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CLIMATE LEADERS

GREENHOUSE GAS INVENTORY PROTOCOL CORE MODULE GUIDANCE

Optional Emissions from **Commuting, Business Travel and Product Transport**

CLIMATE LEADERS
U.S. Environmental Protection Agency

The Climate Leaders Greenhouse Gas Inventory Protocol is based on the Greenhouse Gas Protocol (GHG Protocol) developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD). The GHG Protocol consists of corporate accounting and reporting standards and separate calculation tools. The Climate Leaders Greenhouse Gas Inventory Protocol is an effort by EPA to enhance the GHG Protocol to fit more precisely what is needed for Climate Leaders. The Climate Leaders Greenhouse Gas Protocol consists of the following components:

- Design Principles Guidance
- Core Modules Guidance
- Optional Modules Guidance

All changes and additions to the GHG Protocol made by Climate Leaders are summarized in the Climate Leaders Greenhouse Gas Inventory Protocol Design Principles Guidance.

For more information regarding the Climate Leaders Program, visit us on the Web at www.epa.gov/climateleaders.

Introduction

Optional emissions are emissions from sources that are not part of a Partner's core direct or indirect emission sources but are a result of the Partner's activities. These emission sources are not owned or controlled by the Partner and are considered to be Scope 3 emissions under the Greenhouse Gas Protocol developed by the *World Resources Institute (WRI) and the World Business Council on Sustainable Development (WBCSD)*. Therefore, the emission calculation methodologies in this guidance document may not conform to methodologies for Scope 1 and Scope 2 emissions in other Climate Leaders guidance documents or from other nationally and internationally accepted protocols.

Although control options surrounding Scope 3 emissions can be limited (i.e., reduction in corporate business travel does not necessarily reduce GHG emissions from airline flights), Climate Leaders considers the quantification of these emissions as a good means of developing a more comprehensive view of a Partner's climate impact.

This document presents guidance for estimating optional GHG emissions resulting from mobile sources. Specifically, this guidance provides methodologies to estimate optional GHG emissions from employee commuting, business travel and product transport.

1.1 Greenhouse Gases Included

Greenhouse gas (GHG) emissions are produced by mobile sources as fossil fuels are burned. Carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) are emitted directly through the combustion of fossil fuels in different types of mobile equipment. While CO_2 can be reasonably estimated by applying an appropriate carbon content and fraction of carbon oxidized factor to the fuel quantity consumed, CH_4 and N_2O emissions depend largely on the emissions control equipment used (e.g., type of catalytic converter) and distance traveled. Emissions of these gases also vary with the efficiency and vintage of the combustion technology, as well as maintenance and operation practices. A more detailed discussion of the difference in the calculation methodologies for CO_2, CH_4, and N_2O emissions from mobile sources is provided in the Climate Leaders Guidance for *Direct Emissions from Mobile Combustion Sources*.

1.2 Optional Mobile Source Activities

GHG emissions from mobile sources that may be optionally reported by a Partner include:

- Employee business travel
- Employee commuting
- Product transport
  - — Transportation of sold products
  - — Transportation of purchased materials or goods
  - — Transportation of purchased fuels
  - — Transportation of waste

Partners should report optional GHG emissions only from the above activities that are relevant to their business, and for which they have reliable information. Also, Partners should only report optional GHG emissions from sources for

which a standardized calculation methodology exists, such as those provided in this document.

Care should be taken to assure that these optional mobile emission sources are not already included in the Partner's core direct emissions (e.g., vehicles owned or controlled by the Partner).

Methods for Estimating Emissions from Employee Business Travel

Optional GHG emissions associated with employee business travel are from ground and air transportation sources. This guidance specifically addresses GHG emissions from passenger vehicles, buses, railways, commuter transportation (e.g., subways), and commercial airplanes.

2.1 Passenger Vehicle Business Travel

The GHG emissions from passenger vehicle business travel are generally from gasoline or diesel rental and personal vehicles, and taxi cabs. This protocol provides guidance for estimating CO_2, CH_4, and N_2O emissions from passenger vehicle business travel, which are based on emission factors for cars, light-duty trucks (e.g., pick-up trucks, sport utility vehicles, etc.), and motorcycles.

The preferred methodology to estimate CO_2, CH_4, and N_2O emissions from passenger vehicle business travel is based on fuel usage, vehicle mileage, and vehicle/control technology. Partners should refer to the calculation methods provided in the Climate Leaders Guidance for *Direct Emissions from Mobile Combustion Sources (Tables A-1, and B-1)* to estimate the CO_2, CH_4, and N_2O emissions from these sources.

If Partners do not have enough data available to follow the methods in the Climate Leaders Guidance for *Direct Emissions from Mobile Combustion Sources*, then CO_2, CH_4, and N_2O emissions may be estimated with information on business travel distance. Specifically, emission factors in this section are provided in Table 1 in terms of the distance traveled by the vehicle regardless of the number of passengers (vehicle-mile).

The emission factors for Table 1 were derived from statistical information of passenger vehicle-miles, which is provided in Table VM-1 of the Federal Highway Administration *Highway Statistics 2005* along with CO_2, CH_4, and N_2O emissions data from transportation sector in the *U.S. Greenhouse Gas Emissions and Sinks: 1990–2005*. CO_2, CH_4, and N_2O emissions data for cars and light-duty trucks (i.e., light-duty trucks and other 2-axle, 4-tire vehicles) were obtained from Table 2-17 and CO_2 data for motorcycles were obtained from Table A-108 of the *U.S. Greenhouse Gas Emissions and Sinks: 1990–2005*. CH_4 and N_2O emissions data for motorcycles reflect the estimates of distance traveled by motorcycles with and without control technology multiplied by emissions factors for each configuration (see discussion of methodology and data sources in pages A102 to A105 of the *U.S. Greenhouse Gas Emissions and Sinks: 1990–2005*).

Table 1: Emission Factors for Passenger Vehicle Business Travel (vehicle-mile)

Vehicle Type	CO_2 Emission Factor (kg CO_2/vehicle-mile)	CH_4 Emission Factor (g CH_4/vehicle-mile)	N_2O Emission Factor (g N_2O/vehicle-mile)
Car	0.364	0.031	0.032
Light-duty Truck	0.519	0.036	0.047
Motorcycle	0.167	0.070	0.007

Equation 1 provides the method to determine emissions from passenger vehicle business travel in terms of vehicle miles. This equation can be used for business travel in passenger cars, light-duty trucks and motorcycles. Total CO_2-equivalent emissions are in kg units, vehicle distance in units of vehicle-mile and other values in the appropriate units provided in Table 1.

Equation 1: Passenger Vehicle Business Travel Emissions (vehicle-mile)

$$E = VMT * (EF_{CO2} + EF_{CH4} * 0.021 + EF_{N2O} * 0.310)$$

where:

E = Total CO_2-equivalent Emissions

VMT = Vehicle Miles Traveled

EF_{CO2} = CO_2 Emission Factor

EF_{CH4} = CH_4 Emission Factor

EF_{N2O} = N_2O Emission Factor

0.021 = Conversion Factor

0.310 = Conversion Factor

2.2 Rail Business Travel

The GHG emissions from rail business travel are comprised of transit rail (e.g., subway, tram), commuter rail, and intercity rail (e.g., Amtrak). This protocol provides guidance for estimating CO_2, CH_4, and N_2O emissions from rail business travel.

To estimate CO_2, CH_4, and N_2O emissions from these sources, the Partner should use the emission factors provided in Table 2. These emission factors are provided in terms of mass of emissions per passenger-mile.

The emission factors provided in Table 2 were derived from statistical information of railway services from Tables 9.10 to 9.12 and Tables A.13 to A.15 of the Center for Transportation Analysis, *Transportation Energy Data Book: Edition 26*. This annual statistical information (e.g., energy use, average trip length, etc.) was converted to emissions data by using emission rates from the Climate Leaders Guidance for *Direct Emissions from Mobile Combustion Sources* and *Indirect Emissions from Purchases/Sales of Electricity and Steam*. The conversion process is provided in Equation 2 for each type of rail system.

The calculation process is provided in Equation 2 for each of the rail type systems. The use of this equation is appropriate for intercity rail (e.g., Amtrak), commuter rail, and transit rail (e.g., trams and subways). Total CO_2-equivalent emissions are in kg units, passenger distance in units of passenger-mile and other values in the appropriate units provided in Table 2.

Equation 2: Rail Business Travel Emissions (passenger-mile)

$$E = PMT * (EF_{CO2} + EF_{CH4} * 0.021 + EF_{N2O} * 0.310)$$

where:

E = Total CO_2-equivalent Emissions

E = Passenger Miles Traveled

EF_{CO2} = CO_2 Emission Factor

EF_{CH4} = CH_4 Emission Factor

EF_{N2O} = N_2O Emission Factor

0.021 = Conversion Factor

0.310 = Conversion Factor

Table 2: CO_2, CH_4, and N_2O Emission Factors for Rail Business Travel (passenger-mile)

Rail System Type	CO_2 Emission Factor (kg CO_2/passenger-mile)	CH_4 Emission Factor (g CH_4/passenger-mile)	N_2O Emission Factor (g N_2O/passenger-mile)
Intercity Rail (e.g., Amtrak)	0.185	0.002	0.001
Commuter Rail	0.172	0.002	0.001
Transit Rail (e.g., Trams and Subways)	0.163	0.004	0.002

2.3 Bus Business Travel

The GHG emissions from bus business travel are primarily due to diesel fired buses and, to a lesser extent, other fuels such as compressed natural gas (CNG). This protocol provides guidance for estimating CO_2, CH_4, and N_2O emissions from bus business travel based on passenger-mile. To estimate CO_2, CH_4, and N_2O emissions from this source, the Partner should use the emission factors provided in Table 3. As mentioned previously, these emission factors are based on the assumption that the bus travel is conducted in buses mainly fueled by diesel. If the Partner has specific fuel information on the bus travel, they should refer to the Climate Leaders Guidance for *Direct Emissions from Mobile Combustion Sources*.

The emission factors in Table 3 were derived from statistical information on passenger-mile in Table VM-1 of the Federal Highway Administration's *Highway Statistics 2005*, along with emissions data from Table 2-17 from the *U.S. Greenhouse Gas Emissions and Sinks: 1990–2005*. CH_4 and N_2O emissions data for bus business travel were estimated from the values in Table 2-17 for "Other Trucks and Buses" and were apportioned based on fuel usage and vehicle type (see discussion of methodology and data sources in pages A102 to A105 of the *U.S. Greenhouse Gas Emissions and Sinks: 1990–2005*).

Equation 3 can be used to determine the emissions from bus business travel. Total CO_2-equivalent emissions are in kg units, passenger distance in units of passenger-mile and other values in the appropriate units provided in Table 3.

Table 3. Emission Factors for Bus Business Travel (passenger-mile)

CO_2 Emission Factor (kg CO_2/passenger-mile)	CH_4 Emission Factor (g CH_4/passenger-mile)	N_2O Emission Factor (g N_2O/passenger-mile)
0.107	0.0006	0.0005

Equation 3: Bus Business Travel Emissions (passenger-mile)

$E = PMT * (EF_{CO2} + EF_{CH4} * 0.021 + EF_{N2O} * 0.310)$

where:

E = Total CO_2-equivalent Emissions

PMT = Passenger Miles Traveled

EF_{CO2} = CO_2 Emission Factor

EF_{CH4} = CH_4 Emission Factor

EF_{N2O} = N_2O Emission Factor

0.021 = Conversion Factor

0.310 = Conversion Factor

2.4 Airline Business Travel

The GHG emissions from airline business travel are divided by flight distance. Specifically, the airline travel is divided into long, medium, and short hauls. This protocol provides guidance for estimating CO_2, CH_4, and N_2O emissions from airline business travel.

To estimate emissions from these sources, the Partner should use the emission factors provided in Table 4. These emission factors are provided in terms of mass of emissions per passenger-mile. Therefore, the Partner should obtain passenger-mile information for each category of flight distance and multiply that value by the appropriate emission factor.

The CO_2 emission factors provided in Table 4 were derived from an aggregate representation of typical emissions per passenger mile, Table 9, *UK DEFRA, Guidelines to Defra's Greenhouse Gas (GHG) Conversion Factors for Company Reporting*, June 2007. The CH_4 and N_2O emission factors were derived from statistical information of passenger-miles from Table 1-37 of the *Bureau of Transportation Statistics, National Transportation Statistics for 2007* along CH_4, and N_2O emissions data from the *U.S. Greenhouse Gas Emissions and Sinks: 1990–2005* (see discussion of methodology and data sources in pages A102 to A105). These emission factors do not include additional impacts of radiative forcing.

In cases where Partners do not have information on individual flight lengths of airline travel they may use a single passenger-mile emission factor for all airline travel based on emissions per passenger-mile of domestic and international commercial flights. The Partner should multiply the total passenger-mile traveled by the value in Table 4 for "Distance Not Known." These emission factors were derived from statistical information of passenger-mile from Table 1-37 of the Bureau of Transportation Statistics, *National Transportation Statistics for 2007* along CO_2 emissions data from Table A-110 of the *U.S. Greenhouse Gas Emissions and Sinks: 1990–2005*. Equation 4 is used to determine CO_2 emissions from aircraft business travel in terms of passenger-mile. Total CO_2-equivalent emissions are in kg units, passenger distance in units of passenger-mile and other values in the appropriate units provided in Table 4.

Table 4: Emission Factors for Airline Business Travel (passenger-mile)

Airline Travel Distance	CO_2 Emission Factor (kg CO_2/passenger-mile)	CH_4 Emission Factor (g CH_4/passenger-mile)	N_2O Emission Factor (g N_2O/passenger-mile)
Long Haul (≥ 700 miles)	0.185	0.0104	0.0085
Medium Haul (≥ 300 and < 700 miles)	0.229	0.0104	0.0085
Short Haul (< 300 miles)	0.277	0.0104	0.0085
Distance Not Known	0.271	0.0104	0.0085

Equation 4: Airline Business Travel Emissions (passenger-mile)

$$E = PMT * (EF_{CO2} + EF_{CH4} * 0.021 + EF_{N2O} * 0.310)$$

where:

E = Total CO_2-equivalent Emissions

PMT = Passenger Miles Traveled

EF_{CO2} = CO_2 Emission Factor

EF_{CH4} = CH_4 Emission Factor

EF_{N2O} = N_2O Emission Factor

0.021 = Conversion Factor

0.310 = Conversion Factor

Methods for Estimating Emissions from Employee Commuting

Optional GHG emissions associated with employee commuting travel occur from ground transportation sources. This guidance specifically addresses optional GHG emissions from passenger vehicles, buses, railways, and commuter transportation (e.g., subways).

3.1 Employee Commuting by Passenger Vehicle

The emissions from employee commuting by passenger vehicle are primarily from personal vehicles. This protocol provides guidance for estimating CO_2, CH_4, and N_2O emissions from employee commuting by passenger vehicle, which are based on emission factors for cars and light-duty trucks.

The methodology to estimate CO_2, CH_4, and N_2O emissions from employee commuting by passenger vehicle are based on fuel usage, vehicle mileage, and vehicle/control technology. Refer to the calculation methods provided in this document for passenger vehicle business travel (Section 2.1 Passenger Vehicle Business Travel) to estimate the CO_2, CH_4, and N_2O emissions from these sources wherever there is insufficient data to follow the Climate Leaders Guidance for *Direct Emissions from Mobile Combustion Sources*.

3.2 Employee Commuting by Rail

The emissions from rail employee commuting are due to transit rail (e.g. subway, tram), commuter rail, and intercity rail (e.g., Amtrak). This protocol provides guidance for estimating CO_2, CH_4 and N_2O emissions from employee commuting by rail.

The methodology to estimate CO_2, CH_4, and N_2O emissions from employee commuting by rail are based on employee passenger-mile traveled. Therefore, the Partner should obtain passenger-mile information per rail system type and multiply that value by the appropriate CO_2, CH_4, and N_2O emission factor. Refer to the calculation methods provided in this document for rail business travel (Section 2.2 Rail Business Travel) to estimate the CO_2, CH_4, and N_2O emissions from these sources.

3.3 Employee Commuting by Bus

The GHG emissions from bus business travel are primarily due to diesel fired buses and, to a lesser extent, other fuels such as compressed natural gas (CNG). This protocol provides guidance for estimating CO_2, CH_4, and N_2O emissions from bus employee commuting.

The methodology to estimate CO_2, CH_4, and N_2O emissions from employee commuting by bus are based on employee passenger-mile traveled. Therefore, the Partner should obtain bus passenger-mile information and multiply that value by the appropriate CO_2, CH_4, and N_2O emission factors. Refer to the calculation methods provided in this document for bus business travel (Section 2.3 Bus Business Travel) to estimate the CO_2, CH_4, and N_2O emissions from these sources.

Methods for Estimating Emissions from Product Transport

Optional GHG emissions associated with product transport stem from ground, air and waterborne transportation sources. This guidance specifically addresses the optional GHG emissions from passenger vehicles, trucks, railways, aircraft, and waterborne craft.

EPA's SmartWay Transport Partnership (SmartWay) has tools available on their Web site (www.epa.gov/smartway) to help companies calculate CO_2 emissions associated with product transport. These tools also help companies estimate potential emissions reductions from various strategies, including shipping more freight with fuel-efficient SmartWay carriers. Partners who are also participating in the SmartWay program may use the outputs from the SmartWay tools, as long as Partners identify the specific data and factors in their Inventory Management Plan. Partners should use the methodologies in this document to estimate CH_4 and N_2O emissions from any sources where SmartWay tools are used to determine CO_2 emissions.

4.1 On-Road Vehicle Product Transport

The GHG emissions from on-road vehicle product transport include those from gasoline or diesel, and to a lesser extent, other fuels such as compressed natural gas (CNG). This protocol provides guidance for estimating CO_2, CH_4, and N_2O emissions from on-road vehicle product transport, which are based on emission factors for passenger vehicles, light-duty trucks (i.e., light-duty trucks and other 2-axle, 4-tire vehicles), and medium and heavy-duty trucks (i.e., other trucks, single-unit 2-axle, 6-tire or more trucks, and combination trucks).

The methodology to estimate CO_2, CH_4, and N_2O emissions from on-road vehicle product transport is based on fuel usage, vehicle mileage, and vehicle/control technology. The Partner should refer to the calculation methods provided in the Climate Leaders Guidance for *Direct Emissions from Mobile Combustion Sources (Tables A-1 and B-1)* to estimate the CO_2, CH_4, and N_2O emissions from these sources.

If fuel usage or vehicle type information is not available, CO_2, CH_4, and N_2O emissions may be estimated based on vehicle-mile for all vehicle types or ton-mile for medium- and heavy-duty trucks. Emission factors for estimating emissions based on vehicle mileage are provided in Table 5.

The emission factors in Table 5 were derived from statistical information of annual vehicle distance traveled in miles from Table VM-1 of the U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics 2005* along with CO_2, CH_4, and N_2O emissions data for the transportation sector from Table 2-17 of the *U.S. Greenhouse Gas Emissions and Sinks: 1990–2005*. CH_4 and N_2O emissions data for medium and heavy-duty trucks (i.e., other trucks and buses) from Table 2-17 of the *U.S. Greenhouse Gas Emissions and Sinks, 1990-2005*, was apportioned based on fuel usage and vehicle type (see discussion of methodology and data sources in pages A102 to A105 of the *U.S. Greenhouse Gas Emissions and Sinks: 1990-2005*).

Table 5: Emission Factors for On-Road Vehicle Product Transport (vehicle-mile)

Vehicle Type	CO_2 Emission Factor (kg CO_2/vehicle-mile)	CH_4 Emission Factor (g CH_4/vehicle-mile)	N_2O Emission Factor (g N_2O/vehicle-mile)
Passenger Car	0.364	0.031	0.032
Light-duty Truck	0.519	0.036	0.047
Medium- and Heavy-duty Truck	1.726	0.021	0.017

The equation used to determine emissions from passenger vehicle product transport in terms of vehicle-miles is provided below. Total CO_2-equivalent emissions are in kg units, vehicle distance in units of vehicle-mile and other values in the appropriate units provided in Table 5.

Equation 5: On-Road Vehicle Product Transport Emissions (vehicle-mile)

$$E = VMT * (EF_{CO2} + EF_{CH4} * 0.021 + EF_{N2O} * 0.310)$$

where:

E = Total CO_2-equivalent Emissions

VMT = Vehicle Miles Traveled

EF_{CO2} = CO_2 Emission Factor

EF_{CH4} = CH_4 Emission Factor

EF_{N2O} = N_2O Emission Factor

0.021 = Conversion Factor

0.310 = Conversion Factor

In cases where Partners have information on ton-mile for on-road vehicle transport from medium- and heavy-duty trucks, the Partner should multiply the ton-mile activity data by the values in Table 6. The emission factors were derived from statistical information of freight transport from Table 1-46b of the Bureau of Transportation Statistics, *National Transportation Statistics for 2007* along with emissions data from the transportation sector from Table 2-17 of the *U.S. Greenhouse Gas Emissions and Sinks: 1990–2005*.

Table 6. Emission Factors for On-Road Truck Product Transport (ton-mile)

CO_2 Emission Factor (kg CO_2/ton-mile)	CH_4 Emission Factor (g CH_4/ton-mile)	N_2O Emission Factor (g N_2O/ton-mile)
0.297	0.0035	0.0027

The equation used to determine emissions from on-road vehicle product transport from medium- and heavy-duty trucks is provided below. Total CO_2-equivalent emissions are in kg units, transport distance in units of ton-mile, and other values in the appropriate units provided in Table 6.

Equation 6: On-Road Truck Product Transport Emissions (ton-mile)

$$E = TMT * (EF_{CO2} + EF_{CH4} * 0.021 + EF_{N2O} * 0.310)$$

where:

E = Total CO_2-equivalent Emissions

TMT = Ton Miles Traveled

EF_{CO2} = CO_2 Emission Factor

EF_{CH4} = CH_4 Emission Factor

EF_{N2O} = N_2O Emission Factor

0.021 = Conversion Factor

0.310 = Conversion Factor

4.2 Rail Product Transport

The GHG emissions from rail product transport are primarily due to diesel freight rail systems. This protocol provides guidance for estimating CO_2, CH_4, and N_2O emissions from rail product transport.

The methodology to estimate CO_2, CH_4, and N_2O emissions from rail product transport is based on fuel usage. The Partner should refer to the calculation methods provided in the *Climate Leaders Guidance for Direct Emissions from Mobile Combustion Sources* (Table A-6, B-1 and B-2) to estimate CO_2, CH_4, and N_2O emissions from these sources.

If fuel usage information is not available, CO_2, CH_4, and N_2O emissions may be estimated using the emission factors provided in Table 7. These emission factors were derived from statistical information of freight transport provided in Table 1-46b of the Bureau of Transportation Statistics, *National Transportation Statistics for 2007*, along with freight rail fuel consumption data provided in Table A.12 of the Center for Transportation Analysis, *Transportation Energy Data Book: Edition 26* as well as personal communications with the American Short Line Railroad Association. In the case of CH_4 and N_2O emissions, fuel consumption data from the above sources were converted to emissions data by using the emission rates in Table A-6 of the *Climate Leaders Guidance for Direct Emissions from Mobile Combustion Sources*.

The methodology for estimating emissions from rail product transport is provided in the following equation. Total CO_2-equivalent emissions are in kg units, transport distance in units of ton-mile and other values in the appropriate units provided in Table 7.

Table 7. Emission Factors for Rail Product Transport (ton-mile)

CO_2 Emission Factor (kg CO_2/ton-mile)	CH_4 Emission Factor (g CH_4/ton-mile)	N_2O Emission Factor (g N_2O/ton-mile)
0.0252	0.002	0.0006

Equation 7: Rail Product Transport Emissions (ton-mile)

$$E = TMT * (EF_{CO2} + EF_{CH4} * 0.021 + EF_{N2O} * 0.310)$$

where:

E = Total CO_2-equivalent Emissions

TMT = Ton Miles Traveled

EF_{CO2} = CO_2 Emission Factor

EF_{CH4} = CH_4 Emission Factor

EF_{N2O} = N_2O Emission Factor

0.021 = Conversion Factor

0.310 = Conversion Factor

4.3 Waterborne Craft and Aircraft Product Transport

The methodology to estimate CO_2, CH_4, and N_2O emissions from waterborne craft and aircraft product transport is based on fuel usage. The Partner should refer to the calculation methods provided in the *Climate Leaders Guidance for Direct Emissions from Mobile Combustion Sources* (Tables A-6, B-1 and B-2) to estimate CO_2, CH_4, and N_2O emissions from these sources.

If Partners do not have enough data available to follow the methods in the *Climate Leaders Guidance for Direct Emissions from Mobile Combustion Sources*, then CO_2, CH_4, and N_2O emissions may be estimated with distance information (ton-mile) on waterborne craft or and/or aircraft product transport. The emission factors based on ton-mile data are provided in Table 8.

The emissions factors in Table 8 for waterborne craft reflect freight ton-mile data from Table 1-46b in *National Transportation Statistics 2008* (table was published in July 2007) and calcula-

Table 8: Emission Factors for Waterborne Craft and Aircraft Product Transport (ton-mile)

Transport Type	CO_2 Emission Factor (kg CO_2/ton-mile)	CH_4 Emission Factor (g CH_4/ton-mile)	N_2O Emission Factor (g N_2O/ton-mile)
Waterborne Craft	0.048	0.0041	0.0014
Aircraft	1.527	0.0417	0.0479

tions used to develop emissions summarized in Table A-101 of the *Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2006*. The Inventory's passenger- and freight-specific estimates were developed by assuming that all residual oil-powered ships are engaged in freight movement; all gasoline-powered vessels are engaged in passenger transport, and that diesel powered vessels serve both functions. The freight component reflects total waterborne diesel, less diesel associated with recreational boats, the latter of which reflects estimates from EPA's NONROAD model. CO_2 emissions by fuel type are summarized in Table 3-7 of the *Inventory of U.S. Greenhouse Gas Emissions and Sinks*. Fuel consumption estimates for recreational boats (passenger) and ships and boats (freight) are shown in Table A-74 of the *Inventory of U.S. Greenhouse Gas Emissions and Sinks*. To compute CH_4 and N_2O emissions, these fuel consumption estimates can be multiplied by emissions factors shown in Table A-90 of the *Inventory of U.S. Greenhouse Gas Emissions and Sinks*.

The emissions factors in Table 8 for commercial aircraft were taken from ton-mile data from Table 1-46b in National Transportation Statistics 2008 and calculations used to develop Table A-101 in the *Inventory of U.S. Greenhouse Gas Emissions and Sinks*. The passenger- and freight-specific estimates were developed by determining the relative weight of passengers and freight carried on commercial aircraft. As described on page A-123 of the *Inventory of U.S. Greenhouse Gas Emissions and Sinks*, it was assumed that an average passenger weighs 150 pounds and travels with 50 pounds of luggage; estimates of freight and mail weight were taken from Bureau of Transportation Table T-100, available at www.transtats.bts.gov/Fields.asp?Table_ID=310.

The methodology for estimating emissions for waterborne craft and aircraft product transport in terms of ton miles is provided in Equation 8. Total CO_2-equivqlent emissions are in kg units, transportation distance in units of ton-mile and other values in the appropriate units provided in Table 8.

Equation 8: Waterborne Craft and Aircraft Product Transport Emissions (ton-mile)

$$E = TMT * (EF_{CO2} + EF_{CH4} * 0.021 + EF_{N2O} * 0.310)$$

where:

E = Total CO_2-equivalent Emissions

TMT = Ton Miles Traveled

EF_{CO2} = CO_2 Emission Factor

EF_{CH4} = CH_4 Emission Factor

EF_{N2O} = N_2O Emission Factor

0.021 = Conversion Factor

0.310 = Conversion Factor

Completeness

In order for a Partner's corporate GHG inventory to be complete, it must include all emission sources within the company's inventory boundaries. See Chapter 3 of the *Climate Leaders Design Principles* for detailed guidance on setting organizational boundaries and Chapter 4 of the *Climate Leaders Design Principles* for detailed guidance on setting operational boundaries of the corporate inventory. Organizational boundaries are not typically applied to optional source reporting. However, EPA suggests that Partners report all optional emissions that are applicable with each included source category (e.g., employee commuting emissions for all corporate employees).

Additional optional GHG emission sources not addressed in this guidance may include stationary fuel combustion, purchases of electricity, HFC emissions from air conditioning equipment and process or fugitive related emissions of sources upstream or downstream to the Partner. Partners should refer to this guidance document and to the Climate Leaders core guidance documents as appropriate. For example, to calculate optional HFC and PFC emissions from employee commuting vehicle air conditioning equipment the Partner should refer to the Climate Leaders Guidance for *Direct HFC and PFC Emissions from Use of Refrigeration and Air Conditioning Equipment*.

As described in Chapter 1 of the *Climate Leaders Design Principles*, there is no materiality threshold set for reporting emissions. The materiality of a source can only be established after it has been assessed. Partners are strongly encouraged to include all sources within their organizational boundary for which there is verifiable data when considering optional sources. The inventory should also accurately reflect the timeframe of the report. In the case of Climate Leaders, the emissions inventory is reported annually and should represent a full year of emissions data.

Uncertainty Assessment

There is uncertainty associated with all methods of calculating optional CO_2 emissions from mobile combustion sources. As outlined in Chapter 7 of the *Climate Leaders Design Principles*, Climate Leaders does not require Partners to quantify uncertainty as +/-% of emissions estimates or in terms of data quality indicators.

Climate Leaders recommends that Partners attempt to identify any areas of uncertainty in their optional emissions estimates and make an effort to use the most accurate data possible. The accuracy of estimating emissions from fossil fuel combustion in mobile sources is partially determined by the availability of data on the amount of fuel consumed or purchased. If the amount of fuel combusted is directly measured or metered, then the resulting uncertainty should be fairly low. Data on the quantity of fuel purchased should also be a fairly accurate representation of fuel combusted, given that any necessary adjustments are made for changes in fuel inventory, fuel used as feedstock, etc. However, uncertainty may arise if only the dollar value of fuels purchased is used to estimate fuel consumption. If the bottom-up method is used to determine fuel use, uncertainty may arise if distance traveled and/or fuel economies are estimated.

The accuracy of estimating optional emissions from mobile combustion sources is also determined by the factors used to convert fuel use into emissions. Uncertainty in the factors is primarily due to the accuracy with which they are measured, and the variability of the supply source.

Reporting and Documentation

Partners who choose to report optional emissions from mobile combustion sources are required to complete the Climate Leaders Reporting Requirements. In order to ensure that estimates are transparent and verifiable, the documentation sources listed in Table 9 should be maintained. These documentation sources should be collected to ensure the accuracy and transparency of the related emissions data, and should also be reported in a Partner's Inventory Management Plan (IMP).

Table 9: Documentation Sources for Optional GHG Emissions from Mobile Combustion

Vehicle Type	Documentation Source
Highway Vehicles	Records of vehicle-mile traveled, passenger-mile traveled or ton-mile of freight transported (must be given by vehicle type)
Air Transport	Distance traveled (passenger-mile), Fuel usage (ton-mile)
Waterborne Transport	Fuel usage (ton-mile)
Rail Transport	Distance traveled (passenger-mile traveled or ton-mile of freight transported)

Inventory Quality Assurance and Quality Control (QA/QC)

Chapter 7 of the *Climate Leaders Design Principles* provides general guidelines for implementing a QA/QC process for all emission estimates. For optional GHG emissions from mobile combustion sources, the activity data and emission factors can be verified using a variety of approaches:

- Fuel energy use data can be compared with data provided to the Department of Energy or other EPA reports or surveys.
- If any emission factors were calculated or obtained from the fuel supplier, these factors can be compared to U.S. average emission factors.
- Partners should review all activity data (e.g., fuel consumption data, distance traveled estimates), as well as any information used to develop customized emission factors (e.g., location of fuel purchases, aircraft fuel consumption).
- Fuel use calculations can be checked through a comparison of the bottom-up and top-down approaches. These approaches are discussed in more detail in the Climate Leaders Guidance for *Direct Emissions from Mobile Combustion Sources*.
- Cross checks using back-calculation of fuel economy can highlight order-of-magnitude errors.

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