California Environmental Protection Agency

Air Resources Board

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

PUBLIC MEETING AGENDA

February 26, 2009

February 26, 2009
9:00 a.m.

Agenda Item #

09-2-1: Health Update: Exposure to Traffic-Related Air Pollution and Indicators of Adverse Health Effects in Adults with Heart Disease

It is well recognized that exposure to particulate matter (PM) is associated with heart disease and premature death. However, little is known regarding which components of PM are most responsible for harmful effects. This study showed that increased levels of heart disease indicators were most associated with smaller particles and the directly emitted organic carbon component of traffic-related PM.

09-2-2: Public Hearing to Consider 11 Research Proposals

1. *"Environmental Exposures in Early Childhood Education Environments," University of California, Berkeley, $417,496, Proposal No. 2665-263.*
2. *"Measurement of Diesel Solid Nanoparticle Emissions Using a Catalytic Stripper for Comparison to Europe's PMP Protocol," University of California, Riverside, $170,000, Proposal No. 2664-263.*
3. *"Integrated Physical, Chemical and Optical Measurements of Heavy-Duty Diesel Emissions at NASA AMES Full Scale Wind Tunnel," University of California, Davis, $419,917, Proposal No. 2673-263.*
4. *"Advanced Understanding of Particle Radioactive Forcing Emitted from Combustion Sources in California," University of California, San Diego/University of California, Berkeley, $796,403, Proposal No. 2678-263.*
5. *"Assessment of Baseline Nitrous Oxide Emissions in California Cropping Systems," University of California, Davis, $300,000, Proposal No. 2669-263.*
6. *"Nocturnal Chemistry in the Urban Boundary Layer of Los Angeles," University of California, Los Angeles, $289,097, Proposal No. 2674-263.*

7. *"Characterization of Atmospheric Chemistry in the Southern San Joaquin Valley and Initial Comparison with Chemistry in the South Coast Air Basin," $1,050,000, Proposal No. 2677-263.*

8. *"Study of In-Use Engine Deterioration in Diesel Off-Road Equipment," University of California, Riverside, $300,000, Proposal No. 2676-263.*

9. *"Development of an Updated Base Case Ambient VOX Mixture for Assessing Atmospheric Reactivity," University of Texas, $40,000, Proposal No. 2670-263.*

10. *"Characterization of Ambient Aerosol Sources and Processes During CalNex 2010 with Aerosol Mass Spectrometry," University of Colorado, Boulder, $285,000, Proposal No. 2672-263.*

11. *"Low VOC, Stain Blocking Specialty Primer Coating," California Polytechnic University, $249,996, Proposal No. 2675-263.*

09-2-3: Public Hearing to Consider the Adoption of a Proposed Regulation to Reduce Greenhouse Gas Emissions from California Semiconductor Operations

Staff will propose a new regulation to reduce greenhouse gas emissions from semiconductor operations. This discrete early action measure under Assembly Bill 32 establishes emission limits for semiconductor operations, which will reduce greenhouse gases. The regulation also requires recordkeeping and reporting.

09-2-4: Public Hearing to Consider Adopting a Regulation to Reduce Sulfur Hexafluoride Emissions in Non-Semiconductor and Non-Utility Applications

Staff will propose a new regulation to phase-out sulfur hexafluoride from non-semiconductor and non-electrical applications. This proposed regulation would impact two main sectors: magnesium casting and tracer gas users (particularly engineering firms). Additional covered uses include research, and miscellaneous uses in retail products. The regulation would result in a decrease of at least 0.10 million metric tons carbon dioxide equivalent in a cost-effective manner.

09-2-5: Public Meeting to Present to the Board the Climate Change Scoping Plan Implementation Update and Consideration of Appointment of Replacement Members to the Economic and Technology Advancement Advisory

Staff will update the Board on the status of implementing the Climate Change Scoping Plan and propose appointment of replacement members to ETAAC.

09-2-6: Public Meeting to Report to the Board on Staff's Nonattainment Area Recommendations for the Revised Federal 8-Hour Ozone Standard

Staff will present nonattainment area recommendations for the new federal 0.075 ppm 8-hour ozone standard. ARB will submit these recommendations to the United States Environmental Protection Agency by March 12, 2009.

09-2-7: Public Meeting to Consider the Approval of New Grants under the Innovative Clean Air Technologies (ICAT) Program

In response to a public solicitation for applications to the ICAT program, staff has received and reviewed proposals for the quality of their innovative technologies, their potentials for reducing air pollution and for commercial application in California, their potential economic benefits for California, the quality of the proposed demonstration projects, and their values to ARB programs. Staff is recommending grants for four of the proposed projects.

09-2-8: Public Meeting to Present "Beyond the Press Release: How a Comprehensive Outreach Campaign Can Help Drive Policy"

The Director of Communications will provide an overview of how comprehensive, strategic communications programs can compliment the Board's regulatory programs.

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.

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:

If you require special accommodations or language needs, please contact the Clerk of the Board at (916) 322-5594 or by Fax at (916) 322-3928 as soon as possible, but no later than 10 business days before the scheduled board hearing. TTY/TDD/Speech to Speech users may dial 711 for the California Relay Service.

SMOKING IS NOT PERMITTED AT MEETINGS OF THE CALIFORNIA AIR RESOURCES BOARD

California Environmental Protection Agency

Air Resources Board

PUBLIC MEETING AGENDA

LOCATION:
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9:00 a.m.

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TITLE 17. CALIFORNIA AIR RESOURCES BOARD

NOTICE OF PUBLIC HEARING TO CONSIDER THE ADOPTION OF A PROPOSED REGULATION TO REDUCE GREENHOUSE GAS EMISSIONS FROM CALIFORNIA SEMICONDUCTOR OPERATIONS

The Air Resources Board (ARB or the Board) will conduct a public hearing at the time and place noted below to consider adoption of a regulation to reduce greenhouse gas (GHG) emissions from semiconductor and related devices (semiconductor) operations.

DATE: February 26, 2009

TIME: 9:00 a.m.

PLACE: California Environmental Protection Agency
Air Resources Board
Bryon 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., February 26, 2009, and may continue at 8:30 a.m., February 27, 2009. This item may not be considered until February 27, 2009. Please consult the agenda for the meeting, which will be available at least 10 days before February 26, 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 to the meeting date.

INFORMATIVE DIGEST OF PROPOSED ACTION AND POLICY STATEMENT OVERVIEW

Sections Added: Proposed adoption of California Code of Regulations, title 17, Subchapter 10, Article 4, Subarticle 2. Semiconductor Operations, sections 95320, 95321, 95322, 95323, 95324, 95325, and 95326.

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 June 2007, the Board approved a discrete early action measure to reduce emissions of fluorinated greenhouse gases from semiconductor operations.

Description of Proposed Regulatory Action:

The purpose of this regulation is to reduce fluorinated gas emissions from semiconductor operations. Fluorinated gases are GHGs and are used in cleaning chemical vapor deposition (CVD) tool chambers where thin films are deposited on wafers, and in etching integrated circuits into those thin films. The regulation pertains to fluorinated gases used in these processes and requires an owner or operator of a semiconductor operation that emits more than 0.0008 million metric tons of carbon dioxide equivalent per year to comply with emission standards effective January 1, 2012. Operators that are replacing 150 millimeter wafer process tools with newer 200 millimeter or larger wafer tools would have until January 1, 2014 to comply.

The proposed semiconductor regulation would set new maximum allowable emission limits for semiconductor operations. The emission limits for semiconductor operations are tiered, and vary depending on the quantity of wafers (thin semiconductor material from which integrated circuits or "chips" are made) processed at an operation. All new semiconductor operations established on or after January 1, 2010 will be required to meet the most stringent emission standard, regardless of the quantity of wafers produced.

Reporting requirements specify that an owner or operator must submit annual reports to the permitting agency for emissions occurring in the immediate previous calendar year. The annual reports are to include the amount of fluorinated gases used, wafer processing volume, emissions calculations, and other information.

Recordkeeping requirements specify that the owner or operator maintain records on quantities of fluorinated gases purchased, as well as records on emission control equipment malfunctions and failures.

Environmental and Economic Impacts

The proposed regulation is estimated to achieve an emissions reduction equivalent to 0.18 million metric tons of carbon dioxide per year. No significant adverse environmental impacts should occur from the proposed regulation. Semiconductor operators may use any combination of three compliance options. The first, process optimization, reduces the volume of fluorinated gases used and emitted, and does not generate by-products. The second, alternative chemistries, uses replacement gases in CVD chamber cleaning. Replacement gases are used more efficiently, and therefore result in lower emissions. The final option, abatement, uses systems that rely primarily on combustors to destroy emissions. Abatement devices generate emissions of nitrogen oxides (NO_x). Semiconductor operations are required to obtain air district permits for abatement devices to ensure that NO_x impacts are minimized. While hydrogen fluoride is also generated by combustors, it is treated effectively with water scrubbers.

Overall, the proposed regulation is not expected to have a significant impact on semiconductor businesses in California. The cost to affected businesses would be approximately $22 million in initial capital costs and about $850,000 in annual recurring costs. These costs correspond to $3.7 million annually over the useful life of the regulation, assumed to be ten years. The cost-effectiveness is estimated to be 21 dollars per metric ton of carbon dioxide equivalent reduced which corresponds to cost estimates for other GHG regulations identified in the Scoping Plan.

Staff also estimated profitability impacts on businesses by calculating the decline in the return on owner's equity (ROE). The threshold value of 10 percent has been used consistently by the ARB staff to determine impact severity. The proposed regulation is expected to result in an average ROE decline of 0.4 percent.

COMPARABLE FEDERAL REGULATION

There is no comparable federal regulation related to reducing greenhouse gas emissions from semiconductor operations.

AVAILABILITY OF DOCUMENTS AND AGENCY CONTACT PERSONS

The Board staff has prepared an Initial Statement of Reasons (ISOR) Report, which includes a summary of the economic and environmental impacts of the proposal, and which describes the basis of the proposed action in more detail. The ISOR is entitled, "Initial Statement of Reasons for Proposed Measure to Reduce Fluorinated Gas Emissions from Semiconductors and Related Devices."

Copies of the ISOR Report with 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, First Floor, Sacramento, CA 95814, (916) 322-2990 at least 45 days prior to the scheduled hearing on February 26, 2009.

Upon its completion, the Final Statement of Reasons (FSOR) will be available and copies may be requested from the agency contact persons identified below, 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. Terrel Ferreira, Manager of the Greenhouse Gas Measures Section, at (916) 445-3526, or by email at tferreir@arb.ca.gov, or Mr. Dale Trenschel, Air Pollution Specialist, at (916) 324-0208, or by email at dtrensch@arb.ca.gov.

Further, the agency representative and designated back-up contact persons to whom non-substantive inquiries concerning the proposed administrative action may be directed are Ms. Lori Andreoni, Manager, Board Administration & Regulatory Coordination Unit, (916) 322-4011, and Ms. Trini Balcazar, Regulations Coordinator, (916) 445-9564. 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 also available on the ARB Internet site for this rulemaking at http://www.arb.ca.gov/regact/2009/semi2009/semi2009.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.

The proposed regulatory action will create costs to local air pollution control and air quality management districts (the "districts"). However, these costs to the districts are recoverable by fees that are within the districts' authority to assess (see Health and Safety Code sections 42311 and 40510).

In developing this regulatory proposal, the ARB staff evaluated the potential economic impacts on representative private persons or businesses. The Executive Officer has initially determined that there will be a potential cost impact on private persons or businesses directly affected as a result of the proposed regulatory action. As explained in the ISOR, the proposed regulation will impact some individual businesses, but the overall statewide impacts are not expected to be significant.

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 initially 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 would affect small businesses. Thirty-eight of 74 operations subject to the proposed regulation are small businesses, those with less than 250 employees. Five of the 38 small businesses will be required to reduce their emissions to comply with the proposed regulation.

In accordance with Government Code sections 11346.3(c) and 11346.5(a)(11), 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 or businesses than the proposed action.

SUBMITTAL OF COMMENTS

The public may present comments relating to this matter orally or in writing at the hearing, and in writing or by e-mail before the meeting. To be considered by the Board, written comments or submissions not physically submitted at the meeting must be received **no later than 12:00 noon, Pacific Standard Time, February 25, 2009,** and addressed to the following:

Postal mail: Clerk of the Board
Air Resources Board
1001 I Street, 23rd Floor
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 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 to the ARB in sections 38501, 38510, 38560, 38560.5, 38580, 39600, and 39601, Health and Safety Code. This action is proposed to implement, interpret, or make specific sections 38501, 38505, 38510, 38550, 38551, 38560, 38560.5, 39003, 39500, 39600, and 39601, 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 the event that such modifications are made, 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.

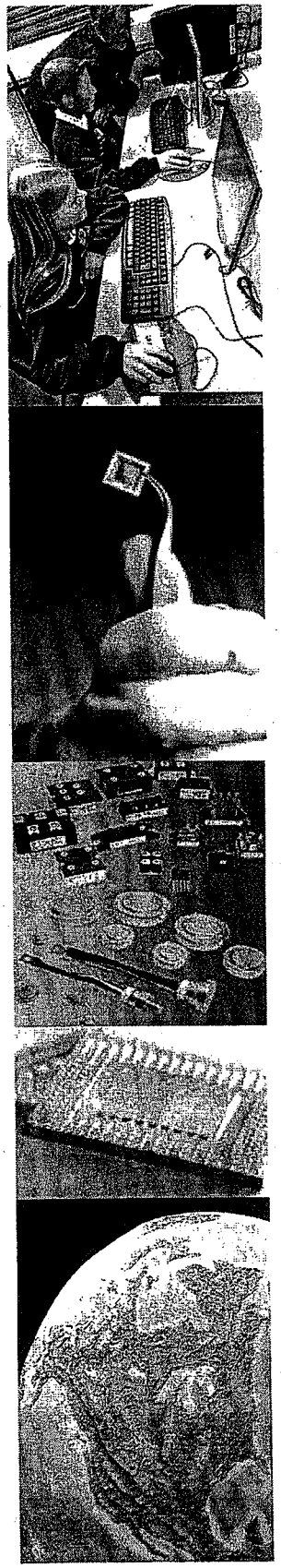
The public may request a copy of the modified regulatory text from the ARB's Public Information Office, Air Resources Board, 1001 I Street, Visitors and Environmental Services Center, First Floor, Sacramento, California 95814, (916) 322-2990.

CALIFORNIA AIR RESOURCES BOARD

Michael N Schaible

James N. Goldstene
for Executive Officer

Date: December 30, 2008



INITIAL STATEMENT OF REASONS FOR PROPOSED REGULATION TO REDUCE GREENHOUSE GAS EMISSIONS FROM SEMICONDUCTOR OPERATIONS

STATIONARY SOURCE DIVISION
MEASURES ASSESSMENT BRANCH

January 2009

State of California
AIR RESOURCES BOARD

INITIAL STATEMENT OF REASONS FOR PROPOSED RULEMAKING

Public Hearing To Consider

ADOPTION OF PROPOSED REGULATION TO REDUCE GREENHOUSE GAS EMISSIONS FROM SEMICONDUCTOR OPERATIONS

To be considered by the Air Resources Board
On February 26, 2009

at

Cal/EPA Headquarters
1001 I Street
Sacramento, California

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

This report has been prepared by the staff of the Air Resources Board. Publication does not signify that the contents reflect the views and policies of the Air Resources Board, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

State of California
AIR RESOURCES BOARD

PROPOSED REGULATION TO REDUCE GREENHOUSE GAS EMISSIONS FROM SEMICONDUCTOR OPERATIONS

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California Air Resources Board

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Mike Scheible, Deputy Executive Officer, Executive Office

January 9, 2009

Acknowledgements

We wish to acknowledge the participation and assistance of the following semiconductor manufacturers, gas suppliers, marketers, trade associations, and various other stakeholders listed below that participated in the rulemaking process:

3M
Applied Materials, Incorporated
CRB Consulting Engineers, Incorporated
Defense Microcircuits
Defense Microelectronics Activity (DMEA)
DuPont Fluoroproducts
Gemini Structured Carbon Limited
Hitachi Global Storage Technologies, Incorporated
Intel Corporation
Intevac, Incorporated
JDS Uniphase Corporation
Lam Research Corporation
Lawrence Livermore National Laboratory
Linear Technology Corporation
Manatt, Phelps & Phillips, LLP
Matheson Tri-Gas
National Semiconductor Corporation
NEC Electronics America, Incorporated
Novellus Systems, Incorporated
Philips Lumileds Lighting, Incorporated
Semiconductor Equipment and Materials International (SEMI)
Semiconductor Industry Association (SIA)
Skyworks Solutions, Incorporated
Spansion, Incorporated
Spectrolab, Incorporated
TecHarmonic, Incorporated
Tetra Tech E M, Incorporated
Transcarbon International
United States Environmental Protection Agency

We would also like to acknowledge the participation and assistance of air pollution control and air quality management districts. In particular, we would like to thank the following district representatives that participated in the ARB/District Working Group:

Carol Lee, Bay Area Air Quality Management District
Don Duffy, Placer County Air Pollution Control District
Rod Millican, South Coast Air Quality Management District
Kerby Zozula, Ventura County Air Pollution Control District

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ACRONYMS

AB	Assembly Bill
APCD	Air Pollution Control District
AQMD	Air Quality Management District
ARB/Board	Air Resources Board
BAAQMD	Bay Area Air Quality Management District
Cal/OSHA	California Occupational Safety and Health Administration
CAT	Climate Action Team
CC	Climate Change
CCA	California Clean Air Act
CCR	California Code of Regulations
CEQA	California Environmental Quality Act
CO_2	Carbon Dioxide
CFR	Code of Federal Regulations
CRF	Capital Recovery Factor
FTIR	Fourier Transform Infrared Spectroscopy
GHG	Greenhouse Gas
GWP	Global Warming Potential
HAP	Hazardous Air Pollutant
HCFC	Hydrochlorofluorocarbon
HFC	Hydrofluorocarbon
HFE	Hydrofluoroether
HSC	Health and Safety Code
IPCC	Intergovernmental Panel on Climate Change
ISOR	Initial Statement of Reasons
Kg	Kilogram(s)
MMT CO_2e	Million Metric Tons of Carbon Dioxide Equivalents
MT CO_2e	Metric Tons of Carbon Dioxide Equivalents
MW	Molecular Weight
N_2O	Nitrous Oxide
NAAQS	National Ambient Air Quality Standards
NAICS	North American Industry Classification System
NESHAP	National Emission Standards for Hazardous Air Pollutants
NIOSH	National Institute for Occupational Safety and Health
OEHHA	Office of Environmental Health Hazard Assessment
OSHA	Occupational Safety and Health Administration
PFC	Perfluorocarbon
PPM	Parts Per Million
REL	Reference Exposure Level
ROE	Return On Owner's Equity
SB	Senate Bill
SCC	Source Classification Code
SCAQMD	South Coast Air Quality Management District
SIC	Standard Industrial Classification

ACRONYMS

Survey	2006 Survey of Semiconductor Industry
TAC	Toxic Air Contaminant
U.S. EPA	United States Environmental Protection Agency
UV	Ultraviolet
VCAPCD	Ventura County Air Pollution Control District
VOC	Volatile Organic Compound

EXECUTIVE SUMMARY

In this rulemaking, California Air Resources Board (ARB or Board) staff is proposing to reduce greenhouse gas (GHG) emissions, also referred to as fluorinated gases, from semiconductor and related devices operations (semiconductor operations). The proposed regulation to reduce the emissions of fluorinated gases with high Global Warming Potential (GWP) was developed in accordance with the discrete early action measure requirements set forth in the California Global Warming Solutions Act of 2006, Assembly Bill (AB) 32. The proposed regulation would be codified in title 17, California Code of Regulations, sections 95320 through 95326.

The proposed regulation would set new maximum allowable GHG emission limits for semiconductor operations. When fully implemented, GHG emissions would be reduced by 56 percent or 0.18 million metric tons of carbon dioxide equivalent (MMT CO_2e) per year. The annualized cost of this regulation is approximately $3.7 million, or about $21 per metric ton of CO_2e emissions reduced.

In developing this proposal, staff evaluated economic and environmental impacts and found no significant adverse impacts. Staff also found that reducing the emissions of fluorinated gases with high GWP would have a beneficial impact on climate change.

This Executive Summary provides a description of the staff's proposed regulation and explains the rationale for the regulation. The Executive Summary and subsequent chapters (Chapters I through VIII and Appendices A through C) constitutes the Initial Statement of Reasons for Proposed Rulemaking (ISOR) required by the California Administrative Procedures Act. In accordance with Government Code section 11346.2(a)(1), Chapter V provides a "plain English" summary of the proposal in more detail.

A. INTRODUCTION

1. What are semiconductor operations?

Semiconductor operation refers to the processing of semiconductor devices or related solid state devices. This may include, but is not limited to, the processing of diodes, zeners, stacks, rectifiers, integrated microcircuits, transistors, solar cells, light-sensing devices, and light-emitting devices. The types of operations include manufacturers, research and development organizations, and universities that do research and development. California has approximately 85 semiconductor operations; most are located in the Bay Area.

Semiconductor operations use fluorinated gases to process blank wafers into finished "chips." Chips contain multiple layers of integrated circuits that are

formed after many process steps. In the course of processing wafers, fluorinated gases are used to clean chemical vapor deposition (CVD) chambers and etch circuits in the layers. Finished chips are used in various products ranging from computers and cell phones to automobiles.

Semiconductor operations vary widely in their wafer processing capacity, as well as type and size of wafers, use of fluorinated gases, vintage of processing tools, and use of emission control technology.

2. What existing regulations impact semiconductor operations?

Four districts regulate volatile organic compound (VOC) emissions from semiconductor operations. Emissions are controlled by applying improved emission control systems, using low VOC content materials, minimizing solvent losses and observing good business practices. District rules also include annual reporting and recordkeeping requirements, test methods for determining VOC content, and exemptions for small operations. The districts that have these rules and the respective rule numbers are:

- Bay Area Air Quality Management District, Rule 8-30;
- Placer County Air Pollution Control District, Rule 244;
- South Coast Air Quality Management District, Rule 1164; and
- Ventura County Air Pollution Control District, Rule 74.21.

Two other districts, Sacramento Metropolitan Air Quality Management District, and Santa Barbara County Air Pollution Control District have a few, small semiconductor operations that are not subject to VOC regulations.

3. Are there voluntary programs to reduce GHG emissions from semiconductor operations?

In 1996, Semiconductor Industry Association (SIA) member companies joined the U.S. EPA in signing a Memorandum of Understanding (MOU) agreeing to reduce the amount of GHG emissions. Under the MOU, member companies report GHG emissions to the U.S. EPA, share information regarding technology to reduce GHG emissions, and undertake research and development to determine if industry should set goals for GHG emission reductions.

In 1999, the World Semiconductor Council (WSC)[1] approved a perfluorocarbon (PFC) emissions reduction goal calling on member associations to reduce aggregate absolute emissions of GHGs from semiconductor operations by

[1] WSC members at the time of the signing consisted of the European Electronic Components Manufacturer Association (now the European Semiconductor Industry Association, or ESIA), the Electronic Industries Association of Japan (now the Japanese Semiconductor Industry Association, or JSIA), the Korean Semiconductor Industry Association (KSIA), and the Semiconductor Industry Association (SIA).

10 percent or greater from baseline[2] levels by 2010. Concurrently, the SIA negotiated a second voluntary PFC Reduction/Climate Partnership MOU with the U.S. EPA. This MOU applies to U.S. semiconductor operations and supports the WSC agreement for a collective 10 percent reduction in emissions by 2010.

B. STATUTORY AUTHORITY

1. What does California law say regarding GHG emissions?

In 2006, the Global Warming Solutions Act (AB 32) was signed into law. This law created a comprehensive, multi-year program to reduce GHG emissions in California. The California Health and Safety Code, commencing with section 38500, contains the provisions that apply to reducing the impacts of GHGs used in semiconductor operations. AB 32 requires ARB to develop regulations and consider market-based compliance mechanisms that will ultimately restore California's GHG emissions to the 1990 baseline year by 2020. The regulations developed under AB 32 must be designed to achieve the maximum technologically feasible and cost-effective reductions in GHG emissions. Beyond the requirements of AB 32, the Governor's Executive Order EO-S-03-05 calls for an additional GHG emissions reduction of 80 percent below 1990 levels by 2050.

AB 32 further requires immediate progress, described as discrete early action measures, to reduce GHGs. Discrete early action measures are defined as regulations adopted to reduce GHG emissions that become enforceable by January 1, 2010. Reduction of emissions from fluorinated gases with high GWP used in semiconductor operations has been designated as a discrete early action measure.

C. EMISSIONS AND GLOBAL WARMING IMPACTS

The ARB staff conducted a detailed survey of semiconductor operations to determine the emissions of fluorinated gases used in the CVD chamber cleaning and etching processes in 2006. The fluorinated gases used by semiconductor operations are considered to be high GWP gases.

1. What are the global warming potentials of fluorinated gases used by semiconductor operations?

Table ES-1 shows the GWP of the primary fluorinated gases used by semiconductor operations. Additional gases, used in small quantities, are listed in Chapter III. These GWP values are taken from the Intergovernmental Panel on Climate Change (IPCC) assessment reports.

[2] The baseline year for the ESIA, JSIA and SIA is 1995 and the KSIA baseline year is 1997. The Taiwan Semiconductor Industry Association (TSIA), joining the WSC after this agreement was signed, defined their baseline as the average of 1997 and 1999 emissions.

TABLE ES-1
GWP Values of Gases Used in Semiconductor Operations

Gas	GWP (SAR)*
hexafluoroethane (C_2F_6)	9,200
octafluoropropane (C_3F_8)	7,000
tetrafluoromethane (CF_4)	6,500
trifluoromethane (CHF_3)	11,700
octafluorocyclobutane (c-C_4F_8)	8,700
nitrogen trifluoride (NF_3)	17,200**
sulfur hexafluoride (SF_6)	23,900

* 100 year timeframe, IPCC Second Assessment Report (SAR)
** 100 year timeframe, IPCC Fourth Assessment Report.

The GWP of fluorinated gases used in semiconductor operations is high relative to that of CO_2. For example, the GWP of one kilogram of SF_6 is approximately 23,900 times greater than that of one kilogram of CO_2.

2. What are the GHG emissions from semiconductor operations?

Table ES-2 shows the GHG emissions in 2006 from fluorinated gas usage based on ARB's survey results. This table shows that 50 percent of the emissions are attributed to C_2F_6, the predominant gas used in CVD chamber cleaning.

Table ES-2
2006 Fluorinated Gas Use and Emissions

Fluorinated Gas	Use in Etch Process (Kg)	Use in CVD Chamber (Kg)	Etch Emissions (MMT CO_2e)	CVD Chamber Emissions (MMT CO_2e)	Percent of Total Emissions
C_2F_6	7,270	28,700	0.03	0.13	50
C_3F_8	1,280	7,500	0.007	0.02	8
CF_4	13,100	1,270	0.05	0.004	17
CHF_3	4,080	90	0.01	0.0008	4
c-C_4F_8	980	4,320	0.003	0.007	3
NF_3	4,480	15,090	0.01	0.006	5
SF_6	9,110	155	0.04	0.003	13
Total	**40,300**	**57,125**	**0.15**	**0.17**	**100**

In addition to the seven fluorinated gases listed above, the proposed regulation includes octafluorocyclopentene (C_5F_8), difluoromethane (CH_2F_2), octafluorotetrahydrofuran (C_4F_8O), hexafluoro-1,3-butadiene (C_4F_6), and carbon fluoride oxide (COF_2) in the definition of fluorinated gases. These additional fluorinated gases are included in the definition to ensure that all of the GHGs that are available for use in semiconductor operations are subject to the proposed regulation.

3. What are the estimated emission reductions from the proposed regulation?

Table ES-3 shows the estimated emission reductions and the percent complying market share by category for the proposed regulation. The Tier 1, 2 and 3 categories correspond to the large, medium and small semiconductor operations that are subject to varying emission standards in the proposed regulation. This table shows that the proposed regulation will reduce emissions by 0.18 MMT CO_2e or 56 percent. It also shows that fifty-seven percent of the wafers processed by Tier 1 operations already comply with the proposed emission standard. The complying market shares for the proposed emission standards for Tiers 2 and 3 are 43 percent and 34 percent, respectively.

Table ES-3
Emissions and Emission Reductions
CVD Chamber Cleaning and Etching Processes

Category*	Number of Operations in 2006	2006 Emissions (MMT CO_2e)	Percent Complying Market Share	Emission Reductions (MMT CO_2e)
Tier 1	5	0.17	57	0.11
Tier 2	11	0.08	43	0.03
Tier 3	12	0.05	34	0.04
Reporting Only	57	0.02	NA	NA
Total	**85**	**0.32**	**NA**	**0.18**

* Tier 1 operations process > 37.7 million square centimeters/year; Tier 2 operations process >3.7 and ≤ 37.7 million square centimeters/year; and Tier 3 operations process ≤ 3.7 million square centimeters/year.

4. What are the impacts of global warming?

Scientists predict that if the increase in GHG emissions continues unabated, temperatures will rise by as much as 10 degrees Fahrenheit by the end of this century. It is impossible to predict exactly how global warming will affect California's ecosystems and economy in the future. However, the expected physical changes will impact California's public health, economy and ecology.

These impacts include the exacerbation of air quality problems, a reduction in the supply and quality of water to the state from the Sierra snowpack, a rise in sea

levels resulting in the displacement of thousands of coastal businesses and residences, damage to marine ecosystems, an increase in infectious diseases, asthma and other human health-related problems. Global warming will have detrimental effects on California's largest industries, including agriculture, wine, tourism, skiing, recreational and commercial fishing, and forestry.

The magnitude of the climate change problem justifies reductions from both large and small sources wherever such regulations are technically feasible and cost-effective. Emissions from semiconductor operations exceed the 0.1 MMT CO_2e de minimus threshold for source categories that is described in the Climate Change Scoping Plan that was unanimously approved by the Board on December 11, 2008.

D. DEVELOPMENT OF PROPOSED REGULATION

1. How were interested parties involved in developing the proposed regulation?

ARB staff formed two working groups to develop the proposed regulation. The industry working group included industry association and semiconductor fabrication representatives, process tool makers, GHG suppliers, emission control equipment manufacturers and the U.S. EPA. The second working group included the air districts with semiconductor operations. In addition to many technical experts, participation was open to any member of the public. Three meetings of the industry working group and conference calls with the air district working group were conducted to discuss the proposed regulation.

2. What other actions were taken to involve interested parties and collect necessary information?

Further outreach, in addition to the formation of the working groups, was conducted to identify and involve stakeholders in the development of this discrete early action measure. For example, in December 2007, ARB conducted a survey of the semiconductor industry (survey). The SIA and other stakeholders participated in developing the survey, which was sent to over 300 entities. Staff analyzed the survey data and contacted representatives of semiconductor operations to clarify survey responses and request additional information as needed. Survey results were posted on the ARB semiconductor website. The survey was used to identify affected companies, update the emissions inventory estimate, determine the volume of gases used in processing wafers, and collect information on the use of emission control technologies.

Staff also visited three semiconductor operations to learn more about semiconductor technology processes, the use of fluorinated gases, and emission control technologies. Additionally, staff conducted numerous meetings with individual stakeholders.

Staff conducted four public workshops in 2008, posting workshop notices and staff and industry presentations in advance of each workshop on ARB's semiconductor website. A List Serve was established to electronically inform over 450 interested parties of upcoming proceedings and actions.

3. How does the proposed regulation apply to semiconductor operations?

The proposed regulation applies to an owner or operator of a semiconductor or related devices operation that uses fluorinated gases or fluorinated heat transfer fluids. This includes the processing of diodes, zeners, stacks, rectifiers, integrated microcircuits, transistors, solar cells, light-sensing devices, and light-emitting devices. This listing is collectively referred to as semiconductors. The proposed regulation applies to the use of fluorinated gases during the etching of wafers, or selective removal of material from wafers. It also applies to the use of fluorinated gases to clean CVD chambers, in which insulating layers are laid down in alternation with conducting layers on the wafer.

The proposed regulation includes emission standards, and reporting and recordkeeping requirements. The proposed emission standards apply to semiconductor operations that emit more than 0.0008 MMT CO_2e per year. These operations, which include the large (Tier 1), medium (Tier 2), and small (Tier 3) manufacturers, account for 94 percent of the GHG emissions from the semiconductor industry. The reporting and recordkeeping requirements apply to all semiconductor operations in California.

Owners or operators of semiconductor operations would be required to comply with the emission standards by January 1, 2012. However, an operation replacing 150 millimeter (mm) wafer processing tools with 200 mm or larger tools would have until January 1, 2014 to comply with the emission standards. Providing more time for sources that are upgrading their wafer processing tools to comply with emission standards encourages early GHG reductions that are achievable with more efficient 200 mm or larger tools. The additional time also avoids the costly situation of installing abatement devices on old processing tools just before they are scheduled to be replaced. All semiconductor operations would be subject to the same timeframe for reporting and recordkeeping requirements.

4. What are the proposed emission standards?

The proposed emission standards for semiconductor operations are tiered, and vary depending upon the quantity of wafers (thin semiconductor material from which integrated circuits or "chips" are made) processed at a facility. The quantity of wafers processed is measured in square centimeters and includes all wafers processed at a facility, including those that do not pass inspection.

The proposed emission standards, expressed in kilograms of carbon dioxide equivalent (kg CO_2e) per square centimeter of wafer processed, are based on the quantity of wafers processed at an operation in a calendar year. They are grouped into three tiers as follows:

Tier 1: Up to 0.2 kg CO_2e per square centimeter of wafer processed may be emitted by operations processing greater than 37.7 million square centimeters of wafers in the calendar year.

Tier 2: Up to 0.3 kg CO_2e per square centimeter of wafer processed may be emitted by operations processing greater than 3.7 and less than or equal to 37.7 million square centimeters of wafers in the calendar year, provided operations were in existence prior to January 1, 2010.

Tier 3: Up to 0.5 kg CO_2e per square centimeter of wafer processed may be emitted by those operations processing less than or equal to 3.7 million square centimeters of wafers in the calendar year, provided operations were in existence prior to January 1, 2010.

Because Tier 2 and Tier 3 emission standards apply only to facilities in operation prior to January 1, 2010, all semiconductor operations established on or after that date will be required to meet the Tier 1 standard if they emit more than 0.0008 MMT CO_2e per year. Semiconductor operations installing emission control equipment must apply to the permitting agency for a permit.

5. Why are some semiconductor operations only subject to reporting and recordkeeping requirements?

Based on ARB's survey results, 57 semiconductor operations that emit 0.0008 MMT CO_2e or less per year account for six percent of the GHG emissions. Twenty-seven of these operations are small businesses, and all 57 operations account for only three percent of fluorinated gas usage. Our analysis indicates that the minor emission reductions achievable by subjecting these research and development operations to the emission standards are not cost-effective. Consequently, we are proposing to cap their emissions at the 0.0008 MMT CO_2e threshold level and subject them to annual reporting and recordkeeping requirements.

6. What are the reporting requirements?

Emissions reporting requirements include both initial and annual reporting. For the initial report, due to the permitting agency no later than March 1, 2011, semiconductor operations must report fluorinated gas emissions for the 2010 calendar year. For annual emissions reports, due to the permitting agency beginning March 1, 2012 and each year thereafter, semiconductor operations must report for the previous calendar year. In addition to emissions of fluorinated gases, the annual emissions report will collect information on the amounts of fluorinated gases used in CVD chamber cleaning and etching operations, the amount of semiconductor wafers processed, the use of process optimization, alternative chemistries, or equipment used to reduce fluorinated gas emissions, and information regarding the use of fluorinated heat transfer fluids. The initial emissions report and subsequent annual reports will be provided to the district having permit authority for the operation.

7. What are the recordkeeping requirements?

Recordkeeping provisions would require the owner or operator to maintain records on quantities of fluorinated gases and heat transfer fluids purchased or delivered, as well as records of emission control equipment malfunctions and failures. All records must be maintained at the facility and be readily accessible for inspection for at least three years.

8. What compliance options are available to semiconductor operations?

Semiconductor operations have the flexibility of choosing process optimization, alternative chemistries, abatement technologies, or a combination of these options to comply with the proposed regulation. Table V-2 in Chapter V shows which combinations of options are already being used by complying semiconductor operations. Two operations in Tiers 1 and 2 rely on all three compliance options to meet the emission standards. Three of the complying operations in Tier 3 rely on process optimization to meet the emission standard.

9. How does process optimization reduce GHG emissions?

Process optimization reduces fluorinated gas emissions from CVD chamber cleaning through the use of endpoint detectors and/or process parameter variation to find the optimum volume for fluorinated gas use. Process optimization continues to focus on CVD chamber cleaning because it is the greatest source of fluorinated gas emissions. Because the CVD chamber is cleaned when wafers are not in the chamber, this process can be optimized without negatively affecting wafer processing.

For CVD chamber cleaning, process optimization is estimated to reduce emissions from 10 to 56 percent compared to a baseline use of C_2F_6. It is the lowest cost strategy and may be more useful for older semiconductor operations that have not optimized the CVD chamber cleaning process.

10. How do alternative chemistries reduce GHG emissions?

Alternative chemistries is the substitution of one gas for another to achieve a net GHG benefit. This may occur through the use of lower GWP gases or through the use of higher GWP gases that are more efficient. Four gases, C_3F_8, c-C_4F_8, C_4F_8O and NF_3 are possible alternatives to the use of C_2F_6 for CVD chamber cleaning. The first three alternatives are "drop-in" replacements for C_2F_6, while NF_3 requires new machinery because of the aggressive nature of the gas. Table ES-4 compares the efficiency and emission benefits of alternative chemistries to that of C_2F_6 in CVD chamber cleaning.

Table ES-4
Alternative Chemistries Summary

C_2F_6 Replacement Chemistry	Utilization Efficiency* (%)	Emissions Reduction from Baseline C_2F_6 Process (%)
C_3F_8	30–60	12–70
c-C_4F_8	70–90	50–85
C_4F_8O	85–90	70–90
NF_3	60–80	20–90

*Utilization efficiency is the percentage of the gas used in the process. A 30 percent utilization efficiency means that 70 percent of the gas is emitted.

11. What are the primary alternative chemistries used by the semiconductor industry?

The largest portion of the GHG emission reductions achieved to date stem from substituting NF_3 for C_2F_6 in the CVD chamber cleaning process. Although NF_3 has a higher GWP than C_2F_6, less NF_3 is used in the CVD chamber cleaning process. The industry has developed remote plasma clean technologies to replace C_2F_6 for in-situ CVD chamber cleans and CF_4 used for nitride chamber cleaning. In a remote plasma system, the CVD chamber cleaning gas (NF_3) is raised to a high temperature before entering the CVD tool chamber. The plasma state is achieved using a radio frequency power source and the process is highly efficient. For in-situ CVD chamber cleaning, the gas flows directly into the CVD chamber and is raised to a high temperature within the chamber.

12. Do problems result from the use of alternative chemistries?

Implementing remote NF_3 chamber cleaning generates more fluorine (F_2) and hydrogen fluoride (HF) emissions than fluorocarbon-based cleans and,

depending on the operation, may require additional treatment to remove these gases from the exhaust stream. Semiconductor operations typically treat F_2 and HF exhaust streams with water scrubbers. The additional loading on central end-of-pipe (EOP) water scrubbers may require modifications to the scrubber systems or installation of point-of-use (POU) scrubbers. Depending upon the operation's wastewater discharge limits, scrubber effluent may require treatment to decrease the fluoride loading. Many facilities have existing fluoride waste treatment facilities that remove fluoride by precipitation with some form of calcium, generating calcium fluoride.

13. What GHG emission control technologies are semiconductor operations using?

The most common technologies used to abate fluorinated gas emissions from semiconductor operations are high temperature and catalytic oxidation, and plasma destruction. Some operations include post-treatment to remove byproducts, such as F_2 and HF, produced during the abatement process.

Most emission control technologies apply to fluorinated gas emissions from both CVD chamber cleaning and etching processes, although several companies have developed plasma abatement systems specifically for emissions from etching.

14. What alternatives to the proposal were considered?

California Government Code section 11346.2 requires ARB to consider and evaluate reasonable alternatives to the proposed regulation and provide reasons for rejecting those alternatives. Staff considered two alternatives to the current proposal. These are no action and alternative standards. Staff determined that the alternatives did not meet the objective of Health and Safety Code section 38560 to achieve the maximum technologically feasible and cost-effective GHG emission reductions.

The "no action" alternative would forego or delay the adoption of the proposed rulemaking. This alternative was rejected as it would result in failure to make progress in reducing emissions of high GWP compounds from semiconductor operations.

The second alternative considered would impose separate emission standards for CVD chamber cleaning and etching processes. The emission standards for Tiers 1, 2 and 3 would reflect the lowest emitting operations for each process. The total emission reduction would increase from 0.18 to 0.22 MMT CO_2e. This alternative would impact more businesses, increasing the annual cost from $3.7 to $6.3 million. This option also increases the complexity of the regulation. Industry expressed concern that process specific emission standards would not

be technically feasible and would not provide sufficient compliance flexibility. Staff concurs and, therefore, rejected this alternative.

E. ENVIRONMENTAL IMPACTS

The intent of the proposed regulation is to reduce GHG emissions from semiconductor operations. An additional consideration is the impact that the proposed regulation may have on the environment. The California Environmental Quality Act (CEQA) requires an agency to identify and adopt feasible mitigation measures that would minimize any significant adverse environmental impacts.

1. Are there any significant adverse environmental impacts from the proposed regulation?

The ARB staff has concluded that no significant adverse environmental impacts should occur from adoption of, and compliance with, the proposed regulation. This regulation reduces GHG emissions and is not expected to result in any significant adverse air quality, wastewater, or hazardous waste impacts. Therefore, no mitigation measures would be necessary.

2. Is this proposal consistent with ARB's Environmental Justice Policy?

The proposed regulation is consistent with our environmental justice policy to reduce health risk in all communities, including those with low-income and ethnically diverse populations, regardless of location. Potential risks from global warming due to GHGs can affect both urban and rural communities. Therefore, reducing emissions of GHGs from semiconductor operations will provide benefits to urban and rural communities in the State, including low-income and ethnically diverse communities. The decrease in GHG emissions will occur in areas where semiconductor manufacturing facilities are located, which are primarily outside of residential areas. Residents in close proximity to a manufacturing facility will not be adversely impacted.

As noted previously in the discussion on the use of alternative chemistries, some processes for reducing GHG emissions, such as the use of NF_3 for CVD chamber cleaning, may generate additional HF. Because HF is a toxic air contaminant (TAC), new and modified sources of HF emissions are subject to air district review. The air district review includes evaluating potential public exposure and health risk, mitigating potentially significant health risks resulting from these exposures, and decreasing health risk by improving the level of emissions control. Semiconductor operations located in the Bay Area Air Quality Management District (AQMD), for example, are subject to New Source Review of TACs when sources emit more than 540 pounds of HF per year.

Further public protection is provided through The Air Toxics "Hot Spots" Information and Assessment Act (AB 2588, 1987, Connelly) which requires stationary sources, such as semiconductor operations, to report the types and quantities of certain substances routinely released into the air. TACs, such as HF, are among the substances that are reportable. The goals of the Air Toxics "Hot Spots" Act are to collect emission data, identify facilities having localized impacts, ascertain health risks, notify nearby residents of significant risks, and reduce those significant risks to acceptable levels.

The compounds subject to the proposed regulation are GHGs. They are not carcinogens, hazardous air pollutants or ozone precursors. Staff's qualitative health risk assessment therefore concludes that public health will not be adversely affected by the regulation. A complete analysis of potential environmental impacts is contained in Chapter VI.

F. ECONOMIC IMPACTS

ARB evaluates the costs to comply with the proposed regulation by considering the potential impacts on profitability and other aspects of business, the cost-effectiveness of the proposed regulation, and the estimated cost impacts to consumers. Cost-effectiveness is one measure of a regulation's efficiency in reducing a given amount of emissions, and is often reported in dollars spent per metric ton of emissions reduced.

1. What is the cost-effectiveness of the proposed regulation?

Based on our analysis, staff estimates the overall cost-effectiveness of the proposed semiconductor regulation is approximately $21 per metric ton of CO_2e reduced. The cost-effectiveness of the Tier 1, 2, and 3 emission standards is shown in Table ES-5. Initial capital costs would be about $22 million with annual recurring costs of $850,000 (2007 dollars). These costs correspond to $3.7 million per year over the 10 year life of the regulation, or a total cost of $37 million. These figures include the cost of emission control equipment, operating costs, permit fees, reporting and recordkeeping.

Table ES-5
Cost-Effectiveness of Emission Standards by Tier

Tier	Total Annual Cost	Total Emission Reduction (MMT CO_2e)	Cost-Effectiveness
Tier 1	$2,280,000	0.11	$20.70
Tier 2	$700,000	0.03	$23.40
Tier 3	$680,000	0.04	$17.00
Total	**$3,660,000**	**0.18**	**$21**

2. What effect would this regulation have on the profitability of semiconductor operations?

Staff estimated profitability impacts by calculating the decline in the return on owner's equity (ROE). Assuming that semiconductor operations will have to absorb all of the costs associated with the proposed regulation, the average decline in ROE is 0.4 percent. This is well below the threshold that is considered to be a significant impact on the profitability of affected businesses. The decline in ROE is shown by tier in Table ES-6. ARB staff considers a decline in ROE of greater than 10 percent to be a significant economic impact. This threshold for determining significant impacts is consistent with the thresholds used by the U.S. EPA and others.

Table ES-6
Changes in Return on Owner's Equity

Tier	ROE Change
Tier 1	0.9%
Tier 2	0.05%
Tier 3	0.1%
Average	**0.4%**

Note: All changes in ROEs shown are negative which indicates a decline in profitability.

3. What is the average annual cost to semiconductor operations that do not currently meet the standards?

The average annual cost to those operations that would need to reduce emissions to meet the proposed emission standards is $280,000 in 2007 dollars.

4. Are there any small business impacts?

Five small businesses exceed the proposed emissions standards and would need to use a combination of emission reduction options. However, no significant adverse cost impacts are expected for these small businesses. The average annual cost to these businesses is $89,000 per year. Chapter VII contains a more thorough assessment of the economic impacts of the proposal.

G. FUTURE PLANS

1. What other activities is ARB planning?

If the Board approves the proposed regulation, ARB staff will develop a calculation tool to help the industry perform the IPCC Tier 2b emission calculations required by the proposal. Staff will also support the districts by offering secondary review of emission calculations, exchanging information on

new technology developments, or helping resolve enforcement issues that may develop. Finally, ARB staff plans to evaluate the value of developing a sample format for the annual emissions reports to ease the reporting burden to industry and lessen the review time for district personnel.

The proposed regulation requires reporting on the use of fluorinated heat transfer fluids (HTF). ARB staff will continue to further research uses and quantify emissions of fluorinated heat transfer fluids (HTF) in semiconductor operations. HTFs have long atmospheric lifetimes and high GWP. To the extent that they evaporate into the atmosphere, their contribution to global warming is a concern.

H. RECOMMENDATION

We recommend that the Board adopt the proposed regulation for semiconductor and related devices operations.

I. INTRODUCTION

This report presents ARB staff's technical justification and analysis of the proposed measure to reduce fluorinated gas emissions from semiconductors and related devices (semiconductors). The proposed discrete early action measure would reduce the emissions of high Global Warming Potential (GWP) fluorinated gases, also referred to as greenhouse gases (GHGs), from the manufacturing or processing of semiconductors. The proposed rulemaking is designed in accordance with the discrete early action measure requirements as set forth in the California Global Warming Solutions Act of 2006 (AB 32, Health and Safety Code Section 38500 *et seq.*).

This report describes the rule development process and provides information on the following items:

- Enabling legislation and background;
- Background on semiconductor operations and voluntary efforts to reduce GHG emissions;
- The process used to develop the proposed rulemaking;
- A description of the proposed rulemaking and alternatives to the proposal;
- An analysis of the expected environmental and economic impacts from the proposed rulemaking; and,
- A summary of future activities.

The proposed regulation is provided in Appendix A of this document. A complete list of the acronyms used in this report is on page vi following the List of Figures.

A. OVERVIEW

The semiconductor industry consists of semiconductor manufacturers, research and development organizations, and universities as well as companies that supply the gases, process tools and emission control equipment used. Operations use fluorinated gases to process semiconductor wafers, usually round thin slices of silicon, which contain many individual integrated electronic circuits, or "chips." These chips contain multiple layers and are used in various products including computers, cell phones and automobiles.

Processing begins with a blank wafer and involves a series of steps which can number over 100 until a chip is complete. Organizations that process wafers vary widely in their production levels as well as type and size of wafers, volumes of fluorinated gases used, vintage of their processing tools, choice of chemistry and emission control technology used. Most operations are located in the Bay Area, although southern and central California businesses also exist.

Executive Order S-3-05, issued by Governor Schwarzenegger in June 2005, directed the Secretary of the California Environmental Protection Agency to form a Climate Action Team (CAT) to report on the impacts to California of global warming and progress toward meeting emission reduction targets set in the order. The CAT recognized the potential for reducing GHG emissions from the semiconductor industry in its March 2006 report to Governor Schwarzenegger and the Legislature. In October 2007, the California Air Resources Board (ARB or Board) designated GHG reductions from the semiconductor industry as a discrete early action measure, placing the strategy on an accelerated path to regulatory action.

B. ENABLING LEGISLATION

In 2006, Assembly Bill (AB) 32 was signed into law. This law, known as the Global Warming Solutions Act, created a comprehensive, multi-year program to reduce GHG emissions in California. AB 32 added section 1, division 25.5 (commencing with section 38500) to the California Health and Safety Code. These sections require ARB to develop regulations and consider market mechanisms that will ultimately reduce California's GHG emissions to the 1990 emissions level by 2020. AB 32 requires ARB to make immediate progress towards the reduction of GHG emissions. Specific discrete early action measures are to be identified and regulations are to be adopted and made enforceable by January 1, 2010. These early action measures must achieve the maximum technologically feasible and cost-effective reductions in GHGs from sources or categories of sources. Beyond the requirements of AB 32, the Governor's Executive Order EO-S-03-05 calls for an additional GHG reduction of 80 percent below the 1990 emissions level by 2050.

C. BACKGROUND

Four districts regulate volatile organic compound (VOC) emissions from semiconductor operations. Emissions are controlled by applying improved emission control systems, using low VOC content materials, meeting solvent loss minimization requirements and observing good business practices. District rules include annual reporting and recordkeeping requirements, test methods for determining VOC content, and exemptions for small operations. The applicable districts and rule numbers are:

- Bay Area Air Quality Management District, Rule 8-30;
- Placer County Air Pollution Control District, Rule 244;
- South Coast Air Quality Management District, Rule 1164; and,
- Ventura County Air Pollution Control District, Rule 74.21.

Two additional districts have small semiconductor operations within their jurisdictions, but do not regulate these operations. The districts are Sacramento Metropolitan Air Quality Management District and Santa Barbara County Air

Pollution Control District. Chapter IV, Table IV-3, shows the number of operations in the districts. The district rules exempt GHG emissions.

In California, GHG emission control by the semiconductor industry has only occurred voluntarily, through agreements with the United States Environmental Protection Agency (U.S. EPA) and a small number of California manufacturers. Three of the 85 semiconductor operations in California currently participate in the voluntary agreement with the U.S. EPA.

In 1996, Semiconductor Industry Association (SIA) member companies joined the U.S. EPA in signing a Memorandum of Understanding (MOU) agreeing to reduce GHG emissions, share information regarding technology to reduce GHG emissions, report GHG emissions to the U.S. EPA, and undertake research and development to determine if the industry should set goals for GHG emission reductions (SIA, 2007).

In 1999, the World Semiconductor Council (WSC)[3] approved a perfluorocarbon (PFC) emissions reduction goal calling on member associations to reduce aggregate absolute emissions of GHGs from semiconductor manufacturing operations by ten percent or greater from baseline[4] levels by 2010. Concurrent with the establishment of the WSC goal, the United States semiconductor industry negotiated a second voluntary PFC Reduction/Climate Partnership MOU with the U.S. EPA. This MOU applies to United States semiconductor manufacturing operations and supports the WSC agreement for a collective ten percent reduction in emissions by 2010 (SEMATECH, 2005).

In 2000, SIA member companies entered into a second MOU with the U.S EPA, agreeing to commit to reducing the total PFC emissions in the United States to ten percent below 1995 levels by the year 2010. Participating member companies are attempting to achieve these emission reductions nationwide through process optimization, development of alternative chemistries, capture/recovery, and emissions abatement (SIA, 2007).

In addition to the MOU, there are two other voluntary GHG programs. One is known as Climate Leaders, an industry/U.S. EPA partnership where companies commit to reducing emissions of GHGs by completing an inventory of their GHG emissions, setting reduction goals, and annually reporting progress to the U.S. EPA. A few semiconductor-related California companies participate in the partnership with each setting goals unique to the company. By participating,

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[3] WSC members at the time of the signing consisted of the European Electronic Components Manufacturer Association (now the European Semiconductor Industry Association, or ESIA), the Electronic Industries Association of Japan (now the Japanese Semiconductor Industry Association, or JSIA), the Korean Semiconductor Industry Association (KSIA), and the Semiconductor Industry Association (SIA).

[4] The baseline year for the ESIA, JSIA and SIA is 1995 and the KSIA baseline year is 1997. The Taiwan Semiconductor Industry Association (TSIA), joining the WSC after this agreement was signed, defined their baseline as the average of 1997 and 1999 emissions.

companies create a credible record of their accomplishments and receive U.S. EPA recognition as corporate environmental leaders.

The second effort is a global warming-related organization that includes semiconductor operations among its 210 members, known as the Silicon Valley Leadership Group (SVLG). The organization involves member companies and government officials to address broad policy issues affecting the economic health and quality of life in Silicon Valley. Reducing fluorinated gas emissions from semiconductor wafer processing is not specifically addressed, although lowering GHG emissions through greater energy efficiency and other means characterize SVLG member accomplishments.

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II. STATUTORY REQUIREMENTS

In this chapter, we describe State law requirements related to setting GHG emission limits and how our proposal meets these criteria.

A. GHG REDUCTIONS THROUGH EARLY ACTIONS

AB 32 requires the Board to identify a list of discrete early action GHG emission reduction measures by June 30, 2007. Discrete early action measures are to be adopted and become legally enforceable (approved by the Office of Administrative Law) by January 1, 2010. The proposed measure to reduce emissions of fluorinated gases from semiconductor operations is one of the nine discrete early action measures listed by the Board.

B. AB 32 REQUIREMENTS

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 semiconductor operations by establishing emission standards for semiconductor processing. The following discussion explains why staff believes this proposed regulatory action meets the requirements of State law.

- **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.**

  Staff developed the proposed regulation to reduce GHG emissions from the semiconductor industry in consultation with affected industries in an open, public process through four public workshops and several individual consultation meetings. See Chapter V, Section A of this report for additional details.

  The proposed regulation is technologically feasible based on information from the ARB's survey of semiconductor operations, and discussions with semiconductor manufacturers and manufacturers of fluorinated gas emission control devices. Many semiconductor operations already use process optimization, alternative chemistries and control devices to minimize GHG emissions and comply with the proposed regulation. A detailed discussion of technological feasibility is included in Chapter III.

  The proposed regulation is cost-effective, with an estimated cost-effectiveness of $21 per metric ton of CO_2e reduced. These cost estimates are based on discussions with semiconductor manufacturers, air districts, gas suppliers, and emission control equipment manufacturers. A detailed discussion of economic feasibility is included in Chapter VII.

- **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 proposed regulation for semiconductor operations was designed to achieve the maximum benefit while minimizing the cost to the affected industry. ARB's survey of semiconductor operations was used to characterize the industry and develop emission standards that consider the size of the operation and the ability to reduce emissions in a cost-effective manner. The cost-effectiveness of the proposed regulation is about $21 per metric ton of CO_2e emissions reduced.

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

  The decrease in GHG emissions will occur in areas where semiconductor operations are currently located, which is mainly away from residential areas. Residents living near a semiconductor operation, regardless of income level, would not be disproportionately impacted.

- **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.**

  The initial emissions reduction goal of 0.5 MMT CO_2e reflected the 2004 emissions inventory estimate of 0.88 MMT CO_2e. To establish a more recent and accurate inventory estimate, staff conducted a survey. The emission reduction goal was then adjusted to reflect reductions achieved through voluntary efforts. The adjusted reduction goal became 0.18 MMT CO_2e based on a 2006 inventory of 0.32 MMT CO_2e. We also considered voluntary efforts of operators to upgrade process tools. The proposed regulation allows an additional two years for compliance with the emission standards for any operation replacing older process tools with newer tools. This additional time alleviates the expense of installing abatement equipment for older tools that would soon be no longer in use.

- **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.**

  The proposed GHG emissions limits are not expected to cause an increase in the emissions of criteria pollutants or toxic air contaminants (TACs) with the possible exception of a slight increase in oxides of nitrogen (NO_x) emitted from certain types of abatement equipment. The proposed regulation will not interfere with district requirements for controlling VOC and TAC emissions from semiconductor operations because GHG emissions are not subject to district rules.

- **Consider cost-effectiveness of these regulations.**

  The cost-effectiveness of the proposed emission limits is about $21 per metric ton of CO_2e reduced. See Chapter VII, Economic Impacts of Proposed Regulation, and Appendix C for a more detailed description.

- **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 emissions limits for semiconductors are not expected to cause any significant adverse impacts to society or the environment. California will benefit from the reduction of GHG emissions. The proposed regulation will not cause a significant increase in VOC or TAC emissions, however, a slight increase in NO_x emissions may occur. No increase to

the solid waste stream is anticipated. See Chapter VI for a more detailed discussion.

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

  The administrative burden to manufacturers of complying with the proposed regulation is minimal as it has very few administrative requirements. The air districts would likely enforce the proposed regulation since these manufacturers are already subject to district permit and control requirements for VOCs and TACs. We are proposing to develop tools to calculate emissions and standardize the reporting format to ease the administrative burden on industry and the air districts.

- **Minimize leakage.**

  Leakage occurs when an emission limit set by the State causes manufacturing or other activities to be displaced outside of California. If leakage were to occur, jobs and other economic benefits to California would be lost. According to information provided by industry associations, the number of semiconductor manufacturing operations in California has already declined because manufacturers have relocated to other states and overseas. No, or minimal, leakage is expected from the proposed regulation based on discussions with the California semiconductor manufacturing industry. Therefore, the regulation would not create a situation where a manufacturer located in California would be placed in a competitive disadvantage compared to manufacturers out-of-state.

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

  Semiconductor operations emitted 0.32 MMT CO_2e in 2006. This exceeds the 0.1 MMT CO_2e significance threshold for source categories that the Board approved in the Scoping Plan. The projected reductions that will be achieved are about 0.18 MMT CO_2e per year. While this reduction is somewhat modest, it is necessary to achieve the long term GHG emission reduction goals. When the reduction is considered in conjunction with current and future GHG emission reductions in other sectors, the total reductions are significant. The proposed regulation considers the minimal impacts of sources emitting under 0.0008 MMT CO_2e per year by exempting them from emission standards and only subjecting them to reporting and recordkeeping requirements.

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

  We believe that the emissions and emission reductions for semiconductor operations are real since they were determined from gas usage data submitted by manufacturers and research and development organizations in the affected industry. The data were submitted in accordance with State law and were certified by an officer of the company whose data was submitted. The GHG emissions and reductions were quantifiable by using the Tier 2b method in the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories and based on GWP values defined by the IPCC Second Assessment Report (IPCC, 1996). The GHG reductions are verifiable through annual reporting and recordkeeping requirements included in the proposed regulation. These requirements also support enforcement efforts. Sources installing abatement devices to comply with the proposed emission limits are subject to district permitting requirements. Once the proposed regulation is approved by the Office of Administrative Law, the proposed emission limits will become State law.

- **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 emissions limits for semiconductor operations are the first GHG emissions limits affecting this industry. No other State, federal, or other requirements, specific to the manufacturing in California and affecting emissions of GHGs, are known to exist.

- **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 requirement is not applicable to the proposed emission limits for semiconductor operations. This regulation achieves its emission reductions as direct emissions.

- **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 to develop the proposed regulation for reducing GHG emissions from semiconductor operations. Chapter VII includes a detailed description of the economic impacts of the proposed emission limits. Chapters III and IV discuss processes to be regulated and estimated emissions and emission reductions, respectively.

III. SEMICONDUCTOR OPERATIONS AND PROCESSES

This chapter provides an overview of semiconductor chamber cleaning and etching processes, and a brief description of the fluorinated gases used in these operations.

A. SEMICONDUCTOR OPERATIONS

The manufacturing of semiconductors involves a series of sequential processes such as photomask creation, photoresist coating, Chemical Vapor Deposition (CVD) and CVD chamber cleaning, plasma etching, photoresist stripping, transistor formation, metallization, and wafer inspection. Two of these processes, CVD chamber cleaning and plasma etching, use plasma-generated fluorinated gases. The gases react at the surfaces of process equipment and semiconductor wafers to remove deposited materials from process chamber walls (CVD chamber cleaning) or selectively create circuitry patterns on wafers (plasma etching). There may be over 100 processing steps, of which a number use fluorinated gases, in forming complex circuits (Van Zant, 2004). The fluorinated gases include, but are not limited to:

- hexafluoroethane (C_2F_6);
- octafluoropropane (C_3F_8);
- octafluorocyclopentene (C_5F_8)
- tetrafluoromethane (CF_4);
- trifluoromethane (CHF_3);
- difluoromethane (CH_2F_2);
- octafluorocyclobutane (c-C_4F_8);
- octafluorotetrahydrofuran (C_4F_8O);
- hexafluoro-1,3-butadiene (C_4F_6);
- carbon fluoride oxide (COF_2);
- nitrogen trifluoride (NF_3); and,
- sulfur hexafluoride (SF_6).

In the CVD process, chemicals are used to produce high-purity, high-performance solid materials. Extremely thin films (layers) that are only billionths of a millimeter thick are formed on wafers. Many layers are necessary to create an intricate pattern of transistors and semiconductor circuitry. Over time, residual deposition gases form on the walls of the CVD chamber tool and must be removed to prevent particle contamination and reduce the percentage of nonfunctioning die per wafer.

Figure III-1 shows a worker loading 200 millimeter wafers into processing equipment.

Figure III-1 - Fab Worker

Figure Courtesy of March Plasma Systems.

CVD chamber cleaning requires the use of high GWP fluorinated gases because the fluorine molecules are needed to break the bond of the residue with the walls. Typical fluorinated gases used include, but are not limited to, CF_4, C_2F_6, C_3F_8, and NF_3 (U.S. EPA, 2001). One option for cleaning the tool is to use a remote plasma system where the gas is raised to a high temperature before entering the tool chamber. The plasma state is achieved using a radio frequency power source. The other option requires the gas to flow directly into the CVD chamber, then striking a high temperature within the chamber. This is referred to as in-situ plasma.

In the etching process, layers are chemically removed from the surface of a wafer. Unlike the CVD process where the entire wafer is coated, in the etching process the wafer must be oriented so the ions remove material from every die on the wafer. This process aids in forming transistors, diodes, and other electrical components. Every wafer undergoes many etching steps where high GWP gases are applied before it becomes a series of chips.

These processes are also used by universities that experiment with wafer processing and by research and development (R&D) operations that work with wafer manufacturing companies.

Initially, chlorofluorocarbons (CFCs) were used in these processes. With the signing of the Montreal Protocol in 1987 and the phase out of ozone depleting substances in the early 1990s, fluorinated gases have replaced CFCs (U.S. EPA, 2006). Fluorinated gases are preferred because the fluorine atom's strong bonding energy effectively removes material that has either bonded to the CVD chamber wall or to the wafer, or substrate material in wafer etching. However, 10 to 80 percent of the fluorinated gases can pass through the manufacturing tool chambers unreacted and be released into the air (SEMATECH, 2005).

Approximately 53 percent of the fluorinated gas emissions from semiconductor operations occur during CVD chamber cleaning and 47 percent during etching (ARB, 2007).

B. CHEMICAL VAPOR DEPOSITION AND CHAMBER CLEANING

As noted previously, semiconductor manufacturers, universities and R&D operations use the CVD process to layer thin films onto wafers. The wafer material in predominant use is silicon, although many non-silicon materials can be used such as gallium arsenide, gallium nitride, zinc selenide, and germanium. The wafer substrate is exposed to one or more gaseous molecules, called volatile precursors due to their high reactivity. The gases react with the surface to deposit a layer of material. Examples of material deposited include: silicon, carbon fiber, silica, tungsten, silicon nitride and titanium nitride (Wikipedia, 2008).

Figure III-2 shows how the volatile precursors react with the substrate. Some move downward and bond to the substrate, while others are removed as effluent.

Figure III-2
Gas Molecule Reaction with Substrate

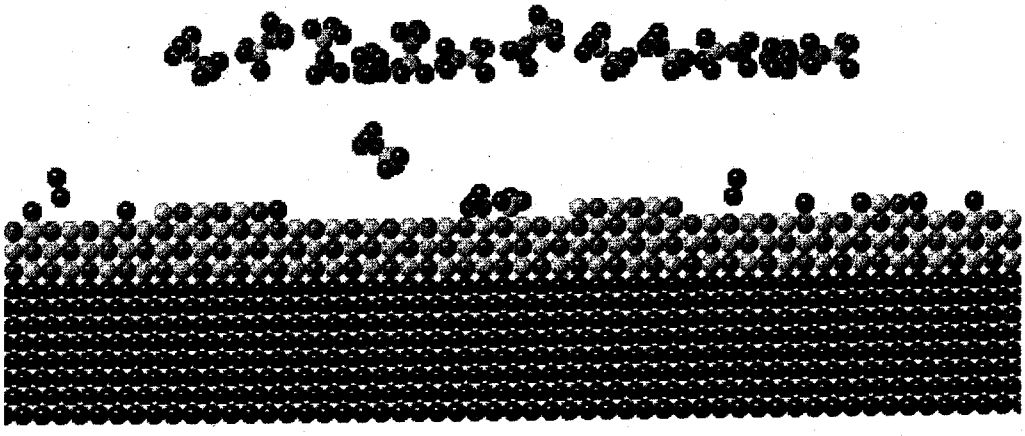


Figure courtesy of Hsin-Tien Chiu.

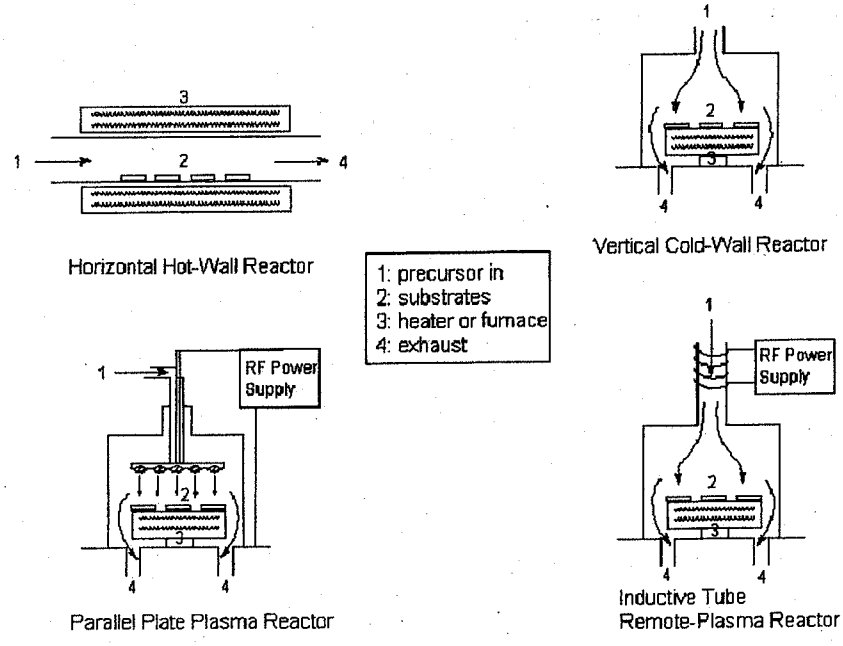
Over time the gas deposits also bond to the sides of the chambers. They can become thick enough to cause particle problems on the wafer surface. Some companies will clean the chamber after thousands of passes of wafers. Other companies have continuous monitoring equipment to tell more precisely when cleaning is necessary. This equipment includes Fourier Transform Infrared Spectroscopy (FTIR) machinery which is designed to measure numerous chemicals exiting the chamber for one instant of time. The counterpart to FTIR machinery is the Quadrapole Mass Spectrometer, which is designed to measure flow rates of major chemicals.

Process tools vary significantly in design. Some tools have only one CVD chamber with one wafer to be layered at a time. Other tools can layer three or

more wafers at a time. Still other tools have multiple chambers of which one is for layering. The number of layers required is determined by the product recipe and ranges from one to more than twenty layers per wafer.

The fluorinated gas most widely used to clean CVD chamber walls is C_2F_6. However, this gas does not have a high utilization efficiency such that up to 70 percent of the input gas may be emitted (SEMATECH, 2005). With the use of alternative chemistries there has been an increase in the removal rate of chamber debris per pound of gas used. Some of the alternative chemistries, such as NF_3, are so aggressive in the removal of materials that the chamber walls may be damaged. Therefore new tools with specially designed chamber walls may be required. Figure III-3 shows various CVD chambers and how the precursors move near the chamber walls.

Figure III-3
Gas Movement by CVD Chamber Walls



Note: The abbreviation "RF" in Figure III-3 refers to Radio Frequency power sources.

Figure courtesy of Hsin-Tien Chiu.

C. ETCHING

Etching is a chemical reactive process for selectively removing material deposited on a wafer during manufacturing. The purpose of this removal is to fill the trenches with metal that will form the wires that connect components. Etching includes wet etching with liquid chemicals, such as buffered hydrofluoric acid, or dry etching (plasma etching) with fluorinated, ionized gases. Etchants

include, but are not limited to, CF_4, CHF_3, C_2F_6, C_3F_8, c-C_4F_8, NF_3, and SF_6 (U.S. EPA, 2001).

Etching removes materials at a finer thickness than three micrometers, which is the limit for wet etching. Plasma etching allows the creation of a feature size, meaning the minimum width of a pattern such as used in defining a transistor, of less than $1/100^{th}$ the width of a human hair. This requires the atoms in the plasma etchant to have the right ratio of oxygen, hydrogen, carbon and fluorine and is achieved by adding the right amount of oxygen with fluorinated gases such as CF_4, c-C_4F_8, CHF_3, SF_6 and others (Glade, 2008).

Occasionally fluorinated gases are used to clean the etch chamber, however, this is not done as frequently as for CVD chamber cleaning because much lower volumes of gases are used in etching.

Figure III-4
Etch Tool

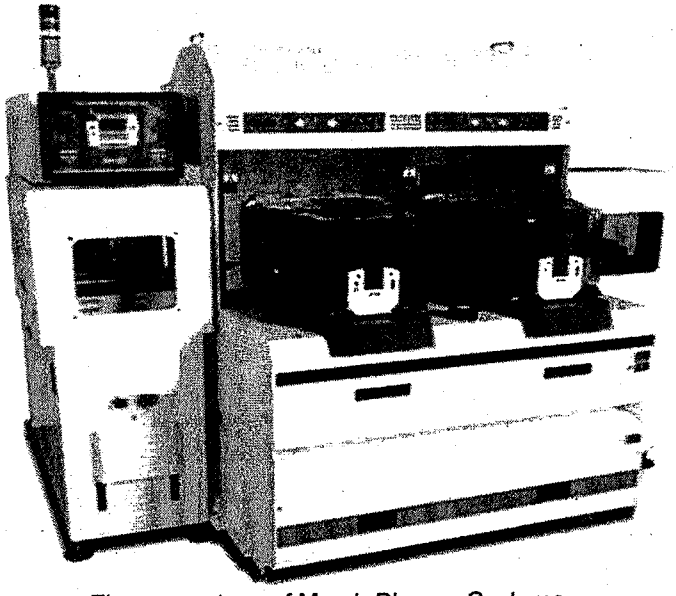


Figure courtesy of March Plasma Systems.

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IV. EMISSIONS

California's extreme air quality problems require unique strategies for improving air quality and slowing global warming. This chapter provides an overview of climate change and its predicted impacts. This chapter also presents GHG emissions estimates for the semiconductor industry based on ARB survey results, and the estimated emission benefits from the proposed rulemaking.

A. CLIMATE CHANGE

Climate change, or global warming, is the process whereby emissions of anthropogenic pollutants, together with other naturally-occurring gases, absorb infrared radiation in the atmosphere, leading to increases in the overall average global temperature. While carbon dioxide (CO_2) is the largest contributor to radiative forcing, methane, halocarbon, nitrous oxide (N_2O) and other species also contribute to climate change. Gases in the atmosphere can contribute to the greenhouse effect both directly and indirectly. Direct effects occur when the gas itself is a GHG. The standard definition of a GHG includes, but is not limited to, six substances as identified in the Kyoto Protocol and AB 32; CO_2, methane (CH_4), N_2O, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). Nitrogen trifluoride (NF_3), while not a Kyoto gas, is included in the proposed regulation as a GHG.

While there is relative agreement on how to account for direct effects of GHG emissions, accounting for indirect effects is more problematic. Indirect radiative forcing occurs when chemical transformations of the original gas produce other GHGs, when a gas influences the atmospheric lifetimes of CH_4, and/or when a gas affects atmospheric processes that alter the radiative balance of the earth (e.g. affect cloud formation) (ARB, 2008).

High global warming potential (GWP) gases are a unique challenge in that just a few pounds of high GWP materials can have the equivalent effect on global warming as several tons of carbon dioxide. GHG emissions from semiconductor operations are small relative to other sources such as vehicle exhaust, however, some of the most potent gases are used in this industry. The magnitude of the climate change problem justifies reductions from smaller sources wherever such regulations are technically feasible and cost-effective.

Controlling multiple substances that jointly contribute to climate warming requires some method to compare the effects of the different gases because the physical properties (climate warming impact and persistence in the atmosphere) of the GHGs are very different. The current solution to this problem is the calculation made by the IPCC (IPCC, 2006). The basic idea is to calculate the cumulative climate warming over a specified time span resulting from one unit mass of the GHG emitted. The estimates of GWPs have been extensively reviewed by many

climate scientists around the world. The IPCC is constantly evaluating GWP values and the assessment is generally updated every six years.

By convention, the GWP index is defined relative to CO_2 which has a GWP of one. The IPCC defines the GWP of a GHG as the ratio of the time-integrated radiative forcing impact from an instantaneous release of 1 kilogram (kg) of a trace substance relative to that of 1 kg of CO_2. The standard unit of measurement used to express the emissions of a GHG is MMT CO_2e per year. The GWP values used by staff were the IPCC Second Assessment Report (SAR) GWP values (ARB, 2007a). The values, shown in Table IV-1, are used when converting emissions of fluorinated gases to CO_2e. The GWP values from the SAR as opposed to the IPCC Fourth Assessment Report were used for all fluorinated gases except NF_3 to maintain consistency with the Board's Discrete Early Action Report, other statewide and national GHG inventories, and the Scoping Plan.

Table IV-1
IPCC GWP Values

Fluorinated Gas	Second Assessment 100-Year Values
C_2F_6	9,200
C_3F_8	7,000
CF_4	6,500
CHF_3	11,700
c-C_4F_8	8,700
NF_3	17,200*
SF_6	23,900

*Used IPCC Fourth Assessment 100-Year GWP value because no Second Assessment 100-Year GWP value is available.

The proposed regulation to reduce emissions of fluorinated gases from semiconductor operations will have an overall beneficial impact on climate change. The adoption of this proposed regulation will result in an estimated reduction of 0.18 MMT CO_2e per year (ARB, 2007b).

B. PREDICTED CLIMATE CHANGE IMPACTS

Global average temperatures have risen both on land and in the oceans, with observable impacts already occurring. Scientists predict that if the increase in GHG emissions continues unabated, temperatures will rise by as much as 10 degrees Fahrenheit by the end of this century (ARB, 2008). It is impossible to predict exactly how climate change will affect California's ecosystems and economy in the future. However, the expected physical changes will impact California's public health, economy and ecology.

One area of considerable concern is the effect of climate change on California's water supply. During the winter, in our mountains, snow accumulates in a deep pack, preserving much of California's water supply. If winter temperatures are warmer, however, more precipitation will fall as rain, decreasing the size of the snow pack. Heavier rainfall in the winter could bring increased flooding. Less spring runoff from a smaller snow pack will reduce the amount of water available for hydroelectric power production and agricultural irrigation. Evidence of this problem already exists. Throughout the 20th century, annual April to July spring runoff in the Sierra Nevada has been decreasing, with water runoff declining by about ten percent over the last 100 years.

Another predicted outcome of climate change is a rise in sea level. California has already experienced a 3 to 8 inch rise in sea level in the last century. If the trend continues, large populations living along California's coast will face 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.

Air pollution will also be exacerbated by increasing temperatures. Higher temperatures, strong sunlight, and stable air masses could lead to increased concentrations of ground-level ozone.

Climate change could impact California agriculture by increasing demand for irrigation to meet higher evaporative demand, while supply will become less reliable due to declining snow pack in the mountains. Climate change will also put our forests at greater risk for fire and disease (ARB, 2008).

C. SEMICONDUCTOR INDUSTRY EMISSIONS SURVEY RESULTS

Originally, the emissions inventory estimate for the semiconductor industry in California was 0.88 MMT CO_2e for the 2004 calendar year (U.S. EPA, 2007a). This was based on U.S. EPA national emissions data (U.S. EPA, 2007b) and U.S. Census Bureau shipment figures (U.S. Census, 2002). After discussions with the industry and other interested parties, ARB staff determined that the emissions inventory overestimated the GHG emissions from semiconductor operations. To refine the emissions estimate for the semiconductor industry, ARB staff conducted a survey of California's semiconductor operations (ARB, 2007c).

The survey collected 2006 data from semiconductor manufacturers, research and development organizations, tool manufacturers, and universities. The survey was developed with the participation of semiconductor manufacturers and members of the SIA, air district staff, U.S. EPA staff and other interested parties. The mailing list was derived from the ARB's emissions inventory and the air districts' databases. The survey provided ARB staff with the following information:

- types and amounts of fluorinated gases used;
- sizes and quantities of wafers produced or processed;
- business information on employees to identify small businesses;
- operation types;
- process optimization and alternative chemistries used;
- emissions abatement technologies used;
- information needed to calculate emissions; and
- other strategies used to reduce fluorinated gas emissions.

The survey was sent to over 300 semiconductor operations statewide and over ninety percent responded to the survey. A copy of the survey is contained in Appendix B.

The proposed regulation was based on the survey results, technical information provided by interested parties and staff's research efforts. During the workgroup meetings and public workshops, staff presented specific proposals and alternatives for consideration. Staff modified the original proposal after considering comments offered.

Eighty-five operations were identified as semiconductor operations in California that are subject to the proposed regulation. Table IV-2 contains a summary of respondent statistics.

Table IV-2
Summary of Survey Respondents

Number of operations surveyed	308
Number of operations that responded	302
Number of operations using fluorinated gases in California	85

To protect confidentiality, ARB staff posted to ARB's webpage a summary detailing fluorinated gas usage in aggregate form and provided estimated emissions for the semiconductor industry. The preliminary results were discussed at a public workshop and input from industry was used to correct any inaccuracies in the data. The survey data provide a sound basis for developing the proposed regulation and estimating emissions.

The number of semiconductor operations by size category and district is shown in Table IV-3.

Table IV-3
2006 Semiconductor Operations by District

Size Category	Total Operations	Bay Area	South Coast	Ventura	Santa Barbara	Sacramento	Placer
Tier 1: >37.7 Million Sq Cm Per Year	5	2	2	0	0	0	1
Tier 2: >3.7 and ≤37.7 Million Sq Cm Per Year	11	8	1	2	0	0	0
Tier 3: ≤3.7 Million Sq Cm Per Year	12	9	3	0	0	0	0
Reporting Only*	57	38	11	3	3	2	0
Total Operations	**85**	**57**	**17**	**5**	**3**	**2**	**1**
% of Total Operations		67	20	6	4	2	1

Note: * Emission threshold for Reporting Only operations is 0.0008 MMT CO2e. Reporting Only operations include tool manufacturers, R&D, and other small operations.

D. SEMICONDUCTOR INDUSTRY EMISSIONS

This section discusses the emission estimates from the proposed rulemaking for the semiconductor industry. The emissions in MMT CO_2e for a fluorinated gas are determined by multiplying the emissions calculated using the IPCC Tier 2b methodology by the GWP value for that gas and dividing by one billion, or the number of kilograms in one MMT. Emission factors and destruction efficiency values are based on the IPCC 2006 report (IPCC, 2006).

Table IV-4 shows the volume of fluorinated gas used and CO_2e emissions by process for each gas. Fifty percent of total emissions are attributed to C_2F_6, the predominant gas used in CVD chamber cleaning.

Table IV-4
2006 Fluorinated Gas Use and Emissions

Fluorinated Gas	Use in Etch Process (Kg)	Use in CVD Chamber (Kg)	Etch Emissions (MMT CO_2e)	CVD Chamber Emissions (MMT CO_2e)	Percent of Total Emissions
C_2F_6	7,270	28,700	0.03	0.13	50
C_3F_8	1,280	7,500	0.007	0.02	8
CF_4	13,100	1,270	0.05	0.004	17
CHF_3	4,080	90	0.01	0.0008	4
c-C_4F_8	980	4,320	0.003	0.007	3
NF_3	4,480	15,090	0.01	0.006	5
SF_6	9,110	155	0.04	0.003	13
Total	**40,300**	**57,125**	**0.15**	**0.17**	**100**

Table IV-5 shows the proposed emission standards, number of potentially impacted operations, and emission estimates.

Table IV-5
Proposed Emission Standards for Semiconductor Operations
Effective 1/1/2012

Category (Million Sq Cm Per Calendar Yr)	Maximum Emissions Limit Per Square Centimeter for a Calendar Year (Kg CO_2e/cm^2)	Number of Operations	2006 Emissions (MMT CO_2e)
Tier 1: >37.7	0.2	4*	0.17
Tier 2: >3.7 and ≤37.7	0.3	8*	0.08
Tier 3: ≤3.7	0.5	12	0.05
Reporting Only	NA	NA**	0.02
Total	**NA**	**24**	**0.32**

* From the survey, we were informed that one business in Tier 1 (already is in compliance) and three businesses in Tier 2 were planning on ceasing operation before the emission standards were proposed.
** Reporting Only operations (57) are not subject to the proposed emission standards.

The emission standards, expressed in kilograms of carbon dioxide equivalent (Kg CO_2e) per square centimeter of wafer processed, are based on the quantity of wafers processed at the semiconductor operation in a calendar year. As Table IV-5 shows, an owner or operator of a semiconductor operation must meet the emission standards by January 1, 2012. The Tier 1 emission standard applies to an owner or operator of any size semiconductor operation that begins operation after January 1, 2010, and emits more than 0.0008 MMT CO_2e per year. Owners or operators that replace certain processing equipment with newer equipment are allowed an additional two years, until January 1, 2014, to comply with the standards. The provision will encourage early emission reductions to occur as newer process tools are more efficient and have greater longevity.

Semiconductor operations that emit 0.0008 MMT CO_2e or less per reporting calendar year are not subject to the emissions standards in Table IV-5, but are subject to the annual reporting and recordkeeping requirements. Staff considered further emission reductions from these 57 operations, referred to as "reporting only," as not cost-effective. Collectively they represent only 6 percent of the total emissions.

Under the current proposal and based on the 2006 survey results, 24 semiconductor operations would be subject to emission standards and reporting and recordkeeping requirements. Fifty-seven operations would be subject to reporting and recordkeeping requirements only. All owners or operators would be required to submit an emissions report annually for the emissions occurring in the previous calendar year.

REFERENCES

1. Air Resources Board. ARB Compendium of Emission Factors and Methods to Support Mandatory Reporting of Greenhouse Gas Emissions, Appendix A. October 2007. (ARB, 2007a)

2. Air Resources Board. Initial Statement of Reasons for Proposed Amendments to the California Consumer Products Regulation. May 9, 2008. (ARB, 2008)

3. Air Resources Board. Expanded List of Early Action Measures to Reduce Greenhouse Gas Emissions in California Recommended for Board Consideration. October 2007. (ARB, 2007b)

4. Air Resources Board. Semiconductor Emissions Survey. December 14, 2007. (ARB, 2007c)

5. Intergovernmental Panel on Climate Change. 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3, Chapter 6. (IPCC, 2006)

6. United States Environmental Protection Agency. Fast Facts (April 2007), Office of Atmospheric Programs, U.S. GHG Emissions Inventory (PDF, 2pp.) EPA 430-F-07-004. Online Internet at http://epa.gov/climatechange/emissions/downloads/2007GHGFastFacts.pdf. (U.S. EPA, 2007b)

7. United States Environmental Protection Agency. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005. April 15, 2007. (U.S. EPA, 2007a)

8. United States Census Bureau. U.S. Census Bureau's Economic Census, http://www.census.gov/econ/census02/ (for value of semiconductor shipments produced at the state and national levels.) Information is listed by NAICS Code Number. The NAICS Code for "Semiconductor Manufacturing = #334413" (U.S. Census, 2002)

V. DEVELOPMENT OF PROPOSED REGULATION

In this chapter, staff provides a "plain English" discussion of key requirements of the proposed regulation to reduce emissions of fluorinated GHGs from semiconductor operations. This chapter begins by presenting the public outreach efforts used in developing the regulation, then summarizes the proposed regulation and concludes by describing each major requirement and compliance option. A copy of the proposed regulation is available in Appendix A of this report.

A. PUBLIC OUTREACH

The Administrative Procedures Act (Government Code section 11340 *et seq.*) requires public input during rulemaking development. Staff has made extensive efforts to provide opportunities for participation in the rulemaking process. Staff's public outreach efforts included participation from members of SIA, semiconductor manufacturers, process tool manufacturers, fluorinated gas suppliers, air district staff, U.S. EPA staff, public health representatives, environmental and pollution prevention association representatives and other interested parties.

Staff's outreach activities included the following:

- Provided a draft survey to the SIA and select manufacturers for review and comment;
- Conducted a survey of California's semiconductor operations;
- Held working group meetings;
- Held four public workshops;
- Made extensive personal contacts with industry representatives, and other interested parties through meetings, telephone calls, and mail- outs;
- Formed an ARB/Industry Working Group and conducted three conference calls with group members;
- Formed an ARB/District Working Group and conducted conference calls with group members;
- Created a website and maintained an email address list to automatically update interested parties about rulemaking developments;
- Mailed workshop notices and posted workshop materials on the website; and
- Conducted site visits to three semiconductor operations.

Air districts' staff were also actively involved in the rulemaking development process. Staff from the air districts provided comments on the draft regulatory language and information on permitting requirements for the semiconductor operations within their jurisdiction.

B. SUMMARY OF PROPOSED REGULATION

The proposed regulation applies to semiconductor operations in California that use fluorinated GHGs in CVD chamber cleaning or etching processes. The proposed emission standards only apply to semiconductor operations in California that emit more than 0.0008 MMT CO_2e per calendar year. These 28 sources account for 94 percent of the emissions from semiconductor operations. The proposed emission standards do not apply to semiconductor operations that emit 0.0008 MMT CO_2e or less per year because they constitute only six percent of the emissions and it would not be cost-effective to regulate these small businesses, primarily research and development operations.

Reporting and recordkeeping requirements apply to all operations, including those emitting less than or equal to 0.0008 MMT CO_2e per year. Owners and operators must comply with emission standards effective January 1, 2012. All owners and operators subject to the regulation are required to keep records of semiconductor operations and submit an initial report and annual reports thereafter to the air districts.

Owners or operators of semiconductor operations generally would be required to comply with the emission standards by January 1, 2012. However, an operation replacing 150 millimeter (mm) wafer processing tools with 200 mm or greater tools would have until January 1, 2014 to comply with the emission standards. Providing more time for sources that are upgrading their wafer processing tools to comply with emission standards encourages early GHG reductions that are achievable with more efficient 200 mm tools. The additional time also avoids the costly situation of installing abatement devices on old processing tools just before they are scheduled to be replaced. All semiconductor operations would be subject to the same timeframe for reporting and recordkeeping requirements.

The emission standards for semiconductor operations are tiered, and vary depending upon the quantity of wafers (thin semiconductor material from which integrated circuits or "chips" are made) processed at a facility. The quantity of wafers processed is measured in square centimeters, and includes all wafers processed at a facility, including those that do not pass inspection.

We are proposing that seven sections be added to title 17, Subchapter 10, Article 4, Subarticle 2 of the California Code of Regulations. These are: section 95320 "Purpose," section 95321 "Applicability," section 95322 "Definitions," section 95323 "Standards for a Semiconductor Operation," section 95324 "Reporting Requirements," section 95325 "Recordkeeping Requirements," and section 95326 "Severability."

1. PURPOSE (Section 95320)

The purpose of this regulation is to reduce fluorinated gas emissions from semiconductor operations pursuant to the California Global Warming Solutions Act of 2006.

2. APPLICABILITY (Section 95321)

This regulation applies to semiconductor operations using fluorinated gases in their etching and chemical vapor deposition (CVD) chamber cleaning processes. It also requires reporting on the use of fluorinated heat transfer fluids. Semiconductors and related devices include, but are not limited to, diodes, zeners, stacks, rectifiers, integrated microcircuits, transistors, solar cells, light-sensing devices, and light-emitting devices.

The proposed emission standards apply only to semiconductor operations in California that emit more than 0.0008 MMT CO_2e per calendar year, although reporting and recordkeeping provisions apply to all operations regardless of emissions levels. Owners and operators of semiconductor operations must comply with emission standards effective January 1, 2012, except those operations replacing 150 millimeter (mm) wafer processing tools with 200 mm or larger tools. Those operations would have until January 1, 2014 to comply with the proposed standards. The time extension recognizes the value of voluntary efforts that would reduce emissions, avoids penalizing these operations by requiring emission control technology on older and short-lived tools, and encourages operations to consider process tool upgrades.

3. DEFINITIONS (Section 95322)

To ensure common understanding and improve enforceability of the regulation, this section provides all the terms used in the proposed semiconductor regulation which are not self-explanatory. The definition of fluorinated gases required clarification as the term has various meanings depending upon the source.

Some of the fluorinated gases include, but are not limited to:

- hexafluoroethane (C_2F_6);
- octafluoropropane (C_3F_8);
- octafluorocyclopentene (C_5F_8);
- tetrafluoromethane (CF_4);
- trifluoromethane (CHF_3);
- difluoromethane (CH_2F_2);
- octafluorocyclobutane (c-C_4F_8);
- octafluorotetrahydrofuran (C_4F_8O);
- hexafluoro-1,3-butadiene (C_4F_6);
- carbon fluoride oxide (COF_2);
- nitrogen trifluoride (NF_3); and
- sulfur hexafluoride (SF_6).

4. STANDARDS (Section 95323)

The emission standards for semiconductor operations are tiered, and vary depending upon the quantity of wafers (thin semiconductor material from which integrated circuits or "chips" are made) processed at a facility. The quantity of wafers processed is measured in square centimeters of the surface area of one side of the wafer, and includes all wafers processed at a facility, including those that do not pass inspection.

The emission standards in this regulation, expressed in kilograms of carbon dioxide equivalent (kg CO_2e) per square centimeter of wafer processed, are based on the quantity of wafers in square centimeters processed at a facility in a year, and are grouped into three tiers as follows:

Tier 1: Up to 0.2 kg CO_2e per square centimeter of wafer processed may be emitted by operations processing greater than 37.7 million square centimeters of wafers in a calendar year.

Tier 2: Up to 0.3 kg CO_2e per square centimeter of wafer processed may be emitted by operations processing greater than 3.7 and less than or equal to 37.7 million square centimeters of wafers in a calendar year, provided operations were in existence prior to January 1, 2010.

Tier 3: Up to 0.5 kg CO_2e per square centimeter of wafer processed may be emitted by operations processing less than or equal to 3.7 million square centimeters of wafers in a calendar year, provided operations were in existence prior to January 1, 2010.

All semiconductor operations established on or after January 1, 2010, regardless of square centimeters of wafers processed, would be required to meet the Tier 1 standard if they emit more than 0.0008 MMT CO_2e per year.

The proposed standards shown in Table V-1, achieve the maximum technologically feasible emission reduction based on information obtained in ARB's 2006 survey of semiconductor operations and discussions with semiconductor manufacturers, and manufacturers of fluorinated gas emission control devices.

Table V-1
Emission Standards for Semiconductor Operations
Effective January 1, 2012

CVD Chamber Cleaning and Etching Processes	
Wafer Surface Area Processed (Million Square Centimeters Per Calendar Year)	**Maximum Emissions Limit Per Square Centimeter for a Calendar Year (Kg CO_2e/cm^2)**
Tier 1: >37.7	0.2
Tier 2: >3.7 and ≤ 37.7	0.3
Tier 3: ≤3.7	0.5

The proposed emission standards do not apply to those semiconductor operations that emit 0.0008 MMT CO_2e or less per calendar year. Based on ARB's survey results, 57 semiconductor operations that emit 0.0008 MMT CO_2e or less per year account for six percent of the GHG emissions. Twenty-seven of these operations are small businesses, and all 57 operations account for only three percent of fluorinated gas usage. Our analysis indicates that the minor emission reductions achievable by subjecting these research and development operations to the emission standards are not cost-effective. Consequently, we are proposing to cap their emissions at the 0.0008 MMT CO_2e threshold level and subject them to annual reporting and recordkeeping requirements.

5. REPORTING REQUIREMENTS (Section 95324)

Emissions reporting requirements include both initial and annual reporting. For the initial report, due to the permitting agency no later than March 1, 2011, semiconductor operations must report fluorinated gas emissions from January 1, 2010 through December 31, 2010. For annual emissions reports, due to the permitting agency beginning March 1, 2012 and each year thereafter, semiconductor operations must report for the previous calendar year.

In addition to emissions of fluorinated gases, the annual emissions report will contain information on:

- ❖ the amounts of fluorinated gases used in CVD chamber cleaning and etching operations;
- ❖ the amount of semiconductor wafers processed for operations emitting more than 0.0008 MMT CO_2e per year;
- ❖ the use of process optimization, alternative chemistries, or equipment used to reduce fluorinated gas emissions; and
- ❖ information regarding the use of fluorinated heat transfer fluids.

6. RECORDKEEPING REQUIREMENTS (Section 95325)

Recordkeeping requirements would mandate that the owner or operator maintain records on quantities of fluorinated gases and heat transfer fluids purchased or delivered, as well as records of emission control equipment malfunctions and failures. All records must be maintained at an operation and be readily accessible for inspection for at least three years.

7. SEVERABILITY (Section 95326)

The proposed regulation contains a severability clause stipulating that in the event any portion of the proposed regulation is deemed invalid, the remainder of the proposed regulation will continue in full force and effect.

C. COMPLIANCE WITH THE PROPOSED REGULATION

At present there are many semiconductor operations that comply with the proposal using process optimization, alternative chemistries and control devices that minimize GHG emissions. For several years, some manufacturers in California voluntarily reduced GHG emissions by way of agreements with the U.S. EPA and the World Semiconductor Council. In fact, this proposed regulation will be the first time this industry will be required by law to comply with GHG regulations specific to their industry. While we do not wish to negate the voluntary efforts by the industry to reduce GHG emissions, the proposed regulation will ensure that all semiconductor operations in California reduce GHG emissions to the maximum extent that is technically and economically feasible.

Owners and operators of semiconductor operations have the flexibility of choosing how they will comply with the proposed regulation. They may elect to use process optimization, alternative chemistries, or abatement technologies, in combination or separately, to reduce GHG emissions. Twelve of the 24 operations in Tiers 1, 2, and 3 that responded to the ARB survey already comply with the proposed standards. Table V-2 shows the option(s) currently used by complying operations.

Each tier contains operations that process wafers of varying complexity. Because the volume of gas usage increases with wafer complexity, the operations processing more complex wafers may need to use all three compliance strategies to meet the proposed standards. For example, the complying Tier 1 operation with more complex wafer designs, i.e., a higher average number of layers, uses all three emission reduction options. Those with less complex wafer designs are able to meet the standards with fewer compliance strategies. In some cases, operations may comply without using any of the control strategies.

Table V-2
Compliance Strategies for Complying Operations

Category	Operation	Process Optimization		Alternative Chemistries	Abatement		Remote Plasma
		Use in Etching	Use in CVD Chamber		Use in Etching	Use in CVD Chamber	
Tier 1	1	---	---	---	---	---	---
	2	X	X	X	X	X	X
Tier 2	1	X	X	X	X	X	---
	2	---	---	---	---	---	---
	3	---	---	---	---	---	---
	4	X	X	---	---	---	---
	5	---	X	---	---	---	X
Tier 3	1	X	---	---	---	---	---
	2	---	---	---	---	---	---
	3	X	---	---	---	---	---
	4	X	X	---	---	---	---
	5	---	---	---	---	---	---

Table V-3 shows emissions, emission reductions, and complying market shares. This Table shows complying Tier 1 operations represent 57 percent of the Tier 1 market. The complying market shares for Tiers 2 and 3 are 43 and 34 percent, respectively.

Table V-3
2006 Emissions and Emission Reductions
CVD Chamber Cleaning and Etching Processes

Category	Number of Operations	Emissions (MMT CO_2e)	Percent Complying Market Share	Emission Reductions (MMT CO_2e)
Tier 1	5	0.17	57	0.11
Tier 2	11	0.08	43	0.03
Tier 3	12	0.05	34	0.04
Reporting Only	57	0.02	NA	NA
Total	**85**	**0.32**	**NA**	**0.18**

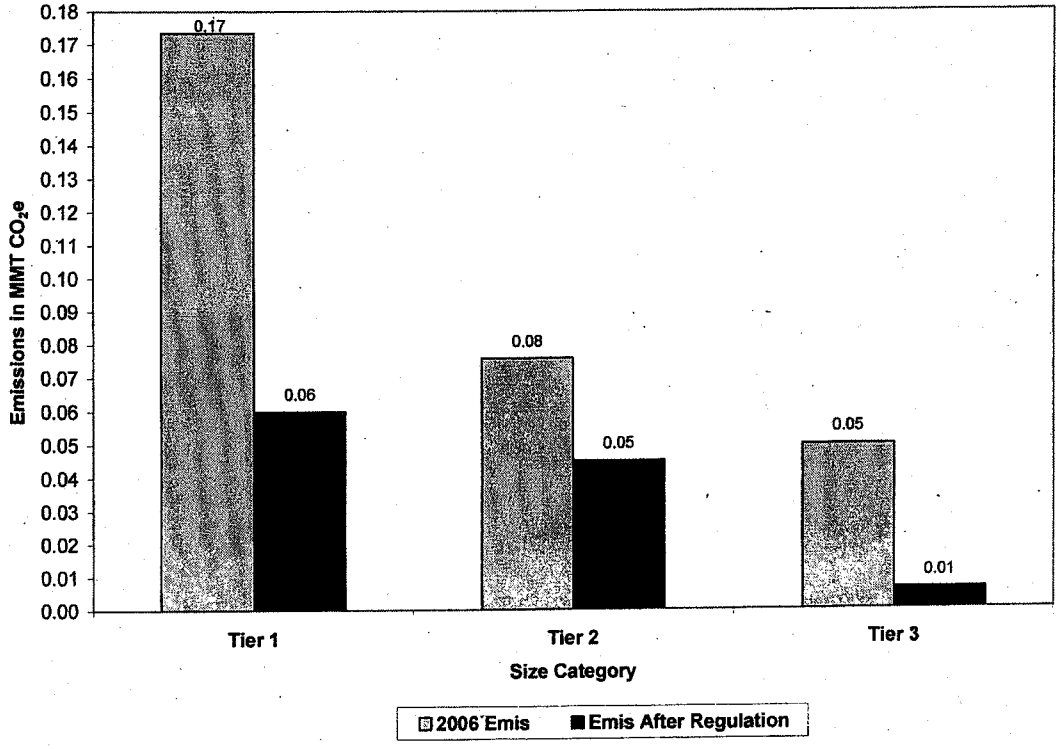
The percent complying market share is tier specific and is simply the wafer production currently complying with the emission standard compared to total wafer production for that tier. Based on the technical feasibility demonstrated through the complying market share and the range of compliance options, staff believes the proposed limits are feasible.

Figure V-1 shows by Tier the 2006 calendar year emissions and the remaining emissions after the proposed regulation becomes effective. Estimated emission reductions for Tier 1 are 0.11 MMT CO_2e per year. Tier 2 and 3 reductions are estimated at 0.03 and 0.04 MMT CO_2e per year, respectively. While Tier 1 operations account for 61 percent of the total emission reduction, Tier 3 operations will achieve the greatest percentage reduction from current practices. This is because these smaller operations have not voluntarily reduced emissions by using emission control options.

1. PROCESS OPTIMIZATION

Process optimization reduces the volume of fluorinated gas used in CVD chamber cleaning to the optimal volume and is achieved by using either a Quadrapole Mass Spectrometer (Q-mas) system or a Fourier Transform Infrared Spectroscopy (FTIR) unit. These devices sample the chemical constituents of the effluent to determine precisely when there are no more residual chemicals flowing through the processing chamber. Process optimization reduces gas consumption thereby reducing operating costs. For example, the International Sematech Manufacturing Initiative report estimates that process optimization for C_2F_6 usage reduces CVD chamber cleaning emissions by 10 to 56 percent (SEMATECH, 2005). Process optimization is the lowest cost emission reduction strategy. It is particularly useful for older fabs that may be using more process gas than necessary.

Figure V-1
Emissions Before and After Proposed Regulation



2. ALTERNATIVE CHEMISTRIES

Alternative chemistry is the substitution of one gas for another to achieve a net environmental benefit. For example, a higher GWP gas can be used to replace a lower GWP gas if the replacement gas is used more efficiently, thereby resulting in a net environmental benefit. Initially, C_2F_6 was the only chemical used by the semiconductor industry for CVD chamber cleaning. More recently, C_3F_8, c-C_4F_8, C_4F_8O and NF_3 have all been found to be possible alternatives. The first three alternatives (C_3F_8, c-C_4F_8, and C_4F_8O) are "drop-in" replacements for C_2F_6, while NF_3 requires new machinery because of the aggressive nature of the gas. Two complying operations in the tier groupings cite the use of alternative chemistry and have replaced C_2F_6 in either CVD chamber cleaning or etch processes.

When a semiconductor operator considers using an alternative chemistry a number of factors are evaluated. An operator needs to evaluate if the change in chemistry would produce any detrimental effects on tool and film properties, including uniformity, number of defects, and the chip performance. Usually the process of evaluating all of these factors before making the change takes six months to a year. There may also be an

initial one to two week downtime for a tool when the change in chemistry is implemented.

Once the decision is made to use an alternative chemistry, only one gas is selected for a given tool. Combinations, such as C_3F_8 and c-C_4F_8, are not used. Alternative chemistries can be used in CVD chamber cleaning or etching.

Table V-4 provides a summary comparison by type of gas for alternative chemistries to replace C_2F_6 in CVD chamber cleaning (SEMATCH 2005).

Table V-4
Alternative Chemistries Summary

C_2F_6 Replacement Chemistry	Utilization Efficiency* (%)	Emissions Reduction from Baseline C_2F_6 Process (%)
C_3F_8	30–60	12–70
c-C_4F_8	70–90	50–85
C_4F_8O	85–90	70–90
NF_3	60–80	20–90

* Utilization efficiency is the percentage of the gas used in the process. A 30 percent utilization efficiency means that 70 percent of the gas is emitted.

3. ABATEMENT

The remaining option to reduce the emissions from semiconductor operations is to abate the emissions before they are released into the atmosphere. The two primary methods of abating high GWP gases from the exhaust streams are: 1) thermal destruction; and 2) plasma destruction. Thermal destruction devices may be applied at a single tool, called point–of–use (POU) abatement, or at the end of several tools, which is called end–of–pipe abatement. The advantage of POU devices is a lesser tendency to have build-up of chemicals in the tubes carrying the effluent to the device. The disadvantage is that the POU devices mitigate the effluent from only one tool.

There are three main types of POU abatement systems:
1) fuel burner–scrubbers; 2) electric heated–scrubbers; and 3) pre-pump plasma units. In each case the exhaust gas is heated to high enough temperatures to "crack" off the fluorine atom from the strong carbon-to-fluorine or fluorine-to-fluorine bond. Toxic hydrofluoric acid (HF) is formed in the process, but can be removed with a water scrubber. The three types of abatement systems differ in how they heat the gas to the high temperatures needed to destroy emissions. The fuel burner–scrubber combusts propane, methane, natural gas or a hydrogen

flame to reach the temperatures needed. The electric heated–scrubber uses an electrically heated mesh of steel that often is white hot. The pre-pump plasma unit uses an inlet of plasma.

Based on our survey, most of the operations in California that use thermal destruction use POU fuel burner–scrubbers. The majority of these operations apply the technology to CVD chamber cleaning, with all three tiers having at least one operation represented. However, several operations also abate etching tool effluents, although this does not occur across all three tiers. Electric heated–scrubbers are also used in both processes, but were fewer in number.

Ten operations cited the use of remote plasma to abate fluorinated gas emissions. Remote plasma is used by operations in Tiers 1 and 2 and in the reporting only category.

There are other abatement technologies that are used less frequently. This includes one operation in the reporting only category that uses catalytic–scrubbers and pre-pump plasma to treat etching gases. Another operation in the same category uses only pre-pump plasma to treat etching gases. One operation uses only catalytic–scrubbers to treat etching and CVD gases and one operation uses end–of–pipe abatement for CVD chamber cleaning emissions. This operation also uses POU-type abatement for some etch tools.

Before operators purchase abatement devices, they need to consider the maximum downtime allowable to make the change, the cost of ownership, and the minimum Destruction Removal Efficiency (DRE) of the device.

D. EVALUATION OF REGULATORY ALTERNATIVES

California Government Code section 11346.2 requires ARB to consider and evaluate reasonable alternatives to the proposed regulation and provide reasons for rejecting those alternatives. This section discusses the alternatives evaluated and provides the reasons why they were not included in the proposed rulemaking. Staff evaluated each of the alternatives and determined that the alternatives did not meet the objective of Health and Safety Code section 38560 to achieve the maximum technologically feasible and cost-effective greenhouse gas emission reductions in furtherance of achieving the statewide GHG emissions limit.

- **No Action** - A "no action" alternative would forego or delay the adoption of the proposed rulemaking. This alternative was rejected as it would result in failure to make progress in reducing emissions of high GWP GHGs from semiconductor operations.

- **Alternative Standards** - The alternative standards option is to impose a different standard on etching processes and CVD chamber cleaning processes. This alternative sets separate emissions limits for CVD chamber cleaning and etching based on the lowest emitting operations for each process within each tier. The total emission reduction would increase from 0.18 to 0.22 $MMTCO_2e$. Since this alternative would impact more businesses than the current proposal, the annual cost was estimated to be $6.3 million. This option also increases the complexity of the regulation. Industry expressed concern that process specific emission standards would not be technically feasible and would not provide sufficient compliance flexibility. Staff concurs and, therefore, rejected this alternative.

E. ALTERNATIVE MEANS OF COMPLIANCE

The proposed regulation allows for flexibility in methods of compliance. Rather than specify a compliance mechanism, operators may choose compliance method(s) best suited to their needs. Process optimization, alternative chemistries, and abatement technologies are among the compliance options available. Operators may choose to implement any or all of these compliance options to meet the proposed emission standards.

ARB staff has concluded that the proposed regulation provides the most effective and least burdensome approach to reducing GHG emissions from semiconductor and related devices operations. The proposed regulation provides operators with flexibility while preserving the emission benefits.

REFERENCES

1. Air Resources Board. Semiconductor Emissions Survey. December 14, 2007. (ARB, 2007)

2. SEMATECH, Inc. Reduction of Perfluorocompound (PFC) Emissions: 2005 State-of-the-Technology Report. December, 2005. (SEMATECH, 2005)

VI. ENVIRONMENTAL IMPACTS

A. INTRODUCTION

The goal of this regulation is to reduce emissions of greenhouse gases from semiconductor operations. An additional consideration is the impact that the proposed regulation may have on the environment. This chapter describes the potential impacts that the proposed regulation may have on air quality, water treatment, and hazardous waste disposal. Based upon available information, we determined that no significant adverse environmental impacts should occur as a result of adopting the proposed regulation.

B. LEGAL REQUIREMENTS APPLICABLE TO THE ANALYSIS

The California Environmental Quality Act (CEQA) and ARB policy require an analysis to determine the potential environmental impacts of proposed regulations. ARB's program for adopting regulations has been certified by the Secretary of Resources, pursuant to Public Resources Code section 21080.5. Consequently, the CEQA environmental analysis requirements may be included in the Initial Statement of Reasons (ISOR) for this regulation. In the ISOR, the ARB must include a functionally equivalent document, rather than adhering to the format described in CEQA of an Initial Study, a Negative Declaration, and an Environmental Impact Report. In addition, staff will respond to all significant environmental issues raised by the public during the 45 day public review period or at the Board hearing in the Final Statement of Reasons for the proposed regulation.

Public Resources Code section 21159 requires that the environmental impact analysis conducted by ARB include the following:

- An analysis of reasonably foreseeable environmental impacts of the methods of compliance;
- An analysis of reasonably foreseeable feasible mitigation measures; and
- An analysis of reasonably foreseeable alternative means of compliance with the proposed regulation.

Compliance with the proposed regulation is expected to directly affect air quality and potentially affect other environmental media as well. Our analysis of the reasonably foreseeable environmental impacts of the methods of compliance is presented in sections C and D.

C. POTENTIAL ENVIRONMENTAL IMPACTS

As previously mentioned, there are several compliance options manufacturers may use to control GHG emissions from semiconductor operations. Each of

these options and any potential environmental impacts are discussed in this section.

1. PROCESS OPTIMIZATION

Process optimization is used primarily for cleaning of CVD chambers, and can reduce fluorinated gas emissions through the use of endpoint detectors and/or process parameter variation to optimize the fluorinated gas use (SIA, 2007). Process optimization continues to focus on CVD chamber cleaning because it is historically the greatest source of fluorinated gas emissions. Because CVD cleaning occurs when wafers are not present in the chamber, this process can be optimized without negatively affecting wafer production (SEMATECH, 2005). Because this compliance option reduces the volume of fluorinated gases used and emitted, and does not generate by-products, staff concludes that it poses no significant environmental impacts.

2. ALTERNATIVE CHEMISTRIES/PROCESSING

The largest portion of GHG emission reductions achieved to date from the U.S. semiconductor industry is through the use of alternative chemistries, primarily from substituting NF_3 for C_2F_6 in the chamber clean process (SIA, 2007). Specifically, the industry has developed remote plasma clean technologies to replace in-situ C_2F_6 chamber cleans (SEMATECH, 2005). ARB survey results also show the use of C_3F_8 and c-C_4F_8 as alternatives for C_2F_6 in CVD chamber cleaning. Alternative gases can be used more efficiently than C_2F_6 and therefore require less gas to accomplish the cleaning task, thereby lowering emissions.

The use of C_3F_8 and c-C_4F_8 can generate CF_4 and C_3F_8 as by-products, from a few percent up to 30 percent of gas input. However, total emissions are reduced up to 90 percent compared to the use of C_2F_6 (SEMATECH, 2005). NF_3 generates a smaller percentage of the by-product CF_4 than other alternative chemistries, but can also generate more fluorine (F_2) and hydrogen fluoride (HF) emissions than fluorocarbon-based cleans. The use of NF_3 may therefore require additional treatment equipment to remove F_2 and HF from the exhaust stream.

Semiconductor operations typically treat HF exhaust streams with end–of–pipe (EOP) water scrubbers. Most semiconductor operations have a separate on-site facility designed to remove HF from the wastewater stream. The HF is converted to a neutral pH and calcium fluoride (CaF_2) is formed, which as a solid is easily filtered. The resulting wastewater is nearly free of HF and clean enough to wash down the municipal sewer (Glade, 2008). Most air districts require the use of water

scrubbers, which provide 90 percent control, to remove HF from exhaust streams.

Because HF is a TAC, new and modified sources of HF emissions are subject to air district review to evaluate potential public exposure and health risk, mitigate potentially significant health risks resulting from these exposures, and decrease health risk by improving the level of emissions control. Semiconductor operations located in the Bay Area Air Quality Management District (AQMD), for example, are subject to New Source Review of TACs when sources emit more than 540 pounds of HF per year (BAAQMD, 2005).

Further public protection is provided through The Air Toxics "Hot Spots" Information and Assessment Act (AB 2588, 1987, Connelly) which requires stationary sources, such as semiconductor operations, to report the types and quantities of certain substances routinely released into the air. TACs, such as HF, are among the substances that are reportable. The goals of the Air Toxics "Hot Spots" Act are to collect emission data, identify facilities having localized impacts, ascertain health risks, notify nearby residents of significant risks, and reduce those significant risks to acceptable levels.

The additional treatment load on EOP scrubbers may require modification to the scrubber systems or installation of point–of–use (POU) scrubbers. Since by-products can be treated with water scrubbers, staff concludes that no significant adverse environmental impacts are associated with the use of alternative chemistries.

3. ABATEMENT TECHNOLOGIES

The most common technologies used to abate fluorinated gas emissions from semiconductor operations include high temperature and plasma destruction. High temperature, or thermal destruction, systems rely on fuel burners, or combustion boxes, to destroy emissions at temperatures in excess of 800 degrees C. While there are several categories of plasma destruction systems, remote plasma, described briefly in Chapter III, is used by several operations in California.

Thermal destruction systems destroy F_2, converting it to HF which is then treated with water scrubbers. As noted in the alternative chemistries section, additional modifications to scrubber systems may be necessary to handle the HF. Depending upon the type of combustor, NO_x may be generated (Semiconductor International, 2007). Inward-fired combustors minimize NO_x emissions to 1 to 10 parts per million. In semiconductor operations, combustor units emit such small amounts of NO_x that they do not currently require district permits. However, the proposed regulation

would impose permitting requirements on all semiconductor operations that are installing abatement to meet the emission limits.

Remote plasma CVD chamber cleaning functions as abatement, although it is classified as alternative processing. NF_3 used in remote plasma is converted to fluorine ions at 95 percent or higher efficiency, thereby reducing emissions by 95 percent (SEMATECH, 2005). Remote clean technology using NF_3 also generates more F_2 and HF than fluorocarbon-based cleans, which again must be treated through water scrubbers to comply with district permitting requirements for TACs.

4. CALIFORNIA ENVIRONMENTAL QUALITY ACT

The California Environmental Quality Act (CEQA) requires an agency to identify and adopt feasible mitigation measures that would minimize any significant adverse environmental impacts described in the environmental analysis. The ARB staff has concluded that no significant adverse environmental impacts should occur from adoption of and compliance with the proposed regulation. This regulation reduces GHG emissions and is not expected to result in any significant adverse air quality, wastewater, or hazardous waste impacts. The NO_x potentially generated by certain thermal destruction system designs will be minimized by requiring sources to go through district permitting processes when abatement devices are installed.

D. SUMMARY OF IMPACTS ON ATMOSPHERIC PROCESSES

In this section, we evaluate the impacts on atmospheric processes. The evaluation includes our assessment on whether the proposed regulation would have a positive, negative, or no impact on these atmospheric processes.

1. IMPACTS OF PROPOSED RULEMAKING ON GROUND-LEVEL OZONE CONCENTRATIONS

Enhanced ground-level ozone formation involves the interaction between VOCs and NO_X in the presence of sunlight. The rate of ozone generation is closely related to the amount and reactivity of VOC emissions as well as the amount of NO_X emissions available in the atmosphere (Seinfeld and Pandis, 1998). Ozone, a colorless gas and the chief component of urban smog, is one of the State's more persistent air quality problems. Ninety-three percent of Californians, or 36 million people, live in areas designated non-attainment for the federal 8-hour ozone standard. It has been well documented that ozone adversely affects the respiratory function of humans and animals. Research has shown that when inhaled, ozone can cause respiratory problems, aggravate asthma, impair the immune system, and cause increased risk of premature death.

In addition to adversely affecting human and animal health, ozone affects vegetation throughout most of California, resulting in reduced yield and quality in agricultural crops, disfiguration or unsatisfactory growth in ornamental vegetation, and damage to native plants. Staff believes that this regulation will not adversely impact ground-level ozone concentrations.

E. ENVIRONMENTAL JUSTICE AND COMMUNITY HEALTH

Environmental justice is defined 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 ARB is committed to integrating environmental justice into all of our activities. On December 13, 2001, the Board approved "Policies and Actions for Environmental Justice," which formally established a framework for integration of environmental justice into the ARB's programs, consistent with the directive of California state law. These policies apply to all communities in California, however, environmental justice issues have been raised specifically in the context of low-income areas and ethnically diverse communities.

Our environmental justice policies are intended to promote the fair treatment of all Californians and cover the full spectrum of ARB's activities. Underlying these policies is a recognition that the agency needs to engage community members in a meaningful way as it carries out its activities. The ARB recognizes its obligation to work closely with all communities, environmental organizations, industry, business owners, other agencies, and all other interested parties to successfully implement these policies.

During the rulemaking process, ARB staff proactively identified and contacted representatives from semiconductor operations and their materials suppliers, environmental organizations, and other parties interested in semiconductor operations. These individuals participated by providing data, reviewing draft regulations, and attending public meetings.

The proposed regulation is consistent with our environmental justice policy to reduce health risk in all communities, including those with low-income and ethnically diverse populations, regardless of location. Potential risks from global warming due to GHGs can affect both urban and rural communities. Therefore, reducing emissions of GHGs from semiconductor operations will provide benefits to urban and rural communities in the State, including low-income and ethnically diverse communities. The decrease in GHG emissions will occur in areas where semiconductor operations are located, which are primarily outside of residential areas. Residents in close proximity to a semiconductor operation will not be adversely impacted.

The compounds subject to the proposed regulation are GHGs. They are not carcinogens, hazardous air pollutants or ozone precursors. Staff's qualitative health risk assessment therefore concludes that public health will not be adversely affected by the regulation. Compliance will not result in any adverse localized impacts.

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VII. ECONOMIC IMPACTS OF PROPOSED REGULATION

In this chapter, we present the estimated costs and economic impacts associated with implementation of the proposed regulation for greenhouse gas emissions from the semiconductor industry. ARB staff quantified the economic impacts to the extent feasible, but economic impact analyses can be inherently imprecise by nature. Therefore, some projections are necessarily qualitative or semi-quantitative, based on general observations about the semiconductor industry.

The economic impacts analysis for the proposed regulation provides a general picture of the economic impacts that typical businesses might encounter, but staff recognizes that individual companies may experience impacts different than those projected in this analysis. The expected capital and recurring costs for potential compliance options are presented. The costs and associated economic impacts are presented for private companies, as well as governmental agencies.

A. SUMMARY OF THE ECONOMIC IMPACTS

Overall, the costs of the proposed regulation to reduce the emissions of GHGs from the semiconductor industry are absorbable, without a major impact on the profitability or operation of the semiconductor businesses in California. Of the 85 semiconductor operations identified in a survey conducted by ARB, 23 businesses are subject to the emission standards in the regulation.

ARB staff estimates the cost of the regulation to affected businesses in California to be approximately $22 million initial capital costs and about $850,000 in annual recurring costs. This corresponds to $3.7 million annually over the useful life of the regulation, assumed to be ten years. This cost represents the capital cost of equipment, annualized over the life of the regulation plus the annual recurring costs in 2007 dollars. The cost-effectiveness is estimated to be $21 per metric ton of carbon dioxide equivalent reduced. This is in line with the cost-effectiveness estimated for similar regulations identified in the Scoping Plan.

The primary customers of semiconductor operations are other businesses in the computer, cell phone, communication, or other technology related field. These businesses then sell their products to retailers or consumers. The impact on consumers is difficult to quantify due to the indirect interaction of consumers and semiconductor businesses.

Overall, ARB expects the proposed regulation to have no significant impact on employment; business creation, elimination or expansion; and business competitiveness in California. ARB staff expects no significant impact on State agencies.

B. LEGAL REQUIREMENTS

Section 11346.3 of the Government Code requires 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's jobs, business expansion, elimination or creation, and the ability of California businesses to compete with businesses in other states.

Also, State agencies are required to estimate the cost or savings to any State or local agency and school district in accordance with instructions adopted by the Department of Finance. The estimate shall include any non-discretionary cost or savings to local agencies and the cost or savings in federal funding to the State.

Health and Safety Code section 57005 requires the Air Resources Board to perform an economic impact analysis of submitted alternatives to a proposed regulation before adopting any major regulation. A major regulation is defined as a regulation that will have a potential cost to California business enterprises in an amount exceeding $10 million in any single year. Because the estimated cost of the regulation does not exceed $10 million in a single year, the proposed regulation is not a major regulation.

C. AFFECTED BUSINESSES

Any business operating a semiconductor operation that uses fluorinated gases or heat transfer fluids will be affected by the proposed regulation. Also, businesses that are customers of semiconductor operations will be potentially affected. The focus of this analysis, however, will be on semiconductor operations because these businesses will be directly affected by the proposed regulation.

There are 85 semiconductor operations of which six are subsidiaries of another business and one is a University of California. However, four of these have plans to cease operations. All of these operations planned to cease operations before the emission standards were proposed. The largest operation that has ceased operating in California already complied with the proposed Tier 1 emission standard. Ten of the 74 semiconductor businesses in California that will be operating after 2008 already comply with the emission standards and 13 have emissions that exceed the emission standards. The remaining fifty-one businesses that emit up to 0.0008 MMT CO_2e per year are expected to be minimally impacted, incurring costs for reporting and recordkeeping requirements.

Table VII-1 shows the number of affected operations and businesses by tier.

Table VII-1
Survey Data Inputs for Cost Calculations

Category	Number of Operations in 2006	Number of Businesses in 2006	Number of Businesses Operating After 2008	Number of Complying Businesses	Number of Non-Complying Businesses
Tier 1	5	5	4*	1	3
Tier 2	11	10	7*	4	3
Tier 3	12	12	12	5	7
Reporting Only	57	51	51	51	0
Total	**85**	**78**	**74**	**61**	**13**

* From the survey, we were informed that one business in Tier 1 (already is in compliance) and three businesses in Tier 2 were planning on ceasing operation before the emission standards were proposed.

ARB has identified the following Standard Industrial Classification (SIC) categories for the affected businesses. The 13 operations that will need to reduce emissions to comply with the emission standards are in the Semiconductors and Related Devices (3674) SIC code category.

Table VII-2
SIC Codes for Semiconductor Operations

SIC Code	Description
3674	Semiconductors and Related Devices
3559	Special Industry Machinery, Not Elsewhere Classified
3825	Instruments for Measuring and Testing of Electricity and Electrical Signals
5065	Electronic Parts and Equipment, Not Elsewhere Classified

D. POTENTIAL IMPACT ON SEMICONDUCTOR BUSINESSES

Three compliance options are available: abatement, process optimization, and alternative chemistries. Any combination of these options can be used to comply with the proposed regulation. To estimate cost, staff determined which compliance options would be needed for operations to reduce emissions to comply with the emission standards. The total cost includes capital cost, annual operating cost, annual permitting cost, and annual reporting and recordkeeping cost. All dollar amounts are in 2007 dollars and the life of the regulation is assumed to be 10 years.

Thirteen businesses will need to reduce their emissions to comply with the emission standards. Capital costs for these businesses include the cost for abatement or process optimization. The capital cost assumes a 5 percent discount rate, a 10 year system life, and a Cost Recovery Factor of 0.13. This produces an annualized capital cost of $2.8 million for the 11 businesses that will need to install abatement devices. The annual operating and maintenance costs are $795,000 for these 11 businesses. Two businesses would be able to comply with the emissions standards without installing abatement devices, through a combination of process optimization and alternative chemistry.

The permitting cost is determined by using the expected incremental cost increase to local air pollution control districts. This was estimated to be $1,000 per year, per operation. Over the life of the proposed regulation, the overall cost is $110,000 for the 11 operations in California that would be required to obtain a permit for abatement equipment.

The recordkeeping and reporting cost is estimated at $600 per year for each operation. Seventy-four businesses will be required to perform recordkeeping and reporting. For the 51 businesses that are only required to keep records and submit annual reports, this will be the only cost incurred. The total annual cost from recordkeeping and reporting is estimated to be $44,400 per year. Over the life of the proposed regulation, the overall cost is $444,000. Therefore, the total annual cost is estimated to be $3.7 million. Over the life of the regulation, the total cost is $37 million. A detailed presentation of these costs is presented in Appendix C.

Cost to individuals was calculated by taking the overall annual cost and dividing by the annual processing of wafers in California. This was calculated to be 0.006 cents per square centimeter of wafer. Actual costs to individuals would be reflected in higher prices for products that contain these semiconductors and related devices. However, it is expected that costs will not be passed onto consumers because California manufacturers would need to remain competitive with manufacturers outside of the State.

The non-recurring costs are annualized into discounted, equal annual payments when multiplied with an appropriate cost recovery factor (CRF), a standardized method recommended by the Cal/EPA for annualizing costs (Cal/EPA, 1996) and is consistent with the methodology used in previous cost analyses of regulations by the ARB (ARB, 2000; ARB, 2007).

The CRF is calculated as follows:

$$CRF = \frac{i(1+i)^n}{(1+i)^n - 1}$$

where,

CRF = cost recovery factor
i = discount rate (assumed 5 percent)
n = project horizon or useful life of equipment (assumed 10 years)

All costs of the control devices are annualized over 10 years. The total annualized cost is obtained by adding the recurring costs to the non-recurring costs using the CRF method. Using this method, the CRF is 0.13, which represents the portion of the initial capital cost that is repaid each year over the life of the equipment.

Staff estimated profitability impacts on businesses by calculating the decline in the return on owner's equity (ROE). The approach used in evaluating the potential economic impact of the proposed regulation on these businesses is outlined as follows:

(1) A sample of representative businesses from different tiers was selected from the list of 13 affected businesses.
(2) Estimated cost was adjusted for federal and State taxes.
(3) The three-year average ROE was calculated, where data were available, for each of these businesses by averaging their ROEs for 2005 through 2007 (Dunn and Bradstreet, 2008). ROE is calculated by dividing the net profit by the net worth. The adjusted cost was then subtracted from net profit data. The results were used to calculate an adjusted three-year average ROE. The adjusted ROE was then compared with the ROE before the subtraction of the adjusted cost to determine the potential impact on the profitability of the businesses. A reduction of more than 10 percent in profitability is considered to indicate a potential for significant adverse economic impacts.

The threshold value of 10 percent has been used consistently by the ARB staff to determine impact severity (ARB, 1990; ARB, 1991; ARB, 1995; ARB, 1998; ARB, 2000; ARB, 2005). This threshold is consistent with the thresholds used by the U.S. EPA and others.

The ROEs before and after the subtraction of the adjusted compliance costs were calculated for each business using financial data for 2005 through 2007. The calculations were based on the following assumptions:

(1) Selected businesses are representative of affected businesses;
(2) All affected businesses are subject to the highest federal and State corporate tax rates of 35 percent and 9.3 percent respectively; and
(3) Affected businesses are not able to increase the prices of their products, nor can they lower their costs of doing business through short-term, cost-cutting measures.

Given the limitation of available data, staff believes these assumptions are reasonable for most businesses at least in the short run; however, they may not be applicable to all businesses.

Typical California businesses are affected by the proposed regulation to the extent that the additional costs imposed by the proposed requirements would change their profitability. Staff estimated profitability impacts by calculating the decline in the ROE. Assuming that semiconductor manufacturers will have to absorb all of the costs associated with the regulation, the proposed regulation is expected to result in an average ROE decline of 0.4 percent, as shown in Table VII-3, which is not considered to be a significant impact on the profitability of affected businesses.

Table VII-3
Changes in Return on Owner's Equity

Tier	ΔROE
Tier 1	0.9%
Tier 2	0.05%
Tier 3	0.1%
Average	**0.4%**

Note: All ΔROEs shown are negative which indicates a decline in profitability.

As shown in Table VII-3, the projected change in profitability of typical businesses in the semiconductor industry varied widely. This variation in the impact of the proposed regulation can be attributed mainly to the following factors. First, large businesses incur higher costs due to the quantity of wafers they manufacture. Second, small businesses are usually dependent more financially on affected products than large businesses. Finally, the performance of businesses differs from year to year. Hence, the average 2005 through 2007 financial data used may not be representative of an average-year performance for some businesses.

There will be 38 small businesses in operation after 2008 that will be affected by the proposed regulation. Thirty-three of these businesses will only be required to perform recordkeeping, and make reports. The remaining five will be required to reduce their emissions. Staff estimates that four of these businesses will need to install an abatement device, and one will comply through process optimization. The average annual cost to these businesses is $89,000 per year.

E. POTENTIAL IMPACT ON EMPLOYMENT

The proposed regulation is not expected to cause a noticeable change in California employment and payroll. According to the 2002 U.S. Census Bureau, California employment in the semiconductor and related devices industry (SIC 3674) was 39,843 in 2002, or about 24 percent of the national employment in the industry. This also represents only about 0.2 percent of the total manufacturing jobs in California. These employees working in 391 establishments generated about $2.4 billion in payroll, accounting for less than 0.5 percent of the total California manufacturing payroll in 2002 (BLS, 2008). It is assumed that the semiconductor industry has declined since the most recent data available from the U.S. Census Bureau.

F. COSTS TO PUBLIC AGENCIES

This regulation will impact two State agencies, ARB and the University of California, Berkeley, and local air pollution control districts. Districts will have primary responsibility for enforcing this regulation, and ARB will be responsible for oversight. One State agency, the University of California, Berkeley, has a semiconductor operation for research purposes. This agency will be minimally impacted, incurring costs due to reporting and recordkeeping estimated at $600 per year.

The expected incremental cost increase to air districts is estimated to be $11,000 per year. It is expected that districts will recover their costs through permit fees and GHG fees under the authority of Health and Safety Code sections 40510 and 42311.

While the proposed measure will be enforced statewide, the Bay Area AQMD and South Coast AQMD will have the most impact. More than 85 percent of the State's semiconductor operations are located in these districts. The Bay Area AQMD has adopted a GHG fee rule to help recover costs associated with enforcement. Other districts have little or no semiconductor operations.

There will not be a need to increase the ARB budget for the current fiscal year, or in the next two fiscal years. However, there will be a need to request an increase starting in the 2011-2012 fiscal year. ARB estimates a need for one personnel per year at $170,000 to handle oversight and reporting for this proposed regulation.

G. COST OF THE PROPOSED REGULATION

Based on information provided in ARB's survey of semiconductor operations in California and discussions with the semiconductor industry, staff estimated the total cost of the regulation. We considered the cost of abatement equipment, operating costs, permit fees and reporting and recordkeeping costs. Based on these analyses, the total cost to businesses is estimated to be $3.7 million annually over the life of the regulation. A detailed example of the cost calculation is presented in Appendix C. The annual cost to a typical operation that is not subject to the emissions standard is expected to be about $600 annually. The average impact for the 13 businesses that we expect would need to reduce emissions is estimated to be an annual cost of $280,000 in 2007 dollars over the life of the regulation.

REFERENCES

1. Air Resources Board. Executive Summary and Technical Support Document. Initial Statement of Reasons for Proposed Amendments to the California Consumer Products Regulation. (a.k.a. "Mid-Term Measures I"). June 6, 1997. (ARB, 1997)

2. Air Resources Board. Hearing Notice and Staff Report. Proposed Amendments to the California On-Road Motorcycle Regulation. October 1998. (ARB, 1998)

3. Air Resources Board. Initial Statement of Reasons for a Proposed Statewide Regulation to Reduce Volatile Organic Compound Emissions from Aerosol Coating Products and Amendments to the Alternative Control Plan for Consumer Products. February 3, 1995. (ARB, 1995)

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VIII. FUTURE AND ONGOING ACTIVITIES

A. FLUORINATED GAS EMISSIONS

1. EMISSION CALCULATIONS

If the Board approves the proposed regulation, ARB staff will develop a calculation tool to help the industry perform the IPCC Tier 2b emission calculations required by the regulation. Staff will confer with the industry and the districts as we develop the emissions reporting tool. The objective is to ensure that any interested owner or operator receives sufficient information to submit complete and accurate reports to the districts. The emission calculation tool will be developed for the industry's use prior to the initial report due on March 1, 2011.

2. MONITORING

AB 32 specifies that GHG reductions are to be real, verifiable and enforceable. In consultation with the districts and considering the fact that the districts have permit authority for semiconductor operations, the districts will receive the emissions reports and will carry out enforcement functions. ARB staff will support the districts as needed. This may include secondary review of emission calculations, exchanging information on new technology developments, or helping to resolve enforcement or other issues that may develop.

3. REPORTING

ARB staff will also work with the districts to evaluate the need for developing a sample format for reports to promote consistency in the information provided. The intent is to ease the reporting burden for industry and lessen the review time for district personnel. ARB staff expects that districts will specify whether reports should be filed electronically or in hard copy form.

B. HEAT TRANSFER FLUIDS

1. FURTHER RESEARCH

During the manufacture of semiconductors, heat transfer fluids (HTFs) serve as coolants in chillers, removing excess heat during operations processes. Semiconductor testing often involves heating or cooling containers of HTFs, and immersing manufactured devices into the HTFs to test their integrity. In addition, when testing the function of semiconductors, HTFs are used to remove the heat the semiconductors generate while being tested. HTFs are also used to attach

semiconductors to circuit boards via solder, which may be melted by the vapor of HTF heated to its boiling point. Finally, HTFs may serve to cool semiconductors and other devices or systems that generate high heat during operation (U.S. EPA, 2006).

While HTFs are contained in closed-loop systems, evaporative losses do occur over time from equipment operation. Losses may also occur when filling newly purchased equipment. Since HTFs have long atmospheric lifetimes and high global warming potential their contribution to global warming is a concern.

HTFs are used in semiconductor operations separate from CVD chamber cleaning and etching. Therefore, they are not subject to the proposed emission standards. However, ARB staff will continue to research their use and rely upon IPCC methodologies in quantifying evaporative emissions from HTFs.

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Appendix A

Proposed Regulation Order

Division 3. AIR RESOURCES

Chapter 1. AIR RESOURCES BOARD

Subchapter 10. Climate Change

Article 4. Regulation to Achieve Greenhouse Gas Emission Reductions

Subarticle 2. Semiconductors and Related Devices

PROPOSED REGULATORY LANGUAGE

Adopt new Article 4, Subarticle 2, Semiconductors and Related Devices, sections 95320 to 95326, title 17, California Code of Regulations, to read as follows:

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

Subchapter 10. Climate Change
Article 4. Regulation to Achieve Greenhouse Gas Emission Reductions
Subarticle 2. Semiconductors and Related Devices

Semiconductors and Related Devices

§ 95320 Purpose

The purpose of this regulation is to reduce fluorinated gas emissions from the semiconductor industry pursuant to the California Global Warming Solutions Act of 2006 (Health & Safety Code, sections 38500 et.seq.).

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.

§ 95321 Applicability

This regulation applies to an owner or operator of a semiconductor or related devices operation that uses fluorinated gases or heat transfer fluids. This includes, but is not limited to, the processing of diodes, zeners, stacks, rectifiers, integrated microcircuits, transistors, solar cells, light-sensing devices, and light-emitting devices.

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.

§ 95322 Definitions

(a) For the purposes of this article, the following definitions apply:

(1) "Alternative Chemistries" means the substitution of a fluorinated gas in the chamber cleaning or etching process to increase utilization efficiency and reduce the carbon dioxide equivalent emissions.

(2) "Calendar Year" means the time period from January 1 through December 31.

(3) "Carbon Dioxide Equivalent" or "CO_2e" means a measure for comparing carbon dioxide with other greenhouse gases, based on the quantity of those gases multiplied by the appropriate global warming potential (GWP) factor.

(4) "CO_2e Emissions Limit" means the maximum allowable kilograms of CO_2e emissions per square centimeter of wafers processed in a calendar year.

(5) "Chamber Cleaning" means the process of using fluorinated gases to remove excess materials from chemical vapor deposition chamber walls to prevent contamination of wafers to be processed.

(6) "Chemical Vapor Deposition (CVD)" means deposition of thin films on wafers by placing the wafers in a mixture of gases, including nitrogen or another gas used as a carrier, which react at the surface of the wafers.

(7) "Equipment" means any article, machine, or other contrivance, or combination thereof, which may cause the issuance or control the issuance of fluorinated gas emissions in etching or CVD chamber cleaning processes.

(8) "Etching" means a chemical reactive process for selectively removing material on a wafer using fluorinated, ionized gases.

(9) "Fluorinated Gases" means a compound that contains fluorine and exists in a gaseous state at 25 degrees Celsius and 1 atmosphere of pressure. Fluorinated gases include, but are not limited to:

(i) hexafluoroethane (C_2F_6),
(ii) octafluoropropane (C_3F_8),
(iii) octafluorocyclopentene (C_5F_8),
(iv) tetrafluoromethane (CF_4),
(v) trifluoromethane (CHF_3),
(vi) difluoromethane (CH_2F_2),
(vii) octafluorocyclobutane (c-C_4F_8),

(viii) octafluorotetrahydrofuran (C_4F_8O),
(ix) hexafluoro-1,3-butadiene (C_4F_6),
(x) carbon fluoride oxide (COF_2),
(xi) nitrogen trifluoride (NF_3), and
(xii) sulfur hexafluoride (SF_6).

(10) "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.

(11) "Global Warming Potential Value" or "GWP Value" means the global warming potential value of a chemical or compound as specified in the IPCC: 1996 Second Assessment Report (SAR), Table 2.14, in Climate Change 2007: The Physical Sciences Basis, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, which is incorporated by reference herein.

If Table 2.14 does not contain a SAR 100-year GWP Value for a specific chemical or compound, then the 100-year GWP Value in Table 2.14 for that chemical or compound must be used.

(12) "Heat Transfer Fluid" means a fluorinated fluid which prevents a device, such as a semiconductor, from overheating by removing excess heat produced during a manufacturing process.

(13) "Permitting Agency" means any air pollution control district or air quality management district.

(14) "Process Optimization" means the practice of using end-point detectors and/or process parameter variation to achieve optimum gas usage to reduce excess fluorinated gas emissions.

(15) "Semiconductor Operation" means an operation performed to process semiconductor devices or related solid state devices. It may include, but is not limited to, the processing of diodes, zeners, stacks, rectifiers, integrated microcircuits, transistors, solar cells, light-sensing devices, and light-emitting devices.

(16) "Wafer" means a thin, usually round, slice of a material from which integrated circuits, or chips, are made.

(17) "Wafer Surface Area" means the entire surface area of one side of a wafer, or multiple wafers, and includes wafers that do not pass owner or operator inspection.

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.

§ 95323 Standards

(a) Except as provided in section 95323(b), an owner or operator of a semiconductor operation must meet the emission standards in Table 1 by January 1, 2012. An operation that is replacing CVD or etching tools that process 150 millimeter diameter wafers with tools that process 200 millimeter diameter or larger wafers must comply with the Table 1 emission standards by January 1, 2014.

The Tier 1 emission standard shall apply to an owner or operator of a semiconductor operation that processes more than 37.7 million square centimeters of wafer surface area per calendar year. The Tier 1 emission standard shall also apply to the owner or operator of a semiconductor operation that begins operation after January 1, 2010.

(1) Emissions Calculation Method
An owner or operator must express fluorinated gas emissions in CO_2e units. The kilograms of fluorinated gas emissions are determined using the Tier 2b calculation method in the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories, incorporated by reference herein. The IPCC 1996 Second Assessment Report (SAR) provides the GWP values used to calculate fluorinated gas emissions, with the exception of NF_3 which is based on the GWP value from the IPCC Fourth Assessment Report.

An owner or operator of a semiconductor operation may request that the permitting agency approve the use of an alternative destruction removal efficiency (DRE) value that exceeds the default DRE value in the Tier 2b calculation method. An alternative DRE must be based on independent third party measured results for the emission control equipment used by the operation.

The kilograms of fluorinated gas emissions from CVD chamber cleaning and etching are converted to million metric tons of CO_2 equivalent (MMT CO_2e) using the following formula:

Total Fluorinated Gas Emissions in MMT $CO_2e = \sum E_i(GWP_{100})_i/10^9$

Where:
E = the kilograms of fluorinated gas emitted using the Tier 2b method
i = the fluorinated gas
GWP_{100} = the GWP of the fluorinated gas
10^9 = the number of kilograms per million metric ton

For an operation emitting more than 0.0008 MMT CO_2e per calendar year, total fluorinated gas emissions in MMT CO_2e are converted to kilograms of CO_2 equivalents per square centimeter (Kg CO_2e/cm^2) using the following formula:

Emissions in Kg CO_2e/cm^2 = (MMT CO_2e)(10^9) / $\sum[(\pi r_n^2 Wf_n)/100]$

Where:
10^9 = the number of kilograms per million metric ton
π = 3.1416
r_n = one half the diameter in millimeters of a given size wafer
n = diameter of a wafer in millimeters
Wf_n = the number of wafers of a given size processed in the calendar year
100 = the number of square millimeters per square centimeter

Table 1
Emission Standards for Semiconductor Operations
Effective January 1, 2012

CVD Chamber Cleaning and Etching Processes	
Wafer Surface Area Processed (Million Square Centimeters Per Calendar Year)	**Maximum Emissions Limit Per Square Centimeter for a Calendar Year** (Kg CO_2e/cm^2)
Tier 1: >37.7	0.2
Tier 2: >3.7 and ≤ 37.7	0.3
Tier 3: ≤3.7	0.5

(b) The emission standards in Table 1 shall not apply to a semiconductor operation that emits 0.0008 million metric tons or less of CO_2e per calendar year.

(c) The owner or operator of a semiconductor operation that is installing equipment to meet the emission standards in Table 1 must submit a permit application to the permitting agency no later than March 1, 2011.

(d) The owner or operator of a semiconductor operation that is installing equipment to meet the emission standards in Table 1 by January 1, 2014 pursuant to section 95323(a), must submit a permit application to the permitting agency no later than March 1, 2013.

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.

§ 95324 Reporting Requirements

(a) Initial emissions reporting requirement

The owner or operator of a semiconductor operation must submit an initial emissions report pursuant to the requirements in section 95324(b) to the permitting agency no later than March 1, 2011. This report must quantify the monthly and annual emissions from semiconductor operations conducted during the 2010 calendar year.

(b) Annual emissions reporting requirements

The owner or operator of a semiconductor operation must submit an annual report to the permitting agency by March 1st of each calendar year that quantifies CO_2e emissions occurring in the previous calendar year.

The annual report must include, but may not be limited to, all of the following in subsections (b)(1) through (b)(11).

(1) the company name, address, telephone number, designated contact person and e-mail address for the contact person;

(2) the monthly and annual amounts, in kilograms, of each of the following fluorinated gases used for CVD chamber cleaning and etching:

i. hexafluoroethane (C_2F_6),
ii. octafluoropropane (C_3F_8),
iii. octafluorocyclopentene (C_5F_8),
iv. tetrafluoromethane (CF_4),
v. trifluoromethane (CHF_3),
vi. difluoromethane (CH_2F_2),
vii. octafluorocyclobutane (c-C_4F_8),

viii. octafluorotetrahydrofuran (C_4F_8O),
ix. hexafluoro-1,3-butadiene (C_4F_6),
x. carbon fluoride oxide (COF_2),
xi. nitrogen trifluoride (NF_3), and
xii. sulfur hexafluoride (SF_6).

(3) the monthly and annual square centimeters of wafers processed;

(4) the use of process optimization, alternative chemistries, or equipment to reduce fluorinated gas emissions and estimated emissions reductions in CO_2e per square centimeter of wafer processed;

(5) monthly and annual CO_2e emissions determined in accordance with section 95323 (a)(1);

(6) the volume of fluorinated heat transfer fluids used in the processing of semiconductors;

(7) the volume of fluorinated heat transfer fluids purchased;

(8) whether the heat transfer fluid was added to an existing cooling system, used to fill a new system, or both;

(9) the volume of heat transfer fluid added to an existing cooling system or used to fill a new system;

(10) the specific brand name of the heat transfer fluid used; and

(11) a certification statement from the owner or operator that the information provided is true, accurate and complete.

(c) The owner or operator of a semiconductor operation shall report emission control equipment breakdowns, malfunctions, and failures in accordance with the permitting agency's requirements.

(d) The owner or operator of a semiconductor operation that emits 0.0008 MMT or less of CO_2e per calendar year is not subject to the reporting requirements in section 95324(b)(3) and (b)(4) and may provide annual data in lieu of monthly data in the emission reports.

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.

§ 95325 Recordkeeping Requirements

(a) Purchase or delivery records

The owner or operator of a semiconductor operation must maintain monthly records that clearly document all purchased quantities of the fluorinated gases and fluorinated heat transfer fluids as defined in section 95322. All records required by this subsection (a) must be readily accessible on site for inspection and review by the permitting agency or the Air Resources Board at the semiconductor operation for at least three calendar years. If so requested by the permitting agency or the Air Resources Board, the owner or operator must provide copies of the records to the permitting agency or the Air Resources Board. The owner or operator of a semiconductor operation that emits 0.0008 MMT or less of CO_2e per calendar year may keep annual in lieu of monthly records.

(b) Emission control equipment malfunctions and failures

The owner or operator of a semiconductor operation must maintain monthly records of the occurrence, date of occurrence, duration, cause (if known), and action taken for each equipment malfunction and/or failure. All records must be maintained for at least three calendar years.

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.

§ 95326 Severability

Each part of this section is deemed severable, and in the event that any part of this section is held to be invalid, the remainder of this section 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

2006 SEMICONDUCTOR INDUSTRY SURVEY FORM

Page 1

California Air Resources Board

SEMICONDUCTOR EMISSIONS SURVEY

Is this page confidential?

Click cell and use drop down menu in blue areas.

Type in response in yellow areas.

Responses will be kept confidential to the extent indicated in the paragraph below.* Results will be made available in aggregate form to protect confidentiality.

1	Company/Organization Name:	
2	Contact Person:	
3	Title:	
4	Phone:	
5	E-mail:	
6	Standard Industrial Classification (SIC) Code:	
7	Total number of California employees :	

8 What type of semiconductor facility does your company/organization operate?

Manufacturer	
R & D	
University	
Other (please specify):	

9 Is the company/organization a member of any industry association?

	Other Association ?
Semiconductor Industry Association (SIA) member?	

(If yes, please specify:)

10 **Does the company currently participate in any voluntary agreement (Memorandum of Understanding) with the U.S. Environmental Protection Agency to reduce fluorinated gas emissions?**

** In accordance with title 17, California Code of Regulations (CCR), sections 91000 to 91022, and the California Public Records Act (Government Code section 6250 et seq.), the information that a company provides to the Air Resources Board (ARB) may be released: (1) to the public upon request, except trade secrets which are not emissions data or other information which is exempt from disclosure or the disclosure of which is prohibited by law; (2) to the United States Environmental Protection Agency (U.S. EPA), which protects trade secrets as provided in section 114(c) of the Clean Air Act and amendments thereto (42 USC 7401 et seq.) and in federal regulation; and (3) to other public agencies provided that those agencies preserve the protections afforded information which is identified as a trade secret, or otherwise exempt from disclosure by law (section 39660(e)).*

Page 2

Is this page confidential?

11 **Which of these fluorinated gases do you use?**

Hexafluoroethane (C_2F_6)	
Octofluoropropane (C_3F_8)	
Tetrafluoromethane (CF_4)	
Trifluoromethane (CHF_3)	
Octofluorocyclobutane (c-C_4F_8)	
Octafluorotetrahydrofuran(C_4F_8O)	
Hexafluoro-1,3-butadiene (C_4F_6)	
Nitrogen Trifluoride (NF_3)	
Sulfur Hexafluoride (SF_6)	
Other (please specify):	

If you are <u>not</u> using any of the chemicals listed in question 11, please skip to page 5; type in your name and the date; save the file to your computer; and send it by e-mail to dtrensch@arb.ca.gov.

12 **How many kilograms of these gases did you <u>purchase</u> in calendar year 2006? (Specific process information is important to develop an effective regulation. Please provide your best estimate if process specific information is not readily available.)**

Original Chemical	Etching	CVD Chamber Cleans	Other (please specify) _____
C_2F_6			
C_3F_8			

CF_4			
CHF_3			
c-C_4F_8			
C_4F_8O			
C_4F_6			
NF_3			
SF_6			
Other: (please specify)			

13 What size(s) of wafers are you currently producing?

150 mm or less		
200 mm		
300 mm		
Prototypes (please specify mm)		(mm)
Other (please specify):		

14 How many wafers were produced from the facility in calendar year 2006, rounded to the nearest hundred?

150 mm or less	
200 mm	
300 mm	
Other: (please specify)	

Page 3

Is this page confidential?

15 Do you have any plans to relocate your California fab to another state or country or close the facility? (This information is important to assess emissions "leakage" and future emissions trends.)

Relocate?		Close?	
	If yes, please indicate relocation year.	If yes, please indicate closure month.	If yes, please indicate closure year.
If yes, please indicate relocation month.			
New Location (please specify)			

16 Do you currently use optimization strategies for the processes below to reduce fluorinated gas emissions?

CVD Chamber Cleans	Etch Cleans	Other Process (please

specify)

If you do not use process optimization, please explain why.

17 Do you currently use remote plasma to reduce fluorinated gas emissions?

18 Do you currently use alternative chemistries to reduce fluorinated gas emissions?

If yes, please indicate the change in chemicals and the process affected.

Original Chemical	Changed to?	Process (etching, CVD clean, both, other?)
C_2F_6		
C_3F_8		
CF_4		
CHF_3		
c-C_4F_8		
C_4F_8O		
C_4F_6		
NF_3		
SF_6		
Other: (please specify)		

If you do not use alternative chemistries, please explain why.

Page 4

Is this page confidential?

19 Do you currently use capture/recovery systems to reduce fluorinated gas emissions?

If yes —

Is it a centralized building-wide system?

Is it a small system used for single fluorinated gas high-volume

process?

If you do not use capture/recovery, please explain why.

20 Which of the following abatement technologies, and for what processes, do you use to reduce fluorinated gas emissions?

Technology	Process: CVD Chamber Cleans	Process: Etch
Point of Use Fuel Burner — Scrubber		
If yes.....		
Point of Use Catalytic — Scrubber		
If yes.....		
Point of Use Electrically Heated — Scrubber		
If yes.....		
Point of Use Atmospheric Plasma		
If yes.....		
Point of Use Pre-pump Plasma		
If yes.....		
Centralized Atmospheric Plasma		
If yes.....		
End of Pipe Abatement System		
If yes.....		

If you do not use abatement equipment, please explain why.

21 Are there any other fluorinated gas emission reduction strategies you have implemented?

If yes, please describe the strategy.

To complete the survey, please type in your name, title, and date below; save the file to your computer; then send it by e-mail to dtrensch@arb.ca.gov. Please see the survey instructions tab for information on password protecting your survey responses before sending your survey by e-mail.

RETURN your survey by FRIDAY, February 15, 2008 to:

dtrensch@arb.ca.gov

If submitting your survey by hardcopy, please send to:

Air Resources Board
Stationary Source Division
Attn: Dale Trenschel
P.O. Box 2815
Sacramento, CA 95812

Questions? Contact Dale Trenschel at 916-324-0208 or e-mail dtrensch@arb.ca.gov.

I certify that the information being provided is true, accurate and complete.

Printed Name _____

Title _____

Signature (if submitting by hardcopy) _____

Date _____

APPENDIX C

ECONOMIC ANALYSIS DETAILS

SUMMARY OF ECONOMIC ANALYSIS METHODOLOGY

SUMMARY

The total cost of the proposed regulation to affected businesses is estimated to be $3.7 million annually over 10 years. This represents the cost of reducing emissions through abatement, alternative chemistries, process optimization, plus permit costs, and annual reporting and recordkeeping costs.

This appendix covers the methodology used in the Economic Analysis presented in Chapter VII. The methodology is similar to what was used in previous ARB regulations (ARB, 1990; ARB, 1991; ARB, 1997; ARB, 1999; ARB, 2000; ARB, 2003; ARB, 2004; ARB, 2005; ARB, 2007) and follows guidelines recommended by Cal/EPA for economic analysis (Cal/EPA, 1996).

METHODOLOGY

For this analysis, we considered the impact to semiconductor operations. Although other entities may be impacted, semiconductor operations will be the primary entities affected.

First, we analyzed data from ARB's survey of semiconductor operations in California to determine which operations would need to reduce their emissions. Thirteen businesses would need to reduce emissions. The survey results are summarized in Table C-1.

Table C-1
Survey Data Inputs for Cost Calculations

Category	Number of Operations in 2006	Number of Businesses in 2006	Number of Businesses After 2008	Number of Complying Businesses	Number of Non-Complying Businesses	Emission Reduction (MMT CO_2e)
Tier 1	5	5	4*	1	3	0.11
Tier 2	11	10	7*	4	3	0.03
Tier 3	12	12	12	5	7	0.04
Reporting Only	57	51	51	51	0	0
Total	**85**	**78**	**74**	**61**	**13**	**0.18**

* From the survey, we were informed that one business in Tier 1 (already in compliance) and three businesses in Tier 2 were planning on ceasing operation before the emission standards were proposed

Second, we evaluated what strategies each of the 13 businesses could use to comply with the emission standards. For abatement, we assumed businesses in Tier 1 and 2 would use end of pipe systems, and businesses in Tier 3 would use point of use systems.

For alternative chemistries, businesses would need to replace higher GWP gases with lower GWP gases or less efficient gases with more efficient gases to comply with the emission standards. While replacement gases would cost more than the existing gases, less of the replacement gases would be needed. Therefore, we considered the cost of using alternative chemistries as an emission reduction strategy to be zero.

Some businesses would need to optimize their processes to lower their emissions. This involves reducing emissions by improving the efficiency of their operations. The cost of this strategy is significantly less than the cost of the abatement strategy.

Based on the emission reductions needed by each business, Table C-2 shows the strategies by tier that would be required to comply with the emission standards.

Table C-2
Emission Reduction Strategies for Businesses

	Tier	Number of Businesses	Abatement Devices	Alternative Chemistries	Process Optimization
	1	3	6	3	1
	2	3	2	2	0
	3	7	11	3	3
Total		**13**	**19**	**8**	**4**

Third, we estimated the cost to comply with the regulation. The cost of reducing emissions includes abatement devices, alternative chemistries and process optimization, plus permit fees and annual reporting and recordkeeping costs. Capital costs and recurring costs were estimated based on discussions with industry and manufacturers (NEC, 2008; SIA, 2008).

Capital costs include the cost of equipment and installation and initial permitting costs. Recurring costs include operation and maintenance costs, as well as energy costs. In cases where a business provided us with an estimate of their cost to meet the emissions standards, we used the figures provided to us. Otherwise, it was estimated that a business using end of pipe abatement would incur $2.2 million dollars in initial capital costs, and have a recurring cost of $65,000 dollars per unit, and businesses using point of use abatement would incur $250,000 in initial capital costs, and have a recurring cost of $25,000 per unit. Businesses using process optimization to reduce emissions would incur an initial cost of $150,000. These cost estimates are summarized in Table C-3. All figures are in 2007 dollars.

Table C-3
Cost and Number of Emission Reduction Strategies

Strategy	Number of Devices	Estimated Cost for One Unit	Recurring Costs for One Unit	Total Initial Cost	Total Recurring Cost
End of Pipe Abatement	8	$2,200,000	$65,000	$17,600,000	$520,000
Point of Use Abatement	11	$250,000	$25,000	$2,750,000	$275,000
Process Optimization	4	$150,000	0	$600,000	0
Total				**$20,350,000**	**$795,000**

The non-recurring costs are annualized into discounted, equal annual payments when multiplied with an appropriate cost recovery factor (CRF), a standardized method recommended by Cal/EPA for annualizing costs (Cal/EPA, 1996) and is consistent with the methodology used in previous cost analyses of regulations by the ARB (ARB, 2000; ARB, 2007).

The CRF is calculated as follows:

$$CRF = \frac{i(1+i)^n}{(1+i)^n - 1}$$

where,

CRF = cost recovery factor
i = discount rate (assumed 5 percent)
n = project horizon or useful life of equipment (assumed 10 years)

All costs of the control devices are annualized over 10 years. The total annualized cost is obtained by adding the recurring costs to the non-recurring costs using the CRF method. Using this method, the CRF is 0.13, which represents the portion of the initial capital cost that is repaid each year over the life of the equipment.

Some businesses chose to provide us with their own cost estimate to comply with the emission standards. These estimates were used in place of our assumptions where appropriate. This resulted in an increase to the total initial cost to businesses that needed to reduce emissions by $1.3 million, or to a total of $21.8 million. Using the CRF of 0.13, this equates to annual costs of $2.8 million. Each of the 13 businesses would incur an annual cost of $600 for recordkeeping and reporting, and 11 businesses would incur an annual cost of $1,000 for permits. These costs will total $18,800 per year, as shown in Table C-4. Combined with the recurring cost from operation and maintenance of $795,000 per year, the total recurring cost is

$814,000 per year. The total cost to the 13 businesses that need to reduce emissions is estimated to be nearly $3.7 million per year. These costs are summarized by tier in Table C-4.

Table C-4
Total Costs to Businesses That Need to Reduce Emissions by Tier

Tier	Initial Costs	Recurring Costs	Costs for Recordkeeping, Reporting, and Permits	Total Annual Cost
1	$14,500,000	$390,000	$4,800	$2,280,000
2	$4,400,000	$130,000	$3.800	$700,000
3	$2,900,000	$275,000	$10,200	$680,000
Total	**$21,800,000**	**$795,000**	**$18,800**	**$3,660,000**

The cost for recordkeeping and reporting was estimated to be $600 dollars per year. As shown in Table C-5, the total cost is estimated to be $36,600 annually for businesses that do not need to reduce emissions. For the 61 businesses that do not need to reduce emissions, and only need to conduct recordkeeping and reporting, this would be the only cost incurred. This includes the 10 businesses that already comply with the emission standards, and the 51 businesses that are only required to keep records and submit annual reports.

Table C-5
Cost to Businesses That Do Not Need to Reduce Emissions

Number of Businesses	Cost for Recordkeeping and Reporting	Total Annual Cost
61	$600	$36,600

Cost-effectiveness was determined by dividing the total annual cost by the expected emission reduction. As shown in Table C-6, this ranged from $17 per metric ton of carbon dioxide equivalent reduced, to $23.40 per metric ton reduced. Overall, the cost-effectiveness of this regulation is estimated to be $21 per metric ton of carbon dioxide equivalent reduced.

Table C-6
Cost-Effectiveness by Tier

Tier	Total Annual Cost	Total Emission Reduction	Cost-Effectiveness
1	$2,280,000	0.11	$20.70
2	$700,000	0.03	$23.40
3	$680,000	0.04	$17.00
Total	**$3,660,000**	**0.18**	**$21**

REFERENCES

1. Air Resources Board. Executive Summary and Technical Support Document. Initial Statement of Reasons for Proposed Amendments to the California Consumer Products Regulation. (a.k.a. "Mid-Term Measures I"). June 6, 1997. (ARB, 1997)

2. Air Resources Board. Hearing Notice and Staff Report. Proposed Amendments to the California On-Road Motorcycle Regulation. October 1998. (ARB, 1998)

3. Air Resources Board. Initial Statement of Reasons for a Proposed Statewide Regulation to Reduce Volatile Organic Compound Emissions from Aerosol Coating Products and Amendments to the Alternative Control Plan for Consumer Products. February 3, 1995. (ARB, 1995)

4. Air Resources Board. Initial Statement of Reasons for the Proposed Amendments to the California Aerosol Coating Products, Antiperspirants and Deodorants, and Consumer Products Regulations, Test Method 310, and Airborne Toxic Control Measure for Para-Dichlorobenzene Solid Air Fresheners and Toilet/Urinal Care Products. May 7, 2004. (ARB, 2004)

5. Air Resources Board. Introduction and Executive Summary and Technical Support Document. Initial Statement of Reasons for Proposed Amendments to the California Consumer Products Regulation. (a.k.a. "Mid-Term Measures II"). September 10, 1999. (ARB, 1999)

6. Air Resources Board. Staff Report for the 2000 Suggested Control Measure for Architectural Coatings. June 2000. (ARB, 2000)

7. Air Resources Board. Staff Report for the 2007 Suggested Control Measure for Architectural Coatings. September 2007. (ARB, 2007)

8. Air Resources Board. Staff Report for the Proposed Suggested Control Measure for Automotive Coatings. October 2005. (ARB, 2005)

9. Air Resources Board. Staff Report. Proposed Alternative Control Plan Regulation for Consumer Products. August 1994. (ARB, 1994)

10. Air Resources Board. Technical Support Document. Proposed Amendments to the Statewide Regulation to Reduce Volatile Organic Compound Emissions from Consumer Products – Phase II. (a.k.a. "Phase II Consumer Products Regulation). October 1991. (ARB, 1991)

11. Air Resources Board. Technical Support Document. Proposed Regulation to Reduce Volatile Organic Compound Emissions from Consumer Products. (a.k.a. "Phase I Consumer Products Regulation). August 1990. (ARB, 1990)

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13. Hoovers.com. On-line financial database by subscription for selected publicly-owned companies. November 2008. (Dunn and Bradstreet, 2008)

14. NEC Electronics America, Inc. Discussions with manufacturer. December 2008. (NEC, 2008)

15. Semiconductor Industry Association. Letter. "Comments of the Semiconductor Industry Association on the California Air Resource Board's Draft Scoping Plan for AB 32." August 11, 2008. (SIA, 2008)

TITLE 17. CALIFORNIA AIR RESOURCES BOARD

NOTICE OF PUBLIC HEARING TO CONSIDER ADOPTING A REGULATION TO REDUCE SULFUR HEXAFLUORIDE EMISSIONS IN NON-SEMICONDUCTOR AND NON-UTILITY APPLICATIONS

The Air Resources Board (ARB or the Board) will conduct a public hearing at the time and place noted below to consider adopting a regulation to reduce sulfur hexafluoride use in non-semiconductor and non-utility applications. Sulfur hexafluoride (SF_6) is a potent greenhouse gas with a lifetime of 3,200 years and a one-hundred year global warming potential (GWP) of 23,900, the most potent greenhouse gas the IPCC has evaluated. The main uses of SF_6 in California that are not directly related to utilities or semiconductor manufacturing include:

- Magnesium casting operations
- Tracer gas (including fume hood testing, research, and bioterrorism studies)
- Medical uses (e.g. eye surgery)
- Military applications
- Other uses

This notice summarizes the proposed regulatory action. The staff report document presents the proposed regulation and information supporting the adoption of the regulation in greater detail.

DATE: February 26, 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. on February 26, 2009, and may continue at 8:30 a.m. on February 27, 2009. This item may not be considered until February 27, 2009. Please consult the agenda for the meeting, which will be available at least 10 days before February 26, 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 to the meeting date.

INFORMATIVE DIGEST OF PROPOSED ACTION AND POLICY STATEMENT OVERVIEW

Sections Affected:

Proposed adoption of California Code of Regulations (CCR), title 17, subchapter 10, article 4, new subarticle 3, sections 95340, 95341, 95342, 95343, 95344, 95345, and 95346.

Background:

In 2006 the Legislature passed and Governor Schwarzenegger signed the California Global Warming Solutions Act of 2006 (AB 32; Stats. 2006, chapter 488). In AB 32 the legislature declared that global warming poses a serious threat to the economic wellbeing, public health, natural resources, and the environment of California. The Legislature further declared that global warming will have detrimental effects on some of California's largest industries including agriculture and tourism, and will increase the strain on electricity supplies. While national and international actions are necessary to fully address the issue of global warming, the Legislature recognized that action taken by California to reduce emissions of greenhouse gases will have far-reaching effects by encouraging other states, the federal government, and other countries to act. AB 32 creates a comprehensive, multi-year program to reduce GHG emissions in California, with the overall goal of restoring emissions to 1990 levels by the year 2020. AB 32 requires ARB to do many things, including:

- Establishing a statewide GHG emissions cap for 2020, based on 1990 emissions;
- Adopting a scoping plan by January 1, 2009, indicating how emission reductions will be achieved from significant GHG sources via regulations, market mechanisms and other actions;
- By June 30, 2007, adopting a list of discrete, early action GHG emission reduction measures that can be implemented and enforced no later than January 1, 2010;and
- By January 1, 2010, adopting regulations to implement the measures identified on the list of discrete early action measures.

In 2007 the Board approved a list of nine discrete early action measures. The list includes a measure entitled: "SF_6 reductions from non-electric and non-semiconductor applications." The proposed regulation is designed to implement this measure.

DESCRIPTION OF THE PROPOSED REGULATORY ACTION

The proposed regulation would achieve GHG emission reductions from SF_6 use in non-semiconductor and non-utility applications through a phase-out of use over the next several years. The regulation has several components in order to achieve the emission reductions from this sector. Cost-effective alternatives are available for most

applications but may need to be tested and proven effective and usable. To allow for this testing, the regulation includes a phase-in period for particular uses. The use and sales requirements do exclude a limited number of uses such as in eye surgeries. In addition, the regulation includes a process to apply for an exemption to the restrictions if one of two criteria is met: 1) uses of sulfur hexafluoride that result in reduced greenhouse gas emissions; or 2) uses of sulfur hexafluoride with no alternatives.

Applicability

The proposed regulation would apply to any individual who uses, possesses, purchases, distributes, manufactures, offers for sale, or sells SF_6, with a limited number of exemptions. Potential affected groups include manufacturers and distributors of SF_6, engineering firms and other who conduct tracer tests, magnesium casters, and others who use the goods or services of those industries or individuals.

The regulation exempts uses covered by other regulations. These include chemical vapor deposition (CVD) chamber cleaning and etching uses of SF_6 as well as dielectric or arc quenching medium uses. Additional exemptions include uses which have been determined by the Executive Officer to meet one of the two criteria for an exemption: 1) uses of sulfur hexafluoride that result in reduced greenhouse gas emissions; or 2) uses of sulfur hexafluoride with no alternatives.

Phase Out

This regulation would achieve GHG emission reductions from SF_6 use in non-semiconductor and non-utility applications through a phase-out of use over the next several years. Cost-effective alternatives are available for most applications but may need to be tested and proven effective and usable. To allow for this testing, the regulation includes a phase-in period for particular uses. The use and sales requirements do exclude a limited number of uses such as in eye surgeries. In addition, the regulation includes a process to apply for an exemption to the restrictions if one of two criteria is met: 1) uses of sulfur hexafluoride that result in reduced greenhouse gas emissions; or 2) uses of sulfur hexafluoride with no alternatives. The regulation also includes a registration, record-keeping, and reporting requirement for distributors of SF_6 and a record-keeping requirement for purchasers of SF_6.

Notice to Purchasers

The proposed regulation specifies that anyone who sells SF_6 within California must provide a copy of the final regulation to customers who have purchased SF_6. Documentation must be retained for a period of three years.

Registration, Reporting and Record-keeping

Anyone who sells SF_6 within California must register with ARB. The sellers must retain invoices for at least three years and provide an annual report to ARB including the sales by buyer and amount.

Impacts

Implementation of this regulation would reduce emissions by 0.10 million metric tonnes of carbon dioxide equivalent ($MMTCO_2E$) annually or more than 60 percent from business as usual. The regulation would affect approximately 50 - 125 businesses including 4 magnesium casters, 30 - 60 tracer gas users and other users such as universities, aerospace industry, defense industry, and national labs. Alternatives are available for most applications and an exemption process is incorporated. The regulation would also impact distributors and manufacturers of SF_6. In addition to affecting current uses and users, this regulation would act as a barrier against new uses of SF_6. The proposed regulation achieves emission reductions in a cost-effective manner.

COMPARABLE FEDERAL REGULATIONS

There are no comparable federal regulations.

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 Executive Summary* of the ISOR provides an overview of the proposed amendments to the Statewide 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, First Floor, Sacramento, California 95814, (916) 322-2990 at least 45 days prior to the scheduled hearing on February 26, 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. Jorn Herner, Manager of the Greenhouse Gas Technology and Field Testing Section, at (916) 324-9299 or by email at jherner@arb.ca.gov or Elizabeth Scheehle, Air Pollution Specialist, Greenhouse Gas Technology and Field Testing Section, (916) 324-0621 or by e-mail at escheehl@arb.ca.gov.

Further, the agency representative and designated back-up contact persons to whom non-substantive inquiries concerning the proposed administrative action may be directed, are Lori Andreoni, Manager, Board Administration & Regulatory Coordination Unit, (916) 322-4011, or Trini Balcazar, Regulations Coordinator, (916) 445-9564. 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/nonsemi09/nonsemi09.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 not create costs or savings 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.

In developing this regulatory proposal, ARB staff evaluated the potential economic impacts on representative private persons or businesses. The sector as a whole is expected to experience a total annualized cost of approximately $200,000. A typical business will experience an annualized cost of around $20,000 and small businesses will have a similar cost. Initial costs are expected to be around $30,000 to $50,000 with small annual costs. Specialized firms with large uses will experience greater costs.

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 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. The record-keeping is expected to be in line with normal business book keeping operations.

The Executive Officer has also determined, pursuant to title 1, CCR, section 4, that the proposed regulatory action would affect small businesses.

In accordance with Government Code sections 11346.3(c) and 11346.5(a)(11), 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 by e-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, February 25, 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 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 in Health and Safety Code, sections 38510, 38560, 38560.5, 38580, 39600, 39601, 41510, 41511, and 41513. This action is proposed to implement, interpret, and make specific sections 38560, 38560.5, 38580, 39600, 39601, 41510, 41511, and 41513.

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, First Floor, Sacramento, California 95814, (916) 322-2990.

CALIFORNIA AIR RESOURCES BOARD

Michael H. Scheible

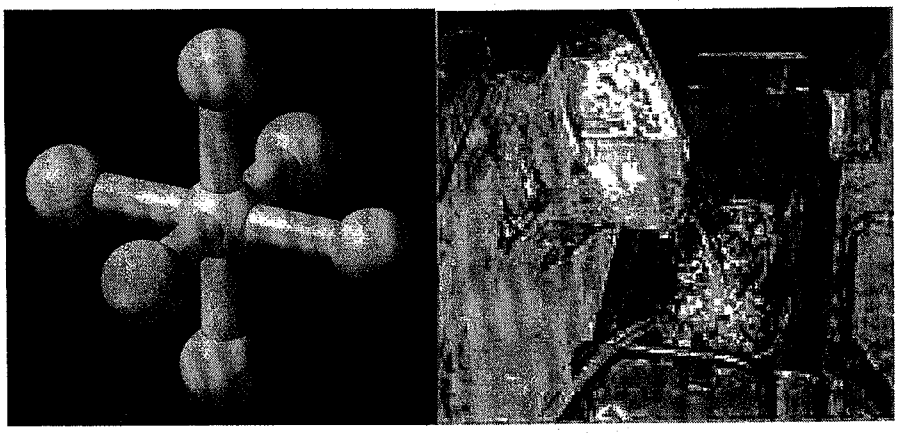
for James N. Goldstene
Executive Officer

Date: December 30, 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 REDUCTION OF SULFUR HEXAFLUORIDE FROM NON-SEMICONDUCTOR AND NON-UTILITY APPLICATIONS

Release Date:
January 9, 2009

State of California
AIR RESOURCES BOARD

INITIAL STATEMENT OF REASONS FOR PROPOSED RULEMAKING

Public Hearing to Consider

ADOPTION OF THE PROPOSED REGULATION FOR REDUCTION OF SULFUR HEXAFLUORIDE EMISSIONS FROM NON-SEMICONDUCTOR AND NON-UTILITY APPLICATIONS

To be considered by the California Air Resources Board
On February 26-27, 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 REDUCTION OF SULFUR HEXAFLUORIDE EMISSIONSFROM NON-SEMICONDUCTOR AND NON-UTILITY APPLICATIONS

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January 9, 2009

ACKNOWLEDGEMENTS

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

Stakeholders including Thomas Rappolt, Tracer ES&T; Larry Wong. University of California; Kurt Werner and Dean Milbrath, 3M, Robert Mueller, Airgas; the magnesium industry, and others. We thank staff from Cal/OSHA – Michael Horowitz and Steve Smith; Office of Environmental Health Hazard Assessment – John Budroe; and US EPA – Scott Bartos. We also thank ARB staff members Mike Orbansky, Russell Grace, Barbara Fry, Terrel Ferreira, Dale Trenschel, David Mehl, Judy Lewis, and Ryman Simangan for their assistance on this regulation. The photograph on the cover is courtesy of 3M.

DISCLAIMER

This report has been prepared by the staff of the Air Resources Board. Publication does not signify that the contents reflect the views and policies of the Air Resources Board, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

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ABBREVIATIONS AND ACRONYMS

AB 32	Assembly Bill 32, California Global Warming Solutions Act of 2006
ARB	Air Resources Board
ASHRAE	American Society of Heating, Refrigeration, and Air Conditioning Engineers
Cal/OSHA	California Occupational Safety and Health Administration
DoD	US Department of Defense
GHG	Greenhouse gas
GWP	Global warming potential
IPCC	Intergovernmental Panel on Climate Change
N_2O	Nitrous Oxide
PFC	Perfluorocarbon
ppmv	parts per million by volume
$MTCO_2E$	Metric ton of carbon dioxide equivalents
$MMTCO_2E$	Million metric tons of carbon dioxide equivalents
PY	Person years
SF_6	Sulfur hexafluoride
U.S. EPA	U.S. Environmental Protection Agency

EXECUTIVE SUMMARY

The California Global Warming Solutions Act of 2006 (AB 32) 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 beginning as soon as possible. Sulfur hexafluoride (SF_6) reductions from non-semiconductor and non-utility applications is a proposed Discrete Early Action measure (ARB, 2007a). Uses of SF_6 in semiconductor and utility and related applications will be covered by two other early action measures, one of which is also a Discrete Early Action measure.

Why Regulate Sulfur Hexafluoride?

Sulfur hexafluoride is a potent greenhouse gas with a lifetime of 3,200 years and a one-hundred year global warming potential (GWP) of 23,900, the most potent greenhouse gas the Intergovernmental Panel on Climate Change (IPCC) has evaluated (IPCC, 2007). In the last five years, atmospheric concentrations have been growing at a rate of 5% per year (NOAA, 2008). The growth rate could be the result of increasing emissions in any or all emission sectors. Without intervention it is anticipated that the growth rate will continue at a similar rate for the next several years. Given these characteristics and the availability of alternatives, SF_6 use warrants scrutiny, particularly in the emissive applications covered by this proposed regulation.

What Sources of Sulfur Hexafluoride Will Be Covered By This Regulation?

The main applications covered by the proposed regulation include magnesium casting, tracer gas uses, medical uses, and product uses. Sulfur hexafluoride is used as a cover gas in magnesium casting to prevent oxidation that could lead to product defects. Tracer gas applications use SF_6 to analyze a system. The tracer gas is released into a system to be tracked. It is subsequently measured or collected and analyzed to determine how a gas or the gas' media moves through the system. The specific uses are many and varied, ranging from atmospheric transport simulation to groundwater flow analysis, to testing building ventilation systems. The most common use of SF_6 in medical applications is for retinal detachment surgeries. Finally, SF_6 has previously been used in products such as tennis balls and tennis shoes. Although our efforts, including literature reviews, contacting tennis ball manufacturers, and an analysis by ARB's Monitoring and Laboratory Division's, concluded no current uses, the regulation will serve as a barrier against new uses.

What Are The Requirements of the Proposed Regulation?

This regulation would achieve GHG emission reductions from SF_6 use in non-semiconductor and non-utility applications through a phase-out of use over the next several years. Cost-effective alternatives are available for most applications but may need to be tested and proven effective and usable. To allow for this testing, the regulation includes a phase-in period for particular uses. The use and sales requirements do exclude a limited number of uses such as in eye surgeries. In addition, the regulation includes a process to apply for an exemption to the restrictions if one of two criteria is met: 1) Uses of sulfur hexafluoride that result in reduced greenhouse gas emissions or 2) essential use with no alternative. The regulation also includes a registration, record-keeping, and reporting requirement for distributors of SF_6, and record keeping for users of SF_6.

What Are the Emissions and Expected Reductions?

The estimate for current annual emissions from non-semiconductor and non-electric utility uses in California is 0.15 $MMTCO_2E/yr$ (million metric tons carbon dioxide equivalent per year). Reductions of SF_6 from these uses will be close to 100% but there may be increases in emissions of other gases due to this substitution. We do not expect any adverse impacts from the alternatives. Using conservative estimates for the increase in other greenhouse gases, staff estimate that the reduction will be no less than 0.10 $MMTCO_2E$ from 2007 levels. Reductions from the 2020 baseline may be higher but emission projections are not available for SF_6.

Who Will Be Impacted By The Regulation?

The proposed regulation would apply to any individual who uses, possesses, purchases, distributes, manufactures, offers for sale, or sells sulfur hexafluoride or products containing sulfur hexafluoride in California, with a limited number of exemptions. Potential affected groups include manufacturers and distributors of SF_6, engineering firms and others who conduct tracer tests, magnesium casters, and others who use the goods or services of those industries such as universities and laboratories.

What Are The Expected Costs?

Total annualized costs are expected to be less than $200,000 for the entire regulation. The annualized costs for a typical magnesium caster would be around $4,000 and for an engineering firm with significant tracer work, a typical annualized cost would be less than $20,000. The estimated cost per metric ton of CO_2E ($MTCO_2E$) reduced (in 2007 dollars) is approximately $2.00 for all sectors with the magnesium sector cost-effectiveness at around $0.30/$MTCO_2E$ reduced and tracer gas cost-effectiveness at approximately $3.70/$MTCO_2E$. For tracer gas uses, due to the higher cost of alternatives, it is anticipated that industry will

experience a slight loss in profit but not significant enough to cause adverse impacts.

Was There a Public Process To Develop The Regulation?

Staff worked closely with stakeholders throughout the development process of this regulation. Staff held three public workshops and two working group meetings in Sacramento with an additional magnesium-specific working group meeting in Los Angeles and a tracer gas-specific working group conference call. The public process proved valuable information that fed into the phase-out schedule and exemption development.

I. INTRODUCTION

A. OVERVIEW

In this rulemaking, California Air Resources Board (ARB or Board) staff is proposing a regulation to reduce SF_6 emissions. The regulation is codified in Title 17, California Code of Regulations, sections 95340 – 95346. The proposed regulation is deigned in accordance with the Discrete Early Action Measure requirements set forth in the California Global Warming Solutions Act of 2006 (AB 32).

B. ENABLING LEGISLATION

In 2006, The Global Warming Solutions Act (AB 32) was signed into law. This law created a comprehensive, multi-year program to reduce greenhouse gas emissions in California. AB 32 added section 1, division 25.5 (commencing with section 38500) to the California Health and Safety Code. These sections require ARB to develop a Scoping Plan and consider regulations, market mechanisms, incentives, and other approaches to ultimately reduce California's GHG emissions equivalent to the 1990 baseline year by 2020. Among other things, AB 32 requires ARB to make immediate progress towards the reduction of GHG emissions. Discrete Early Action Measures are to be identified and regulations are to be adopted and enforceable by January 1, 2010. Beyond the requirements of AB 32, the Governor's Executive Order S-03-05 calls for an additional GHG reduction of 80 percent below 1990 levels by 2050. Additionally, the Scoping Plan proposed by ARB includes a provision for ongoing reductions beyond 2020.

C. EARLY ACTION PROCESS

AB 32 required ARB to identify a list of Discrete Early Action Greenhouse Gas Reduction Measures by June 30, 2007. These actions are to be adopted and legally enforceable (approved by the Office of Administrative Law) by January 1, 2010. Reduction of SF_6 from emissive applications (non-semiconductor and non-utility) was placed on the list of recommended Discrete Early Actions that the Board considered and approved at its October 2007 hearing. By approving the list, the Board directed staff to work through its traditional regulatory process with stakeholders to develop a recommendation for its consideration. The proposed regulation for the mitigation of SF_6 emissions that is the subject of this report is the culmination of the public process that has occurred over the past year.

D. BACKGROUND

Sulfur hexafluoride (SF_6) is a potent greenhouse gas with a lifetime of 3,200 years and a one-hundred year global warming potential (GWP) of 23,900, the most potent greenhouse gas the IPCC has evaluated, as shown in Figure 1 (IPCC, 2007). In the last five years, atmospheric concentrations have been growing at a rate of 5% per year (NOAA, 2008). The growth rate could be the result of increasing emissions in any or all emission sectors. However, given the long lifetime of SF_6, even declining emissions will result in an increasing atmospheric concentration. Further, without intervention it is anticipated that the

Figure 1 - 100 year Global Warming Potentials

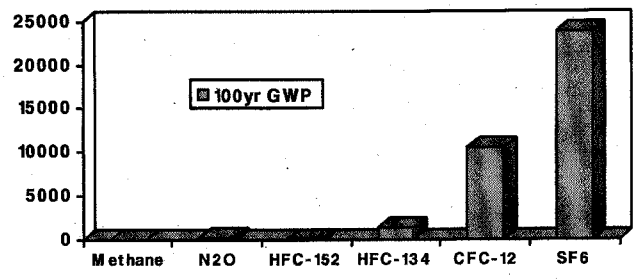

Figure 1 – 100 year Global Warming Potentials

growth rate will continue at a similar rate for the next several years. Given these characteristics, SF_6 use warrants scrutiny, particularly in emissive applications.

SF_6 emissions from non-semi-conductor and non-utility applications in California are 0.15 $MMTCO_2E$ and, based on sales data, global emissions are greater than 11 $MMTCO_2E$. Although a modest contribution to the AB 32 reduction goal of 169 $MMTCO_2E$, the measure is in combination with numerous other High GWP GHG measures that together achieve an expected reduction of over 20 $MMTCO_2E$. In addition, this measure will not only influence the policies of other states and countries, but also incentivize research into alternatives that could have a global impact.

SF_6 is used in a multitude of sectors including the use by utilities as well as the semiconductor industry, both of which will be addressed under separate measures developed by ARB staff. This regulation focuses on the non-utility/semiconductor-related emissions of SF_6 but includes registration and reporting requirements for all distributors of SF_6. The main uses of SF_6 in California that are not directly related to utilities or semiconductor manufacturing include:

- Magnesium casting operations.

- Tracer gas (including fume hood testing, research, and bioterrorism studies).
- Medical uses (e.g. eye surgery).
- Other uses including for military purposes.

Not listed are SF_6 usage as an etchant in electronics manufacture and use as an insulator for particle accelerators, which will be covered by the semiconductor and utility measures, respectively.

The above sources generate approximately 0.15 million metric tons carbon dioxide equivalent ($MMTCO_2E$) in emissions annually, primarily in tracer gas uses and magnesium casting operations. The regulation would affect approximately 50-125 businesses including 4 magnesium casters, 30-60 tracer gas users (primarily engineering firms), and other users such as universities, national labs, and others. The regulation would also impact distributors and manufacturers of SF_6. In addition to affecting current uses and users, this regulation would act as a barrier against new uses of SF_6.

Further, this regulation could also influence national and international regulatory approaches. As the U.S. and other countries move forward with climate change goals, this and other California regulations may serve as a guideline if successively implemented. The changes made in accordance with this goal could also have larger impacts by pushing technology to alternatives that are then utilized by the global community.

E. STAFF RECOMMENDATION

The proposed regulation specifies a phase out on the use of SF_6 in the covered uses. A copy of the regulation can be found in Attachment A. The proposal achieves the maximum technically feasible reductions in a cost-effective manner. The sources are emissive so capture and recycling is not an option. Alternatives are available for most applications but may need to be tested and proven usable. To allow for this testing, the regulation includes a phase-in period for particular uses. Performance standards were considered but these are emissive sources with cost effective and technologically feasible alternatives available. Performance standards would be difficult to implement with the large number of varied uses, particularly in the tracer gas sector.

The use and sales requirements do exclude a limited number of uses such as in eye surgeries. In addition, the regulation includes a process to apply for an exemption to the restrictions if one of two criteria is met. The two criteria are: 1) uses of sulfur hexafluoride that result in reduced greenhouse gas emissions or 2) an alternative is not available for a specific essential use. The conditional exemptions allow use where necessary or logical but put the onus of proof on the user. The excluded uses mentioned earlier either fall into one of these two categories or are being regulated under another measure. In addition to the use

and sales restrictions, the regulation includes registration and reporting requirements for distributors of SF_6, and required recordkeeping for users of SF_6. An upstream fee on high global warming potential gases, proposed in the Scoping Plan, will serve as a complement to this regulation by adding the greenhouse gas impact into the cost of SF_6 and thus incentivizing research into alternatives for the exempted uses.

Staff estimate that the current annual emission from non-semiconductor and non-electric utility uses is 0.15 $MMTCO_2E/yr$. Reductions of SF_6 from these uses will be close to 100% but there may be increases in emissions of other gases due to this substitution. We do not expect any adverse impacts from the alternatives. Using conservative estimates for the increase in other greenhouse gases, staff estimate that the net reduction will be no less than 0.10 $MMTCO_2E$ from 2007 levels. Reductions from the 2020 baseline may be higher but reliable projections are not available. The estimated cost per metric ton of CO_2E reduced (in 2007 dollars) is estimated at approximately $\$2.00/MTCO_2E$ for all sectors with the magnesium sector cost-effectiveness at around $\$0.30/MTCO_2E$ reduced and tracer gas cost-effectiveness at approximately $\$3.70/MTCO_2E$. It is anticipated that industry will experience a slight loss in profit but not significant enough to cause adverse impacts.

Staff worked closely with stakeholders throughout the development process of this regulation. Staff held three public workshops and two working group meetings in Sacramento with an additional magnesium-specific working group meeting in Los Angeles and a tracer gas-specific working group conference call. The public process provided valuable information that fed into the phase-out schedule and exemption development.

Staff recommends that the Board adopt the regulation for several reasons. Sulfur hexafluoride is a very potent greenhouse gas and this regulation achieves emission reductions in a cost-effective manner. Alternatives are available and an exemption process is provided to allow necessary uses. In addition, this regulation not only addresses current uses but any uses that may evolve over time. In the past, SF_6 has been used unnecessarily in products such as athletic shoes and this regulation will eliminate both current and future non-essential uses.

II. AFFECTED INDUSTRIES

This chapter will describe the four main uses and associated industries affected by this regulation: magnesium casting, tracer gas users, medical uses, and other uses.

Magnesium casting

SF_6 is used in magnesium casting and production. California has no production and four casting facilities. In casting, SF_6 is used as a cover gas to prevent the rapid oxidation of molten magnesium in the presence of air. This is accomplished when a small portion of the SF_6 reacts with the magnesium to form a thin molecular film of mostly magnesium oxide and magnesium fluoride (EPA, 2007a).

There are three types of magnesium casting in California: die-casting, sand casting, and investment casting. Sand and investment casting involve higher temperatures and a more open process so not all options for alternatives available for die-casting are available for sand and investment casting. The four California facilities include three sand casters and one die caster. One of the companies also does investment casting.

Tracer uses

SF_6 has proven to be a good tracer gas for several reasons. It is not found naturally in the environment and background levels are close to zero. In addition to the low background levels, SF_6 is measurable at low concentrations. It is also generally considered to be non-toxic and inert and resistant to microbial degradation. Alternatives must be able to satisfy similar characteristics, depending on the use.

ARB has defined the following tracer gas categories:

- Atmospheric transport
  - Model validation
  - Definition of source/receptor relationships
  - Identification of single source impact in multi-source location
  - Micro-scale impact analysis (i.e., Environmental Justice neighborhoods)
- Characterization of ventilation systems:
  - Fume hood
  - Building ventilation
- Air infiltration studies
  - Energy audit
  - Test adequacy of shelters for biochemical attacks
- Leak testing
  - Automotive
  - Pipes
  - Underground reservoirs
  - Piping systems
  - Heat exchangers
  - Others
- Characterizing flow patterns
  - Underground petroleum reservoirs

  - Potable water reservoirs
  - Water distribution grid
- Other uses including for military purposes

Characterization of ventilation systems includes several test types that may be amenable to reduction options. In particular, fume hood testing is a use with potentially large emissions. Current state law includes requirements for fume hood testing, including a tracer gas test, on hoods to be run at a lower face velocity, which saves energy and associated greenhouse gas emissions. Although the tracer tests are not required for all new hoods, many facilities choose to test all new hoods according to this accepted standard (ANSI/ASHRAE 110), which prescribes both the emission rate and duration of the test. The current ANSI/ASHRAE standards require the use of SF_6 as the tracer gas but allow for alternate gases if SF_6 is not suitable for the type of fume hood being tested and if the alternative gas meets certain criteria. The test requires approximately 1.5 – 1.75 pounds of SF_6 use per hood test which corresponds to approximately 16 metric tons of CO_2-equivalent gas released per hood test.

Given the wide variety of uses, several industries will be affected by the proposed regulation. The main affected industry will be engineering firms which conduct many of the tests for other organizations such as universities. Most of these firms conduct many different types of engineering services but a few specialize in tracer uses and will be the most impacted by the regulation. Laboratories and universities may conduct tracer studies but these are usually on an irregular basis and may not be every year. Many firms will be indirectly impacted by services conducted by contractors. For example, fume hood testing or building ventilation testing is often conducted by outside contractors. The costs for these services may increase. Indirectly impacted organizations include universities, laboratories, government agencies, biotechnology firms, and others.

Medical Uses

Medical uses of SF_6 include eye surgery and ultrasound imaging. In eye surgery, SF_6 is used in retinal detachment related operations. SF_6 is used as an insulator in X-ray machines. Additionally, one type of ultrasound imaging utilizes SF_6 micro-bubbles as a contrast agent to enhance blood vessel visibility; however this ultrasound technology is not currently marketed in the United States. This technique may be viable for other contrast applications. Given the superiority of SF_6 in this use and the public health concerns, medical uses are exempt from the phase-out.

Other

The identified uses in this category are in consumer products and recreational uses (magic tricks) and for military purposes.

Since SF_6 is very dense, many objects will float on top of it and since the gas is also clear, those objects appear to float in mid-air. Additionally, SF_6 can deepen people's voices, similar to helium's effect on increasing the pitch of your voice.

In addition to magic tricks, SF_6 has been used in several other products. For example, it can remain in rubber insulated products for an extended period of time and provides a shock absorption that is useful in products such as tennis balls and shoes. Tennis balls, tennis shoes, and tires have all used SF_6 for the above reasons. SF_6 use in tennis shoes was eliminated in the late 1990s. Tires and sound-proof windows made in Germany and other European countries used SF_6 but these uses have also been discontinued. The only remaining anecdotal use is in tennis balls. Although mentioned in several publications, no evidence of SF_6 in tennis balls is available. ARB's Monitoring & Laboratory Division tested different brands and types of tennis, racquet, and squash balls and none contained SF_6 above the detection limit of 5 ppm. Additionally, staff inquired with the product manufacturers and received responses from 3 of the major tennis ball manufacturers. The responses confirm that SF_6 is not currently used in their products.

Sulfur hexafluoride is also used for military purposes. The amount and type of uses are highly uncertain.

III. DEVELOPMENT OF PROPOSED REGULATION

This Chapter contains a description of the public process used to develop the proposed regulation. The Administrative Procedures Act (APA) (Government Code section 11340 *et seq.*) requires that the development of regulations must allow for public input. This Chapter also describes the staff's evaluation of emission reduction opportunities and alternatives to the final proposal that were considered.

A. PUBLIC PROCESS FOR DEVELOPING PROPOSED REGULATION

In this Chapter, we describe our process to involve the public in developing the proposed regulation, and the staff's evaluation of emission reduction strategies. In order to involve the public, we developed a technical working group that was open to any member of the public. The technical working group was instrumental in the development of the regulation. In addition, we held three public workshops to garner further input.

ARB identified and conducted outreach to involve stakeholders in the development of the proposed regulation. ARB staff established a list serve and

developed and continually updated a website for this measure. The list serve and website were mentioned throughout the workshops, workgroup meetings, and during individual stakeholder consultations. Staff contacted specific organizations including US EPA, Cal/OSHA, and ASHRAE. Staff also identified specific companies that could be impacted and contacted them. Specific magnesium companies, engineering firms, gas distributors, and gas manufacturers were contacted. The Environmental Justice Advisory committee (Health and Safety Code 38591) was informed of the measure and list serve.

As part of the process, in June 2008, ARB conducted a survey of SF_6 users, manufacturers, and distributors. See Appendix B for a copy of the blank surveys and a summary of results. The intent of the survey was to determine emission estimates in 2007, and in the base-year of 1990 as well as to evaluate options and alternatives and the associated costs to reduce SF_6 emissions. Table 1 details the meeting dates, coverage and outcomes.

Sulfur hexafluoride manufacturers, distributors, trade associations, and various other stakeholders, have actively participated in the process. Representatives from local air districts and federal agencies have also been involved in the process.

Table 1 – Summary of Public Process

Type of Meeting	**Date (2008)**	**Coverage**	**Major Comments or Outcomes**
Public Workshop	February 15	Kick-off	Workgroup formation
Working Group Meeting	March 27	1. Regulatory Options 2. Cal/OSHA regulation for fume hoods 3. Tracer gas uses of SF_6	ARB action: Letter to ASHRAE (American Society of Heating, Refrigerating, and Air Conditioning Engineers) requesting change to standard 110 for fume hood testing
Working Group Meeting	May 28	Draft staff analysis: 1. Emissions 2. Reductions 3. Costs 4. Initial Preferred Approach	No major concerns or action items.
Tracer Specific Working Group Call	July 2	Update on change to preferred approach for tracer uses	Concern over some uses. ARB action: Exemption process should deal with these concerns.
Public Workshop	July 30	Draft staff analysis: 1. Emissions 2. Reductions 3. Costs 4. Initial Preferred Approach	Concerns voiced over magnesium sector phase out. ARB action: Hold magnesium specific meeting to discuss issues.
Magnesium Specific Working Group Meeting	August 25	Reduction options, research options, and draft regulatory language	Concerns about acceptance by buyers. ARB action: ARB and EPA to draft a letter to major magnesium parts buyers.
Public Workshop	September 29	Draft Regulatory language	Participants requested exemptions for research, DoD, and fume hood testing. ARB response: Request additional data on DoD and research needs

			(what uses, availability of alternatives?). Current exemption process addresses sources. Staff believe that there are adequate alternatives for fume hood testing either currently or in development.

B. STAFF EVALUATION OF EMISSION REDUCTION OPPORTUNITIES

Development of the proposed regulation began with a review of scientific literature, voluntary industry programs, and federal government programs. This process led to the identification of four potential source categories: tracer uses, magnesium casting, medical uses, and other uses (magic tricks and products such as tennis shoes and tennis balls).

Staff identified key stakeholders including industry, trade organizations, and government. Staff then developed a survey to ascertain emissions, reduction options, costs of reduction options, and identify additional stakeholders for each sector. Recipients of the survey included universities, national labs, manufacturers, distributors, trade organizations, and individual companies. The survey requested the following information from users:

- Amount of SF_6 used or emitted in 2007 by type of use
- Supplier
- Amount used per activity
- Use for 1990 and 2004-2006
- Price for SF_6
- Expected cost for an alternative gas and any change in equipment needed for use of an alternative

For manufacturers and distributors the following information was requested:

- Sales to California users and distributors in 2007
- Sales by end-use category
- Information on typical cylinders
- Wholesale and retail prices

Appendix B provides a copy of the distributed survey and an aggregate of the results.

In addition to the survey, ARB obtained information on emissions and mitigation options from the U.S. EPA. The U.S. EPA has a voluntary program to reduce SF_6 emissions from the magnesium sector. Member companies have agreed to

voluntarily phase-out the use of SF_6 in the magnesium industry by the end of 2010. The program has been successful at reducing SF_6 use and finding cost-effective alternatives in the magnesium sector nationally. National reductions are projected at 1 $MMTCO_2E$ for 2007 and over 4 $MMTCO_2E$ by 2011 (EPA 2008). Although two of the four casters are part of this program, neither has switched to an alternative gas. U.S. EPA data and technical reports provided a starting basis for the analysis.

The technical workgroup served an invaluable role in this analysis by providing data on emission reduction opportunities. Based on information from the literature, ARB's survey, U.S. EPA, and the technical working group, staff developed specific proposals and alternatives and presented them to the workgroup and public. Staff made some modifications to the original proposal after consideration and evaluation of comments.

C. ALTERNATIVES CONSIDERED

Government Code section 11346.2 requires ARB to consider and evaluate reasonable alternatives to the proposed regulation and provide reasons for rejecting those alternatives. Staff identified three alternative approaches to the current proposal: "No Action", "Fee on SF_6 use in non-utility and non-semiconductor applications", or "Establishing Performance Standards".

Alternative One – No Action

A "No Action" alternative would be to forego adopting the proposed regulation or delay adoption of the proposed measures. The "No Action" alternative would have no cost to business, however doing nothing would result in failing to make progress in reducing the use of SF_6, a greenhouse gas with a GWP 23,900 higher than CO_2. .

Alternative Two – Fee on SF_6 use in non-utility and non-semiconductor applications

Staff evaluated the option of a fee, based on the amount of CO_2 equivalent tons emitted. Staff determined that a fee on a subset of SF_6 emissions would be difficult to both implement and enforce, and it does not account for total greenhouse gas reductions. In many cases, there are cost-effective alternatives available thus the phase-out. However, to the extent that there are not viable alternatives an upstream fee may serve as a complement to the proposal.

Alternative Three – Establishing Performance Standards

Staff evaluated the option of establishing performance standards. A performance standard could be a set amount of SF_6 emissions per a given time or event constraint. For illustrative purposes, a tracer use might have a standard of 0.5 pounds of SF_6 per test. Given the wide variety of uses covered by this regulation, performance standards would need to be developed for a large number of uses. The development of the numerous standards would be time and resource intensive and the resulting regulations would either be burdensome to implement and enforce and would likely cost more than the recommended proposal.

For this regulation, staff is proposing a phase out of all SF_6 use in the emissive sources covered by this regulation with limited exemptions. This action would result in reductions, and make progress towards ARB's commitments. The recommendation is based on the fact that for many uses technologically feasible and cost-effective alternatives are currently available.

IV. STATUTORY REQUIREMENTS FOR EMISSION REDUCTIONS

In this Chapter, we describe State law requirements related to setting greenhouse gas limits, and how our proposals meet these criteria. We also provide the information which indicates the limits are commercially and technologically feasible in the timeframes provided.

A. GHG REDUCTIONS

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. Reduction of SF_6 from emissive applications (non-semiconductor and non-utility) was placed on the list of recommended Discrete Early Actions that the Board considered and approved at its October 2007 hearings. By approving the list, the Board directed staff to work through its traditional regulatory process with stakeholders to develop a recommendation for its consideration. The proposed regulation for the mitigation of SF_6 emissions that is the subject of this report is the culmination of the public process that has occurred over the past year.

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.

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 proposal was developed in consultation with affected parties in an open, public process through three public workshops, technical working group meetings, and several individual consultation meetings. Section III discusses the public process that was followed to develop the proposed regulation.

2. **Design the regulations, including distribution of emissions allowance 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 proposed regulation results in emission reductions with covered uses required to eliminate SF_6 use in California. In addition to achieving significant reductions, the regulation has a weighted total cost-effectiveness of approximately $2.00 per metric ton of carbon dioxide equivalents. See Chapter VII, Economic Impacts, for the detailed description. Most applications occur throughout the state but all magnesium casters are located in the Los Angeles area, therefore, the largest reductions will occur in this area.

Nothing in the regulation discourages early action to reduce GHG emissions. In fact, two of the four magnesium casters in California have already agreed to eliminate SF_6 use by 2010.

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

Emissive uses of SF_6 occur throughout the state but one sector (magnesium casters) is concentrated exclusively in the Los Angeles area. Compliance with this proposal will require the use of an alternative gas but U.S. EPA studies have shown that the alternatives do not pose an occupational or community concern (US EPA 2006, 2008). The level of use is small and sporadic. Therefore, residents living near a magnesium caster would not be disproportionately impacted. Magnesium parts are used in many products with California casters focused largely on aerospace, vehicular, and military uses. The cost of these products is not expected to increase due to this regulation so consumers will not

be impacted significantly. Additionally, these products are not used disproportionately by low-income communities. Tracer gas use is not based on population or income level. The measures are low cost and not expected to translate into a discernable increase to the price of goods or services.

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.**

Two of the four magnesium casters in California have agreed to voluntarily reduce their greenhouse gas emissions by 2010. The regulation takes into account the efforts underway to meet that target and has implemented a phase in date of 2013 to ensure adequate testing time to meet the target.

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.**

Elimination of SF_6 will not cause a significant increase in criteria or toxic air pollutants. The most promising alternatives for magnesium casting include a carrier gas mixed with either SO_2 or a fluorinated ketone and others. We do not expect the use of alternatives to interfere with efforts to achieve and maintain federal and state ambient air quality standards and to reduce toxic air contaminant emissions.

6. **Consider cost-effectiveness of these regulations**

The cost-effectiveness of the regulation is $2.00 per metric ton of carbon dioxide equivalents. See Chapter VII for more details on the cost-effectiveness calculation.

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 will benefit from the reduction of GHG emissions.

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

The administrative burden of complying with the proposed regulation is minimal. There are reporting and registration requirements but they are reasonable and considered to be within the scope of current activities of distributors. The requirements include recordkeeping and annual reporting of sales by transaction.

9. **Minimize leakage**

Leakage occurs when a policy intervention by the State causes activities to be displaced outside of California. If leakage were to occur, emissions, jobs and other economic benefits to California would be lost without any reductions in greenhouse gas emissions. Leakage is a concern as a result of this regulation for the magnesium casting sector only. However, based on ARB's analysis, the regulation would not have a significant adverse impact on this sector so leakage is not expected to be a concern. The costs are low and the industry can absorb the costs with a very small expected change in their return on equity. In addition, there are less than 10 magnesium sand casters within North America and the three in California produce high quality items that are not easily transitioned to other casters. This limits the potential for leakage and limits the economic impact. Tracer uses are often needed for a specific place. For example, testing building ventilation or a fume hood must be done at that location. Therefore, work cannot be moved outside of California.

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

Sulfur hexafluoride has the highest GWP currently identified by the IPCC at 23,900 and a very long atmospheric lifetime of 3,200 years. The sources covered in this regulation are emissive and cannot be captured and recycled. Given the long lifetime and potent GWP, emissions of SF_6 are important to consider. The projected reductions that will be achieved through implementation of the proposed limit are equivalent to reducing 0.10 $MMTCO_2E$ per year. Further, the action will prevent growth in the use of SF_6 by other sectors.

This regulation could also influence national and international regulatory approaches. As the U.S. and other countries move forward with climate change goals, this and other California regulations may serve as a guideline if successively implemented. The changes made in accordance with this goal could also have larger impacts by pushing technology to alternatives that are then utilized by the global community.

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

The emissions and emission reductions occur in sectors where the emissions would have continued over time so the reductions are both real and permanent. An emission inventory methodology has been developed and annual estimates will be possible, enabling the quantification and verification of reductions. The regulation is enforceable. The availability of record-keeping from distributors will allow for verification of user-provided data and inspections.

12. **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.**

Sulfur hexafluoride from these uses are not included in any other federal or state regulation. Other states have expressed interest in our regulation and may establish a similar requirement.

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 requirement is not specifically applicable to the proposed regulation. The regulation is a direct regulation, though it provides flexibility (e.g. phase in timetable) to ensure a smooth transition.

14. **The state board shall rely upon the best 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. Staff surveyed key stakeholders and conducted a literature review for other available economic and scientific information.

B. COMPLIANCE WITH THE PROPOSED REGULATION – TECHNICAL FEASIBILITY

Since the use of SF_6 is phased out in the regulation, users will need to substitute another substance for SF_6. The alternative chosen will depend on the use. ARB is requiring a phase-out of SF_6 use in non-electrical and non-semiconductor applications with the following timetable

Table 2 – Effective Dates for Phase-Out by Application

Applications	**Effective Dates**
All applications except those listed below	January 1, 2011
Tracer Gas Uses	January 1, 2013
Magnesium Sand Casting	January 1, 2013
Magnesium Investment Casting	January 1, 2013
Military Applications	January 1, 2013

This section will outline the alternatives available for compliance with the phase-out for each sector.

Magnesium Casting

As mentioned earlier, there are three types of magnesium casting in California: die-casting, sand casting, and investment casting. Sand and investment casting involve higher temperatures and a more open process so not all options available for die-casting are available for sand and investment casting. Alternative cover gases that have been tested and proven effective include SO_2, a fluorinated ketone, HFC-134a, and frozen CO_2 (EPA 2007). The alternative gases react in a similar manner as SF_6 in the presence of magnesium. Most testing has occurred in die-casting facilities but there have been successful tests in sand casting facilities for both SO_2 and the fluorinated ketone. Sand and investment casting may have limitations on available alternatives but SO_2 and the fluorinated ketone appear to be an option for those facilities. HFC-134a may also be an option for some sand casting, depending on the temperature during SF_6 use.

The alternatives would produce at least a 98% reduction in greenhouse gas emissions. Table 2 provides the average emissions and reductions by alternative cover gas, based on a 2007 U.S. EPA measurement study.

Table 3 - Reduction of Greenhouse Gas Emissions for the Magnesium Casting Industry

Cover Gas Mixtures	Average GHGs by cover gas		Reduction from SF_6 (%)
	g CO_2E/hr	$MTCO_2E$/yr	
SF_6 with CDA	381,309	3340	-
Novec 612 with CO_2	2,790	24	99
HFC-134a with CDA	8,557	75	98
SO_2 with CDA	3	0.03	>99.9
Frozen CO_2	8,460	74	98

Note: CDA stands for Completely Denatured Alcohol
Source: U.S. EPA 2007b

The industry does have concerns about the ability to certify the quality of the products in a timely and cost-effective manner to enable renegotiated contracts using a new cover gas. Based on this concern, staff has proposed a later phase-in date for magnesium casting.

Tracer Uses

Tracer gas testing is the release of a gas into an enclosure, room, building, or environment and the subsequent collection and analysis to determine how a gas moves through the system. Tracer gas methods can be used to evaluate building ventilation systems, airflow patterns, ventilation rates, the ability of an enclosure to contain a gas release or vapors generated from a spill, and contaminant control

SF_6 has proven to be a good tracer gas for several reasons. It is not found naturally in the environment and background levels are close to zero. In addition to the low background levels, SF_6 is measurable at low concentrations. It is also generally considered to be non-toxic and inert and resistant to microbial degradation. Alternatives must be able to satisfy similar characteristics, depending on the use.

A phase out on tracer gas uses would have two potential effects: a movement to perfluorocarbon or other alternative tracers or a discontinuation of tracer studies. Each type of tracer study has alternatives that could be used. This section will outline a few potential alternatives based on the type of use.

1. Atmospheric transport studies

The most likely substitutes for atmospheric studies are perfluorocarbon (PFC) tracers. These gases are already used alongside an SF_6 tracer or in place of SF_6 for long range atmospheric transport studies. Although more expensive per pound than SF_6, PFCs can be measured at a lower concentration, thus less gas is needed per experiment. On the other hand analysis per sample is more expensive for PFCs than SF_6. Long range studies require more tracer gas and thus PFCs are already used for many longer range studies (>20km) due to cost issues.

2. Fume hood testing

As mentioned earlier, the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE), has a voluntary standard (ASHRAE 110) for conducting tests on fume hoods. The ASHRAE 110 standard includes a tracer gas test that specifies the use of SF_6 of approximately 1.5 – 1.75 pounds per test (equal to approximately 16 $MTCO_2E$ of emissions per test). Many fume hood owners use this standard voluntarily and Cal/OSHA requires a one-time ASHRAE 110 test in order to operate using an energy saving technology that allows fume hoods to run at 60 feet per minute instead of 100 feet per minute when unattended — saving energy, money, and greenhouse gas emissions.

ARB calculated greenhouse gas reductions from running at a lower face velocity and the following calculation of annual greenhouse gas emission reductions

based on an LBNL fume hood calculator (using default parameters, except for a difference in face velocity of 100 feet per minute to 60 feet per minute):

Energy use at 100 feet per minute:	34,611 kWh
Energy use at 60 feet per minute:	20,767 kWh
Difference:	13,845 kWh

Assuming 0.96 pounds CO_2 emitted per kWh (ARB 2008), reductions in face velocity can save over 6.0 $MTCO_2E$ per fume hood per year. Comparing greenhouse gas reductions from the energy savings to SF_6 from testing (~16 $MTCO_2E$) the amount of CO_2 saved from energy reductions would outweigh use of SF_6 in the test in just a few years. This is a rough estimate assuming a California average emission factor for CO_2 per kilowatt-hour. If another gas or method is allowed to certify the hoods at the lower face velocity under Cal/OSHA regulations, both an energy and SF_6 benefit could be achieved. ARB, in coordination with the U.C. Office of the President and Cal/OSHA, sent a letter to ASHRAE to request them to revise the standard to allow an alternative tracer gas. See Appendix D for a copy of the letter.

There are potential alternatives which result in significant greenhouse gas reductions. One organization is performing tests using nitrous oxide and has completed various analyses to evaluate its effectiveness and safety. Nitrous oxide is a greenhouse gas but its global warming potential is 310, orders of magnitude lower than the GWP for SF_6. PFCs could be used and although the GWP for PFCs are high, the GWPs for all the PFCs are at least half that of SF_6.

3. Other Tracer Uses

In general, PFCs or other gases are applicable for most tracer gas uses. In some specialized cases, SF_6 may be the only viable option. For example, some filtering systems may catch PFCs and other potential alternative tracers. We have tried to identify these cases and excluded them from the phase-out up front but the regulation also has an exemption process if there is no viable alternative.

Medical Uses

Given the superiority of SF_6 in this use, the extremely low usage of only 40 metric tons CO_2E or 4 pounds of SF_6 for all surgeries annually, and the public health concerns, medical uses are exempt from the phase-out.

Other
The identified uses in this category are in consumer products and recreational uses (magic tricks).

Since the gas is very dense, many objects will float on top of it and since the gas is also clear, those objects appear to float in mid-air. Additionally, SF_6 can

deepen people's voices giving a comic effect. These are non-essential uses and no alternative is necessary, however, the fluorinated ketone available for other SF_6 applications may also serve the voice deepening purpose.

In addition to magic tricks, SF_6 is used in products and remains in rubber insulated products for an extended period of time and provides a shock absorption that is useful in products such as tennis balls and shoes. Tennis balls, tennis shoes, and tires have all used SF_6 for the above reasons. SF_6 use in tennis shoes was eliminated in the late 1990s. Tires and sound-proof windows made in Germany and surrounding countries used SF_6 but these uses have also been discontinued. The only remaining potential use that has been identified is use in tennis balls. Although mentioned in several publications, no evidence of SF_6 in tennis balls is available. Not all tennis balls use SF_6; many use pressurized air for the same purpose and it is possible that no tennis balls use SF_6. The phasing out of SF_6 use in products would require some tennis ball companies to find a replacement gas. Compressed air or nitrogen may be used.

Sulfur Hexafluoride use for military purposes is currently uncertain. The federal government is undergoing an inventory process in the next year and will be conducting research into alternatives. If alternatives are not available for specific purposes, an exemption could be requested.

V. EMISSIONS

Sulfur hexafluoride reductions are a key component of the strategy to address climate change and reduce greenhouse gas emissions to 1990 levels by 2020. In this Chapter, we discuss the importance of regulating greenhouse gases, the importance of regulating SF_6, and we summarize the emissions from the applications covered by this regulation.

A. THE CALIFORNIA GLOBAL WARMING SOLUTIONS ACT OF 2006

Scientists have concluded that the evidence is overwhelming that the planet is warming from the higher concentration of greenhouse gases in the atmosphere. Although greenhouse gases (GHG) are naturally occurring, the steep increase in these heat-trapping gases since the Industrial Revolution leaves very little doubt that human activity is to blame for these recent climate change trends. The fact that GHGs remain in the atmosphere for a very long time, and that man-made emissions of GHGs are continuing to increase, mean that the world will continue to warm in the centuries ahead. This warming, or climate change, is a global issue. Clearly, no single state or country can single-handedly solve the problem. However, California is stepping forward to do its part. To address the problem,

Assembly Bill 32, the California Global Warming Solutions Act of 2006 (AB 32), was signed into law by the Governor in September 2006.

By enacting this Legislation, the legislature declared:

"Global warming poses a serious threat to the economic well-being, public health, natural resources, and the environment of California. The potential adverse impacts of global warming include the exacerbation of air quality problems, a reduction in the quality and supply of water to the state from the Sierra snowpack, a rise in sea levels resulting in the displacement of thousands of coastal businesses and residences, damage to marine ecosystems and the natural environment, and an increase in the incidences of infectious diseases, asthma, and other human health-related problems."

This legislation is codified in the California Health and Safety Code, commencing with section 38500. Beyond the AB 32 requirements the Governor's Executive Order EO S-03-05 calls for an additional 80 percent reduction in GHG emissions from 1990 levels by 2050.

While carbon dioxide is the GHG emitted in the largest quantity, other GHGs include, but are not limited to, methane, nitrous oxide, hydrofluorocarbons and SF_6.

1. Climate Change

Climate change, or global warming, is the process whereby emissions of anthropogenic pollutants, together with other naturally-occurring gases, absorb infrared radiation in the atmosphere, leading to increases in the overall average global temperature. The standard definition of "greenhouse gas" includes, but is not limited to six substances as identified in the Kyoto Protocol; carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), HFCs, perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). Changes in the atmospheric abundance of GHGs alter the energy balance of the climate system. These changes are expressed in terms of radiative forcing. While CO_2 is the largest contributor to radiative forcing, methane, halocarbon, N_2O, and other species also contribute to climate change.

Controlling multiple substances that jointly contribute to climate warming requires some method to compare the effects of the different gases because the physical properties (climate warming impact and persistence in the atmosphere) of the GHGs are very different. The current solution to this problem is the calculation made by the Intergovernmental Panel on Climate Change (IPCC), known as Global Warming Potentials (GWP) (IPCC, 2007; IPCC, 1996). The basic idea is to calculate the cumulative climate warming over a specified time span resulting from one unit mass of the GHG emitted. The estimates of GWPs have extensively been reviewed by many climate scientists around the world. The

IPCC is constantly evaluating GWP values and the assessment is generally updated every 6 years.

By convention, the GWP index is defined relative to CO_2 which has a GWP of 1. The IPCC Second Assessment Report (SAR) (IPCC, 1996), defines the GWP of a GHG as the ratio of the time-integrated radiative forcing impact from an instantaneous release of 1 kilogram (kg) of a trace substance relative to that of 1 kg of CO_2. The standard units of measurement used to express the emissions of a GHG is million metric tons of CO_2 equivalents ($MMTCO_2E$) per year.

The GWP values used by ARB are generally the IPCC Second Assessment Report values (IPCC, 1996). These values are used when converting emissions of GHGs to carbon dioxide equivalent values (CO_2E). The SAR GWP values are used to be consistent with the Board's Discrete Early Action Report, other statewide and national GHG inventories, and the Scoping Plan. The GWPs for SF_6 are close between the three most recent versions of the IPCC Assessment Reports with a value of 23,900 from the Second Assessment Report, 22,200 from the Third Assessment Report, and 22,800 from the Fourth Assessment Report.

The climate warming impact from emissions of GHGs is the product of two factors: (1) the mass of GHG emitted, and (2) its warming potential. In addition to uncertainty in the mass of emissions, there is also uncertainty in attributes of warming potential (as a function of direct and indirect warming impacts and the atmospheric lifetime) and thus in the assessment of GWP.

2. Predicted Climate Change Impacts

Global average temperatures have risen both on land and in the oceans. Scientists predict that if the increase in GHG emissions continues unabated, temperatures will rise by as much as 10 degrees Fahrenheit by the end of this century (Pew, 2006). It is impossible to predict exactly how climate change will affect California's ecosystems and economy in the future. However, the expected physical changes will impact California's public health, economy and ecology, and there are many areas of concern.

One area of considerable concern is the effect of climate change on California's water supply. During the winter, in our mountains, snow accumulates in a deep pack, preserving much of California's water supply. If winter temperatures are warmer, however, more precipitation will fall as rain, decreasing the size of the snowpack. Heavier rainfall in the winter could bring increased flooding. Less spring runoff from a smaller snowpack will reduce the amount of water available for hydroelectric power production and agricultural irrigation. Evidence of this problem already exists. Throughout the 20th century, annual April to July spring runoff in the Sierra Nevada has been decreasing, with water runoff declining by about ten percent over the last 100 years.

Another predicted outcome of climate change is a rise in sea level. California has already experienced a 3 to 8 inch rise in the last century. If the trend continues, large populations living along California's coast will face 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.

Air quality will also be exacerbated by increasing temperatures. Higher temperatures, strong sunlight, and stable air masses could lead to increased concentrations of ground-level ozone [Mahmud et al., 2006, Steiner et al. 2006].

Climate change could impact California agriculture by increasing demand for irrigation to meet higher evaporative demand, while supply will become less reliable due to declining snowpack in the mountains. Climate change will also put our forests at greater risk for fire and disease (ARB, 2003).

3. Discrete Early Action Plan and Scoping Plan

The Global Warming Solutions Act requires ARB to design and adopt an overall Scoping Plan, by January 1, 2009, that identifies how GHG emissions can be reduced back to 1990 levels by 2020. AB 32 additionally recognizes that immediate progress in reducing GHG emissions can and should be made. Accordingly, AB 32 required ARB to identify a list of "discrete early action GHG reduction measures" by June 30, 2007.

Discrete Early Actions are Board adopted regulations to reduce GHG emissions which are legally effective by January 1, 2010. These measures are to become part of the State's comprehensive strategy for achieving GHG reductions.

In June 2007, the ARB approved a list of early action GHG reduction measures. Additions to the list were approved by the Board at its October 2007 hearing. A subset of these early action measures was identified as discrete early action measures. One of the approved Discrete Early Action Measures designated in the Early Action Report calls for the reduction of SF_6 in non-electric utility and non-semiconductor applications. The measure is estimated to achieve an emission reduction of 0.10 $MMTCO_2E$ per year, a sizable portion of all SF_6 emissions as shown in Figure 2.

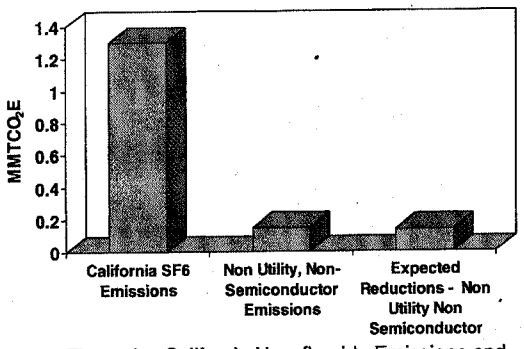

Figure 2 – California Hexafluoride Emissions and reductions from this measure

The objective of this Discrete Early Action measure is to reduce SF_6 when alternatives are available. In this rulemaking, we are proposing a phase-out of SF_6 use in non-electric and non-semiconductor applications. We expect to achieve the estimated reduction of 0.10 $MMTCO_2E$ per year through this rulemaking.

B. IMPORTANCE OF REGULATING SULFUR HEXAFLUORIDE EMISSIONS

Sulfur hexafluoride (SF_6) is a potent greenhouse gas with a lifetime of 3,200 years and a hundred year global warming potential (GWP) of 23,900[1], one of the largest GWPs currently identified. In the last five years, atmospheric concentrations have been growing at a rate of 5% per year (NOAA 2008). Given these characteristics, SF_6 use warrants scrutiny, particularly in emissive applications.

The sources covered in this regulation are emissive and cannot be captured and recycled. The projected reductions that will be achieved through implementation of the proposed limit are equivalent to reducing 0.10 $MMTCO_2E$ per year. Though the amounts seem modest, the severity of the problem requires reductions from any source where it is feasible.

Additionally, this regulation could also influence national and international use and regulatory approaches. As the United States and other countries move forward with climate change goals, this and other California regulations may serve as a guideline if successively implemented. The changes made in accordance with this goal could also have larger impacts by pushing technology to alternatives that are then utilized by the global community.

C. ESTIMATED EMISSIONS FROM MAGNESIUM CASTING, TRACER USES, AND OTHER USES

1. Survey of sulfur hexafluoride users, distributors, and manufacturers

ARB mailed an electronic and hard copy survey to over 60 users, distributors, and manufacturers. The survey had a 100% response from magnesium casters.

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[1] The GWP for SF_6 is taken from the IPCC Second Assessment Report (1995) in order to be consistent with the California Greenhouse Gas Inventory

The other sectors had a lower response rate. The overall response rate for users of SF_6 was approximately 40%. The manufacturers and distributors response rates were 50% and 20% respectively. Given this level of response, the survey was mainly used as a guide for the lower bound of potential emissions. The variety of uses makes it impractical to extrapolate the survey results to a California total.

2. Emission estimation methodology and results

Magnesium Casting

Based on ARB survey results and a 100% response rate, emissions for this sector have been estimated at approximately 0.05 $MMTCO_2E$.

Tracer & Other Uses

Total emissions are estimated at 0.1 $MMTCO_2E$. Given the lack of robust bottom-up data, the emission estimate was developed using global and national level information that predicts that all uses beyond the electronics, utilities, and magnesium sectors are 5% of the total SF_6 emissions. For California this translates into 0.1 $MMTCO_2E$ based on the most current information. In order to calculate this, staff needed the emission estimates for other SF_6 uses: magnesium casting, semiconductor uses, and utility uses. Semiconductor emission estimates were taken from the semiconductor survey results, Magnesium estimates were taken from the survey results discussed above, and utility estimates are from the most recent GHG inventory (ARB 2008a, ARB 2008b, ARB 2008c).

VI. PROPOSED REGULATION

In this Chapter, we provide a description of the proposed regulation and explain the rationale for the key provisions of the regulation. The proposed regulation can be found in Appendix A.

The title of the regulation is "Regulation for Reducing Sulfur Hexafluoride Use and Sales" and the intent is to reduce use in the non-semiconductor and non-electric utility sectors. The regulation includes reporting and record-keeping requirements on all sales of SF_6. The proposed regulation includes a phase-out of SF_6 in all non-semiconductor and non-utility applications except for a limited number of exclusions. The phase-out begins on January 1, 2010 with an extended deadline to January 1, 2013 for magnesium sand and investment casting and for tracer gas and military uses.

A. APPLICABILITY (Section 95341)

The article applies to anyone who uses, buys, or sells SF_6 with a limited number of exemptions. The exemptions include uses covered by other regulations. Chemical vapor deposition (CVD) chamber cleaning and etching uses of SF_6 are being covered by a different regulation, which will reduce fluorinated gas emissions from semiconductor and related devices operations. Uses of SF_6 as a dielectric or arc quenching medium are exempted from this regulation because they will be covered by a forthcoming regulation on SF_6 use in electric utility applications. There are five more specific exemptions mentioned in the applicability section. They are excluded because they fall under one of the two criteria for a conditional exemption.. These five uses are still subject to record-keeping requirements.

The proposed regulation includes an exemption process for a user that meets one of two criteria: 1) Uses of sulfur hexafluoride that result in reduced greenhouse gas emissions or 2) essential use with no alternative.

The first criteria applies when the use of SF_6 instead of an alternative would actually reduce greenhouse gas emissions over the lifecycle of the process or equipment, for instance by reducing energy use. This exemption removes a potential negative consequence of a phase-out. Since the proposed regulation addresses only SF_6, emissions of greenhouse gases on a CO_2E basis could still increase (e.g., SF_6 is replaced with a substance having a lower GWP but the amount of the alternative necessary to do the job is greater to the point that it offsets the benefits). Given the high GWP of SF_6, this is expected to be a rare occurrence that can be dealt with on a case-by-case basis.

The second criteria is for essential uses with no alternatives. For this exemption, a user must provide documentation that either no viable alternatives could be identified or that potentially viable alternatives were identified and either tested or otherwise proven to be ineffective in the specified use. This conditional exemption will provide a route for using SF_6 but only if the user can show that promising alternatives have been investigated or tested.

For the second criteria, the applicant must provide a mitigation plan to minimize SF_6 usage and emissions. The plan would include a set of actions to be undertaken to reduce emissions and could include minimizing usage, reducing leakage, gas recycling, or destruction.

To apply for either of the conditional exemptions, a person must apply in writing to the Executive Officer and provide documentation that the criteria for at least one of the conditional exemptions have been met. Within 30 days of application receipt, ARB will deem whether the application is complete or not. Within 90 days after the application is deemed complete, ARB will determine if the exemption is granted and under what conditions the exemption is granted. ARB may require

best management practices or implementation of the mitigation plan. ARB may also determine that the type of use is exempt for a specified period of time. This would include use by anyone, not just the applicant. The Executive Officer may modify or cancel the exemption if circumstances change. This process allows ARB the chance to fully review the proposal. The conditional exemptions are meant to be flexible to allow for varying lengths of times, amounts of use, and to expand to more users than the original applicant. For example, an exemption for research related uses could be granted for a specific use and could include an upper limit on the amount of SF_6 used. Such an exemption could be good for several years with a renewal possibility.

Since this regulation is proscriptive and phases out SF_6 use altogether in certain uses, there is a need for exemptions to allow practical and logical uses of SF_6 in necessary applications. The exemption process ensures that all potentially feasible alternatives be considered and only to the extent that other options are not available would the use of SF_6 potentially be permitted.

B. DEFINITIONS (Section 95342)

This section provides all the terms used in the regulation which are not self-explanatory. Table 4 lists the definitions.

Table 4 - Definitions Proposed for Regulation

ARB	Executive Officer
Arc Quenching Medium	Greenhouse Gas
Cal/OSHA	Investment Casting
Chamber Cleaning	Laboratory Fume Hood
Chemical Vapor Deposition	Military Applications
Dielectric Medium	Person
Distributor	Sand Casting
Etching	Tracer Gas Testing
Equipment Calibration	

A few definitions warrant further description.

Distributor

A distributor is any person who sells or supplies SF_6 within California for the purpose of commerce. A user who sells SF_6 in order to recycle or return the gas is not included in this definition. A person who recycles SF_6 as a business is subject to the distributor requirements.

Tracer Gas Testing

Tracer gas testing is the process of marking of air or other media with a gas or other substance , which is released into an enclosure, laboratory fume hood, room, building, or environment to detect, measure, monitor, or evaluate flow rate, leakage, or movement characteristics. A tracer is released into a system to be tracked. It is subsequently measured or collected and analyzed to determine how a gas or the gas' media moves through the system. The purpose can be to measure flow through the atmosphere, groundwater, buildings, ventilation systems, and other systems. The following list is not exhaustive but contains some of the more common uses:

- Atmospheric transport
  - Model validation
  - Definition of source/receptor relationships
  - Identification of single source impact in multi-source location
  - Micro-scale impact analysis (i.e., environmental justice neighborhoods)
- Characterization of ventilation systems:
  - Fume hood
  - Building ventilation
- Air infiltration studies
  - Energy audit
  - Test adequacy of shelters for biochemical attacks
- Leak testing
  - Automotive
  - Pipes
  - Underground reservoirs
  - Piping systems
  - Heat exchangers
  - Others
- Characterizing flow patterns
  - Underground petroleum reservoirs
  - Potable water reservoirs
  - Water distribution grid
- Other Uses

C. Restrictions on Sulfur Hexafluoride Use, Possession, Sales and Release of Sulfur Hexafluoride (Section 95343)

1. Proposed Restrictions

The proposed regulatory action would not allow any person to purchase, use, sell, or distribute SF_6. This section also prohibits the sale of products containing SF_6 and the intentional release of SF_6. Staff proposes that no one can have SF_6 on premises except for approved exempted uses, after one year of the phase-out date for the application. This restriction improves enforceability of the regulation by enabling inspectors to easily identify unlawful canisters. The facilities will no longer need the gas after the phase-out and are not allowed to vent the gas so the gas should be returned to the distributor or recycled. A year is allowed to give the user time to properly dispose of any remaining gas.

The reason for the prescriptive restrictions is that SF_6 is the most potent greenhouse gas currently recognized by the Intergovernmental Panel on Climate Change, with a global warming potential of 23,900 and a lifetime of 3,200 years. These uses are emissive with limited opportunities for capture and recycling. Additionally, there are cost-effective alternatives available in almost all cases. The conditional exemptions, which will be discussed later, provide a route for those cases where a restriction is not viable or would not provide real reductions due to the consideration of lifecycle emissions.

2. Effective Dates

Staff proposes that the restrictions start on January 1, 2011 except for the following applications.

For tracer gas uses, the restriction effective date is recommended as January 1, 2013. The reason for the later start date is to allow for testing and development of alternatives. For example, a common atmospheric tracer that could substitute for SF_6 are perfluorocarbons, however, the real-time measurement capability is not yet developed but is on the near-term time horizon. Additionally, many standards in different applications suggest the use of SF_6 but allow for other tracer gases.

For magnesium sand and investment casting, staff proposes an effective date of January 1, 2013. There are two promising alternatives for the magnesium sector: sulfur dioxide and a fluorinated ketone. Each has been tested in die-casting facilities successfully. In addition each is undergoing or scheduled to undergo testing at a sand casting facility. The three-year window allows for the magnesium casters to test the alternative gas and ensure that all products are of comparable quality. It also allows time to complete the process of testing and changing the entire line of products.

For military purposes, staff also proposes an effective date of January 1, 2013. The military is undergoing a process to determine all uses and consider alternatives. The start date allows time for the military to complete the analysis and research.

D. Enforcement (Section 95344)

This section allows enforcement personnel to enter facilities covered by this regulation and issue injunctions and assess penalties or fees pursuant to section 41513 of the Health and Safety Code. This section is necessary to provide penalties that will serve as an incentive to comply with the regulation.

E. Registration, Record-keeping, and Reporting Requirements (Section 95345)

Anyone who sells SF_6 within California must register within 30 days of conducting business in California or by March 30, 2010 for those already conducting business in California. The sellers must retain invoices for at least three years and provide an annual report to ARB including the sales by buyer, date, and amount for each transaction.

This section also requires users of SF_6 to retain use records of the annual quantity of SF_6 purchased and used. Users must also provide the records to ARB upon request. This ensures that ARB has an accurate record of emissions in the state and allows verification of sales data. Users associated with the semiconductor of electric utility industries do not have to report as they have record-keeping requirements in other proposed regulations.

This section will increase the enforceability of the regulation. The registration is necessary to ensure that ARB is aware of all distributors. The recordkeeping and reporting will allow ARB to validate user-provided information and ensure that no SF_6 is being used in the phased out applications.

VII. ECONOMIC IMPACTS

This Chapter provides our analysis of the estimated economic impacts we predict from implementation of the proposed regulation. In general, economic impact analyses are inherently imprecise, given the unpredictable behavior of companies in a competitive market. While staff has quantified the economic impacts to the extent feasible, some projections are necessarily qualitative, and based on general observations and facts known about the industries. This analysis, therefore, serves to provide a general picture of the economic impacts typical businesses subject to the proposed limits might encounter. Individual companies may experience different impacts than projected.

A. SUMMARY

Overall most affected businesses are expected to be able to either absorb the costs (or pass through some of the cost to clients) of the proposed regulation with no significant adverse impacts on their profitability. This finding is indicated by the staff's estimated change in "return on owner's equity" analysis. The analysis found that the change was less than 10% percent for all industries. As noted earlier, the magnesium industry and engineering firms will be most heavily impacted. The analysis found that the change in return on equity for magnesium firms was less than 1%. Engineering firms can be further divided into: 1) specialized, large users of SF_6 as a tracer gas; and 2) average firms with small usage of SF_6 as a tracer gas. The specialized firms will be the most impacted with a change in return on equity of around 7% but only a handful of firms fall into this category of users. The analysis showed that the average engineering firm (25-55 firms) would experience a change in return on equity of around 2%. Because the proposed measures would not significantly alter the profitability of most businesses, we do not expect a noticeable change in employment; business creation, elimination, or expansion; and business competitiveness in California. We also found no significant adverse economic impacts to any local or State agencies.

Our analysis shows that the cost-effectiveness of the proposed regulation is reasonable at an overall cost-effectiveness of $2.00/MT$CO_2E$ reduced.

We estimate that the total cost to industry to comply with this regulation is approximately $4 million over 20 years or $200,000 a year. These cost estimates are based on assumptions specific to each sector. Costs may vary between individual firms with some more heavily impacted than others.

B. ANALYSIS OF THE COST-EFFECTIVENESS OF THE PROPOSED REGULATION

1. Introduction

In the following analysis, we evaluated the anticipated cost effectiveness (CE) of the proposed regulation. Such an evaluation allows us to compare the efficiency of the proposed limits in reducing a metric ton of CO_2E. To do this, we applied a well-established methodology for converting compliance costs, both nonrecurring and recurring, to an annual basis. We then report the ratio of the annualized costs to the annual emission reductions in terms of dollars spent per metric ton of CO_2E reduced for the regulation.

2. Methodology, Assumptions, and Results

The cost-effectiveness of a reduction strategy is defined as the cost per unit of reduced emissions of greenhouse gases adjusted for its global warming potential. The units for reduced emissions will be mass in metric tons of carbon dioxide equivalent. Costs include annualized nonrecurring fixed costs (e.g. total research and development (R&D), product and consumer testing, equipment purchases/modifications, etc.) and annual recurring costs (e.g., raw materials, labeling, packaging, etc.).

We annualized nonrecurring fixed costs under the Capital Recovery Method, as recommended under guidelines issues by the California Environmental Protection Agency (Cal/EPA). Using this method, we multiply the estimated total fixed costs to comply with the limits by the Capital Recovery Factor (CRF) to convert these costs into equal annual payments over the project horizon (i.e., the projected useful life of the investment) at a discount rate of 5%. We then sum the annualized fixed costs with the annual recurring costs and divide that sum by the annual emission reductions to calculate the cost-effectiveness of the regulation, as shown by the following equation:

Cost-Effectiveness = [(Annualized Fixed Costs) + Annual Recurring Cost)] / (Annual Mass Reduction in GHGs)

Where:

Annualized Fixed Costs	=	Fixed Costs * CRF
Capital Recovery Factor (CRF)	=	$[i (1+i)^n] / [(1+i)^n - 1]$
i	=	discount rate over the project horizon, %
n	=	number of years in project horizon
Fixed Costs	=	total nonrecurring cost per industry

Magnesium

For the magnesium sector, fixed costs range from $40,000 to $60,000 per facility (Werner, 2008). We used a mid-range of $50,000. We assumed a 20-year project lifetime, based on the expected lifetime of the equipment (Werner 2008). We also assumed a fixed discount rate of 5 percent throughout the project lifetime. Based on these assumptions, the Capital Recovery Factor is 0.0802. The annualized fixed costs are $4,000 per facility. There are four facilities resulting in an industry-wide annualized total of $16,000.

For the annual recurring costs, we assumed that there would be no additional costs. One alternative gas is cheaper on a per pound basis and although the other alternative is more expensive on a per pound basis, the amount used is less so the per-use cost is comparable to SF_6.

Using the emission inventory information submitted by each facility and the equation above, the cost-effectiveness for the magnesium industry is $0.32 per $MTCO_2E$ reduced. Table 5 summarizes the magnesium sector costs used to determine the cost-effectiveness.

Table 5 – Costs Associated with the Magnesium Sector

	Fixed Cost	Annualized Fixed Cost	Annual Cost	Total Annualized Cost per company	Number of Companies	Total Industry Wide Cost
Magnesium Caster	$50,000	$4,000	$0	$4,000	4	$16,000

Tracer Gas

For the tracer gas sector, there are two main types of users – 1) firms that specialize in tracer gas applications and have corresponding high usage and 2)

firms that do occasional tracer type tests (maybe less than 1 a year) and have corresponding low usage. Each category will have different fixed and annual costs.

ARB estimated fixed cost between $5,000 and $50,000 in 2007 dollars for new equipment or recalibration of equipment for each organization (Werner 2008; ARB survey; Delle, 2008). There will be cases where the cost is much higher or lower but most organizations are expected to fall within our estimated cost range. We assumed a fixed discount rate of 5 percent throughout the project lifetime. Based on these assumptions, the Capital Recovery Factor is 0.0802.

For annual recurring costs, we calculated an average cost differential between SF_6 and alternative gases, using responses to our survey (ARB Survey 2008). The cost differential assumes a similar amount of the alternative gas is used but this may overestimate the cost. ARB estimates the cost differential at $168/kg.

Specialized large users of SF_6 as a tracer gas

For category 1 (Specialized larger users), the fixed cost is estimated at $25,000. A cost slightly below average was chosen because specialized firms are likely to have equipment to measure alternative tracers. The annualized fixed cost, using the Capital Recovery Factor of 0.0802, is $2,000 for each firm. Assuming 3-4 firms fall into this category, the total annualized fixed cost for large users in total is $7,000.

On the other hand these users will have higher annual costs associated with the differential in tracer gas cost. Using the cost differential of $168/kg and an average usage of 87 kg (based on the ARB SF_6 survey), annual costs for the large users is $14,600. Again, assuming 3-4 firms, annual industry-wide costs are around $51,000.

Adding together the annualized fixed cost and the annual cost, the total annualized costs for a tracer firm with large usage of SF_6 is approximately $17,000.

Small users of SF_6 as a tracer gas

For category 2 (Small users), the fixed cost is estimated at $30,000 per firm from a range of $5,000 to $50,000. The mid-range was chosen because some users will already have necessary equipment and some will need to purchase new equipment. The annualized fixed costs, using the Capital Recovery Factor of 0.0802, are thus $2,400 per firm. ARB estimates that 30-60 engineering firms and other tracer users will be directly impacted by the regulation. We used 45 businesses for an industry-wide annualized fixed cost of $108,000.

Based on an inventory estimate for 2007 of 417 kg SF_6 (0.1 $MMTCO_2E$) usage in California per year and the estimate of 304 kg used by the specialized firms, approximately 113 kg are used by the remaining small users. This translates into about 2.5 kg/firm per year. This is a small amount but some firms may conduct tracer studies less than once a year and others may do small-scale studies. Overall, it is a representative estimate. Using the cost-differential of $168, the annual costs per firm is thus $420 with a corresponding total of $19,000 for all small users

Total tracer uses

The total annualized costs (fixed +annual) amount to $185,000 for the tracer sector. Using the emission inventory information submitted by each facility and the equation above, this translates to a cost-effectiveness for the tracer gas sector of $3.70 per $MTCO_2E$ reduced. Table 6 summarizes the tracer sector costs used to determine the cost-effectiveness.

Table 6 – Costs Associated with the Magnesium Sector

	Fixed Cost	Annualized Fixed Cost	Annual Cost	Total Annualized Cost per company	Number of Companies	Total Industry Wide Annualized Cost
Specialized Firm with Large Usage	$25,000	$2,000	$14,600	$16,600	3-4 (used 3.5)	$58,000
Firm with Small Usage	$30,000	$2,400	$420	$2,800	30-60 (used 45)	$127,000

Overall

Considering the industry wide annualized costs (fixed + annual) and the total inventory for both the magnesium casting and the tracer gas sectors, the regulation would have a cost-effectiveness of $2.00 per $MTCO_2E$ reduced.

C. ECONOMIC IMPACTS ANALYSIS ON CALIFORNIA BUSINESSES, CONSUMERS, AND EMPLOYMENT

1. Legal Requirements

Section 11346.3 of the Government Code requires State agencies to assess the potential for adverse economic impacts on California business enterprises and

individuals when proposing to adopt any administrative regulation. The assessment must 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 with businesses in other states.

Also, State agencies are required to estimate the cost or savings to any State or local agency and school district in accordance with instructions adopted by the Department of Finance. The estimate shall include any nondiscretionary cost or savings to local agencies and the cost or savings in federal funding to the State.

2. Potential Impact on California Businesses

Overall, most affected businesses will be able to absorb the costs of the proposed measures with no significant adverse impacts on their profitability. It is likely that all costs will not be absorbed by businesses, and will pass at least a portion through to purchasers. For the purposes of this analysis, however, we assumed that all costs are absorbed by affected businesses. Because the change on the return on owner's equity has been determined to be quite low, the proposed measure would not significantly alter the profitability of affected businesses. As a result, we do not expect a noticeable change in employment, business creation, elimination or expansion, and business competitiveness.

a. Return on Owner's Equity

This portion of the economic impacts analysis is based on a comparison of the return on owner's equity for affected businesses before and after inclusion of the cost to comply with the proposed requirements. The data used in this analysis are obtained from Dun and Bradstreet, Inc. (DNBi) online financial data, the ARB's 2008 Survey on SF_6 (ARB, 2008 Survey), and the Staff's cost-effectiveness analysis discussed later in this Chapter.

b. Affected Businesses

Any business which uses, sells, buys, or distributes SF_6 in California can be directly affected by this regulation. These businesses include magnesium casters, universities, engineering firms, laboratories, and manufacturers and distributors of SF_6. The industries most directly affected by the regulation are the magnesium casters and engineering firms. Most of the businesses only use or sell SF_6 in a portion of their operation. For example, magnesium casters also cast other metals that do not utilize SF_6. Distributors sell many other gases.

c. Study Approach

This study covers the two main industries (magnesium casting and tracer/engineering firms) expected to be most impacted by the regulations. The number of affected businesses is estimated at between 30-60. The approach used in evaluating the potential economic impact of the proposed measures on these businesses is as follows:

(1) A typical business was selected from the 2008 Survey respondents from each of the two main industries – engineering firms and magnesium casters.
(2) A range of compliance costs were estimated for affected firms in each industry. The mid-range cost for each industry was used in this analysis.
(3) Estimated cost was annualized and adjusted for Federal and State taxes.
(4) The Return on Owner's equity (ROE) was calculated for the two main industries by dividing the net profit by the net worth. The adjusted cost was then subtracted from net profit data. The results were used to calculate an adjusted ROE. The adjusted ROE was then compared with the ROE before the subtraction of the cost to determine the potential impact on the profitability of business.

A reduction of more than 10 percent in profitability is generally considered to be an indicator of potentially significant adverse economic impacts thus meriting further analysis. The value has been used historically by the ARB staff to determine impact severity.

d. Assumptions

This study uses actual financial data for a case study of a business in each affected industry. These data were used to calculate the ROEs before and after the subtraction of the compliance costs. The calculations were based on the following assumptions:

(1) The case study business is representative of a typical California business in that industry;

(2) All affected businesses were subject to federal and State tax rates of 35 percent and 9.3 percent respectively; and

(3) Affected businesses are not able to increase the prices of their products, nor can they lower their costs of doing business through short-term cost-cutting measures.

Given the limitation of available data, staff believes these assumptions are reasonable for most businesses at least in the short run; however, they may not be applicable to all businesses. Further, it is likely that at least a portion of the

increase in cost could be passed on to consumers, thus indicating that the impacts on return on equity are overstated.

e. Compliance Cost Data

Based on our cost assessment of the proposed limits, detailed in Section B, we estimate the per-business annualized compliance costs at $4,000 for the magnesium sector, $16,600 for a specialized tracer firm, and approximately $2,800 for the smaller users.

Magnesium
For the magnesium sector the costs are annualized fixed costs with no expected annual costs. The annualization of the fixed costs is shown in Table 5.

Tracer Gas
For the tracer gas sector, the costs include both the annualized fixed costs and annual costs per business. As shown in Table 6, the annualized fixed costs are approximately $2,400 for small users and $2,000 for larger use, specialized firms. The cost is lower for larger users because those firms are likely to already have the necessary equipment.

The annual costs are how much more an average company will spend on an alternate gas. The difference in alternate gas prices is $168/kg based on ARB survey results.

As shown in Section b(2), there is a significant difference in annual costs between the two types of tracer gas firms. The larger users have an average usage of 87 kg, based on the ARB SF_6 survey. Using the cost differential of $168 and an average usage of 87 kg (based on the ARB SF_6 survey), annual costs for the large users is $14,600.

Most impacted companies use small amounts of SF_6, we chose to use the average usage from survey respondents. Assuming approximately 2.5 kg of SF_6 is used by an average firm. This is small amount but some firms may conduct tracer studies less than once a year and others may do small scale studies. The annual costs per average firm are thus $420.

Overall, the total annualized costs will be $16,600 and $2,800 for a specialized and an average firm, respectively.

f. Results

Typical California businesses are affected by the proposed new limits to the extent that the implementation of these requirements would change their profitability. Using ROE to measure profitability, we found that the proposed

regulation would reduce profitability in the magnesium sector by 0.33% and in the tracer gas sector by 7% for specialized firms and less than 2% for small firms. Both sectors are expected to experience a change in ROE of less than 10%.

The potential impacts to businesses' ROEs may be overestimated since affected businesses would not absorb all of the increase in their costs of doing business. They may be able to either pass some of the cost on in higher prices or reduce their costs, or both.

3. Potential Impact on Small Businesses

Overall there are approximately 50 to 125 affected businesses in California but only a portion are small businesses. There are four magnesium casters impacted by this regulation and two of them are small businesses. The return on equity calculated above is very low and there is not expected to be a significant impact. There are 30-60 firms that utilize tracer gases. A large majority of these firms are also small businesses. Although the proposed regulation is expected to have a larger impact on the profitability of businesses in the tracer gas sector than the magnesium sector, the impacts are not considered to be significant based on historical indicators. In addition, there are manufacturers, distributors, universities and others that will be impacted to a lesser extent, for a total of 50-125 affected businesses but these additional businesses are not small businesses.

4. Potential Impact on Business Creation, Elimination, or Expansion

The proposed measure would have no noticeable impact on business creation, elimination, or expansion in California. This is because the costs are not expected to have a significant impact on the profitability of affected businesses in California.

5. Potential Impact on Business Competitiveness

The proposed measures would have a limited impact on the ability of California businesses to compete nationally and internationally. For tracer uses, the measure applies to all businesses that use tracers within the state, no matter their location. California-based businesses may also buy and use SF_6 in other states. Therefore the proposal should not present any economic disadvantage specific to California industry in this sector.

The magnesium industry does compete both nationally and globally. However, there are less than 10 sand casters within North America. Of those outside of California, at least two are testing alternative gases. Therefore the impact of this regulation on competitiveness is limited. Additionally, the change in ROE is minor

for this industry and the regulation should not have a significant impact on competitiveness.

6. Potential Impact on California Consumers

The proposed regulation is not expected to have an impact on California consumers. Consumers are not directly impacted by tracer uses of SF_6. Much of the increase in the price of magnesium is likely to be absorbed by either the casting company or the purchaser of the magnesium part. Since the average caster will face an annualized compliance cost of approximately $4,000 per year for the whole range of magnesium parts, the cost to any individual part should be minimal. Additionally, the magnesium parts are often a small cost of the overall products such as an airplane of automobile.

7. Potential Impact on California Employment

The proposed measures are not expected to cause a noticeable change in California employment and payroll. According to the US Census, employment by engineering firms in California was over 116,000 in 2006, however, many engineering firms do not use SF_6 and most firms who do use SF_6, conduct tracer tests as only a portion of their business. Based on our survey of affected magnesium casters, employment in California was approximately 400. Employees in affected industries are not expected to be significantly impacted and, they represent a very small percentage of total California employment.

D. ANALYSIS OF POTENTIAL IMPACTS TO CALIFORNIA STATE OR LOCAL AGENCIES

We have identified two state agencies that could be impacted. The California Department of Industrial Relations, Division of Occupational Safety and Health (Cal/OSHA) requires the use of SF_6 for one regulation. We have excluded this use from the restrictions. In addition, the California Department of Public Health mentions the use of SF_6 in an upcoming draft regulation; however, they require the use of a tracer gas and not specifically SF_6. Therefore, ARB does not anticipate an impact on CDPH or Cal/OSHA.

Universities would also be minimally impacted. Some universities conduct tracer tests on an irregular basis. In addition to direct costs, universities may have a cost related to contractor services in leak testing and safety certification. The cost of tracer tests may increase substantially but tracer uses will not be phased out until January of 2013, therefore costs to universities are expected to be negligible in the next three years. Universities may experiences costs after that date. Table

7 shows examples of increases in cost for a few types of tracer tests. The costs are for the change in gas and do not incorporate fixed costs. For atmospheric studies, the costs decrease dependent on the range of the study because PFCs are detectable on a lower level and less is needed. So although the cost per volume is more, the total amount is less. The difference in amount needed increases based on distance.

Table 7 – Estimated cost for typical tracer uses

		Change in Cost	Change in % cost	Cost-effectiveness
Atmospheric Tracer Studies	Long Range (100km)	Savings of >$400,000	-75%	Savings of $2/ $MTCO_2E$
	Medium Range (10km)	Savings of $13,000	-10%	Savings of $1 / $MTCO_2E$
	Short Range (1km)	$17,000	14%	$12 / $MTCO_2E$
Fume Hood Test	PFC alternative	$125	>10%	$15/$MTCO_2E$
	Nitrous Oxide alternative	Savings		

VIII. ENVIRONMENTAL IMPACTS

ARB staff have evaluated the environmental impacts of the proposed regulation. Overall, we found that the proposed regulation would have beneficial effects and no significant adverse impacts were identified.

A. LEGAL REQUIREMENTS APPLICABLE TO THE ANALYSIS

The environmental impact analysis conducted by ARB, and fulfilling CEQA requirements, includes the following: (1) an analysis of reasonably foreseeable environmental impacts of the methods of compliance, (2) an analysis of reasonably foreseeable mitigation measures; and (3) an analysis of reasonably foreseeable alternative means of compliance with the regulation.

B. SUMMARY OF ATMOSPHERIC IMPACTS, OCCUPATIONAL SAFETY CONCERNS, AND MITIGATION OPTIONS

For all sectors there is not expected to be an impact on particulate matter, ground level ozone, or stratospheric ozone. The following section covers potential concerns with air toxics and sulfur dioxide. OEHHA and ARB's health experts reviewed the regulation and found limited concerns with alternatives, primarily with the potential for fluorinated compounds to bioaccumulate or biopersist.

Magnesium Casting

The proposed regulation could result in a move from the use of SF_6 with a carrier gas (SO_2, Clean Dry Air (CDA) or SO_2/CDA) to the use of a mixture of sulfur dioxide (SO_2)/carrier gas mixture or the use of a fluorinated ketone/carrier gas mixture, in place of SF_6. There are two associated concerns – air quality and worker safety. Two U.S. EPA studies examined these concerns: one looked at a die-casting operation and the other looked at an ingot operation. The ingot facility is most similar to the sand casting operations predominant in the California Magnesium industry. Neither study showed any occupational safety concerns. We present information from both studies but due to similarities in the process, the results from the ingot casting facility are more relevant for the sand casting operations.

Die-casting introduces the cover gas in a small, enclosed crucible with approximately one cubic meter of headspace. In die casting the cover gas is introduced in the heated crucible, full of molten metal, before the molten metal is poured. The cover gas is at a high temperature and in an enclosed environment, which creates conditions amenable for reactions beyond the desired oxidation cover gas use.

On the other hand, ingot and sand casting use open operations that involve higher temperatures at certain parts of the process. Specifically for sand casting and ingot casting, the cover gas is introduced into the mold itself. The process is open. This is done by flooding the mold with cover gas for a period of time before the metal is transferred. The metal is then poured and the mold is filled. The continuous flow of magnesium into the system means that the cover gas is reacting with the magnesium to prevent oxidation and alternative breakdown into hazardous by-products is limited. As the mold is filled the magnesium rapidly cools and solidifies. Only the cover gas agent in the mold at the time of filling is available for reaction and it will only react if the temperature is high enough for thermal degradation. Since the cover gas reacts with new magnesium and the

mold and metal cool quickly, the opportunity for by-products is much lower in sand and ingot casting than in die-casting.

As mentioned one of the potential alternatives for use in magnesium casting is an SO_2 mixture. Sulfur hexafluoride is often used with a carrier gas containing clean dry air and potentially SO_2 and CO_2 and, when the SF_6 carrier gas includes SO_2, has similar associated by-products as a predominately SO_2 system. Staff evaluated the potential impacts on air quality and worker safety due to SO_2 emissions. An SO_2 mixture would contain at most .01% SO_2. Additionally, at least 30% of the SO_2 will be destroyed in the process according to both U.S. EPA studies, with no hazardous destruction products detected. In the die-casting facility, U.S. EPA also found that there were few destruction byproducts and the byproducts consisted of ambient air components (H_2O, CO_2, CH_4), byproducts formed from ambient air dilution during ingot loading (CH_2O and C_2H_4) or nitrogen oxides formed from the carrier gas. H_2SO_4 was not detectable (U.S. EPA, 2007). Nitrogen oxide levels were lower than levels associated with use of SF_6. SO_2 levels were higher with a concentration averaging 0.03 ppmv as measured near the ingot loading area. Concentrations further from the process would be lower as the SO_2 mixes with surrounding air. The average concentrations were found to be well below state and national occupational safety standards (OSHA, 2005, Cal/OSHA 2007, OEHHA, 2008). There was one incident where a door malfunctioned, resulting in an elevated SO_2 concentration of 1.6 ppmv, still below the most stringent exposure limit of 2 ppmv.

The results were different for the ingot casting facility with no detectable SO_2 levels in worker areas. The range of SO_2 concentrations in the casting hood was similar for an SF_6 system and an SO_2 system. For the ingot casting study using an SO_2 cover gas, H_2S and H_2SO_4 were not detectable in any locations and SO_2 levels were similar to SO_2 levels using an SF_6 cover gas, whose carrier gas is generally SO_2 (EPA 2008).

The second potential alternative is a fluorinated ketone alternative, whose destruction may produce some byproducts of concern. Hydrogen fluoride (HF) is potential toxic byproduct with low occupational and non-occupational exposure limits (e.g., 8 hour PEL = 3 ppm and 1 hour REL = 6 ppm). EPA's study on die casting found hazardous levels of HF in the crucible, but levels were non-detectable in worker areas. The study at an ingot casting facility showed elevated HF levels compared to SF_6 use, however, even within the mold the levels were below standards set by OSHA but there were instances within the casting hood when the HF exceeded the recommended levels set by California's Office of Environmental Health Hazard Assessment (OEHHA). Most importantly, in worker and other areas outside the casting hood, HF and other potentially hazardous by-products were non-detectable.

Since both studies showed concentrations in worker areas well below limits established by Cal/OSHA, ARB concludes that worker safety from emissions is not a significant concern. In addition, emissions to the surrounding community should be negligible since the emissions will be diluted even further.

For both SO_2 and HF, unsafe conditions may be noticeable due to the distinctive smell of the gases. For example, HF has a very sharp, unpleasant odor and would be a warning for the employer to evaluate employee exposure and provide an appropriate level of protection.

Offsite levels should be well below standards. The casters do not vent directly to the outside. HF is none detectable in worker areas and SO_2 is below detectable levels in worker areas even with a machine malfunction. Since both will be diluted even further as it mixes with outside air, offsite levels should be well below standards.

Tracer Uses

Tracer gas users have numerous alternatives and this document will briefly discuss two of the most likely alternatives, nitrous oxide and perfluorocarbons. Nitrous oxide is already being tested for use in the fume hood testing application. Perfluorocarbons are used in many other applications including as an atmospheric tracer.

Nitrous oxide does have toxicity concerns with a lower exposure limit than SF_6 at 50 ppm. The concerns are related to chronic exposure resulting in reproductive toxicity. In order to limit any toxicity issues, users introduce precautions to avoid high levels of nitrous oxide. These include avoiding unnecessary tests, ensuring the tests are never left unattended, audible alarms at all times, and coordination with clients. In addition, nitrous oxide is used by some as a recreational drug and thus the gas must be well tracked to limit the potential for such a misuse. In California, it is illegal to breathe, inhale, or ingest nitrous oxide for recreational purposes. Currently nitrous oxide is used safely in a number of occupational applications including dentistry. Additionally, nitrous oxide can be found in common products such as canned whipped cream. Only a few pounds are used for fume hood testing and off-site concentrations should not be a concern as the small amounts of N_2O will be quickly diluted in the air. Nitrous oxide is a greenhouse gas but its global warming potential is 310, orders of magnitude lower than the GWP for SF_6.

Perfluorocarbons (PFCs) are already used as an atmospheric tracer and are stable, non-toxic gases. Concerns have been noted for some derivatives of PFCs, notably PFOA and PFOS, but these are not by-products of atmospheric decomposition and PFCs used as tracers are long-lived non-toxic gases. In fact, PFCs are used today in medical operations that include use of the gases within the body for a number of uses including as a blood substitute.

For military purposes, the federal government is undergoing a process to determine all uses and consider alternatives.

C. OTHER POTENTIAL ENVIRONMENTAL IMPACTS

ARB does not expect adverse environmental impacts in other sectors including waste disposal, water quality or energy use.

D. ALTERNATIVE MEANS OF COMPLIANCE

The regulation includes an exemption process if there are unanticipated environmental impacts. Absent use of the exemption process, staff is not aware of any additional compliance means, other than direct compliance with the proposed amendments.

E. ENVIRONMENTAL JUSTICE

State law defines environmental justice as the fair treatment of all people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies. The ARB is committed to evaluating community impacts of proposed of proposed regulations, including environmental justice concerns.

Tracer users are not point sources and not expected to be localized to a particular area. For these reasons, we do not believe that people of any given race, culture, or income would be disproportionally impacted by the proposed regulation. Magnesium casters are all located in the Los Angeles area but the alternatives are not expected to have any adverse impacts. All Californians should benefit equally from the reduction in greenhouse gas emissions. The other provisions in the regulation (i.e., phasing out the use of SF_6 from use as a tracer gas) are not expected to adversely impact environmental justice communities in California.

The reduction of SF_6 will support California's effort to mitigate greenhouse gas emissions and climate change. Low-income communities are disproportionately impacted by climate change, lacking the resources to avoid or adapt to these impacts. For example, low-income residents are less likely to have access to air conditioning to prevent heat stroke and death in heat waves.

IX. IMPLEMENTATION AND ENFORCEMENT

ARB staff would review and approve exemption packages. Enforcement activities will be pursued to assure that SF_6 sold is in compliance with the regulation. This will involve inspection of records provided by distributors to determine if there are any sales to persons who may be using the gas for an application where its use is already phased out. ARB staff will also inspect facilities where the use of SF_6 is phased out. Should any aspect of this regulation be out of compliance, the ARB's Enforcement Division will respond as appropriate including assessing penalties as outlined in HSC section 38580 et seq. Enforcement action can also include developing a court case, testifying in court, and responding to legal action. Resources needed for implementation and enforcement are explained in Section VI.

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Appendix A: Proposed Regulatory Language

Appendix B: Blank Surveys Distributed to Stakeholders

Appendix C: Aggregate Survey Results

Appendix D: Letter to American Society of Heating, Refrigeration, and Air Conditioning Engineers

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 3. Regulation for Reducing Sulfur Hexafluoride Emissions

PROPOSED REGULATION ORDER

Regulation for Reducing Sulfur Hexafluoride Emissions

Adopt new Subarticle 3, Regulation for Reducing Sulfur Hexafluoride Emissions, sections 95340 to 95346, title 17, California Code of Regulations, to read as follows:

Subchapter 10. Climate Change
Article 4. Regulations to Achieve Greenhouse Gas Emission Reductions

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

Subarticle 3. Regulation for Reducing Sulfur Hexafluoride Emissions

§ 95340 Purpose.

The purpose of this Subarticle is to reduce sulfur hexafluoride emissions pursuant to the California Global Warming Solutions Act of 2006 (Health and Safety Code, sections 38500 et.seq.).

NOTE: Authority cited: Sections 38510, 38560, 38560.5, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38560, 38560.5, 39600, and 39601, Health and Safety Code.

§ 95341 Applicability and Exemptions.

(a) This Subarticle applies to any person that uses, possesses, purchases, distributes, manufactures, offers for sale, or sells sulfur hexafluoride or products containing

sulfur hexafluoride in California, with the exception that section 95343 does not apply to the following uses:

(1) Use in chemical vapor deposition (CVD) chamber cleaning.

(2) Use in etching.

(3) Use as a dielectric medium including equipment containing sulfur hexafluoride for use as a dielectric medium.

(4) Use as an arc quenching medium including equipment containing sulfur hexafluoride for use as an arc quenching medium.

(5) Use in one-time testing per laboratory fume hood, provided that the use is in compliance with Cal/OSHA ventilation requirements for laboratory fume hood operations set forth in title 8, California Code of Regulations, section 5154.1(c)(2)(B), for the purpose of reducing laboratory fume hood face velocity when the hood is unattended and realizing the associated energy savings.

(6) Medical uses, which includes only the following applications:

(A) Injection or other entry of sulfur hexafluoride into the human body for the purpose of improving health,

(B) Use of sulfur hexafluoride in a diagnostic tool in order to either identify a disease or condition by its outward signs and symptoms or analyze the underlying physiological/biochemical cause(s) of a disease or condition,

(C) Use of sulfur hexafluoride in a medical treatment process for a disease or other medical condition.

(7) Use in testing nuclear power plant control room emergency ventilation systems every six years in compliance with the Technical Specifications Task Force (TSTF) Specification 448.

(8) Use in equipment calibration and in testing to find alternatives to sulfur hexafluoride use.

(9) Use in testing hyperspectral remote sensing systems to detect toxic gases in the infrared portion of the spectrum.

(b) Any person may apply for an exemption from section 95343 as specified below:

(1) A person may apply in writing to the Executive Officer for an exemption from the requirement of section 95343 for the uses of sulfur hexafluoride identified below in subsections (A) or (B). The application must include documentation that supports the exemption claim, including the data and test methods used to generate the data, if applicable. Information submitted pursuant to this section may be claimed as confidential and such information shall be handled in accordance with the procedures specified in title 17, California Code of Regulations, sections 91000-91002.

(A) *Uses of sulfur hexafluoride that result in reduced greenhouse gas emissions.*

The Executive Officer may allow the use of sulfur hexafluoride if the applicant demonstrates to the satisfaction of the Executive Officer that the use of sulfur hexafluoride will result in less greenhouse gas emissions over the lifetime of the equipment, facility, or process than the use of all other alternatives.

(B) *Uses of sulfur hexafluoride with no alternatives.*

The Executive Officer may allow the use of sulfur hexafluoride if the applicant demonstrates to the satisfaction of the Executive Officer that there is no viable alternative to sulfur hexafluoride in the specified use. No exemption shall be granted unless the applicant provides and agrees to comply with a mitigation plan identifying a list of actions to be undertaken by the applicant to minimize greenhouse gas and sulfur hexafluoride emissions.

(2) *Procedure for responding to an exemption from section 95343.*

(A) Within 60 days of receipt of an exemption application the Executive Officer shall determine whether the application is complete, or that specified additional documentation is required to make it complete. Within 60 days of receipt of the specified additional information, the Executive Officer shall advise the applicant in writing either that the application is

complete, or that specified additional information is still required before it can be deemed complete.

(B) Within 90 days after an application has been deemed complete, the Executive Officer shall determine whether, and under what conditions, an exemption from the requirements of section 95343 will be permitted. The Executive Officer shall notify the applicant of the decision in writing and shall specify such terms and conditions as are necessary to insure that the requirements of section 95341(b)(1)(A) or 95341(b)(1)(B) are met and will continue to be met.

(C) The Executive Officer and the applicant may mutually agree to an extension of any of the time periods specified in this section, and additional supporting documentation may be submitted by the applicant before a decision has been reached.

(3) *Revocation or Modification of Exemption*: If the Executive Officer determines that the use for which an exemption has been granted no longer meets the criteria specified in section 95341(b)(1)(A) or (b)(1)(B), or that the applicant is not following the mitigation plan submitted pursuant section 95341(b)(1)(B), the Executive Officer may modify or revoke the exemption. The Executive Officer shall not modify or revoke the exemption without first affording the applicant an opportunity for a hearing in accordance with the procedures specified in title 17, California Code of Regulations, Division 3, Chapter 1, Subchapter 1.25, Article 2 (commencing with section 60055.1).

NOTE: Authority cited: Sections 38510, 38560, 38560.5, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38560, 38560.5, 39600, and 39601, Health and Safety Code.

§ 95342 Definitions.

(a) For the purposes of this Subarticle, the following definitions apply:

(1) "ARB" means the California Air Resources Board.

(2) "Arc Quenching Medium" means the use of a material to interrupt an electrical arc.

(3) "Cal/OSHA" means the California Department of Industrial Relations, Division of Occupational Safety and Health.

(4) "Chamber Cleaning" means the process of using fluorinated gases to remove excess materials from chemical vapor deposition chamber walls to prevent contamination of wafers to be processed.

(5) "Chemical Vapor Deposition (CVD)" means deposition of thin films on wafers by placing the wafers in a mixture of gases, including nitrogen or other gas used as a carrier, which react at the surface of the wafers.

(6) "Dielectric Medium" means the use of a material that does not conduct electricity but can sustain an electric field, with electrical conductivity of less than a millionth (10^{-6}) of a siemens.

(7) "Distributor" means any person who sells or supplies sulfur hexafluoride in California, except that "distributor" does not include users who sell to a recycler or persons who return products to the seller.

(8) "Etching" means a chemical reactive process for selectively removing material on a wafer using fluorinated, ionized gases

(9) "Equipment Calibration" means the process of establishing the relationship between a measuring device and the units of measure. This is done by comparing a device or the output of an instrument to a standard having known measurement characteristics.

(10) "Executive Officer" means the Executive Officer of the California Air Resources Board, or his or her delegate.

(11) "Greenhouse gas" includes carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs).

(12) "Investment Casting" (also called "precision casting" or the "lost wax process") means the process of casting magnesium into a mold produced by surrounding, or investing, an expendable pattern with a refractory material.

(13) "Laboratory fume hood" means a boxlike structure enclosing a source of potential air contamination, with one open or partially open side, into which air is moved for the purpose of containing and exhausting air contaminants, generally

used for bench-scale laboratory operations but not necessarily involving the use of a bench or table.

(14) "Military Applications" means the acquisition, research, development, testing, evaluation and training related to tactical vehicles, vessels, aircraft, equipment and weaponry associated with said tactical vehicles, vessels, aircraft equipment and weaponry owned or operated by the armed forces of the United States.

(15) "Person" shall have the same meaning as defined in Health and Safety Code section 39047.

(16) "Sand Casting" means the process of producing a part by forming a mold from a sand mixture and pouring molten magnesium into the cavity in the mold.

(17) "Tracer Gas Testing" means the process of marking air or other media with a gas or other substance , which is released into an enclosure, laboratory fume hood, room, building, or environment to detect, measure, monitor, or evaluate flow rate, leakage, or dispersion or dilution characteristics.

NOTE: Authority cited: Sections 38510, 38560, 38560.5, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38560, 38560.5, 39600, and 39601, Health and Safety Code.

§ 95343. Restrictions on Use, Sale, Possession and Release of Sulfur Hexafluoride.

(a) Except as provided in section 95341(Applicability), the following sulfur hexafluoride restrictions apply beginning on the dates specified below in Section 95343(b):

(1) No person shall purchase or use sulfur hexafluoride in California. This restriction does not apply to distributors.

(2) No person shall own or otherwise possess sulfur hexafluoride in California after one year from the applicable effective date specified in section 95343(b).

(3) No person shall sell, supply, distribute, or offer for sale sulfur hexafluoride in California.

(4) No person shall sell, supply, distribute, offer for sale, or manufacture for sale any product that contains sulfur hexafluoride in California.

(5) No person shall intentionally emit sulfur hexafluoride in California. This restriction does not apply to accidental releases that occur when recycling or recovering sulfur hexafluoride or when filling or refilling sulfur hexafluoride canisters.

(b) Section 95343(a) shall apply after the effective dates specified in the following Table:

Applications	Effective Dates
All applications except those listed below	January 1, 2011
Tracer Gas Testing	January 1, 2013
Magnesium Sand Casting	January 1, 2013
Magnesium Investment Casting	January 1, 2013
Military Applications	January 1, 2013

NOTE: Authority cited: Sections 38510, 38560, 38560.5, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38560, 38560.5, 39500, 39600, and 39601, Health and Safety Code.

§ 95344 Enforcement.

(a) *Injunctions and Penalties.* If the Executive Officer determines that a person is manufacturing for sale, advertising for sale, selling, purchasing, distributing or offering for sale in California sulfur hexafluoride in violation of the requirements of this subarticle, the Executive Officer may enjoin the person from any further manufacture, advertisement, sales, offers for sale, or distribution in California pursuant to section 41513 of the Health and Safety Code. The Executive Officer may also assess penalties for any violation of this subarticle as provided in Health and Safety Code section 38580.

(b) **Right of Entry.** An agent or employee of ARB has the right of entry to applicable facilities for the purpose of inspecting operations and their records to

determine compliance with this subarticle, as provided in Health and Safety Code section 41510.

NOTE: Authority cited: Sections 38510, 38560, 38560.5, 38580, 39600, 39601, 41510, and 41513, and Health and Safety Code.

Reference: Sections 38560, 38560.5, 39600, 39601, 41510, and 41513 Health and Safety Code.

§95345 Registration, Recordkeeping, and Reporting Requirements.

(a) **Registration for Distributors of Sulfur Hexafluoride.** Distributors of sulfur hexafluoride must register with ARB on or before March 30, 2010. Distributors who begin conducting business in California after March 30, 2010, must register with ARB no later than 30 days after the start of their business operations. Registration shall be in the form of a letter to the Executive Officer and must include the business names, physical address, contact name, telephone number, fax number, e-mail address, and web site address of the distributor, as applicable. Distributors will receive a copy of the regulation within 60 days of registering with the Executive Officer.

(b) **Recordkeeping for Distributors of Sulfur Hexafluoride.** For each sale or supply of sulfur hexafluoride, distributors of sulfur hexafluoride must retain invoices showing the purchaser's name, business name, intended use, physical address, contact name, telephone number, fax number, e-mail address, web site address, as applicable sale date, and quantity of sulfur hexafluoride purchased. These invoices must be retained by the distributor for at least three years.

On or before March 30, 2010 distributors must also provide all of their known purchasers of sulfur hexafluoride within the last five years, except for those purchasers exempted under section 95341(a)(1-4), a copy of this regulation (*title 17, California Code of Regulations, sections 95340 – 95346*), as approved by ARB and the California Office of Administrative Law. Distributors must also retain documentation showing that they have met this requirement for a period of three

years. This documentation requirement will be satisfied if the distributor retains a copy of the materials mailed or emailed and the contact information for where the materials were sent. Contact information includes the retailer name, business name, physical address, contact name, telephone number, fax number, e-mail address, and web site address, as applicable.

Distributors of sulfur hexafluoride must also provide records and other sources to ARB upon request by the Executive Officer or his or her designee. Records include copies of all invoices, books, correspondence, electronic data, or other pertinent documents in its possession or under its control that the manufacturer, distributor or retailer retains that are necessary to prove compliance with the requirements of this subarticle.

(c) **Recordkeeping for Purchasers and Users of Sulfur Hexafluoride.**

After March 30, 2010 or upon the operative date of this subarticle, whichever is later, all persons who purchase or use sulfur hexafluoride, except for those users exempted under section 95341(a)(1-4), must keep records showing the annual quantity of sulfur hexafluoride purchased and used. These records must be retained for at least three years. Users of sulfur hexafluoride must also provide ARB with copies of records and other sources upon request by the Executive Office or his or her designee.

(d) **Annual Reporting for Distributors of Sulfur Hexafluoride.**

Beginning in calendar year 2011, each distributor of sulfur hexafluoride must submit an annual report to the Executive Officer by March 30th for the previous calendar year. The report must include:

(1) Total quantity in mass of sulfur hexafluoride sold; and

(2) A record of transactions of sales to each purchaser of sulfur hexafluoride, including the complete contact information listed in section 95345(b). Records must include the date and quantity of each sale.

(e) **Treatment of Confidential Information**

Information submitted pursuant to this section may be claimed as confidential, and such information shall be handled in accordance with the procedures specified in title 17 California Code of Regulations, sections 91000-91022.

NOTE: Authority cited: Sections 38510, 38560, 38560.5, 38580, 39600, 39601, and 41511 Health and Safety Code. Reference: Sections 38560, 38560.5, 39600, 39601, and 41511 Health and Safety Code.

§95346 Severability.

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

NOTE: Authority cited: Sections 38510, 38560, 38560.5, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38560, 38560.5, 39600, and 39601, Health and Safety Code.

Appendix B

1- Blank Surveys of Users of Sulfur Hexafluoride

2- Blank Survey of Manufacturers and Distributors of Sulfur Hexafluoride

Page 1

California Air Resources Board
Survey on Sulfur Hexfluoride Use

Check if this page is confidential ☐

1	Company/Organization Name:	
2	Parent Company name, if applicable :	
3	Address:	
4	Contact Person:	
5	Phone:	
6	Email:	
7	SIC Code:	
8	Total number of California Employees:	
9	Webpage address:	
10	Does your company currently use SF_6?	
11	Has your organization used SF_6 at any time since 1990?	
12	If located in California, does your organization currently have plans to relocate to another state or country?	

Page 2

Check if this page is confidential ☐

13 **Do you use sulfur hexafluroide for:**
Please check all that apply

Tracer studies
- Atmospheric Transport ☐
- Fume hood testing ☐
- Building ventilation ☐
- Air Infiltration ☐
- Leak Testing ☐
- Other (Please specify below) ☐

- Magnesium Casting ☐
- Medical uses ☐
- Other uses excluding semiconductor or utility applications: (please specify) ☐

14 a If you answered yes to any part of question 13, how many kilograms of SF_6 did you use for each purpose in **2007** in the state of California (if use data is not available, please provide purchase information. If actual data is not available, please provide your best estimate. Note below whether the data is actual or estimated. If the specified categories are not appropraite for any of your use, please include in other and specify use.

Is the use/purchase data Actual or Estimated?

	SF6 (in kilograms)	Used or Purchased?	Purchased from?	Additional Information
Atmospheric Transport				
Fume Hood Testing				
Other Tracer Uses (please specify in additional information)				
Magnesium Casting				
Medical Use (please specfiy in additional information)				
Other (please specify)				

Page 3

Check if this page is confidential ☐

14b For information provided in Part a, please provide the number of studies, tests, surgeries, or other events in 2007 (California only). If data is not available, please provide the average SF_6 emissions per event and whether this has changed over time.

Use	Number of events in 2007 (provide units)	Average emissions per event (provide units)	Actual or Estimated?
Please choose Tracer Use			
Magnesium	Example: Metric Tons of Magnesium		
Medical Uses			
Tennis Ball Manufacture	Example: Number of Tennis Balls		
Other			

14c If available, please provide use in CA (in kilograms) for 1990, 2004, 2005, and 2006 by source type (available in the dropdown menu Space is available for two uses, if your company has more than two uses, please add additional lines here or in an attachment. If information is only available in total, please choose 'All Uses'

Use	1990	2004	2005	2006	2007
Please Choose Use					
Please Choose Use					

14d Did your organization purchase and use the SF_6 directly or contract the service out to another entity? If applicable, provide the name of the contracted entity.

14e How many kilograms of sulfur hexalfuoride do you typically have in stock?

Page 4

Check if this page is confidential ☐

15 Is your company organization a member of any industry group? If yes, please state the association.

16 Do you have any reduction strategies to minimize SF_6 emissions? If so, please explain your strategy

17 What is the current price you pay for one kilogram sulfur hexafluoride (in US$)?

18a If considering a switch to another gas, what gas would you use?

18b What is your expected price for the alternative gas?

18c If you were to switch to another gas, would you need to change any equipment?

18d If you answered yes to 18c, What is the likely cost for an equipment change?

18e If you answered yes to 18c, are there any annual operating costs or savings associated with the equipment change and if so, please provide them (in US$)

18f If your organization performs tracer services for others, provide the annual average income from tracer studies or certifications.

19 If there is any additional information you would like to provide, please provide it in the following space.

Page 5

I certify that the above information is true, accurate, and complete

Printed Name

Title

Signature (if submitting a hardcopy)

Date

PLEASE RETURN THE SURVEY TO ELIZABETH SCHEEHLE at ESCHEEHL@ ARB.CA.GOV BY JULY 7, 2008
Filing Electronically without Password Protection

Type in your name, title and date; save the file to your computer and name it your company name (e.g., ABC Company.xls). Submit the survey as an e-mail attachment to escheehl@arb.ca.gov by July 7, 2008. Please title your e-mail **SF6 SURVEY**.

Filing Electronically with Password Protection

If you wish to add password protection to your electronic submittal follow these steps. When you have completed the survey online in Excel, go to **File**, **Save As...**. change the filename to Survey_electronic_ your company name. Still in the **Save As...** window, click on the **Tools** icon in the upper right hand corner, then **General Options**, and respond to the prompt by typing in a password to open the file (remember passwords are case sensitive). Then click **OK**.

In a second separate e-mail titled **SURVEY ACCESS**, also sent to escheehl@arb.ca.gov, please include the filename and the password to your survey in the body of the e-mail.

Page 4

I certify that the above information is true, accurate, and complete

Printed Name

Title

Signature (if submitting a hardcopy)

Date

PLEASE RETURN THE SURVEY TO ELIZABETH SCHEEHLE at ESCHEEHL@ ARB.CA.GOV BY July 7, 2008
Filing

Type in your name, title and date; save the file to your computer and name it your company name (e.g., ABC Company.xls). Submit the survey as an e-mail attachment to escheehl@arb.ca.gov by July 7, 2008. Please title your e-mail **SF6 SURVEY**.

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Page 1

California Air Resources Board

Survey on Sulfur Hexafluoride Manufacture and Distribution

Check if this page is confidential ☐

1	Company/Organization Name:	
2	Parent Company name, if applicable :	
3	Address:	
4	Contact Person:	
5	Phone:	
6	Email:	
7	SIC Code:	
8	Total number of California Employees:	
9	Webpage Address:	
10	Does your company currently manufacture or distribute SF_6?	
11	Has your organization manufactured or distributed SF_6 at any time since 1990?	
12	If located in California, does your organization currently have plans to relocate to another state or country?	

If you are a manufacturer, please go to page 2, if you are a distributor please go to page 3

Page 2 **To be filled in by Sulfur Hexafluoride Manufacturers**

Check if this page is confidential ☐

13 How much sulfur hexafluoride (in kilograms) did you sell in 2007:
a. Directly to California users

b. To California distributors

14 Please provide a list of distributors in California and neighboring states: (may provide as an attachment)

15 The following questions relate to how SF_6 cylinders are sold/used:

a If by cylinder, what are the typical sizes (kg/cylinder)?

b Are the cylinders one-way?

c Do the cylinders contain a heel? What portion of the cylinder represents the heel?

16 Provide a breakdown of sales by end-use type (in California):

	%	or kg
Tracer uses		
Magnesium Casting		
Medical Uses		
Tennis Ball Manufacturers		
To Distributors		
Electric Utilities		
Particle Accelerator		
Other (please specify)		
Unknown		

17a How are your sales priced (e.g. $/kg, $/lb)?

17b Do you provide bulk sales? If so, what volume is needed to qualify as bulk?

18 What is your current retail sales price for 1 kg SF_6?

19 What is your current bulk price per kg, if applicable?

20 What are your annual sales of SF_6 in kg and dollars?

Page 3 **To be filled in by Sulfur Hexafluoride Distributors**

SF_6 manufacturers please go to page 4 to complete the survey

Check if this page is confidential ☐

21 How much sulfur hexafluoride (in kilograms) did you sell directly to California users in 2007?

22 The following questions relate to how SF_6 cylinders are sold/used:

a What are the typical sizes (kg/cylinder)?

b Are the cylinders one-way?

c Do the cylinders contain a heel? What portion of the cylinder represents the heel?

23 Provide a breakdown of sales by end-use type (in California):

	%	or kg
Tracer uses		
Magnesium Casting		
Medical Uses		
Tennis Ball Manufacturers		
To Distributors		
Electric Utilities		
Particle Accelerator		
Other (please specify)		
Unknown		

24a How are your sales priced (e.g. $/kg, $/lb)?

24b Do you provide bulk sales? If so, what volume is needed to qualify as bulk?

25 What is your current retail sales price for 1 kg SF_6?

26 What is your current bulk price per kg, if applicable?

27 What are your annual sales of SF_6 in kg and dollars?

Page 4

I certify that the above information is true, accurate, and complete

Printed Name

Title

Signature (if submitting a hardcopy)

Date

PLEASE RETURN THE SURVEY TO ELIZABETH SCHEEHLE at ESCHEEHL@ ARB.CA.GOV BY July 7, 2008
Filing

Type in your name, title and date; save the file to your computer and name it your company name (e.g., ABC Company.xls). Submit the survey as an e-mail attachment to escheehl@arb.ca.gov by July 7, 2008. Please title your e-mail **SF6 SURVEY**.

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In a second separate e-mail titled **SURVEY ACCESS**, also sent to escheehl@arb.ca.gov, please include the filename and the password to your survey in the body of the e-mail.

Appendix C

Aggregate Magnesium Survey Results

Magnesium Survey Results

	1990	2004	2005	2006	2007
Magnesium Casters	0.07	0.06	0.07	0.04	0.05

	Number
Die Casters	1
Sand Casters	3
Investment Casters	1

Note that investment caster is also sand caster

Appendix D

ARB Letter to ASHRAE

August 6, 2008

Ms. Claire Ramspeck
Assistant Director of Technology for Standards and Special Projects
American Society of Heating, Refrigeration, and Air Conditioning Engineers
1791 Tullie Circle, NE
Atlanta, Georgia 30329-2305

Dear Ms. Ramspeck:

The California Air Resources Board in coordination with the California Division of Occupational Safety and Health (Cal/OSHA) and the University of California (UC) requests ASHRAE to consider the greenhouse gas implications associated with sulfur hexafluoride (SF_6) tests outlined in the ANSI/ASHRAE 110 -1995 standard (Method of Testing Performance of Laboratory Fume Hoods) and determine if there are safe and effective alternatives to SF_6. According to the Intergovernmental Panel on Climate Change (IPCC), SF_6 is a potent greenhouse gas with a global warming potential (GWP) of 23,900, one of the highest GWPs currently identified. Given this high GWP, use of an alternative gas could have a significant impact on greenhouse gas emissions, especially given the international acceptance of ASHRAE standards.

Sulfur hexafluoride emissions are of particular concern in California since the California Global Warming Solutions Act of 2006 (AB 32) sets a greenhouse gas (GHG) reduction target for California to return to 1990 levels by 2020 – an estimated reduction of about 30 percent from the business as usual scenario. AB 32 requires the California Air Resources Board (ARB) to develop a statewide program to achieve the target through strategies that are both technologically feasible and cost-effective. In order to meet the goals of AB 32, ARB is implementing a variety of strategies including regulations. One of the potential regulations relates to minimizing or eliminating SF_6 in non-utility and non-semiconductor applications, including tracer gas uses.

ARB identified tracer gas use in fume hood testing as an SF_6 emissions source with potentially viable reduction options. Fume hood tests performed according to the ASHRAE 110 guidelines emit 1.5 pounds of SF_6, or approximately 16

tonnes of CO_2 equivalent per test. ARB's initial recommended regulatory approach is to phase-out SF_6 use in this application unless required by Cal/OSHA. Alternative gases such as perfluorocarbon tracers or others, could significantly reduce greenhouse gas emissions. For example, perfluorocarbon tracers have global warming potentials of 6,000 to 10,000, less than half the GWP of SF_6. Additionally, these gases have low background concentrations and can be measured at the parts per quadrillion level. Other potential alternatives have even lower global warming potentials.

These gases are well understood and used in other similar applications such as atmospheric transport tracer studies and we would be interested in starting a dialogue with ASHRAE to facilitate the use of the options listed above. Although ARB hopes to phase-out the use of SF_6 from this application in California, greatly reduced usage of SF_6 through a reduced injection rate and more precise measurement technologies could achieve national and international reductions. The use of an electron capture device would allow for a gas release of milliliter per minute compared to the four liter per minute release currently described by the standard. According to our understanding, the use of either SF_6 at a reduced ejection rate or a substitute gas would require validation and approval from the ASHRAE 110 committee in order to be in compliance with the standard.

The ARB, in consultation with Cal/OSHA and the UC, is requesting ASHRAE to revise the fume hood standard in order to consider greenhouse gas emissions resulting from application of the ASHRAE 110 standard. Some options for consideration include revising the specifications for an alternate gas to exclude unnecessary limitations such as molecular weight, and including recommendations for alternate gases. Considering the national and international use of the ASHRAE 110 standards, global greenhouse gas emission reductions could be significant.

The ARB and Cal/OSHA would be interested in starting a dialogue with ASHRAE on SF_6 use in fume hood and other testing protocols and any corresponding research needs. In addition, ARB requests that ASHRAE inform ARB if there are other ASHRAE standards requiring SF_6 use.

ARB invites ASHRAE to participate in our technical working group on the reduction of SF_6 in non-semiconductor and non-utility applications. Additional information on the measure and working group meetings can be found at: http://www.arb.ca.gov/cc/sf6nonelec/sf6nonelec.htm

It is our hope that your participation will foster actions to better protect California citizens against climate change through reduced greenhouse gas emissions.

If you would like further information or have any questions, please contact Elizabeth Scheehle at (916) 324-0621 or escheehl@arb.ca.gov.

Sincerely,

Bart E. Croes, P.E.
Chief, Research Division

cc: Joe S. Adams, Director,
Environment, Health, and Safety.
University of California, Office of the President
1111 Franklin Street
Oakland, CA 94607

Len Welsh, Chief,
Division of Occupational Safety and Health
1515 Clay Street, Suite 1901
Oakland, CA 94612

Elizabeth Scheehle
Research Division

CALIFORNIA AIR RESOURCES BOARD

NOTICE OF PUBLIC MEETING TO CONSIDER A REPORT ON STAFF'S AREA DESIGNATION RECOMMENDATIONS FOR THE REVISED FEDERAL 8-HOUR OZONE STANDARD

The Air Resources Board (ARB or the Board) staff will present recommended area designations for the revised federal 8-hour ozone standard of 0.075 parts per million (ppm).

ARB will submit these recommendations to the United States Environmental Protection Agency (U.S. EPA) by March 12, 2009.

DATE: February 26, 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., February 26, and will continue at 8:30 a.m., February 27, 2009. This item is expected to be considered on February 26, 2009. Please consult the agenda for the meeting, which will be available at least 10 days before February 26, 2009, to determine the day on which this item will be considered.

If you require special accommodations or language needs, please contact the Clerk of the Board at (916) 322-5594 or by Fax at (916) 322-3928 as soon as possible, but no later than 10 business days before the scheduled board hearing. TTY/TDD Speech to Speech users may dial 711 for the California Relay Service.

BACKGROUND

The federal Clean Air Act requires U.S. EPA to set health-based National Ambient Air Quality Standards. On March 12, 2008, the U.S. EPA lowered the 8-hour ozone standard from 0.08 parts per million (ppm) to 0.075 ppm. Under the Clean Air Act, ARB is required to submit recommendations for area designations and appropriate boundaries to U.S. EPA by March 12, 2009. ARB's recommendations are based on 2006 through 2008 ozone monitoring data.

U.S. EPA plans to finalize the area designations by March 12, 2010. ARB anticipates that U.S. EPA will base the final designations on the most recent data, which will most likely be data collected during 2007 through 2009. State implementation plans are due

three years after the effective date of the final designations, with attainment dates ranging from 2013 to 2030, depending on the severity of the problem.

PROPOSED ACTION

Because the revised ozone standard of 0.075 ppm is more stringent than the previous standard of 0.08 ppm, more areas fall into the nonattainment category. ARB staff will recommend that U.S. EPA designate six new or expanded areas as nonattainment for the revised ozone standard:

- Northeast San Bernardino County
- Southern Inyo County
- Pinnacles National Monument (San Benito County portion)
- San Luis Obispo County
- Tuscan Buttes (Tuscan Buttes area above 1800 feet in Tehama County)
- Eastern Kern County (expand to include Indian Wells Valley area)

Apart from these new areas, ARB will not recommend any change to the existing federal 8-hour nonattainment areas (all areas that violated the old standard continue to violate the lower, revised standard). A table summarizing both the new and the existing nonattainment areas is included as an attachment to this notice. Also included for completeness are tables summarizing attainment and unclassifiable areas.

AVAILABILITY OF DOCUMENTS

ARB staff will prepare a written Staff Report prior to the meeting. Copies of the Staff Report may be obtained from the Board's Public Information Office, 1001 "I" Street, First Floor, Environmental Services Center, Sacramento, California 95814, (916) 322-2990. This notice and Staff Report are also accessible on ARB's internet site at: www.arb.ca.gov/desig/desig.htm.

SUBMITTAL OF COMMENTS

Interested members of 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 comment submissions not physically submitted at the meeting must be received no later than 12:00 noon, February 25, 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 written and e-mail statements be filed 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 Ms. Gayle Sweigert, Manager of the Air Quality Analysis Section, at (916) 322-6923 or by e-mail at gsweiger@arb.ca.gov, or Marcella Nystrom, Staff Air Pollution Specialist, at (916) 323-8543 or by e-mail at mnystrom@arb.ca.gov.

CALIFORNIA AIR RESOURCES BOARD

James N. Goldstene
Executive Officer

Date: February 10, 2009

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

ATTACHMENT

Recommended California Nonattainment Areas for the Federal 8-Hour Ozone Standard Based on 2006-2008 Ozone Air Quality Data

	Nonattainment Area	*Area Included*
New Areas	Northeast San Bernardino County	Remainder of the Mojave Desert portion of San Bernardino County outside the Western Mojave ozone nonattainment area
	Southern Inyo County	Inyo County portions of federal hydrologic units 16060015, 18090202, 18090203, 18090204, and 18090205
	Pinnacles National Monument	San Benito County portion of Pinnacles National Monument
	San Luis Obispo County	San Luis Obispo County
	Tuscan Buttes	Tuscan Buttes in Tehama County above 1800'
Expanded Area	Eastern Kern County	Mojave Desert Air Basin portion of Kern County, including Indian Wells Valley
Existing Areas	South Coast Air Basin	Western Los Angeles (including Catalina and San Clemente Islands), Orange, southwestern San Bernardino, and western Riverside counties
	San Joaquin Valley	San Joaquin, Stanislaus, Merced, Madera, Fresno, Kings, Tulare, and western Kern counties
	Sacramento Metro Area	Sacramento, Yolo, eastern Solano, southern Sutter, and western portions of El Dorado and Placer counties
	San Francisco Bay Area	Marin, southern Sonoma, Napa, western Solano, Contra Costa, Alameda, Santa Clara, San Francisco, and San Mateo counties
	Ventura County	Continental portion of Ventura County (excludes Anacapa and San Nicolas islands)
	Western Mojave Desert	Central San Bernardino County
	Antelope Valley	Northeastern Los Angeles County
	Coachella Valley	Central Riverside County
	San Diego County	San Diego County
	Imperial County	Imperial County
	Sutter Buttes	Sutter Buttes in Sutter County above 2000'
	Central Mountain Counties	Amador and Calaveras counties
	Southern Mountain Counties	Tuolumne and Mariposa counties
	Western Nevada County	Portion of Nevada County west of the crest of the Sierra Nevada
	Butte County	Butte County

Recommended California Attainment Areas for the Federal 8-Hour Ozone Standard Based on 2006-2008 Ozone Air Quality Data

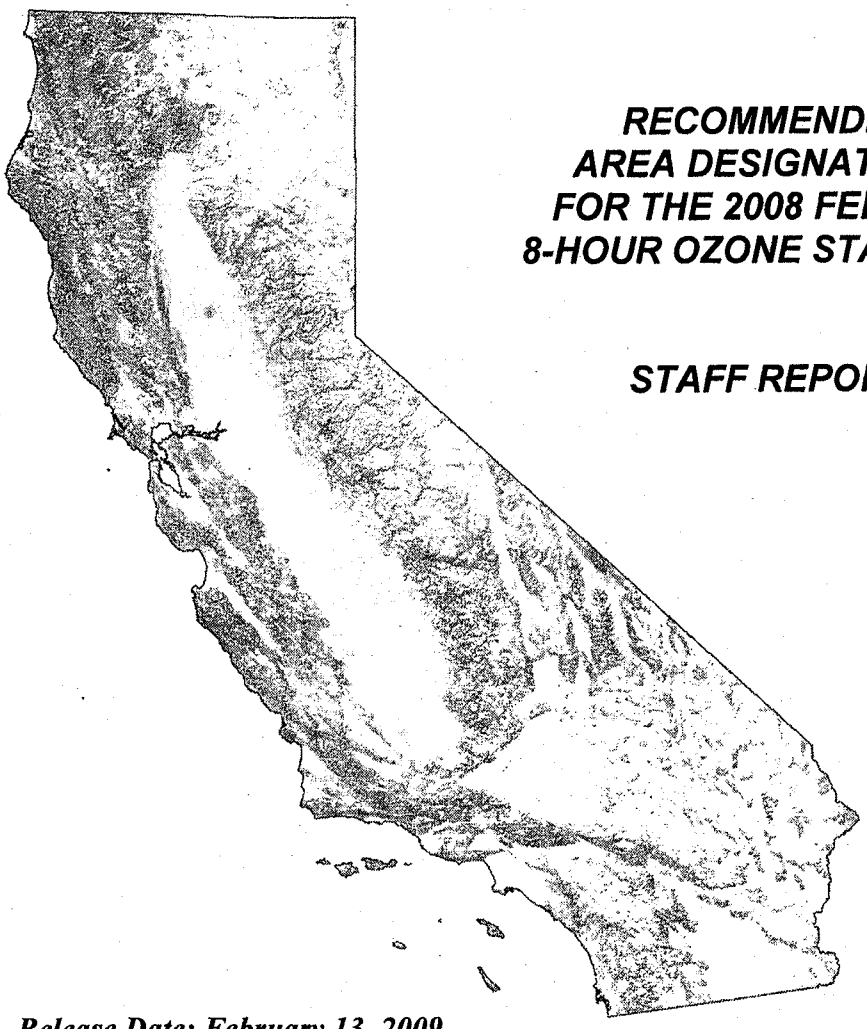
Attainment Area	*Area Included*
North Coast Air Basin	Del Norte, Humboldt, Mendocino, and Trinity counties and the North Coast Air Basin portion of Sonoma County
Shasta County	Shasta County
Tehama County	Portion of Tehama County outside Tuscan Buttes area
Glenn County	Glenn County
Colusa County	Colusa County
Sutter and Yuba Counties	Yuba County and portion of Sutter County outside Sacramento Metro Area and Sutter Buttes area
Lake County	Lake County
Lake Tahoe Air Basin	Lake Tahoe Air Basin portions of El Dorado and Placer counties
North Central Coast Air Basin	Monterey County, Santa Cruz County, San Benito County outside Pinnacles National Monument boundary
Santa Barbara County	Continental portion of Santa Barbara County (excludes San Miguel, Santa Barbara, Santa Cruz, and Santa Rosa islands)
Eastern Riverside County	Portion of Riverside County in Mojave Desert Air Basin

Recommended California Unclassifiable Areas for the Federal 8-Hour Ozone Standard

Unclassifiable Area	*Area Included*
Great Basin Valleys Air Basin	Alpine County, Mono County, portion of Inyo County outside Southern Inyo County nonattainment area
Northern Mountain Counties	Plumas and Sierra counties
Northern Channel Islands	The islands located in the South Central Coast Air Basin, including Anacapa, San Miguel, San Nicolas, Santa Barbara, Santa Cruz, and Santa Rosa
Eastern Nevada County	Portion of Nevada County east of the crest of the Sierra Nevada mountains
Northeast Plateau Air Basin	Lassen, Modoc, and Siskiyou counties

State of California

AIR RESOURCES BOARD



RECOMMENDED AREA DESIGNATIONS FOR THE 2008 FEDERAL 8-HOUR OZONE STANDARD

STAFF REPORT

Release Date: February 13, 2009
Hearing Date: February 26, 2009

California Environmental Protection Agency

Air Resources Board

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BACKGROUND

On March 12, 2008, U.S. EPA revised the federal 8-hour average air quality standard for ozone, lowering it from 0.08 parts per million (ppm) to 0.075 ppm. Both the primary and the secondary standard are set at the same level. Under the Clean Air Act, all states, including California, are required to develop recommendations for area designations and appropriate boundaries. The purpose of this report is to summarize the staff's technical analyses and area designation recommendations which are due to U.S. EPA by March 12, 2009. U.S. EPA then has one year to review these recommendations and will promulgate final designations by March 12, 2010. State implementation plans are due three years after the effective date of the final designations, with attainment dates ranging from 2013 to 2030, depending on the severity of the ozone problem.

ARB staff completed analyses to determine appropriate designation areas throughout the State using the criteria outlined in U.S. EPA's guidance memo (*December 4, 2008, Area Designations for the 2008 Revised Ozone National Ambient Air Quality Standards, Memorandum from Robert J. Meyers, Principal Deputy Assistant Administrator, Office of Air and Radiation to Regional Administrators, Regions I-X*). Determining an area's designation is based on comparing the design value to the level of the standard. The design value reflects a three-year average of the 4th highest 8-hour concentration. If the design value is 0.076 ppm or greater, it violates the federal standard. The recommendations in this report are based on design values reflecting 2006 through 2008 ozone data. However, ARB anticipates that U.S. EPA will base the final designations on the most recent data, which will most likely be data collected during 2007 through 2009.

Under U.S. EPA's guidance, air quality data may be excluded from the design value calculation if they were affected by an exceptional event. An exceptional event is an event, such as a wildfire, that causes an exceedance that is not reasonable to control through the regulatory process. During 2007 and 2008, wildfires impacted air quality throughout California. However, there is only one area in the State, Shasta County, where excluding such data makes a difference between attainment and nonattainment based on the design value for the 2006 through 2008 timeframe. Attachment A to this staff report includes a list of sites and dates for Shasta County that we are evaluating for identification as exceptional events.

In addition to Shasta County, other areas of California were also adversely impacted by wildfires. In some cases, the fire-impacted days may adversely impact design values, based on the 2007 through 2009 data that we expect U.S. EPA to use in determining the final area designations. Such measurements might also affect an area's classification with respect to the 0.075 ppm ozone

standard. ARB and the local districts are still investigating these impacts, and will submit documentation to U.S. EPA in accordance with established rules and regulations.

OZONE AIR QUALITY

ARB maintains a comprehensive network of federally sanctioned ozone monitors. This network comprises nearly 200 monitors, statewide. We are basing our initial recommendations on ambient ozone concentrations measured during 2006 through 2008 at locations sited and operated in accordance with federal requirements.

Ozone is not directly emitted, but is formed in the atmosphere via photochemical reactions. Because it takes time for these reactions to occur, high concentrations are often found at downwind locations, sometimes far away from the initial precursor emissions sources. In California, many of these transport-impacted areas do not have significant emissions sources of their own, and therefore are dependent on emissions controls in the upwind region to mitigate their ozone problem.

Our recommendations for several of California's new nonattainment areas recognize the importance of transport. Recent photochemical modeling completed as part of the planning process for the 0.08 ppm federal 8-hour ozone standard showed that many of the State's downwind transport-impacted areas will attain the standard as a result of upwind emissions controls. The modeling also showed that because ozone concentrations in the transport-impacted areas are generally lower, they should attain earlier than the upwind urban areas. This is particularly true for areas located downwind of the South Coast Air Basin. As a result, our recommended ozone nonattainment boundaries recognize these differences in the challenge, and also, differences in the level of control requirements, as well as local planning jurisdictions.

RECOMMENDED AREA DESIGNATIONS

Section 107(d)(1)(A) of the Clean Air Act defines a nonattainment area as any area that does not meet or that contributes to nearby areas not meeting the ambient air quality standard. U.S. EPA guidance recommends that the Core Based Statistical Area (CBSA) or Combined Statistical Area (CSA), which includes two or more CBSAs, serve as the starting point or "presumptive" boundary for an ozone nonattainment area. When a violating monitor is not located in a CBSA or CSA, U.S. EPA recommends that the boundary of the county in which the monitor is located serve as the presumptive boundary. In further refining the extent of the boundaries, U.S. EPA recommends that states evaluate each area on a case-by-case basis, considering nine factors:

- Air quality data
- Emissions data
- Population density and degree of urbanization
- Traffic and commuting patterns
- Growth rates and patterns
- Meteorology
- Geography/topography
- Jurisdictional boundaries
- Level of control of emission sources

Evaluation of these factors may support nonattainment area boundaries that are either larger or smaller than the presumptive boundary. Although each of our recommended nonattainment areas is unique, the boundaries embody several broad principles:

- For existing 8-hour ozone nonattainment areas, we retained the same nonattainment area boundaries, with the exception of expanding one area.

- For new nonattainment areas, a single monitor showing violations of the 8-hour ozone standard places the area into nonattainment status. While the starting point for a new nonattainment area is generally the county, our consideration of factors outlined in U.S. EPA guidance justified a smaller nonattainment area in many cases.

As shown in Figure 1, most of California will be nonattainment for the 8-hour ozone standard. We are proposing the State be divided into 21 distinct nonattainment areas. We are also proposing that 11 areas be designated as attainment. Table 1 presents a summary of the recommended nonattainment areas and corresponding boundaries. Following the figure and table, we discuss each of the nonattainment area recommendations, followed by a discussion of areas that qualify as attainment and areas that qualify as unclassified.

FIGURE 1

Recommended Area Designations for the Federal 8-Hour Ozone Standard

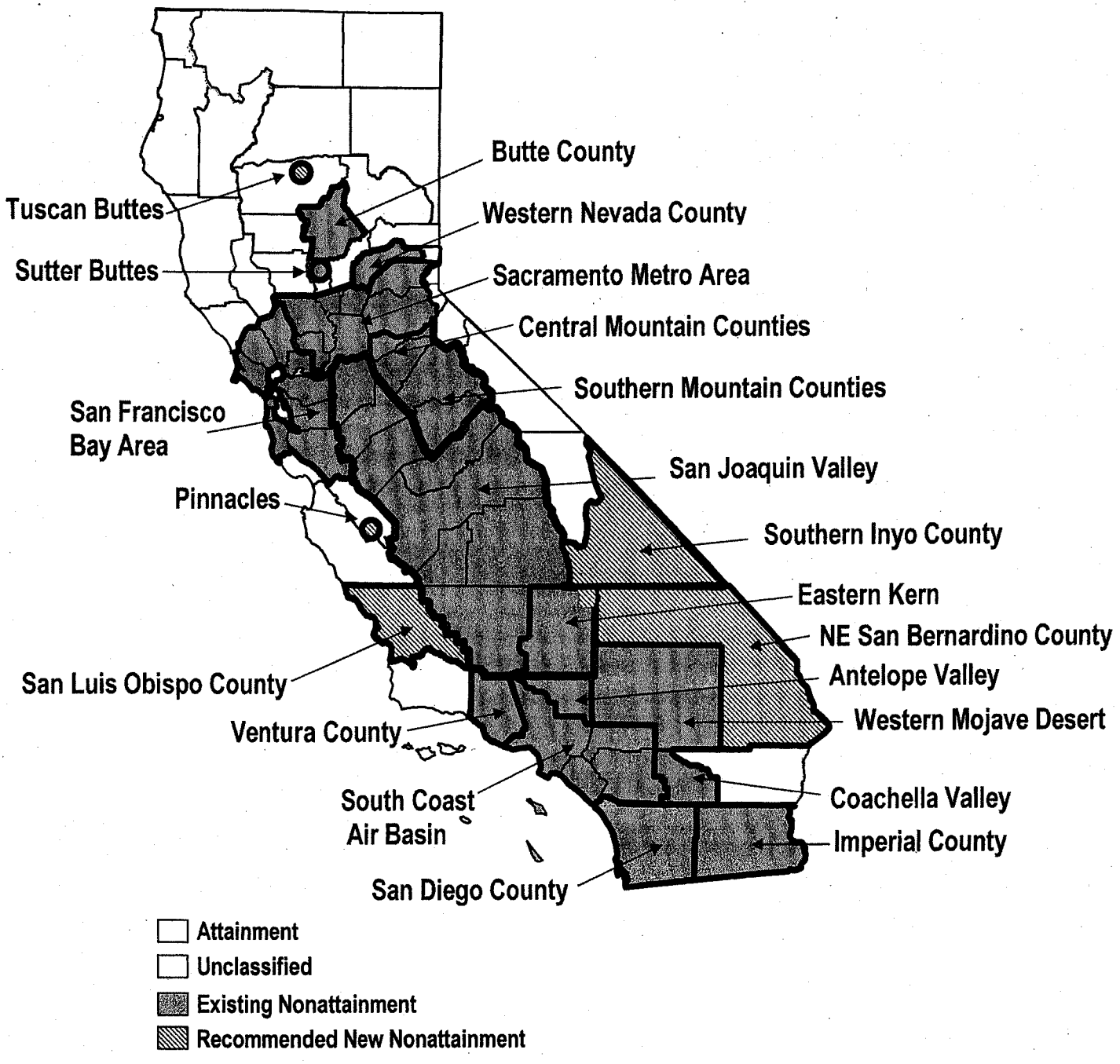

TABLE 1

Recommended California Nonattainment Areas for the Federal 8-Hour Ozone Standard Based on 2006-2008 Ozone Air Quality Data

	Nonattainment Area	*Design Value[1] (ppm)*	*Area Included*
New Areas	Northeast San Bernardino County	0.080	Remainder of the Mojave Desert portion of San Bernardino County outside the Western Mojave ozone nonattainment area
	Southern Inyo County	0.081	Inyo County portions of federal hydrologic units 16060015, 18090202, 18090203, 18090204, and 18090205
	Pinnacles	0.079	San Benito County portion of Pinnacles National Monument
	San Luis Obispo County	0.088	San Luis Obispo County
	Tuscan Buttes	0.085	Tuscan Buttes in Tehama County above 1800'
Expanded Area	Eastern Kern County	0.086	Mojave Desert Air Basin portion of Kern County, including Indian Wells Valley
Existing Areas	South Coast Air Basin	0.119	Western Los Angeles (including Catalina and San Clemente Islands), Orange, southwestern San Bernardino, and western Riverside counties
	San Joaquin Valley	0.108	San Joaquin, Stanislaus, Merced, Madera, Fresno, Kings, Tulare, and western Kern counties
	Sacramento Metro Area	0.102	Sacramento, Yolo, eastern Solano, southern Sutter, and western portions of El Dorado and Placer counties
	San Francisco Bay Area	0.081	Marin, southern Sonoma, Napa, western Solano, Contra Costa, Alameda, Santa Clara, San Francisco, and San Mateo counties
	Ventura County	0.088	Continental portion of Ventura County (excludes Anacapa and San Nicolas islands)
	Western Mojave Desert	0.104	Central San Bernardino County
	Antelope Valley	0.094	Northeastern Los Angeles County
	Coachella Valley	0.097	Central Riverside County
	San Diego County	0.092	San Diego County
	Imperial County	0.082	Imperial County
	Sutter Buttes	0.085	Sutter Buttes in Sutter County above 2000'
	Central Mountain Counties	0.089	Amador and Calaveras counties
	Southern Mountain Counties	0.088	Tuolumne and Mariposa counties
	Western Nevada County	0.091	Portion of Nevada County west of the crest of the Sierra Nevada
	Butte County	0.085	Butte County

[1]The design value is the 3-year average (2006-2008 data) of the annual fourth highest 8-hour ozone concentration at the highest monitor (if greater than 0.075 ppm = nonattainment; if less than or equal to 0.075 = attainment). 2008 data are preliminary.

New Nonattainment Areas

Northeast San Bernardino County

San Bernardino County is the largest county in the nation, comprising over 20,000 square miles. Because of its size, it encompasses a very diverse landscape. Currently, the central portion of San Bernardino County, located in the Mojave Desert Air Basin, is defined as the Western Mojave Desert (WMD) nonattainment area. While the presumptive boundary for an expanded nonattainment area would include the entire Mojave Desert portion of San Bernardino County, ARB is recommending the area be designated as two separate areas, based on differences in the nature and severity of the ozone problems.

With a population of more than 350,000 (2006 estimate), the WMD portion of San Bernardino County is adjacent to the South Coast Air Basin. Given its proximity to the South Coast, major highways traveling through the WMD carry significant commuter and truck traffic in and out of the South Coast region. Principal cities in the area include Hesperia, Phelan, Victorville, Apple Valley, and Twentynine Palms. Previous transport assessments show that ozone concentrations in the WMD portion of San Bernardino County are impacted by transport from the South Coast and San Joaquin Valley air basins, which are the areas with the highest ozone levels in the state. Along with the transport impact, there is also a local component to the ozone problem in this area. The design value for the WMD is 0.104 ppm at the Joshua Tree-National Monument site. Design values for other sites in the area are similar in magnitude, though slightly lower.

In contrast to the WMD, the more remote northeast portion of San Bernardino County is sparsely populated. There are no sizable cities, and the area has few significant emission sources. Because the area lacks significant population centers and emissions sources capable of generating ozone locally, the transport component is even more important. Furthermore, the design value for this part of San Bernardino County is 0.080 ppm, which is substantially lower than the WMD design value.

Although the northeast portion of San Bernardino County is contiguous with the existing WMD nonattainment area and is part of the same county, ARB staff is recommending it be defined as a separate nonattainment area. The design value for the WMD portion of San Bernardino County is 30 percent higher than the design value for the northeast portion of the County. Although both areas will rely on controls from upwind areas to reach attainment, because the magnitude of their problems is so different, the northeast portion of San Bernardino County should attain the standard in a shorter timeframe. Designating the area separately would give them a classification consistent with their overall air quality problem and facilitate a more timely attainment finding.

Southern Inyo County

Inyo County is the second largest county in California and one of the largest counties in the nation. It encompasses more than 10,000 square miles, from the below sea level floor of Death Valley to the 14,000 foot peaks of the Sierra Nevada. The only long-term ozone monitor in Inyo County is located at the Death Valley National Monument in southeast Inyo County. The site is operated by the National Park Service and has a design value of 0.081 ppm, which exceeds the federal standard. The area has an extremely low population, with only 0.22 residents per square mile, and lacks industrial emissions sources. While the presumptive boundary for the nonattainment area would include all of Inyo County, ARB is recommending a smaller nonattainment area because of the diversity of the area's geography and the nature of the ozone impact.

Previous studies suggest that ozone concentrations at the Death Valley site are substantially impacted by transport. Wind flow into the southern portion of the County is generally from the southwest to northeast, carrying pollutants and emissions from the highly urbanized South Coast and southern San Joaquin Valley air basins into southern Inyo County. Although Death Valley is the only monitoring site in southern Inyo County, data are also collected at the Trona site in San Bernardino County, just 2 miles south of the Inyo County line. These data suggest that exceedances are also likely to occur in the southwest portion of Inyo County. During 2004 through 2008, about half of the exceedance days at Trona coincide with exceedance days at Death Valley, indicating that the nonattainment area should include the southwest portion of Inyo County, as well as the Death Valley area.

In addition to these data, limited 2008 ozone monitoring data are available for a site at Bishop, in the northern portion of Inyo County. The site is operated by the Bishop Piute Tribe. The Bishop data show several days with concentrations above the federal 8-hour standard, but because the data are incomplete, it is not possible to calculate a valid design value for this site and determine if it would violate the standard. Furthermore, an analysis completed by the Great Basin Unified Air Pollution Control District (APCD) shows that emissions and pollutants from this area do not likely contribute to the exceedances at Death Valley.

In determining the appropriate nonattainment area boundary, ARB staff consulted with the local Great Basin Unified APCD. The recommended boundary for this area is based on federal hydrologic units. Hydrologic units are based on topography and drainage, similar in many respects to the way California's air basins are defined. Therefore, it is appropriate to use them in defining the nonattainment area boundary, since mountainous terrain affects the transport and mixing depth of pollution. In addition, hydrologic units have been used previously to define designated areas for ozone. ARB staff recommends the Southern Inyo County ozone nonattainment area comprise the Inyo County

portions of federal hydrologic units 16060015, 18090202, 18090203, 18090204, and 18090205. These units cover not only the areas exceeding the standard, but also the areas most heavily impacted by transport from the major upwind urban areas.

Pinnacles National Monument

San Benito County is located in California's north central coast region, just south of the San Francisco Bay Area (Bay Area). Although it is considered part of the coastal region, San Benito County is located inland. The federal ozone standard is exceeded at only one site in this area, the Pinnacles National Monument site, with a design value of 0.079 ppm.

With the exception of 2008, the trend in the design value for Pinnacles has been consistently downward. In fact, the 2006 and 2007 design values for this site (0.075 ppm and 0.074 ppm, respectively) show attainment. The higher value for 2008 likely reflects the impact of wildfires that burned throughout the State during the summer of 2008. If the impacted days were removed from consideration, the 2008 design value would be more consistent with values for previous years. However, the area would still be nonattainment. In contrast to Pinnacles, design values for sites in the surrounding north central coast region are all well below the level of the standard, ranging from 0.052 ppm to 0.069 ppm.

Pinnacles is an elevated site (1000 feet) located in an area of complex terrain within the boundaries of Pinnacles National Monument. Previous transport study indicates that exceedances measured at Pinnacles can be overwhelmingly impacted by transport aloft from the Bay Area. Although the San Francisco Bay Area does not yet attain the standard, design values for Bay Area sites have decreased since the early 2000s, similar to those for Pinnacles. As emissions in the Bay Area continue to decrease, ozone concentrations in downwind areas such as Pinnacles will also improve.

Because exceedances in San Benito County are measured only at Pinnacles and nowhere else in the local area, ARB recommends limiting the nonattainment area. The ozone problem at Pinnacles is attributable to transport from the Bay Area, which is already designated as nonattainment. Designating Pinnacles as nonattainment, as well, would adequately reflect the impact region for the upwind urban area. Specifically, ARB recommends limiting the nonattainment area to that portion of Pinnacles National Monument located within San Benito County. Using the Monument boundary would provide for an easily identifiable nonattainment area.

San Luis Obispo County

San Luis Obispo County is located in California's south central coast region and encompasses coastal, as well as inland areas. The design value for the County is 0.088 ppm, measured at the Red Hills site. This site is located in an unpopulated area and was originally sited to provide information on transport impacts from the San Joaquin Valley. The design value for a second inland site, Carrizo Plains School-9640 Carrizo, is also above the standard at a level of 0.084 ppm. In contrast to Red Hills, the Carrizo Plains site is in a populated area. Design values for all other sites in San Luis Obispo County are below the level of the standard, as are design values for sites in counties located both to the north and to the south of San Luis Obispo County.

Previous studies have shown that ozone and ozone precursor emissions from the San Joaquin Valley are transported west, impacting sites in eastern San Luis Obispo County, including Red Hills and Carrizo Plains. Countywide ozone concentrations can also be impacted by transport south from the San Francisco Bay Area. Reducing the transport impact will be critical to attaining the federal standard throughout San Luis Obispo County. Although the federal ozone standard is exceeded only at sites in the eastern portion of the County, backward trajectories on exceedance days indicate that emissions from sites in the western portion of San Luis Obispo County may have a contributing impact. Therefore, ARB recommends that all of San Luis Obispo County be designated as nonattainment.

Tuscan Buttes

Tuscan Buttes in Tehama County is located in the Sacramento Valley, where the majority of the land is near sea level. There are two monitors in the County. The first site, Red Bluff-Oak Street, is in the town of Red Bluff at an elevation of 322 feet. While the design value for this site currently meets the standard, several of the high measurements at this site during 2008 may have been impacted by wildfires. The District and ARB are currently reviewing this data, and if warranted, ARB plans to include documentation to support the exclusion of these measurements as exceptional events when we submit our designation recommendations to U.S. EPA in March 2009.

The second monitor in Tehama County, Tuscan Buttes, has a design value of 0.085 ppm which exceeds the standard. Located at an elevation of 1,877 feet, the Tuscan Buttes monitor is similar to the Sutter Buttes monitor in Sutter County. Both of these monitors were sited to study high-elevation transport of pollutants from the Sacramento urban nonattainment region into the upper Sacramento Valley, and there are no pollution sources or populated areas near either site. Furthermore, design values for low elevation sites in areas

surrounding Tehama County (Colusa and Glenn counties and northern Sutter County) are below the level of the standard, lending additional support to the argument that the ozone problem at Tuscan Buttes is unique and isolated.

Because of the elevated location and lack of population exposure at the Tuscan Buttes site, ARB recommends the geographic scope of the nonattainment area be limited to that portion of the Tuscan Buttes area with an elevation of 1800 feet or more. This approach is consistent with the approach U.S. EPA used in designating the Sutter Buttes ozone nonattainment area.

Expanded Nonattainment Area

Eastern Kern County

Kern County is located in two different air basins: the San Joaquin Valley Air Basin and the Mojave Desert Air Basin. The eastern portion, located in the Mojave Desert Air Basin, falls under the jurisdiction of the Kern County Air Pollution Control District. Currently, the Eastern Kern nonattainment area, which does not include Indian Wells Valley, is desighated as nonattainment based on a design value of 0.086 ppm for the Mojave-Poole Street site.

In contrast, Indian Wells Valley (defined as the Kern County portion of hydrologic unit 18090205), in the northeastern portion of Kern County, is designated as attainment for the 0.08 ppm ozone standard. Indian Wells Valley is a desert region that includes the China Lake Naval Air Weapons Station and the town of Ridgecrest. Similar to the rest of Eastern Kern, Indian Wells Valley is sparsely populated, with few significant emissions sources. Furthermore, previous studies have shown that ozone concentrations in both of these areas are overwhelmingly impacted by transport from the San Joaquin Valley and South Coast air basins.

Ozone data collected during 2006 through 2008 are available for a site located in the China Lake area of Indian Wells Valley. Although these data have not been reviewed or forwarded to U.S. EPA, the design value for the site, 0.081 ppm, exceeds the federal standard and is comparable to the design value of 0.086 ppm for the Mojave-Poole Street site in the existing Eastern Kern nonattainment area. Because the design values for these two areas are similar in magnitude and both areas are impacted by ozone transported from the same upwind areas, ARB staff recommends that the existing Eastern Kern nonattainment area be expanded to include Indian Wells Valley. As a result, the Eastern Kern ozone nonattainment area would include the entire Mojave Desert Air Basin portion of Kern County.

Existing Nonattainment Areas

South Coast Air Basin

The South Coast Air Basin nonattainment area would continue to include all of the South Coast Air Basin: western Los Angeles (including Catalina and San Clemente Islands, which are not part of the Channel Islands), Orange, southwestern San Bernardino, and western Riverside counties. This nonattainment area violates the 8-hour standard with a design value of 0.119 ppm at the Crestline monitoring site in San Bernardino County.

San Joaquin Valley

The San Joaquin Valley nonattainment area would continue to comprise the entire San Joaquin Valley Air Basin: San Joaquin, Stanislaus, Merced, Madera, Fresno, Kings, Tulare, and western Kern counties. The San Joaquin Valley violates the federal 8-hour standard with a design value of 0.108 ppm at the Arvin-Bear Mountain Blvd. monitoring site in Kern County.

Sacramento Metro Area

The Sacramento Metro nonattainment area would continue to include all of Sacramento and Yolo counties, southern Sutter County, the Sacramento Valley Air Basin portion of Solano County, the Sacramento Valley and Mountain Counties air basin portions of Placer County, and the Mountain Counties Air Basin portion of El Dorado County. This area violates the standard with a design value of 0.102 ppm at the Folsom-Natoma Street site in Sacramento County. Although the nonattainment area involves multiple local air pollution control agencies, all but the Solano County portion are covered by a single transportation planning agency.

San Francisco Bay Area

The San Francisco Bay Area nonattainment area would continue to comprise all of the San Francisco Bay Area Air Basin: Marin, Napa, Contra Costa, Alameda, Santa Clara, San Francisco, and San Mateo counties and the San Francisco Bay Area Air Basin portions of Solano and Sonoma counties. The area's nonattainment designation is based on a design value of 0.081 ppm for the Livermore-793 Rincon Avenue site in Alameda County.

Ventura County

The Ventura County 8-hour nonattainment area would continue to include only the continental portion of Ventura County. Anacapa and San Nicolas Islands, two of the Channel Islands, would not be included. Ventura County violates the

federal standard with a design value of 0.088 ppm at the Simi Valley-Cochran Street site.

Western Mojave Desert

The Western Mojave Desert nonattainment area would continue to comprise the central portion of San Bernardino County that is located in the Mojave Desert Air Basin. Ozone concentrations at a number of sites in this area violate the federal 8-hour standard, and the area has a design value of 0.104 ppm at the Joshua Tree-National Monument site.

Antelope Valley

The Antelope Valley nonattainment area would continue to comprise the portion of Los Angeles County that is located in the Mojave Desert Air Basin. The area has a design value of 0.094 ppm at the Lancaster-43301 Division Street site.

Coachella Valley

The Coachella Valley ozone nonattainment area would continue to include the portion of Riverside County that is located in the Salton Sea Air Basin. The design value for this area is 0.097 ppm at the Palm Springs-Fire Station site.

San Diego County

The 8-hour nonattainment area would continue to include all of San Diego County. Ozone concentrations in the County exceed the standard at several sites, and the design value is 0.092 ppm at Alpine-Victoria Drive.

Imperial County

Similar to San Diego County, the Imperial County nonattainment area would continue to include the entire County. The design value for Imperial County is 0.082 ppm at both El Centro-9th Street and Westmorland-West 1st Street.

Sutter Buttes

The Sutter Buttes nonattainment area would continue to include that portion of the Sutter Buttes above 2000 feet elevation. Located in Sutter County, the design value for this area is 0.085 ppm at the Sutter Buttes site.

Central Mountain Counties

The Central Mountain Counties nonattainment area would continue to include all of Amador and Calaveras counties. The design value for this two-county area is 0.089 ppm at the San Andreas-Gold Strike Road site in Calaveras County.

Southern Mountain Counties

The Southern Mountain Counties nonattainment area would continue to include all of Mariposa and Tuolumne counties. The design value for this area is 0.088 ppm at the Turtleback Dome site in Yosemite National Park, which is in Mariposa County.

Western Nevada County

This nonattainment area would continue to comprise the western portion of Nevada County, up to the crest of the Sierra Nevada. The current design value for western Nevada County is 0.091 ppm at the Grass Valley-Litton Building site.

Butte County

This nonattainment area would continue to comprise all of Butte County. There are two monitoring sites in Butte County, and both have design values that violate the standard. The Paradise-4405 Airport Road site has the higher value, with a design value of 0.085 ppm.

Attainment Areas

A number of areas in California have ozone monitoring data that are in attainment of the 2008 federal 8-hour standard according to the criteria established by U.S. EPA *(U.S. EPA, December 1998, Guideline on Data Handling Conventions for the 8-Hour Ozone NAAQS)*. One of these areas, Shasta County, attained the 0.08 ppm standard but has ozone data showing violations of the federal 0.075 ppm standard. However, a number of days in this area during 2008 were impacted by wildfires, an exceptional event. If these days are excluded, Shasta County's design value is below the 2008 federal 8-hour ozone standard. A second area, Eastern Riverside County, was previously designated as unclassified because of incomplete data. Now that complete data are available, the area qualifies as attainment. The remaining nine areas all have design values in attainment of the 0.075 ppm ozone standard, and ARB recommends they also be designated as attainment. All of the recommended attainment areas are summarized in Table 2, below.

Shasta County

Currently, Shasta County in northern California is designated as attainment for the federal 0.08 ppm ozone standard. There are three monitoring sites in Shasta County: Anderson-North Street, Redding-Health Department Roof, and Lassen Volcanic National Park-Manzanita Lake. Using all data collected at these sites during 2006 through 2008, the design values for both Anderson (0.076 ppm) and Lassen (0.077 ppm) are just slightly above the federal standard.

During the summer of 2008, a significant number of wildfires in California impacted ambient ozone readings at sites throughout the State. Shasta County Air Quality Management District has documented these impacts and requested that high ozone measurements during 16 days in June and July 2008 be excluded as impacted by exceptional events (refer to Attachment A). ARB is still in the process of reviewing these data. However, if the measurements are excluded in accordance with U.S. EPA's exceptional events rule, the revised design value would be 0.073 ppm for all three sites in Shasta County.

If the impacted data are excluded, the design value for Shasta County is below the 2008 federal 8-hour ozone standard. Therefore, pending ARB concurrence with the District's evaluation, we recommend that Shasta County be designated as attainment for the federal 8-hour ozone standard.

Eastern Riverside County

Riverside County is subdivided among three air basins: South Coast Air Basin, Salton Sea Air Basin (Coachella Valley), and Mojave Desert Air Basin. The urbanized South Coast and Coachella Valley portions of the County have design values that violate the standard, and these areas are designated as nonattainment. In contrast, the eastern portion of Riverside County, located in the Mojave Desert Air Basin, is sparsely populated, with few emissions sources. This portion of the County is currently designated as unclassified for the federal 8-hour ozone standard.

When U.S. EPA designated areas for the 0.08 ppm ozone standard, complete ozone monitoring data were not available for eastern Riverside County, and the area was designated as unclassified. Since then, the ozone monitoring site at Blythe (Blythe-445 West Murphy Street) has continued to operate. The Blythe data show a design value of 0.063 ppm, based on data collected during 2006 through 2008. Because this value is below the standard, ARB recommends that eastern Riverside County be designated as attainment for the 2008 federal 8-hour ozone standard.

Other Areas

A number of other areas in California that were attainment or unclassified for the 0.08 ppm standard also qualify as attainment for the revised federal ozone standard of 0.075 ppm. These areas are listed in Table 2, along with their design values, based on data collected during 2006 through 2008. ARB recommends that all these areas be designated as attainment for ozone.

TABLE 2
Recommended California Attainment Areas for the Federal 8-Hour Ozone Standard Based on 2006-2008 Ozone Air Quality Data

Attainment Area	*Design Value[1] (ppm)*	*Area Included*
North Coast Air Basin	0.058	Del Norte, Humboldt, Mendocino, and Trinity counties and the North Coast Air Basin portion of Sonoma County
Shasta County	0.073	Shasta County
Tehama County	0.075	Portion of Tehama County outside Tuscan Buttes area
Glenn County	0.065	Glenn County[2]
Colusa County	0.069	Colusa County
Sutter and Yuba Counties	0.072	Yuba County and portion of Sutter County outside Sacramento Metro Area and Sutter Buttes area
Lake County	0.062	Lake County
Lake Tahoe Air Basin	0.070	Lake Tahoe Air Basin portions of El Dorado and Placer counties
North Central Coast Air Basin	0.069	Monterey County, Santa Cruz County, San Benito County outside Pinnacles National Monument boundary
Santa Barbara County	0.073	Continental portion of Santa Barbara County (excludes San Miguel, Santa Barbara, Santa Cruz, and Santa Rosa islands)
Eastern Riverside County	0.063	Portion of Riverside County in Mojave Desert Air Basin

[1]The design value is the 3-year average (2006-2008 data) of the annual fourth highest 8-hour ozone concentration at the highest monitor (if greater than 0.075 ppm = nonattainment; if less than or equal to 0.075 = attainment). 2008 data are preliminary.
[2] Reflects combined data from 2 monitoring sites.

Unclassifiable Areas

The areas listed in Table 3 have either no ozone monitoring data or the available monitoring data do not meet completeness criteria established by U.S. EPA. Therefore, ARB recommends they be considered unclassifiable at the current time.

TABLE 3
Recommended California Unclassifiable Areas for the Federal 8-Hour Ozone Standard

Unclassifiable Area	*Area Included*
Great Basin Valleys Air Basin	Alpine County, Mono County, portion of Inyo County outside Southern Inyo County nonattainment area
Northern Mountain Counties	Plumas and Sierra counties
Northern Channel Islands	The islands located in the South Central Coast Air Basin, including Anacapa, San Miguel, San Nicolas, Santa Barbara, Santa Cruz, and Santa Rosa
Eastern Nevada County	Portion of Nevada County east of the crest of the Sierra Nevada mountains
Northeast Plateau Air Basin	Lassen, Modoc, and Siskiyou counties

ATTACHMENT A

SUMMARY OF OZONE DATA
POTENTIALLY IMPACTED BY EXCEPTIONAL EVENTS

INTRODUCTION

Under U.S. EPA's guidance, air quality data may be excluded from the designation process if they were affected by an exceptional event. During 2007 and 2008, wildfires impacted air quality throughout California. However, there is only one area in the State, Shasta County, where excluding such data makes a difference between attainment and nonattainment based on the design value for the 2006 through 2008 timeframe. The dates and sites being considered for identification as exceptional events for this area are listed in Table A-1, below.

In addition to Shasta County, there are other areas in California where it is uncertain if measurements impacted by wildfires would adversely affect their design values based on the 2007 through 2009 data that U.S. EPA is expected to use in determining the final area designations. It is also uncertain whether excluding such measurements would affect their classification with respect to the 0.075 ppm ozone standard. Therefore, additional dates and sites may be identified. ARB anticipates that documentation of all exceptional events will be submitted to U.S. EPA in March 2009.

TABLE A-1

Summary of Data Being Evaluated as Potentially Affected by Exceptional Events

COUNTY	MONITORING SITE	DATES
Shasta	Anderson-North St	Jun 14-15, 24-25, 28-30, 2008 and Jul 2, 13, 17-19, 23-26, 2008
	Lassen Vol NP_Manzanita Lk	same dates as Anderson
	Redding-Health Dept Roof	same dates as Anderson

ATTACHMENT B

2006-2008 FEDERAL 8-HOUR OZONE DESIGN VALUES BY SITE

TABLE B-1
SUMMARY OF DATA AND FEDERAL 8-HOUR OZONE DESIGN VALUES FOR CALIFORNIA SITES BASED ON 2006 THROUGH 2008 DATA

				Year			
Basin Name	County Name	Site Name	Statistic	2006	2007	2008*	2008* Design Value
Great Basin Valleys	Inyo	Death Valley Natl Monument	4th High	0.082	0.085	0.077	0.081
			Valid Days	347	351	320	
	Alpine	NO MONITORS					
	Mono	NO MONITORS					
Lake County	Lake	Lakeport-Lakeport Blvd	4th High	0.062	0.057	0.068	0.062
			Valid Days	360	354	328	
Lake Tahoe	El Dorado	South Lake Tahoe-Airport Road	4th High	0.069	0.070	0.072	0.070
			Valid Days	160	169	151	
	Placer	NO MONITORS					
Mojave Desert	Kern	Mojave-923 Poole Street	4th High	0.089	0.078	0.093	0.086
			Valid Days	357	358	188	
	Los Angeles	Lancaster-43301 Division Street	4th High	0.098	0.091	0.095	0.094
			Valid Days	363	357	360	
	Riverside	Blythe-445 West Murphy Street	4th High	0.057	0.066	0.067	0.063
			Valid Days	361	284	237	
	San Bernardino	Barstow	4th High	0.086	0.084	0.090	0.086
			Valid Days	344	356	364	
		Hesperia-Olive Street	4th High	0.095	0.098	0.098	0.097
			Valid Days	358	356	362	
		Joshua Tree-National Monument	4th High	0.103	0.104	0.105	0.104
			Valid Days	348	342	322	
		Phelan-Beekley Rd & Phelan Rd'	4th High	0.097	0.093	0.099	0.096
			Valid Days	363	356	365	
		Trona-Athol and Telegraph	4th High	0.080	0.077	0.084	0.080
			Valid Days	360	351	339	
		Victorville-14306 Park Avenue	4th High	0.091	0.087	0.089	0.089
			Valid Days	363	362	359	
Mountain Counties	Amador	Jackson-Clinton Road	4th High	0.085	0.073	0.101	0.086
			Valid Days	363	344	265	
	Calaveras	San Andreas-Gold Strike Road	4th High	0.098	0.076	0.094	0.089
			Valid Days	364	356	267	
	El Dorado	Cool-Highway 193	4th High	0.099	0.093	0.102	0.098
			Valid Days	183	181	150	
		Echo Summit	4th High	0.075	0.075	0.078	0.076
			Valid Days	148	135	135	
		Placerville-Gold Nugget Way	4th High	0.097	0.085	0.106	0.096
			Valid Days	363	333	272	
	Mariposa	Jerseydale - 6440 Jerseydale	4th High	0.080	0.083	0.089	0.084
			Valid Days	175	181	183	

Basin Name	County Name	Site Name	Statistic	Year 2006	2007	2008*	2008* Design Value
Mountain Counties (continued)	Mariposa (continued)	Yosemite NP-Turtleback Dome	4th High	0.084	0.087	0.094	0.088
			Valid Days	292	334	317	
	Nevada	Grass Valley-Litton Building	4th High	0.096	0.088	0.091	0.091
			Valid Days	328	365	247	
		Truckee-Fire Station	4th High	0.076	0.071	0.066	0.071
			Valid Days	225	281	265	
		White Cloud Mountain	4th High	0.089	0.082	0.091	0.087
			Valid Days	162	182	153	
	Placer	Colfax-City Hall	4th High	0.105	0.079	0.084	0.089
			Valid Days	346	356	338	
	Plumas	Quincy-N Church Street	4th High	0.064			0.064
			Valid Days	229			
	Tuolumne	Sonora-Barretta Street	4th High	0.079	0.084	0.098	0.087
			Valid Days	365	360	271	
	Sierra	NO MONITORS					
North Central Coast	Monterey	Carmel Valley-Ford Road	4th High	0.060	0.059	0.060	0.059
			Valid Days	364	365	332	
		King City-415 Pearl Street	4th High		0.054	0.06	0.057
			Valid Days		215	304	
		King City-750 Metz Road	4th High	0.063	0.054		0.058
			Valid Days	360	134		
		Salinas-#3	4th High	0.054	0.053	0.060	0.055
			Valid Days	358	354	322	
	San Benito	Hollister-Fairview Road	4th High	0.071	0.068	0.068	0.069
			Valid Days	359	352	329	
		Pinnacles National Monument	4th High	0.078	0.075	0.086	0.079
			Valid Days	355	361	324	
	Santa Cruz	Davenport	4th High	0.052	0.049	0.056	0.052
			Valid Days	364	362	322	
		Santa Cruz-2544 Soquel Ave	4th High	0.054	0.053	0.057	0.054
			Valid Days	358	358	329	
		Scotts Valley-Scotts Valley Dr	4th High	0.062	0.059	0.064	0.061
			Valid Days	361	361	332	
		Watsonville-Airport Boulevard	4th High	0.054	0.054	0.058	0.055
			Valid Days	363	364	334	
North Coast	Humboldt	Eureka-Jacobs	4th High		0.046	0.049	0.047
			Valid Days	17	308	347	
	Mendocino	Ukiah-E Gobbi Street	4th High	0.060	0.053	0.061	0.058
			Valid Days	356	352	302	
		Willits-899 S Main Street	4th High	0.049	0.046	0.045	0.046
			Valid Days	351	358	149	

Basin Name	County Name	Site Name	Statistic	Year 2006	2007	2008*	2008* Design Value
North Coast (continued)	Sonoma	Healdsburg-Municipal Airport	4th High	0.056	0.060	0.055	0.057
			Valid Days	338	341	271	
	Del Norte	NO MONITORS					
	Trinity	NO MONITORS					
Northeast Plateau	Siskiyou	Yreka-Foothill Drive	4th High	0.067	0.060	0.058	0.061
			Valid Days	318	332	264	
	Lassen	NO MONITORS					
	Modoc	NO MONITORS					
Sacramento Valley	Butte	Chico-Manzanita Avenue	4th High	0.076	0.074	0.080	0.076
			Valid Days	360	363	262	
		Paradise-4405 Airport Road	4th High	0.089	0.083	0.084	0.085
			Valid Days	361	364	269	
	Colusa	Colusa-Sunrise Blvd	4th High	0.069	0.066	0.072	0.069
			Valid Days	357	361	269	
	Glenn	Willows-720 N Colusa Street	4th High	0.059	0.069	0.067	0.065
			Valid Days	106	361	271	
		Willows-E Laurel Street	4th High	0.063			0.063
			Valid Days	252			
	Placer	Auburn-Dewitt-C Avenue	4th High	0.098	0.079	0.095	0.090
			Valid Days	330	347	351	
		Roseville-N Sunrise Blvd	4th High	0.094	0.082	0.094	0.090
			Valid Days	363	350	271	
	Sacramento	Elk Grove-Bruceville Road	4th High	0.087	0.078	0.082	0.082
			Valid Days	357	359	330	
		Folsom-Natoma Street	4th High	0.102	0.090	0.114	0.102
			Valid Days	358	354	327	
		North Highlands-Blackfoot Way	4th High	0.092	0.071	0.072	0.078
			Valid Days	356	341	245	
		Sacramento-3801 Airport Road	4th High	0.077	0.077	0.080	0.078
			Valid Days	311	299	201	
		Sacramento-Del Paso Manor	4th High	0.093	0.081	0.087	0.087
			Valid Days	349	362	323	
		Sacramento-T Street	4th High	0.084	0.073	0.081	0.079
			Valid Days	351	342	292	
		Sloughhouse	4th High	0.104	0.080	0.102	0.095
			Valid Days	214	208	212	
	Shasta	Anderson-North Street	4th High	0.073	0.075	0.081	0.076
			Valid Days	327	365	274	
		Lassen Vol NP-Manzanita Lk	4th High	0.074	0.076	0.083	0.077
			Valid Days	353	362	316	
		Redding-Health Dept Roof	4th High	0.080	0.070	0.077	0.075
			Valid Days	357	365	338	

Basin Name	County Name	Site Name	Statistic	Year			
				2006	2007	2008*	2008* Design Value
Sacramento Valley (continued)	Solano	Vacaville-Ulatis Drive	4th High	0.080	0.071	0.084	0.078
			Valid Days	358	365	354	
	Sutter	Sutter Buttes-S Butte	4th High	0.090	0.077	0.088	0.085
			Valid Days	184	183	153	
		Yuba City-Almond Street	4th High	0.078	0.072	0.068	0.072
			Valid Days	352	343	264	
	Tehama	Red Bluff-Oak Street	4th High	0.073	0.072	0.080	0.075
			Valid Days	330	357	319	
		Tuscan Butte	4th High	0.087	0.082	0.087	0.085
			Valid Days	183	184	146	
	Yolo	Davis-UCD Campus	4th High	0.078	0.075	0.077	0.076
			Valid Days	358	359	258	
		Woodland-Gibson Road	4th High	0.088	0.073	0.076	0.079
			Valid Days	365	363	356	
	Yuba	NO MONITORS					
Salton Sea	Imperial	Brawley-220 Main Street	4th High	0.043	0.067	0.057	0.055
			Valid Days	91	89	14	
		Calexico-East	4th High	0.078	0.083	0.078	0.079
			Valid Days	352	325	341	
		Calexico-Ethel Street	4th High	0.068	0.087	0.087	0.080
			Valid Days	362	353	363	
		Calexico-Grant Street	4th High	0.065	0.071		0.068
			Valid Days	356	205		
		El Centro-9th Street	4th High	0.091	0.083	0.074	0.082
			Valid Days	331	349	362	
		Niland-English Road	4th High	0.072	0.078	0.075	0.075
			Valid Days	354	355	362	
		Westmorland-W 1st Street	4th High	0.086	0.085	0.077	0.082
			Valid Days	355	353	360	
	Riverside	Indio-Jackson Street	4th High	0.085	0.087	0.088	0.086
			Valid Days	361	360	237	
		Joshua Tree National Park	4th High	0.079	0.076	0.084	0.079
			Valid Days	270	281	129	
		Palm Springs-Fire Station	4th High	0.099	0.097	0.096	0.097
			Valid Days	354	360	241	
San Diego	San Diego	Alpine-Victoria Drive	4th High	0.094	0.086	0.098	0.092
			Valid Days	357	358	301	
		Camp Pendleton	4th High	0.072	0.071	0.070	0.071
			Valid Days	355	349	300	
		Chula Vista	4th High	0.065	0.070	0.074	0.069
			Valid Days	357	351	299	
		Del Mar-Mira Costa College	4th High	0.067	0.072	0.075	0.071
			Valid Days	364	362	305	

Basin Name	County Name	Site Name	Statistic	Year			2008* Design Value
				2006	2007	2008*	
San Diego (continued)	San Diego (continued)	El Cajon-Redwood Avenue	4th High	0.076	0.073	0.082	0.077
			Valid Days	349	332	297	
		Escondido-E Valley Parkway	4th High	0.078	0.075	0.089	0.080
			Valid Days	352	355	291	
		Otay Mesa-Paseo International	4th High	0.061	0.064	0.066	0.063
			Valid Days	359	357	273	
		San Diego-1110 Beardsley St	4th High	0.061	0.060	0.063	0.061
			Valid Days	362	330	291	
		San Diego-Overland Avenue	4th High	0.07	0.073	0.082	0.075
			Valid Days	354	357	296	
San Francisco Bay Area	Alameda	Berkeley-6th Street	4th High		0.029	0.045	0.037
			Valid Days		23	269	
		Fremont-Chapel Way	4th High	0.069	0.055	0.061	0.061
			Valid Days	358	352	271	
		Hayward-La Mesa	4th High	0.067	0.055	0.068	0.063
			Valid Days	244	242	182	
		Livermore-793 Rincon Avenue	4th High	0.089	0.067	0.087	0.081
			Valid Days	361	361	270	
		Oakland-Davie	4th High		0.034	0.057	0.045
			Valid Days		60	268	
		San Leandro-County Hospital	4th High	0.06	0.052	0.067	0.059
			Valid Days	243	243	175	
	Contra Costa	Bethel Island Road	4th High	0.081	0.071	0.076	0.076
			Valid Days	358	360	271	
		Concord-2975 Treat Blvd	4th High	0.085	0.071	0.078	0.078
			Valid Days	360	360	270	
		Pittsburg-10th Street	4th High	0.079	0.067	0.067	0.071
			Valid Days	357	356	271	
		San Pablo-Rumrill Blvd	4th High	0.045	0.049	0.057	0.050
			Valid Days	353	356	265	
	Marin	San Rafael	4th High	0.047	0.048	0.055	0.050
			Valid Days	353	356	266	
	Napa	Napa-Jefferson Avenue	4th High	0.064	0.055	0.067	0.062
			Valid Days	361	355	269	
	San Francisco	San Francisco-Arkansas Street	4th High	0.044	0.047	0.049	0.046
			Valid Days	347	354	266	
	San Mateo	Redwood City	4th High	0.051	0.052	0.058	0.053
			Valid Days	354	357	266	
	Santa Clara	Gilroy-9th Street	4th High	0.08	0.068	0.072	0.073
			Valid Days	229	240	183	
		Los Gatos	4th High	0.085	0.059	0.074	0.072
			Valid Days	363	363	273	
		San Jose-Jackson Street	4th High	0.073	0.057	0.067	0.065
			Valid Days	329	352	269	

Basin Name	County Name	Site Name	Statistic	Year			2008* Design Value
				2006	2007	2008*	
San Francisco Bay Area (continued)	Santa Clara (continued)	San Martin-Murphy Avenue	4th High	0.088	0.070	0.071	0.076
			Valid Days	238	239	182	
		Sunnyvale-910 Ticonderoga	4th High	0.064	0.054	0.063	0.060
			Valid Days	243	243	183	
	Solano	Benicia-East 2nd Street	4th High		0.063	0.075	0.069
			Valid Days		270	266	
		Fairfield-Chadbourne Road	4th High	0.074	0.062	0.068	0.068
			Valid Days	242	241	183	
		Vallejo-304 Tuolumne Street	4th High	0.06	0.054	0.067	0.060
			Valid Days	346	354	267	
	Sonoma	Santa Rosa-5th Street	4th High	0.049	0.047	0.059	0.051
			Valid Days	362	357	269	
San Joaquin Valley	Fresno	Clovis-N Villa Avenue	4th High	0.094	0.092	0.108	0.098
			Valid Days	357	341	269	
		Fresno-1st Street	4th High	0.101	0.094	0.108	0.101
			Valid Days	362	360	265	
		Fresno-Drummond Street	4th High	0.085	0.079	0.093	0.085
			Valid Days	359	357	241	
		Fresno-Sierra Skypark #2	4th High	0.097	0.088	0.101	0.095
			Valid Days	355	359	262	
		Parlier	4th High	0.099	0.090	0.094	0.094
			Valid Days	339	356	231	
	Kern	Arvin-Bear Mountain Blvd	4th High	0.111	0.102	0.112	0.108
			Valid Days	350	353	292	
		Bakersfield-5558 California Ave	4th High	0.107	0.085	0.101	0.097
			Valid Days	348	361	298	
		Bakersfield-Golden State Hwy	4th High	0.091	0.08	0.094	0.088
			Valid Days	362	358	209	
		Edison	4th High	0.108	0.093	0.107	0.102
			Valid Days	361	361	301	
		Maricopa-Stanislaus Street	4th High	0.09	0.086	0.084	0.086
			Valid Days	351	291	265	
		Oildale-3311 Manor Street	4th High	0.100	0.090	0.104	0.098
			Valid Days	354	357	303	
		Shafter-Walker Street	4th High	0.093	0.083	0.093	0.089
			Valid Days	361	353	303	
	Kings	Hanford-S Irwin Street	4th High	0.086	0.080		0.083
			Valid Days	339	297		
	Madera	Madera-Pump Yard	4th High	0.081	0.077	0.091	0.083
			Valid Days	363	360	250	
	Merced	Merced-S Coffee Avenue	4th High	0.086	0.087	0.105	0.092
			Valid Days	167	363	256	
	San Joaquin	Stockton-Hazelton Street	4th High	0.083	0.075	0.077	0.078
			Valid Days	362	361	267	

Basin Name	County Name	Site Name	Statistic	Year			2008* Design Value
				2006	2007	2008*	
San Joaquin Valley (continued)	San Joaquin (continued)	Tracy-Airport	4th High	0.093	0.079	0.090	0.087
			Valid Days	355	354	269	
	Stanislaus	Modesto-14th Street	4th High	0.090	0.076	0.090	0.085
			Valid Days	358	362	268	
		Turlock-S Minaret Street	4th High	0.092	0.075	0.106	0.091
			Valid Days	363	361	265	
	Tulare	Sequoia & Kings Canyon NP	4th High	0.104	0.099	0.112	0.105
			Valid Days	300	238	232	
		Sequoia NP-Lower Kaweah	4th High	0.097	0.091	0.101	0.096
			Valid Days	348	360	325	
		Visalia-N Church Street	4th High	0.092	0.086	0.105	0.094
			Valid Days	361	361	301	
South Central Coast	San Luis Obispo	Atascadero-Lewis Avenue	4th High	0.071	0.066	0.069	0.068
			Valid Days	356	352	330	
		Carrizo Plains School-Carrizo	4th High	0.086	0.080	0.088	0.084
			Valid Days	340	349	322	
		Morro Bay	4th High	0.053	0.053	0.058	0.054
			Valid Days	351	343	320	
		Nipomo-Regional Park	4th High	0.055	0.056	0.066	0.059
			Valid Days	345	351	325	
		Paso Robles-Santa Fe Avenue	4th High	0.072	0.068	0.064	0.068
			Valid Days	360	363	190	
		Red Hills	4th High		0.084	0.092	0.088
			Valid Days		362	330	
		San Luis Obispo-S Higuera St	4th High	0.055	0.057	0.060	0.057
			Valid Days	356	356	242	
	Santa Barbara	Carpinteria-Gobernador Road	4th High	0.058	0.066	0.072	0.065
			Valid Days	349	354	272	
		El Capitan Beach	4th High	0.056	0.057	0.066	0.059
			Valid Days	364	364	299	
		Gaviota-GTC Site B	4th High	0.055	0.055	0.058	0.056
			Valid Days	360	362	241	
		Goleta-Fairview	4th High	0.064	0.057	0.062	0.061
			Valid Days	364	358	301	
		Las Flores Canyon #1	4th High	0.07	0.078	0.070	0.072
			Valid Days	363	360	330	
		Lompoc-HSandP	4th High	0.062	0.066	0.067	0.065
			Valid Days	363	358	301	
		Lompoc-S H Street	4th High	0.051	0.056	0.062	0.056
			Valid Days	362	356	302	
		Paradise Road-Los Padres NF	4th High	0.075	0.077	0.068	0.073
			Valid Days	363	355	301	
		Santa Barbara-E Canon Perdido	4th High	0.056	0.063	0.062	0.060
			Valid Days	357	359	240	

Basin Name	County Name	Site Name	Statistic	Year 2006	2007	2008*	2008* Design Value
South Central Coast (continued)	Santa Barbara (continued)	Santa Maria-906 S Broadway	4th High	0.048	0.048	0.056	0.050
			Valid Days	349	354	217	
		Santa Ynez-Airport Road	4th High	0.064	0.063	0.067	0.064
			Valid Days	364	363	301	
		Vandenberg AFB-STS Power	4th High	0.059	0.069	0.065	0.064
			Valid Days	356	358	331	
	Ventura	El Rio-Rio Mesa School #2	4th High	0.059	0.061	0.065	0.061
			Valid Days	364	351	297	
		Ojai-Ojai Avenue	4th High	0.094	0.076	0.081	0.083
			Valid Days	363	361	301	
		Piru-3301 Pacific Avenue	4th High	0.085	0.076	0.081	0.080
			Valid Days	359	358	304	
		Simi Valley-Cochran Street	4th High	0.089	0.086	0.090	0.088
			Valid Days	360	357	295	
		Thousand Oaks-Moorpark Road	4th High	0.076	0.074	0.077	0.075
			Valid Days	364	358	301	
		Ventura-Emma Wood State Bch	4th High	0.062	0.065	0.067	0.064
			Valid Days	362	350	294	
	Channel Islands	NO MONITORS					
South Coast	Los Angeles	Azusa	4th High	0.091	0.096	0.101	0.096
			Valid Days	357	355	236	
		Burbank-W Palm Avenue	4th High	0.098	0.088	0.092	0.092
			Valid Days	358	356	235	
		Glendora-Laurel	4th High	0.106	0.105	0.112	0.107
			Valid Days	354	352	241	
		Lebec-Peace Valley Road	4th High	0.095	0.063		0.079
			Valid Days	321	82		
		Los Angeles-North Main Street	4th High	0.075	0.072	0.073	0.073
			Valid Days	355	337	224	
		Los Angeles-Westchester Pkwy	4th High	0.062	0.067	0.065	0.064
			Valid Days	358	355	221	
		Lynwood	4th High	0.064	0.057	0.055	0.058
			Valid Days	357	357	235	
		North Long Beach	4th High	0.057	0.057	0.064	0.059
			Valid Days	354	350	236	
		Pasadena-S Wilson Avenue	4th High	0.096	0.090	0.091	0.092
			Valid Days	360	357	232	
		Pico Rivera-4144 San Gabriel	4th High	0.078	0.079	0.077	0.078
			Valid Days	222	352	233	
		Pomona	4th High	0.108	0.103	0.100	0.103
			Valid Days	354	352	238	
		Reseda	4th High	0.104	0.093	0.095	0.097
			Valid Days	355	339	242	

Basin Name	County Name	Site Name	Statistic	Year 2006	2007	2008*	2008* Design Value
South Coast (continued)	Los Angeles (continued)	Santa Clarita	4th High	0.112	0.102	0.103	0.105
			Valid Days	357	351	235	
		West Los Angeles-VA Hospital	4th High	0.068	0.067	0.075	0.070
			Valid Days	360	345	236	
	Orange	Anaheim-Pampas Lane	4th High	0.071	0.074	0.076	0.073
			Valid Days	361	357	239	
		Costa Mesa-Mesa Verde Drive	4th High	0.061	0.065	0.073	0.066
			Valid Days	362	341	236	
		La Habra	4th High	0.09	0.082	0.078	0.083
			Valid Days	349	355	238	
		Mission Viejo-26081 Via Pera	4th High	0.09	0.081	0.092	0.087
			Valid Days	353	358	239	
	Riverside	Banning Airport	4th High	0.105	0.095	0.108	0.102
			Valid Days	353	359	237	
		Lake Elsinore-W Flint Street	4th High	0.102	0.097	0.108	0.102
			Valid Days	353	352	239	
		Perris	4th High	0.114	0.103	0.106	0.107
			Valid Days	348	362	243	
		Riverside-Rubidoux	4th High	0.112	0.099	0.111	0.107
			Valid Days	358	356	236	
	San Bernardino	Crestline	4th High	0.111	0.126	0.120	0.119
			Valid Days	363	365	234	
		Fontana-Arrow Highway	4th High	0.114	0.113	0.110	0.112
			Valid Days	351	346	234	
		Redlands-Dearborn	4th High	0.125	0.112	0.112	0.116
			Valid Days	364	362	244	
		San Bernardino-4th Street	4th High	0.119	0.117	0.112	0.116
			Valid Days	356	352	236	
		Upland	4th High	0.112	0.112	0.108	0.110
			Valid Days	360	354	236	

** 2008 data are preliminary and may not be complete. Therefore, the 2008 Design Value should be considered preliminary.*

CALIFORNIA AIR RESOURCES BOARD

NOTICE OF PUBLIC MEETING TO CONSIDER APPROVAL OF GRANTS UNDER THE INNOVATIVE CLEAN AIR TECHNOLOGIES (ICAT) PROGRAM

The Air Resources Board (ARB or the Board) will conduct a public meeting at the time and place noted below to consider approval of grants under the Innovative Clean Air Technologies (ICAT) program

DATE: February 26, 2009

TIME: 9:00 am

PLACE: California Environmental Protection Agency
Air Resources Board
Byron Sher Auditorium
1001 I Street
Sacramento, California 95812

This item will be considered at a two-day meeting of the Board, which will commence at 9:00 a.m., February 26, 2009, and may continue at 8:30 a.m., February 27, 2009. This item may not be considered until February 27, 2009. Please consult the agenda for the meeting, which will be available at least 10 days before February 26, 2009, to determine the day on which this item will be considered.

If you require special accommodations or language needs, please contact the Clerk of the Board at (916) 322-5594 or by Fax at (916) 322-3928 as soon as possible, but no later than 10 business days before the scheduled Board hearing. TTY/TDD/Speech to Speech users may dial 711 for the California Relay Service.

The Board's ICAT program co-funds demonstrations of new technologies that can improve air quality in California and support ARB programs. ARB staff will recommend that the Board approve co-funding for three projects to demonstrate new technologies for controlling greenhouse gas emissions. These projects were selected because they address important ARB program needs, are technically sound, can reduce emissions, and can succeed commercially. The Board will consider proposed resolutions to approve co-funding for these projects at its meeting.

ARB staff will provide an oral presentation at the meeting. The three projects to be considered are the following: "Removal of H_2S from Biogas and NO_x from Engine Exhaust at a Dairy Digester Using Microwave Technology" submitted by Sacramento Municipal Utility District for a total amount not to exceed $246,309; "Series Hybrid Hydraulic Drivetrain in a Package Delivery Vehicle" submitted by Eaton Corporation for a total amount not to exceed $214,401; and "Fuel-Efficient Active Flow Control for Tractor-Trailers," submitted by Advanced Transit Dynamics, Inc., for a total amount not to exceed $249,194.

Interested members of the public may also 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 comment submissions not physically submitted at the meeting must be received **no later than 12:00 noon, February 25, 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 30 copies of any written submission. Also, ARB requests that written and e-mail statements 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 Bart Croes, Chief, Research Division, (916) 445-0753, P.O. Box 2815, Sacramento, California 95812.

CALIFORNIA AIR RESOURCES BOARD

Bart E. Croes for

James N. Goldstene
Executive Officer

Date: February 26, 2009

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