

NC Greenhouse Gas Emission (GHG) Inventory Instructions

April 2009

Status of the Reporting Rule

Adoption of the Annual Emissions Reporting Rule (15A NCAC 02Q .0207) that adds reporting of greenhouse gas (GHG) emissions, will not be in effect prior to this year's inventory submittal due date. As a result, the Division of Air Quality will **not** require Title V facilities to include GHG emissions in their regular emission inventory for calendar year 2008 (to be submitted by June 30, 2009). NC facilities are encouraged to report their 2008 GHG emissions voluntarily.

The Environmental Management Commission (EMC) is scheduled to vote on the Annual Emissions Reporting Rule later this year. If the EMC votes to adopt the rule, the Rules Review Commission will review the amendments prior to the rule becoming state effective. Based on the outcome of these decisions, NC Title V facilities may be required to include GHG emissions for calendar year 2009 (to be submitted by June 30, 2010).

Voluntary emissions estimation and reporting will help facilities determine if they will be subject to the newly proposed Federal Mandatory GHG Reporting Rule (<http://www.epa.gov/climatechange/emissions/ghgrulemaking.html>), and will help facilities prepare for reporting of calendar year 2009 emissions.

For either voluntary or mandatory reporting, facilities will not be billed for greenhouse gas emissions in their air permit fees.

The following sections provide instructions for reporting GHG emissions, background information on GHGs and provide references on available calculation methodologies and tools that could be used for estimating GHG emissions. These instructions will be aligned with the Federal Mandatory GHG Reporting Rule after EPA issues a final rule, as deemed appropriate by the Division of Air Quality.

Voluntary Reporting Instructions for 2008 Emissions

Actual Point Source emission estimates will be reported in the units of short tons (US) per year, unless otherwise specified. North Carolina GHG emission inventory process requires estimation of only larger and direct emissions (i.e., emissions originating from processes on-site, not from related vehicle fleets, electricity purchased from off-site supplier, etc.). Firms reporting GHG emissions for programs such as [The Climate Registry](#) and [EPA's Climate Leaders](#) are required to report both direct and in-direct emissions. Table 1 identifies the GHGs to be reported.

Table 1. GHGs Required in NC Emission Inventory

Carbon Dioxide (CO ₂)
Methane
Nitrous Oxide (N ₂ O)
Sulfur Hexafluoride (SF ₆)
Perfluorocarbons (PFCs), see Table 2
Hydrofluorocarbons (HFCs), see Table 2

North Carolina Title V facilities reporting GHG emissions will follow the same procedures as those used to report criteria, hazardous, and toxic air pollutants. That is, GHG emissions will be reported for all permitted sources and sources listed in the Insignificant Activities List of their air permit. Emission sources defined as insignificant may be excluded from reporting if (1) criteria pollutants, hazardous air pollutants, and toxic air pollutants are not required to be reported for those sources or (2) the facility-wide total GHG emission rate is below the thresholds listed in Table 2. The reporting thresholds have been assigned to identify larger sources and minimize reporting of smaller incidental emissions, and are subject to revision based on practical experience. If a valid argument can be made for different values, the reporting community should make this comment early in the process.

Certain emission sources, identified as neither permitted nor insignificant are exempt from reporting as discussed in [Annual Air Pollutant Point Source Emissions Inventory Instructions \(Pg. 9-10\)](#). NC Rule (15A NCAC 02Q .0102) defines specific sources that are generally not required to be reported. Examples include: air conditioning/ventilation systems, space/comfort heaters, certain types of storage tanks, internal combustion engines for landscaping purposes, and fugitive emissions from certain Title V sources. DAQ recognizes that some of these sources emit GHGs; and in some cases, may be significant contributors to facility-wide total emissions. DAQ is currently leaving the decision to include such sources at the discretion of the facility. DAQ welcomes voluntary reporting of these sources to further our understanding and characterization of GHG sources. These sources may be reported under the designation *GHG*.

All emissions will be reported via the [Air Emissions Reporting On-line \(AERO\)](#) tool. It is accessible by permitted facilities required to provide an emission inventory update as defined in a notification letter mailed from DAQ. Authorized facility staff must use the User ID and PIN sent in the notification letter that defined the inventory requirement. From this web page, instructions are provided to download and print the required forms that have been pre-filled with facility information from DAQ's database, or to access the on-line update capability.

This document provides information and guidance on estimating GHG emissions from the type of sources typically encountered in North Carolina. The instructions are developed based on our current state of knowledge. DAQ expects to modify the instructions using lessons learned from the voluntary reporting period and feedback received from NC reporters. Further improvements will be made as additional guidance is provided from future federal programs and other inventory efforts.

Table 2. GHG Reporting Thresholds and Global Warming Potentials

CAS or Pollutant Code	Chemical Formula	Chemical Name	Facility-Wide Reporting Threshold (ton/year) ^a	100-Year GWP	
				IPCC 1995 ^b	IPCC 2001 ^c
124389	CO ₂	Carbon Dioxide	5,000	1	1
74828	CH ₄	Methane	10	21	23
10024972	N ₂ O	Nitrous Oxide	1	310	296
2551624	SF ₆	Sulfur Hexafluoride	0.05	23,900	22,200
Perfluorocarbons (PFC)					
115253	C ₄ F ₈	Perfluorocyclobutane (octafluorocyclobutane)	0.05	8,700	10,000
355259	C ₄ F ₁₀	Perfluorobutane (decafluorobutane)	0.05	7,000	8,600
76164	C ₂ F ₆	Perfluoroethane (hexafluoroethane)	0.05	9,200	11,900
355420	C ₆ F ₁₄	Perfluorohexane (tetradecafluorohexane)	0.05	7,400	9,000
75730	CF ₄	Perfluoromethane (tetrafluoromethane)	0.05	6,500	5,700
678262	C ₅ F ₁₂	Perfluoropentane (dodecafluoropentane)	0.05	7,500	8,900
76197	C ₃ F ₈	Perfluoropropane (octafluoropropane)	0.05	7,000	8,600
Hydrofluorocarbons (HFC)					
75467	CHF ₃	HFC-23 (trifluoromethane)	0.05	11,700	12,000
75105	CH ₂ F ₂	HFC-32 (difluoromethane)	0.05	650	550
593533	CH ₃ F	HFC-41 (fluoromethane)	0.05	150	97
138495428	CF ₃ CHFCHFCF ₂ CF ₃	HFC-43 10mee (1,1,1,2,3,4,4,5,5,5-decafluoropentane)	0.05	1,300	1,500
354336	CHF ₂ CF ₃	HFC-125 (pentafluoroethane)	0.05	2,800	3,400
359353	CHF ₂ CHF ₂	HFC-134 (1,1,2,2-tetrafluoroethane)	0.05	1,000	1,100
811972	CH ₂ FCF ₃	HFC-134a (1,1,1,2-tetrafluoroethane)	0.05	1,300	1,300
430660	CHF ₂ CH ₂ F	HFC-143 (1,1,2-trifluoroethane)	0.05	300	330
420462	CF ₃ CH ₃	HFC-143a (1,1,1-trifluoroethane)	0.05	3,800	4,300
624726	CH ₃ FCH ₂ F	HFC-152 (1,2-difluoroethane)	0.05	43*	43
75376	CH ₃ CHF ₂	HFC-152a (1,1-difluoroethane)	0.05	140	120
353366	CH ₃ CH ₂ F	HFC-161 (fluoroethane)	0.05	12*	12
431890	CF ₃ CHFCF ₃	HFC-227ea (1,1,1,2,3,3,3-heptafluoropropane)	0.05	2,900	3,500
60598110	CH ₂ FCF ₂ CF ₃	HFC-236cb (1,1,1,2,2,3-hexafluoropropane)	0.05	1,300*	1,300
431630	CHF ₂ CHFCF ₃	HFC-236ea (1,1,1,2,3,3-hexafluoropropane)	0.05	1,200*	1,200
690391	CF ₃ CH ₂ CF ₃	HFC-236fa (1,1,1,3,3,3-hexafluoropropane)	0.05	6,300	9,400
679867	CH ₂ FCF ₂ CHF ₂	HFC-245ca (1,1,2,2,3-pentafluoropropane)	0.05	560	640
460731	CHF ₂ CH ₂ CF ₃	HFC-245fa (1,1,3,3-	0.05	950*	950

		pentafluoropropane)			
431630	CF ₃ CH ₂ CF ₂ CH ₃	HFC-365mfc (1,1,1,3,3-pentafluorobutane)	0.05	890*	890
<p>^a For sources listed in the Insignificant Activities List of the facility's air permit.</p> <p>^b Source: Intergovernmental Panel on Climate Change, Second Assessment Report, 1995</p> <p>^c Source: Intergovernmental Panel on Climate Change, Third Assessment Report, 2001: Climate Change 2001: The Scientific Basis</p> <p><u>Note:</u> The standard practice used by EPA, TCR, and other organizations is to use IPCC 2nd Assessment Reported GWPs. Conversion to more updated GWPs may occur in the coming years. To maintain consistency, the NC DAQ will convert mass emission rates of GHGs to CO₂ equivalent basis using the GWPs used by EPA, currently IPCC 1995.</p> <p>* Assigned based on IPCC 2001 GWPs.</p>					

Greenhouse Gas Overview

Gases that trap heat in the atmosphere are often called greenhouse gases (GHG). For more information on the science of climate change, please visit [EPA's Climate Change science home page](#). Some GHGs, such as methane (CH₄) and carbon dioxide (CO₂), also occur naturally and are emitted to the atmosphere through natural processes as well as human activities. Other GHGs such as fluorinated gases are created and emitted solely through human activities. The principal GHG that enter the atmosphere because of human activities are:

- **Carbon Dioxide (CO₂)**: Carbon dioxide enters the atmosphere through the burning of fossil fuels (oil, natural gas, and coal), solid waste, trees and wood products, and also as a result of other chemical reactions (e.g., manufacture of cement). Since combustion is a stoichiometric chemical reaction, the relation of CO₂ to carbon burned is well established (12 pounds of carbon burn to form 44 pounds of CO₂). CO₂ is also removed from the atmosphere (or “sequestered”) when it is absorbed by plants as part of the biological carbon cycle, absorbed through the ocean-atmosphere exchange, or as they may be permanently injected into receptive geological strata.
- **Methane (CH₄)**: Methane is emitted naturally from the ground, mines, and ocean and during the production and transport of coal, natural gas, and oil. Methane emissions also result from the decomposition of livestock waste and other agricultural operations and by the anaerobic decay of organic waste in landfills, sewage treatment and many other operations. Estimation of accurate methane emissions may be difficult, as methane has traditionally been systematically excluded from the federal definition of Volatile Organic Compounds (VOC) for emission inventory reporting purposes. In this case, some test methods for determining “non-methane” VOC have resulted in destruction of the methane before quantification. A strong effort to establish typical emissions for methane from a source or source category may be necessary before the related emission factors are reasonably adequate.
- **Nitrous Oxide (N₂O)**: Nitrous oxide is emitted during agricultural and industrial activities. There are also limited emissions during combustion of fuels and solid waste. However, under complete combustion situations, most oxides of nitrogen will tend to be more completely oxidized to NO₂, which is not considered a GHG.
- **Fluorinated Gases**: Hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride are synthetic compounds. They are potent greenhouse gases that are emitted from a variety of industrial

processes and leaks. Fluorinated gases are sometimes used as substitutes for [ozone-depleting substances](#) (i.e. CFCs, HCFCs, and halons). These gases are typically emitted in smaller quantities, but because of their potency, they are sometimes referred to as High Global Warming Potential gases (“High GWP gases”). A detailed list of gases identified by the [Intergovernmental Panel on Climate Change](#) as GHGs is listed below.

Global Warming Potential

Due to their infrared radiation absorption characteristics, each GHG generally has a different *global warming potential*. Studies have provided a “potency” factor for many individual substances. This factor defines the infrared radiation trapping potential of these substances relative to that of CO₂ and establishes these ratios as a number (absolute or unit-less) to estimate the Global Warming Potential (GWP) of that substance. This ratio times the quantity emitted results in the CO₂ equivalency (CO₂e) of those emissions. For example, a ton of methane is approximately equivalent (regarding the light/energy retention of the atmosphere) to 21 tons of CO₂.

When reporting GHG emissions to NC DAQ, facilities must report actual emissions (i.e., do not report equivalencies). Table 2 contains the GWP factors for information purposes only. The DAQ online emission inventory reporting system, AERO, will perform these calculations and report both the raw emissions and the CO₂e emissions. However, separate voluntary reporting to groups such as [The Climate Registry](#) may require reporting in GHG equivalents in accordance with their respective protocols.

Emission Factors and Emission Estimation Methods

The NC emission inventory process generally requires the estimation of only larger and direct emissions. Emissions to be reported will be on a scale of short tons (US) per year. Major categories to include in your GHG emission inventory are:

- Stationary Combustion
- Process Emissions
- Fugitive Emissions

Emission factors for common GHG sources (e.g., combustion of various carbon-based fuels) have been developed and tabulated in many places. Usually, these factors are in good agreement, but may be in units that are not familiar to some users. The [IPCC](#) has developed internationally accepted methods and factors for preparing GHG inventories and other groups such as [TCR](#), [The California Climate Action Registry](#), [EPA](#), and [The Greenhouse Gas Protocol Initiative](#) are constantly improving on the volume, variety, and detail of such emission factors.

The [Revised 1996 IPCC Guidelines](#), along with [IPCC Good Practice](#), form the basis of existing U.S. (national) and many individual state inventories. The [2006 IPCC Guidelines](#) contain updated and expanded information that may prove useful to some facilities in these efforts. The IPCC Guidelines provide flexibility to use a range of methods and data, reflecting the diversity of national circumstances around the world. North Carolina’s instructions and procedures are intended to take full advantage of the existence of these guidelines and their flexibility so that they apply specifically to situations that exist in North Carolina.

DAQ has prepared guideline documents for several GHG emission sources. The emission calculation routines for some of these sources have been integrated into DAQ spreadsheets. The facilities may use either the guideline document or spreadsheets to determine site-specific GHG emissions. Users may access them by clicking on the links listed below. Emission sources for which DAQ guidelines have not yet been finalized, facilities are encouraged to use the methods developed by many respectable organizations (see links below).

Table 3. GHG Emission Estimation Guidance Documents

Emission Sources	Main Features	Primary GHGs Emitted	Guidance Document (s)	Calculation Tool (s)
Stationary Combustion	<ul style="list-style-type: none"> - Outlines procedures for calculating direct GHG emissions from combustion of fuels in stationary equipment - Emission factors are provided for different fuels - Equipment includes boilers, burners, turbines, heaters, furnaces, internal combustion engines, kilns, ovens, thermal oxidizers, dryers, and flares 	<u>CO₂, CH₄, N₂O</u>	DAO Guideline Document	DAO Spreadsheets for Estimating Emissions Coal Combustion Internal Combustion – small gasoline and diesel engines Internal Combustion – large gasoline and diesel engines Fuel Oil Combustion LPG Combustion Natural Gas Combustion Wood Waste Combustion
Refrigeration And Air Conditioning	<ul style="list-style-type: none"> - Provides guidance on determining direct fugitive emissions of HFCs and PFCs - Emissions are based on refrigerant type, refrigerant charge, and annual leak rates - Equipment include commercial and industrial refrigeration and air conditioning systems 	<u>HFC, PFC</u>	TCR General Reporting Protocol, Chapter 16	Emission Calculation Worksheet
			EPA – Climate Leaders GHG Inventory Guidance, Direct HFC and PFC Emissions from Refrigeration and AC Equipment	
			The GHG Protocol Initiative – HFC and PFC emissions from Refrigeration and AC Equipment	
Industrial Sectors				
Adipic Acid Production	<ul style="list-style-type: none"> - Provides mass balance approach for determining process emissions from production of nylon fibers and plastics, plasticizer for polyvinyl chloride, etc - Provides default and plant-specific emission factors 	<u>N₂O</u>	TCR General Reporting Protocol, Appendix E.1	Emission Calculation Worksheet
			The GHG Protocol Initiative – N₂O Emissions From Production of Adipic Acid	
Aluminum Production	<ul style="list-style-type: none"> - Provides process-specific mass balance approach for CO₂ emissions from carbon anode 	<u>CO₂, PFC</u>	TCR General Reporting Protocol, Appendix E.2	

	oxidation, electrolysis, and PFC and fugitive emissions from fuel line, HFC and PFC usage - Provides site-specific and generic methods for calculating PFC emissions by technology type		The GHG Protocol Initiative – CO₂ Emissions From Production of Aluminum	Emission Calculation Worksheet
Ammonia Production	- Provides plant specific carbon content of feedstock fuels	<u>CO₂</u>	TCR General Reporting Protocol, Appendix E.3	
			The GHG Protocol Initiative – CO₂ Emissions From Production of Ammonia	Emission Calculation Worksheet
Cement Production	- Provides clinker method and mass balance approach for determining CO ₂ emissions from calcinations of limestone	<u>CO₂</u>	TCR General Reporting Protocol, Appendix E.4	
			The GHG Protocol Initiative – CO₂ Emissions From Production of Cement	Emission Calculation Worksheet
Electricity Transmission and Distribution	- Provides mass balance approach for determining fugitive emissions from electric systems	<u>SE₆</u>	TCR General Reporting Protocol, Appendix E.5	
HCFC-22 Production	- Provides mass balance approach for determining process emissions from HFC venting and fugitive emissions from HFC use - Emission factors based on process efficiencies and production data are provided	<u>HFC</u>	TCR General Reporting Protocol, Appendix E.6	
			The GHG Protocol Initiative – HCFC-23 Emissions From Production of HCFC-22	Emission Calculation Worksheet
Iron and Steel Production	- Provides mass balance approach for determining process emissions (crude iron oxidation, consumption of reducing agent, and carbon content of crude iron/ferroalloys) and fugitive emissions - Emission factors based on plant-specific and carbon content data are provided	<u>CO₂</u>	TCR General Reporting Protocol, Appendix E.7	
			The GHG Protocol Initiative – CO₂ Emissions From Production of Iron and Steel	Emission Calculation Worksheet
			EPA – Climate Leaders GHG Inventory Guidance, Direct Emissions from Iron and Steel Production	
Lime Production	- Provides mass balance approach for determining emissions using production and carbonate inputs	<u>CO₂</u>	TCR General Reporting Protocol, Appendix E.8	

			The GHG Protocol Initiative – CO₂ Emissions From Production of Lime	Emission Calculation Worksheet
Municipal Solid Waste Disposal (landfilling), excluding flares	- Provides guidance on determining direct emissions from methane generation in landfills and fugitive losses from landfill gas control systems - NOTE: landfill flare CO ₂ and CH ₄ emissions are covered in stationary source combustion	<u>CH₄</u>	EPA – Climate Leaders GHG Inventory Guidance, Direct Emissions From MSW Landfilling	
Pulp and Paper Production	- Provides mass balance approach for determining emissions from make-up carbonates used in pulp mill and from limestone/dolomite used in flue gas desulfurization - Provides estimation approach for waste treatment processes at landfills	<u>CO₂, CH₄</u>	TCR General Reporting Protocol, Appendix E.10	
			The GHG Protocol Initiative – GHG Emissions From Pulp and Paper Mills	Emission Calculation Worksheet
Refrigeration and AC Equipment Manufacturing	- Provides mass balance approach using refrigerant data	<u>HFC, PFC</u>	TCR General Reporting Protocol, Appendix E.11	
Semiconductor Manufacturing	- Methods for determining process emissions from wafer fabrication and fugitive emissions from process gas storage leaks are provided	<u>PFC, SF₆</u>	TCR General Reporting Protocol, Appendix E.12	
Oil and Natural Gas	- Describes options and recommendations for accounting and reporting GHG emissions from natural gas transmission, storage and distribution facilities - Chapters VI.6.1 and VI.6.2 cover non-routine activities for transmission and distribution, and Chapter VII covers fugitives	<u>CO₂</u>	World Resources Institute Discussion Paper for a Natural Gas Transmission and Distribution Greenhouse Gas Reporting Protocol Final Draft Report (see Chapters VI.6.1, VI.6.2 and VII)	
Municipal Solid Waste Combustion, Limestone and Dolomite Use, Soda ash Consumption	Guidance being developed	<u>CH₄, CO₂</u>	Use guidance developed by Iowa until DAQ guidance is completed	

Note 1: Caution should be exercised in converting units between English and Metric systems
Note 2: Guidelines/protocols should be read carefully to avoid double counting of emissions
Note 3: For the following industrial sectors, combustion source emissions should also be added (where applicable) to process and fugitive emissions total:

- Aluminum: bauxite to aluminum processing, coke baking, lime, soda ash and fuel use, on-site CHP
- Iron and Steel: coke, coal and carbonate fluxes, boilers, flares
- Adipic Acid: boilers, flaring, reductive furnaces, flame reactors, steam reformers
- Cement and Lime: clinker kiln, drying of raw materials, etc.
- Municipal Solid Waste: incinerators, boilers, flares
- Pulp and Paper: production of steam and electricity, fossil fuel-derived emissions from calcinations of calcium carbonate in lime kilns, drying products with infrared dryers fired with fossil fuels
- HCFC-22: Production of electricity, heat or steam
- Semiconductor Production: oxidation of volatile organic waste, production of electricity, heat, or steam
- Wood Products, Furniture and other coating operations: combustion used for drying operations; thermal oxidizers used for VOC control
- Oil and Gas: process heaters, engines, turbines, flares, incinerators, oxidizers, etc.

Attachment A

Revision Summary

June 2008: Original guideline document

January 2009:

- Added text to reflect that Rule 15A NCAC 02Q .0207 is undergoing revision process, and is not yet effective.
- Clarified which sources must report and added GHG reporting thresholds for insignificant sources
- Specified how voluntary reporting of un-permitted sources can be made

February 2009:

- In Table 3, added guidance links for the following industries: Oil and natural gas, Municipal Solid Waste Combustion, Limestone and Dolomite Use, and Soda ash Consumption

April 2009:

- In Table, changed link to the Stationary Combustion Guidance to refer to an updated version.