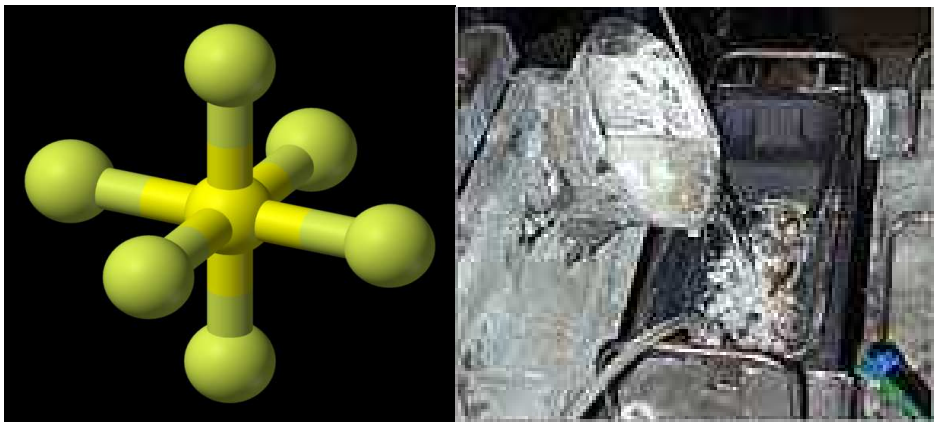
California Environmental Protection Agency

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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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

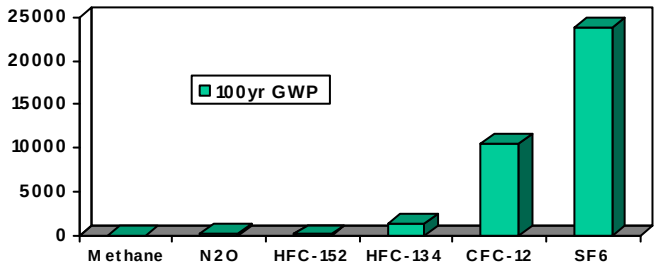

Figure 1 – 100 year Global Warming Potentials

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.

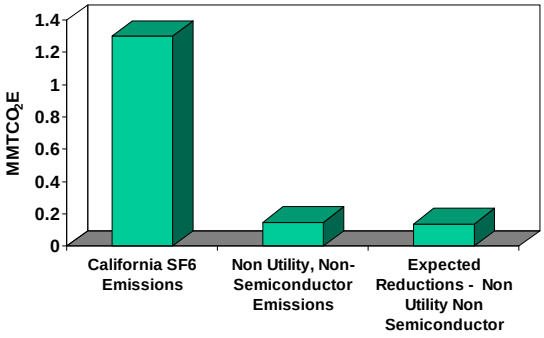

Figure 2 – California Hexafluoride Emissions and reductions from this measure

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.

[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/MTCO_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.

REFERENCES

29 CFR §1910.1000. Code for Federal Regulations, 7-1-05 Edition. http://edocket.access.gpo.gov/cfr_2005/julqtr/pdf/29cfr1910.1000.pdf

California Code of Regulations. Title 8 §5154.1 http://www.dir.ca.gov/Title8/5154_1.html

ARB. 2008a. Climate Change Proposed Scoping Plan. October, 2008. http://www.arb.ca.gov/cc/scopingplan/document/scopingplandocument.htm

ARB, 2008b. California Greenhouse Gas Emissions Inventory Data – 1990 to 2004, 2008. http://www.arb.ca.gov/cc/inventory/data/data.htm http://www.arb.ca.gov/cc/inventory/pubs/reports/appendix_a2_Inventory_IPCC_All_1990.pdf

ARB 2008c. Results from Survey of Semiconductor Industry. Personal Communication from Dale Trenschel. 2008.

ARB 2008d. Results for Magnesium Industry from Survey for Non-electric and non-semiconductor SF_6 Industry. 2008. See Appendix B.

ARB, 2003. Fact sheets Backgrounder: The Greenhouse Effect and California. March, 2003. http://www.arb.ca.gov/cc/factsheets/ccbackground.pdf

Mahmud, A., M. Tyree, D. Cayan, N. Motallebi, and M. J. Kleeman (2008), Statistical downscaling of climate change impacts on ozone concentrations in California, J. Geophys. Res., 113, D21103, doi:10.1029/2007JD009534.

Milbrath 2008. Memo from Dean Milbrath, 3M. Dated October 9, 2008.

NOAA, 2008. Sulfur Hexafluoride Atmospheric Concentrations from Interactive Atmospheric Data Visualization. Earth Systems Research Laboratory. Global Monitoring Division. Accessed November 2008. http://www.esrl.noaa.gov/gmd/ccgg/iadv/

NIOSH, 2005. Pocket Guide on Hydrogen Sulfide. September 2005. http://www.cdc.gov/niosh/npg/npgd0334.html

IPCC, 2007. Climate Change 2007: The Physical Science Basis, IPCC Working Group 1 Fourth Assessment Report, 2007.

http://ipcc-wg1.ucar.edu/wg1/wg1-report.html

Pew, 2006. The Pew Center on Global Climate Change and the Pew Center on the States. Climate Change 101: Understanding and Responding to Global Climate Change. December, 2006. http://www.pewclimate.org/docUploads/Climate101-FULL_121406_065519.pdf

Steiner, A. L., S. Tonse, R. C. Cohen, A. H. Goldstein, and R. A. Harley. 2006. "Influence of future climate and emissions on regional air quality in California." Journal of Geophysical Research-Atmospheres 111:D18303, doi:10.1029/2005JD006935.

U.S. EPA 2007. Characterization of Emissions and Occupational Exposure Associated with Five Cover Gas Technologies for Magnesium Die Casting. USEPA #430-R-07-008. August 2007. http://www.epa.gov/highgwp/magnesium-sf6/documents/lunt_measurement_study_full.pdf

U.S EPA, 2008a. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2006, USEPA #430-R-08-005. April 2008.* http://www.epa.gov/climatechange/emissions/usinventoryreport.html

U.S. EPA, 2008b. Accomplishments of SF6 Emission Reduction Partnership for the Magnesium Industry. http://www.epa.gov/highgwp/magnesium-sf6/accomplishments.html

U.S. EPA 2008c. Characterization of Cover Gas and Byproduct Emissions from Secondary Magnesium Ingot Casting. USEPA #430-R-08-008

Werner, 2008. Email communication from Kurt Werner, 3M, September 17, 2008.

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 (t*itle 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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Attach the file to an e-mail addressed to escheehle@arb.ca.gov. Please title your e-mail **SF6 SURVEY.**

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 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 Hexalfuoride 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**.

Filing Electronically with Password

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**.

Attach the file to an e-mail addressed to escheehle@arb.ca.gov. Please title your e-mail **SF6 SURVEY.**

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 mililiter 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

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