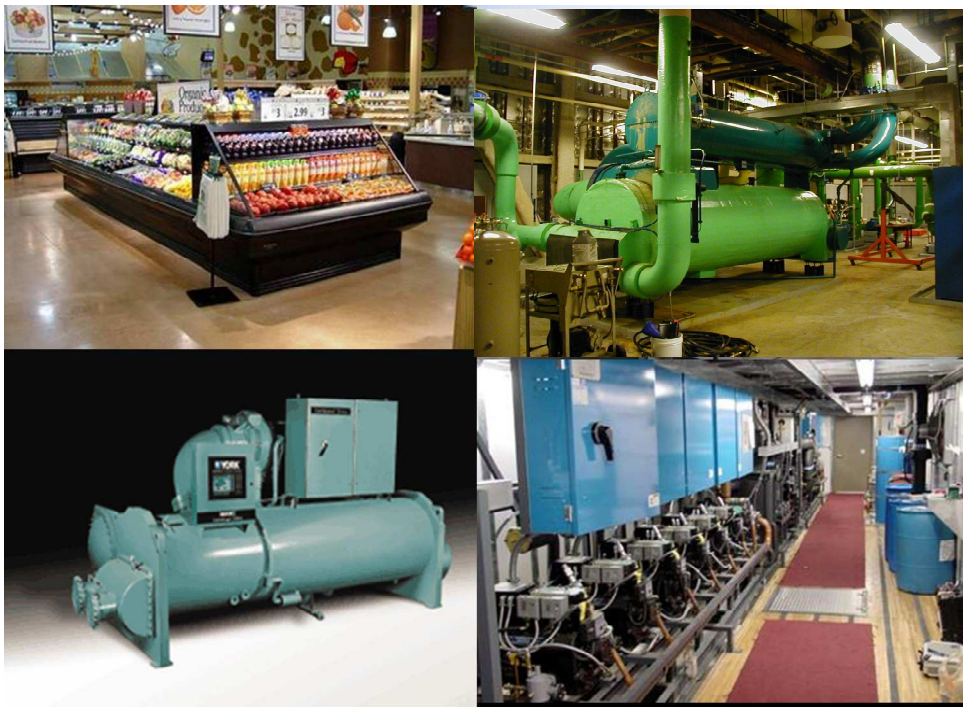
STATE OF CALIFORNIA

California Environmental Protection Agency

Air Resources Board

INITIAL STATEMENT OF REASONS FOR PROPOSED REGULATION FOR

THE MANAGEMENT OF HIGH GLOBAL WARMING POTENTIAL REFRIGERANTS FOR STATIONARY SOURCES



Research Division

Release Date

October 23, 2009

This page is intentionally left blank

State of California
AIR RESOURCES BOARD

INITIAL STATEMENT OF REASONS FOR PROPOSED RULEMAKING

Public Hearing to Consider

ADOPTION OF THE PROPOSED REGULATION FOR THE MANAGEMENT OF HIGH GLOBAL WARMING POTENTIAL REFRIGERANTS FOR STATIONARY SOURCES

To be considered by the California Air Resources Board
On December 9-10, 2009

at

Cal/EPA Headquarters
1001 I Street
Sacramento, California

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

This page is intentionally left blank

State of California
AIR RESOURCES BOARD

PROPOSED REGULATION FOR THE MANAGEMENT OF HIGH GLOBAL WARMING POTENTIAL REFRIGERANTS FOR STATIONARY SOURCES

Prepared by:

Research Division
California Air Resources Board

Lead Authors

Chuck Seidler
Brooke Baythavong
Glenn Gallagher
Ken Bowers

Reviewed by:

Pamela Gupta, Manager, Greenhouse Gas Reduction Strategy Section
Anthony Andreoni, Chief, Research and Economic Studies Branch
Richard Corey, Assistant Chief, Research Division
Bart Croes, Chief, Research Division
Mike Scheible, Deputy Executive Officer, Executive Office

October 23, 2009

This page is intentionally left blank

ACKNOWLEDGEMENTS

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

- Air Conditioning, Heating and Refrigeration Institute
- Airgas
- Alliance for Responsible Atmospheric Policy
- Arkema Inc.
- California Air Pollution Control Officers Association, Climate Protection Committee
- California Citrus Growers Association
- California Energy Commission
- California Grocers Association
- California Retailers Association
- California Small Business Association
- Carrier Corporation
- E. I. du Pont de Nemours and Company (DuPont)
- Environmental Defense Fund
- Governor's Office of Planning and Research, Office of the Small Business Ombudsman
- Greenpeace
- Heating, Air Conditioning & Refrigeration Distributors International
- Honeywell International Inc.
- Hudson Technologies
- Hussman Company
- Ingersoll-Rand Company
- Kroger
- Lennox International Inc.
- Natural Resources Defense Council
- Raleys Company
- Safeway Inc.
- Small Business California
- South Coast Air Quality Management District
- SuperValu Inc.
- Trane Inc.
- University of California, Davis
- U.S. Environmental Protection Agency
- Wal-Mart Stores, Inc

We also thank Jeff Cohen, previously of the U.S. Environmental Protection Agency; ARB staff members Terone Preston, Judy Lewis, and Mark Stover of the Enforcement Division and Karin Donhowe of the Office of Climate Change; prior Research Division staff Bill Dean, Whitney Leeman, and Yachun Chow; and the program's prior student assistant Satapana Buthken for their assistance on the development of this regulation.

DISCLAIMER

This page is intentionally left blank

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

A. Proposed Refrigerant Management Program Regulation

B. California Facilities and Greenhouse Gas Emissions Inventory

C. Economic Impact Estimates

D. Summary of the Public Process in Development of the High-Global Warming Potential Stationary Source Refrigerant Management Program

E. South Coast Air Quality Management District Rule 1415

F. Code of Federal Regulations, Title 40, Part 82, Subpart F – Recycling and Emissions Reductions

ABBREVIATIONS AND ACRONYMS

AB 32	Assembly Bill 32, California Global Warming Solutions Act of 2006
Air District	Air Quality Management District or Air Pollution Control District
AC	Air Conditioning
APA	Administrative Procedures Act
APCO	Air Pollution Control Officer
ARB	Air Resources Board
AHRI	Air-Conditioning, Heating and Refrigeration Institute
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BAU	Business-As-Usual
Btu	British Thermal Units
CAAA	Clean Air Act and its Amendments
CAPCOA	California Air Pollution Control Officers Association
CAR	Climate Action Reserve
CCR	California Code of Regulations
CEQA	California Environmental Quality Act
CO_2E	Carbon Dioxide Equivalents
CEC	California Energy Commission
CFC	Chlorofluorocarbon
CFR	Code of Federal Regulations
DX	Direct Expansion (Refrigeration Systems)
CO_2	Carbon Dioxide
EOL	End-of-life
EU	European Union
F-Gas	Fluorinated Gas
FR	Federal Register
GHG	Greenhouse Gas or Greenhouse Gases
GWP	Global Warming Potential
HARDI	Heating, Air Conditioning & Refrigeration Distributors International

HCFC	Hydrochlorofluorocarbon
HFC	Hydrofluorocarbon
HVAC	Heating, Ventilation, and Air Conditioning
ICLEI	International Council for Local Environmental Initiatives
IPCC	Intergovernmental Panel on Climate Change
ISOR	Initial Statement of Reasons
LCCP	Life Cycle Climate Performance
$MTCO_2E$	Metric Tonnes of Carbon Dioxide Equivalent
$MMTCO_2E$	Million Metric Tonnes of Carbon Dioxide Equivalent
MVAC	Motor Vehicle Air Conditioning
NAICS	North American Industry Classification System
ODS	Ozone Depleting Substance
PFC	Perfluorocarbon
ppm	parts per million
R/AC	Refrigeration or Air Conditioning or Refrigeration and Air Conditioning
SCAQMD	South Coast Air Quality Management District
SNAP	U.S. EPA Significant New Alternatives Policy
SIC	Standard Industrial Classification
TEAP	Technology and Economic Assessment Panel
UNFCC	United Nations Framework Convention on Climate Change
U.S. EPA	U.S. Environmental Protection Agency
U.S. DOT	U.S. Department of Transportation
VMT	Vehicle Miles Traveled

EXECUTIVE SUMMARY

I. Introduction

This report presents the California Air Resources Board (ARB) staff's proposed regulation for the management of high global warming (GWP) potential refrigerants from stationary sources (Regulation), which is generally referred to as the Refrigerant Management Program to 1) reduce emissions of high-GWP refrigerants from leaky stationary, non-residential refrigeration equipment, 2) reduce emissions resulting from the installation and servicing of refrigeration and air-conditioning (R/AC) appliances using high-GWP refrigerants, and 3) verify greenhouse gas(es) (GHG) emission reductions. High-GWP refrigerants are potent GHG, trapping heat in the atmosphere at many times that of carbon dioxide on a pound-for-pound basis. These gases are also used in many applications, with refrigeration and air conditioning among the most important for society and the economy. In many cases, however, the systems that contain these gases, or the practices used in servicing those systems, allow refrigerants to be emitted into the atmosphere, contributing to the overall effect of global warming. The United States Environmental Protection Agency (U.S. EPA) estimates that 37 percent of the stationary source refrigeration and air-conditioning related emissions of high-GWP gases are from stationary, large commercial refrigeration systems

To address this situation, ARB staff has developed the proposed Regulation to mitigate the emissions of high-GWP refrigerants from stationary sources. Specific objectives of the proposed program and accompanying Regulation include:

- Reduce refrigerant emissions from existing refrigeration systems annually by 8 million metric tonnes of carbon dioxide equivalent ($MMTCO_2E$).
- Improve service practices for existing and future systems to reduce refrigerant leaks and maximize reclamation and recycling of high-GWP refrigerants from the servicing of stationary R/AC appliances.
- Improve refrigerant management by restricting sales of high-GWP refrigerants to properly trained personnel and improve disposal practices to provide for refrigerant recovery from R/AC appliances and refrigerant storage cylinders.
- Minimize administrative requirements on business while crafting a program that leads to significant emission reductions of GHG at low cost or a net savings for most businesses impacted.
- Provide clear best management standards of practice for managing refrigeration systems to meet the objectives of the proposed Regulation and complement existing federal, state, and local laws and regulations.

The Regulation provides annual emission reduction of 8 $MMTCO_2E$. Currently ozone depleting substances (ODS) are regulated under the Clean Air Act and Amendments (CAAA) to a limited degree, but non-ODS, high-GWP refrigerants are not managed other than by way of a federal restriction on venting.

For this reason, the Refrigerant Management Program is designed to not only complement federal regulations but also to present a template for a management framework for all high-GWP refrigerants that can be used by other states and the U.S. EPA.

What is the Source of Authority to Regulate Stationary Refrigeration and Air Conditioning?

In 2006, The California Global Warming Solutions Act (AB 32)[1] was signed into law, creating a comprehensive, multi-year program to reduce GHG emissions in California.

What are the Environmental Benefits of Reducing Greenhouse Gases?

Greenhouse gases remain in the atmosphere for many years, decades, and even centuries. As a result, the climate change effect of gases emitted years ago may not yet be fully realized. The primary environmental benefit of reducing GHG emissions is the potential mitigation of future environmental and health risks that accompany global warming.

California's landscape and geography make it particularly vulnerable to climate change. Climate change affects the high Sierra Nevada snowpack. Throughout the 20th century annual April to July spring runoff has been decreasing, with total water runoff declining by about ten percent over the last 100 years. "Average spring snowmelt from the Sierra Nevada into the Sacramento River has decreased by about 12 percent since 1906."[2] This observation has direct consequences - less spring runoff for hydroelectric power production, agricultural irrigation, and human consumption.

California has seen a sea level rise of 3 – 8 inches in the last century. This can lead to serious consequences such as flooding of low-lying property, loss of coastal wetlands, erosion of cliffs and beaches, saltwater contamination of drinking water, and damage to roads and bridges.[3] Research on sea level changes indicates that the mean sea level rise values, determined from a survey of several climate models, range from approximately 10–80 cm (3.9–31 in) between 2000 and 2100. The middle to higher end of this range would substantially exceed the historical rate of sea level rise of 15–20 cm (5.9–7.9 in) per century observed at San Francisco and San Diego during the last 100 years.[4]

Climate change will also adversely affect the public health of Californians. ARB modeling indicates that even with very effective programs to clean up the remaining sources of criteria pollutants, we will have to pay a 'climate penalty' since elevated temperatures will affect our cities, raising ozone levels.

---

[1] California Global Warning Solutions Act of 2006, Statutes of 2006, Chapter 488. Health & Safety Code 38500 - 38599.
[2] California Environmental Protection Agency and California Resources Agency, Environmental Protection Indicators for California, 2004 update.
[3] Air Resources Board, Fact Sheet – The Greenhouse Effect and California. http://www.arb.ca.gov/cc/factsheets/ccbackground.pdf. (accessed September 14, 2009.
[4] California Climate Change Center, Projecting Future Sea Level, March 2006.

What Are the Requirements of the Proposed Regulation?

The proposed Regulation focuses on the largest refrigeration sources of GHG emissions. The Regulation would establish requirements by category of refrigeration system: large (uses 2,000 pounds or more of refrigerant; medium (uses between 200 and 2,000 pounds of refrigerant); and small (uses between 50 and 200 pounds of refrigerant).

Below is a brief summary of the key requirements of the Regulation. There are additional administrative requirements in the proposed Regulation. For details on the proposed regulatory provisions, see the Refrigerant Management Program Proposed Regulatory Provisions section (Section VI) of this report.

1. **Registration Requirements for Facilities with Stationary Refrigeration Systems (Section 95383)**: registration will be required in 2012, 2014, and 2016 based on the refrigerant charge size category of the largest refrigeration system in operation at a facility.
2. **Implementation Fees for Facilities with Stationary Refrigeration Systems (Section 95384):** an initial and annual fee to cover the costs of administering and enforcing the Regulation will be required for facilities with large and medium refrigeration systems - $370 for a facility with a large refrigeration system starting in 2012 and $170 for a facility with a medium refrigeration system starting in 2014. There is no fee for a facility with a small refrigeration system.
3. **Leak Detection and Monitoring Requirements for Facilities with Stationary Refrigeration Systems (Section 95385)**: starting in 2011, an automatic leak detection system or quarterly or annual leak inspections will be required for large, medium, and small refrigeration systems, respectively.
4. **Leak Repair Requirements for Facilities with Stationary Refrigeration Systems (Section 95386):** a refrigerant leak repair is generally required by a U.S. EPA certified technician within 14 days of leak detection. Under specified conditions up to 45 or 120 days after leak detection are allowed.
5. **Requirements to Prepare Retrofit or Retirement Plans for Facilities with Leaking Stationary Refrigeration Systems (Section 95387):** this plan is required if a refrigerant leak cannot be repaired.
6. **Reporting Requirements for Facilities with Stationary Refrigeration Systems (Section 95388)**: annual reporting of refrigeration system service and leak repair and refrigerant purchases and use will be required for facilities with large and medium refrigeration systems starting in 2012 and 2014 respectively. There is no annual reporting for a facility with a small refrigeration system.
7. **Recordkeeping Requirements for Facilities with Stationary Refrigeration Systems (Section 95389):** to document compliance, recordkeeping is required with records retained for a minimum of five years.

8. **Required Service Practices for High-GWP Appliances (Section 95390)**: will be specific to all high-GWP refrigerants and are based on existing U.S. EPA regulations specific to ODS refrigerants.
9. **Prohibitions (Section 95391)**: will be specific to sales of all high-GWP refrigerants and are based on existing U.S. EPA regulations specific to ODS refrigerants.
10. **Reporting Requirements for Refrigerant Distributors, Wholesalers, and Reclaimers (Section 95392):** annual reporting of refrigerant purchased and sold, or reclaimed for certified reclaimer reporting, will be required on a company-wide basis.
11. **Recordkeeping Requirements for Refrigerant Distributors, Wholesalers, and Reclaimers (Section 95393):** to document compliance, recordkeeping is required with records retained for a minimum of five years.

Who Will Be Impacted By the Regulation?

The proposed Regulation will apply to:

- anyone operating a facility with a refrigeration system charged with more than 50 pounds of a high-GWP refrigerant.
- anyone who maintains or repairs a R/AC appliance using a high-GWP refrigerant.
- anyone who distributes or reclaims a high-GWP refrigerant.

What Types of Stationary, Non-residential Refrigeration Systems are Covered?

The proposed Regulation will apply to any non-residential facility that has a refrigeration system that requires more than 50 pounds of a high-GWP refrigerant for the registration, leak detection and monitoring, leak repair, retrofit or retirement plan, and recordkeeping provisions. The implementation fee and facility reporting provisions of the proposed Regulation will additionally apply to any non-residential facility that has a refrigeration system that requires 200 pounds or more of a high-GWP refrigerant.

Some of the types of facilities that are likely to have these types of refrigeration systems include: cold storage warehouses; food preparation and processing service facilities; grocery stores and supermarkets; hotels and recreational facilities; and facilities with process cooling equipment. Many facilities that tend to be owned or operated by small businesses such as bars and restaurants, gas stations, bakeries, and liquor stores are not expected to be subject to the proposed Regulation as research conducted for the ARB indicates that the refrigerant charge size for refrigeration systems used by these facilities are generally below 50 pounds.

Further, facilities using ammonia-based refrigeration systems, or refrigeration systems using any refrigerant with a GWP less than 150, are not subject to the proposed Regulation.

What Are the Current Emissions and Expected Reductions?

Under the proposed Regulation, the total estimated GHG emission reductions in 2020 are 8.1 $MMTCO_2E$, as compared to the estimated 2020 business-as-usual (BAU) emissions of 15.8 $MMTCO_2E$. This proposed strategy will provide the sixth largest quantity of GHG reductions as outlined in the approved Scoping Plan, and is an essential part of ARB's efforts to meet the 2020 emissions reduction target as required under AB 32.

As described in Appendix B, BAU emissions and potential emission reductions were determined based on empirical emissions data reported by businesses to the South Coast Air Quality Management District (SCAQMD) pursuant to Rule 1415. BAU emissions were based on existing average leak rates determined for specific categories of refrigeration systems. The potential emission reductions are equal to the difference in the statewide emissions estimated using the average BAU leak rates and the statewide emissions estimated using the leak rates obtainable using best management practices.

Why Focus on High-GWP Refrigerants from Stationary Refrigeration Systems?

The proposed Regulation is the largest component of a suite of sector-specific measures and is necessary to mitigate emissions from the stationary source high-GWP GHG sector. The Regulation focuses on the largest source of emissions from this sector – large commercial refrigeration systems, which, in aggregate, have extensive GHG emissions. As previously noted, the U.S. EPA estimates that 37 percent of the stationary source R/AC related emissions of high-GWP gases are from stationary, large commercial refrigeration systems.

Of all refrigeration systems using more than 50 pounds of a high-GWP refrigerant that were reported to the SCAQMD, on average, 29 percent leak annually. These leaking refrigeration systems lost, on average, 65 percent of their refrigerant charge annually.

In many cases, owners and operators of refrigeration systems can benefit financially from using the refrigerant best management practices required by the proposed rule as these practices will result in cost savings by reducing the need to purchase refrigerant to replenish the refrigerant that had leaked.

What Are The Expected Costs?

Total annualized gross costs for impacted facilities after full implementation in 2020 are estimated at $49 million. However, total annualized net costs for these facilities are estimated at a savings of $19 million, reflecting a cost savings resulting from reduced refrigerant consumption.

Annual costs for refrigerant distributors, wholesalers, and reclaimers are estimated at $0.2 million.

Cost estimates were made specific to emission reductions for Kyoto gases[5] only and for Kyoto gases and non-Kyoto gases combined. The estimated cost-effectiveness is a savings of $2 per metric tonne carbon dioxide equivalent ($MTCO_2E$) of GHG reduced (in 2008 dollars) based on estimated reductions in 2020 for Kyoto gases only. The result for Kyoto gases and non-Kyoto gases combined is approximately the same at $2 saved for each $MTCO_2E$ of GHG reduced.

ARB staff conducted an analysis to determine how sensitive the average cost-effectiveness of the proposed rule is to the discount rate used. A range of discount rates were used to determine their impact on the average cost-effectiveness of the proposed rule. This analysis resulted in a net savings or net cost depending on the discount rate used with all results within the range of cost-effectiveness for measures approved by the Board in 2009, which have ranged from over $100 in savings to a cost of $21 per $MTCO_2E$.

What Was The Public Process to Develop The Regulation?

The proposed Regulation was developed through an extensive public process involving multiple stakeholders, state agencies, the U.S. EPA, the California Air Pollution Control Officers Association (CAPCOA), and the public. A large number of industry stakeholders including various trade associations, facility owners and operators, refrigerant and appliance manufacturers, agricultural industry, technicians, contractors, refrigerant distributors and reclaimers, technician training institutions and individual businesses actively participated in the proposed rule development process.

ARB staff held technical workgroup meetings and public workshops including:

- A kick-off public workshop in Sacramento specific to the stationary source, high-GWP GHG sector.
- Five technical working group meetings.
- Two series of public workshops with each including a workshop in three cities representing the southern, northern, and Central Valley areas of California.
- A public workshop in Sacramento to outline current recommendations.

Each public workshop in Sacramento was webcast to ensure the greatest possible access.

Public meeting notices, the draft regulation, emission estimates, cost analyses documents and the revised versions were posted on the web page created to provide information and periodic updates to anyone interested in the development of the proposed Refrigerant Management Program. Three ARB

[5] Kyoto gases include all gases specially listed in the Kyoto Protocol including carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.

email lists were used to distribute information to approximately 6,700 individuals who expressed interest in the proposed program and climate change.

The public process also included direct outreach to businesses and facilities including:

- Surveys of facilities
- Surveys of stationary heating, ventilation, and air conditioning (HVAC) service contractors and technicians
- Development and distribution of a Frequently Asked Questions (FAQ) pamphlet
- Development and distribution of refrigerant best management practices brochure
- Pilot outreach efforts conducted in two California cities (City of Industry and Merced) selected based on their size and the distribution of business in industries relevant to the proposed Refrigerant Management Program.
- Communications with several small business associations in California, including the California Small Business Association, Small Business California, and the Merced and City of Industry chambers of commerce, as well as small business advocates such as the Governor's Office of Planning and Research, Office of the Small Business Advocate.

A detailed discussion of the public process and outreach is provided in Appendix D.

How Will Facilities Submit Reports and Pay Fees?

The development of an efficient reporting and payment system will be integral to the success of the Regulation. A web-based, secure reporting and payment system will be developed to provide a user-friendly reporting and payment framework.

Important characteristics of the reporting and payment system include:

1. Web-based recordkeeping and submittal of reports and payments.
2. Web-based batch data entry from existing refrigerant management software programs used by facilities.
3. Web-accessible interface that provides selective and secure access.
4. User-friendly interface with pull-down screens and help-based tools to facilitate accurate and efficient data entry and transfer.
5. Recordkeeping templates to assist facilities with implementing effective refrigerant management practices to reduce refrigerant consumption.

How Will the Proposed Regulation be Enforced?

The proposed Refrigerant Management Program affects GHG sources statewide. However, local and regional air districts have extensive expertise in enforcement, and already have relationships with many of the facilities that will be regulated. It

is ARB's goal to leverage the expertise of the air districts in the administration of the proposed Regulation. Air districts may elect to assume the lead in enforcing the Regulation in two ways:

1. Entering a collaborative agreement between air districts and ARB. The agreement between the ARB and air district will outline all roles and responsibilities, enforcement performance requirements, and the amount and methods of payments that ARB will remit to the air district.
2. Air district adoption and implementation of a regulation that is functionally equivalent to the statewide Regulation.

As a statewide regulation, ARB will have full responsibility and authority to enforce the Regulation. This will include the collection and administration of fees.

Recommendation

Staff recommends that the Board approve its proposal to adopt sections 95380 through 95398 of title 17, California Code of Regulations, known as the Refrigerant Management Program.

I. OVERVIEW AND STAFF RECOMMENDATION

The California Global Warming Solutions Act of 2006 (AB 32) created a comprehensive program to reduce greenhouse gas (GHG) emissions in California. AB 32 required 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. Additionally, AB 32 requires that rules and regulations adopted achieve maximum technologically feasible and cost-effective GHG emission reductions.

As part of its analysis to identify feasible and cost-effective emission reductions, ARB staff identified stationary refrigeration and air-conditioning (R/AC) appliances and refrigerant cylinders as sources of GHG emissions. The analysis revealed significant emissions from R/AC appliances and informed options to achieve GHG emission reductions from these appliances on the order of millions of metric tons of carbon dioxide equivalents ($MMTCO_2E$). In this rulemaking, the ARB staff is proposing a Regulation to: 1) reduce emissions of high-GWP refrigerants from stationary, non-residential refrigeration equipment, 2) reduce emissions resulting from the installation and servicing of R/AC appliances using high global warming potential (GWP) refrigerants, and 3) verify GHG emission reductions. This will be accomplished through registration, leak detection and monitoring, leak repair, retrofit or retirement planning, required service practices, refrigerant distributor and wholesaler prohibitions, and reporting and recordkeeping. The proposed Regulation is designed in accordance with AB 32 and was outlined in both the Early Action Report and Scoping Plan approved by the Board in October 2007 and December 2008, respectively.

This report with its appendices represents the Initial Statement of Reasons (ISOR) for Proposed Rulemaking required by the California Administrative Procedures Act. In this report the ARB staff presents the proposed Regulation for high-GWP refrigerant management for stationary sources, how it was developed, and why the proposed options were selected.

ARB staff estimates that business-as-usual (BAU) emissions from stationary R/AC appliances in 2020 will be 17.2 $MMTCO_2E$; 15.8 $MMTCO_2E$ from refrigeration systems and 1.4 $MMTCO_2E$ from air-conditioning systems. A significant fraction of these emissions can be reduced through technologically feasible, cost-effective best management practices enabling the earlier detection and repairs of refrigerant leaks. Implementation of this Regulation is estimated to reduce emissions by 7.2 $MMTCO_2E$ of Kyoto gases (HFC refrigerants) and 0.9 $MMTCO_2E$ of non-Kyoto gases (ozone depleting substances, or ODS, refrigerants), as compared to the 2020 BAU, on an annual basis once fully implemented. The estimated cost-effectiveness of the proposed Regulation is an approximate savings of $2 per metric tonne of carbon dioxide equivalent ($MTCO_2E$) of reduced emissions.

In developing the proposed Regulation, staff worked with stakeholders including representatives of refrigerant manufacturers, appliance manufacturers, non-

governmental organizations, and organizations representing the users of R/AC appliances such as grocers, property managers, and agricultural industries.

Staff recommends that the Board adopt the proposed Regulation for the following reasons:

1. The proposed Regulation will achieve an annual reduction of 7.2 $MMTCO_2E$ of Kyoto gases, as compared to the 2020 BAU, to make a significant contribution towards achieving the total statewide emission reduction goal of approximately 169 $MMTCO_2E$ by 2020.
2. The proposed Regulation addresses the fastest growing sector of GHG emissions – the high-GWP GHG sector.
3. The proposed Regulation is technologically feasible and provides a necessary transition from management of ODS refrigerants only to management of non-ODS, high-GWP refrigerants and ensures a consistent regulatory framework for ODS and non-ODS refrigerants that complements existing federal regulations specific to ODS refrigerants originally published in 1993, and last amended in 2004.
4. The proposed Regulation is cost-effective. It requires improved refrigerant management practices such as leak detection and monitoring and leak repair, which are technologically feasible and are also good economic policy that, in a majority of cases can create cost savings to facility owners.

II. REQUIREMENTS OF AB 32

AB 32 (California Health and Safety Code, section 1, division 25.5 (commencing with section 38500), The California Global Warming Solutions Act of 2006, creates a comprehensive, multi-year program to reduce GHG emissions in California. Specifically, Health and Safety Code section 38562 requires that ARB adopt regulations that "achieve the maximum technologically feasible and cost-effective reductions in greenhouse gas emissions" from the sources identified for early actions or strategies. Section 38562(d) requires that reductions must be real, permanent, quantifiable, verifiable, and enforceable. AB 32 criteria are summarized below, with staff's assessment as to why the proposed regulatory action meets these criteria. The proposed regulatory action will reduce GHG emissions attributable to stationary, non-residential refrigeration systems.

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.**

   This Regulation was developed through an extensive public process involving multiple stakeholders, state agencies, the United States Environmental Protection Agency (U.S. EPA), the California Air Pollution Control Officers Association (CAPCOA), and the public. A large number of stakeholders including various trade associations, facility owners and operators, refrigerant and appliance manufacturers, agricultural industry, technicians, contractors, refrigerant distributors and reclaimers, technician training institutions and individual businesses actively participated in the proposed rule development process.

   The staff held several technical workgroup meetings and public workshops including:

   - One kick-off public workshop specific to the stationary source high-GWP GHG sector.
     - Sacramento, February 2008
   - Five technical working group meetings in Sacramento.
     - April, May, and June 2008
     - January and July 2009
   - Public workshops in cities throughout southern, northern, and Central Valley areas of California.
     - Sacramento, Fresno, and El Monte - September 2008
     - Sacramento, Modesto, and Diamond Bar - February 2009
   - One public workshop to outline current recommendations.
     - Sacramento, August 2009

   Each public workshop in Sacramento was also webcast to ensure access by a broader audience.

   Public meeting notices, the draft regulation, emission estimates, cost analyses documents and the respective revised versions were posted on the

web page created especially to provide information and periodic updates to anyone interested in the development of the proposed Refrigerant Management Program. Three ARB email list serves were used to distribute information to approximately 6,700 individuals who signed up and expressed interest in the proposed program and climate change.

The public process also included direct outreach to businesses and facilities including:

- Surveys of facilities
- Surveys of stationary heating, ventilation, and air conditioning (HVAC) service contractors and technicians
- Development and distribution of a Frequently Asked Questions (FAQ) pamphlet
- Development and distribution of refrigerant best management practices brochure
- Pilot outreach effort conducted in two CA cities (City of Industry and Merced) selected based on their size and the distribution of business in industries relevant to the proposed Refrigerant Management Program.
- Staff communicated with several small business associations in California, including the California Small Business Association, Small Business California, and the Merced and City of Industry chambers of commerce, as well as small business advocates such as the Governor's Office of Planning and Research, Office of the Small Business Advocate.

The estimated reduced emissions are technically feasible as they are based on known best management practices such as automatic leak detection and regularly scheduled leak inspections, and leak repair as soon as practicable after detection.

The proposed Regulation is cost-effective as due to reduced refrigerant consumption, costs are reduced for facilities with stationary refrigeration systems and, on average, result in a net savings.

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

The proposed Regulation is designed to maximize emission reductions through improved refrigerant leak detection and monitoring and expedited refrigerant leak repair. Requirements have also been designed to be equitable and applicable to potential GHG emission risk as it is related to the refrigerant charge of a R/AC appliance. Costs have been minimized through reduced requirements for facilities with refrigeration systems that use less than 200 pounds of refrigerant. Due to reduced refrigerant consumption,

costs are reduced and, on average, result in a net savings, which encourages early action prior to the adoption of the Regulation.

The leak detection and monitoring, leak repair, and retrofit or retirement components of the proposed Regulation all become effective in 2011 for facilities with refrigeration systems of all applicable refrigerant charge size categories to maximize the emission reductions, while providing for a multi-year phase-in for registration and implementation fee elements.

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

   The proposed Regulation is applied consistently throughout the State and is not anticipated to disproportionately impact any community. The proposed Regulation is not expected to result in significant negative impacts in any community.

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.**

   The proposed Regulation is based on best management practices. There are facilities in California that are already meeting the majority of the requirements of the proposed Regulation by voluntarily using best management practices. To a great degree, it is the example set by such facilities that has informed the proposed Regulation. In these cases, based on their current business decisions, these facilities may not incur any additional costs to meet the regulatory inspection and maintenance requirements.

   Additionally, proposed implementation fees will be waived for a facility that certifies to have maintained refrigeration systems in the prior calendar year using advanced technologies, strategies, and practices that reduce refrigerant charges and emissions of ozone-depleting substances and greenhouse gases.

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.**

   High-GWP GHG emissions are distinct from criteria pollutants and toxic air contaminants that have historically been regulated through federal and state air quality standards. The proposed Regulation does not interfere with and is complementary of existing federal, state, and local laws and regulations.

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

   The average cost-effectiveness of the proposed Regulation is a savings of about $2 per $MTCO_2E$ in reduced emissions, on average, for facilities with stationary refrigeration systems. Throughout the rulemaking process, staff have met with stakeholders to ensure a thorough understanding of cost impacts and refined the proposed Regulation to be as cost-effective as possible by considering alternatives to balance costs and potential emission reductions. See Appendix C for a more detailed discussion regarding economic impact estimates.

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 overall adverse impacts to society or the environment. California will benefit from the reduction of GHG emissions, and thereby contributes towards the mitigation of potential adverse impacts of climate change. The proposed Regulation originally included specifications for new refrigeration systems. This component has been removed from the proposed Regulation to be integrated with work in collaboration with the California Energy Commission (CEC) as it will allow for a full assessment of the interrelationship between refrigerant management, energy efficiency, and lifecycle GHG emissions.

   The primary focus of the proposed Regulation is HFC refrigerants used in stationary refrigeration systems as a GHG explicitly included in AB 32. PFC refrigerants (also explicitly included in AB 32) used in stationary refrigeration systems are also included, but they are in limited use. But, ODS such as CFC typically have GWPs on the order of 2 to 10 times that of HFC, so preventing the emission of CFC result in significant additional societal benefits in terms of climate change.

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

   The proposed Regulation affects a large number of facilities, so it has been developed to phase in many requirements based on the refrigerant charge size category of refrigeration systems to reduce the administrative burden of implementation on ARB and stakeholders.

   Table I provides the refrigeration system categories based on the refrigerant charge size, including the estimated number of facilities statewide that the refrigeration system category will apply. The refrigeration system category for a facility is based on the refrigeration system at a facility with the largest refrigerant charge size.

Table I. Proposed Refrigerant Charge Size Categories		
Refrigeration System Category	**Refrigerant Charge Size Category Description**	**Estimated Number of Facilities**
Large Refrigeration System	Refrigeration Systems with a Refrigerant Charge 2,000 pounds or Greater	2,000
Medium Refrigeration System	Refrigeration Systems with a Refrigerant Charge 200 pounds or Greater, but Less than 2,000 pounds	8,500
Small Refrigeration System	Refrigeration Systems with a Refrigerant Charge Greater than 50 pounds, but Less than 200 pounds	15,500

As an example of phased-in requirements, the registration provision will require facilities in the Large Refrigeration System category to register in 2012, in the Medium Refrigeration System category in 2014, and in the Small Refrigeration System category in 2016. The phased in approach reduces the administrative burden of data management and allows time for online reporting systems to be developed.

A similar approach is proposed for the facility reporting provision. Reporting will begin based on the same dates as registration. The primary difference between the reporting and registration requirements is the removal of all reporting for facilities with refrigeration systems requiring between 50 and 200 pounds of a high-GWP refrigerant.

The proposed Regulation requires facilities and refrigerant distributors, wholesalers, and reclaimers to record and report data to facilitate identifying and mitigating emissions of refrigerant. ARB is currently working on an on-line reporting system to reduce the burden of compliance through the allowance of electronic reporting and batch uploading of data from existing refrigerant management software packages currently in use by some facilities.

9. Minimize leakage.

Leakage is not expected to occur as a result of the proposed Regulation. Leakage occurs when an emission limit or regulatory requirement set by the State causes business activities to be displaced outside of California. The focus of the proposed Regulation applies to facilities with refrigeration systems in California. The use of best management practices in a California facility will not create a competitive disadvantage for California facilities because the proposed Regulation provides, on average, a cost savings through reduced consumption of refrigerant.

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

The California GHG emissions inventory shows that high-GWP GHG are a very significant and fast growing sector of the California anthropogenic GHG

inventory. Unless controls are enacted, emissions are expected to more than triple between 2004 and 2020 to reach over 46 $MMTCO_2E$. This increase would result in the high-GWP sector equaling 8 percent of the total estimated 2020 California GHG inventory.

The proposed Regulation will achieve emission reductions of about 7.2 $MMTCO_2E$ per year in Kyoto gases in 2020. See Appendix B for additional details. These emission reductions are an essential component of the statewide emission reduction goal of approximately 169 $MMTCO_2E$ by 2020.

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

The emissions and emission reductions from stationary R/AC appliances were calculated based on data available from reports submitted by facilities in the jurisdiction of the South Coast Air Quality Management District (SCAQMD) pursuant to Rule 1415 (Reduction of Refrigerant Emissions from Stationary Refrigeration and Air-conditioning Systems); this data was extrapolated statewide. The carbon dioxide equivalent GHG emissions and reductions were calculated based on GWP values defined by the Intergovernmental Panel on Climate Change (IPCC).[6] As outlined in Appendix B, additional data was obtained, including data from the U.S. EPA Vintaging Model and California specific Commercial End-Use Survey, to validate and verify emissions data used.

The proposed Regulation requires facilities to record data specific to refrigeration system and refrigerant use. Facilities with large and medium refrigeration systems will be required to annually report this information to the ARB. The reported data will be the basis of emission reduction quantification. Additionally, refrigerant distributors and wholesalers will report high-GWP refrigerant received and sold annually. This information will be used to verify the emission reductions quantified from reports submitted by facilities. As stationary, non-residential refrigeration systems constitute a large single component of all high-GWP emissions, assuming all other refrigerant use trends are held equal or can be estimated based on California high-GWP specific policies, emission reductions will be verified by changes in projected BAU statewide consumption of high-GWP refrigerants.

The reported data will identify facilities with apparent refrigerant leaks that have not been addressed and be the basis for investigation and potential enforcement actions. In addition, the data will inform ARB staff of factors that help to direct inspection and enforcement resources at the greatest risk of GHG emissions and non-compliance.

As a result of detailed research conducted to quantify current emissions and potential emission reductions, as provided in Appendix B, and effective data

[6] Intergovernmental Panel on Climate Change (IPCC), Second Assessment Report (SAR), 1995; IPCC, Fourth Assessment A-3 Report (AR4), 2007.

collection on refrigerant consumption, estimated emission reductions associated with the Refrigerant Management Program will be real, permanent, quantifiable, verifiable, and enforceable.

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

Regulations relevant to refrigerant management currently are limited to an existing set of requirements specific to ODS refrigerants promulgated by the U.S. EPA under section 608 (Stratospheric Ozone Protection, Stationary Sources) of the Clean Air Act and Amendments (CAAA). In response to the CAAA the SCAQMD adopted Rule 1415. These regulations created the basis of the BAU scenario.

The proposed Regulation complements federal regulations by recognizing a growing regulatory need to address all high-GWP refrigerants (and specifically non-ODS refrigerants) as production of ODS refrigerants is phased out. The proposed Regulation provides a transition of regulations from ODS refrigerants to ODS substitute refrigerants (HFC) resulting in a consistent management framework throughout the phase out of ODS. The proposed Regulation is also broader than historical federal regulations in that it includes more rigorous leak detection and monitoring requirements, as well as leak repair for any refrigerant leak that is detected.

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.

The Regulation achieves its emission reductions from direct emissions.

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

ARB staff used the best economic and scientific information available to develop the proposed Regulation. Appendix B describes in detail the scientific and technical information used for the development of estimated BAU emissions and emission reductions. Appendix C describes in detail the economic information used as the basis for determining economic impacts of the proposed Regulation.

This page is intentionally left blank

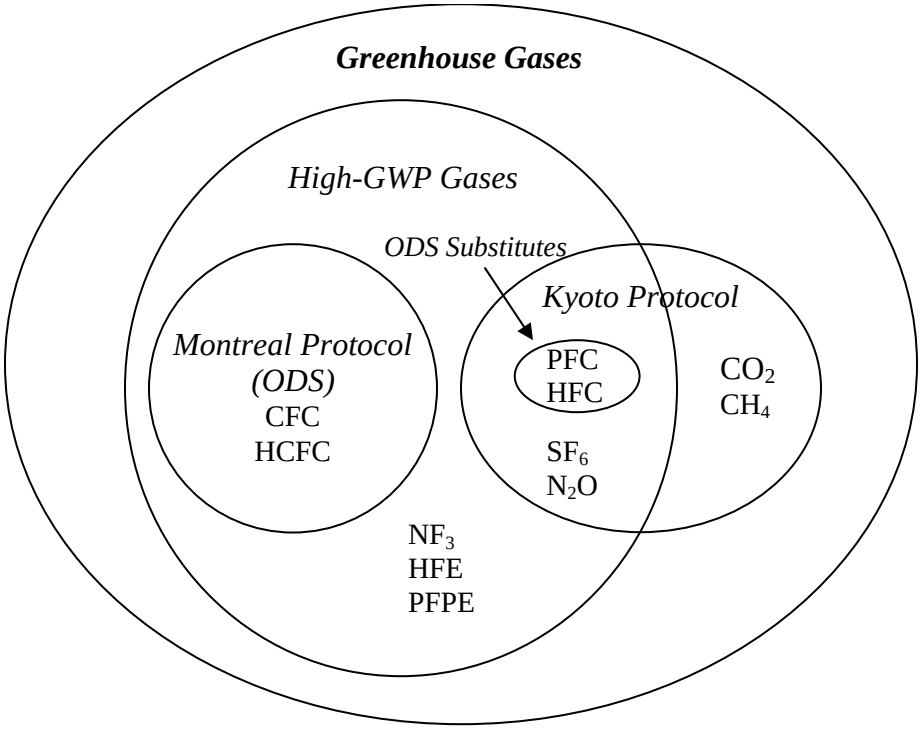
III. BACKGROUND

A. Stationary Source High-GWP GHG Sector

While not a discrete segment of the California economy, the stationary source high-GWP GHG sector consists of a broad range of sources that emit gases that on a pound for pound basis have hundreds to thousands of times the climate impact of carbon dioxide (CO_2). High-GWP refrigerants serve an important purpose as refrigerants in stationary HVAC, mobile vehicle air conditioning (MVAC), and refrigeration. High-GWP gases are also used as foam-blowing agents, in electrical transmission, as fire suppressants, in consumer products, and in the semiconductor industry.

As illustrated in Figure 1, high-GWP GHG used in stationary source R/AC appliances can generally be categorized as Kyoto Protocol gases, Montreal Protocol gases, and several miscellaneous gases not covered under either treaty.[7]

Figure I. High-GWP Greenhouse Gas Categories



An important category of high-GWP GHG is ODS, which include chlorofluorocarbons (CFC) and hydrochlorofluorocarbons (HCFC). ODS production is being phased out under the Montreal Protocol as a result of concerns about stratospheric ozone depletion, but legacy emissions from existing

[7] Figure 1. copied from: California Air Resources Board, Climate Change Scoping Plan Appendices, VOLUME I: SUPPORTING DOCUMENTS AND MEASURE DETAIL, December 2008.

sources are not controlled. Thus, ODS used as refrigerants were regulated as a result of concerns about stratospheric ozone depletion, but not due to concerns about climate change. The underlying assumption of the Montreal Protocol is that the gases produced will eventually be emitted due to equipment refrigerant leaks, servicing, or at end-of-life (EOL).

As a result of the Montreal Protocol's phaseout of ODS, ODS refrigerants used in stationary R/AC appliances have typically been replaced with hydrofluorocarbons (HFC) and perfluorocarbons (PFC), which are hence referred to as ODS substitutes. As an example, alternatives currently being used to replace HCFC-22 as a refrigerant are HFC blends with higher GWPs.[8] While ODS have negative impacts for both climate change and stratospheric ozone, ODS substitutes are not ozone-depleting but are typically potent GHG.

The majority of ODS substitutes are listed in the Kyoto protocol, and emissions of these gases are increasing as ODS refrigerants are replaced by ODS substitute refrigerants. Global HFC emissions in 2050 are estimated to be equivalent to 9 to 19 percent of the projected global BAU GHG emissions, on a CO_2 equivalent basis.[9] Specific to California, the 2002 – 2004 average GHG emissions explicitly identified in AB 32 for the high-GWP GHG sector was estimated to represent 3 percent of the California anthropogenic GHG inventory. However, the sector is growing rapidly due to the increased use of Kyoto gases as substitutes for ODS and is anticipated to reach 8 percent of the total estimated 2020 California BAU GHG inventory. As indicated in Figure II, by 2020 under the California-specific BAU scenario, high-GWP gases will become a much greater component of the California GHG inventory, which pursuant to AB 32 must be reduced to a baseline 1990 target by 2020.

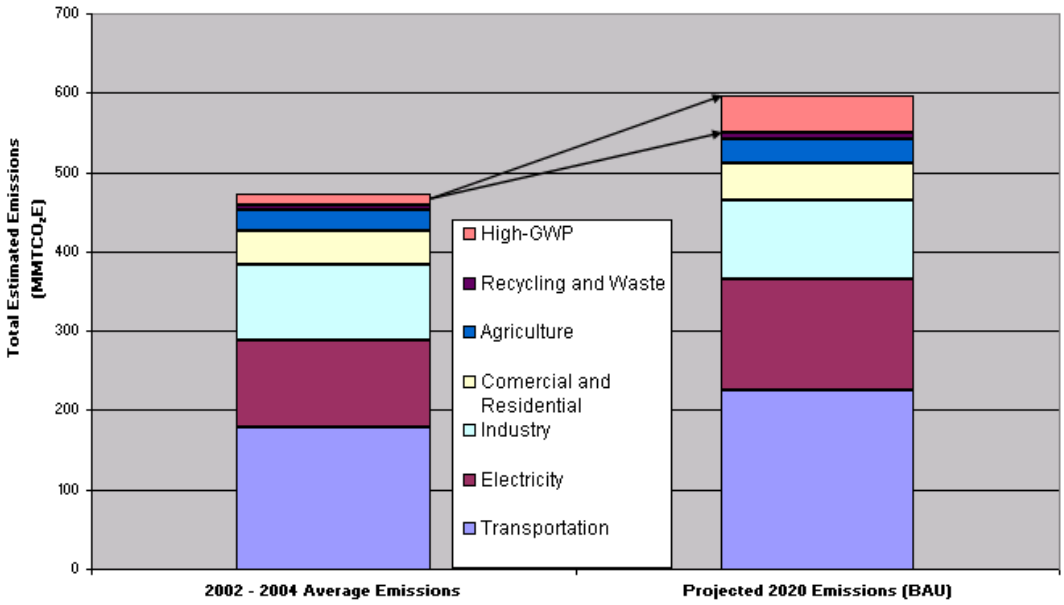
Currently there is a significant gap created in emission control efforts for non-ODS, high-GWP refrigerants. The proposed measure is the first of its kind in the United States to explicitly address emissions of all high-GWP refrigerants.

Figure II provides a comparison of the estimated 2002-2004 average emissions and projected 2020 emissions, and illustrates the significant growth of the high-GWP GHG sector as compared to other sectors of the statewide GHG inventory.

[8] J.M. Velders, S.O. Andersen, J.S. Daniel, D.W. Fahey, and M. McFarland, The importance of the Montreal Protocol in protecting climate, Proceedings of the National Academy of Sciences, USA, March 2007.

[9] J.M. Velders, D.W. Fahey, J.S. Daniel, M. McFarland, and S.O. Andersen, The large contribution of projected HFC emissions to future climate forcing, Proceedings of the National Academy of Sciences, USA, June 2009.

Figure II. Comparison of 2002-2004 Average Emissions and Projected 2020 Emissions (BAU) by Percent of Total California GHG Inventory



Based on most recent available data from Air Resources Board, Climate Change Scoping Plan, December 2008.

Stationary refrigeration is a source of high-GWP refrigerant emissions due to a lack of incentives to reduce emissions. There are many companies that maintain effective refrigerant management practices that reduce emissions and reduce maintenance costs. However, the low cost of many high-GWP refrigerants, as well as a lack of incentives for emission control, has resulted in a common practice of re-charging leaky, poorly designed, or poorly maintained R/AC appliances without attempting a repair. As a result, venting of refrigerant occurs during maintenance or EOL disposal. The Refrigerant Management Program's leak detection and monitoring, leak repair, and retrofit or retirement components are a suite of integrated strategies to address a well documented problem.

In the absence of effective controls, emissions from the high-GWP GHG sector are expected to more than triple over the next several years, resulting in over 46 $MMTCO_2E$ of high-GWP Kyoto gas emissions in 2020; 15.8 $MMTCO_2E$ from stationary, non-residential refrigeration. The proposed Regulation is expected to yield GHG emission reductions of 7.2 $MMTCO_2E$ of Kyoto gases by 2020. Additionally, the proposed Regulation is expected to yield an added benefit of GHG emission reductions of 0.9 $MMTCO_2E$ of non-Kyoto gases, or ODS, by 2020.

B. Stationary Refrigeration and Air-Conditioning Systems

Tens of millions of stationary commercial and industrial R/AC appliances exist in California, ranging from small, tightly sealed refrigerators and air-conditioning units to large parallel rack refrigeration systems (refrigeration systems commonly used in supermarkets) and centrifugal chillers (commonly used in process

cooling and commercial building air-conditioning systems) containing thousands of pounds of refrigerant.

Emissions from stationary R/AC appliances are categorized as direct refrigerant emissions and indirect emissions (CO_2-equivalent emissions resulting from energy use to operate the system). The focus of the Regulation is to minimize direct emissions that occur during the equipment lifetime (i.e., from leaks, ruptures, maintenance, etc.), with an emphasis on large non-residential refrigeration systems. Thus, approximately 26,000 facilities throughout California with refrigeration systems with a refrigerant charge greater than 50 pounds of a high-GWP refrigerant would be affected by the proposed Regulation.

R/AC appliances serve many diverse purposes and, as a result, vary greatly in the type of refrigerant used and the total refrigerant charge. A primary determinant of the potential emissions from a R/AC appliance is the refrigerant charge. Common equipment types can be categorized by refrigerant charge sizes as provided in Table II, which provides refrigerant charge size categories as discussed in the proposed Regulation. Table II does not include R/AC appliances with a refrigerant charge of 50 pounds or less as the proposed Regulation does not establish requirements for these systems with respect to leak detection and repair as they are usually tightly sealed and result in limited refrigerant leaks.

Table II. Equipment Type and Refrigerant Charge Size Categories of R/AC Appliances

Equipment Type	Typical Application and Refrigerant Charge Size
Process cooling and cold storage equipment	Mostly refrigeration systems with refrigerant charge greater than 2,000 pounds A small percentage of refrigeration systems with refrigerant charge between 200 and 2,000 pounds
Centralized refrigeration equipment (i.e. parallel rack and remote condensing refrigeration systems)	Mostly parallel rack refrigeration systems with refrigerant charge between 200 and 2,000 pounds A small percentage of refrigeration systems with refrigerant charge greater than 2,000 pounds
Condensing unit refrigeration equipment (i.e., large walk in refrigeration units, condensing units supporting several refrigerated cabinets)	Nearly 100% of applicable refrigeration systems with refrigerant charge between 50 and 200 pounds
Air-conditioning chillers	Mostly packaged chiller air-conditioning systems with refrigerant charge between 200 and 2,000 pounds A small to moderate percentage of centrifugal chiller air-conditioning systems with refrigerant charge greater than 2,000 pounds
Air-conditioning rooftop units and unitary systems	Nearly 100% of systems with refrigerant charge greater than 50 pounds are between 50 and 200 pounds A small percentage of systems with refrigerant charge between 200 and 2,000 pounds

The facilities types that commonly use R/AC appliances, along with the typical refrigerant charge sizes of R/AC appliances used can be categorized as provided in Table III.

Table III. Facility Types and Typical Refrigeration and Air-conditioning Appliance Refrigerant Charge Sizes	
Facility type	**Typical Refrigerant Charge Size**
Food processing facilities	Greater than 2,000 pounds (Large)
Cold storage warehouses	Greater than 2,000 pounds (Large)
Petroleum industry	Greater than 2,000 pounds (Large)
Manufacturing facilities	Greater than 2,000 pounds (Large)
Grocery stores	Between 200 and 2,000 pounds (Medium)
Small retail food stores	Between 50 and 200 pounds (Small)
Office Buildings	Between 50 and 200 pounds (Small)

C. Typical Refrigeration and Air-conditioning Appliances In Operation

Appendix B provides detailed descriptions of the primary types of R/AC appliances in operation. Table IV provides a brief description and images of typical systems listed in Table II.

Table IV. Typical Refrigeration and Air-conditioning Appliances in Use[10]	
Refrigerant Charge Size Category	**Typical R/AC Appliance**
Large Centralized Cooling System Duty Types: Industrial Process, Comfort Cooling, or Other Refrigeration	

[10] Images provided courtesy of Environmental Support Solutions.

Refrigerant Charge Size Category	Typical R/AC Appliance
Large Centralized Centrifugal Chiller Duty Types: Industrial Process, Comfort Cooling, or Other Refrigeration	
Large or Medium Commercial Refrigeration Duty Types: Refrigeration for Supermarket or Cold Storage	
Medium Packaged Centrifugal Chiller Duty Types: Industrial Process, Comfort Cooling, or Other Refrigeration	

Refrigerant Charge Size Category	Typical R/AC Appliance
Medium or Small Unitary Chillers Duty Types: Industrial Process, Comfort Cooling, or Other Refrigeration	
Small Unitary Industrial Process Chiller Duty Type: Refrigeration	

D. Refrigerant Leaks

Facilities with R/AC appliances will always face the potential for refrigerant leaks, and the sources of leaks vary greatly. A refrigerant leak may occur in a R/AC appliance due to a weakened valve, rust in filter dryers or heat pump accumulator, tiny holes on capillary tubing due to friction, a damaged line set that carries refrigerant from the condenser to the evaporator coil, or a failure of the flare connection.[11] Additional common areas for refrigerant leaks include leaking joints, seals, gaskets and cracked pipes, as well as areas subject to significant vibration.[12] Refrigerant leaks may also include incidents where some aspect of

[11] Stouffer, D., "Refrigerant Leak Creates Environmental Problems for Businesses," February, 2009, http://air.environmental-expert.com/resultEachArticle.aspx?cid=32055&codi=45718&idproducttype=6, (accessed March 9, 2009).
[12] British Refrigeration Association, Code of Practice for Refrigerant Leak Tightness in compliance with the F-Gas Regulation, December 2007.

the refrigerant circuit is breached releasing refrigerant to the atmosphere; significant breaches are typically observed and quickly repaired.

Figure III. Refrigerant Leak Illustration

The image to the left illustrates a leaking expansion valve component in a small direct expansion system. The refrigerant leak is indicated by the stain on the ground.

E. Refrigerant Use, Sale, and Disposal

Refrigerants use, sale, and disposal are based on their varied purposes and their value chain impacts several industries. Stationary HVAC and refrigeration service industries are the primary end users of refrigerants related to refrigerant management.

Refrigerants are distributed and sold in a wide variety of cylinder sizes; common sizes for stationary HVAC and MVAC service are 30 to 50 pounds. Although refillable cylinders are available on the market, non-refillable cylinders are more often used. Without regard to the size of a cylinder or if a cylinder is refillable, residual refrigerant is always present in the cylinder when considered empty by a technician, but may not be useable due to a lack of sufficient pressure in the cylinder. This residual refrigerant, or heel, is a source of GHG emissions.

IV. OVERVIEW OF RELATED FEDERAL, STATE, AND LOCAL LAWS AND REGULATIONS

ARB staff reviewed existing international, federal and local laws and regulations governing high-GWP refrigerants to use as the foundation for this proposed statewide Regulation. In developing the proposed Regulation ARB staff worked with U.S. EPA staff and SCAQMD staff to ensure that the proposed Regulation is complementary to existing rules and can be easily harmonized into one consistent regulatory framework to reduce GHG emissions.

A. International Regulations

The primary international regulation reviewed was the Fluorinated Gas (F-Gas) Regulation (Regulation (European Council) No 842/2006). The objective of the F-Gas regulation is to contain, prevent and thereby reduce emissions of fluorinated greenhouse gases covered by the Kyoto Protocol. The F-gas Regulation became effective in June 2006.[13]

B. Federal Laws and Regulations

The proposed Regulation to a great extent is modeled from existing regulations promulgated under the CAAA section 608. California businesses currently using R/AC appliances requiring more than 50 pounds of an ODS refrigerant are subject to leak repair, required service practices, and recordkeeping requirements under existing U.S. EPA regulations outlined below. The proposed Regulation expands these existing federal regulations to include R/AC appliances using all high-GWP refrigerants.

Federal management of refrigerants is through regulations promulgated under the CAAA; section 608 of the CAAA includes requirements applicable to refrigerant use during stationary HVAC servicing, while Section 609 includes requirements specific to refrigerant use during MVAC servicing. These regulations originate from laws passed to mitigate stratospheric ozone depletion.

Section 608 of the CAAA includes required service practices that maximize the recycling of ODS during the service of stationary HVAC systems. Section 608 includes requirements specific to venting, approved equipment, technician training and certification, recordkeeping, certification requirements, and sales restrictions.

Section 609 of the CAAA is similar to Section 608, but it is specific to management of refrigerants while maintaining, servicing, repairing, or disposing of MVAC systems. Section 609 includes requirements specific to venting, evacuation, reclamation, equipment certification, refrigerant leaks, technician certification, sales restrictions, certification by owners of recycling and recovery equipment, reclaimer certification, safe disposal, and recordkeeping.

[13] Fluorocarbons and Sulphur Hexafluoride, http://www.fluorocarbons.org/en/debate/regulatory_developments/f_gas_regulation.html, (accessed September 24, 2009)

Final regulations promulgated under section 608 of the CAAA, published on May 14, 1993 (58 Federal Register (FR) 28660), established a recycling program for ODS refrigerants recovered during the servicing and maintenance of R/AC appliances. Together with the prohibition on venting during the maintenance, service, repair, and disposal of class I and class II ODS (January 22, 1991; 56 FR 2420), these regulations were intended to substantially reduce the production and emissions of ODS refrigerants. The final rule on venting and sales of refrigerant substitutes (March 12, 2004; 69 FR 11946) sustained the prohibition against venting HFC and PFC refrigerants.

Federal regulations specific to refrigerant cylinder management are based on the CAAA and U.S. Department of Transportation (DOT) cylinder specifications. The CAAA prohibits the sale of ODS refrigerants, except to a U.S. EPA certified technician or the employer of a certified technician. DOT regulations applicable to refrigerant management include: 1) Title 49: Transportation, Part 173, Shippers, General Requirements of Shipments and Packaging; and 2) Title 49, Transportation, Part 178, Specifications for Packagings, Subpart C, Specifications for Cylinders. These regulations outline requirements specific to cylinder type, size, service pressure, test pressure, size limitation, maximum water capacity, pressure of contents, material (steel or aluminum), and markings.

Federal Refrigeration Training and Certification Program

As required by the CAAA, the U.S. EPA has established refrigeration training and certification requirements for management of refrigerants. Section 609 training and certification is required for servicing of MVAC systems. Section 608 training and certification is required for servicing stationary HVAC systems, and includes four types of certification:

1. Type I - for servicing small appliances (e.g., residential refrigerators, household air-conditioning systems, etc.)
2. Type II - for servicing or disposing of high- or very high-pressure appliances (e.g., commercial retail food refrigeration systems), except small appliances and MVAC
3. Type III - for servicing or disposing of low-pressure appliances (e.g., R-123-based chillers)
4. Universal - for servicing all types of equipment

The U.S. EPA training programs focus on issues related to ODS and stratospheric ozone layer protection. The core of the training program includes the following topics:

1. Ozone Depletion
2. Clean Air Act and Montreal Protocol
3. Section 608 Regulations
4. Substitute Refrigerants and Oils

5. Refrigeration
6. Three R's – Recover, Recycle, and Reclaim
7. Recovery Techniques
8. Dehydration Evacuation
9. Safety
10. Shipping

In addition to the core program, the Type II training (High Pressure) includes training specific to high pressure systems in the core program topic categories, and also includes the following additional topics:

1. Leak Detection
2. Leak Repair Requirements
3. Recovery Techniques
4. Recovery Requirements

In addition to the core program, the Type III training (Low Pressure) includes training specific to low pressure systems in the core program topic categories, and also includes the following additional topics:

1. Leak Detection
2. Leak Repair Requirements
3. Recovery Techniques
4. Recharging Techniques
5. Recovery Requirements
6. Refrigeration
7. Safety[14]

In California there are 52 programs[15] that provide instruction in basic engineering principles and technical skills in support of engineers and other professionals engaged in developing and using refrigeration and stationary HVAC and MVAC systems. The instruction includes principles of heating and cooling technology, design and operational testing, inspection and maintenance procedures, installation and operation procedures, and report preparation. A primary purpose for this instruction is to prepare technicians to pass the test to become U.S. EPA certified technicians. A large component of these available training programs is through California's community college network, which provides a partnership

[14] U.S. EPA, "Overview of Issues on EPA Certification Test," U.S. EPA, http://www.epa.gov/Ozone/title6/608/technicians/certoutl.html, (accessed July 15, 2008).
[15] California Employment Development Department, "Training Program Summary," http://www.labormarketinfo.edd.ca.gov/cgi/dataBrowsing/traProgramSummary.asp?menuChoice=&cipcode=150501&geogArea=0601000000, (accessed July 15, 2008).

opportunity between the ARB and community colleges. Currently, ARB is working with community college instructors with a focus on training ARB and air district staff as an initial step in developing a partnership with a goal of evolving into technician training programs for refrigerant best management practices.

These training institutions will be important in the process of outreach and education of certified technicians specific to the requirements of the proposed Regulation and the use of best management practices to reduce high-GWP refrigerant emissions.

C. State Statute, Regulations, and Programs

There currently are few California statewide laws specific to emissions of high-GWP refrigerants from stationary R/AC appliances.

California laws and regulations specific to refrigerant cylinders are limited and generally applicable to cylinder labeling. Although the California Health and Safety Code includes statutes specific to refrigeration manufacturers (Section 19800) and certified appliance recyclers (Sections 25211-25214), there are no laws or regulations specific to the management of refrigerants in cylinders.

The California Code of Regulations (CCR) does include regulations specific to cylinder labeling. CCR, Business Regulations, title 4, Division of Measurement Standards Section 4051 requires that compressed gas cylinders be labeled with the tare weight, net contents, product identity, name and address of responsible company.

California Health and Safety Code Section 25212 provides that materials requiring special handling contained in major appliances (major appliances in this reference is specific to appliances such as household refrigerators) shall not be disposed of at a solid waste facility and shall be removed from major appliances prior to the appliance being processed in a manner that could release materials that require special handling.

Public Resources Code Section 42175 requires that materials requiring special handling be removed from major appliances prior to crushing for transport or transferring to a baler or shredder for recycling.

Public Resources Code Section 42167 provides definitions of "materials that require special handling" to include: PCBs, CFC, HCFC, other non-CFC replacement refrigerants, used oil in major appliances, and mercury found in switches and temperature control devices.

D. South Coast Air Quality Management District Rule 1415

Similar to the U.S. EPA’s requirements under Section 608 of the CAAA, SCAQMD issued Rule 1415 in 1991 aimed at reducing emissions of ODS refrigerants from stationary R/AC appliances.

In addition to being modeled from existing federal regulations, the proposed Regulation has been developed to be consistent with SCAQMD Rule 1415. Businesses in the SCAQMD jurisdiction are subject to leak inspection, leak repair, registration and fee, reporting, and recordkeeping requirements under the SCAQMD's Rule 1415.

The rule requires any person within SCAQMD's jurisdiction, who owns or operates a refrigeration or air-conditioning system, to minimize refrigerant emissions. A refrigeration system is defined for the purposes of the rule, as any non-vehicular equipment used for cooling or freezing, which holds more than 50 pounds of, any combination of class I and/or class II refrigerant, including, but not limited to, refrigerators, freezers, or air-conditioning equipment or systems. Equipment that is found to be leaking any ODS refrigerant must be repaired within 14 days.

The SCAQMD requires biennial reporting from owners and operators of stationary R/AC appliances holding more than 50 pounds of an ODS refrigerant. Specific information collected includes: number of R/AC appliances in operation; type of refrigerant in each R/AC appliances; amount of refrigerant in each R/AC appliance; date of the last annual audit or maintenance performed for each R/AC appliance; and the amount of additional refrigerant charged to each R/AC appliance every year. For the purposes of the rule, additional refrigerant charge is defined as the quantity of refrigerant (in pounds) charged to a refrigeration system in order to bring the system to a full-capacity charge and replace refrigerant that has leaked.

This page is intentionally left blank

V. REFRIGERANT MANAGEMENT PROGRAM REGULATION DEVELOPMENT

A. Public Process in Rule Development

As part of ARB's regulatory development, staff made extensive personal contacts with industry representatives, state and local regulatory agencies, and other interested parties through site visits, meetings, telephone calls, and electronic mail. The regulatory development process spanned over 18 months and included several meetings of a technical workgroup and drafting of regulatory proposals with stakeholder review and comments.

The public process specific to the Refrigerant Management Program was initiated with a February 15, 2008 public workshop to present all measures being considered by the ARB in the stationary source high-GWP GHG sector. A primary action during this meeting was to solicit the attending public and industry representatives to join technical workgroups to assist and guide the ARB staff in the research and regulation development process.

Technical workgroup meetings specific to the proposed Regulation were held starting in April 2008, with the first Commercial Refrigeration Technical Workgroup meeting. In May 2008, the first Stationary Source High-GWP Refrigerant Tracking/Reporting/Repair Program technical workgroup meeting was conducted; the second was held in July 2008. The July 2008 technical workgroup meeting introduced the concept to integrate the Specification for New Commercial and Industrial Refrigeration Systems measure and High-GWP Refrigerant Tracking/Reporting/Repair Program for Stationary Sources measure resulting in the Refrigerant Management Program measure. Based on stakeholder input and to ensure the ARB and CEC do not have potentially confusing and duplicative regulations related to energy efficiency and the resulting GHG impacts, ARB and CEC will collaborate to incorporate direct GHG emission reductions and whole-building energy efficiency in the next phase of updates to the California Building Standards Code (Title 24). Thus, the focus of the proposed Regulation that is the subject of this report is existing refrigeration systems. A fourth technical work group meeting was held in January 2009 followed by a fifth technical work group meeting in July 2009.

Public workshops were conducted in September, 2008, in the cities of Sacramento, Fresno, and El Monte. Additional public workshops were conducted in February, 2009, in the cities of Sacramento, Modesto, and Diamond Bar. All Sacramento public workshops were also webcast to ensure access by a broader audience. A webcast public workshop to present current staff recommendations was held in Sacramento in August 2009.

In late 2008 ARB staff conducted refrigeration and air-conditioning contractor and technician surveys. In July and August 2009, ARB staff conducted a facility survey to research common characteristics of R/AC appliances used commercially and to outreach to the business communities that could be impacted by the proposed Regulation.

In summary, ARB staff visited several businesses as well as held private meetings with stakeholders, technical workgroup meetings, and public workshops throughout the state of California. In addition to these meetings and workshops ARB staff conducted extensive outreach efforts via phone and e-mail to approximately 67 trade organizations, 600 individual businesses, 20 state and local government agencies, and several e-mail list serves.

Outreach to potentially impacted facilities and persons were extensive and are described in detail in Appendix D.

B. Stationary Source High-GWP BAU Emissions Inventory and Potential Emissions Reductions

The estimate of total stationary source high-GWP emissions is a range established based on several data sources. The estimates include a "top-down" approach based on national estimates from the U.S. EPA Vintaging Model as well as a "bottom-up" approach using facility reporting from the SCAQMD. The Vintaging Model was developed as a tool for estimating the annual chemical emissions from industrial sectors that have historically used ODS in their products[16]. Both approaches were refined with additional data obtained from ARB staff research and research conducted through contract on behalf of the ARB.

Potential 2020 emissions based on a BAU scenario from stationary, non-residential R/AC appliances is 17.2 $MMTCO_2E$ – 15.8 $MMTCO_2E$ from refrigeration systems and 1.4 $MMTCO_2E$ from air-conditioning systems. The potential 2020 emission reductions estimate is 8.1 $MMTCO_2E$ from refrigeration systems - 7.2 $MMTCO_2E$ of Kyoto gases (HFC refrigerants) and 0.9 $MMTCO_2E$ of non-Kyoto gases.

As described in Appendix B, BAU emissions and potential emission reductions were determined based on emissions data reported by businesses to the SCAQMD pursuant to Rule 1415. BAU emission rates were based on average leak rates determined for specific categories of refrigeration systems. These emission rates were extrapolated statewide and emission estimates were based on the estimated number of facilities and refrigeration systems in each category.

ARB conducted a comprehensive study to determine the possible 2020 average achievable leak rates obtainable through the use of best management practices. The potential emission reductions are equal to the difference in the statewide emissions estimated using the average BAU leak rates and the statewide emissions estimated using the leak rates obtainable using best management practices.

The 2020 BAU emissions inventory and post-implementation GHG emission reductions estimates are outlined in Table V.

16 Godwin, D. (U.S. EPA), Martin Van Pelt, M. and Peterson, K. (ICF Consulting), Modeling Emissions of High Global Warming Potential Gases from Ozone Depleting Substance Substitutes, 2003. http://www.epa.gov/ttn/chief/conference/ei12/green/godwin.pdf, retrieved December 1, 2008.

Table V. Potential Emissions and Emission Reductions Associated with the Proposed Regulation in 2020.				
	Emissions			Emission Reductions
Refrigeration System Category	**2010 BAU**	**2020 BAU**	**2020 Post-Rule**	**2020 Total GHG Reduction**
Small Refrigeration System	1.2	1.4	0.5	0.9 (0.8 HFC, 0.1 ODS)
Medium Refrigeration System	5.7	7.9	4.6	3.3 (3.0 HFC, 0.3 ODS)
Large Refrigeration System	5.0	6.5	2.6	3.9 (3.3 HFC, 0.6 ODS)
Total Emissions and Potential Emission Reductions	11.9	15.8	7.7	8.1 (7.2 HFC, 0.9 ODS)

Notes:
All emissions and emission reductions are expressed in $MMTCO_2E$.
Totals may not sum due to rounding.
See Appendix B for detailed discussion of estimates.

The full description of the analyses conducted to determine the BAU emissions inventory and potential emission reduction estimates, including the uncertainty in the estimates, is provided in Appendix B.

Data reported to the SCAQMD pursuant to Rule 1415 served as the primary source of data to estimate BAU emissions and potential emission reductions. The statewide estimates were based on extrapolations of Rule 1415 data. As detailed in Appendix B, several other sources of data were used to assist in validating statewide estimates.

This page is intentionally left blank

VI. REFRIGERANT MANAGEMENT PROGRAM PROPOSED REGULATORY PROVISIONS

The proposed Regulation consists of several primary components outlining applicability and specific requirements. The purpose and the applicability of the proposed Regulation are outlined in sections 95380 and 95381. Definitions used in the proposed Regulation are outlined in section 95382.

The general requirements for facilities with stationary refrigeration systems are included in the following provisions:

- Registration Requirements for Facilities with Stationary Refrigeration Systems (section 95383)
- Implementation Fees for Facilities with Stationary Refrigeration Systems (section 95384)
- Leak Detection and Monitoring Requirements for Facilities with Stationary Refrigeration Systems (section 95385)
- Leak Repair Requirements for Facilities with Stationary Refrigeration Systems (section 95386)
- Requirements to Prepare Retrofit or Retirement Plans for Facilities with Leaking Stationary Refrigeration Systems (section 95387)
- Reporting Requirements for Facilities with Stationary Refrigeration Systems (section 95388)
- Recordkeeping Requirements for Facilities with Stationary Refrigeration Systems (section 95389)

The general requirements for persons installing or servicing R/AC appliances using high-GWP refrigerants are included in the Required Services Practices for High-GWP Appliances provision (section 95390).

The general requirements specific to refrigerant sales and refrigerant distributors, wholesalers, and reclaimers are included in the following provisions:

- Prohibitions (section 95391)
- Reporting Requirements for Refrigerant Distributors, Wholesalers, and Reclaimers (section 95392)
- Recordkeeping Requirements for Refrigerant Distributors, Wholesalers, and Reclaimers (section 95393)

Additional provisions describe implementation and enforcement issues:

- Confidentiality (section 95394)
- Enforcement (section 95395)
- Equivalent Local Rules (section 95396)
- Approval of Exemptions (95397)
- Severability (95398)

This section discusses the general requirements and rationale for each provision of the proposed Regulation.

95380. Purpose

Summary of Proposed Regulation

This section states the purpose of the Regulation. The purpose of this Regulation is to reduce emissions of high-GWP refrigerants from stationary, non-residential refrigeration equipment and from the installation and servicing of refrigeration and air-conditioning appliances using high-GWP refrigerants.

Rationale for Proposed Regulation

This section is necessary to ensure the regulated public understands that the proposed Regulation is an emission reduction measure to reduce emission of high-GWP refrigerants, which are GHG, pursuant to Health & Safety Code section 38562, in accordance with the approved Scoping Plan prepared pursuant to Health & Safety Code section 38561.

95381. Applicability

Summary of Proposed Regulation

This section outlines that the proposed rule requirements are applicable to 1) a person who owns or operates a stationary refrigeration system that uses more than 50 pounds of a high-GWP refrigerant; 2) a person who installs, repairs, maintains, services, replaces, recycles, or disposes of a R/AC appliance; and 3) a person who distributes or reclaims high-GWP refrigerants.

Rationale for Proposed Regulation

This section is necessary to identify the persons to which the Regulation would apply.

95382. Definitions

Summary of Proposed Regulation

This section defines the terms used in the Regulation.

Rationale for Proposed Regulation

It is necessary that ARB defines these terms as they apply to the Refrigerant Management Program. Many of the terms are used in other Articles and Titles in the California Code of Regulations, Government Code sections or statutes, and the Code of Federal Regulations, and it is necessary that ARB be consistent with existing definitions to the extent that they apply to this Regulation.

Description of Proposed Regulation

The proposed Regulation has many definitions to provide clarity. A primary factor in the development of proposed definitions and use of terms is consistency with 1) international conventions for reporting GHG emissions, 2) existing federal

and local regulations, and 3) current understanding of terms by the regulated community based on existing federal regulation guidelines and industry standards.

The following terms warrant a detailed discussion to set out their meaning within the context of existing conventions, laws and regulations, and industry use of terms.

Global Warming Potential Value: The "global warming potential value" or "GWP value" definition is provided to ensure that estimated emission reductions resulting from the proposed Regulation are consistent with the international convention for reporting GHG emissions. With respect to the GWP of a high-GWP refrigerant, the Fourth Assessment Report (AR4) published by the Intergovernmental Panel on Climate Change (IPCC) represents the latest scientific thinking. However, to calculate emissions and potential emission reductions, the IPCC's Second Assessment Report (SAR) is still used by international convention for reporting GHG emissions. The U.S. EPA uses the SAR GWP values for reporting the United States' GHG emissions under the United Nations Framework Convention on Climate Change (UNFCC). The Climate Action Reserve (CAR) and the International Council for Local Environmental Initiatives (ICLEI) both reference use of the SAR GWPs as well.

This is a long-standing issue since the IPCC's third assessment report (TAR, 2001) - the decision was made to base the Kyoto Protocol on the GWP values published in the SAR. As a result, those GWPs were locked in. A decision to update to more scientifically correct GWPs has not yet been made. Thus, the annual U.S. reporting and ARB are being consistent in using SAR as the source of GWPs.

Additionally, and most significantly, the California GHG baseline inventory, and thus the 2020 GHG emission target, is based on GWP values published in the SAR. Analysis and reporting for regulatory measures must be based on the GWP values published in the SAR in order to ensure an apples-to-apples comparison with the California GHG baseline inventory and emission reduction target.

There are several definitions that are copied, in whole, or in part from, or are provided by reference to, existing federal regulations to ensure that the meanings of the definitions are consistent with the language of federal regulatory text, guidance provided by the U.S. EPA, and the common understanding of the regulated community based on over a decade of complying with existing federal regulations. Definitions that are copied or referenced from existing federal regulations include the following:

Appliance
Certified reclaimer
Certified refrigerant recovery or recycling equipment
Certified technician
Commercial refrigeration
Normal operating characteristics and conditions
Reclaim
Recover
Recycle
Retire

Follow-up verification test	Retrofit
Industrial process refrigeration	System mothballing

In the above list of definitions developed based on consistency with existing federal regulations there is one definition that warrants further discussion.

Follow-up Verification Test: The definition of a follow-up verification test is important as it reflects the varied applications of such a test for a refrigerant leak. This test is required for a variety of refrigeration systems but may be foregone under some conditions, as such it requires flexibility. As an example, the definition includes the term, "except in cases where sound professional judgment dictates." This language is consistent with existing federal regulations and provides a required flexibility understood by the regulated community. It is provided to ensure a test that provides limited benefit in some circumstances is not required, and does not add unnecessary costs. Conversely, if reasonable professional judgment would find that the test is appropriate under the specific circumstance and it provides a benefit of preventing refrigerant emissions, then it is required.

95383. Registration Requirements for Facilities with Stationary Refrigeration Systems

Summary of Proposed Regulation

This section describes the facilities required to register based on their use of a refrigeration system with more than 50 pounds of a high-GWP refrigerant. Additionally, this section sets out the registration schedule and the information that must be provided during registration.

Rationale for Proposed Regulation

Registration is necessary to identify facilities that have potential GHG emissions from their stationary refrigeration systems, and to identify the characteristics of the refrigeration systems that can be indicators of potential GHG emissions that are targeted for reduction pursuant to Health & Safety Code section 38562.

The average lifetime of the commercial refrigeration equipment applicable under the facility registration provision, according to U.S. EPA Vintaging Model technical data sheet estimates, is between 15 and 25 years, with most equipment expected to last about 20 years before replacement. The expected annual turnover rate based on the equipment lifetime is estimated to be in the range of 4% - 7% based on the system type. Based on the long useful lifetime of refrigeration systems having registration of facilities with these systems in operation is necessary to assist in enforcement activities and to identify the characteristics of the refrigeration systems that can be indicators of potential GHG emissions.

The phased-in approach proposed for registration is necessary to ensure that requirements for each facility reflect the potential GHG emission risks from each facility based on the refrigeration system(s) used.

Description of Proposed Regulation

The potential high-GWP refrigerant emission risk from stationary, non-residential refrigeration systems is directly related to the refrigerant charge size of the refrigeration system. The phased-in approach for registration is based on refrigerant charge size categories according to the following titles:

A. Large Refrigeration Systems: refrigerant charge greater than or equal to 2,000 pounds

B. Medium Refrigeration Systems: refrigerant charge greater than or equal to 200 pounds, but less than 2,000 pounds

C. Small Refrigeration Systems: refrigerant charge greater than 50 pounds, but less than 200 pounds

The refrigerant charge size categories were developed to focus requirements on facilities with refrigeration systems with the greatest potential emissions, while also reducing the administrative burden of implementation. A principal rationale for the refrigerant charge size lower limit of greater than 50 pounds is consistency with requirements pursuant to existing U.S. EPA regulations, and the SCAQMD Rule 1415. Additionally, R/AC appliances with a refrigerant charge of 50 pounds and less are commonly tightly sealed to prevent the escape of air or any other gases and result in limited refrigerant emissions.

Owners and operators of facilities with stationary, non-residential refrigeration systems with a refrigerant charge size of more than 50 pounds of a high-GWP refrigerant will have to register with the ARB.

Registration is required based on schedule provided in Table VI.

Table VI. Registration Requirement Schedule

Refrigeration System Category	Initial Registration Due Date
Large Refrigeration Systems	March 1, 2012
Medium Refrigeration Systems	March 1, 2014
Small Refrigeration Systems	March 1, 2016

Registration will include the following information pertaining to the facility and to the refrigeration equipment.

Table VII. Registration Requirement Data Submitted

Facility Information	Equipment Information
Name of operator	System identification number
Operator federal tax ID number	Equipment type
Facility NAICS business type code	Equipment manufacturer
Facility SIC code	Equipment model or description
Name of facility, including a facility identifier such as store number	Equipment model year

Facility Information	Equipment Information
Facility mailing address	Equipment serial number. An equipment serial number is not required if a refrigeration system is assembled with multiple components with individual serial numbers, the serial number is inaccessible after assembly, or the appliance does not otherwise have an serial number
Facility physical location address	Physical location of the refrigeration system
Facility contact person	Refrigeration system temperature classification – low temperature system, medium temperature system, or other
	Full charge of the refrigeration system
Facility contact person phone number	Type of high-GWP refrigerant used
Facility contact person e-mail address	

In the registration process a facility will obtain a facility identification number. If they use the web-based registration process to be developed by the ARB, then the facility identification number will be auto-generated in the process of starting a new registration. Alternately, a facility can contact ARB staff and they will be provided a facility identification number. All other data will be specific to the facility registering.

The average lifetime of commercial refrigeration equipment that is applicable under the facility registration provision, according to U.S. EPA Vintaging Model technical data sheet estimates, is between 15 and 25 years, with most equipment expected to last about 20 years before replacement. The expected annual turnover rate based on the equipment lifetime is estimated to be in the range of 4% - 7% based on the system type. Based on the long useful lifetime of the refrigeration systems having registration of facilities with these systems in operation is necessary to assist in enforcement activities and to identify the characteristics of the refrigeration systems that can be indicators of potential GHG emissions.

95384. Implementation Fees for Facilities with Stationary Refrigeration Systems

Summary of Proposed Regulation

This section describes the initial and annual implementation fee a facility with a refrigeration system that uses 200 pounds or more of a high-GWP refrigerant will be required to pay.

Rationale for Proposed Regulation

Implementation fees are necessary to fund the implementation and enforcement of this Regulation and cost-effectively achieve specified GHG reductions pursuant to Health & Safety Code section 38562.

The imposition of fees only on facilities with medium or large refrigeration systems reflects the greater environmental impact posed by a leak at such a facility. A leak from a small refrigeration system presents a much smaller environmental impact.

The average lifetime of commercial refrigeration equipment that is applicable under the facility registration provision, according to U.S. EPA Vintaging Model technical data sheet estimates, is between 15 and 25 years, with most equipment expected to last about 20 years before replacement. The expected annual turnover rate based on the equipment lifetime is estimated to be in the range of 4% - 7% based on the system type. Based on the long useful lifetime of the refrigeration systems, requiring registration of facilities with these systems in operation is necessary to assist in enforcement activities and to identify the characteristics of the refrigeration systems that can be indicators of potential GHG emissions.

The proposed implementation fee exemption provides an incentive for facilities to use refrigeration systems that utilize advanced strategies and practices reducing refrigerant charges and emissions of ozone-depleting substances and greenhouse gases.

Description of Proposed Regulation

Implementation fees are proposed annually for facilities with a large or medium refrigeration system to be paid with the initial registration and annually thereafter. No implementation fee is proposed for facilities with only a small refrigeration system(s).

The amounts of the proposed implementation fees are based on discussions with CAPCOA and the ARB Enforcement Division staff related to their time and materials that would be needed to conduct inspections. The time needed includes pre-inspection time for facility reports review; on-site equipment inspection; review of equipment service records and leak repair records; review of refrigerant purchase, use, and shipping records; travel planning; and report writing. It is anticipated that compliance can be maintained with periodic enforcement inspections prioritized on facilities' potential or demonstrated leak risk, i.e. those facilities with a refrigeration system with a larger refrigerant charge size (greater potential emissions in the case of a leak) and equipment type(s) that is more prone to leaks or with a higher leak rate demonstrated by their annual report.

Implementation fees will fund staff to conduct inspection and enforcement activities, implement the program, provide outreach, assist the regulated community, and establish and maintain an on-line payment and reporting system to streamline all reporting requirements.

The implementation fees specific to each refrigerant charge size category are based on the average staff costs for administration of the proposed Regulation. The staff costs are related to the potential GHG emissions per facility as the time required for enforcement activities is estimated based on the need to focus on

the facilities with the greatest potential GHG emissions. The implementation fees proposed for a facility with a medium and large refrigeration system are justified by the greater environmental impact posed by systems with a larger charge size. Facilities with large refrigeration systems represent approximately 8 percent of all facilities, but 41 percent of projected 2020 BAU GHG emissions. Facilities with medium refrigeration systems represent approximately 33 percent of all facilities, but 50 percent of projected 2020 BAU GHG emissions. Conversely, facilities with small refrigeration systems represent approximately 60 percent of all facilities, but only 9 percent of projected 2020 BAU GHG emissions.

A facility with multiple refrigeration systems will be required to pay fees based only on the largest refrigeration system in operation at the facility. For example if a facility has one large refrigeration system and two medium refrigeration systems they will pay a single implementation fee of $370.

The implementation fee structure is provided in Table VIII.

Table VIII. Proposed Implementation Fee

Refrigeration System Category	Annual Implementation Fee
Large Refrigeration Systems	$370
Medium Refrigeration Systems	$170
Small Refrigeration Systems	$0

Additional detailed information on the development of the implementation fee amount is provided in Appendix C.

The proposed implementation fee exemption provides an exemption from paying either an initial or annual implementation fee to incentivize facilities to use, or install in newly constructed facilities, refrigeration systems that decrease the environmental impact posed by a refrigeration system through the use of advanced strategies and practices to reduce emissions of ozone-depleting substances and greenhouse gases.

95385. Leak Detection and Monitoring Requirements for Facilities with Stationary Refrigeration Systems

Summary of Proposed Regulation

This section describes the leak detection and monitoring systems or practices that will be required for refrigeration systems that use over 50 pounds of a high-GWP refrigerant.

Rationale for Proposed Regulation

Leak detection and monitoring is necessary to ensure detection of high-GWP refrigerant emissions and allow expedited refrigerant leak repair. High-GWP refrigerant leaks can be on-going for long periods of time without detection or loss of apparent operational efficiency. The Regulation's leak monitoring and inspection requirements are the primary means of achieving the emission reductions required by Health & Safety Code section 38562.

The tiered requirements for leak detection and monitoring and the specific performance standards for automatic leak detection systems are necessary to ensure that requirements for each facility relate to the potential emission risks from each facility based on the refrigeration system(s) used.

Description of Proposed Regulation

Starting in January 2011, leak detection and monitoring for high-GWP refrigerant leaks will be required for any system that requires more than 50 pounds of a high-GWP refrigerant. The requirements and frequency will depend on the refrigerant charge size category of the individual refrigeration system(s) in operation as summarized in Table IX.

Table IX. Proposed Leak Detection and Monitoring Requirements

Refrigeration System Category	Monitoring Requirement
Large Refrigeration Systems	Automatic leak detection system with continuous monitoring
Medium Refrigeration Systems	Quarterly leak inspections
Small Refrigeration Systems	Annual leak inspections

Automatic leak detection is required only for facilities with a large refrigeration system. Due to the time required to obtain funding for new equipment the automatic leak detection system requirement will be effective beginning in 2012, with monthly refrigerant leak inspections required in 2011 if an automatic leak detection system is not in operation.

The automatic leak detection systems that will be required are based on existing technology as described in ANSI/ASHRAE Standard 15-2001 Safety Standard for Refrigeration Systems. The proposed Regulation is consistent with this industry standard in that the detector must be continuously operated and provides real-time information. The detector required is not specified, but rather the function of the detector is specified to allow the system designer to select the type of detector based on the application.[17]

Facilities that use large commercial and industrial refrigeration systems can vary greatly ranging from petroleum refineries to a neighborhood supermarket. Similar types of facilities may have very different refrigerant monitoring requirements. In one scenario, a 50,000 square foot supermarket may have a machine room with one chiller that houses the entirety of high-GWP refrigerant used at the facility; this may be effectively monitored with only one or two sensors. Alternatively, the same market may have a machine room with refrigerant distributed to several compressors and many display cases throughout the entire facility; this will likely require many more than two sensors to be effectively monitored.

[17] American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. User's Manual for ANSI/ASHRAE Standard 15-2001 Safety Standard for Refrigeration Systems, 2003

Other factors that must be included in the design of a refrigerant monitoring system include the vapor density of the specific refrigerant used and the airflow pattern of the facility in areas with potential refrigerant leaks.[18] Due to the many factors involved, application-specific design for refrigeration systems and the necessary refrigerant leak detection systems is required. This requires a flexible regulatory framework.

The proposed regulatory language seeks to balance the need for exacting clarity in requirements with the need for flexibility to accommodate the varied, application-specific designs of refrigeration systems and refrigerant monitoring systems. Imprecise terms such as "proximity to principal components" and "areas of high potential for a refrigerant leak" are necessary to achieve this practical balance. ARB staff considered being more specific and prescriptive, for example requiring a minimum of three sensors. But, in some cases this would be overly prescriptive and add costs without the benefit of more effective monitoring, and in other cases this would not provide effective monitoring.

Any facility that installs an automatic leak detection system with continuous monitoring that directly detect the presence of refrigerant in air must place sensors or intakes such that they will measure the refrigerant concentrations in air in proximity to principal components of the refrigeration system (e.g., compressor, evaporator, condenser).

Automatic leak detection systems that directly detect the presence of refrigerant in air will be required to meet performance standards including the following:

1. Ability to accurately detect the presence of 10 ppm of refrigerant in the atmosphere.
2. Generate an alarm signal when the level of refrigerant in the atmosphere exceeds 100 ppm.

Automatic leak detection systems that use an indirect system (i.e. interpreting measurements that indicate a refrigerant leak) must alert the operator when measurements indicate a loss of 10 percent of the refrigerant charge or 50 pounds, whichever is less.

Some large refrigeration systems are intended to operate less than 12 months per year, or outside an enclosed building or structure. For these systems an automatic leak detection system is not required, but a leak inspection is required within 30 days of each initial operation of the refrigeration system, and at least quarterly during continued operations.

Medium or small facilities that are not required to have an automatic detection system must respectively use a calibrated refrigerant leak detection device, bubble test, or observation of oil residue. Facilities with small refrigeration systems only must do so annually, facilities with medium refrigeration systems

[18] Ibid.

must do so quarterly. Any leaks initially detected by observation of oil residue must then be confirmed by a calibrated refrigerant leak detection device or bubble test. If a medium or small refrigeration system is monitored via an automatic leak detection system that meets the proposed standards, them the facility owner or operator will not be required to conduct quarterly or annual leak inspections.

As the loss of refrigerant in a refrigeration system is an indication of a refrigerant leak, a leak inspection is required for all refrigeration systems that require more than 50 pounds of a high-GWP refrigerant any time an additional refrigerant charge is required that is equal to or greater than 5 pounds, or one percent of the refrigeration system full charge, whichever amount is greater.

95386. Leak Repair Requirements for Facilities with Stationary Refrigeration Systems

Summary of Proposed Regulation

This section describes the leak repair requirements for refrigeration systems that use over 50 pounds of a high-GWP refrigerant.

Rationale for Proposed Regulation

Leak repair is necessary to ensure emissions of high-GWP refrigerants are reduced pursuant to Health & Safety Code section 38562.

Description of Proposed Regulation

Leaks repair must be completed within either 14, 45, or 120 days of leak detection. The applicable time-limit depends upon the nature of the system, and the circumstances surrounding the leak.

ARB is proposing that any refrigerant leak from a stationary, non-residential refrigeration system requiring more than 50 pounds of a high-GWP refrigerant be repaired by a U.S. EPA certified technician within 14 days of initial leak detection. Based on communications with representatives of facilities using best management practices, refrigerant leaks are commonly corrected within several hours or days of leak detection depending on the severity of the leak. This repair time-frame is primarily due to the economic cost of a continued refrigerant leak in terms of refrigerant consumption. The proposed Regulation provides up to 14 days to complete a refrigerant leak repair, although under certain circumstances, such as the unavailability of a certified technician or a required part, or if a refrigerant leak repair requires an industrial process shutdown, addition time for repair may apply. A facility owner or operator has 45 days to repair a refrigerant leak any of the following conditions applies:

1. Additional time is required to order components or secure the services of a U.S. EPA certified technician.
2. The ARB has approved an exemption, or there is a pending exemption request.

3. The leak repair requires the shutdown of an industrial process.

A facility owner or operator has 120 days to repair a refrigerant leak if all of the following conditions apply:

1. The facility owner or operator is an entity subject to Mandatory Greenhouse Gas Emissions Reporting requirements pursuant to section 95101 of the Health and Safety code.
2. The refrigeration system is an industrial process refrigeration appliance.
3. The refrigerant leak repair requires an industrial process shutdown.
4. Written records are maintained to document that all the above conditions were met.

Following any leak repair of a system subject to the Regulation initial and follow-up verification tests will be required.

If the refrigerant leak cannot be repaired and verified within the applicable 14, 45, or 120 days then the system owner or operator must prepare and implement a retrofit or retirement plan within a specified time period.

The following points are relevant to the functional need for the lengthy 120 day repair period that will be applicable under certain circumstances. As noted above, to qualify for the 120 day repair period a facility must be subject to Mandatory Greenhouse Gas Emissions Reporting under section 95101 of the Health and Safety code. Such facilities include electricity generating facilities, electricity retail providers and power marketers, oil refineries, hydrogen plants, cement plants, cogeneration facilities, and industrial sources that emit over 25,000 $MTCO_2E$ per year from stationary source combustion. For example, a facility that may be subject to the 120-day provision would be a petroleum refinery as it is required to annually report their GHG emissions and would likely also have to comply with the proposed Regulation.

The 120-day provision for leak repair at such facilities is provided to mitigate the Regulation's potential to require the shutdown of an industrial process due to a refrigerant leak with the related significant energy-related economic impacts. Repair of a refrigerant leak must ultimately be accomplished, but this provision seeks a balance between the importance of mitigating refrigerant leaks and the potential economic impact of the shutdown of facilities producing petroleum or other resources for California's consumers industries.

The 120-day provision for leak repair allows time for the specific life-cycle emissions and economic impact of the refrigerant leak. The determination of the net benefit of repairing the refrigerant leak and the economic costs that may result would be required if a facility applies for a conditional exemption under the proposed Regulation.

95387. Requirements to Prepare Retrofit or Retirement Plans for Facilities with Leaking Stationary Refrigeration Systems

Summary of Proposed Regulation

This section describes the refrigeration system retrofit or retirement plan for refrigeration systems that use over 50 pounds of a high-GWP refrigerant and are shown to have unrepairable refrigerant leaks.

Rationale for Proposed Regulation

Retrofit or retirement plans for refrigeration systems that continually leak high-GWP refrigerants are necessary to reduce GHG emissions, pursuant to Health & Safety Code section 38562.

Description of Proposed Regulation

If a refrigerant leak persists, the refrigeration system owner or operator will be required to prepare a retrofit or retirement plan that establishes a schedule to retrofit or retire the system within six months of the initial leak detection.

The retrofit or retirement plan will not be submitted to the ARB, but will be maintained in a facility's on-site records, and will be required to include the following information pertaining to the facility and to the retrofitted or newly installed refrigeration systems.

Equipment Information

1. System Identification Number.
2. Equipment type.
3. Equipment manufacturer.
4. Equipment model or description.
5. Intended physical location of the refrigeration system through schematic or floor plan with location clearly noted.
6. Refrigeration system temperature classification – low temperature system, medium temperature system, or other.
7. Full charge of the refrigeration system.
8. Type of high-GWP refrigerant used.
9. A plan for the old refrigeration system disposition.
10. A detailed timetable including: the anticipated dates to begin and complete the installation, construction, or retrofit.
11. Date and signature of responsible facility representative.

95388. Reporting Requirements for Facilities with Stationary Refrigeration Systems

Summary of Proposed Regulation

This section describes the reporting requirements for facilities with refrigeration systems that use 200 pounds or more of a high-GWP refrigerant.

Rationale for Proposed Regulation

Facility reporting is necessary to quantify GHG emission reductions that result from the proposed Regulation as required pursuant Health & Safety Code section 38562.

The reporting requirements are proposed only for facilities with large and medium refrigeration systems to minimize the administrative burden upon ARB in implementing the proposed Regulation and upon stakeholders in complying with the proposed Regulation as required pursuant to Health & Safety Code section 38562.

Reporting is not necessary for facilities with small refrigeration systems as nearly 90 percent of total GHG emission reductions are expected to result from facilities with large and medium refrigeration systems. Total statewide emissions that result from the proposed Regulation can be quantified based on reports from facilities with large and medium refrigeration systems extrapolated to quantify GHG emission reductions from all refrigeration systems using more than 50 pounds of a high-GWP refrigerant.

Description of Proposed Regulation

ARB is proposing that owners or operators of stationary, non-residential refrigeration systems that use 200 pounds or more of a high-GWP refrigerant report to the ARB annually by March 1 after the end of each calendar year.

Reporting will be phased in based on the schedule provided in Table X.

Table X. Proposed Facility Reporting Schedule

Refrigeration System Category	Initial Annual Report
Large Refrigeration Systems	March 1, 2012
Medium Refrigeration Systems	March 1, 2014
Small Refrigeration Systems	No Reporting Required

The information required in an annual Facility Stationary Refrigeration report falls into the following broad categories: facility refrigeration system(s), refrigeration system service and leak repairs, and refrigerant purchases and use. Each of these categories must respectively include the information described below.

Refrigeration System Information

1. System identification number.
2. Equipment type.
3. Equipment manufacturer.
4. Equipment model or description.
5. Equipment model year.

6. Equipment serial number. The serial number(s) of the affected equipment or component must be recorded when present and accessible. When the affected equipment or component is part of an assembly without a serial number or does not have an individual serial number or is not accessible after assembly, the physical location of the affected equipment must be recorded in enough detail to permit positive identification.
7. Physical location of a refrigeration system through schematic or floor plan with equipment locations clearly noted.
8. Temperature classification – The refrigeration system must be identified as a low temperature system, a medium temperature system, or other.
9. Full charge of the refrigeration system.
10. Type of high-GWP refrigerant(s) used.
11. Date of initial installation.

Refrigeration System Service and Leak Repair Information

1. Date leak detected, if applicable.
2. Date service provided or leak repair completed.
3. Cause of refrigerant leak, if applicable.
4. Description service provided or leak repair completed.
5. Date(s) of initial verification test(s), if applicable.
6. Date(s) of follow-up verification test(s), if applicable.
7. Total additional refrigerant charge of each type of high-GWP refrigerant, if applicable.
8. Purpose for additional refrigerant charge (leak repair, topping off, initial refrigerant charge, or seasonal adjustment), if applicable.
9. Name of certified technician completing leak repair, if applicable.
10. The certified technician's identification number issued by an approved technician certification program pursuant to Title 40 of the Code of Federal Regulation, Part 82, §82.161, if applicable.
11. The certified technician's certification type(s) issued by an approved technician certification program pursuant to Title 40 of the Code of Federal Regulation, Part 82, §82.161, if applicable.

Refrigerant Purchase and Use

1. The total weight in pounds of each type of high-GWP refrigerant that was purchased.
2. The total weight in pounds of each type of high-GWP refrigerant that was charged into a refrigeration system.
3. The total weight in pounds of each type of high-GWP refrigerant that was recovered from a refrigeration system.
4. The total weight in pounds of each type of high-GWP refrigerant that was stored in inventory at the facility, or stored at a different location for use by the facility, on the last day of the calendar year.
5. The total weight in pounds of high-GWP refrigerant that was shipped by the owner or operator for reclamation and destruction.

95389. Recordkeeping Requirements for Facilities with Stationary Refrigeration Systems

Summary of Proposed Regulation

This section describes the recordkeeping requirements for facilities with refrigeration systems that use over 50 pounds of a high-GWP refrigerant.

Rationale for Proposed Regulation

Facility recordkeeping is necessary to verify reported data and to ensure the Regulation is enforceable, pursuant to Health & Safety Code section 38562, based on findings from the review of facility records.

Description of Proposed Regulation

Facilities will be required to keep records and to retain records for a minimum of five years; recordkeeping must include the following:

1. Registration required by section 95383.
2. Documentation of all leak detection systems, leak inspections, and automatic leak detection system annual audit and calibrations required by section 95385.
3. Records of all refrigeration system and refrigeration system service and refrigerant leak repairs, and documentation of any conditions allowing repair of a refrigerant leak to be conducted more than 14 days after leak detection, as required by section 95386. Refrigeration system and refrigeration system service and refrigerant leak repair records must include documentation of all items reported pursuant to section 95388.
4. Retrofit or retirement plans required by section 95387.
5. All reports required by section 95388.
6. Invoices of all refrigerant purchases.

7. Records on of all shipments of refrigerants for reclamation or destruction.
8. Records of all refrigeration systems component data, measurements, calculations, and assumptions used to determine the full charge.

95390. Required Service Practices for High-GWP Appliances

Summary of Proposed Regulation

This section describes the required service practices to reduce emissions resulting from the installation and servicing of R/AC appliances using high-GWP refrigerants.

Rationale for Proposed Regulation

The required service practices are necessary to ensure emissions of high-GWP refrigerants are reduced pursuant to Health & Safety Code section 38562. Additionally, the required service practices are modeled from Title 40, Part 82 of the Code of Federal regulations to ensure consistency with federal regulations specific to ODS refrigerants.

Description of Proposed Regulation

ARB is proposing the following set of requirements as part of the Regulation to reduce emissions resulting from the installation and servicing of R/AC appliances using high-GWP refrigerants.

Required service practices proposed are rooted in the foundation of the CAAA, although they will be expanded to include all high-GWP refrigerants. The required service practices include the following:

1. In preparing an appliance for recycling or disposal, the person must not intentionally disrupt the refrigerant circuit of the appliance resulting in a discharge of refrigerant into the atmosphere, unless an attempt to recover refrigerant is made using specified equipment.
2. A person must make a recovery attempt using specified equipment for the specific type of appliance prior to opening an appliance to atmospheric conditions.
3. A person must not add refrigerant to an appliance during manufacture or service, unless such refrigerant is an ODS refrigerant, or a refrigerant approved under the U.S. EPA's Significant New Alternatives Policy (SNAP) program or is otherwise approved by the Executive Officer for the specific end use.
4. A person must not add an additional refrigerant charge to any appliance known to have a refrigerant leak, except that it is permissible to add an additional refrigerant charge for seasonal adjustment or to maintain operations while complying with refrigerant leak repair requirements.
5. A person servicing an appliance must hold a current, valid, and applicable certificate issued in accordance with Title 40 of the Code of Federal Regulations, Part 82, section 82.161.

6. A person must employ procedures approved by the U.S. EPA or Executive Officer for the certified refrigerant recovery or recycling equipment used. .
7. A person must use certified refrigerant recovery or recycling equipment as specified by the equipment manufacturer, unless the manufacturer's specifications conflict with the procedures approved by the U.S. EPA or Executive Officer.
8. A person must evacuate refrigerant from a non-refillable cylinder to a vacuum of 15 inches of mercury, relative to standard atmospheric pressure of 29.9 inches of mercury, prior to recycling or disposal.
9. A person must satisfy job site evacuation of refrigerants during recycling, recovering, reclaiming, or disposing in accordance with Title 40 of the Code of Federal Regulations, Part 82, §82.156.

In general, required service practices are based on Title 40 of the CFR, Part 82. The primary impact of placing these service practices in the proposed Regulation is to expand the existing requirements for ODS refrigerants (CFC and HCFC refrigerants) to cover all high-GWP refrigerants (CFC, HCFC, HFC, and PFC refrigerants).

The required service practices provision is an another area of the Regulation where language is copied from existing federal regulations. The terms, “attempt to recover refrigerant”, “reasonably be expected”, “recovery attempt”, and “reason to believe” are from existing federal regulations and proposed to match federal regulatory text (so as to be consistent with industry’s common understanding of the terms based on the U.S. EPA past guidance).

Title 40 of the CFR, Part 82 does not specify an evacuation requirement for non-refillable refrigerant cylinders. In researching non-refillable refrigerant cylinder evacuation standards several options were reviewed. Evacuation levels of a vacuum of 4 inches of mercury below atmospheric pressure and 15 inches of mercury, relative to standard atmospheric pressure of 29.9 inches of mercury, were considered. The standard of 4 inches is consistent with the CFR Appendix D to Subpart B of Part 82—Standard for HFC-134a Recover-Only Equipment. This requirement is specific to the use of extraction equipment for MVAC systems that must be capable of ensuring removal of refrigerant from the system being serviced by reducing the system pressure to a minimum of 102 mm (4 in) of mercury below atmospheric pressure (i.e., vacuum).

The standard of 15 inches is consistent with the CFR, Subpart F of Part 82, section 82.156. This requirement is specific to required levels of evacuation for appliances and specifies that when using recovery or recycling equipment manufactured or imported on or after November 15, 1993 evacuation is required at the following levels: 1) high-pressure appliance, or isolated component of such appliance, normally containing 200 pounds or more of refrigerant (10 inches of mercury); 2) medium-pressure appliance, or isolated component of such appliance, normally containing less than 200 pounds of refrigerant (10 inches of mercury); and medium-pressure appliance, or isolated component of such

appliance, normally containing 200 pounds or more of refrigerant (15 inches of mercury).

Based on these requirements, certified refrigerant recovery and recycling equipment has been developed to meet the specified evacuation requirements. The AHRI certified product directory lists a wide variety of certified refrigerant recovery and recycling equipment available. The equipment ratings in the product directory provide a "Shut Off Vacuum" rating. The vast majority of the certified equipment listed is designed and tested to obtain a vacuum of 15 inches or higher before reaching the shut off vacuum rating.[19] Thus, the proposed evacuation requirements are technologically feasible with current equipment manufactured and required for use by existing U.S. EPA regulations.

95391. Prohibitions

Summary of Proposed Regulation

This section describes specific prohibitions of refrigerant sale, use, and disposal practices.

Rationale for Proposed Regulation

The prohibitions are necessary to ensure emissions of high-GWP refrigerants are reduced, pursuant to Health & Safety Code section 38562, by ensuring proper use of high-GWP refrigerants by qualified persons. Additionally, the prohibitions are modeled from Title 40, Part 82 of the Code of Federal regulations to ensure consistency with federal regulations specific to ODS refrigerants.

Description of Proposed Regulation

The Prohibitions provision is focused on reducing emissions caused by the distribution or reclamation of high-GWP refrigerants. The regulatory concept would place restrictions on refrigerant cylinder use that are consistent with Required Service Practices (section 95390), and would only allow refrigerant sales to qualified technicians.

Federal requirements and prohibitions specific to the purchase of refrigerants, recycling and reuse of refrigerants, and/or sale of reclaimed refrigerants are currently specific only to ODS refrigerants; the proposed Regulation will extend the requirements to all high-GWP refrigerants thus requiring emissions control on ODS refrigerants as well as ODS substitute refrigerants. Additional prohibitions focus on the use of approved refrigerants and reduction of refrigerant emissions from refrigerant cylinders.

The prohibitions include the following:

1. A person, effective January 1, 2011, must not sell, distribute, offer for sale or distribution, or purchase any high-GWP refrigerant for use as a refrigerant in a container of two pounds or greater to a person unless: 1)

[19] Air-Conditioning, Heating and Refrigeration Institute, Certified Product Directory, January 2009, http://www.ahridirectory.org/ahridirectory/pages/rrr/RRRE%2015%20January%2009_Directory.pdf, (accessed April 7, 2009).

the buyer is a certified technician; 2) the buyer is an employer of a certified technician; 3) the refrigerant is sold only for eventual resale to certified technicians, to air-conditioning or refrigeration appliance manufacturers, or the refrigerant is being sent for reclamation; or 4) the refrigerant is contained in a R/AC appliance.

2. A person must not sell used refrigerant to a new owner for use as a refrigerant unless the used refrigerant has first been reclaimed by a U.S. EPA-certified refrigerant reclaimer.
3. A person must not sell or distribute or offer to sell or distribute any refrigerant for any R/AC appliance unless such refrigerant is an ODS refrigerant, or a refrigerant approved under the U.S. EPA's Significant New Alternatives Policy (SNAP) program or the Executive Officer for the specific end use.
4. A person must not recycle or dispose of a non-refillable cylinder before the non-refillable cylinder has been evacuated to a vacuum of 15 inches of mercury, relative to standard atmospheric pressure of 29.9 inches of mercury.
5. A person must not distribute or sell certified refrigerant recovery or recycling equipment unless such equipment meets the levels of evacuation to be achieved by recovery or recycling equipment as specified in Title 40 of the Code of Federal Regulations, Part 82.
6. A person must not refill a non-refillable cylinder or use it as a temporary receiver during service.
7. A person must not repair or modify a non-refillable cylinder in any way to allow the non-refillable cylinder to be refilled.

95392. Reporting Requirements for Refrigerant Distributors, Wholesalers, and Reclaimers

Summary of Proposed Regulation

This section describes the reporting requirements for refrigerant distributors, wholesalers, and reclaimers.

Rationale for Proposed Regulation

Distributors, wholesalers, and reclaimers reporting is necessary to verify GHG emission reductions that result from the proposed Regulation as required pursuant to Health & Safety Code section 38562.

Description of Proposed Regulation

ARB is proposing that refrigerant distributors, wholesalers, and certified reclaimers report specified information to the ARB annually by March 1, beginning March 1, 2012.

The refrigerant distributor or wholesaler annual reports will include: the refrigerant distributor or wholesaler company name, address, and contact person information; a listing of all California facilities; and the following aggregated information (on a company-wide basis):

1. The total annual aggregated weight in pounds of each type of high-GWP refrigerant that was purchased or received for the purpose of subsequent resale or delivery, or for any purpose other than reclamation or destruction.
2. The total annual aggregated weight in pounds of each type of high-GWP Refrigerant that was sold or distributed:

The certified reclaimer annual reports will include: the certified reclaimer company name, address, and contact person information; a listing of all California facilities, and the following aggregated information (on a company-wide basis):

1. The total annual aggregated weight in pounds of high-GWP refrigerant that was received for reclamation or destruction.
2. The total annual aggregated weight in pounds of each type of high-GWP refrigerant that was reclaimed in California.
3. The total annual aggregated weight in pounds of high-GWP refrigerant that was shipped out of California for reclamation.
4. The total annual aggregated weight in pounds of high-GWP refrigerant that was destroyed or shipped out of California for destruction.

A primary requirement of AB 32 is that emission reductions s can be quantified and verified. The primary quantification of emission reductions is based on facility reporting. The direct GHG emissions reported by each facility statewide are summed to quantify the emissions from facilities with large and medium refrigeration systems. As only facilities with large and medium refrigeration system report, the total statewide emissions reported from facilities with large and medium refrigeration systems would be extrapolated to encompass the entire stationary, non-residential refrigeration sector statewide, including facilities with small refrigeration systems. Emission reductions are quantified as the difference between current emissions, as outlined in Appendix B, and the quantified statewide emissions based on annual facility reports.

Statewide emission reductions are verified using data obtained through refrigerant distributor and wholesaler reporting. For each $MTCO_2E$ emission reduced there is a corresponding reduction in pounds of refrigerant emitted, for example based on the GWP of 1,500 for each $MTCO_2E$ emission reduced of R-22 refrigerant approximately 1.5 pounds of refrigerant is not emitted. The 1.5 pounds of R-22 that is not emitted also does not need to be purchased and charged into a refrigeration system to bring the system to its full refrigerant charge. Thus, the emission reductions result in reduced refrigerant consumption statewide, as compared to BAU.

The statewide emission verification process is a broad comparison of refrigerant emissions based on facility reporting and the overall impact on high-GWP refrigerant consumption. On a statewide basis there are many factors impacting refrigerant sales, so a one-to-one mass balance of emissions as compared to refrigerant consumption is not possible. But, as stationary, non-residential

refrigeration systems constitute approximately 20 percent of all high-GWP emissions, the relationship between refrigerant sales and emission reductions does enable a verification of total emission reductions through refrigerant consumption trends and should be detected given the significant reductions anticipated as a result of the proposed Regulation.

95393. Recordkeeping Requirements for Refrigerant Distributors, Wholesalers, and Reclaimers

Summary of Proposed Regulation

This section describes the recordkeeping requirements for high-GWP refrigerant distributors, wholesalers, and reclaimers.

Rationale for Proposed Regulation

Distributors, wholesalers, and reclaimers recordkeeping is necessary to verify reported data and to ensure the Regulation is enforceable, pursuant to Health & Safety Code section 38562, based on findings from the review of distributors, wholesalers, and reclaimers records.

Description of Proposed Regulation

Refrigerant distributors, wholesalers, and reclaimers will be required to maintain on-site records and to retain records for a minimum of five years; recordkeeping must include the following:

1. Annual reports required by section 95392.
2. Invoices of all High-GWP refrigerant received through sale or transfer and all High-GWP refrigerant distributed through sale or transfer.

95394. Confidentiality.

Summary of Proposed Regulation

This section describes the confidentiality requirements for all reports and information provided by a facility or refrigerant distributor, wholesaler, or reclaimer to the ARB.

Rationale for Proposed Regulation

This section is necessary to ensure the regulated public understands how reports and information are managed to ensure compliance with title 17 of the California Code of Regulations, sections 91000 to 91022.

Description of Proposed Regulation

All information submitted to the Executive Officer in a Facility Refrigerant Purchase and Use report shall not be designated as confidential.

Except for data reported specifically designated as a public record, a person submitting information to the Executive Officer may designate the information as confidential because it is a trade secret or otherwise exempt from public disclosure. All such requests for confidentiality shall be handled in accordance

with the procedures specified in title 17, California Code of Regulations, sections 91000 to 91022.

95395. Enforcement

Summary of Proposed Regulation

This section describes the legal basis of the enforcement of the proposed Regulation.

Rationale for Proposed Regulation

This section is necessary to ensure the Regulation is enforceable as required pursuant to Health & Safety Code section 38562.

Description of Proposed Regulation

If the Executive Officer finds that any facility owner or operator, certified technician, non-certified technician, certified reclaimer, refrigerant distributor, refrigerant wholesaler, or other person does not comply with the requirements of this subarticle, the Executive Officer may seek an injunction or otherwise assess penalties to the extent permissible under Chapter 1.5 of Part 5, Division 26 of the Health and Safety Code commencing with Section 42400.

95396. Equivalent Local Rules

Summary of Proposed Regulation

This section describes the mechanism for ensuring all regions of the state are subject to similar requirements, regardless of whether it is subject to a local air-district rule.

Rationale for Proposed Regulation

This section is necessary to ensure the regulated public understands how the Regulation will be implemented in a specific air district in which they operate a facility and to minimize the administrative burden of compliance, as required pursuant to Health & Safety Code section 38562, with the potential for a statewide regulation and a rule adopted by a local air district.

Description of Proposed Regulation

If the Executive Officer formally determines that an air district has adopted regulations that will achieve emission reductions from stationary, non-residential refrigeration systems that are equivalent or greater to those that would be achieved via sections 95383 through 95389 of this Regulation, and enforcement and resulting benefits are demonstrated, then the requirements specified in sections 95383 through 95389 will be considered as having been satisfied.

95397. Approval of Exemptions

Summary of Proposed Regulation

This section describes the conditions upon which a facility may be exempted from specific sections of the proposed Regulation.

Rationale for Proposed Regulation

This section is necessary to ensure there is a mechanism to consider broader societal benefits, as required pursuant to Health & Safety Code section 38562, including economic impacts such as energy related economic impacts as well as total life cycle emissions specific to an individual facility.

Description of Proposed Regulation

The primary purpose of this provision is to provide flexibility in implementation of the proposed Regulation to address significant hardship that may be created by the leak repair and retrofit or retirement requirements of the Regulation. The Executive Officer may provide an exemption to the leak repair and retrofit or retirement plan requirements described above based on: life cycle emissions of a refrigeration system, economic hardship, or emissions caused by a natural disaster. Such exemptions would only be granted following a facility owner or operator's written application.

95398. Severability

Summary of Proposed Regulation

This section describes the severability of each part of the proposed Regulation and that if any part is held invalid, the remainder will continue in full force and effect.

Rationale for Proposed Regulation

This section is necessary to ensure that if any part of the proposed regulation is held invalid emissions of high-GWP refrigerants are still reduced based on other parts remaining in effect.

VII. REFRIGERANT MANAGEMENT PROGRAM IMPLEMENTATION AND ENFORCEMENT

A. Implementation

The proposed Regulation will impact approximately 26,000 California facilities. The greatest focus in implementation will be outreach to impacted facilities and training for compliance assistance. The Refrigerant Management Program will require significant planning to ensure successful implementation.

B. Implementation Activities

The success of this regulatory effort depends upon a well executed outreach and implementation plan that includes an effective electronic reporting system, outreach to facilities, implementation assistance to air districts and impacted facilities, enforcement training for air district and other personnel, and best practices technician training.

Upon Board approval of the proposed Regulation, staff will initiate outreach and implementation efforts. Primary implementation planning components will include:

- Facility Outreach and Compliance Training and Assistance Plan
- Reporting and Payment System Development
- Air District Enforcement Agreement Development and Assistance
- Inspection and Enforcement Guidelines Development

The time frame for implementation activities is January 2010 (post adoption) through January 2011. However, even after this date it is anticipated that there will be an ongoing need to reach out to impacted businesses to assist with implementation and compliance.

As described in Appendix D, based on outreach efforts conducted during the rule development process, staff determined a primary outreach challenge will be to provide clear and easy to understand instructions to facility owners on how to determine the refrigerant charge size of refrigeration systems used in their business. This is especially important for facilities with smaller refrigeration systems that need to determine if their refrigeration system uses more than 50 pounds of refrigerant, making it subject to the registration, refrigerant leak detection and monitoring, leak repair, and facility recordkeeping provisions of the proposed Regulation. This will be a primary task in the early part of developing outreach material.

<u>Facility Outreach and Compliance Training and Assistance Plan</u>

ARB staff will develop a plan to first focus on ensuring that facilities subject to the requirements are aware of the Regulation and that they can easily determine the full refrigerant charge of their refrigeration systems to understand which

provisions are applicable to their business. The plan for post-regulation adoption outreach is explained in detail in Appendix D.

Reporting and Payment System Development

In order to manage the data generated from facilities, and allow facilities to submit reports and pay implementation fees online, a reporting and payment system will be developed. The system will facilitate efficient recording and tracking of information related to this Regulation and will have the following features:

1. Full database management system for recordkeeping, data reporting, storage, and retrieval that allows affected businesses to efficiently record data, submit reports, and pay implementation fees.
2. Web-accessible interface that provides selective and secure access.
3. User-friendly interface with pull-down screens and help-based tools to facilitate accurate and efficient data entry and transfer.
4. Internal checks so that data is screened for reasonableness and applicability.
5. Report generation for compliance determination and inspection prioritization.
6. Standard reports to evaluate program performance and estimate emission reductions.
7. Capability to allow batch data entry from refrigerant management software programs used currently by facilities.
8. Provide recordkeeping templates to assist facilities and enforcement personnel allowing them to better ensure compliance with recordkeeping requirements and report the benefits of reduced refrigerant consumption.

The development of an effective and efficient reporting and payment system will be integral to the success of the Refrigerant Management Program. Data will be made available to ARB and air district staff based on specified security rules to ensure data remains secure and is available only to appropriate persons authorized to review the information.

The data required to be reported will also provide facilities information specific to refrigerant leak frequency and the total refrigerant used and help them in determining the cost-effectiveness of refrigerant management and any savings from reduced refrigerant consumption.

Air District Enforcement Agreement Development and Assistance

It is anticipated that air districts will provide the primary mechanism for enforcing the program and be supported by implementation fees. ARB staff conducted a survey to determine how local air districts are likely to participate in the Refrigerant Management Program. Based on survey responses, air districts

representing 94 percent of the State's population are likely to enforce the proposed Regulations in their jurisdiction. This can be accomplished by establishing a Refrigerant Management Program Enforcement agreement with air districts and/or by the district adopting an equivalent program.

Upon Board approval of the proposed Regulation, staff will work with a committee including representatives of CAPCOA and local air districts to develop a model Refrigerant Management Program Enforcement agreement. The agreement between the ARB and air districts will outline all roles and responsibilities, enforcement performance requirements, and the amount and methods of payments that ARB will remit to the air districts.

Staff will also develop guidelines and materials to assist air districts in the implementation of the Refrigerant Management Program including guidelines and protocols to ensure proper revenue accounting and payment remitted to air districts.

Assistance to air districts will include development of training materials for air district staff (as well as ARB staff) to ensure that enforcement staff have a clear technical understanding of the Regulation and the inspection and enforcement guidelines developed. Because there are numerous facility and system types subject to the proposed Regulation requirements staff will require broad knowledge of these systems. Training materials will be developed that include guidelines and materials to direct enforcement staff to ensure inspections are effective. It will also include review and use of reports that facilities have filed or the on-site records that they are required to maintain.

Inspection and Enforcement Guidelines Development

A multi-division team of ARB staff will develop inspection and enforcement guidelines for the Regulation and develop training materials on how to implement the guidelines. The guidelines will provide a mechanism to develop consistent standards for use statewide whether inspections and enforcement are conducted by ARB staff or local air district staff.

Program Implementation

Upon Board approval of the proposed Regulation, staff will initiate outreach activities and implementing the Regulation.

As outlined in Appendix D, the focus of program implementation will be to provide clear and concise information on the applicability of the proposed Regulation and how to comply, as well as how to most effectively reduce refrigerant emissions. The primary implementation outreach topics anticipated include:

- How to determine the refrigeration system full charge
- How to comply with the Regulation provisions applicable to your facility
- How to benefit from use of refrigerant best management practices for all high-GWP appliances
- How to effectively conduct leak inspections

C. Enforcement

The proposed Refrigerant Management Program affects GHG sources statewide. However, local and regional air districts have extensive expertise in enforcement, and already have relationships with many of the facilities that will be regulated. It is ARB's goal to leverage the expertise of the air districts in the administration of the proposed Regulation. Air districts may elect to assume the lead in enforcing the Regulation two ways.

1. Entering a collaborative agreement between air districts and ARB. The agreement between the ARB and air district will outline all roles and responsibilities, enforcement performance requirements, and the amount and methods of payments that ARB will remit to the air district.
2. Adopting and implementation of a regulation that is functionally equivalent to the statewide Regulation.

ARB staff has conducted a survey to determine which air districts are likely to participate in the proposed Refrigerant Management Program. Air districts representing approximately 94 percent of the State's population have indicated that they are likely to enforce the Regulation in their jurisdiction.

Without regard to the enforcement options chosen by an air district, the ARB will have a statewide, on-line reporting and payment system that is anticipated to be used by ARB and air district staff to conduct analysis of reported data and determine potential areas of non-compliance. The goal is to ensure a consistent statewide reporting system to reduce the impact on businesses with facilities in multiple air districts and to provide ARB and air district staff a consistent perspective of reported data to identify facilities not in compliance with the Regulation and to inform enforcement staff of where the greatest risk of GHG emissions and non-compliance could be based on the data submitted.

VIII. AFFECTED INDUSTRIES

The scope of affected industries is framed by the type of refrigerant (all high-GWP refrigerants) used by industries including facilities and certified technicians that use applicable refrigerants, and refrigerant distributors, wholesalers, and reclaimers that buy, sell, distribute, or reclaim applicable refrigerants.

Industries regulated by this action include those who: 1) own or operate facilities with a stationary, non-residential refrigeration system using more than 50 pounds of a high-GWP refrigerant; 2) service any appliance using a high-GWP refrigerant; or 3) distribute or reclaim a high-GWP refrigerant. Such entities include, but are not limited to, owners or operators of facilities using commercial refrigeration systems such as refrigerated warehouses; retail food stores, including supermarkets, grocery stores, wholesale markets, supercenters, and convenience stores; beverage and food manufacturers, distributors, and packagers; ice rinks; and other industrial process refrigeration applications. Additionally, the proposed Regulation will apply to any individual who distributes or reclaims high-GWP refrigerants.

The scope of facilities regulated specific to facilities with stationary refrigeration systems is outlined in Table XI with the facilities' related North American Industry Classification System (NAICS) code.

Table XI. Scope of Facilities and NAICS Codes Applicable to Registration for Facilities with Stationary Refrigeration Systems Provision

Category	North American Industry Classification System (NAICS) Code	Examples of regulated entities
Industrial Process Refrigeration	311, 325, 3254, 31212, 31211, 312113, 324110	Owners or operators of refrigeration equipment used in the manufacture of pharmaceuticals, frozen food, dairy products, baked goods, food and beverage, petrochemicals, chemicals, ice manufacturing
Commercial Refrigeration	493120, 452910, 445110, 446110, 445120	Owners or operators of refrigerated warehousing and storage facilities supermarket, grocery, warehouse clubs, supercenters, convenience stores.
Other Refrigeration	622110, 812220, 611310	Owners or operators of large hospitals, mortuaries/crematories, universities

U.S. EPA Certified Technicians and Refrigerant Reclaimers, Wholesalers and Distributors

It is estimated that there are 60,000 HVAC and refrigeration technicians in California that are certified by the U.S. EPA. This estimate is based on the number of licensed air-conditioning and refrigeration contractors in California

obtained from the Contractors State License Board. There are approximately 10,000 contractors with a valid and active California business license in the Warm-Air Heating, Ventilating & Air Conditioning category, an additional 600 with a license in the Refrigeration category, and 1,400 with a license in both categories. Based on the U.S. Census data for HVAC businesses it was determined that HVAC firms have on average 10 paid employees. It was assumed that 50 percent of paid employees would require certification. Not all technicians require certification as a contractor's employees have many roles. As an example, an installer that installs an appliance prior to being charged with refrigerant or an employee that specializes in electronic components does not require certification. Certification is required only for those employees that maintain or service an appliance in a way that has a reasonable potential to emit a high-GWP refrigerant – or those working on refrigerant circuit components of an appliance. Assuming each contractor has on average five employees that require certification then there would be approximately 60,000 technicians in California. The proposed Regulation will require that any refrigerant leak be repaired by technicians certified pursuant to the CFR, Title 40, Part 82, § 82.161.

The proposed Regulation also applies to U.S. EPA certified reclaimers, as well as refrigerant distributors and wholesalers. The U.S. EPA maintains a national list of certified reclaimers including 40 reclaimers that provide services in California. A complete list of U.S. EPA approved reclaimers is available at: http://www.epa.gov/Ozone/title6/608/reclamation/reclist.html. Based on information from Heating, Air Conditioning & Refrigeration Distributors International (HARDI), a trade organization representing refrigerant wholesalers, there are approximately 230 companies in California that distribute refrigerants.

IX. ENVIRONMENTAL IMPACTS OF THE PROPOSED REGULATION

The ARB staff has conducted an analysis of the potential environmental impacts of the proposed Regulation. Based on our analysis, we have determined that the proposed Regulation will have no significant adverse environmental impacts.

A. Air Quality Impacts of the Proposed Regulation

The proposed Regulation is expected to reduce direct emissions of high-GWP GHG with no associated increases in criteria pollutants or air toxics. Total estimated GHG emission reductions in 2020 is about 8 $MMTCO_2E$.

The full description of the analysis to determine the potential high-GWP GHG emission reductions estimates is provided in Appendix B.

B. Legal Requirements Applicable to the Environmental Impact Analysis

The California Environmental Quality Act (CEQA) and ARB policy require an analysis to determine the potential environmental impacts of proposed regulations. The Secretary of Resources, pursuant to Public Resources Code section 21080.5, has certified the ARB rulemaking process. Consequently, the CEQA environmental analysis requirements may be included in the ISOR for this rulemaking. The ISOR serves as a functionally equivalent document to an initial study, a Negative Declaration, and an Environmental Impact Report. In addition, staff will respond, in the Final Statement of Reasons for the Regulation, to all significant environmental issues raised by the public during the public review period or at the ARB public hearing. Public Resources Code section 21159 requires that the environmental impact analysis conducted by the ARB include the following:

1. An analysis of the reasonably foreseeable environmental impacts of the methods of compliance.
2. An analysis of reasonably foreseeable feasible mitigation measures.
3. An analysis of reasonably foreseeable alternative means of compliance with any amendments to the proposed Regulation.

Regarding mitigation measures, CEQA requires an agency to identify and adopt feasible mitigation measures that would minimize any significant adverse environmental impacts described in the environmental analysis.

1. <u>Reasonably Foreseeable Environmental Impacts of the Methods of Compliance</u>

   The ARB staff has not identified any significant adverse environmental impacts from complying with the proposed Regulation.

2. <u>Reasonably Foreseeable Feasible Mitigation Measures</u>

   CEQA requires an agency to identify and adopt feasible mitigation measures that would minimize any significant adverse environmental

impacts described in the environmental analysis. ARB staff has concluded that no significant adverse environmental impact would occur from adoption of, and compliance with, the Regulation. Therefore, no mitigation measures would be necessary.

3. Reasonably Foreseeable Alternative Means of Compliance with the Amendments to the Refrigerant Management Program

   The ARB is required to do an analysis of reasonably foreseeable alternative means of compliance with the proposed amendments to the Regulation. The ARB staff concluded that the proposed Regulation provides the most effective measure that is cost-effective and results in verifiable, enforceable GHG emission reductions. Alternatives considered are outlined in detail in the "Alternatives Considered" discussion in the Economic Impacts of the Proposed Regulation section (Section X) of this Staff Report.

C. Environmental Justice

ARB is committed to evaluating community impacts of proposed regulations including environmental justice concerns. Given that some communities experience higher exposure to air pollutants, it is a priority of ARB to ensure that full protection is afforded to all Californians. The proposed Regulation is not expected to result in significant negative impacts in any community.

To ensure that everyone has had an opportunity to stay informed and participate fully in the development of this regulation, staff has held multiple workshops and workgroup meetings, provided opportunities to participate in meetings by internet webcasting and phone, widely distributed all materials, and maintained consistent contact with interested stakeholders.

X. ECONOMIC IMPACTS OF THE PROPOSED REGULATION

ARB staff has reviewed the costs of the proposed Regulation for calendar years 2011 through 2020.

Table XII provides the cost estimated for 2020, to reflect the average annual total cost of the proposed Regulation once fully implemented.

Table XII. Statewide Annual Cost of the Proposed Rule in 2020

Proposed Rule Components	Annual Cost (HFC plus ODS systems) ($ millions)	Annual Cost (HFC systems only) ($ millions)
Net Costs: Sections 95383 through 95390	$19.1 savings	$12.8 savings
Net Costs: Sections 95391 through 95393	$0.2	$0.1
Entire Rule Net cost	$18.9 savings	$12.7 savings
Proposed Rule Emissions Reductions	8 $MMTCO_2E$	7 $MMTCO_2E$
Proposed Rule Cost-effectiveness	$2/$MTCO_2E$ savings	$2/$MTCO_2E$ savings

Note: all costs are estimated in constant 2008 dollars.

The majority of costs are related to the general requirements for facilities with stationary refrigeration systems including the following provisions: Registration Requirements for Facilities with Stationary Refrigeration Systems (section 95383), Implementation Fees for Facilities with Stationary Refrigeration Systems (section 95384), Leak Detection and Monitoring Requirements for Facilities with Stationary Refrigeration Systems (section 95385), Leak Repair Requirements for Facilities with Stationary Refrigeration Systems (section 95386), Requirements to Prepare Retrofit or Retirement Plans for Facilities with Leaking Stationary Refrigeration Systems (section 95387), Reporting Requirements for Facilities with Stationary Refrigeration Systems (section 95388), and Recordkeeping Requirements for Facilities with Stationary Refrigeration Systems (section 95389). The total costs of these provisions combined are a savings of approximately $19 million annually.

Additional costs are associated with provisions related to refrigerant distributors, wholesalers, and reclaimers including the following provisions: Prohibitions (section 95391), Refrigerant Distributor, Wholesaler and Reclaimer Reporting (section 95392), and Refrigerant Distributor, Wholesaler and Reclaimer Recordkeeping (section 95393). The total costs of these provisions combined are less than $200,000 annually.

The total cost-effectiveness of the proposed Regulation is a savings of $2/$MTCO_2E$ for the emission reductions of Kyoto gases and Non-Kyoto gases combined, and Kyoto gases only. A detailed analysis of costs and economic impacts is provided in Appendix C.

The cost and economic impacts analysis was conducted by determining average costs for each component of the proposed Regulation, including:

- Implementation fees

- Average capital and operating cost for automatic leak detection system
- Average leak inspection costs
- Average leak repair costs
- Average recordkeeping cost
- Average reporting costs
- Average refrigerant costs

The costs for each component of the proposed Regulation was multiplied by the estimated number of facilities and refrigeration systems outlined in Appendix B to determine a total cost for the proposed Regulation. These estimates were done separately for the ODS and HFC refrigerants and the total combined refrigerants.

Leak repair costs attributed to the proposed Regulation are a percentage of the total actual repair costs. Average leak repair costs represent the difference between immediate repairs as required under the proposed Regulation and BAU repairs at an estimated time when a repair would likely be conducted in any case to maintain operations. The time for repairs to occur to maintain operations is estimated as the point at which the loss of refrigerant exceeds 35 percent of the refrigerant charge at the charge loss rate indicated by staff research for specific equipment categories based on refrigeration system type and refrigerant charge size.

Example equipment categories include cold storage requiring over 2,000 pounds of a high-GWP refrigerant or refrigerant condensing units requiring between 50 and 200 pounds of a high-GWP refrigerant. The interest cost (or lost opportunity cost) at 5 percent per year of the gross repair cost (parts, labor, and refrigerant recharge) is attributed to the proposed Regulation. As an example, the average annual leak for medium refrigeration systems is approximately 17 percent, so it would take slightly over 2 years to leak 35 percent (17 percent per year for slightly over 2 years equals approximately 35 percent) of the refrigerant charge. At 5 percent per year for two years, the leak repair cost attributed to the proposed Regulation would be approximately 10 percent of the total leak repair cost.

The annual discount rate of 5% used in this analysis is representative of the cost of money when high-risk technologies and activities are not involved and is consistent with cost assumption of the AB 32 Scoping Plan. The Scoping Plan's analysis of costs and savings used a uniform real discount rate of 5% to estimate the cost of money for all proposed measures and provided the first step towards annualizing the upfront or capital expenditures. ARB staff conducted a sensitivity analysis to determine how sensitive the average cost-effectiveness of the proposed rule is to the discount rate used. A range of discount rates were used to determine their impact on the average cost-effectiveness of the proposed rule. This analysis resulted in a net savings or net cost depending on the discount rate used with all results within the range of cost-effectiveness for measures approved by the Board in 2009, which have ranged from over $100 in savings to a cost of $21 per $MTCO_2E$.

A detailed analysis of costs and economic impacts attributed to the proposed Regulation is provided in Appendix C.

The proposed Regulation cost-effectiveness was calculated by dividing the total cost by the emissions reductions outlined in Appendix B.

A. Legal Requirements for Fiscal Analysis

In proposing to adopt or amend any administrative regulation Section 11346.3 of the Government Code requires that State agencies must assess the potential for adverse economic impacts on California business enterprises and individuals, including the ability of California businesses to compete with businesses in other states. The assessment must also include the potential impact of the regulation on California jobs; business expansion, elimination or creation; and the ability of California business to compete with businesses in other states.

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

The economic impacts analysis of the proposed Regulation was conducted to meet current legal requirements under the Administrative Procedure Act (APA) and the results are detailed in the required Form 399.

B. Potential Impact on California Businesses

California businesses having facilities with refrigeration systems that require more than 50 pounds of a high-GWP refrigerant will be impacted by the proposed Refrigerant Management Program through registration and the imposition of implementation fees, and leak monitoring and detection, leak repair, retrofit or retirement plan, reporting, and recordkeeping requirements. It is important to note that currently the majority of applicable R/AC appliances in operation use ODS refrigerants. California businesses currently using refrigeration systems requiring more than 50 pounds of an ODS refrigerant are subject to leak repair, required service practices, and recordkeeping requirements under existing U.S. EPA regulations. The same California businesses in the SCAQMD jurisdiction are subject to leak inspection, leak repair, registration and implementation fee, reporting, and recordkeeping requirements under the SCAQMD's Rule 1415. Thus, the recordkeeping and leak repair provisions of the proposed Regulation are consistent with existing requirements for California businesses, though certain elements of the proposal such as the facility implementation fees and reporting are new for businesses outside of the SCAQMD's jurisdiction.

Refrigeration and air-conditioning service contractors will be impacted through required service practices. The majority of these businesses, approximately 12,000, are refrigeration and air-conditioning service contractors that will be only minimally impacted by the required service practices provision, which in most

cases are common business practices already required for ODS refrigerants pursuant to existing U.S. EPA regulations.

C. Potential Impact on Small Businesses

To the extent that small businesses have refrigeration systems requiring more than 50 pounds of a high-GWP refrigerant they will be subject to the proposed Regulation. Approximately 64 percent of the estimated 26,000 facilities affected by the proposed Regulation are small businesses (i.e., businesses having fewer than 100 employees). Approximately 90 percent of the 12,000 refrigeration and air-conditioning contractors are small businesses. The number of small businesses was estimated using census data describing the distribution of business size (by number of employees) for the industries affected by the proposed Regulation. The estimate of small business impacted is based on a legal definition of 100 employees, as compared to what many may perceive as a small business, which would be as few as 10 employees.

In the regulation development process, ARB staff developed several provisions specifically to minimize the impact to small businesses while still delivering the vast majority of potential emission reductions, including the following:

1. Set refrigerant charge size threshold at more than 50 pounds – eliminates most bars and restaurants, gas stations, bakeries, and liquor stores.
2. Apply leak inspection, repair, reporting, and recordkeeping requirements only to refrigeration systems, as compared to all R/AC appliances – eliminates facilities with only air-conditioning appliances.
3. Develop reduced requirements for facilities with small refrigeration systems only
    a. Annual leak inspection, as compared to quarterly
    b. No reporting
    c. No implementation fee.
4. Ensure requirements are consistent with existing rules already applicable to small businesses
    a. Consistency with federal regulations specific to ODS refrigerants
    b. Consistency with SCAQMD Rule 1415 requirements.

One alternative reviewed by ARB staff was to include all refrigeration systems with a refrigerant charge equal to or greater than 30 pounds. One result of recommending the threshold to be set at more than 50 pounds of a high-GWP refrigerant is a significant reduction in the number of small businesses impacted. In several cases facilities that tend to be owned or operated by small businesses will not be impacted based on the 50-pound refrigerant charge size threshold. Research conducted for the ARB indicates that the refrigerant charge size for

refrigeration systems (condensing units) for bars and restaurants, gas stations, bakeries, and liquor stores are all generally below 50 pounds.[20]

One alternative selected that resulted in a significant cost reduction to small businesses is the focus on refrigeration systems only as compared to all R/AC appliances. As discussed further in the "Alternatives Considered" discussion in the Economic Impacts of the Proposed Regulation section (Section X) of this report, this alternative resulted in substantially reduced costs, including reduced costs for small businesses.

The types of facilities impacted tend to be highly represented in market segments dominated by large companies. As an example, the facilities using small refrigeration systems are dominated by large companies as about 30 percent of the over 15,500 facilities using small refrigeration systems are pharmacies and 63 percent of pharmacies are represented by only three major chains (CVS, Rite-Aid, Walgreens).

The potential impact of the proposed Regulation on small businesses will depend on the specific refrigeration systems used at a facility and their current refrigerant management practices. Based on ARB staff research, use of the best management practices described in the proposed Regulation resulting in meeting a 10 percent annual leak rate, on average, will result in a net savings to these small businesses.

The refrigerant sale, use, and disposal provisions of the Regulation will primarily affect small businesses in the refrigerant distribution, wholesale, and reclamation business sectors. This will include an estimated 230 refrigerant distributors and wholesalers and 40 refrigerant reclaimers.

One sector of positively impacted small businesses will be service contractors that specialize in refrigeration systems; there are approximately 2,000 in California. The provisions of the proposed Regulation provide business opportunities for these contractors as they will be needed to perform leak repairs and will likely conduct additional leak inspections.

D. Potential Impact on Business Creation, Elimination, or Expansion

No negative change is expected for California businesses as a result of this Regulation. This is because the proposed Regulation will impose requirements on businesses serving California clients, and the proposed Regulation is not anticipated to impact the level of services required by these clients.

The proposed Regulation requires that all refrigerant leak repairs be conducted by a U.S. EPA certified technician to be consistent with existing U.S EPA regulations specific to ODS refrigerants. Industry stakeholders have stated that there is a limited pool of certified technicians, so the proposed Regulation may have a positive business impact by creating greater demand for U.S. EPA certified technicians. It is anticipated that growth may occur in business for

[20] ARMINES, Inventory of Direct and Indirect GHG Emissions from Stationary Air conditioning and Refrigeration Sources, with Special Emphasis on Retail Food Refrigeration and Unitary Air conditioning, Final Report, March 2009.

current certified technicians as well as encourage current non-certified technicians to become certified to fill the increased demand.

The proposed Regulation will also result in potential business expansion including increased sales and service agreements for automatic leak detection systems.

E. Potential Impact on Business Competitiveness

The proposed Regulation will have little or no impact on the ability of California businesses to compete with businesses in other states. Many of the businesses affected by the Regulation are local businesses serving California clients, and may not be strongly subject to interstate competition. Additionally, as the proposed Regulation will uniformly impact any company providing services in California, there is no anticipated adverse impact resulting from out-of-state competition. Based on reduced refrigerant consumption, on average, the proposed Regulation is anticipated to result in a savings of $2 per $MTCO_2E$ in emissions reduced, which may provide a benefit to many businesses.

F. Potential Impact on California Consumers

No noticeable change in consumer prices is expected from the proposed Regulation; although initially some potential increased refrigerant distributor business costs may be passed to the consumer through price changes for refrigeration and air-conditioning repair services.

As businesses begin to use greater refrigerant best management practices required by the proposed Regulation and obtain the resulting cost benefits of reduced refrigerant consumption, the net savings of the proposed Regulation may also be passed on to consumers, though any savings would be expected to be quite small.

G. Potential Impact on California Employment

ARB staff expects no significant change in employment due to the compliance costs.

The proposed Regulation requires that all refrigerant leak repairs be conducted by a U.S. EPA certified technician to be consistent with existing U.S EPA regulations specific to ODS refrigerants. Industry stakeholders have stated that there is a limited resource of certified technicians, so the proposed Regulation may have a positive employment impact on creating greater demand for businesses and employment requiring U.S. EPA certified technicians. It is anticipated that growth may occur in business for current certified technicians as well as encourage current non-certified technicians to become certified to fill the increased demand.

H. Potential Impacts to California State and Local Agencies

Potential impacts to California state and local agencies are specific to either state and local agency compliance costs or implementation costs.

State and Local Agency Compliance Costs

The fiscal impact on state government related to compliance with the proposed Regulation is due to the registration, leak detection and monitoring, leak repair, reporting and recordkeeping provisions for state owned and leased buildings (including state universities).

Data characterizing the number of refrigeration systems used by state colleges and universities was obtained from the SCAQMD Rule 1415 dataset. This refrigeration system inventory was extrapolated statewide based on the total number of community colleges, state colleges and state universities present in California.

The annual impact on colleges and universities is estimated to be a net savings, on average, of approximately $122,000 ($3,500 savings per facility). The estimates include the statewide inventory of refrigeration systems (not including air-conditioning systems) of state government buildings and state university buildings.

There is limited expected fiscal impact on state government buildings since most are not expected to have impacted facilities. The impact to state facilities was dramatically reduced based on the selected alternative to focus on refrigeration systems only, as compared to refrigeration and air-conditioning systems.

There are no reports of state owned or operated facilities in the SCAQMD that could be extrapolated statewide. But, based on reports of county facilities including correctional and medical facilities, it is assumed state correctional and medical facilities may be impacted by the proposed Regulation. Any impacts are anticipated to be minimal.

The local government and state agencies that could be subject to required service practices include some cities, counties, public utility districts, school districts, or other agencies that maintain and service facilities that include refrigeration and air-conditioning appliances. But, these requirements are substantially the same as currently required under existing federal regulations specific to ODS refrigerants.

There are a few county owned facilities with small and medium size refrigeration systems that will have impacts. This cost is estimated to be approximately $700 statewide annually; approximately, on average, $20 per facility. County facilities applicable to the proposed Regulation will include facilities such as correctional facilities, medical facilities, and morgues.

There are no expected fiscal impacts on cities and local schools (K-12) in relation to the registration, leak detection and monitoring, leak repair, reporting and recordkeeping provisions since they are not expected to have impacted facilities.

The inventory of refrigeration equipment used by local governments and local schools was estimated using data obtained from the SCAQMD Rule 1415 dataset and a survey of local governments conducted by ARB staff. Refrigeration inventories for representative cities and counties were extrapolated statewide based on the total number of cities and counties in California. Existing data available from the SCAQMD Rule 1415 dataset indicated that no local schools in California use refrigeration systems with more than 50 pounds of refrigerant.

State and Local Agency Implementation Costs

State and local agency costs incurred to administer and enforce the Refrigerant Management Program will be related to activities of the ARB or local air districts. An air district may decide to enforce the proposed Regulation, which will result in additional expenses. These expenses will be compensated based on agreements between the respective air district and the ARB. Funding for these expenses is anticipated from the collection of implementation fees collected under the proposed Regulation, which were planned to cover the costs of program administration and enforcement. No enforcement costs to the state, beyond those covered by fees, are expected. Where air districts do not enforce the Regulation, the ARB staff will be required to enforce the Regulation.

Based on a phased implementation approach, the proposed regulatory action potential cost impact for implementation of the program (including cost of agreements with local air districts) is estimated at $0.4 million starting in fiscal year 2010-11, an additional $0.7 million starting in fiscal year 2012-13, and an additional $1.2 million starting in fiscal year 2014-15 to reach a total of 2.3 million in fiscal year 2014-15 and each year thereafter. Implementation fees are set to cover the estimated costs of implementing and enforcing the Regulation.

The costs of the program are associated with required staff positions (estimated at $175,000 per position with approximately 2 positions required in fiscal year 2010-11, and each year thereafter, prior to any receipt of implementation fees. The cost per position used in the calculations ($175,000) is based on the average ARB fully loaded cost per position (typical positions used for inspections in Enforcement division of ARB are Air Pollution Specialists and/or Air Resources Engineers).The primary role of these positions will be program administration, reporting and payment system development and maintenance, training for air district staff and facility owners and operators, and outreach to impacted facilities. After fiscal year 2011-12, additional staff will be required. The primary role of these positions will be program enforcement and administration, although they will also be involved in training for air district staff and facility owners and operators, and outreach to impacted facilities. Starting in fiscal year 2012-13, additional costs will be due to the need for an additional 4 positions. Starting in fiscal year 2014-15, additional costs will be due to the need for an additional 7 positions for a total of 13 positions required for fiscal year 2014-15 and each year thereafter. Costs for positions starting in fiscal year 2012-13 and after will be funded through the receipt of implementation fees.

The ARB anticipates that cost will include ARB staffing costs as well as funds for fee-for-service agreements with local air districts for administration and enforcement activities. It is anticipated that the majority of these positions will be air district staff compensated through the Regulation implementation fees to assist with program implementation and enforcement. ARB will require two administrative positions and one enforcement position. All other positions are anticipated to be required throughout local air districts.

Anticipated staffing allocations are based on a preliminary survey of air districts to determine how each air district is likely to participate in the Refrigerant Management Program. Air districts representing approximately 94 percent of the State's population responded that they are likely to enforce the Regulation in their jurisdiction, although final determinations by air districts are likely to occur after adoption of the proposed Regulation.

I. 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.

The ARB staff considered alternatives for all components of the proposed Regulation to ensure that the proposed Regulation achieves the maximum technologically feasible and cost-effective GHG emission reductions from stationary R/AC appliances. The discussion that follows is organized by alternatives that were considered for key components of the program (e.g., applicable refrigerant charge size subject to the Regulation).

Refrigerant Charge Size Criteria

The owner or operator of a facility with a stationary refrigeration system with a full charge of more than 50 pounds of high-GWP refrigerant will be subject to the provisions of the proposed Regulation. ARB staff also considered a minimum refrigerant charge threshold of 30 pounds for all refrigeration systems to capture smaller roof top units, walk-in coolers, and other smaller equipment. One commenter in the technical working group argued that smaller equipment accounts for significant refrigerant emissions and therefore should not be excluded from regulatory control. Other working group members, however, commented that smaller R/AC equipment tends to be tightly sealed and would therefore not result in significant emissions on a per-unit basis. These commenters agreed with ARB staff that by lowering the threshold to less than 50 pounds, tens of thousands of additional California facilities would be impacted, which would increase the administrative burden of the proposed Regulation while not resulting in significant emission reductions.

Further, because existing U.S. EPA regulations as well as SCAQMD regulations are based on R/AC appliances with a refrigerant charge of more than 50 pounds of ODS as the regulatory threshold, a different threshold in California could create confusion.

ARB estimates that lowering the refrigerant charge threshold to 30 pounds for refrigeration systems would increase the total number of impacted facilities by a factor of 4 or more (from 26,000 facilities to 108,000 facilities). Further, the refrigeration systems that use less than 50 pounds of refrigerant tend to be small tightly sealed appliances with very low per unit refrigerant leak rates.

Using a minimum refrigerant charge of 30 pounds or greater is estimated to have a net total cumulative cost of $96 million for 10 years, an increase of $284 million (difference between a net savings of $188 million in the Regulation and a net cost of $96 million in this alternative) ($27 million increase in 2020) over the proposed Regulation, but would have limited additional emission reductions and unduly burden small businesses. The cost effectiveness of the proposed regulation would change from a savings of $2 per $MTCO_2E$ to savings of $1 per $MTCO_2E$. Additionally, due to the increased number of facilities, administrative cost for the program would likely be substantially increased.

ARB also considered using a threshold of 200 pounds of refrigerant. But, there was significant concern regarding the issue of consistency with existing federal and local regulations being based on a 50-pound refrigerant threshold. This proposal would also reduce possible emission reductions by approximately 0.9 $MMTCO_2E$.

ARB will monitor changes in technologies that would warrant a revised threshold.

Leak Detection and Monitoring

ARB is proposing that by January 1, 2012, owners or operators of a stationary refrigeration system with a full charge greater than or equal to 2,000 pounds of high-GWP refrigerant, and which operates, or is intended to be operated, year-round must have an automatic leak detection system with continuous monitoring.

ARB staff had considered requiring continuous monitoring for all systems with a full charge greater than 600 pounds of high-GWP refrigerant. This lower threshold was based primarily on consistency with the Fluorinated Gas, or F-gas, regulations recently adopted by the European Commission that requires continuous monitoring for comparably sized-systems (>300 kg [approximately 660 pounds] refrigerant charge).[21]

ARB staff concluded that 2,000 pounds is a more appropriate threshold. The greatest risk for large refrigerant leaks is from large systems used for cold storage and process cooling. These risks are derived from the large refrigerant charge sizes contained within these systems and, in some cases, high existing refrigerant leak rates. See Appendix B for a detailed review of existing refrigerant leak rates.

[21] Official Journal of the European Union, REGULATION (EC) No 842/2006 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 May 2006 on certain fluorinated greenhouse gases, http://www.fluorocarbons.org/documents/library/Legislation/JO_L161_1_842_2006_Regulation.pdf, (accessed September 3, 2009).

Further, ARB believes that it is more appropriate to require continuous monitoring for systems that are operating year-round, and not for systems that operate on a seasonal or intermittent cycle. For these latter systems, leak inspections are required any time the system is re-activated and quarterly thereafter, rather than requiring an automatic leak detection system.

Requiring all refrigeration systems with more than 600 pounds of high-GWP refrigerant charge to be fitted with an automatic leak detection system would have a total net cumulative cost of $255 million for 10 years, an increase of $443 million (difference between a net savings of $188 million in the Regulation and a net cost of $255 million in this alternative) ($46 million increase in 2020) over the proposed Regulation. The cost effectiveness of the proposed regulation would change from a savings of $2 per $MTCO_2E$ to cost of $3 per $MTCO_2E$.

Include all Refrigeration and Air-conditioning Systems

Staff considered including all stationary, non-residential R/AC appliances containing more than 50 pounds of a high-GWP refrigerant. Staff received comments that the emissions profiles of refrigeration and air-conditioning systems as two distinct sectors were quite different and that it would result in very different impacts in regards to cost-effectiveness and emission reductions. Staff obtained additional data that addressed these concerns.

Table XIII clearly illustrates why staff concluded that refrigeration systems should be the focus of the proposed Regulation. A regulation focused on refrigeration will include an estimated 26,000 facilities to address 2020 BAU emissions of 15.8 $MMTCO_2E$ and reduce emissions by about 8.1 $MMTCO_2E$ of GHG, including Kyoto and non-Kyoto GHG. Including air-conditioning systems at a similar cost structure per facility would expand the scope of the program by including 23,000 more facilities to address 2020 BAU emissions of 1.4 $MMTCO_2E$ while only providing additional emission reductions of 0.5 $MMTCO_2E$.

Table XIII. Refrigeration and Air-Conditioning GHG Emission Profiles Summary

R/AC System Charge Size	Estimated Facilities	Estimated 2020 BAU Emissions (MMTCO2E)	Potential 2020 Emission Reductions (MMTCO2E)
	REFRIGERATION		
Small Refrigeration Systems	~ 15,500	1.4	0.9
Medium Refrigeration Systems	~ 8,500	7.9	3.3
Large Refrigeration Systems	~ 2,000	6.5	3.9
Total Facilities with Refrigeration Systems	~ 26,000	15.8	8.1

R/AC System Charge Size	Estimated Facilities	Estimated 2020 BAU Emissions (MMTCO2E)	Potential 2020 Emission Reductions (MMTCO2E)
	AIR CONDITIONING		
Small Air-Conditioning Systems	~ 14,000	0.7	0.4
Medium Air-Conditioning Systems	~ 6,300	0.3	0.1
Large Air-Conditioning Systems	~ 2,700	0.4	*0.0
Total Facilities with Air-Conditioning Systems	~ 23,000	1.4	0.5

Notes:
Totals may not sum due to rounding.
* See Appendix B for detailed discussion of estimates.

The difference in the emission profile between refrigeration and air-conditioning systems would have a significant impact on cost-effectiveness.

It was found that including these systems would result in an estimated net cumulative cost of the Regulation of $57 million in 10 years; an increase of $245 million (difference between a net savings of $188 million in the Regulation and a net cost of $57 million in this alternative) ($26 million increase in 2020) over the proposed Regulation.

The majority of these systems are either small tightly sealed systems or chiller systems which, as a group, have very low leak rates. Annual emissions reductions as a result of including air-conditioning systems were approximately 0.5 $MMTCO_2E$ greater than the current proposal. The cost effectiveness of the proposed regulation including all R/AC systems would change from a savings of $2 per $MTCO_2E$ to cost of $1 per $MTCO_2E$, but the cost-effectiveness in the year 2020 specific to the approximately 23,000 facilities with only air-conditioning appliances would be approximately $43 per additional $MTCO_2E$ reduced.

Leak Repair Limit

The proposed Regulation will require repair of any refrigerant leak in a stationary refrigeration system with a full charge of more than 50 pounds of high-GWP refrigerant. ARB staff also considered adoption of the current U.S. EPA requirement that repairs be made when the annual leak rate of ODS refrigerant exceeds 35 percent in commercial or industrial refrigeration appliances, or 15 percent for comfort cooling appliances.

ARB staff chose not to propose a leak rate trigger for a number of reasons. First, ARB staff believes that any detected refrigerant leak should be investigated and repaired. Although one indication of a refrigerant leak is the need to add refrigerant, adding refrigerant alone does not confirm a leak. If refrigerant is required, it should be assumed that the system is leaking, and a leak inspection should be conducted. Exceptions to this general rule are additions of refrigerant required for seasonal adjustment, or an additional refrigerant charge into a R/AC appliance evacuated for repair.

Second, ARB staff believes that calculating an annual leak rate creates an additional compliance and recordkeeping burden that could be avoided without compromising environmental protection. For example, to determine if a leak requires repair, under the federal regulation, a refrigeration appliance owner or operator would have to calculate the leak rate based on monitoring over 12-consecutive months before adding refrigerant to an appliance. This may not be possible if there is no recorded use of refrigerant in this 12-month period. Without determining a leak rate, they would have no means of determining if the appliance's leak rate was kept beneath 35 percent, and would not know if further action was warranted.

ARB staff did consider requiring the calculation of the leak rate (as defined in CFR, Title 40, Part 82, § 82.152) upon each addition of refrigerant to the system, unless the addition is made in order to recharge refrigerant immediately following a retrofit or the addition is made as a seasonal adjustment. ARB staff views these revisions to be reasonable alternatives, but unnecessary compared to the simpler approach that is proposed.

Additionally, if the proposed Regulation allowed a 35 percent leak rate for refrigeration systems prior to leak repair, and this target leak rate applied to all systems during the year, then the GHG emission reductions compared to BAU are substantially reduced from 7.2 $MMTCO_2E$ to less than 1 $MMTCO_2E$ for Kyoto gases.

Finally, the SCAQMD Rule 1415 requires all leaks to be repaired. A similar statewide requirement would better ensure clarity and consistency with this existing program.

Banning of Non-refillable Refrigerant Cylinders

Alternatives staff reviewed specific to refrigerant cylinder are similar to concepts proposed, but not enacted, in U.S. EPA regulations. U.S. EPA regulations do not prohibit the use of non-refillable refrigerant cylinders, although this regulatory concept has been reviewed in the context of the management of 30-pound non-refillable refrigerant cylinders. Options the U.S. EPA had considered included: 1) a complete ban of non-refillable containers, 2) evacuation of cylinders, using industry guidelines, prior to disposal, and 3) a ban on importation of Class 1 ODS refrigerants in non-refillable cylinders.[22]

The banning of non-refillable cylinders could result in a GHG emission reduction benefit from refrigerant cylinders, although criteria pollutant emissions including diesel particulates from transportation may increase. Additionally, there may be other business impacts such as additional personnel injuries resulting from the use of heavier cylinders.

[22] ARI's Policy and Public Affairs - Executive Branch, http://ariadman.tempdomainname.com/ga/executive-branch/index.html, retrieved on May 13, 2008.

The banning of non-refillable cylinders would require substantial changes in the refrigerant distribution industry, and additional costs.

Placing restrictions on the sale of non-refillable cylinders would require capital expenditures for the manufacture of refillable cylinders to replace currently used non-refillable cylinders.

Based on a literature review of the U.S. market for common refrigerants such as R-22 and R-134a the total number of non-refillable cylinders sold in California is estimated at 720,000 annually. This is based on national sales estimates of one million 30-pound cylinders in the MVAC market and five million in the stationary HVAC market scaled down to the California population – 12 percent of six million 30-pound cylinders.[23] If non-refillable cylinders are banned, then these non-refillable cylinders must be replaced with refillable cylinders, which will increase manufacturing costs. These one-time replacement manufacturing costs would be recovered over time as non-refillable cylinders are manufactured each year while refillable cylinders are not required to be manufactured each year.

The proposed option would also require infrastructure development for refilling refrigerant cylinders. There is no existing data available specific to the cost of infrastructure development for cylinder refilling.

In the alternative scenario of a non-refillable cylinder ban there are other cost issues that may be a barrier. The tare weight of a 30-pound refillable cylinder may be 300 percent or greater than the tare weight of a non-refillable cylinder. Based on manufacturer data a non-refillable cylinder's tare weight would be around 6 pounds, while a refillable cylinder's tare weight may be as high as 21 pounds.[24] As the servicing locations for R/AC appliances are often up stairs or on rooftops, increased weight may increase workers' injuries or create the need for a lighter refillable cylinder, which would increase the number of times a technician may need to carry a cylinder to a servicing location. These costs are not quantified due to a lack of data, but may be extensive.

The requirement for refrigerant cylinders to be returned to a refrigerant distributor for refilling may result in additional vehicle miles traveled (VMT). Currently most refilling is completed at refrigerant manufacturing plants in southeastern United States. Until a high-GWP refrigerant refilling infrastructure is established in California VMT for refrigerant cylinders could increase substantially, requiring travel back to plants in or around Baton Rouge, Louisiana. Additionally, as refillable cylinders are heavier, the total tons per mile for local service vehicles would increase, which would increase total transportation related cost and emissions.

---

[23] Batt, J. Attachment 1: Description of Emission Reduction Measure Form, http://www.arb.ca.gov/cc/scopingplan/submittals/other/carb_solicitation_for_ideas_use_of_refillable_refrigerant_cylinders.pdf, (accessed March 16, 2009.

[24] Based on cylinder specifications from Amtrol Inc., http://www.amtrol.com/pdf/refrigrec.pdf, (accessed September 1, 2009), and Worthington Cylinders, http://www.worthingtoncylinders.com/Specifications/Refrigerant.aspx, (accessed September).

Requiring a Deposit on Non-refillable Refrigerant Cylinders

ARB staff considered requiring a $35 deposit on all non-refillable cylinders to ensure they are returned to a distributor for final evacuation and disposal.

The ARB received stakeholder comments and concerns regarding the need to understand the entire life cycle emissions and related transportation emissions associated with requiring a $35 deposit on non-refillable cylinders. There were concerns related to potential increases in GHG emissions related to increased transportation while transporting empty cylinders back to a central site.

Additionally, the distribution network currently is not developed to collect and process these cylinders for recycling or disposal, so the concept may result in third party contracts with other companies to provide this service. This service would require additional transportation from a refrigerant distributor to a third party service contractor facility.

The proposed alternative regulatory option would require infrastructure development for refrigerant cylinder evacuation and final recycling or disposal.

Prior to recommending any final action specific to a requirement to use refillable cylinders or to place a deposit on non-refillable cylinders, the total lifecycle GHG emissions impact of refrigerant cylinders including direct heel emissions as well as indirect emissions related to increased VMT must be further reviewed. ARB staff will continue to conduct research in this area and work with industry to find additional regulatory or voluntary solutions that will have a net GHG emissions reductions impact.

Analysis to estimate the cost, emissions, and potential emission reductions related to refrigerant cylinder management is a component of a research contract approved by the ARB with ICF International to investigate the costs and benefits of recovering and destroying or recycling high-global warming potential greenhouse gases. The contract began in June 2008, and is titled “Lifecycle Analysis of High-Global Warming Potential Greenhouse Gas Destruction”. A final report is expected in late 2010.

Requiring new commercial and industrial refrigeration systems to meet specified performance standards.

ARB staff considered including general requirements for specification for new commercial and industrial refrigeration to reduce leaks and to increase energy efficiency. The alternative considered would have required that: 1) a facility with a new commercial and industrial refrigeration system use best available refrigeration technology - defined as any available technology used in a commercial refrigeration system that has a maximum refrigerant charge equivalent to 1.75 pounds of high-GWP refrigerant per 1000 British Thermal Units (Btu) per hour, or 2) a facility be designed to have a “total carbon footprint” 25 percent less than a specified baseline facility carbon footprint.

Emissions from commercial and industrial refrigeration systems are categorized as direct refrigerant emissions and indirect emissions (CO_2-equivalent emissions resulting from energy use). Commercial and industrial refrigeration systems exist in California, ranging from small, tightly sealed refrigerators to large direct expansion (DX) refrigeration systems containing hundreds or thousands of pounds of refrigerant. This measure was proposed to apply to a portion of new commercial and industrial refrigeration systems, including large DX refrigeration systems used in supermarkets, cold storage warehouses, and industrial processes, including food processing.

Staff concluded that a more holistic look at both direct and indirect emissions is the most appropriate way to ensure the greatest impact on GHG emission reduction benefits. To accomplish this the ARB and California Energy Commission (CEC) are collaborating to incorporate the new commercial and industrial refrigeration systems specifications based on direct GHG emission reductions and whole-building energy efficiency in the next phase of updates to the California Building Standards Code (Title 24).

A significant focus of the California Building Standards Code approach is to allow flexibility as long as a specific performance standard is met in the form of an energy budget. Energy use has a significant impact on the Life Cycle Climate Performance (LCCP) of a refrigeration system and buildings. One concept that will be reviewed in this process is the integration of a building energy budget and direct refrigerant emission impacts – or a building's LCCP.

To better understand the balance of direct and indirect emissions in terms of LCCP the ARB entered into a contract to inventory the direct and indirect GHG emissions from stationary refrigeration sources. The Final Report titled "Inventory of Direct and Indirect GHG Emissions from Stationary Air Conditioning and Refrigeration Sources, with Special Emphasis on Retail Food Refrigeration and Unitary Air Conditioning" is available at: **http://www.arb.ca.gov/cc/commref/commref.htm**.

Additional research is under consideration by the ARB titled, "Greenhouse Gas Performance Analysis for Commercial Buildings with Large Refrigeration/Air Conditioning Systems" to initiate a review of possible performance specifications.

Requirements for Best Practices Certified Technician Program

During the rulemaking process for the Refrigerant Management Program staff received comments regarding the need for better technician training. This need was discussed in detail with trade associations representing heating and air-conditioning equipment distributors and refrigeration and air-conditioning service contractors.

In reviewing the potential for a Best Practices Certified Technician regulatory or voluntary component it is important to note that there is already some activity in this general work area, although it is specific to energy efficiency. As a result of work being conducted by the California Public Utilities Commission (CPUC) and CEC, an HVAC Technician subcommittee has been created to discuss technician

training opportunities to increase energy efficiency. Any further activity to address a potential Best Practices Certified Technician program would need to be in collaboration with the HVAC Workgroup to avoid duplication.

The general concept of a potential Best Practices Certified Technician regulatory or voluntary component would be based on the following principles:

- All certified technicians are to be certified to understand best practices to reduce refrigerant emissions as outlined in ANSI/ASHRAE standard 147, or similar standards or guidelines.
- Certification is developed by the current network of HVAC & Refrigeration training programs in California; there are currently 52.
- The ARB role is to certify/approve a training program training and certification plan for each institution.

J. Plans for the Future

Plans for the future include consulting with current technical workgroup members on the possibility of establishing regulatory and/or voluntary programs specific to two alternatives considered that would serve to complement the Refrigerant Management Program:

1. Requiring new commercial and industrial refrigeration systems to meet specified performance standards
2. Requirement for Best Practices Certified Technician Program

As discussed previously, the new commercial and industrial refrigeration systems performance standards will be coordinated with the CEC. The Potential Best Practices Certified Technician program option will be important to ensuring that the emission reductions anticipated from the proposed Refrigerant Management Program are realized.

These two components will be important in furtherance of achieving the total statewide emission reductions target, but they will be considered separately from the proposed Refrigerant Management Program.

Additional plans for the future include a proposed high-GWP mitigation fee. The Climate Change Scoping Plan recommends applying a mitigation fee to high-GWP compounds with high potency, such as high-GWP refrigerants. High-GWP gases are used in a broad range of applications, including significant usage in stationary HVAC, MVAC, and refrigeration. High-GWP gases are also used in a wide range of other applications, such as foam-blowing agents, electrical transmission, fire suppressants, consumer products, and the semiconductor industry. In concept, a mitigation fee would address all high-GWP gases in a consistent manner and serve to decrease GHG emissions in several ways. It could change behavior by increasing price (e.g. improve leakage reduction efforts), induce new lower GWP alternative products, or provide fees to mitigate GHG emissions elsewhere within or outside of a given sector. The mitigation fee approach would be used to address emissions that are difficult to address via

traditional regulatory approaches due to 1) many small uses that would require complicated regulations, 2) new gases and new or evolving usages, and 3) uses with no current alternative and a lack of incentive to either develop an alternative or reduce leakage beyond regulatory standards. High-GWP specific fees are already in place in several other countries including Australia, Norway, and Denmark.

If a mitigation fee is applied to high-GWP gases in the future, it would be harmonized with this Regulation. This may include the deletion of the implementation fee if a potential high-GWP fee would fully fund required enforcement and administration costs to ensure the emission reductions anticipated from the Refrigerant Management program are maintained.

XI. CONCLUSIONS AND RECOMMENDATIONS

ARB staff proposes a new regulation to address GHG emissions attributable to stationary R/AC appliances, with a focus on stationary, non-residential refrigeration systems.

The proposed Regulation fulfills the requirements applicable to AB 32 direct emission reduction measures to “achieve the maximum technologically feasible and cost-effective reductions in greenhouse gas emissions” and helps meet the goals of reducing GHG emissions to 1990 levels by 2020.

No alternatives considered by the Board would be more effective in achieving the goals of this proposal, nor would they be less burdensome to facilities that use refrigeration systems.

Staff recommends that the Board approve its proposal to adopt Sections 95380 through 95398 of title 17, California Code of Regulations.

This page is intentionally left blank

XII. REFERENCES

Air-Conditioning, Heating and Refrigeration Institute, Certified Product Directory, January 2009, http://www.ahridirectory.org/ahridirectory/pages/rrr/RRRE%2015%20January%2009_Directory.pdf, retrieved April 7, 2009.

Air-conditioning and Refrigeration Institute, Policy and Public Affairs - Executive Branch, http://ariadman.tempdomainname.com/ga/executive-branch/index.html, retrieved on May 13, 2008.

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. User's Manual for ANSI/ASHRAE Standard 15-2001 Safety Standard for Refrigeration Systems, 2003.

Amtrol, Inc. Refrigerant Recovery Cylinders, http://www.amtrol.com/pdf/refrigrec.pdf, retrieved September 14, 2009.

ARMINES, Inventory of Direct and Indirect GHG Emissions from Stationary Air conditioning and Refrigeration Sources, with Special Emphasis on Retail Food Refrigeration and Unitary Air conditioning, Final Report, March 2009.

Batt, J. Attachment 1: Description of Emission Reduction Measure Form, http://www.arb.ca.gov/cc/scopingplan/submittals/other/carb_solicitation_for_ideas_use_of_refillable_refrigerant_cylinders.pdf, retrieved March 16, 2009.

British Refrigeration Association, Code of Practice for Refrigerant Leak Tightness in compliance with the F-Gas Regulation, December 2007.

California Air Pollution Control Officers Association, Memo to Anthony Andreoni, November 4, 2008.

California Air Resources Board, Fact Sheet – The Greenhouse Effect and California. http://www.arb.ca.gov/cc/factsheets/ccbackground.pdf. Accessed September 14, 2009.

California Air Resources Board, Climate Change Scoping Plan, December 2008.

California Air Resources Board, Climate Change Scoping Plan Appendices, VOLUME I: SUPPORTING DOCUMENTS AND MEASURE DETAIL, December 2008.

California Air Resources Board, Refrigerant Management Best Practices, July 21, 2009, http://www.arb.ca.gov/cc/reftrack/best_management_practices_pamphlet_electronic_version.pdf

California Air Resources Board, Refrigerant Management Program Frequently Asked Questions, July 21, 2009, http://www.arb.ca.gov/cc/reftrack/refrigerant_management_program_faq.pdf

California Air Resources Board. Refrigerant Management Program. Technician survey results. December 2008.

California Air Resources Board, STAFF REPORT: INITIAL STATEMENT OF REASONS FOR RULEMAKING PROPOSED REGULATION FOR MANDATORY REPORTING OF GREENHOUSE GAS EMISSIONS PURSUANT TO THE CALIFORNIA GLOBAL WARMING SOLUTIONS ACT OF 2006 (ASSEMBLY BILL 32), October 2007.

California Climate Change Center, Projecting Future Sea Level, March 2006.

California Employment Development Department, "Training Program Summary," http://www.labormarketinfo.edd.ca.gov/cgi/dataBrowsing/traProgramSummary.asp?menuChoice=&cipcode=150501&geogArea=0601000000, retrieved July 15, 2008.

California Energy Commission, California Commercial End-Use Survey (CEUS), March 2006. http://www.energy.ca.gov/ceus/ (accessed August 27, 2009).

California Environmental Protection Agency and California Resources Agency, Environmental Protection Indicators for California, 2004 update.

Energy Information Administration, Commercial Buildings Energy Consumption Survey (CBECS), 2003, http://www.eia.doe.gov/emeu/cbecs/

Energy Information Administration. Commercial Buildings Energy Consumption Survey (CBECS). Heating Equipment, Number of Buildings for Non-Mall Buildings. 2003. http://www.eia.doe.gov/emeu/cbecs/

Enhanced Capital Allowances, ECA ENERGY TECHNOLOGY CRITERIA LIST 2008 – REFRIGERATION EQUIPMENT Automated Permanent Refrigerant Leak Detection Systems, July 29, 2008, http://www.eca.gov.uk/NR/rdonlyres/286051AC-63CC-4199-BF20-7A083E220070/0/08Refrigeration_AutomatedPermanentRefrigerantLeakDetectionSystems.pdf, retrieved February 24, 2009.

European Fluorocarbons Technical Committee, Fluorocarbons and Sulphur Hexafluoride, http://www.fluorocarbons.org/en/debate/regulatory_developments/f_gas_regulation.html, (accessed September 24, 2009)

Godwin, D. (U.S. EPA), Martin Van Pelt, M. and Peterson, K. (ICF Consulting), Modeling Emissions of High Global Warming Potential Gases from Ozone Depleting Substance Substitutes, 2003. http://www.epa.gov/ttn/chief/conference/ei12/green/godwin.pdf, retrieved December 1, 2008.

ICF International, Memo to ARB, October 21, 2008.

ICF International, Memo to ARB, November 10, 2008.

Intergovernmental Panel on Climate Change and Technology and Economic Assessment Panel, Special Report on Safeguarding the Ozone Layer and the Global Climate System, Issues related to Hydrofluorocarbons and Perfluorocarbons, 2005.

http://www.ipcc.ch/publications_and_data/publications_and_data_reports_safeguarding_the_ozone_layer.htm (accessed September 24, 2009)

Intergovernmental Panel on Climate Change, Climate Change 2007: The Physical Science Basis, Chapter 2, Changes in Atmospheric Constituents and in Radiative Forcing, IPCC Working Group 1 Fourth Assessment Report, 2007, http://www.ipcc.ch/ipccreports/ar4-wg1.htm

Intergovernmental Panel on Climate Change, Climate Change 2001: The Scientific Basis, Chapter 6, Radiative Forcing of Climate Change, IPCC Working Group 1 Third Assessment Report, 2001. http://www.grida.no/publications/other/ipcc_tar/ (accessed January 28, 2009).

Intergovernmental Panel on Climate Change, Climate Change 1995: IPCC Second Assessment, 1995, http://www1.ipcc.ch/ipccreports/assessments-reports.htm

Intergovernmental Panel on Climate Change 2006 Guidelines for National Greenhouse Gas Inventories, Volume 3 (Industrial Processes and Product Use). http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol3.html (accessed July 6, 2009).

Lewis, Kimberly, Guidelines for Refrigerant Leak Monitor Installation, RSES Journal, April, 2002.

Official Journal of the European Union, REGULATION (EC) No 842/2006 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 May 2006 on certain fluorinated greenhouse gases.

South Coast Air Quality Management District (SCAQMD) Rule 1415 (Reduction of Refrigerant Emissions from Stationary Refrigeration and Air Conditioning Systems) dataset, 2000-2005.

Stouffer, D., Refrigerant Leak Creates Environmental Problems for Businesses, February, 2009, available at: http://air.environmental-expert.com/resultEachArticle.aspx?cid=32055&codi=45718&idproducttype=6, retrieved March 9, 2009.

Troy, Eugene F, Options for Reducing Refrigerant Emissions from Supermarket Systems, EPA-600/R-97-039, April 1997.

United Nations Environment Programme 1998 Report of the Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee, October 1998; Annex III-Refrigerant Data. http://ozone.unep.org/teap/Reports/RTOC/index.shtml (accessed September 30, 2009).

United Nations Environment Programme 2006 Report of the Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee, January 2007. http://ozone.unep.org/teap/Reports/RTOC/index.shtml (accessed September 30, 2009).

U.S. Census Bureau censtats (census statistics) database: http://censtats.census.gov/cbpnaic/cbpnaic.shtml (Accessed August 17, 2009).

U.S. Census Bureau North American Industrial Classification System (NAICS) code guide. http://www.census.gov/eos/www/naics/ (accessed August 17, 2009).

U.S. EPA Vintaging Model national greenhouse gas emission estimates, 2010-2030; November 2008

U.S. EPA Vintaging Model refrigerant distribution for refrigeration equipment, 2010 and 2020, November 2008.

U.S. EPA Vintaging Model Alternative Fluorocarbons Environmental Acceptability Study Comparison for Common Refrigerants, April 2007.

J.M. Velders, S.O. Andersen, J.S. Daniel, D.W. Fahey, and M. McFarland, The importance of the Montreal Protocol in protecting climate, Proc. Natl. Acad. Sci. USA, March 2007.

J.M. Velders, D.W. Fahey, J.S. Daniel, M. McFarland, and S.O. Andersen, The large contribution of projected HFC emissions to future climate forcing, Proc. Natl. Acad. Sci. USA, June 2009.

Worthington Industries, Refrigerant Cylinders, http://www.worthingtoncylinders.com/Specifications/Refrigerant.aspx, retrieved September 14, 2009.