and tested; and

(vi) Test data.

·5. TEST PROCEDURES

(a) *Test Procedures for avec Converted Vehicles:*
Test procedures set forth in the "California Exhaust Emission Standards and Test Procedures for 2005 Through 2008 Model Zero-Emission Vehicles and 2001 Through 2010 Hybrid Electric Vehicles in the Passenger Car, Light-Duty Truck, and Medium-DutyVehicle Classes," as incorporated by reference in section 1962, title 13, CCR; the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes," as incorporated by reference in section 1962.1, title 13, CCR; the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles," as incorporated by reference in section 1976, title 13, CCR, and the "California Refueling Emission Standards and Test Procedures for 2001 and SUbsequent Model Motor Vehicles," as incorporated by reference in section 1978, title 13, CCR, shall be used to determine the emission levels of OVCC .converted vehicles.

(b) *Applicable Standards:*
The conversion system shall meet the emission standards for the model year of original manufacture and certification. The conversion system must also be durable for the useful life of the vehicle. The manufacturer shall demonstrate compliance with these requirements through durability and emission testing.

(c) *Demonstration of Durability:*
The manufacturer shall propose a durability program for advance approval by the Executive Officer. The durability program shall consist of:

(i) Whole vehicle full mileage accumulation or whole vehicle accelerated mileage accumulation over the useful life or equivalent useful life of the vehicle; bench aging of individual components or systems over the useful life of the vehicle; or alternative methods that would effectively predict the deterioration of the converted vehicle over its useful life.

(ii) A maximum of one durability data vehicle per test group for which certification is sought shall be required.,

(iii) The vehicle is assumed to have zero miles at the time of conversion. Vehicle 'mileage accumulation shall be conducted using vehicle drive, patterns found in actual use.

(iv) Bench aging shall simulate component or system aging under vehicle drive patterns and operational conditions found in actual use. The list of components or systems to be aged and their aging techniques must be approved in advance by the Executive Officer. Approval of bench aging and alternative methods shall be contingent upon a demonstration by the manufacturer that they result in deterioration at least as great as the deterioration from vehicle mileage accumulation.

(d)· *Demonstration* of *Emission Compliance:*
The manufacturer shall propose the procedures for determining compliance with the emission standards for advance approval by the Executive Officer. Emission compliance shall be determined by:

(i) Testing a vehicle aged with the cOnversion system; installing aged components or systems on an emission data vehicle prior to testing; or using alternative methods that would effectively predict the useful life emissions of the converted vehicle.

(ii) A maximum of one emissiqn data vehicle per test group for which certification is sought shall be required.

(iii) Alternative methods must be approved in advance by the Executive Officer.

(e) Prior to the commencement of testing, the choice of durability data vehicle and emission data vehicle must be approved by the Executive Officer as being representative of the range of test groups for which certification is sought.

6. APPROVAL

(a) *Issuance* of *Executive Orders:*
If, after reviewing the test data and other information submitted by the manufacturer, the Executive Officer determines that the conversion system meets the applicable emission standards demonstrated under an approved test plan, an Executive Order shall be issued certifying the conversion system for

sale and installation on the vehicles with the test groups specified in the certification request.

(b) *Carry-Over and Carry-Across:*

(i) Carry-over and carry-across of durability and emission test data from the previous model year to the following model year and from one test group to similar test groups will be allowed if the Executive Officer determines that the carry-over/carry-acrossdata will adequately represent the durability and emission performance of the conversion system to be certified.

(ii) Requests for carry-over and carry-across must be accompanied by an engineering analysis demonstrating that the durability and emission performance of the conversion system and the test group for which certification is sought will be adequately represented by a certified conversion *system/test* group.

7. WARRANTY REQUIREMENTS

(a) *Requirements of Manufacturers:*
Each manufacturer of a conversion system shall warrant to the person having the vehicle converted and to each subsequent purchaser of the vehicle that the conversion system is designed and manufactured to conform with the applicable requirements of these Procedures and is free from defects in materials and workmanship which cause the conversion system to fail to conform with the applicable requirements of these Procedures or cause damage to any part on the converted vehicle. This warranty requirement will be effective for the applicable warranty period specified in section 2037(b), title 13, CCR, from the date of installation if the conversion system is installed on the vehicle within four years of the date the vehicle is first acquired by an ultimate purchaser. If the conversion system is installed on the vehicle after four years of the date the vehicle is first acquired by an ultimate purchaser, the warranty period will be three years or half the applicable warranty period mileage specified in section 2037(b), title 13, eCR, whichever occurs first from the date of installation. For PZEVs, this warranty requirement will be effective for the applicable warranty period specified in section 1962(c) or section 1962.1 (c), title 13, CCR, from the date of installation if the conversion system is installed on the vehicle within six years of the date the vehicle is first acquired by an ultimate purchaser. If the conversion system is installed on the PZEV after six years of the date the vehicle is first acquired by an ultimate purchaser, the warranty period will be five years or half the applicable warranty period mileage specified in section 1962(c)or section 1962.1 (c), title 13, eeR, whichever occurs first from the date of installation. This warranty shall cover customer service and the full repair or replacement costs including the costs of diagnosis, labor, and parts, including any part on the converted vehicle that is damaged due to a defect in the conversion system.

(b) *Requirements of Installers:*
Each installer of a conversion system shall warrant to the person having the vehicle converted and to each subsequent purchaser of the vehicle that the conversion· system will not fail to. conform with the applicable requirements of these Procedures due to incorrectinstallation and that no part-on the converted vehicle will be damaged due to incorrect installation. Installers of conversion systems shall install only those systems of a certified configuration and shall agree to indemnify the person having the vehicle converted and to each subsequent purchaser of the vehicle for the cost of repair of any vehicle upon which a noncertified configuration was installed. In addition, the installer shall agree to indemnify the person having the vehicle converted and to each subsequent purchaser of the vehicle for any tampering fines that may be imposed as a result of improper installation of the conversion system. The warranties and agreements to indemnify shall be effective for the applicable warranty period specified in section 2037(b)(2), title 13, CCR. This warranty shall cover customer service and the full repair or replacement costs including the cost of diagnosis, labor, and parts, including any part on the converted vehicle that is damaged due to incorrect installation of the conversion system. Before an installer installs a conversion system, the installer shall submit to ARB a sample of the warranty statement to be provided by the installer as specified above.

8. IN-USE TESTING REQUIREMENTS'

The Air Resources Board may select up to five conversion systems per manufacturer per year for in-use testing. The manufacturer must provide the in-use OVCC converted vehicle(s) selected by the Air Resources Board to be sent to the Air Resources Board facility or a designated independent laboratory for testing in accordance with the test procedures in paragraph (5)(a) of these Procedures. Testing costs will be borne by the Air Resources Board, except for those conversion systems that do not comply with the applicable emission standards. If one or more of the conversion system fails to meet the applicable emission standards in an applicable test vehicle, the Air Resources Board may rescind a previously granted Executive. Order, request further analysis and data from the manufacturer, or require, at the manufacturer's expense, additional vehicles to be tested.- Additional vehicles to be tested shall be limited to no more than five for each failed conversion system.

# APPENDIX H

# TECHNICAL SUPPORT DOCUMENT FOR PROPOSED AMENDMENTS RELATED TO EXHAUST TEST PROCEDURES.

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**Hybrid-Electric Vehicle Range Tests**

The current hybrid-electric vehicle (HEV) exhaust test procedures determine the all-electric range (AER) of a hybrid by measuring the mileage driven from when the vehicle starts driving with a fully charged battery over defined test cycles to . when the IC engine first starts. This mode of operation is called the "charge ' depleting mode" because the battery state of charge is continually depleted since it is the sole source of vehicle motive power. Once the IC engine starts, the vehicle operates in the "charge-sustaining mode" (also called "charge balanced operation") in which continuous charge and discharge of the battery occurs, but there is no substantial net increase or decrease in battery energy or state-of-charge (SOC) overthe driving cycle.

For a plug-in HEV (PHEV)1 that has a distinct all-electric charge 'depleting range of operation and a distinct IC engi'ne-assisted charge-sustaining range of operation, the current HEV test procedures provide an accurate measure of the electric range of the vehicle.. However, future PHEV designs may engage the IC engine during the charge depleting mode. This is referred to as a "blended operation mode". A blended operation'mode is a differentcategory of charge depleting mode where propulsion power is provided either by the electric motor, the IC engine, or some combination of both, but where a significant portion of the propulsion power nonetheless is provided by electricity derived from off-vehicle sources. During blended operation the SOC of the battery continually decreases. This design feature may be included because the battery is sized such that it cannot provide sufficient power to provide full vehicle performance capability. Since the existing test procedure is incapable of measuring the contribution of the battery during blended operation, a new test procedure is required.

The following, sections provide brief descriptions of and rationale for the proposed amendments to the Exhaust Test Procedures to accommodate PHEVs.

Urban Charge Depleting Range Test

For PHEVs which have two distinct modes of operation, one using battery power alone and another in which motive power is derived from the IC engine only, the current procedure for the urban charge depleting range test to determine all electric range is accurate. For the urban charge depleting range test, continuous urban dynamometer driving schedule (UDDS) test cycles with a 10-minute soak period between each UDDS are conducted until charge-sustaining operation is achieved for two consecutive UDDS cycles. A second UDDS may be omitted if

1 Staff is using the more common term of PHEV forreadability. The use of PHEV is not meant to restrict the use of the vehicles to receive charging only from the grid, as with the PHEV definition used in pavely. To address this restriction, staff refers to these vehicles as avec HEVs through out the test procedures and regulatory text.

data is provided showing charge-sustaining operation can be determined from one UDDS.

Alternative Urban Charge Depleting Range Test

For test laboratories with equipment that are not readily adaptable to the proposed charge depleting range test, an alternative urban charge depleting range test sequence is provided whereby pairs of urban cycles are conducted with a 10 minute soak after the first urban cycle and a 10-20 minute soak after the second urban test cycle. The longer hot soak periods provide additional time to perform emission measurements and reset test equipment.

Highway Charge Depleting Range Test

Similarly, for the highway charge depleting range test, four continuous highway fuel economy driving schedule (HFEDS) test cycles with a 15 second key-on hot soak period between tests are conducted. After every fourth HFEDS, an optional key-off soak period of 0-30 minutes is provided to reset test cell equipment. The test sequence is continued until the vehicle achieves charge-sustaining operation for one highway cycle.

Alternative Highway Charge Depleting Range Test

Again, for test laboratories with equipment that are not readily adaptable to the new test procedure, an alternative HFEDS test sequence is provided whereby two HFEDS cycles with a 15 second key-on hot soak period between tests are conducted followed by a 10-20 minute key-off soak period between each pair of HFEDS. The longer hot soak periods provide additional time to perform emission measurements and reset test equipment.

US06 Charge Depleting Range Test

The US06 charge depleting range test is being proposed to determine the all-electric range during aggressive driving modes and is used to demonstrate that .the HEV meets the criteria for a Type Gadvanced componentry allowance. The US06 charge depleting range test consists of a repeated series of US06 driving cycles with a 1-2 minute key-on soak between each US06. The test ends when the le engine first starts or when the vehicle fails to meet the speed tolerance of the US06 test cycle. Since this is an all-electric range test, emission measurements are not required. To qualify as for a Type G advanced componentry allowance, the vehicle must demonstrate a minimum 10 mile all-electric range over the US06 test cycle while meeting a speed tolerance of ± 2 mph of the required speed within ± one second of the given time of the US06 driving schedule.

**Equivalent All-Electric Range (EAER)**

Testing.for equivalent all-electric range (EAER) is a new procedure designed to quantify the electric driving range provided by the battery-powered electric motor during a blended operation mode of a PHEV.

The procedure is based on comparing the propulsion energy contributed by the .IC engine during charge-sustaining mode"(when net energy is supplied by the IC engine only) to the. proportion of propulsion energy contributed by the fuel-powered IC engine during charge depleting mode (when net energy is supplied by either the IC engine, the electric motor, or a combination of both). Since any $CO_2$ emitted during the test cycles can be attributed to the IC engine alone and is proportional to the fuel consumed by the IC engine, when compared over the same driving distance, $CO_2$ mass emissions can be used to determine the net energy contribution of the IC engine and thereby, indirectly, the net energy contribution of the battery.

Because the test procedure does not require the vehicle to be driven over the same distance during charge depleting and charge-sustaining modes, the C02 mass emissions from charge-sustaining mode ($M_{cs}$) must be adjusted to represent the C02 emissions from vehicle operation over the same distance driven during the 'charge depleting mode. Only two test cyctes are required to determine emissions during charge-sustaining mode since there is a net energy balance requirement over the test cycles. Accordingly, the $CO_2$ mass emissions from the charge-sustaining mode are multiplied by the ratio of the charge depleting distance ($R_{cdc}$) to the distance driven over one Charge-sustaining operation test cycle. For the urban test cycle, the C02 mass emissions from charge-sustaining mode are adjusted as follows:

$$M_{cs} = Y_c + Y_h * \left[\left(\frac{R_{cdcu}\ D_c}{D_c}\right)\right]$$

where:

| | | |
|---|---|---|
| $R_{cdcu}$ | = | Urban Charge Depleting Cycle Range, in miles |
| Dc | = | measured driving distance of the cold start UDDS,in miles. |
| | = | Grams per mile C02 emissions from the cold start UDDS |
| | = | Grams per mile C02 emissions from the hot start UDDS |

The measured C02 mass emissions in grams per mile during charge depleting operation ($M_{cd}$) is then compared to the measured C02 mass emissions in grams per mile produced during charge-sustaining operation ($M_{cs}$) on an equal miles driven basis. The difference in $CO_2$ mass emissions is proportional to the net energy required to provide propulsion electrically, since the only source of energy besides the fuel used for propulsion is electricity provided by the battery. Dividing this difference by $M_{cs}$ provides the fraction of the propulsion energy derived from the battery. MUltiplying the distance traveled during charge depleting operation (Rcdc) by this fraction yields the EAER in miles. For the urban test cycle the formula for EAER is as follows:

$$EAER = \frac{M_{cs} - M_{cd}}{M_{cs}} * R_{cdcu}$$

Where EAER = Equivalent All-Electric Range (mi)

$M_{cd}$ = Mass of C02 (g) accumulated during charge depleting mode

$M_{cs}$ = Mass of C02 (g) accumulated during charge-sustaining mode for an equal distance of charge depleting .cycle range

$R_{cdcu}$ = Urban Charge Depleting Cycle Range (mi)

The transition from charge depleting operation to charge-sustaining operation for a blended PHEV may occur over a period of time as the battery control system responds to battery loading, road load demand, and driver power demand. Therefore, to assure that sufficient emission samples are collected and to simplify the test procedure, charge depleting range testing is measured over discrete test cycles. Accordingly, the transition to charge-sustaining mode will likely occur during the final charge depleting test cycle. Consequently, the measured $CO_2$ mass emissions for the charge depleting range test will include some fraction of emissions emitted during charge-sustaining operation. These emissions are offset by'adjusting the measured charge-sustaining mass emissions to represent emissions emitted over the same distance as the charge depleting range.

**Hybrid-Electric Vehicle Emissions Tests**

Charge-Sustaining Emission Tests

Emission testing is required for all HEVs during charge-sustaining operation. These tests are designed to determine vehicle emissions during cold-start charge-sustaining operation and are required to demonstrate compliance with all applicable emission requirements. .

Urban Charge-sustaining Emission Test

The urban charge-sustaining emission test procedure is essentially the same for conventional HEVs and PHEVs. The test consists of an initial UDDS to precondition the vehicle, a 12-36 hour soak period, and two UDDS emission tests with a 10 minute key-off soak in between each UDDS. Emissions for each UDDS are weighted as described below.'

Highway Charge-Sustaining Emission Test

The current highway charge-sustaining emission test consists of a h9t-start test conducted within three hours after the urban charge-sustaining test is completed. This proposal changes the requirement for PHEVs to a cold-start test, requiring testing to be conducted after an overnight cold soak.

The emission test consists of an initial HFEDS, a 15 second key-off period, and a second HFEDS. Emissions are measured during both HFEDSs. The SOC criteriamust be met during the second HFEDS. If the vehicle does not meet the SOC criterion during the second HFEDS or additionalIC engine warm-up is required, a third HFEDS is permitted. Emission data from the final HFEDS shall be used to demonstrate compliance with the highway NOx emission requirement.

US06 Charge-Sustaining-Emission Test

The SC06 charge-sustaining emission test consists of two US06 test cycles separated by a 1-2 minute idle period. A third US06 is permitted if additionalIC engine warm up is required. Emissions data from the final US06 shall be used to demonstrate compliance with criteria emission requirements. The vehicle must meet the state-of-charge criterion during the final US06.

SC03 Charge-Sustaining Emission Test

The SC03 charge-sustaining emission test consists of two SC03 test cycles separated by a 1-2 minute idle period. A third SC03 is permitted if additionalIC engine warm up is required. Emissions data from the final SC03 shall be used to demonstrate compliance with criteria emission requirements. Thevehicle must meet the state-of-chargecriterion during- the final US03.

Cold Temperature- Emission Testing

The current HEV test procedures do not specify UDOS emissions tests for CO emissions at 20°F and for NMOG, CO and NOx emission at 50°F. Accordingly, new procedures are proposed for testing PHEVs at 20°F and 50°F in the "worse case" for emissions during either charge-sustaining or charge depleting operation. Worst case operation is defined as either the urban charge depleting or charge-sustaining test with the highest CO emissions for 20°F emission testing and the highest HC + NOxemissions for 50°F emission testing. Testing maybe conducted using either the conventional 3 phase UODS or the optional 4 phase double UDOS. Compliance with the SOC criterion is not required for cold temperature emission testing.


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## SOC Net Tolerances

Compliance with the SOC net tolerance is required to ensure that the net energy balance of the vehicle battery is maintained during charge-sustaining tests and to validate that the vehicle is operating in charge-sustaining operation. Since 1999, ARB test procedures and SAE J1711 have required SOC net tolerances be· based on ±1% of the fuel energy used during the test.

## Battery Charging

Vehicle Charge Start Time

Charging requirements have been modified to simplify and add more flexibility to the current procedure. The current ARB test procedure requires battery charging to begin within one hour after a battery discharge event such as completing the all-electric range test. This is consistent with the current SAEJ1711 hybrid test procedure. The one hour requirement was specified to avoid either self discharge as in the case of NiMH batteries, or sulfation in the case of lead acid batteries, which requires the batteries be recharged as soon as possible to prevent irreversible damage. However, future PHEVs will likely use lithium ion technology, which is less susceptible to self-discharge or damage from long periods of storage at low states of charge. Accordingly, the new procedure provides for battery charging to occur one to three hours after the urban charge-sustaining emission test or highway charge depleting range test.

Vehicle Charging Equivalency Option

To determine energy consumption of off-vehicle electrical energy, the vehicle must be charged from the battery state of charge level achieved during charge-sustaining operation to a full state of charge. The current procedure requires charging PHEVs to full SOC immediately after the urban charge depleting range test. In the new procedures, vehicle charging is performed after the charge-sustaining emission test, eliminating the requirement that the battery be charged and discharged twice.

Testing can be further streamlined if the manufacturer can demonstrate that the charge energy required to reach full charge is equivalent for both the urban (UDDS) and highway (HFEDS) cycles. If equivalency is demonstrated, then the manufacturer can substitute the charge energy determined from the urban charge results to demonstrate charge energy for the highway test.

Emissions Bag Weighting

When the urban emission test was developed in the early 1970's, driving studies demonstrated that43% of IC engine starts were cold starts and 57% were hot starts. Therefore, emissions for the first UDDS (cold start UDDS) are weighted



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Date of Hearing: January 22-23, 2009

43% and emissions from the second UDDS (hot start UDDS) are weighted 53%. This weighting scheme is still in use today. Accordingly, the UDDS emissions are calculated as follows:

$$Y_{wm} = 0.43 * \left(\frac{Y_c}{D_c}\right) + 0.57 * \left(\frac{Y_h}{D_h}\right)$$

Where:

(1) $Y_{wm}$ = Weighted mass emissions of each pollutant, i.e., THC, CO, THCE, NMOG, NMHCE, .$CH_4$, $NO_x$, or C02, in grams per vehicle mile.

(2) $Y_c$ = Mass emissions as calculated from the cold start test, in grams per test.

(3) $Y_h$ = .Mass emissions as calculated from the hot start test, in grams per test.

(4) $D_c$ = The measured driving distance from the cold start test, in miles.

(5) $D_h$ = The measured driving distance from the hot start test, in miles.

**Modifications to the ZEV Highway Range Test**

In the current HEV Test Procedures the IEV highway all-electric range test consists of a repeated series of two HFEDS. To provide consistency with PHEV all electric range test requirements, the IEV highway all-electric range test has been modified to 'require conducting a series of four HFEDS with a 15 second key-on pause between each HFEDS. After every fourth HFEDS, an optional key-off soak period of 0-30 minutes is provided to reset test cell equipment.

# APPENDIX I

# TECHNICAL SUPPORT DOCUMENT FOR PROPOSED AMENDMENTS RELATED TO EVAPORATIVE AND ON ROAD VAPOR RECOVERY TEST PROCEDURES

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## A. Additional Evaporative Einiss'ions Technical Background

### 1. Evaporative Emissions Test Procedures

The Air Resources Board (ARB) first required compliance with motor vehicle evaporative emissions standards and test procedures in 1970. The current evaporative emission requirements were adopted under the second generation of , California's Low Emission Vehicle emission regulations (LEV II evap), and were phased in over the 2004 - 2006 model-years, These LEV II evap requirements apply to 2001 and subsequent model gasoline-, alcohol-, and liquefied petroleum-fueled passenger cars, light-duty trucks, medium-duty vehicles, heavy-duty, vehicles[1], and HEVs. The standards and test procedures do not apply to diesel- and dedicated compressed natural gas-fueled vehicles and HEVs with sealed fuel systems that have no evaporative emissions. The LEV II evap regulations ensure that evaporative emissions are controlled to "near-zero" levels and that this control will be effective for the useful life of the vehicle. As an option, manufacturers may also certify to California's unique' "zero fuel" evaporative emission standard giving manufacturers the opportunity to generate credits to satisfy their Zero-Emission Vehicle requirements. '

Compliance with the LEV IIevap standards is demonstrated by measuring the , vehicle's evaporative emissions over simulated "real-world" conditions. For example, evaporative emissions are measured in an enclosed environmental chamber in which the vehicle is subjected to temperatures swings that are intended to simulate exposure to several hot summer days (Le., diurnals). Evaporative emissions are also measured durin'g simulated driving conditions (i.e., running losses), and immediately after the engine is shut down (i.e., hot soak). Compliance is demonstrated using a series' of two specific test procedure sequences: 1) Three-Day Diurnal plus High-Temperature Hot Soak and Running Loss (3D+HS); and, 2) Supplemental Two-Day Diurnal plus Hot Soak (2D+HS) ("California Evaporative Emission Standards and Test Procedures For 2001 and Subsequent Model Motor Vehicles," adopted August 5, 1999 [hereinafter referred to as "Evap Test Procedures"]; section 1.E.1.(d)). Although each test procedure has its own compliance objective, there is some evaluation overlap between them. For example, both the 2D+HS and 3D+HS tests evaluate canister capacity, permeation control, and canister purge capacity. However, while the 3D+HS test's main objective is to demonstrate that the evaporative emission control system has the ability to capture and hold vapors over a three-day period, the 2D+HS test's main objective is to demonstrate that the system has the ability to adequately purge captured vapors when the vehicle is driven for only a short duration.

1 Incomplete medium-duty vehicles and heavy-duty vehicles, over 14,OOO'pounds gross vehicle weight rating', are certified to the applicable evaporative emission standards sOlely on the basis of an engineering evaluation of the system and data which may be partly derived from evaporative control systems certified for use on light- and medium-duty vehicles.

Both of these procedures involve prescribed methods to suitably condition and stabilize the evaporative emission control system components (e.g., preconditioning of the canister and the vehicle fuel system, fuel tank drain and fills, dynamometer test cycles, etc.) prior to the actual emission tests. Canister preconditioning involves artificially purging and loading vapors into a canister under specific flow rates and in amounts that simulate "real-world" conditions. Certification compliance is also demonstrated by properly aging evaporative emission control system components to the required useful life in advance of any certification tests.

The evaporative certification data submitted by manufacturers are subject to confirmation when requested by the ARB (i.e., confirmatory testing). In addition, a manufacturer-administered in-use compliance program (i.e., the In-Use Verification Program or [IUVP][2]) requires manufacturers to procure and emission test a specified number of in-use vehicles on an "as received" basis at certain mileage intervals. Under the IUVP, vehicles must show compliance with the 3D+HS and 2D+HS emission standards; failure to demonstrate compliance may subject the manufacturer to remedial action. In addition, ARB may conduct its own in-use compliance test program of vehicles that have been identified to have a higher probability of non-compliance.

In order to reduce the testing burden on manufacturers without any reduction in the stringency of the emission standards, the Board adopted certain minor technical "streamlining" amendments to the Evap Test Procedures in June 2006. One of these amendments included a waiver of the requirement for demonstrating compliance with the 2D+HS standard, although this allowance was made available to only integrated evaporative emission control systems.

2. Onboard Refueling Vapor Recovery Emission Test Procedures

The California Onboard Refueling Vapor Recovery (ORVR) test procedures (with amendments) are patterned after the federal ORVR provisions ("California Refueling Emission Standards and Test Procedures For 2001 and Subsequent Model Motor Vehicles," adopted August 5, 1999, [hereinafter "ORVR Test Procedures"]; Introductory Paragraph). The main objective of the ORVR test is to demonstrate the system's ability to ensure that hydrocarbon vapors do not escape to the atmosphere during the r-efueling process. However, as with the 2D+HS and 3D+HS evaporative tests, the ORVR test procedures also have some evaluation overlap of other evaporative emission control system characteristics, such as canister capacity. The ORVR emission standards for California are applicable to passenger cars, light-duty trucks, and medium-duty vehicles with a gross vehicle weight rating less than 8,501 pounds. Test

[2] The In-Use Verification Program was adopted as part of the Compliance Assurance Program ("CAP 2000") amendments included in the LEV II rulemaking.

preparations involve steps for stabilizing the ORVR emission control system, including purging and loading the canister, in a manner similar to the evaporative emission test sequences. The ORVR certification requirements are also subject to confirmatory testing, and in-use compliance testing.

Both integrated and non-integrated systems demonstrate ORVR emission compliance by a single test sequence. However, the test sequence has some procedural differences that apply to each system. In particular, the test sequence for a non-integrated system allows for more vehicle driving and hence, more canister purging, prior to the ORVR test itself. Staff believes that this allowance for more non-integrated system purging is due to the long-held expectation that non-integrated systems would be configured with two separate canisters, and need to purge them both with the 'same amount of engine-produced vacuum that previously had been used to purge only one canister. The vehicle driving distance is based on the number ofUDDSs[3] that the vehicle drives in order to consume 85 percent of its fuel tank capacity (i.e., "drivedown"). For integrated system vehicles the amount of driving is much less and fixed; the distance is dictated by the miles driven over the Federal Test Procedure (FTP) and the Running Loss tests. Thus,a canister on a non-integrated system vehicle will be purged much more than will one on an integrated system vehicle because a non-integrated system vehicle will be driven over a much greater distance. .

## 3. Test Procedures - Canister Preconditioning

A carbon canister must be conditioned ·properly prior to any testing to ensure accurate and representative test results. The Evap Test Procedures specify particular methods for preconditioning a canister for each type of test. For instance, the 3D+HS test sequence prescribes a series of repeated vapor-load-and-purge steps that are performed on the canister to establish an "in-use" state (i.e., stabilization). This stabilization step is then followed by a prescribed injection, or "loading," of a specific amount of vapor into the canister. Thus, the stabilization and loading steps together form the canister preconditioning process. In the case of 3D+HS testing, the prescribed canister-loading uses the "most stringent" condition of one and one-half times the particular working capacity of the canister (U.S. EPA 2(02), as well as·the slowest rate of flow in to the canister in order for greater diffusion of vapors to occur within the canister's activated carbon pores. The 2D+HS test canister precoriditioning differs in that' the stabilization step is not performed, and a less stringent loading condition is used. That loading condition uses a fast vapor flow rate for filling the canister to its nominal working capacity, as gauged by an overflowing breakthrough of excess vapors measuring two grams (i.e., a "two-gram breakthrough"). Note that these two different preconditioning procedures arefollowed when testing a vehicle with an integrated evaporative system, However, non-integrated system

3 A "Uniform Urban Dynamometer Schedule," or "UDDS." is the first two phases of the four-phase, exhaust test FTP that is required for HEVs.

refueling canisters are preconditioned according to the two-gram breakthrough method when performing the 20+HS, 30+HS, and ORVR tests.

## 4. Hybrid-Electric Vehicle Evaporative Emission Characteristics

The emission'characteristics of HEVs differ from conventional vehicles. For instance, exhaust emission control is easier with HEVs than with conventional vehicles because HEV engines are smaller and operate at the most efficient speed and load settings. From an overall emissions impact perspective, HEVs are also superior to that of conventional vehicles because their electric motors are capable of powering the vehicle. However, this beneficial emissions impact characteristic has a negative consequence when controlling evaporative emissions because the canisters are purged only during engine use. Thus, with less engine operation than conventional vehicles, HEVs are more challenged to adequately purge their canisters, and so it is possible that they may not adequately control their evaporative emissions. This concern can be more problematic if HEVs are driven for several days without ever activating their engines, a potentially common occurrence. Without any engine activation over a period of several days, there would not be any opportunity for purging the canisters. Eventually, the canisters would reach a state of saturation, and the evaporative vapors could breakthrough on a continuing basis.

The current Evap Test Procedures address these possible canister-breakthrough scenarios by requiring HEV manufacturers to submit an engineering evaluation of canister purge operation demonstrating its ability for controlling breakthrough emissions, including a manufacturer-specified duration between engine activations solely for purging the canister (Evap Test Procedures, sections 111.0.10.1.12 through 111.0.10.1.14). In practice, such "intrusive" solely canister-purging engine activations are typically unnecessary because other routine engine activations, such as the preparatory warm-up of a catalyst, provides enough engine operating time to effectively purge the canisters.

Off-vehicle charge capable HEVs[4] (Le., those that "plug-in") may present a more severe canister-breakthrough situation than do other HEVs. For instance, in the real world, it is possible that off-vehicle charge capable HEV owners may recharge on a ,regular basis such that the battery energy "state-of-charge" (or "SOC") is always at the highest level prior to each commute. This routine practice without any engine·operating time could last for weeks, months, or even longer. In this situation, evaporative vapors would tend to accumulate in the canister and eventually breakthrough.

4 Staff is using the more common term of PHEV for readability. The use of PHEV is not meant to restrict the use of the vehicles to receive charging only from the grid, as with the PHEV definition used in Pavely. To address this restriction, staff refers to these vehicles as avec HEVs through out the test procedures and regulatory text.

Depending on the particular HEV design and driving characteristics, blended mode off-vehicle charge capable HEVs would also have canister purging concerns because their engine use could vary greatly, which would mean that the canister purging could also vary greatly.

5. Non-Integrated Refueling Canister-Only Systems

A "non-integrated refueling canister-only" evaporative emission control system, such as the system introduced by Toyota, exhibits a unique process of engine operation, canister purge, and fuel consumption and replenishment that is effectively self-balancing. Specifically, the engine vacuum purges the canister as the engine operates and consumes fuel; as fuel is consumed, the tank empties, creating more vaporspace inside the tank; and, refueling the tank generates and displaces new vapors in the tank which are routed to and stored in the canister. Thus, with non-integrated refueling canister-only systems, only refueling vapors are routed to the canister. Evaporative diurnal vapors are never routed to the canister because they are instead always stored inside of the fuel tank until the vehicle is driven, at which time they are routed directly to the engine to be combusted.

B. Description of the Proposed Amendments

1. Clarification of Sealed Fuel Systems

The motor vehicle evaporative emission control standards and test procedures are currently are not applicable to, "...hybrid.;electric vehicles that have sealed fuel systems which can be demonstrated to have no evaporative emissions..." (Title 13, California Code of Regulations (CCR), §1976(b)(1)). This applicability exemption was included when the HEV emission control measures were adopted initially in conjunction with other "first generation" Low Emission Vehicle amendments (or "LEV I") in January 1993. However, the evaporative emission regulations do not include a definition of a truly "sealed fuel system"; this omission causes some ambiguity with respect to the exemption.

In order to function, non'-liquid fuel systems that store and meter fuel under very high pressures, such as compressed natural gas (CNG) systems, must be designed sothat they are, in effect, "perfectly".sealed. Because these systems must be leak-free in order to function, and because they do not have truly "evaporative" emissions, they are exempted from the evaporative emission control standards and test procedures. Other highiy pressurized, non-liquid fuels, such as hydrogen; would be expected to use perfectly sealed designs, and consequently they would also be exempted from the evaporative emission control requirements. In general, highly pressurized, non-liquid fuel systems that are perfectly sealed should be exempted from the evaporative emission control standards and test procedures.

A different interpretation of a "sealed fuel system" was considered during the LEV II rulemaking. That interpretation was based on the expectation that certain conventional fuel system technologies (i.e., gasoline), such as a negatively and positively pressurized fuel and evaporative system, would be capable of eliminating fuel-related evaporative emissions (ARB 1999). Basically, it was thought that a "zero" level of fuel-related emissions could be achieved by using a more robust fuel tank, along with complex sealing and pressurizing mechanisms (ARB 1998). A system's ability to provide such control originated from a study which concluded that a sealed negatively pressurized (i.e., vacuum) fuel system could eliminate fuel permeation. The feasibility of this technology for HEVs was then demonstrated by staff using a prototype HEV with a sealed vacuum fuel system. However, subsequent technical reviews determined that this system would not achieve zero-fuel evaporative emissions after all because permeation would not be totally eliminated (Haskew 2003). In actuality, permeation was later recognized to be a function of concentration, and not a function of a pressure. Although current "Partial Zero-Emission Vehicles" (or "PZEVs") do certify to a nominal zero-fuel evaporative emission level, that permeation control is accomplished by using materials that are highly resistant to permeation, rather than by using sealed pressurized fuel systems[5]. In reality, the design and fabrication costs of a perfectly sealed, gasoline-based fuel system that would have "no evaporative emissions" could be prohibitively high, under the current state of technologies. Thus, the concept of a perfectly sealed fuel system can not be reasonably applied to conventional gasoline-fueled vehicles, including HEVs.

Accordingly, staff proposes that a definition of a "sealed fuel system" be added to the Evap Test Procedures in orderto eliminate ambiguity and clarify the intended exempted applications. Specifically, a sealed fuel system would be one that uses non-liquid fuels that are under very high pressures and has no evaporative emissions, by. virtue of its design specifications. In addition, in the. interest of completeness; staff proposes that the definition be added to the ORVR Test Procedures even though an HEVthat is equipped with a sealed fuel system would not be exempted from the refueling emission standards and test procedures.

## 2. Off-Vehicle Charge Capable Hybrid-Electric Vehicle-Preconditioning

A "vehicle-preconditioning" step is performed as part the exhaust, evaporative, and ORVR test sequences. Its purpose is to properly adapt the vehicle's engine, fuel, and emission control systems with the applicable test fuel by operating a test vehicle on a dynamometer over a single "Urban Dynamometer Driving Schedule," or "UDDS."

[5] "Partial Zero-Emission Vehicles," or "PZEVs," are required to demonstrate compliance with the zero-fuel evaporative emission standard of 0.0 9 for total hydrocarbons per test. The upper tolerance of this "nominal" zero standard value is 54 mg of total hydrocarbons per test.

Battery SOC levels for HEVs are initially set prior to the vehicle-preconditioning step, as currently specified in the "California Exhaust Emission Standards and Test Procedures For 2005 and Subsequent Model Zero-Emission Vehicles, and 2001 and Subsequent Model Hybrid-Electr.ic Vehicles, In The Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Class," adopted AugustS, 1999 (hereinafter referred to as "HEV Exhaust Test Procedures"; section E.6.1.2). These provisions require that the battery SOC be set at a level that causes the engine to operate for the maximum possible cumulative amount of time during the preconditioning drive. In other words, the battery is set at a "low" energy level in order to force engine operation to ensure proper adaptation with the test fuel. However, an "always plugged-in" off-vehicle charge capable HEV could possibly have a "high" SOC level prior to·the vehicle-preconditioning step, which would suppress engine operation and fuel circulation, and thus, inhibit proper vehicle-preconditioning.

Accordingly, staff proposes that the Evap Test Procedures be revised to require that the vehicle conditioning step, for an off-vehicle charge capable HEV, specify that the test vehicle shall be operated continuously on the dynamometer until it reaches its charge-sustaining mode and then for at least one additional UDDS. This requirement will allow for sufficient engine operation to occur and thereby ensure proper test fuel adaptation of the appropriate vehicle systems.

3. Evaporative Testing - "Worst-Case" Battery State-of-Charge Setting

The HEV battery SOC settings used in the 2D+HS and 3D+HS test sequences are specified by reference in the HEV Exhaust Test Procedures. Battery SOC settings are required during testing in order to ensure that the engine emission performance is "reasonably characterized" (ARB 1993). Therefore, the battery SOC settings are currently required to be at the lowest energy level (i.e., the "worst-case" exhaust test condition) so that the engine will operate for the maximum possible cumulative amount of time during the exhaust testing. An additional SOC Criterion testing requirement applies to HEVs operating in a "charge-sustaining" mode during the exhaust testing.

However, off-vehicle .charge capable HEVs, which have the real-world possibility of always being plugged-in, have the possibility of always starting a commute with a high battery SOC setting. Under these conditions, and depending on the particular type of HEV design, the commute is likely to initially involve little or no engine use, and correspondingly, little opportunity for canister purging. Accordingly, evaporative emissions from off-vehicle charge capable HEVs would be "reasonably characterized" during testing only when the battery SOC settings were similar to those real-world .conditions. This means that the battery SOC setting should ·be at a high level prior to the exhaust emission testing portion of the test sequence when conducting the evaporative emission testing. Setting the battery SOC at the highest allowable level will tend to suppress engine operation during the exhaust test driving, which will also suppress canister purging. Thus,


Date of Release: December 5, 2008; 45-Day Notice version
Date of Hearing: January 22-23, 2009

setting the battery SOC at this high level is both more representative of the potential in-use condition, and is the "worst-case" test condition for evaporative emissions testing. ·Additionally, the requirement to satisfy the SOC Criterion at the end of the exhaust emission testing would be unwarranted since the HEVs would be forced to operate primarily in charge-depleting modes.

Accordingly, staff proposes that, when conducting 2D+HS and 3D+HS evaporative emissions testing of off-vehicle charge capable HEVs, the battery SOC setting be at the maximum level allowed by the manufacturer prior to testing. Additionally, an SOC Criterion requirement would not be applicable. The ARB would reserve the right to conduct certification confirmatory and or in-use compliance tests at either the manufacturer's SOC setting or at the lowest manufacturer-allowed SOC setting, or at some SOC setting in between them.

4. ORVR Testing - "Worst-Case" Battery State-of-Charge Setting

The potential real-world condition of a "high" battery SOC setting for off-vehicle charge capable HEVs that would occur with evaporative diurnal emissions testing also applies to ORVR emission testing. Accordingly, to ensure that off-vehicle charge capable HEV ORVR emissions are "reasonably characterized" during testing, the battery SOC settings should be consistent with the evaporative diurnal emission test settings. Therefore, staff proposes that when conducting ORVR emission testing of off-vehicle charge capable HEVs, the battery SOC setting shall be at the maximum level allowed by the manufacturer, prior to performing the ORVR testing. The ARB shall be able to set the battery SOC at any level for purposes of conducting certification confirmatory and in-use compliance testing.

For some non-integrated systems of off-vehicle charge capable HEVs, there may be a situation where a high battery SOC setting could possibly delay starting the "canister-purging" mode of engine operation during the vehicle drivedown step. As described earlier this is because the vehicle must consume 85 percent of its fuel capacity. This could unnecessary increase the amountof time required to complete the ORVR testing. In order to decrease the possible testing burden on manufacturers, staff proposes that an alternative method will be allowed for these situations. Specifically, for ORVR testing of non-integrated systems, the battery SOC may be set initially at a "low" level in order to maximize the cumulative amount of engine operation over the shortest period of vehicle driving. Such an allowance shall require prior Executive Officer approval, and the approval shall be based on good engineering practice. This allowance shall not apply to integrated systems because the duration of the canister-purging driving step for integrated systems is a prescribed driving distance, and notdependent on the amount of fuel consumed.

5. Canister-Loading - Non-Integrated Refueling Canister-Only Systems



Date of Release: December 5, 2008; 45-Day Notice version
Date of Hearing: January 22-23, 2009

Currently, the 2D+HS, 3D+HS, and ORVR tests require that non-integrated system refueling canisters be preconditioned using the two-gram breakthrough method. Accordingly, the refueling canister in a non-integrated refueling canister-only system is also required to be preconditioned using the same method. However, manufacturers have commented that the two-gram breakthrough method is not appropriate for non-integrated refueling canister-only systems because that type of loading is not representative of real-world conditions. In real-world use, only fuel vapors that are generated during a refueling event can ever be routed to the canister because of the system's particular design. The canister will never be exposed to any evaporative vapors formed inside the tank during diurnal events. Instead, these diurnal vapors will remain in the tank until they are eventually routed directly to the engine system for combustion while the vehicle is driving. Thus, the refueling canister will never experience the repeated daily loadings of evaporative diurnal vapors that eventually saturate conventional canisters and lead to a continuing breakthrough of vapors. For testing purposes of conventional systems, these vapor saturating conditions are assured by loading the canisters to either the one-and-one-half times working capacity specification or the two-gram breakthrough specification, as applicable. However, in real-world use, the most stringent type of canister-loading that can occur with non-integrated refueling canister-only systems is a complete refilling of a fuel tank with new fuel during a refueling event.

Nevertheless, staff has concerns over the possibility that even these refueling vapors would ultimately migrate through the interior of the canister and "bleed" out from the canister, particularly out of its fresh air vent on a continuing basis (i.e., "bleed emissions")[6]. In this case, staff initially felt that the current two-gram canister-loading method was still the preferred canister-loading method because its greater stringency provided additional assurance of emission control, especially in light of the potential "never or minimal" canister-purging characteristics of off-vehicle charge capable HEVs. To address these concerns, the Alliance of Automobile Manufacturers provided an engineering evaluation demonstrating the ability for a canister, loaded initially with only refueling vapors, to adsorb further vapor loading even after an additional one-week period. In other words, the canister would be able to adequately control bleed emissions over time because the trapped vapors would tend to migrate deeper in the canister's activated carbon rather than out of the canister's fresh-air vent. A separate engineering evaluation by a manufacturer indicated that some vapor migration outside of the canister did occur; however, the emissions impact was relatively very small.

Accordingly, staff proposes that the canister preconditioning method be revised so that it is more representative of real-world conditions when conducting 2D+HS, 3D+HS, and ORVR testing of off-vehiclecharge capable HEVs that are

[6] The "fresh air vent" is a port on the canister that opens to the ambient atmosphere in order to allow fresh air to enter and purge the canister at the appropriate times. This port is typically opened and closed using a solenoid-actuated, one-way check valve.

equipped with non-integrated refueling canister-only systems. Specifically, under a new "fuel-tank-refill" canister-loading method for a non-integrated refueling canister-only system, the refueling canister shall be loaded with only refueling vapors that are volumetrically displaced from the fuel tank as the tank is replenished with new fuel from a 10 percent to a 95 percent level (nominal volumes), similarly as done in ORVR testing. This method represents the "most stringent" canister-loading method for this particular system.

There are two areas of concern with using this new method. The first concern is that any routine fuel draining or filling of the fuel tank during the vehicle-preconditioning steps could unintentionally route vapors to the refueling canister. This would cause the refueling canister to be loaded with more vapors than intended with the new canister-loading method (Le., causing abnormal purging or loading). Therefore staff proposes that a refueling canister be "isolated" from its system, using any method that does not compromise the integrity of the evaporative emission control system, when performing these routine steps in order to prevent any abnormal purging or loading. To facilitate any ARB certification confirmatory or in-use compliance testing activities, a manufacturer shall include a description of the particular canister isolation method in its certification application. The second concern arises from the inability to vent fuel vapors from the tank to the atmosphere via the isolated refueling canister when the vehicle is refueled. A conventional evaporative emission control system can vent these vapors through its canister; however, these vapors cannot be vented through a refueling canister that is isolated. Accordingly, staff proposes that these vapors be allowed to be routed from the fuel tank directly to the atmosphere when the refueling canister is isolated during a refueling event.

To provide flexibility in implementing this new canister-loading method, staff proposes that modifications may be allowed when approved in advance by the Executive Officer. Lastly, in order to facilitate the implementation and use of this new canister-loading method, staff proposes to add a definition for a "non-integrated refueling canister-only system" to the Evap Test Procedures.

### 6. Canister-Purging Capability - "Worst-Case" SOC Setting

Staff has concerns about the breadth of the 2D+HS test evaluation for off-vehicle charge capable HEVs. Under the proposed "worst-case" battery SOC setting, canister purging will be either suppressed or reduced during the exhaust FTP driving portion of the test sequence. However, as discussed previously, the main objective of the 2D+HS test is to evaluate the purging capability of the evaporative emission control system during a short driving event. Thus, even though a vehicle may have satisfied the 2D+HS emission standard, it may not necessarily demonstrate that the canister adequately purges during real-world short driving events.



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Date of Hearing: January 22-23, *2009*

To address this concern, staff proposes to require manufacturers to demonstrate compliance with the 2D+HSemission standard using a "low" battery SOC level in the test sequence in order to maximize the engine operation during the exhaust FTP test. To reduce the burden of performing this demonstration, staff proposes that a manufacturer have the option to conduct an engineering evaluation demonstrating the evaporative emission control system's capability for sufficiently purging a canister during short driving events. A statement of compliance to this fact shall be included with a manufacturer's certification application. The engineering evaluation shall be provided to the Executive Officer, if requested. In general, it seems reasonable that manufacturerswill have already ascertained a particular system's performance specifications and capabilities while developing the system. Thus, this information should be readily available.

This information would include, but not be limited to, canister type, canister volume, canister working capacity, fuel tank volume, fuel tank geometry, fuel delivery system, description of the input parameters and software strategy used to control canister purge, and nominal purge flow volume (i.e., amount of bed volumes) achieved by a test vehicle after a completed 2D+HS dynamometer drive cycle.

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# APPENDIXJ

# ON BOARD DIAGNOSTICS (OBD) CONSIDERATIONS FOR AFTERMARKET PHEV CONVERSION SYSTEMS

An on board diagnostic (OBO) system is designed to assist in air pollution reduction and prevention. It is a diagnostic system incorporated into the vehicle's powertrain computer that detects emission control system malfunctions as they occur. OBO systems consist mainly of software designed into the vehicle's on-board computer that monitors virtually every component and system that can cause an increase in emissions. When an emission-related malfunction is detected, the OBO system alerts the vehicle operator by illuminating the malfunction indicator light on the instrument panel. By alerting the driver to malfunctions as they occur, repairs can be made promptly, which result in fewer emissions from the vehicle.

As with other ARB requirements, vehicle manufacturers must design their systems to comply with emission standards, certify the systems with ARB, and have in-use liability for recall or other correction if the system fails to meet the requirements in-use. Unlike most other ARB requirements which govern emission levels fora finite portion of the vehicle life (e.g., for the useful life, which is typically 120,000 miles on today's vehicles), the OBO system is required to work for the entire time the vehicle is operated on-road.

Manufacturers ofaftermarket devices that modify certified vehicle configurations are required to demonstrate compliance with the OBO requirements in the modified configuration. As an example, Conversion System Manufacturers of alternate fuel conversion kits (e.g., converting a gasoline vehicle to run on propane or compressed natural gas) are required to certify their systems to the OBO requirements and must integrate their system, add diagnostics where· appropriate, test and recalibrate malfunction thresholds for various diagnostics, perform demonstration testing, and submit a complete application for ARB review and approval. Those manufacturers currently offering such products in California have gone through such a process (and do so annually as new model-year products become available for conversion). Conversion System Manufacturers of devices to add off-vehicle charge capability to HEVs will similarly be required to comply with the OBb requirements for their modified configuration and will be required to submit an application for review and certification that include's the data and information to demonstrate compliance.

Systems or conversions that add hybrid functionality will affect the original vehicle's OBO system. Conversion System Manufacturers will have to plan for OBOcompliance in their system design and likely will need to integrate substantially with the OEM system to be successful. The Conversion System Manufacturers must assume they have adversely impacted the OEM OBO system and will likely need to add OBO content and recalibrate some existing portions of the system to bring the modified vehicle into compliance. Complying with the aBO regulation takes more than showing that the modified vehicle does not set false faults (e.g., cause diagnostics to erroneously conClude there are· faults when none actually exist). A compliant aBO system is one that detects all the required faults when they occur,detects those faults as frequently as required, and detects those faults at the required tailpipe emission levels. A compliant system will detect all faults that can cause an emission increase, including faults of added hardware as part of the conversion system.

**Potential Impacts to OBO by Aftermarket Conversion Systems**

Today's vehicles are incredibly complex; therefore, it is difficult to accurately predict the full impact of aftermarket conversion systems to the aBO system until specifics are known about the base vehicle and about the hybrid modification itself. However, based on staff's experience, there are several areas where added hybrid functionality will likely have an impact and are worth mentioning as "examples. " "

Vehicle manufacturers must design their monitors to accurately detect faults and accordingly, define specific operating conditions that must be met to allow the monitor to run. These conditions can involve IC engine conditions (e.g., idle, cruise, specific speed and load regions, warmed-up.operation, etc.), ambient conditions (e.g., specific altitudes or temperature regions), or many other conditions. Aftermarket systems that alter vehicle characteristics could end up virtually eliminating the conditions necessary for running monitors and result in emission-related components that are no longer monitored. As an example, systems that add an idle off feature can essentially eliminate monitors that only are enabled at idle le engine speeds. Similarly, systems that expand electric vehicle operation (e.g., to higher vehicle speeds or IC engine loads) may effectively eiiminate necessary conditions. Conversion System Manufacturers will need to understand the OEM aBO system thoroughly to be able to assess the impacts their system will have and develop solutions (e.g., prohibit idle off operation until all monitors that require idle have completed running, recalibrate monitors that require idle operation to run off-idle, etc.).

While vehicle manufacturers have to constrain the monitors to only run in conditions where they can accurately detect faults, they must also meet specific frequency requirements on how often such monitors must run on in-use vehicles. Accordingly, they cannot restrict monitoring to a degree that it prevents monitors from running on most driving cycles, regardless of driver habits or operation. If monitors do not run with sufficient frequency, the vehicles can be subjectto recall or other remedial action. Furthermore, infrequent monitoring leads to higher emissions in-use as the time between occurrence of a fault and its detection by the system is lengthened. Aftermarket conversion systems can adversely impact monitoring frequency by lengthening the amount of IC engine operation between occurrence and detection of a fault. As an example, monitors that require extended amounts of continuous IC engine on operation could complete much less frequently if the modified system causes the IC engine to run for shorter periods. So, despite the need for the emission controls to work" properly on each and every restart and period of IC engine operation, the shortened operating windows may provide infrequent opportunities to monitor those components and effectively lengthen the amount of IC engine operation with an emission related malfunction prior to its detection. Aftermarket manufacturers will again need to have a thorough understanding of the OEM system and the OBO requirements to integrate their system in a compliant manner.

A third obvious area where aftermarket conversion systems will likely affect aBO compliance is with all added system hardware, such as controllers, input and output devices such as switches, sensors, and actuators, and the battery pack itself. Under the aBO regulation, these devices will likely fall under the· comp'rehensive components requirements.[1] All electronic input and output components that can affect emissions are required to be monitored for specific failures and the aBO system is required to illuminate the malfunction indicator light and store specific information about the fault in accordance with SAE standards. In this context, it is important to note that "affeots emissions" is defined as causes a measurable increase in emissions during any reasonable driving condition and is not defined as "causes emissions" to exceed the applicable standards. As an example, battery temperature sensors that falsely indicate the battery is too hot and derate or disable hybrid operation would cause the IC engine to operate sooner/more frequently/at a higher load and typically cause an increase in tailpipe emissions. Accordingly, the battery temperature sensor would need to be monitored by the aBO system. Conversion System Manufacturers that add hardware to the system will likely need to add OBO compliant diagnostics for each and every electronic component and carefully integrate fault handling of these diagnostics with the aEM aBO system. Aftermarket conversion systems that simply "disable themselves" or attempt to "revert back to the aEM system" upon malfunction are generally not sufficient solutions to comply and often result in emission faults going undetected in-use.

Staff understands that most Conversion System Manufacturers will need some time to comprehend. the aBO requirements, identify the likely impacts, and develop solutions to bring a compliant product to the marketplace. Accordingly, staff is proposing to use the existing deficiency provisions in the aBO regulation that allow certification of systems that fall short of fully meeting all of the OBO system requirements. Deficiencies can be awarded in cases where the manufacturer has made a good faith effort to comply and has a plan to come into full compliance as expeditiously as possible. Using this mechanism, staff could certify systems that fall short in one or more areas as long as the manufacturer had attempted to comply and had a valid plan to address the shortcomings in a reasonable timeframe. There are some restrictions on items that can be treated as deficiencies, but those are consistent with the type of shortcomings where it would not be appropriate to certify the system.[2] Conversion System .

1 CCR title 13 Section 1968.2

2 ARB will not approve systems with such reduced monitoring frequency that any monitors are effectively disabled or the vehicle is otherwise incompatible with the Smog Check inspection process.

Manufacturers will still need to meet the vast majority of the aBO requirements and relief is expected to primarily be needed in the area of minimum monitoring frequency. Further, such relief could only be granted for short term relief and only· in cases where the Conversion System Manufacturer has determined what is needed to come into full compliance and has a plan to do so in an expeditious manner. Staff's proposal regarding interim relief in the area of monitoring frequency would allow Conversion System Manufacturers to gain necessary in-use experience as to how the vehicle is operated and how often monitors are running and to use that information to refine the system.

# APPENDIX K

## TECHNICAL SUPPORT DOCUMENT FOR ECONOMIC IMPACTS RELATED TO THE PROPOSED EXHAUST AND EVAPORATIVE TEST PROCEDURE AMENDMENTS

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**Exhaust Test Procedure Cost Analysis**

Vehicle Testing

The current Exhaust Test Procedures are the basis for evaluating the cost impact of the proposed test procedure. In comparing the current procedures with the proposed procedures, an analysis is made for a PHEV[1] that has only all-electric range during charge depleting operation since it can be fully tested by both procedures. A blended type PHEV cannot be fully tested using the current procedures, so it cannot be reasonably compared to the proposed procedure.

For this cost analysis, a hypothetical PHEV with a 40-mile all-electric range is chosen. This vehicle is a near worst case example for a PHEV since it would have a charge depleting range of 40 miles, requiring many test cycles to reach charge-sustaining conditions. Most PHEVs introduced initially are expected to have a charge depleting range of around 10 miles.

The cost estimate is based on the following assumptions:

1. The cost of electrical measurement for battery SOC, alternating current (AC) charging, the cost of fuel and drain, and road load derivation is roughly the same between current and proposed procedures.

2. The vehicle emissions test cell is equipped with a relatively new emission sampling and measurement system capable of SULEV emissions measurement.

3. TlTe energy to fully charge after the urban charge-sustaining test or highway charge-sustaining test is assumed to be the same. Although it is possible that the urban and highway charge energies could differ, manufacturers have indicated that they will be the same, which will minimize testing.

4. Prior to the charge-sustaining emission test, it is assumed that at the vehicle battery is either at the charge-sustaining SOC or can be discharged to the charge-sustaining SOC by means of on-road driving.

5. For cold temperature tests at 20°F and 50°F the current procedures only required the vehicles to. be tested in charge-sustaining' operation. However, the proposed procedures require vehicles to be tested in the worst case of charge depleting or charge-sustaining operation, based on results from the urban charge depleting and Charge-sustaining tests. For charge-sustaining tests, testing cost for the current and proposed procedures would be the same. However, for the

[1] Staff is using the more 'common term of PHEV for readability. The use of PHEV is not meant to restrict the use of the vehicles to receive charging only from the grid, as with the PHEV definition used in Pavely. To address this restriction, staff refers to these vehicles as off-vehicle charge capable hybrid electric vehicles or avec HEVs through out the test procedures and regulatory text.

proposed procedure some vehicles will require a charge depleting test instead of the charge-sustaining test. For the purpose of this cost analysis it is assumed that for charge depleting operation at cold temperatures, vehicles will start the engine within the first UDSS to protect the battery and to warm the vehicle for passenger comfort, rather than using electrical energy from the battery. Based on this assumption, the cost for cold temperature charge depleting and charge-sustaining tests would be the same.

6. For simplicity the urban all-electric range and the highway all-electric range are identical.

Individual Test Costs

Table K-1 shows individual test costs. These are typical costs for a commercial vehicle test laboratory. Staff surveyed three laboratories and averaged the individual test cost information.

Table K-1
Cost per Test Type

| Test Type | Cost per Test in $ |
|---|---|
| UDDS | 850 |
| HFEDS | 600 |
| US06 | 700 |
| SC03 | 700 |
| UDDS *w/o* emissions | 450 |
| HFEDS *w/o* emissions | 350 |
| US06 *w/o* emissions | 400 |
| Canister Preconditioning | 150 |

Total Cost of Current Exhaust Test Procedure

Table K-2 shows the cost for the current test procedure for the example vehicle. The table shows the type and quantity of required tests. The total testing cost of the current procedures is $10,400.

**Table K-2**
**Current Procedure Testing Cost - 40-mile AER PHEV**

| Test Sequence | Test Description | Tests Required | No. of Tests | Cost per Test, $ | Total Cost, $ |
|---|---|---|---|---|---|
| -<br>Day 1 | City All-Electric Range Test | UDDS *w/o* emissions | 6 | 450 | 2,700 |
| Day 2 | Highway All-Electric Range Test | HFEDS *w/o* emissions | 4 | 350 | 1,400 |
| Day 3 | Vehicle Preparation | UDDS *w/o* emissions | 1 | 450 | 450 |
| | | Canister Preconditioning | 1 | 150 | 150 |
| Day 4 | Urban Exhaust Emissions Test | UDDS | 2 | 850 | 1,700 |
| | Highway Emissions Test | HFEDS | 2 | 600 | 1,200 |
| | US06 Emission Test | US06 | 2 | 700 | 1,400 |
| | SC03Emission Test | SC03 | 2 | 700 | 1,400 |
| **Total Cost - Current Procedure** | | | | | **$10,400** |

Total Cost of Proposed Exhaust Test Procedure

Table K-3 shows cost a similar cost analysis for proposed procedures. The proposed procedures increase the number required for some test types. The total testing cost of the current procedures is $,15,200.



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Date of Hearing: January 22-23, 2009

Table K-3
Proposed Procedure Testing Cost - 40-mile AER PHEV

| Test Sequence | Test Description | Tests Required | No. of Tests | Cost per Test, $ | Total Cost, $ |
|---|---|---|---|---|---|
| Day 1 | lVehicle Preparation | UDDS | 2 | 850 | 1700 |
| | | Canister Preconditioning | 1 | 150 | 150 |
| Day 2 | Urban Charge Depleting Range Test | UDDS *wlo* emissions | 5 | 450 | 2250 |
| | | UDDS | 3 | 850 | 2550 |
| Day 3 | Urban Charge-Sustaining Emission Test | UDDS | 2 | 850 | 1700 |
| Day 4 | Highway Charge Depleting Range Test | HFEDS *wlo* emissions | 3 | 350 | 1050 |
| | | HFEDS | 2 | 600 | 1200 |
| Day 5 | Highway Charge-Sustaining Emission Test | HFEDS | 3 | 600 | 1800 |
| | US06 Emission Test | US06 | 2 | 700 | 1400 |
| | SC03 Emission. Test | SC03 | 2 | 700 | 1400 |
| Total Cost - Proposed Procedure | | | | | $15,200 |

Vehicles qualifying for the Type G PHEV option would require five additional US06 non-emission tests yielding an additional cost of $2000.

Cost Differential

As shown below, staff estimates that proposed test procedures would increase testing cost for PHEVs by $4,800

Proposed Procedure Testing Cost: $15,200
Current Procedure Testing Cost: $10,400

Increased Testing Cost of Proposed Procedures: $ 4,800

For the Type G PHEV, the differential cost would increase by $2000 for total of $6,800.

A similar analysis was performed for a PHEV with a 10-mile all'electrical range, which also showed an increased testing cost of the proposed procedure to be $4800. Therefore, depending on range,the proposed procedures would increase testing costs by $4,800 to $6,800.

The typical overall costs of testing a blended PHEV are expected be less than that of testing a PHEV with significant all-electric range for the prop'osed procedure. This is because a blended PHEV is typically expected to use a smaller battery than a PHEV with significant all-electric range. The smaller battery of the blended PHEV will result in less electric range and fewer test cycles to deplete the battery, and therefore result in reduced testing costs. In addition, blended PHEVs will typically not be subject to the associated costs of testing for a Type G advanced componentry allowance, since most if not all will not qualify for it. The following example in Table K-4 represents a PHEV with a 10 mile EAER. This vehicle cannot be adequately tested on the current procedure, so a comparison cannot be made to the current test procedure.

Table K-4
Proposed Procedure Testing Cost -10 mile Blended PHEV

| Test Sequence | Test Description | Tests Required | No. of Tests | Cost per Test, $ | Total Cost, $ |
|---|---|---|---|---|---|
| Day 1 | Vehicle Preparation | UDDS | 2 | 850 | 1700 |
| | | Canister PreconditioninQ | 1 | 150 | 150 |
| Day 2 | Urban Charge Depleting Range Test | UDDS | 4 | 850 | 3400 |
| Day3 | Urban Charge-Sustaining Emission Test | UDOS | 2 | 850 | 1700 |
| Day4 | Highway Charge Depleting Range Test | .HFEOS | 2 | 600 | 1200 |
| Day 5 | Highway Charge-Sustaining Emission Test | HFEOS | 3 | 600 | 1800 |
| | US06 Emission Test | US06 | 2 | 700 | 1400 |
| | SC03 Emission Test | SC03 | 2 | 700 | 1400 |

Total Cost - Proposed Procedure $12,750

Test Facility Costs

To accommodate the new test cycles in the proposed procedures such as the continuous urban test, continuous highway test, and continuous US06, test facilities may require hardware and software upgrades. These upgrades are estimated to costfrom $20,000-$100,000 depending on upgrades necessary. This would be a one-time additional cost. The proposed procedures are not expected to significantly change facility maintenance costs.



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**Evaporative-Related Test Procedure Cost Analysis**

Vehicle Testing

The current HEV Evap Test Procedures are used as the basis for evaluating the cost impact of the proposed amendments. There are two distinct changes to these test procedures that impact the associated costs. The first one is the requirement that the vehicle-preconditioning step for 2011 and subsequent model-year PHEVs include at least one UDDS conducted in a charge-sustaining mode of operation instead of the current requirement for HEVs to conduct only a single UDDS. In general, manufacturers are expected to be able to satisfy this vehicle-preconditioning requirement using a single UDDS. However, depending on their own particular design, other manufacturers may choose a more conservative approach of conducting two consecutive UDDS cycles. Thus, staff used the conservative approach in estimating the extra cost of conducting a second UDDS, along with performing both UDDS cycles in a charge-sustaining mode of operation. The second cost-impacting change is the requirement that PHEVs equipped with non-integrated refueling canister-only system use the new fuel-tank-refill canister-loading rnethod. This new method increases the canister-preconditioning costs because it requires more steps and amount of test fuel, in aggregate, needed to perform the process.

The cost impacts related to the proposed vehicle-preconditioning changes are applicable to both AER and blended PHEVs. The cost impacts involving the new fuel-tank-refill canister-loading method are applicable to both AER and blended PHEVs that are equipped with non-integrated refueling canister-only systems. Accordingly, the cost analysis is not specific to any particular type of PHEV. Furthermore, the cost analysis uses the following assumptions:

1. Prior to conducting the vehicle-preconditioning step, it is assumed that the vehicle battery is either at the charge-sustaining state of charge or can be discharged to the charge-sustaining state of charge" by means of on-road driving.

2. Laboratories that will perform testing of non-integrated refueling canister-only system-equipped PHEVs are already equipped with an ORVR-capable SHED, along with the ancillary refueling equipment.

3. A "representative" fuel tank capacity of 12 gallons is assumed for estimation purposes. This is the approximate fuel tank capacity of a current model-year Toyota Prius hybrid-electric veh.icle at an ambient temperature of 70°F.

Additionally, cost estimates used in the analysis are based on limited information from two commercial test laboratory sources.

## Total Cost of Current Evaporative Tests

Estimated costs for the current evaporative-related tests are listed in Table K-5. These estimates include $8,000 for the 3-Day Diurnal plus Hot Soak test sequence (which includes the Running Loss test); $3,000 for the 2-Day Diurnal plus Hot Soak test sequence (which does not include any exhaust emission sampling); and, $6,760 for the ORVR test.

Table K-5
Current Evaporative Test Costs

| Test Sequence | Cost per Test ($) |
|---|---|
| 3-Day Diurnal + Hot Soak Test Sequence (w/RL Test)a | 8,000 |
| • 3-Day Diurnal + High-Temp. Hot Soak Test (3D+HS) | 4,500 |
| • Running Loss Test (RL) (point-source method) | 3,500 |
| 2-Day Diurnal + Hot Soak Test (no exhaust sampling) | 3,000 |
| ORVR Test | 6,760 |

a The "3-Day Diurnal + Hot Soak Test Sequence" includes both the 3D+HS test and the RL test.

## Proposed Fuel-Tank-Refill Canister-Loading Method Costs

The additional costs associated with the proposed fuel-tank-refill canister-loading method for preconditioning canisters on PHEVs equipped with non-integrated refueling canister-only systems are indicated in Table K-6. These total cost of the extra procedural steps and test fuel amounts are approximately $1,400. .

Table K-6
Additional Cost For Proposed Fuel-Tank-Refill
Canister-Loading Method

| Additional Step | Cost per Test ($) |
|---|---|
| Vehicle soak (6 - 24 hr at 80°F) | 900 |
| Fill/drain step | 200 |
| Fuel required (total)a | 285 |
| Tota. Cost: | -1,400 |

a Estimated cost of delivered certification testfuel is *$25.00/gallon.*

Evap Test Total Costs - Proposed Non-Integrated Refueling Canister-Only Equipped PHEVs

Estimated total costs for conducting the proposed evaporative-related tests of PHEVs equipped with non-integrated refueling canister-only systems are provided in Table K-7. These estimates include $10,650forthe 3-Day Diurnal. plus Hot Soak test sequence (including the Running Loss test), $5,650 for the 2-Day Diurnal plus Hot Soak test sequence (no exhaust emission sampling), and $9,410 for the ORVR test.

Table K-7
Proposed Evaporative Test Sequence Total Costs

| Test Sequence Description | No. of Tests | Cost per Test ($) | Total Cost ($) |
|---|---|---|---|
| 3-Day Diurnal + Hot Soak Test Sequence (w/RL Test) | 1 | 8,000 | 8,000 |
| Delete: UDDS *w/o* emissions (ref. Table 1) | 1 | 450 | -450 |
| Add: UDDS (ref. Table 1) | 2 | 850 | 1,700 |
| Add: Fuel-Tank-Refill Canister-Loading Method | 1 | 1,400 | 1,400 |
| Total Cost: | | | 10,650 |
| | | | |
| 2-Day Diurnal + Hot Soak Test | 1 | 3,000 | 3,000 |
| Delete: UDDS *w/o* emissions (ref. Table 1) | 1 | 450 | -450 |
| Add: UDDS (ref. Table 1) | 2 | 850 | 1,700 |
| Add: Fuel-Tank-Refill Canister-Loading Method | 1 | 1,400 | 1,400 |
| Total Cost: | | | 5,650 |
| | | | |
| ORVR Test | 1 | 6,760 | 6,760 |
| Delete: UDDS *w/o* emissions (ref. Table 1) | 1 | 450 | -450 |
| Add: UDDS (ref. Table 1) | 2 | 850 | 1,700 |
| Add: Fuel-Tank-Refill.Canister-Loading Method | 1 | 1,400 | 1,400 |
| Total Cost: | | | 9,410 |

Estimated Cost Differential

Comparing the estimated total costs for the current test procedures (Table K-5) and the proposed test procedures (Table K-7) shows a cost difference of $2,650 for PHEVs that are equipped with non-integrated refueling canister-only systems. This estimated cost difference is applicable toal! of the evaporative-related test sequences, including the 3-Day Diurnal plus Hot Soak test sequence (with the Running Loss test), 2-Day Diurnal plus Hot Soak test sequence (no exhaust emission sampling), and the ORVR test.