Chapter 11 Direct Fugitive Emissions

Who should read Chapter 11:

Chapter 11 applies to organizations with fugitive emissions only.

What you will find in Chapter 11:

This chapter provides guidance on determining direct fugitive emissions, specific guidance and an example on fugitive refrigerant emissions of HFCs, and guidance on additional resources to use for other fugitive emissions.

Information you will need:

To complete this chapter you will need information on the types and quantities of air conditioning equipment, total refrigerant charge, annual leak rates, and the types of refrigerant, as applicable.

Cross-References:

See Chapter 5 on De Minimis Emissions and Significance in estimating HFCs from refrigerants.

Power companies and utilities should refer to the Power/Utility Protocol for guidance on accounting for fugitive emissions associated with electricity transmission and distribution, fuel handling and storage, air conditioning and refrigerant systems, and fire suppression equipment.

The majority of fugitive GHG emissions are specific to various industrial sectors or processes, including: manufacturing, natural gas transport and distribution, coal mining, waste management, wastewater treatment, and refrigerant leakage from air conditioning and refrigeration equipment. This chapter provides specific guidance on direct fugitive emissions from air conditioning, refrigeration, and fire suppression systems below. It also provides a list of resources for calculating other types of fugitive emissions.

III.11.1 Calculating Direct Fugitive Emissions from Refrigeration Systems

Leakage from refrigeration systems, such as air conditioners and refrigerators, is common across a wide range of entities. Only those refrigerants that contain or consist of compounds of the required GHGs should be reported (see Table III.11.1). Hydrofluorocarbons (HFCs) are the primary GHG of concern for refrigeration systems, particularly for motor vehicle air conditioners. Today, HFC-134a is the standard refrigerant for mobile air conditioning systems. For most California Registry participants, emissions of HFCs from refrigeration, air conditioning systems, and fire suppression equipment will be negligible in comparison to other GHG emissions.

Table III.11.1 HFCs and PFCs to be Reported

HFC-23	HFC-143a	HFC-4310mee	C_4F_{10}
HFC-32	HFC-152a	CF_4	C_6F_{14}
HFC-125	HFC-227ea	C_2F_6	
HFC-134a	HFC-236fa	C_3F_8	

Source: U.S. Environmental Protection Agency, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2003, Table 1-2 (April 2005).

Please note that many common refrigerants are blends of multiple HFCs. Table III.11.2 provides some examples of refrigerant blends and their composition. When calculating the emissions related to refrigerant blends, these blends must be broken down and reported as their constituent parts.

Table III.11.2 Composition of Refrigerant Blends

Blend	HFC 32	HFC-125	HFC-134a	HFC-143a
R404A	NA	44%	4%	52%
R407C	23%	25%	52%	NA
R507	NA	50%	NA	50%
R507	NA	50%	NA	50%

Use the following three step process to calculate HFC emissions:

1. Determine whether HFC emissions are significant or de minimis (see Chapter 5 for guidance on de minimis);
2. Perform a mass balance calculation; and
3. Convert each HFC emission to CO_2e.

Table III.11.3 Loss Rates for Refrigeration and Air Conditioning Equipment
Note that all values are estimates and are intended only to serve as guidelines for evaluating de minimis.

Type of Equipment	Capacity (kg)	Annual Loss Rate (% of capacity)
Domestic Refrigeration	0.05 – 0.5	0.5%
Stand-alone Commercial Applications	0.2 – 6	15%
Medium & Large Commercial Refrigeration	50 – 2,000	35%
Transport Refrigeration	3 – 8	50%
Industrial Refrigeration (including food processing and cold storage)	10 –10,000	25%
Chillers	10 – 2,000	15%
Residential and Commercial A/C (including heat pumps)	0.5 – 100	10%
Mobile Air Conditioning	0.5 – 1.5	20%

Source: IPCC, Guidelines for National Greenhouse Gas Inventories (2006), Volume 3: Industrial Processes and Product Use, Table 7.9.

Step 1 estimates whether your fugitive emissions are significant and warrant a more comprehensive review. If the fugitive emissions are not significant, and you wish to categorize them as de minimis, you do not need to complete this section. To perform the significance analysis, you will need information on:

- The types and quantities of air conditioning and refrigeration equipment;
- The total refrigerant charge;
- The annual leak rates; and
- The types of refrigerant.

If you find that your fugitive emissions are indeed significant, continue to Steps 2 and 3 for a more accurate quantification of HFC emissions.

Step 1: Determine whether HFC emissions are significant or de minimis.

This step helps organizations roughly estimate emissions and determine whether HFC emissions are significant or de minimis. Consistent with the California Registry's definition of significance, fugitive HFC emissions greater than or equal to 5% of a participant's total emissions are considered significant, assuming the participant has no other de minimis emissions. Fugitive emissions less than 5% can be considered de minimis, and should be reported as such. However, if fugitive emissions are considered substantial and possibly significant, then a more comprehensive and accurate mass balance approach is required to determine actual emissions.

Ozone Depleting Refrigerants and Climate Change

Did you know that not all refrigerants that affect climate change are considered greenhouse gas emissions? A number of widely-used refrigerants, including R-22 (more commonly known as Freon), are classified as ozone depleting substances (ODS) and are being phased out under the Montreal Protocol, an international treaty designed to protect the ozone layer that entered into force in 1989. While these substances do have a global warming potential, and therefore contribute to climate change, they are not classified as greenhouse gas emissions under the Kyoto Protocol because they are already being phased out under the Montreal Protocol.

When assessing your fugitive emission sources, please keep in mind that CFCs and HCFCs, including Freon, should not be included in your emissions report. You should only include emissions of the HFCs and PFCs listed in Table III.11.1 in this chapter. For more information on ozone-depleting substances and the Montreal Protocol, visit EPA's ozone depletion website at www.epa.gov/ozone/strathome.html.

To estimate emissions using this estimation method, follow these three steps:

- Determine the types and quantities of refrigerants used;
- Estimate annual emissions of each type of HFC; and
- Convert to units of carbon dioxide equivalent and determine total HFC emissions.

Determine the types and quantities of refrigerants used.

To estimate emissions, you must determine the number and types of refrigeration and air conditioning equipment, by equipment category; the types of refrigerant used; and the refrigerant charge capacity of each piece of equipment. If you do not know the refrigerant charge capacity of each piece of equipment, use the upper bound of the range provided by equipment type in Table III.11.3.

Estimate annual emissions of each type of HFC.

For each type of HFC, use Equation III.11a to estimate annual emissions. Default loss rates are provided in Table III.11.3 by equipment type.

Equation III.11a	HFC Emissions from Refrigerant Leakage			
HFC Emissions from Refrigerant Leakage (kg)	=	Total Annual Refrigerant Charge (kg)	x	Assumed Annual Leak Rate (%)

Convert HFCs to carbon dioxide equivalent.

Use the IPCC Second Assessment Report global warming potential factors from Table C.1, Appendix C to convert HFCs to carbon dioxide equivalent. If the sum of the CO_2e emissions for HFCs (plus other estimated de minimis emissions) is less than 5% of total assumed emissions, report these emissions as de minimis; no further calculations are needed.

Proceed to Steps 2-3 if your HFCs are significant.

Step 2: Mass Balance Calculation: Determine base inventory for each HFC and calculate changes to base inventory.

Step 2 utilizes a comprehensive, mass balance approach to accurately determine HFC emissions. Essentially, the mass balance method works by starting with a base inventory of all HFCs in use, and adjusts that total based on purchases and sales of HFCs, and changes to the total refrigerant charge remaining in the equipment. The used HFCs that cannot be accounted for are assumed to have been emitted to the atmosphere. The four elements of these adjustments and changes are described here, with references to Tables III.11.4 and III.11.5, as applicable.

Base Inventory. The first step in calculating HFC emissions is to determine the difference between the quantity of the HFC in storage at the beginning of the year **(A)** and the quantity in storage at the end of the year **(B)**, as shown in Table III.11.4. Note, this quantity will be negative if the inventory increases over the course of the year. Those HFCs contained in cylinders and other storage containers are considered to be HFCs "in inventory"—not HFCs held in operating equipment.

Table III.11.4 Base Inventory

Inventory		Amount (kg)
A	Beginning of year	
B	End of year	

Table III.11.5 Inventory Changes

Inventory		Amount (kg)
Additions to Inventory		
1	Purchases of HFCs (including HFCs in new equipment)	
2	HFCs returned to the site after offsite recycling	
C	Total Additions (1+2)	
Subtractions from Inventory		
3	Returns to supplier	
4	HFCs taken from storage and/or equipment and disposed of	
5	HFCs taken from storage and/or equipment and sent offsite for recycling or reclamation	
D	Total Subtractions (3+4+5)	
Change to Full Charge/Nameplate Capacity		
6	Total full charge of new equipment	
7	Total full charge of retiring equipment	
E	Change to nameplate capacity (6-7)	

Additions and subtractions refer to HFCs placed in or removed from the stored inventory, respectively. The next items in calculating HFC emissions include purchases or acquisitions of refrigerant, sales or disbursements of refrigerant, and any changes to total full charge of refrigeration equipment.

Purchases/Acquisitions of Refrigerant. This is the sum of all the HFCs acquired during the year either in storage containers or in equipment **(C)**, as shown in Table III.11.5.

Sales/Disbursements of Refrigerant. This is the sum of all the HFCs sold or otherwise disbursed during the year either in storage containers or in equipment **(D)**, as shown in Table III.11.5.

Change to Total Full Charge of Equipment. This is the net change to the total equipment volume for a given HFC during the year **(E)**, as shown in Table III.11.5.

Note that the change to total full charge of equipment refers to the full and proper charge of the equipment rather than to the actual charge, which may reflect leakage. It accounts for the fact that if new equipment is purchased, the HFC that is used to charge that new equipment should not be counted as an emission. On the other hand, it also accounts for the fact that if the amount of refrigerant recovered from retiring equipment is less than the full charge, then the difference between the full charge and the recovered amount has been emitted. Note that this quantity will be negative if the retiring equipment has a total full charge larger than the total full charge of the new equipment.

To sum the total annual emissions of each type of HFC, use Equation III.11b.

Equation III.11b	Total Annual Emissions from Refrigerant Leakage
Total Annual Emissions	= A - B + C - D + E

Step 3: Convert HFC emissions to CO_2e (and convert to metric tons) and sum all subtotals.

Finally, use the IPCC Second Assessment Report global warming potential factors from Table C.1, Appendix C to convert each HFC to carbon dioxide equivalent, and sum the totals.

III.11.2 Fugitive Emissions from Fire Suppression Equipment

Your organization may use HFCs in its fire suppression equipment, including hand-held fire extinguishers. HFCs are the most widely employed replacements for Halon 1301 in total flooding applications, and are also employed as replacements for Halon 1211 in streaming applications. Since the production and sale of halons were banned in the United States in 1994, these non-ozone depleting extinguishing agents have emerged as the halon replacement agent of choice in some applications.

As fire protection equipment is tested or deployed, emissions of these HFCs are released. Thus, if you own or operate fire suppression systems and equipment and have tested or deployed these systems, you should assess whether any HFCs have been released. The mass balance approach described in Section III.11.1 can be used for determining emissions from fire suppression systems.

III.11.3 Other Fugitive Emissions

A variety of useful resources exist that may help you to calculate other fugitive emissions. The California Registry recommends reviewing relevant methodologies and/or calculations with technical assistance providers or other environmental experts.

Verification of fugitive emissions will be determined by the expertise and professional judgment of the verifier. Should you have questions about criteria or questions about a verifier's judgments during the verification cycle, you can contact the California Registry at any time.

The following is a list of resources for use in making your calculations:

- Local Government Operations Protocol, California Climate Action Registry. This protocol provides guidance on reporting methane emissions from solid waste facilities and methane and nitrous oxide emissions from wastewater facilities (www.climateregistry.org).
- Corporate GHG Accounting Calculation Tools, prepared under the GHG Protocol Initiative by the World Resources Institute and World Business Council for Sustainable Development (2004) (www.ghgprotocol.org/standard/tools.htm).
- Guidelines for the Measurement and Reporting of Emissions in the UK Emissions Trading Scheme, prepared by the U.K. Department for Environment, Food and Rural Affairs (August 2001) (www.defra.gov.uk/environment/climatechange/trading).
- EPA Climate Leaders Inventory Protocol, U.S. Environmental Protection Agency (in development as of August 2002). EPA's protocol includes core modules addressing methane emissions from solid waste disposal at landfills as well as HFC emissions from refrigeration/air conditioning use (www.epa.gov/climateleaders/index.html).

- Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2000, U.S. Environmental Protection Agency (April 2002) (www.epa.gov/globalwarming/publications/emissions/us2002/index.html).
- Inventory of California Greenhouse Gas Emissions and Sinks: 1990-1999, prepared by the California Energy Commission, November 2002 (www.energy.ca.gov/global_climate_change).
- American Petroleum Institute, Compendium of Greenhouse Gas Emissions Estimation Methodologies for the Oil and Gas Industry (2001).
- Guidance to the California Climate Action Registry: General Reporting Protocol, Appendix B and Appendix C, prepared by the California Energy Commission, P500-02-005F (June 2002), located at www.climateregistry.org. The following list of citations provide some guidance on quantifying direct fugitive emissions:
  - CH_4 emissions from coal mining: Appendix B page B-5, Appendix C page C-3
  - CH_4 emissions from natural gas systems: Appendix B page B-15, Appendix C page C-9
  - CH_4 emissions from petroleum systems: Appendix B page B-17, Appendix C page C-9
  - SF_6 emissions from electricity transmission and distribution equipment: Appendix B page B-6, Appendix C page C-4
  - N_2O emissions from wastewater: Appendix B page B-9
  - CH_4 emissions from wastewater: Appendix B page B-15
  - CH_4 emissions from landfills: Appendix B page B-10
  - N_2O emissions from agricultural soil management: Appendix B page B-2
  - CH_4 emissions from livestock as a result of enteric fermentation: Appendix B page B-7
  - CH_4 and N_2O emissions from manure management: Appendix B page B-13
  - CH_4 emissions from rice cultivation: Appendix B page B-18

III.11.4 Example: Direct Fugitive Emissions from Refrigeration Systems

Produce Chillers, Inc.

Produce Chillers, Inc. is based in California, and operates three large commercial refrigeration units, with an annual capacity of 1,225 kg HFC-23 per system, to refrigerate vegetable produce shortly after harvest, as well as three trucks that use HFC-134a for air conditioning.

Step 1: Determine whether HFC emissions are significant or de minimis.

Produce Chillers' first step is to determine whether its HFC emissions are significant. The upper bound loss rates for Produce Chiller's AC types are shown in Table III.11.3 and the excerpt below.

Air Conditioner Loss Rates for Produce Chillers, Inc.

Type of Equipment	Capacity (kg)	Annual Loss Rate (% of capacity)	Type of Refrigerant
Medium & Large Commercial Refrigeration	50 – 2,000	35%	HFC-23
Mobile Air Conditioning	0.5 – 1.5	20%	HFC-134a

Produce Chillers then uses Equation III.11a to estimate assumed HFC emissions from air conditioning and refrigeration.

Equation III.11a	Assumed HFC Emissions from Annual Air Conditioning												
HFC Emissions from Annual Air Conditioning (kg)	=	Number of Systems	x	[	Total Annual Capacity (kg)	x	Operating Loss Rate (%/yr)	x	Years	]	÷	1,000	
3 Commercial Refrigeration Units	=	3	x	[	1,225	x	0.35	x	1	]	÷	1,000	= 1.286 metric tons HFC-23
3 Trucks	=	3	x	[	1.5	x	0.20	x	1	]	÷	1,000	= 0.0009 metric tons HFC-134a

Produce Chillers must then convert its assumed fugitive HFCs to CO_2e, using Equation III.6c

Equation III.6c	Converting Mass Estimates to Carbon Dioxide Equivalent				
HFC-23 metric tons of CO_2e	= 1.286 metric tons HFC-23	x	11,700 (GWP)	=	15,046.2 metric tons CO_2e
HFC-134a metric tons of CO_2e	= 0.0009 metric tons HFC-134a	x	1,300 (GWP)	=	1.17 metric tons CO_2e
			Total	=	15,047.37 metric tons CO_2e

Produce Chillers has estimated that its total entity-wide GHG emissions are 50,000 metric tons. Consequently, they may choose to report up to 2,500 metric tons (i.e., 5% of 50,000 metric tons) as de minimis emissions. Its estimated fugitive emissions of HFC-23 are found to be significant, but HFC -134a can be classified and reported as de minimis. It must now calculate its HFC-23 emissions.

Step 2: Determine base inventory for HFC-23 and calculate changes to base inventory.

Produce Chillers increased its total vegetable produce refrigeration capacity by 18% with new equipment, decommissioned one refrigeration unit for recycling, and recharged several of its refrigeration units. It also purchased a new truck in the past year. Using Table III.11.4 it shows that the inventory at the beginning of the year is 812.6 kg and at the end of the year it is 805.1 kg.

Base Inventory for Produce Chillers, Inc.
HFC-23 from Commercial Chillers

Inventory		Amount (kgs)
A	Beginning of year	812.6
B	End of year	805.1

Using its purchase and charge records, Produce Chillers calculates its total annual emissions using Table III.11.5 and Equation III.11b

Inventory Changes for Produce Chillers, Inc.
HFC-23 from Commercial Chillers

Inventory		Amount (kgs)
Additions to Inventory		
1	Purchases of HFCs (including HFCs provided by equipment manufacturers with or inside new equipment)	197.5
2	HFCs returned to the site after offsite recycling	0.0
C	Total Additions (1+2)	197.5
Subtractions from Inventory		
3	Returns of HFCs to supplier	0.0
4	HFCs taken from storage and/or equipment and disposed of	0.0
5	HFCs taken from storage and/or equipment and sent offsite for recycling or reclamation	53.3
D	Total Subtractions (3+4+5)	53.3
Change to Full Charge/Nameplate Capacity		
6	Total full charge of new equipment	19.5
7	Total full charge of retiring equipment	0.0
E	Change to nameplate capacity (6-7)	19.5

Equation III.11b	Total Annual Emissions of HFC-23 (kgs)					
Total Annual Emissions	=	A - B + C - D + E				
Total Annual Emissions HFC-23	=	812.6 – 805.1 + 197.5 – 53.3 + 19.5	=	171.2 kg HFC-23		

Step 3: Convert HFC emissions to CO_2e and convert to metric tons.

Equation III.6c	Converting Mass Estimates to Carbon Dioxide Equivalent						
Metric tons of CO_2e	=	Metric tons of GHG	x	GWP (SAR, 1996)			
HFC-23 metric tons of CO_2e	=	132.2 kg HFC-23	x	11,700 (GWP)	x	0.001 metric tons/kg	= 1.5467 metric tons CO_2e
						Total	= 1.5467 metric tons CO_2e

Chapter 12 Optional Reporting

Who should read Chapter 12:

Chapter 12 applies to all participants.

What you will find in Chapter 12:

This chapter provides resources for calculating and/or estimating emissions from sources that are not required to be reported, such as from employee commuting, business travel, waste, and more.

Information you will need:

You will need information about the size and nature of GHG emitting operations throughout your organization.

Cross-References:

It will be useful to consider your geographical and organizational boundaries addressed in Chapters 1 and 2, operational boundaries considered in Chapter 3, and all relevant quantification issues raised in Chapters 5-11.

In addition to reporting required emissions, you can also provide information to the California Registry about other activities of your organization that can help describe your entity's GHG activities and inventory.

Examples of these include:

- Renewable Energy Certificate purchases;
- Off-site waste disposal, including transport;
- Employee commuting, including business travel;
- Production of purchased raw materials, including transport;
- Product use and disposal; and
- Outsourced activities and contracting (especially if, in prior years, you generated these emissions directly).

You can also provide descriptive information about your organization's programs, projects to reduce emissions, environmental goals, and awards and choose to provide quantitative information, including reporting of emissions efficiency metrics or other indirect emissions.

A key feature of the California Registry's program is the reporting of efficiency metrics. GHG emissions are sometimes reported on a normalized basis – as a ratio – instead of, or in addition to, reporting in absolute terms.

Normalized emissions are emissions divided by some measure of output for the reporting entity. The specific output measure depends on the nature of the organization that is reporting and may range from physical units of output (e.g., pound of cement for a cement plant) to economic output (e.g., dollars of revenue for a diversified manufacturer). Reporting normalized emissions allows trends in the emissions intensity of an activity to be gauged by removing the effects of changing outputs on the results. The common term for these measures is "efficiency metrics". Sample efficiency metrics are listed in Appendix F.

III.12.1 Reasons to Report Optional Information

There are potentially many reasons to report optional information:

- To provide a more complete or descriptive picture of your organization's environmental performance.
- To centralize information pertaining to other GHG accounting programs.
- To track other internal programs to monitor GHG emissions performance related to other corporate programs.
- To provide greater public education on sources of GHG emissions.

There are no California Registry-approved protocols for reporting or verifying optional information. Even so, reporting optional sources can serve to improve your organization's understanding of its emissions and its emission performance over time.

Also, the California Registry encourages you to document and report your GHG emissions internationally in the same categories as you report your California or U.S. emissions. While international emissions cannot currently be verified with the California Registry, doing so will only increase your ability to measure and manage your total emissions.

In the process of developing industry-specific guidance, additional recommendations may be developed for optional information reported by industry.

III.12.2 Efficiency Metrics

Many organizations experience business growth and thus their total emissions may increase from year-to-year, regardless of their organization's operational efficiency. Such organizations, in addition to reporting their total

emissions, may also elect to report efficiency metrics that measure GHG emissions per unit of performance or output (e.g., lbs CO_2/ft² of office space, lbs CO_2/customer, lbs CO_2/kWh, lbs CO_2/$ of revenue, etc.). A list of some industry-specific metrics is provided in Appendix F. This information may be reported in CARROT at either the entity- or facility-level, but CARROT is not able to calculate this statistic for you.

For organizations reporting under the General Reporting Protocol, metrics are optional. As the California Registry develops its industry-specific reporting guidance, affected industries may be required to report one or more metrics appropriate to their industry; for instance, power sector companies are required to report three metrics according to the Power/Utility Protocol as well as cement companies under the Cement Protocol.

III.12.3 Other Emissions Information

When reporting information in CARROT, the tool will prompt you to provide descriptive information about your organization in the following areas:

Entity description – You can provide basic information about your organization, including size, types of business and products, number of employees, etc.

Emission management programs—In this section, you can document the efforts of your organization to monitor and evaluate how and where your organization is producing GHG emissions. This could also include a description of other GHG accounting programs to which your organization belongs.

Emission reduction goals –You can enter information on your organization's goals to decrease your emissions of GHGs.

Emission reduction projects—Until additional guidance is developed to provide standardized, verifiable accounting principles for discrete projects to reduce emissions, you can provide descriptions of specific activities, as well as provide a limited amount of statistical information.

Link to external website—You can provide a link or links to external websites that contain information about your organization.

Space constraints in CARROT may limit how much information can be entered, but you can provide your own categories and update this information from year-to-year. You can also upload related documents in CARROT and attach them to your public emissions report.

III.12.4 Optional Indirect Emissions

In addition to reporting indirect emissions from your electricity use, you are encouraged to optionally report other indirect GHGs. Examples of other sources of indirect emissions that you may choose to report include:

- Off-site waste disposal, including transport;
- Employee commuting, including business travel;
- Production of purchased raw materials, including transport;
- Product use and disposal; and
- Outsourced activities and contracting.

The California Registry is still formulating specific guidance on estimating emissions from additional indirect sources such as those listed above. However, a variety of useful resources exist that may help you to estimate emissions from these types of activities. Some of these include:

Off-site waste disposal, including transport

- EPA Climate and Waste Program, yosemite.epa.gov/oar/globalwarming.nsf/WARM?OpenForm

Employee commuting, including business travel

- Calculating GHG emissions from office-based organizations, www.ghgprotocol.org/calculation-tools and www.ghgprotocol.org/calculation-tools/service-sector
- Safe Climate, www.safeclimate.net/calculator
- Climate Care, www.climatecare.org/business

The California Registry will review optionally reported information of participants. It reserves the right to ask for appropriate modifications or removal of specific optionally reported information, if it deems such changes are necessary.

III.12.5 Biogenic Emissions

Biogenic CO_2 emissions are produced from combusting a variety of biofuels, such as biodiesel, ethanol, wood, wood waste, and landfill gas.

International consensus on the net climate impact from the combustion of these fuel sources has not yet been reached. But because of the distinction between biogenic and anthropogenic emissions, the emissions associated with the biofuels should not be included as direct stationary or mobile emissions in your inventory.

The GRP provides limited guidance on calculating and reporting biogenic emissions because participants are only required to report anthropogenic emissions in their emissions inventory. However, biogenic emissions may be reported optionally. Chapter 7 contains guidance to calculate mobile CO_2 emissions from biodiesel, and biogenic emission factors for mobile and stationary combustion are available in Appendix C, Tables C.3 and C.7, respectively, to aid in reporting these optional biogenic sources.

Please note that CH_4 and N_2O emissions from the combustion of biofuels are not considered biogenic and should be calculated and reported as part of your emissions inventory.

Part IV Completing and Submitting Your Report

Now that you have established your reporting parameters in Part II and quantified your emissions in Part III, you are ready to complete your annual GHG emissions report, verify your emissions, and submit your inventory to the California Registry.

Chapter 13, Reporting Your Emissions, describes the steps you need to follow to report your emissions using CARROT, the California Registry's online reporting tool, and the *CARROT Getting Started Guide Version 3* as well as the steps for formally registering your emissions report with the California Registry once you have received verification from a verifier.

Chapter 14, Verification, explains the verification process. This chapter includes an overview of the importance of verification, requirements for meeting verification standards, the process for identifying and working with verifiers, documentation and other items you will need to prepare for verification, the reports you and the California Registry will receive at the conclusion of the process, and the process for correcting your emissions report, if necessary.

Chapter 13 Reporting Your Emissions

Who should read Chapter 13:

Chapter 13 applies to all participants.

What you will find in Chapter 13:

This chapter provides guidance on submitting your emissions report to and accessing your report from the California Registry.

Information you will need:

In order to submit your GHG emissions report, you will need a password from the California Registry, as well as all the relevant information required in your report.

Cross-References:

It may be useful to review the requirements in Chapter 14 on Verification.

Now that you have established your reporting parameters in Part II and quantified your emissions in Part III, you are ready to report your emissions to the California Registry using the California Registry's online reporting tool, CARROT.

IV.13.1 Submitting Your Report Using CARROT

You must report your organization's annual GHG emissions report via the California Registry's web-based reporting application and database, known as the Climate Action Registry Reporting Online Tool (CARROT).

CARROT has four main functions:

1. Helps California Registry participants calculate their annual GHG emissions and/or report these emissions to the California Registry.
2. Allows approved verifiers to review participants' annual GHG emissions reports and submit their verification information to the California Registry.
3. Permits the general public to view aggregated reports of participants' annual GHG emissions and their progress in managing these emissions.
4. Enables California Registry staff to efficiently manage and track participants' data.

CARROT provides you with a secure, online workspace to manage, report, verify, and register your emissions.

The California Registry has designed CARROT to facilitate and ease emissions reporting. CARROT is also designed to streamline the emissions registration process by providing emissions calculations tools, simple reporting features, and administrative controls that allow participants to delegate reporting within your organization.

When you join the California Registry, your organization's technical contact will be provided a UserID and Password that will allow you to access CARROT through the California Registry's website, www.climateregistry.org/CARROT. Other users within your organization can request access from your organization's technical contact.

IV.13.2 CARROT Guidance and Technical Assistance

If you have questions about using CARROT, the California Registry provides reporting assistance and support through the following tools:

- *CARROT Getting Started Guide Version 3* (December 2008), available on the California Registry website in PDF format
- CARROT online help and online documentation
- Email user support at help@climateregistry.org
- Phone user support (213-891-1444, extension 2)

Prospective participants and other interested parties can see how CARROT works by viewing a short demonstration of the tool, accessible on the California Registry's website (www.climateregistry.org/CARROT/Demo). Participants can also familiarize themselves with CARROT by using the CARROT Training Site. Access to the training site may be requested by sending an email to help@climateregistry.org.

IV.13.3 Accessing Your Verified Emissions Data

CARROT provides a variety of tools to help you manage and use your emissions data, and will be regularly updated to reflect current emissions reporting policies. The following are some of the features that will assist you in managing your reported GHG emissions information.

Participant's Administrative Module

CARROT allows you to manage separate emissions submissions, as needed, from within your organization, depending on how many individuals are responsible for reporting a subset of your total GHG emissions report. This is done by creating different types of users within CARROT.

Administrators are responsible for managing each entity's annual emissions report, creating other users to help them input or review data, and submitting an entity's report for verification and finally to the California Registry. They have full read/write access to data for all reported years.

Users are assigned to one or more facilities, and can enter information for specific locations for specific years and submit it to the Administrator for review.

For example, if your organization owns and operates five different facilities, the Administrator can grant permission to five different facility managers to enter the GHG emissions information from their respective facilities. The Administrator will be able to visually assess the status of each of the five facilities and will be the only party with the permission to submit and classify the entity emissions report as "Verification Ready".

Participant Database Query and Reporting

Once you have entered your emissions data, CARROT helps you generate detailed and summary reports of your information. Examples of CARROT reports include:

Reports for Participants

- Total Reported Emissions – Entity
- Total Reported Emissions – by Facility (if applicable)

Reports for the Public

In addition to collecting your GHG emissions data, CARROT will also make limited information about your GHG emissions report and overall California Registry participation available to the public. The public will see the following information, which you are required to report:

- Company name, address, and contact;
- Reporting year;
- Total emissions, by gas and by category (i.e., stationary combustion, mobile combustion, process emissions, fugitive emissions, indirect emissions and de minimis emissions); and
- Baseline year (if chosen).

In addition, the public will see the following information that you may choose to report. This optional information is not verified.

- Reduction goals, projects, management programs
- Entity description
- Total optional emissions, by gas and by category
- Other optional information

Archive Feature

CARROT maintains annual versions of your GHG emissions report submissions. Also, CARROT will keep copies of any revisions with your comments, to enable you to correct your submissions, and for California Registry-approved verifiers to verify your data. You can revise your report at any time; however, once it has been submitted for verification, any subsequent changes will need to be re-verified.

IV.13.4 Movement Reports

For every year of emissions data collection, CARROT will ask you to prepare a Movement Report, in which you identify the major factors that have affected your emissions. The Movement Report is required each year after your first year of reporting.
This should include:

- A list of structural changes (e.g., mergers, acquisitions, divestitures, outsourcing);
- A discussion of how your organization's business cycle is affecting your emissions; and
- A list of any emission reduction projects undertaken by your organization.

Table IV.13.1 provides a sample Movement Report.

Table IV.13.1 Sample Movement Report

Factor Affecting Performance	Details
Structural Change: Acquisition Divestiture Insourced Activities Outsourced Activities Leakage	Name Location Business Unit Affected Change due to California Registry participation Estimated impact on emissions
Organic Growth or Decline: New Construction Plant Closing Decrease in Production Increase in Production Business Cycle Fluctuation	Name Location Business Unit Affected Estimated Impacts on Production Estimated impact on emissions
Emission Reduction Activities: Purchased Offsets Avoided Emissions Sequestration	Project Name Location Estimated impact on emissions
Other	

For each category, CARROT will ask you to provide an explanation of each change to emissions, as well as an estimate of the impact on your total emissions. Thus, for an acquisition, you would indicate the name, location and size of the acquisition, and the estimated associated emissions per year (tons CO_2e/year).

One purpose of this Movement Report is to facilitate verification. Verifiers will reference this Movement Report to understand changes in your emissions data from year to year; however, this information will not be verified for accuracy nor provided to the public.

IV.13.5 Utilizing Your Verified Emissions Data

While the California Registry cannot predict the full range of ways you can utilize your verified emissions data, there are some important uses that are worth considering. For example, once you have started entering your information in the California Registry's CARROT reporting system, you will be able to maintain and track your organization's progress in meeting internal GHG reduction targets with every annual GHG emissions report.

As mentioned earlier, under a possible future regulatory regime, your verified emissions data could provide the basis for any determination of protections or other regulatory rewards for taking early steps to reduce your GHG emissions. Future regulations by the State of California or the federal government might reward organizations that took significant steps to reduce GHG emissions. Similarly, your GHG emissions data might be applicable for participating in voluntary GHG emissions reduction programs, both in the United States and abroad, or ISO 14064[1] for GHG emission reduction practices.

In addition, you may publish your verified emissions data in order to demonstrate your organization's commitment to environmental goals and to addressing climate change, and to disseminate transparent information about the specific steps your organization has taken to achieve reductions in GHG emissions.

1 The ISO 14064 standards for greenhouse gas accounting and verification published in March 2006 by ISO (International Organization for Standardization) provide government and industry with an integrated set of tools for programs aimed at reducing greenhouse gas emissions, as well as for emissions trading (www.iso.org).

Chapter 14 Verification

Who should read Chapter 14:

Chapter 14 applies to all participants.

What you will find in Chapter 14:

This chapter provides guidance on the process for verifying your GHG emissions report, including how to obtain verification services from an approved verifier, and what you will need to prepare for verification.

Information you will need:

Chapter 14 will guide you through the steps involved in determining what information you will need for verification. Table IV.14.1 in this chapter provides a list of specific documentation that will be needed for verification.

Cross-References:

All other chapters in the General Reporting Protocol may be considered during the verification process. In addition, you should review the General Verification Protocol, to be used by approved verifiers, in preparing for verification.

This chapter provides context for the principles underlying verification, explains the verification standards, and overviews the entire verification process.

This General Reporting Protocol is designed to direct the complete, transparent, and accurate reporting of your organization's GHG emissions. Verifying your emissions report is the final step in the reporting process.

Verification is the process used to ensure that a participant's GHG emissions report has met a minimum quality standard and complied with an appropriate set of California Registry-approved procedures and protocols for submitting emissions inventory information. For most California Registry participants, meeting the requirements of the General Reporting Protocol should be sufficient to complete verification. Where a participant is eligible for an industry-specific protocol, they will need to meet those requirements to achieve verification. Participants with relatively small and simple emissions (<500 tons CO_2e per year) may be eligible for batch verification - see Section IV.14.14 for more information on eligibility.

The California Registry's verification process has been designed to promote the credibility, accuracy, transparency, and usefulness of emissions data reported to the California Registry. Once an approved verifier has determined that the emissions report meets a minimum quality standard and is free of material discrepancies, the participant's reported emissions data will be reviewed by the California Registry and accepted into the California Registry's database.

If you are interested in understanding and preparing for the verification process in more detail, and to see the specific process approved verifiers will be using to verify your GHG emissions report, you may obtain a copy of the Verification Protocol, the California Registry's guidance for approved verifiers, from the California Registry's website.

IV.14.1 GHG Reporting Principles and Verification

The purpose of verification is to provide an independent review of data and information submitted to the California Registry, which ensures the credibility of the GHG inventories. To accomplish this objective, the independent verification process maintains the criteria of comparability, completeness, consistency, transparency, and accuracy as its underlying principles. These accounting and reporting principles are described in Section I.4.

IV.14.2 Verification Standard

At a minimum, each annual GHG emissions report (emissions report) must contain all of an entity's emissions of CO_2 in the state of California for a calendar year, reported in five categories: 1) indirect emissions from purchased electricity, imports of steam, district heating and cooling, and direct emissions from 2) mobile combustion, 3) stationary combustion, 4) process emissions, and 5) fugitive emissions. Where a participant is reporting its U.S. emissions, the report must contain all of their emissions nationally. Starting with the fourth year of reporting, each emissions report must contain all emissions of all six greenhouse gases (CO_2, CH_4, N_2O, HFCs, PFCs, SF_6). If a participant is reporting process or fugitive emissions, a separate industry specific protocol may also be used and cited.

Emissions reports may also contain other information about an organization and its emissions that does not require verification. Your verifier will not consider this information when developing an opinion regarding your verifiable annual GHG emissions inventory results.

Additional guidance on reporting optional information is provided in Chapter 12.

IV.14.3 Minimum Quality Standard

An emissions report submitted to the California Registry must be free of material discrepancies to be verified. In other words, a verifier's calculation estimates of the entire inventory must not differ from a participant's estimates of the entire inventory by more than 5%. It is possible that during the verification process differences will arise between the emissions totals estimated by participants and those estimated by verifiers. Differences of this nature may be classified as either material or immaterial discrepancies. A discrepancy is considered to be material if the overall reported emissions differ from the overall emissions estimated by the verifier by 5% or more. Otherwise, it is immaterial.

IV.14.4 The Verification Process

The verification process outlined in the General Verification Protocol is designed to be applied consistently across all participants. However, based on the size and complexity of participants' operations and management systems, verification activities and the duration of the process will vary.

At a minimum the verification process will include the following steps:

- Conducting an evaluation of Conflict of Interest by the California Registry
- Providing notification of planned verification activities to the California Registry
- Scoping and planning a participant's verification activities prior to commencing verification
- Conducting verification activities in accordance with the General Verification Protocol
  - Identifying emissions sources
  - Reviewing methodologies and management systems
  - Verifying emission estimates
- Preparing a participant's Verification Report and Verification Opinion
- Submitting a Verification Opinion and Verification Activity Log to the Participant

Upon the completion of the above steps, the California Registry will accept a participant's verified data into its emissions database.

A step-by-step description of the verification process is described in Section IV.14.9.

Core Verification Activities

The verification process is designed to ensure that there have been no material discrepancies of your reported entity-wide inventory. In order to ensure consistency in the application of verification, the California Registry provides all verifiers with a General Verification Protocol that is based on the guidance contained in this Protocol and any industry-specific protocol. The General Verification Protocol is a guidance document. However, since verifiers face potential financial liability for reports they have verified, it is ultimately at the verifier's discretion whether to verify your report.

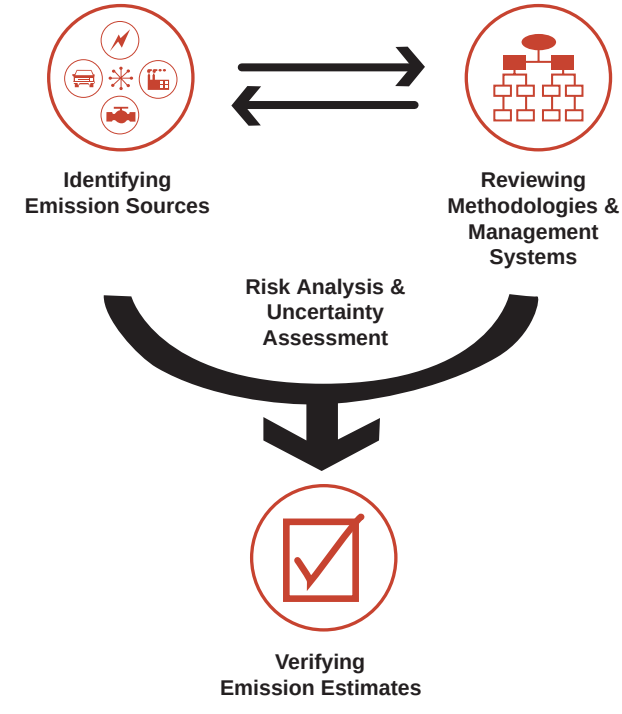
Once the verifier has completed the preparations for verification, including the kick-off meeting and the selection of a general approach to verification, the core verification activities can begin.

The core verification activities include three primary elements:

1. Identifying emissions sources;
2. Understanding management systems and estimation methods used; and
3. Verifying emissions estimates.

The core verification activities are fundamentally a risk assessment and data sampling effort aimed at ensuring that no significant sources are excluded and that the risk of error is assessed and addressed through appropriate sampling and review. The complete core verification process is illustrated in Figure IV.14.1.

Figure IV.14.1 Core Verification Process



IV.14.5 Professional Judgment

Approved verifiers must verify participants' annual GHG emissions reports against the California Registry's General Reporting Protocol using the process outlined in the General Verification Protocol. The California Registry asks verifiers to use their professional judgment when executing the verification activities described in the General Verification Protocol. The purpose of the verifier accreditation process is to ensure that verification firms demonstrate, through their staff's professional qualifications and experience, their ability to render sound professional judgments about GHG emissions reports.

Application of a verifier's professional judgment is expected in the following areas:

- Implementation of verification activities with appropriate rigor for the size and complexity of a participant's organization and with regard to the uncertainty of calculations associated with the participant's emissions sources;
- Review of the appropriateness of a participant's GHG emissions tracking and monitoring procedures, calculation methodologies, and management systems for providing information to the California Climate Action Registry;
- Evaluation of participant compliance with the California Registry's General Reporting Protocol;
- Assessment of methods used for estimating emissions from sources for which the General Reporting Protocol does not provide specific guidance, such as process and fugitive emissions, and indirect emissions from sources other than electricity, imported steam, and district heating and cooling; and
- Appraisal of assumptions, estimation methods, and emission factors that are selected as alternatives to those provided in the General Reporting Protocol.

The General Verification Protocol and training provided by the California Registry are intended to explain to the verifier the California Registry's guidelines and expectations and thus what types of professional judgments are appropriate for this program. In addition to these resources, verifiers and participants may contact the California Registry at any time for clarification of California Registry guidelines, expectations, and policies.

IV.14.6 Conflict of Interest

In order to ensure the credibility of the emissions data reported to the California Registry and its applicability under any future regulatory regime, it is critical that the verification process is completely independent from the influence of the participant submitting the emissions report. While conducting verification activities for California Registry participants, verifiers must work in a credible, independent, nondiscriminatory, and transparent manner, complying with applicable state and federal law and the California Registry's Conflict of Interest (COI) determination process.

Verification bodies must provide information to the accreditation body about their organizational relationships and internal structures for identifying potential conflicts of interest (organizational COI). Then, on an individual basis, the California Registry will review any pre-existing relationship between a verifier and participant and will assess the potential for conflict of interest (case-by-case COI) in conducting a verification. When the California Registry determines there is a low risk of COI, the participant and verifier can finalize negotiations of their contract. Following completion of a verification, the verifier must monitor their business relationships for the next year for situations that may create a COI (emerging COI) and notify the California Registry before entering into new business relationships with these participants.

This conflict of interest clause does not preclude a verifier from engaging in consulting services for other clients that participate in the California Registry for whom the verifier does not provide any verification activities.

Verifiers must submit an updated COI form each year, even if they have verified previous years' emissions reports for a participant.

As an added protection, a verifier may provide verification services to a California Registry participant for, at most, six consecutive years. After a six-year period, the California Registry participant must engage a different verifier. The original verifier may not provide verification services to that participant for three years. This three-year hiatus begins with any lapse in providing annual verification services to a California Registry participant.

In the event that a verifier violates these conditions, the accreditation body, at its discretion, may disqualify an approved verifier for a period of up to five years.

IV.14.7 Reporting and Verification Deadlines

You must submit your GHG emissions report by June 30 of the year following the emissions year to the California Registry to initiate verification activities. Verification should be completed by October 31 of the year the report is submitted to the California Registry. In other words, a GHG emissions report for 2008 emissions should be submitted by June 30, 2009, and the verification process should be completed by October 31, 2009.

Participants who are not able to meet these deadlines must request a reporting or verification extension from the California Registry.

Reporting Deadline: June 30

Verification Deadline: October 31

IV.14.8 State Role in Verification

The California Registry's enabling legislation directed two state agencies, the Resources Agency and the Environmental Protection Agency, to provide technical guidance to the California Registry, including developing verification procedures. The State of California helps the California Registry to oversee verification activities. This includes randomly accompanying verifiers on site visits to evaluate the participant's GHG reporting program and the reasonableness of the participant's reported data. The State has worked through the California Energy Commission, the California Air Resources Board, and the California Department of Forestry and Fire Protection to conduct this oversight.

IV.14.9 Key Verification Steps

Verification consists of a number of procedural steps that must be taken to ensure that the obligations and responsibilities of both the verifier and participant are clear, as well as verification activities that ascertain the accuracy and completeness of an emissions report.

The following summary of the major steps of the verification process is provided as a reference.

1. **Participant Selects Verifier:** The participant may contact one or more State- or California Registry-approved verifiers to discuss verification activities. The participant selects a company to verify its GHG emissions results and begins to negotiate contract terms.
2. **Verifier Submits Case-Specific Notification of Verification Activities and Request for Evaluation of Conflict of Interest Form:** After a participant chooses a verifier, the verifier must submit a Notification of Verification Activities and Conflict of Interest Evaluation Form to the California Registry at a minimum of 10 business days prior to beginning verification activities. This is to establish the plan and scope of verification activities, and to ensure that the likelihood of a COI between parties is low or that risk of any conflict can be sufficiently mitigated by the verification body.
3. **California Registry Sends COI Determination to Verifier:** The California Registry reviews the Evaluation of COI Form and supporting information to determine the level of risk associated with the proposed participant/verifier relationship, and notifies the verifier of its determination.
4. **Verifier and Participant Finalize Contract:** When the California Registry provides a favorable COI determination between a participant and a verifier, verifiers may finalize their contract with a California Registry participant.
5. **Verifier Conducts Verification Activities:** The verifier follows the guidance in the General Verification Protocol to evaluate a participant's annual GHG emissions report.
6. **Verifier Prepares Verification Report and Verification Opinion for Participant:** The verifier prepares a detailed summary (Verification Report) of the verification activities for the participant. The verifier also prepares a Verification Opinion for the participant's review, and a Verification Activity Log.
7. **Verifier and Participant Discuss Verification Report and Opinion:** The verifier meets with the participant to discuss Verification Report and Opinion.
8. **Verifier Completes Verification Form and Verification Activity Log via CARROT:** Once authorized by a participant, the verifier completes the Verification Form and Log via CARROT.
9. **Participant Forwards Verification Opinion to the California Registry:** The participant emails the original Verification Opinion to the California Registry.
10. **California Registry Completes Reporting Process:** The California Registry reviews the Verification Opinion and Verification Activity Log and evaluates the participant's emissions report. Once accepted by the California Registry, a participant's aggregated entity-level emissions become available to the public via CARROT.

IV.14.10 Preparing for Verification

The pre-verification process involves several steps, including:

- Identifying accredited verification bodies on the California Registry's website;
- Executing a competitive bid process or awarding a sole source contract for verification services, or, if you are eligible, participating in batch verification (see Section IV.14.14) through the California Registry;
- Negotiating your contract with your selected verifier; and

- Assembling relevant materials needed by the verifier to verify your emissions data.

Use of California Registry-Approved Verifiers. You must choose your verifier from the list of accredited verification bodies maintained by the California Registry. Information about California Registry-approved verification bodies is provided on the California Registry website at www.climateregistry.org/serviceproviders.

Request for Bids for Verification Services

Options for Soliciting Bids. The California Registry recommends that those participants with complex GHG emissions reports solicit competitive bids for verification services from at least three verification bodies. If your organization has prepared a simpler GHG emissions report and does not seek, or is not eligible for, batch verification, you may wish to either secure competitive bids or to sole-source the verification contract in order to reduce costs and expedite the verification process.

Non-Disclosure Agreements. When preparing to send out a request for bids from verifiers, you should review the list of approved verification bodies and select some or all as prospective bidders. The California Registry recommends that you send the contact person from each prospective bidder a non-disclosure agreement prior to requesting bids or releasing potentially proprietary information.

The Request for Bids. In order to obtain the most competitive bids and ensure that you will receive the most effective verification services, your request for bids should include as much detailed information about your organization and its emissions report as possible.

The California Registry recommends that participants include the following information in their requests for bids from verification bodies:

1. The expected contract duration;
2. A general description of the participant's organization;
3. The geographic boundaries of the participant's report;
4. The number and locations of facilities and operations;
5. The GHGs reported in the participant's emissions report;
6. The emission source categories (and possibly emission sources) in the participant's report; and
7. A copy of the participant's emissions report from CARROT.

You should request bids and negotiate terms and conditions for a complete verification, including:

- A review of your management systems (required in year one and recommended at least every third year thereafter);
- A review of your underlying activity data;
- Confirmation of emissions estimates;
- A final Verification Report; and
- A Verification Opinion submitted to the California Registry.

The California Registry suggests that participants request Commercial and Technical Proposals from potential verifiers that include the following components:

Commercial Proposal

1. History and description of company
2. Explanation of core competencies
3. Proposed price for verification services
4. Proposed staff
5. Statement of verifier liability
6. Confidentiality policy
7. Duration of contract

Technical Proposal

1. Approach to preparing for verification
2. Approach for completing core verification activities
3. Approach for completing the verification process

Negotiating a Contract with the Verifier

After you have selected a verifier from the approved verifiers that gave you bids, you should negotiate complete contract terms. This contract must be for direct services between the participant and an approved verifier. Contracts for verification services typically include the following components:

Scope of the Verification Process. This component of the contract will outline the exact geographic and organizational boundaries of the participant's emissions inventory to be examined. This should, but may not necessarily, match the boundaries used in the GHG emissions report to the California Registry. This scope will indicate whether California-only emissions are included or if both California and U.S. emissions are included. It will also include whether the participant has used the management control, equity share, or other method based on contractual relationships to determine organizational boundaries.

Confirmation of Approved Verifier Status. This is a simple statement that the verification body has been approved by the California Registry to verify emissions reports covering the scope listed above.

Verification Standard. Approved verifiers must verify participants' GHG emissions reports against the California Registry's General Reporting Protocol using the process

outlined in the General Verification Protocol. However, if a participant is reporting process or fugitive emissions, a separate industry-specific protocol may also be used and cited. Some participants may wish to use their GHG emissions report for additional purposes such as registering in another registry or participating in an emissions trading scheme or crediting program, etc., and thus may add additional standards for verification.

Non-Disclosure Terms. The verifier and the participant should agree in advance on methods for identifying and protecting proprietary and business confidential data that may be revealed during verification.

Site Access. The verifier and the participant should agree in advance to the time, place, and conditions of a verifier's site visits, if any are required.

Documentation and Data Requirements. The verifier and participant should agree on how and when the participant will provide emissions data to the verifier. The range of required documentation will largely be determined by the size and complexity of participant operations, and whether the participant has used the online calculation tools available through CARROT.

Period of Performance. The period of performance for verification services will typically be for three years, given that the verification process required by the California Registry is more streamlined in Year 2 and Year 3, if participant operations do not change. However, there may be instances where contracts are negotiated for a single year, pending renewal.

Performance Schedule. Participants and verifiers may wish to agree on a schedule to complete the verification process and for the verifier to deliver a Verification Report and Verification Opinion. Verification should be initiated in time to meet the October 31 verification deadline.

Payment Terms. Typical payment terms include total value, schedule of payments, and method of payment (e.g., electronic funds transfer).

Re-verification Terms. If the verifier identifies material discrepancies, the participant may choose to revise its GHG emissions report. At that time, the participant may ask the verifier to re-verify the report or seek verification from another provider. The verifier may not provide guidance, technical assistance or implementation work on the remediation of material misstatements, as this would be viewed as consulting services and result in a conflict of interest.

Liability. All verifiers are subject to the minimum liability associated with completing the verification per the terms of the verification contract. The participant may require and the verifier may agree to additional liability under this contract.

Contracts. The contract should identify technical leads for the participant and verifier, as well as responsible corporate officials of each party.

Verifier Requirement to Notify State of Verification

When the verifier submits the Notification of Verification Activities and COI Evaluation Form prior to beginning verification activities, the California Registry will notify the State of any and all planned verification activities at the time it makes its determination. This notification period is necessary to allow the State the opportunity to occasionally accompany verifiers on visits to participants' sites. The State observes, evaluates, and reports on the quality and consistency of verification activities. A verifier that does not provide proper notification to the California Registry at least 10 business days prior to beginning verification activities may be disqualified as an approved verifier.

Kick-off Meeting

After the verifier has notified the California Registry and the State of planned verification activities, verifiers should host a kick-off meeting with participants. Meetings can be conducted in person or by telephone. The agenda for that meeting should include:

1. Introduction of the verification team;
2. Review and confirmation of verification process and scope;
3. Transfer of background information and underlying activity data (see Table IV.14.1); and
4. Review and confirmation of the verification process schedule.

Based on the information provided in agenda items two and three, the verifier should determine the most effective, efficient, and credible detailed verification approach tailored to the particular characteristics of the participant.

IV.14.11 The Verification Cycle

While verification is required annually, in some instances it can be thought of as a three-year process. In Year 1, a verifier will need to form a detailed understanding of a participant's operations and consequential GHG emissions. Assuming that there have been no significant changes in the geographic and organizational boundaries of a participant's operations, a verifier is likely to have identified all emission sources and gained a sufficient understanding of the participant's GHG emissions management systems in Year 1 to streamline and

expedite the verification activities to focus on verifying emissions estimates in Year 2 and Year 3. To ensure data integrity, all of the core verification activities should be completed in Year 4.

Thus, the core verification activities each year will likely be as follows:

Year 1: **Identify Emission Sources, Review Management Systems, Verify Emissions Estimates**

Year 2: **Verify Emissions Estimates**

Year 3: **Verify Emissions Estimates**

Year 4: **Same as Year 1**

The California Registry assumes that verifiers will use their best professional judgment when conducting verification activities, and thus, will modify the suggested annual process described above as necessary. Each verifier is also required to complete a number of steps in their review, and to evaluate every participant against a number of criteria. These steps and criteria are listed in the Verification Activity Log, provided in the General Verification Protocol.

When you have specified a baseline, each year your verifier will need to identify changes to your direct emissions, review the cause of the changes, and assess if you have reached the baseline change threshold of 10%. The verifier will also determine if you have adjusted your baseline appropriately, if necessary.

As mentioned earlier, a verifier may provide verification services to a California Registry participant for, at most, six consecutive years (two verification cycles). After a six-year period, the California Registry participant must engage a different verifier and the original verifier may not provide verification services to that participant for three years.

IV.14.12 Online Reporting

If a participant chooses to use the built-in calculators and default emission factors in CARROT and the verifier's document review suggests that data have been collected properly and entered accurately, the verifier will not need to re-calculate the emissions, as the calculations will be automatic. Due to the time savings, this should result in a less expensive and expedited verification process.

IV.14.13 Documentation for Review

The documents that will need to be reviewed during verification will also vary depending on the nature of the emission sources contained in your GHG emissions report to the California Registry. Table IV.14.1 on the following page, provides a list of recommended documents to have ready to provide a verifier for conducting the verification process.

Table IV.14.1 Documents to be Reviewed During Verification Activities

Activity or Emissions Source	Documents
Identifying Emission Sources	
Emission Source Inventory	Facility inventory
	Emission source inventory Stationary source inventory Mobile source inventory Fuel inventory
Understanding Management Systems and Methodologies	
Responsibilities for Implementing GHG Management Plan	Organization chart, greenhouse gas management plan, documentation and retention plan
Training	Training manual, procedures manual, consultant qualification statement
Methodologies	Protocols used (if in addition to the California Registry's General Reporting Protocol)
Verifying Emission Estimates	
Indirect Emissions from Electricity Use	Monthly electric utility bills, emission factors (if not default)
Direct Emissions from Mobile Combustion	Fuel purchase records, fuel in stock, vehicle miles traveled, inventory of vehicles, emission factors (if not default)
Direct Emissions from Stationary Combustion	Monthly utility bills, fuel purchase records, CEMs data, inventory of stationary combustion facilities, emission factors (if not default)
Indirect Emissions from Cogeneration	Monthly utility bills, fuel and efficiency data from supplier, emission factors (if not default)
Indirect Emissions from Imported Steam	Monthly utility bills, fuel and efficiency data from supplier, emission factors (if not default)
Indirect Emissions from District Cooling	Monthly utility bills, fuel and efficiency data from supplier, emission factors (if not default)
Direct Emissions from Manufacturing Processes	Raw material inputs, production output, calculation methodology, emission factors
Refrigeration Systems	Refrigerant purchase records, refrigerant sales records, calculation methodology, emission factors
Landfills	Waste in place data, waste landfilled, calculation methodology, emission factors
Coal Mines	Coal production data submitted to EIA, quarterly MSHA reports, calculation methodology, emission factors
Natural Gas Pipelines	Gas throughput data, calculation methodology, emission factors
Electric Transmission and Distribution	Sulfur hexafluoride purchase records, calculation methodology, emission factors

IV.14.14 Batch Verification

In an effort to minimize the transaction costs of verification for small organizations with relatively simple emissions, the California Registry will contract with an approved verifier to undertake the verification work for interested participants with limited GHG emissions. The California Registry calls this batch verification. Emissions reports verified under batch verification must meet the same standards as non-batch reports. Eligible participants include those with:

- Less than 500 metric tons of CO_2e emissions per year;
- No significant process or fugitive emissions (de minimis emissions in these categories are allowed);
- Indirect emissions from purchased electricity at no more than four sites;
- Direct emissions from no more than five vehicles; and
- Direct emissions from stationary combustion at no more than one site.

Upon the recommendation of the batch verifier, the California Registry reserves the right to deem a participant's GHG emissions inventory too complex for batch verification. The California Registry also reserves the right to grant batch verification eligibility on a case-by-case basis.

Batch Verification Process Overview

The following is a summary of the steps of the batch verification process.

Participants interested in batch verification will notify the California Registry. After confirming the participant's eligibility, the California Registry will keep track of interested participants until a sufficient number have reported their emissions in CARROT and submitted the data for verification.

Each year, the California Registry will solicit competitive bids for batch verification services from at least three approved verifiers. On behalf of batch participants, the California Registry will select one verifier to perform all eligible verifications for that calendar year of emissions.

1. **Batch Verifier & Batch Participants Sign Contracts**: Each participant signs a standardized contract with the verifier. Any participant requiring non-standard contract language cannot participate in batch verification.
2. **Batch Verifier Receives Documentation:** After the entities participating in batch verification have completed their reports, the California Registry will collect the necessary supporting documentation from the participants and forward it to the verifier. Batch verification will not require a site visit, but will consist of document review and telephone interviews.
3. **Batch Verifier Conducts Verification Activities:** The verifier will follow the guidance in the General Verification Protocol to evaluate a participant's GHG emissions report. The verifier will contact each participant to understand their operations.
4. **Batch Verifier Provides Verification Report and Opinion to Participant:** The verifier prepares and discusses a summary of the verification activities with the participant (Verification Report). The verifier also provides the Verification Opinion to the participant. Once authorized by a participant, the verifier completes the Verification Form and Activity Log via CARROT.

The participant then emails the Verification Opinion to the California Registry at help@climateregistry.org.

The California Registry will review the Verification Opinion and Verification Activity Log and evaluate the participant's emissions report. Once accepted by the California Registry, a participant's aggregated entity-level emissions become available to the public via CARROT.

IV.14.15 Verification Report and Opinion

The verifier will prepare a detailed Verification Report for each emissions report. The Verification Report is a confidential document that is shared between a verifier and a participant—it is not available to the California Registry or the public unless a participant chooses to share it, or it is specifically requested by the California Registry.

Verification Report

The Verification Report should include the following elements:

- The scope of the verification process undertaken;
- The standard used to verify emissions (this is the California Registry's General Reporting Protocol, but may also include other protocols or methodologies for those sources for which the California Registry has yet to provide detailed guidance);
- A description of the verification activities, based on the size and complexity of the participant's operations;
- A list of emissions sources identified;
- A description of the sampling techniques and risk assessment methodologies employed for each source;
- An evaluation of the participant's emissions report compliance with the California Registry's General Reporting Protocol;
- A comparison of the participant's overall emission estimates with the verifier's overall emission estimates;
- A list of material discrepancies, if any;

- A list of immaterial discrepancies, if any; and
- A general conclusion to be reflected in the Verification Opinion forwarded to the California Registry.

A participating organization should be provided up to 30 days to review and comment on the Verification Report. At the end of that review, the verifier and the participating organization should hold a meeting to discuss the nature of any material or immaterial discrepancies.

Verification Opinion

The Verification Opinion is a simple confirmation of the verification activities and outcomes for all stakeholders (participants, verifiers, the California Registry, and the public). The Verification Opinion must also follow the same internal review process as the Verification Report, and consequently must be reviewed and signed by the verification firm and submitted by the participating organization.

Exit Meeting

Verifiers should prepare a brief summary presentation of their verification findings for the participant's key personnel. At the exit meeting verifiers and participants might exchange lessons learned about the verification process and share thoughts for improving the verification process in the future. Verifiers and participants may wish to consider joint feedback to the California Registry.

The goals of this meeting should be:

- Acceptance of the Verification Report and Opinion (unless material discrepancies exist and can be remediated, in which case the verification contract may need to be revised, and a re-verification scheduled). If the participant does not wish to retain the verifier for the re-verification process, the verifier shall turn over all relevant documentation to the participant within 30 days.
- Authorization for the verifier to complete the Verification Form in CARROT.

IV.14.16 Submitting a Verified Emissions Report to the California Registry

Once a participant authorizes the Verification Opinion, the verifier must complete the electronic Verification Form in CARROT and send the original Verification Opinion to the participant. The participant must forward the original copy of the Verification Opinion to the California Registry.

Once the electronic Verification Form is completed and the California Registry receives a hardcopy of the Verification Opinion, the participant's report will be reviewed and formally accepted into the California Registry database, and the annual verification process will be completed.

Participants are not required to submit their Verification Opinions to the California Registry for the first two years of their participation. However, a participant's emissions data will not be considered accepted by the California Registry unless the California Registry receives a Verification Opinion indicating a "verified without qualification" assessment.

IV.14.17 Record Keeping and Retention

You should maintain any relevant records from which emissions results have been calculated. Such records may include, but not be limited to, utility bills, fuel consumption records, emissions data, process data and schedules, and past reports. Although it is not possible to predict what any future regulatory regime may require regarding record keeping and retention, it is inadvisable for you to dispose of relevant records immediately after filing emissions reports. This would hinder any future verification or review activities, placing you at a disadvantage in case of some need to re-estimate the emissions results. In addition, your baseline inventory data is the key to determining temporal trends in GHG emissions.

IV.14.18 Correcting or Revising Your GHG Emissions Report

After you have submitted your verified GHG emissions report to the California Registry, you will still be able to make corrections if you have determined an error in your report, have identified new emissions sources, or would like to utilize more thorough calculation methodologies to estimate your emissions. You should note that the California Registry's reporting system is designed to retain all original reports and records it receives as archives, even after a GHG emissions report has been corrected or updated.

Should you update your GHG emissions report, the updated portion will need to be re-verified by a California Registry-approved verifier, following the process described in this chapter. Note that if the specific changes you have made to your report influence or affect the estimations of other elements of your report, you will again need to have the verifier review and verify all relevant sections of your GHG emissions report. Where your overall corrections result in an insignificant change in emissions from your previous GHG emissions report, verification should require only verifying your emissions estimates. Once a revision is initiated in CARROT, the information is not publicly available until all additions to the report are verified.

IV.14.19 Dispute Resolution

There may be instances where a verifier and a participant cannot agree on identification of material discrepancies and/or the findings of the Verification Opinion. In such instances, both parties can request the Dispute Resolution Committee, composed of qualified representatives from California state agencies, the California Registry, and one non-voting verifier, who serves pro bono on an annual, rotating basis. The participant and the verifier will each pay a filing fee equal to 5% of the participant's annual California Registry membership fee to submit the matter to the Dispute Resolution Committee.

The Dispute Resolution Committee will interview the participant and the verifier, review the area of dispute and reach a unanimous, binding decision concerning verifiability. The California Registry will notify the verifier and California Registry participant of the Committee's decision. Thus, as part of contract negotiations, each California Registry participant and verifier will need to sign a form agreeing to this Dispute Resolution policy.

IV.14.20 Key Verification Questions

Verification Deadlines: What is the deadline for completing the verification process?

Emissions should be reported to the California Registry no later than June 30 following the emissions year. Verification should be completed by October 31 following the emissions year. For instance, 2008 emissions should be reported by June 30, 2009 and verified by October 31, 2009.

Costs: What will it cost to have my GHG emissions report verified?

Because verifiers will review GHG emissions reports with more scrutiny every fourth year (barring significant changes to your geographic or organizational boundaries), costs associated with verification are likely to be higher in the first year than in years two or three of the reporting process. In order to obtain an estimate for verification, you will need to convey information about your industrial sector, organization size (annual revenue and number of employees), number of facilities, estimated number and type of direct emissions sources, types of indirect emissions sources (e.g., electricity from a utility or electricity or heat from co-generation), the types of gases you are reporting, and the methodologies you are using to estimate and report your emissions (e.g., CARROT).

You may contact the California Registry for information about the costs associated with verifying your GHG emissions report.

In addition, you may contact California Registry-approved verifiers listed on the California Registry's website at www.climateregistry.org for information about the estimated costs associated with verification.

Batch Verification: What is it? How does it work? How will it affect bidding, contracting, and the overall verification process?

In an effort to minimize transaction costs, eligible California Registry participants may request to participate in batch verification with similar organizations through the California Registry. Eligible participants have relatively simple GHG emission sources and no more than 500 tons of CO_2e from only indirect emissions from electricity consumption at four or fewer sites, direct emissions from stationary combustion at a single site, and/or direct emissions from five or less vehicles. In that situation, bidding, contract negotiations, and the kick-off meeting will take place between the verifier and the California Registry. Standard terms and conditions are expected to apply for all contract elements. The California Registry will initiate the procurement process for batch verification.

Verification and Remediation: What if my GHG emissions report is not verified?

At the completion of the verification process, the verifier will prepare a Verification Report and forward it to the responsible official representing the California Registry participant. (The responsible official includes anyone authorized by the participant to approve the GHG emissions report for submission to the California Registry and will typically be a corporate official or the technical manager of the verification contract.)

If the verifier identifies material discrepancies that prevent a favorable Verification Opinion, those material misstatements should be listed and described in the Verification Report. If possible, the participant may correct those material discrepancies and resubmit the emissions report for verification within a reasonable amount of time. The participant may hire technical assistance to correct material discrepancies but the verifier may not provide such technical assistance as it would create a conflict of interest.

If the participant is unable to correct the material discrepancies, the California Registry will retain the participant's data in the California Registry database for up to two years pending verification. Participants who have submitted a report and undergone verification as part of a "learning by doing" process may wish to retain a pending status for their emissions report for up to two years while the report is enhanced. After that time, the data will be deleted from CARROT. The participant may re-enter the data at a later date with the same conditions.

Verification Report, Verification Opinion, and Verification Activity Log: What are these documents and how are they different?

The Verification Report is a detailed report that a verifier prepares for a participant. The report should describe the scope of the verification process, standards used, emissions sources identified, sampling techniques, and evaluation of the participant's compliance with the General Reporting Protocol, and list material and immaterial discrepancies, if any. The Verification Report is a confidential document between a verifier and participant, and is not shared with the California Registry or the public.

The Verification Opinion is a brief, one-page summary of a verifier's findings that simply states if a participant's emissions report is verifiable or not. The Verification Opinion is submitted to the participant and then to the California Registry. A majority of the contents of the Verification Opinion will be available to the public.

The Verification Activity Log is a form that the verifier must complete that asks them to demonstrate consistency in their professional judgments. The form asks them to respond to a series of yes and no questions, and to provide the dates they have performed verification activities. This information is submitted by the verifier to the California Registry via CARROT, and is not shared with the public.

Confidentiality: Are the results of the verification kept confidential? Are emissions data kept confidential?

The California Registry will make public the Verification Opinion as well as the identity of your verifier, but not your Verification Report. All aggregated entity-level emissions data and metrics reported to the California Registry will be available to the public. However, the California Registry intends to keep confidential all reported emissions, activity data, methodologies, and emissions factors with a higher granularity (at facility, project or source levels). Confidential information will only be accessible to the participant, the California Registry, and the verifier, unless the participant allows others access to such information or wishes to have it available to the public.

General Verification Protocol Revision Policy: Will the General Verification Protocol change over time? How can participants provide feedback to the California Registry?

The California Registry expects to regularly review, revise, update, and augment the General Verification Protocol. The California Registry invites all parties, verifiers, California Registry participants, California State agencies, and the public to provide insights and experiences that will help improve the General Verification Protocol. Anyone with suggestions or concerns is encouraged to contact the California Registry at any time.

Stakeholders will also be able to present suggestions directly to the California Registry's Board of Directors for consideration at their meetings. All suggestions and requests for modifications must be made by utilizing the "Protocol Comment Form" available on the California Registry's website at www.climateregistry.org/protocols.

Appendix A Glossary

Anthropogenic Emissions

GHG emissions that are a direct result of human activities or are the result of natural processes that have been affected by human activities.

Barrel (bbl)

Commonly used to measure quantities of various petroleum products, a volumetric measure for liquids equal to 42 U.S. gallons at 60 degrees Fahrenheit.

Baseline

For the purposes of this Protocol, a datum against which to measure GHG emissions performance or change over time, usually annual emissions in a selected base year.

Base year

The first year in which GHG emissions are reported.

Batch Verification

Simultaneous verification process arranged by the California Registry for multiple participants with simple GHG emissions (typically only indirect emissions from electricity consumption and direct emissions from stationary combustion at a single site and/or direct emissions from a small number of vehicles).

Biogenic Emissions

CO_2 emissions produced from combusting a variety of biofuels, such as biodiesel, ethanol, wood, wood waste and landfill gas.

British Thermal Unit (Btu)

The quantity of heat required to raise the temperature of one pound of water by one degree Fahrenheit at about 39.2 degrees Fahrenheit.

Carbon Dioxide (CO_2)

The most common of the six primary GHGs, consisting of a single carbon atom and two oxygen atoms, and providing the reference point for the GWP of other gases. (Thus, the GWP of CO_2 is equal to one.)

CO_2 equivalent (CO_2e)

A measure for comparing carbon dioxide with other GHGs (which generally have a higher global warming potential (GWP)), based on the amount of those other gases multiplied by the appropriate GWP factor; commonly expressed as metric tons of carbon dioxide equivalents ($MTCO_2e$). CO_2e is calculated by multiplying the metric tons of a gas by the appropriate GWP.

Carbon Intensity

The relative amount of carbon emitted per unit of energy or fuels consumed.

Co-Generation

The generation of two forms of energy such as heat and electricity from the same process with the purpose of utilizing or selling both simultaneously.

Datum

A reference or starting point.

De Minimis

For the purposes of this Protocol, the GHG emissions from one or more sources, for one or more gases which, when summed, equal less than 5% of an organization's total emissions.

Direct Emissions

For the purposes of this Protocol, emissions from applicable sources that are owned or controlled by the reporting organization.

Emission Factor

A unique value for determining an amount of a GHG emitted for a given quantity of activity data (e.g., million metric tons of carbon dioxide emitted per barrel of fossil fuel).

Equity Share

According to the calculated share.

Fugitive Emissions

Emissions that are not physically controlled but result from the intentional or unintentional release of GHGs. They commonly arise from the production, processing, transmission, storage and use of fuels or other chemicals, often through joints, seals, packing, gaskets, etc. Examples include HFCs from refrigeration leaks, SF_6 from electrical power distributors, and CH_4 from solid waste landfills.

Global Warming Potential (GWP)

The ratio of radiative forcing that would result from the emission of one kilogram of a GHG to that from the emission of one kilogram of carbon dioxide over a fixed period of time.

Greenhouse Gases (GHGs)

For the purposes of the California Registry, GHGs are the six gases identified in the Kyoto Protocol: carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6).

Higher Heating Value (HHV)

The amount of heat released from the complete combustion of a fuel including water vapor produced in the process.

Hydrocarbons

Chemical compounds containing only carbon and hydrogen, including fossil fuels and a variety of major air pollutants.

Hydrofluorocarbons (HFCs)

One of the six primary GHGs primarily used as refrigerants, consists of a class of gases containing hydrogen, fluorine, and carbon, and possessing a range of high and very high GWP values from 120 to 12,000.

Indirect Emissions

Emissions that occur because of a participant's actions, but are produced by sources owned or controlled by another entity.

Intergovernmental Panel on Climate Change (IPCC)

An organization established jointly by the United Nations Environment Programme and the World Meteorological Organization in 1988 to assess information in the scientific and technical literature related to all significant components of the issue of climate change, and providing technical analysis of the science of climate change as well as guidance on the quantification of GHG emissions.

Joule

A measure of energy, representing the energy needed to push with a force of one Newton for one meter.

Kilowatt Hour (kWh)

The electrical energy unit of measure equal to one thousand watts of power supplied to, or taken from, an electric circuit steadily for one hour. (A Watt is the unit of electrical power equal to one ampere under a pressure of one volt, or 1/746 horsepower.)

Leakage

A situation where emissions shift from one location to another resulting in a direct increase in emissions.

Lower Heating Value (LHV)

The amount of heat released from the complete combustion of a fuel after netting out the heat that is released with the water vapor produced in the process.

Management Control

The ability of an entity to govern the operating policies of another entity or facility so as to obtain benefits from its activities.

Material

Any emission of GHG that is not de minimis in quantity.

Material Discrepancy

With respect to verifying an entity's emissions inventory, a material discrepancy occurs when a difference in reported emissions between an entity and a verifier exceeds 5% of the reported emissions. A difference is immaterial if it is less than 5% of reported emissions.

Member

An entity that is preparing its annual GHG emissions report, but does not have a current verified emissions report with the California Registry.

Methane (CH_4)

One of the six primary GHGs, consisting of a single carbon atom and four hydrogen atoms, possessing a GWP of 21, and produced through the anaerobic decomposition of waste in landfills, animal digestion, decomposition of animal wastes, production and distribution of natural gas and petroleum, coal production, and incomplete fossil fuel combustion.

Metric Ton

Common international measurement for the quantity of GHG emissions, equivalent to about 2,204.6 pounds or 1.1 short tons.

Mobile Combustion

Burning of fuels by transportation devices such as cars, trucks, airplanes, vessels, etc.

Nitrous Oxide (N_2O)

One of the six primary GHGs, consisting of two nitrogen atoms and a single oxygen atom, possessing a GWP of 310, and typically generated as a result of soil cultivation practices, particularly the use of commercial and organic fertilizers, fossil fuel combustion, nitric acid production, and biomass burning.

Perfluorocarbons (PFCs)

One of the six primary GHGs, consists of a class of gases containing carbon and fluorine (represented by the chemical formula CNF(2N+2)), originally introduced as alternatives to ozone depleting substances and typically emitted as by-products of industrial and manufacturing processes, and possessing GWPs ranging from 5,700 to 11,900.

Process Emissions

Emissions from physical or chemical processing rather than from fuel combustion. Examples include CO_2 emissions from cement manufacturing and PFC emissions from aluminum smelting.

Project Baseline

Datum against which to measure GHG emissions performance of a specific emissions reduction project over time, usually annual emissions measured from a base year.

Outsourcing

The contracting out of activities to other businesses.

Significance Threshold

Significance, in the context of the California Registry, is defined as including all sources that are not de minimis. For the purposes of the California Registry, the significance threshold is set at 95%.

Stationary Combustion

Burning of fuels to generate electricity, steam, or heat.

Short Ton

Common measurement for a ton in the U.S. and equivalent to 2,000 pounds or about 0.907 metric tons.

Sulfur Hexafluoride (SF_6)

One of the six primary GHGs, consisting of a single sulfur atom and six fluoride atoms, possessing a very high GWP of 23,900, and primarily used in electrical transmission and distribution systems.

Therm

A measure of one hundred thousand (10^5) Btu.

Verification

For the purposes of this Protocol, the method used to ensure that a given participant's GHG emissions inventory (either the baseline or annual result) has met a minimum quality standard and complied with an appropriate set of California Registry-approved procedures and protocols for submitting emissions inventory information.

Verification Body

For the purposes of this Protocol, an organization or company that is considered California Registry-approved. This applies to currently approved verification bodies, verification bodies approved by the State of California and verification bodies that are accredited to the international standard ISO 14065:2007 to perform GHG verification activities.

Verified Member

A California Registry participant that has a current verified annual emissions report accepted by the California Registry; also known as a *Climate Action Leader*.

Verifier

For the purposes of this Protocol, an individual that is staff or a subcontractor to a California Registry-approved verification body and is qualified to provide verification services for California Registry participants. All verifiers shall complete California Registry training and shall be identified on the designated staff form submitted to the California Registry.

Appendix B Common Conversion Factors

Energy		
1 quadrillion Btu	=	1.0551 x 10^{18} joules
	=	1.0551 exajoules
	=	10^{9} MMBtu
1 MMBtu (million Btu)	=	1.0551 x 10^{12} joules
	=	1.0551 x 10^{-6} exajoules
	=	10 Therm
1 joule	=	947.9 x 10^{-21} quadrillion Btu
1 exajoule	=	10^{18} joules
	=	0.9479 quadrillion Btu
1 GJ (gigajoule)	=	947,817 Btu
	=	277.8 kilowatt hours (kWh)
	=	0.2778 Megawatt hours (MWh)
1 Therm	=	10^{5} Btu
Mass		
1 short ton (U.S. ton)	=	2,000 pounds (lbs)
	=	0.9072 metric tons
	=	9.072 x 10^{4} grams
1 kilogram	=	2.20462 pounds (lbs)
1 metric ton	=	1.1023 short tons
	=	1.1023 tons (U.S.)
	=	2,204.62 pounds (lbs)
	=	1,000 kg
	=	10^{-3} kilotons
	=	10^{-6} megatons
Volume		
1 cubic centimeter	=	3.531 x 10^{-5} cubic feet
1 cubic meter (m^3)	=	35.3115 ft^3 (cubic feet)
	=	1,000 liters
	=	264.2 U.S. gallons
	=	6.29 barrels
	=	1.308 yd^3 (cubic yards)
1 barrel	=	42 gallons
	=	5.6139 ft^3 (cubic feet)
	=	0.15898 m^3
	=	158.98 liters

Area		
1 acre	=	0.40468724 hectare (ha)
	=	4,047 m^2
1 hectare (ha)	=	35.3115 ft^3 (cubic feet)
	=	10,000 m^2
	=	2.47 acres
Distance		
1 kilometer	=	0.6214 miles
Density		
1,000 cubic feet of methane (CH_4)	=	42.28 pounds
	=	1,000 cubic feet carbon dioxide (CO_2)
	=	115.97 pounds
1 metric ton natural gas liquids	=	11.6 barrels
1 metric ton unfinished oils	=	7.46 barrels
1 metric ton alcohol	=	7.94 barrels
1 metric ton liquefied petroleum gas	=	11.6 barrels
1 metric ton aviation gasoline	=	8.9 barrels
1 metric ton naphtha jet fuel	=	8.27 barrels
1 metric ton kerosene jet fuel	=	7.93 barrels
1 metric ton motor gasoline	=	8.53 barrels
1 metric ton kerosene	=	7.73 barrels
1 metric ton naphtha	=	8.22 barrels
1 metric ton distillate	=	7.46 barrels
1 metric ton residual oil	=	6.66 barrels
1 metric ton lubricants	=	7.06 barrels
1 metric ton bitumen	=	6.06 barrels
1 metric ton waxes	=	7.87 barrels
1 metric ton petroleum coke	=	5.51 barrels
1 metric ton petrochemical feedstocks	=	7.46 barrels
1 metric ton special naphtha	=	8.53 barrels
1 metric ton miscellaneous products	=	8.00 barrels

Metric Prefixes		
Abbreviation	**Prefix**	**Multiple**
k	kilo-	10^3 or 1,000
M	mega-	10^6 or 1,000,000
G	giga-	10^9 or 1,000,000,000
T	tera-	10^{12} or 1,000,000,000,000
P	peta-	10^{15} or 1,000,000,000,000,000

Appendix C Calculation References

Converting to CO_2 Equivalent

To incorporate and evaluate non-CO_2 gases in your GHG emissions inventory, the mass estimates of these gases will need to be converted to CO_2 equivalent (CO_2e). To do this, multiply the emissions in units of mass by the GHGs global warming potential (GWP).

Global warming potentials were developed by the Intergovernmental Panel on Climate Change (IPCC) to quantify the globally averaged relative radiative forcing effects of a given GHG, using carbon dioxide as the reference gas. In 1996, the IPCC published a set of GWPs for the most commonly measured greenhouse gases in its Second Assessment Report (SAR). In 2001, the IPCC published its Third Assessment Report (TAR), which adjusted the GWPs to reflect new information on atmospheric lifetimes and an improved calculation of the radiative forcing of carbon dioxide. However, SAR GWPs are still used by international convention and the U.S. to maintain the value of the carbon dioxide "currency". To maintain consistency with international practice, the California Registry requires participants to use GWPs from the SAR for calculating their emissions inventory.

Table C.1 lists the 100-year GWPs from SAR and TAR. The equation above provides the basic calculation required to determine CO_2e from the total mass of a given GHG using the GWPs published by the IPCC.

Converting Mass Estimates to Carbon Dioxide Equivalent

$$\text{Metric Tons of } CO_2e = \text{Metric Tons of GHG} \times \text{GWP}$$

Table C.1 Comparison of GWPs from the IPCC's Second and Third Assessment Reports

Greenhouse Gas	GWP (SAR, 1996)	GWP (TAR, 2001)
CO_2	1	1
CH_4	21	23
N_2O	310	296
HFC-23	11,700	12,000
HFC-32	650	550
HFC-125	2,800	3,400
HFC-134a	1,300	1,300
HFC-143a	3,800	4,300
HFC-152a	140	120
HFC-227ea	2,900	3,500
HFC-236fa	6,300	9,400
HFC-4310mee	1,300	1,500
CF_4	6,500	5,700
C_2F_6	9,200	11,900
C_3F_8	7,000	8,600
C_4F_{10}	7,000	8,600
C_6F_{14}	7,400	9,000
SF_6	23,900	22,000

Source: U.S. Environmental Protection Agency, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2003 (April 2005).

Emission Factors for Electricity Use

Table C.2 Carbon Dioxide, Methane and Nitrous Oxide Electricity Emission Factors by eGRID Subregion

eGRID Subregion Acronym	eGRID Subregion Name	CO_2 (lbs/MWh)	CH_4 (lbs/MWh)	N_2O (lbs/MWh)
AKGD	ASCC Alaska Grid	1,232.36	0.0256	0.0065
AKMS	ASCC Miscellaneous	498.86	0.0208	0.0041
AZNM	WECC Southwest	1,311.05	0.0175	0.0179
CAMX	WECC California	724.12	0.0302	0.0081
ERCT	ERCOT All	1,324.35	0.0187	0.0151
FRCC	FRCC All	1,318.57	0.0459	0.0169
HIMS	HICC Miscellaneous	1,514.92	0.3147	0.0469
HIOA	HICC Oahu	1,811.98	0.1095	0.0236
MROE	MRO East	1,834.72	0.0276	0.0304
MROW	MRO West	1,821.84	0.0280	0.0307
NEWE	NPCC New England	927.68	0.0865	0.0170
NWPP	WECC Northwest	902.24	0.0191	0.0149
NYCW	NPCC NYC/Westchester	815.45	0.0360	0.0055
NYLI	NPCC Long Island	1,536.80	0.1154	0.0181
NYUP	NPCC Upstate NY	720.80	0.0248	0.0112
RFCE	RFC East	1,139.07	0.0303	0.0187
RFCM	RFC Michigan	1,563.28	0.0339	0.0272
RFCW	RFC West	1,537.82	0.0182	0.0257
RMPA	WECC Rockies	1,883.08	0.0229	0.0288
SPNO	SPP North	1,960.94	0.0238	0.0321
SPSO	SPP South	1,658.14	0.0250	0.0226
SRMV	SERC Mississippi Valley	1,019.74	0.0243	0.0117
SRMW	SERC Midwest	1,830.51	0.0212	0.0305
SRSO	SERC South	1,489.54	0.0263	0.0255
SRTV	SERC Tennessee Valley	1,510.44	0.0201	0.0256
SRVC	SERC Virginia/Carolina	1,134.88	0.0238	0.0198

Source: eGRID2007 Version 1.1, December 2008 (Year 2005 data).
Note: Reporters calculating historical data for calendar years 1990-2007 should use the electricity emission factors in Appendix E.

Emission Factors for Mobile Combustion

Table C.3 Carbon Dioxide Emission Factors for Transport Fuels

Fuel	Carbon Content	Heat Content	Fraction Oxidized	CO_2 Emission Factor
	kg C/MMBtu	MMBtu/barrel		kg CO_2/gallon
Aviation Gasoline	18.87	5.048	1.00	8.32
Biodiesel (B100)* +	NA	NA	1.00	9.46
Crude Oil	20.33	5.80	1.00	10.29
Diesel	19.95	5.825	1.00	10.15
Ethanol (E100)* +	17.99	3.539	1.00	5.56
Jet Fuel (Jet A or A-1)	19.33	5.670	1.00	9.57
Kerosene	19.72	5.670	1.00	9.76
Liquefied Natural Gas (LNG)+	NA	NA	1.00	4.46
Liquefied Petroleum Gas (LPG)+	17.23	3.849	1.00	5.79
Ethane	16.25	2.916	1.00	4.14
Isobutane	17.75	4.162	1.00	6.45
n-Butane	17.72	4.328	1.00	6.70
Propane	17.20	3.824	1.00	5.74
Methanol	NA	NA	1.00	4.10
Motor Gasoline	19.33	5.218	1.00	8.81
Residual Fuel Oil (#5, 6)	21.49	6.287	1.00	11.80
	kg C/MMBtu	Btu/standard cubic foot		kg CO_2/therm
Compressed Natural Gas (CNG)+	14.47	1027	1.00	5.31

* CO_2 emissions from biodiesel and ethanol combustion are considered biogenic and should not be reported as a direct mobile combustion emission (see Chapter 7). These biogenic CO_2 emissions may be reported optionally.

Note: CO_2 emission factors are calculated using the molar mass ratio of carbon dioxide to carbon (CO_2/C) of 44/12. Heat content factors are based on higher heating values (HHV). NA = data not available. A fraction oxidized value of 1.00 is used following the Intergovernmental Panel on Climate Change (IPCC), Guidelines for National Greenhouse Gas Inventories (2006).

Source: U.S. EPA, Inventory of Greenhouse Gas Emissions and Sinks: 1990-2005 (2007), Annex 2.1, Tables A-31, A-34, A-36, A-39, except those marked + (from EPA Climate Leaders Mobile Combustion Guidance). Methanol emission factor is calculated from the properties of the pure compounds.

Table C.4 Methane and Nitrous Oxide Emission Factors for Highway Vehicles by Model Year

Vehicle Types/Model Years	N_2O (g/mile)	CH_4 (g/mile)
Gasoline Passenger Cars		
Model Years 1984-1993	0.0647	0.0704
Model Year 1994	0.0560	0.0531
Model Year 1995	0.0473	0.0358
Model Year 1996	0.0426	0.0272
Model Year 1997	0.0422	0.0268
Model Year 1998	0.0393	0.0249
Model Year 1999	0.0337	0.0216
Model Year 2000	0.0273	0.0178
Model Year 2001	0.0158	0.0110
Model Year 2002	0.0153	0.0107
Model Year 2003	0.0135	0.0114
Model Year 2004	0.0083	0.0145
Model Year 2005 - Present	0.0079	0.0147
Gasoline Light Trucks (Vans, Pickup Trucks, SUVs)		
Model Years 1987-1993	0.1035	0.0813
Model Year 1994	0.0982	0.0646
Model Year 1995	0.0908	0.0517
Model Year 1996	0.0871	0.0452
Model Year 1997	0.0871	0.0452
Model Year 1998	0.0728	0.0391
Model Year 1999	0.0564	0.0321
Model Year 2000	0.0621	0.0346
Model Year 2001	0.0164	0.0151
Model Year 2002	0.0228	0.0178
Model Year 2003	0.0114	0.0155
Model Year 2004	0.0132	0.0152
Model Year 2005 - Present	0.0101	0.0157

Table C.4 Methane and Nitrous Oxide Emission Factors for Highway Vehicles by Model Year (continued)

Vehicle Types/Model Years	N_2O (g/mile)	CH_4 (g/mile)
Gasoline Heavy-Duty Vehicles		
Model Years 1985-1986	0.0515	0.4090
Model Year 1987	0.0849	0.3675
Model Years 1988-1989	0.0933	0.3492
Model Years 1990-1995	0.1142	0.3246
Model Year 1996	0.1680	0.1278
Model Year 1997	0.1726	0.0924
Model Year 1998	0.1693	0.0641
Model Year 1999	0.1435	0.0578
Model Year 2000	0.1092	0.0493
Model Year 2001	0.1235	0.0528
Model Year 2002	0.1307	0.0546
Model Year 2003	0.1240	0.0533
Model Year 2004	0.0285	0.0341
Model Year 2005 - Present	0.0177	0.0326
Diesel Passenger Cars		
Model Years 1960-1982	0.0012	0.0006
Model Years 1983 - Present	0.0010	0.0005
Diesel Light Trucks		
Model Years 1960-1982	0.0017	0.0011
Model Years 1983-1995	0.0014	0.0009
Model Years 1996 - Present	0.0015	0.0010
Diesel Heavy-Duty Vehicles		
All Model Years	0.0048	0.0051

Source: Gasoline vehicle factors from EPA Climate Leaders, Mobile Combustion Guidance, (2008) based on U.S. EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005 (2007). Diesel vehicle factors based on U.S. EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005 (2007), Annex 3.2, Table A-98.

Table C.5 Methane and Nitrous Oxide Emission Factors for Alternative Fuel Vehicles

Vehicle Type	N_2O (g/mile)	CH_4 (g/mile)
Light Duty Vehicles		
Methanol	0.067	0.018
CNG	0.050	0.737
LPG	0.067	0.037
Ethanol	0.067	0.055
Heavy Duty Vehicles		
Methanol	0.175	0.066
CNG	0.175	1.966
LNG	0.175	1.966
LPG	0.175	0.066
Ethanol	0.175	0.197
Biodiesel*	0.050	0.060
Buses		
Methanol	0.175	0.066
CNG	0.175	1.966
Ethanol	0.175	0.197

Source: U.S. EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005 (2007), Annex 3.2, Table A-100, except biodiesel.

* Biodiesel emission factor derived from California Energy Commission, Inventory of California Greenhouse Gas Emissions and Sinks: 1990-1999 (Draft: December 2001), Table 2-20.

Table C.6 Methane and Nitrous Oxide Emission Factors for Non-Highway Vehicles

Vehicle Type/Fuel Type	N_2O (g/gallon)	CH_4 (g/gallon)
Ships & Boats		
Residual Fuel Oil	0.30	0.86
Diesel Fuel	0.26	0.74
Gasoline	0.22	0.64
Locomotives		
Diesel Fuel	0.26	0.80
Agricultural Equipment		
Gasoline	0.22	1.26
Diesel Fuel	0.26	1.44
Construction		
Gasoline	0.22	0.50
Diesel Fuel	0.26	0.58
Other Non-Highway		
Snowmobiles (Gasoline)	0.22	0.50
Other Recreational (Gasoline)	0.22	0.50
Other Small Utility (Gasoline)	0.22	0.50
Other Large Utility (Gasoline)	0.22	0.50
Other Large Utility (Diesel)	0.26	0.58
Aircraft		
Jet Fuel	0.31	0.27
Aviation Gasoline	0.11	7.04
All Non-Highway/Construction Vehicles		
Butane*	0.41	0.09
Propane*	0.41	0.09

Source: U.S. EPA, Climate Leaders, Mobile Combustion Guidance (2008) based on U.S. EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005 (2007), Annex 3.2, Table A-101, except butane and propane.

* Butane and propane emission factors based on stationary combustion emission factors for these fuels from U.S. EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2000 (2002).

Emission Factors for Stationary Combustion

Table C.7 Carbon Dioxide Emission Factors for Stationary Combustion

Fuel Type	Carbon Content	Heat Content	Fraction Oxidized	CO_2 Emission Factor	CO_2 Emission Factor
Coal and Coke	kg C/ MMBtu	MMBtu/ short ton		kg CO_2/ metric ton	kg CO_2/MMBtu
Anthracite	28.26	25.09	1.00	2,865.77	103.62
Bituminous	25.49	24.93	1.00	2,568.39	93.46
Sub-bituminous	26.48	17.25	1.00	1,846.19	97.09
Lignite	26.30	14.21	1.00	1,510.49	96.43
Residential/Commercial	26.00	22.05	1.00	2,317.13	95.33
Industrial Coking	25.56	26.27	1.00	2,713.87	93.72
Other Industrial	25.63	22.05	1.00	2,284.16	93.98
Electric Power	25.76	19.95	1.00	2,077.10	94.45
Coke	31.00	24.80	1.00	3,107.29	113.67
Petroleum Products (Gaseous)	kg C/ MMBtu	Btu/ standard cubic foot		kg CO_2/ standard cubic foot	kg CO_2/MMBtu
Natural Gas (weighted U.S. average)	14.47	1,029	1.00	0.0546	53.06
Acetylene (C_2H_2)	19.48	1,476	1.00	.1043	71.42
Petroleum Products (Liquid)	kg C/ MMBtu	MMBtu/ barrel		kg CO_2/gallon	kg CO_2/MMBtu
Asphalt & Road Oil	20.62	6.636	1.00	11.95	75.61
Aviation Gasoline	18.87	5.048	1.00	8.32	69.19
Distillate Fuel Oil (#1,2&4)	19.95	5.825	1.00	10.15	73.15
Jet Fuel	19.33	5.670	1.00	9.57	70.88
Kerosene	19.72	5.670	1.00	9.76	72.31
LPG (average for fuel use)	17.23	3.849	1.00	5.79	63.16
Propane	17.20	3.824	1.00	5.74	63.07
Ethane	16.25	2.916	1.00	4.14	59.58
Isobutane	17.75	4.162	1.00	6.45	65.08
n-Butane	17.72	4.328	1.00	6.70	64.97
Lubricants	20.24	6.065	1.00	10.72	74.21
Motor Gasoline	19.33	5.218	1.00	8.81	70.88
Residual Fuel Oil (#5 & 6)	21.49	6.287	1.00	11.80	78.80
Crude Oil	20.33	5.800	1.00	10.29	74.54
Naphtha (<401 deg. F)	18.14	5.248	1.00	8.31	66.51
Natural Gasoline	18.24	4.620	1.00	7.36	66.88
Other Oil (>401 deg. F)	19.95	5.825	1.00	10.15	73.15

Table C.7 Carbon Dioxide Emission Factors for Stationary Combustion (continued)

Fuel Type	Carbon Content	Heat Content	Fraction Oxidized	CO_2 Emission Factor	CO_2 Emission Factor
Petroleum Products (Liquid)	kg C/ MMBtu	MMBtu/ barrel		kg CO_2/gallon	kg CO_2/MMBtu
Pentanes Plus	18.24	4.620	1.00	7.36	66.88
Petrochemical Feedstocks	19.37	5.428	1.00	9.18	71.02
Petroleum Coke	27.85	6.024	1.00	14.65	102.12
Still Gas	17.51	6.000	1.00	9.17	64.20
Special Naphtha	19.86	5.248	1.00	9.10	72.82
Unfinished Oils	20.33	5.825	1.00	10.34	74.54
Waxes	19.81	5.537	1.00	9.58	72.64
Non-Fossil Fuels (Solid)	kg C/ MMBtu	MMBtu/ short ton		kg CO_2/ metric ton	kg CO_2/MMBtu
Wood and Wood Waste (12% moisture content)*	25.60	15.38	1.00	1,591.35	93.87
Non-Fossil Fuels (Gas)	kg C/ MMBtu	Btu/ standard cubic foot		kg CO_2/ standard cubic foot	kg CO_2/MMBtu
Biogas*	14.20	502.50	1.00	varies	52.07

*The CO_2 emissions from burning wood, wood waste and biogas are considered biogenic and should not be included as a direct stationary emission in your inventory. You may report these emissions optionally. For biogas, please note that the values above are for the methane fraction of the biogas only. To report all of the biogenic CO_2 emissions associated with biogas, you would also need to report the CO_2 fraction of the biogas.

Note: CO_2 emission factors are calculated using the molar mass ratio of carbon dioxide to carbon (CO_2/C) of 44/12. Heat content factors are based on higher heating values (HHV). A fraction oxidized value of 1.00 is used following the Intergovernmental Panel on Climate Change (IPCC), Guidelines for National Greenhouse Gas Inventories (2006).

Source: U.S. EPA, Inventory of Greenhouse Gas Emissions and Sinks: 1990-2005 (2007), Annex 2.1, Tables A-31, A-32, A-35, and A-36, except: Heat Content factors for Coal (by sector), Naphtha (<401 deg. F), and Other Oil (>401 deg. F) (from U.S. Energy Information Administration, Annual Energy Review 2006 (2007), Tables A-1 and A-5) and Carbon Content and Heat Content factors for Coke and LPG and all factors for Wood and Wood Waste and Biogas (from EPA Climate Leaders, Stationary Combustion Guidance (2007), Tables B-1 and B-2). Acetylene factor derived from API Compendium (February 2004), Exhibit 4.1(a) and HHV from GPSA.

Table C.8 Methane and Nitrous Oxide Emission Factors for Stationary Combustion by Fuel Type and Sector

Fuel Type/End-Use Sector	CH_4 (kg/MMBtu)	N_2O (kg/MMBtu)
Coal		
Residential	0.316	0.0016
Commercial/Institutional	0.011	0.0016
Manufacturing/Construction	0.011	0.0016
Electric Power	0.001	0.0016
Petroleum Products		
Residential	0.011	0.0006
Commercial/Institutional	0.011	0.0006
Manufacturing/Construction	0.003	0.0006
Electric Power	0.003	0.0006
Natural Gas		
Residential	0.005	0.0001
Commercial/Institutional	0.005	0.0001
Manufacturing/Construction	0.001	0.0001
Electric Power	0.001	0.0001
Wood		
Residential	0.316	0.0042
Commercial/Institutional	0.316	0.0042
Manufacturing/Construction	0.032	0.0042
Electric Power	0.032	0.0042
Pulping Liquors		
Manufacturing	0.0025	0.0020

Source: EPA Climate Leaders, Stationary Combustion Guidance (2007), Table A-1, based on U.S. EPA, Inventory of Greenhouse Gas Emissions and Sinks: 1990-2005 (2007), Annex 3.1.

Table C.9 Methane and Nitrous Oxide Emission Factors for Stationary Combustion for Petroleum Products by Fuel Type and Sector

Fuel Type/End-Use Sector	CH_4 (kg/gallon)	N_2O (kg/gallon)
Residential		
Distillate Fuel	0.0015	0.0001
Kerosene	0.0015	0.0001
Liquefied Petroleum Gas (LPG)	0.0010	0.0001
Motor Gasoline	0.0014	0.0001
Residual Fuel	0.0016	0.0001
Propane	0.0010	0.0001
Butane	0.0011	0.0001
Commercial/Institutional		
Distillate Fuel	0.0015	0.0001
Kerosene	0.0015	0.0001
Liquefied Petroleum Gas (LPG)	0.0010	0.0001
Motor Gasoline	0.0014	0.0001
Residual Fuel	0.0016	0.0001
Propane	0.0010	0.0001
Butane	0.0011	0.0001
Manufacturing/Construction		
Distillate Fuel	0.0004	0.0001
Kerosene	0.0004	0.0001
Liquefied Petroleum Gas (LPG)	0.0003	0.0001
Motor Gasoline	0.0004	0.0001
Residual Fuel	0.0004	0.0001
Propane	0.0003	0.0001
Butane	0.0003	0.0001
Electric Power		
Distillate Fuel	0.0004	0.0001
Kerosene	0.0004	0.0001
Liquefied Petroleum Gas (LPG)	0.0003	0.0001
Motor Gasoline	0.0004	0.0001
Residual Fuel	0.0004	0.0001
Propane	0.0003	0.0001
Butane	0.0003	0.0001

Note: All emission factors were converted to kg/gallon using the petroleum products emission factors from Table C.8 and the heat content in MMBtu/barrel from Table C.7 specific to each petroleum fuel: heat content of fuel type (MMBtu/barrel) / 42 (barrels/gallon) x petroleum emission factor (kg/MMBtu) = petroleum emission factor (kg/gallon).

Source: Derived from EPA Climate Leaders, Stationary Combustion Guidance (2007), Table A-1, based on U.S. EPA, Inventory of Greenhouse Gas Emissions and Sinks: 1990-2005 (2007), Annex 3.1.