NC Greenhouse Gas Emission (GHG) Inventory Instructions for Voluntary Reporting

November 2009

Status of the Reporting Rule

The Division of Air Quality (DAQ) will not add mandatory reporting of GHGs by Title V facilities to the NC Annual Emissions Reporting Rule (15A NCAC 02Q .0207) at this time. At the November 19, 2009 meeting, the Environmental Management Commission chose not to take action on this amendment.

The DAQ continues to encourage voluntary reporting of GHG emissions to the Air Emissions Reporting On-line System (AERO). The AERO tool accepts GHG data, and they can be put into the system at the same time as the criteria air pollutants and hazardous air pollutants.

There are many benefits of voluntary reporting. Facilities will:

- get technical assistance on emission calculations.
- be prepared for the EPA's Mandatory Reporting Rule and other Federal programs regarding greenhouse gases under development.
- gain an opportunity to demonstrate good corporate citizenship.
- have a more complete picture of their air emissions.

Nearly a third of Title V sources and numerous smaller sources voluntarily reported their emissions for 2008; the DAQ surveyed many of the sources and found that for stationary combustion operations, the reporting burden was low.

Some North Carolina facilities will be required to report their GHG emissions directly to EPA due to the Final Mandatory Reporting of Greenhouse Gases Rule which was published October 30, 2009 (http://www.epa.gov/climatechange/emissions/ghgrulemaking.html). More information can be found at the following: Presentation on the EPA Final GHG Emissions Reporting Rule and Its Impact on NC Facilities. In addition, there are other EPA proposed actions and Federal Legislation that would potentially require facilities to determine their GHG emissions.

The DAQ will update the guidance and spreadsheets to align them with the calculation procedures in the EPA Final GHG Reporting Rule. These materials are expected to be completed in early 2010.

The calculation methods provided below are not currently aligned with the methods in EPA's Final GHG Reporting Rule.

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_2O)
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_2O	Nitrous Oxide	1	310	296
2551624	SF_6	Sulfur Hexafluoride	0.05	23,900	22,200
Perfluorocarbons (PFC)					
115253	C_4F_8	Perfluorocyclobutane (octafluorocyclobutane)	0.05	8,700	10,000
355259	C_4F_{10}	Perfluorobutane (decafluorobutane)	0.05	7,000	8,600
76164	C_2F_6	Perfluoroethane (hexafluoroethane)	0.05	9,200	11,900
355420	C_6F_{14}	Perfluorohexane (tetradecafluorohexane)	0.05	7,400	9,000
75730	CF_4	Perfluoromethane (tetrafluoromethane)	0.05	6,500	5,700
678262	C_5F_{12}	Perfluoropentane (dodecafluoropentane)	0.05	7,500	8,900
76197	C_3F_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_2F_2	HFC-32 (difluoromethane)	0.05	650	550
593533	CH_3F	HFC-41 (fluoromethane)	0.05	150	97
138495428	$CF_3CHFCHFCF_2CF_3$	HFC-43 10mee (1,1,1,2,3,4,4,5,5,5-decafluoropentane)	0.05	1,300	1,500
354336	CHF_2CF_3	HFC-125 (pentafluoroethane)	0.05	2,800	3,400
359353	CHF_2CHF_2	HFC-134 (1,1,2,2-tetrafluoroethane)	0.05	1,000	1,100
811972	CH_2FCF_3	HFC-134a (1,1,1,2-tetrafluoroethane)	0.05	1,300	1,300
430660	CHF_2CH_2F	HFC-143 (1,1,2-trifluoroethane)	0.05	300	330
420462	CF_3CH_3	HFC-143a (1,1,1-trifluoroethane)	0.05	3,800	4,300
624726	CH_2FCH_2F	HFC-152 (1,2-difluoroethane)	0.05	43*	43

75376	CH_3CHF_2	HFC-152a (1,1-difluoroethane)	0.05	140	120
353366	CH_3CH_2F	HFC-161 (fluoroethane)	0.05	12*	12
431890	CF_3CHFCF_3	HFC-227ea (1,1,1,2,3,3,3-heptafluoropropane)	0.05	2,900	3,500
677565	$CH_2FCF_2CF_3$	HFC-236cb (1,1,1,2,2,3hexafluoropropane)	0.05	1,300*	1,300
431630	CHF_2CHFCF_3	HFC-236ea (1,1,1,2,3,3hexafluoropropane)	0.05	1,200*	1,200
690391	$CF_3CH_2CF_3$	HFC-236fa (1,1,1,3,3,3hexafluoropropane)	0.05	6,300	9,400
679867	$CH_2FCF_2CHF_2$	HFC-245ca (1,1,2,2,3pentafluoropropane)	0.05	560	640
460731	$CHF_2CH_2CF_3$	HFC-245fa (1,1,3,3pentafluoropropane)	0.05	950*	950
431630	$CF_3CH_2CF_2CH_3$	HFC-365mfc (1,1,1,3,3pentafluorobutane)	0.05	890*	890

[a] For sources listed in the Insignificant Activities List of the facility's air permit.
[b] Source: Intergovernmental Panel on Climate Change, Second Assessment Report, 1995
[c] Source: Intergovernmental Panel on Climate Change, Third Assessment Report, 2001: **Climate Change 2001: The Scientific Basis**
Note: 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 CO_2 equivalent basis using the GWPs used by EPA, currently IPCC 1995.
* Assigned based on IPCC 2001 GWPs.

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 (CH_4) and carbon dioxide (CO_2), 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 (CO_2):** 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 stochiometric chemical reaction, the relation of CO_2 to carbon burned is well established (12 pounds of carbon burn to form 44 pounds of CO_2). CO_2 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 (CH_4):** 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 (N_2O):** 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 NO_2, 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 CO_2 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 CO_2 equivalency (CO_2e) of those emissions. For example, a ton of methane is approximately equivalent (regarding the light/energy retention of the atmosphere) to 21 tons of CO_2.

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 CO_2e 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	- 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	CO_2, CH_4, N_2O	DAQ Guideline Document	DAQ 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	- 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	HFC, PFC	TCR General Reporting Protocol, Chapter 16	
			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	Emission Calculation Worksheet
Industrial Sectors				
Adipic Acid Production	- Provides mass balance approach for determining process emissions from production of nylon fibers and plastics,	N_2O	TCR General Reporting Protocol, Appendix E.1	

	plasticizer for polyvinyl chloride, etc - Provides default and plantspecific emission factors		**The GHG Protocol Initiative – N_2O Emissions From Production of Adipic Acid**	**Emission Calculation Worksheet**
Aluminum Production	- Provides process-specific mass balance approach for CO_2 emissions from carbon anode	**CO_2, PFC**	**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 – CO_2 Emissions From Production of Aluminum**	**Emission Calculation Worksheet**
Ammonia Production	- Provides plant specific carbon content of feedstock fuels	**CO_2**	**TCR General Reporting Protocol, Appendix E.3**	
			The GHG Protocol Initiative – CO_2 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	**CO_2**	**TCR General Reporting Protocol, Appendix E.4**	
			The GHG Protocol Initiative – CO_2 Emissions From Production of Cement	**Emission Calculation Worksheet**
Electricity Transmission and Distribution	- Provides mass balance approach for determining fugitive emissions from electric systems	**SF_6**	**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	**HFC**	**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,	**CO_2**	**TCR General Reporting Protocol, Appendix E.7**	

	and carbon content of crude iron/ferroalloys) and fugitive emissions - Emission factors based on plantspecific and carbon content data are provided		**The GHG Protocol Initiative – CO_2 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	**CO_2**	**TCR General Reporting Protocol, Appendix E.8**	
			The GHG Protocol Initiative – CO_2 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	**CH_4**	**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	**CO_2, CH_4**	**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	**HFC, PFC**	**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	**PFC, SF_6**	**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	**CO_2**	**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	**CH_4, CO_2**	**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.

November 2009:

- Changed title of document to voluntary reporting instructions and updated status of NC rule. Note that the calculation procedures will be aligned with the EPA's Mandatory Reporting Rule, and that this document will be revised in early 2010 to do this.