Electronics Manufacturing

Final Rule: Mandatory Reporting of Greenhouse Gases (40 CFR 98, Subpart I)

Under the Mandatory Reporting Rule for Additional Sources of Fluorinated Greenhouse Gases, owners or operators of electronics manufacturing facilities (as defined below) that emit equal to or greater than 25,000 metric tons of carbon dioxide equivalent per year from fluorinated GHGs and nitrous oxide (N_2O) emissions from cleaning and etch processes, heat transfer fluid use, and other source categories (e.g., carbon dioxide [CO_2] from stationary combustion facilities) must report fluorinated greenhouse gas (GHG) emissions from all electronics manufacturing processes and any other source categories located at the facility for which methods are defined in the rule. Owners or operators must collect emission data; calculate GHG emissions; and follow the specified procedures for quality assurance, missing data, recordkeeping, and reporting.

How Is This Source Category Defined?

Under this subpart, the electronics manufacturing category consists of facilities engaged in any of the following electronics manufacturing production processes:

- Processes in which etching uses plasma-generated fluorine atoms and other reactive fluorine-containing fragments, which chemically react with exposed thin-films (e.g., dielectric, metals) or substrate (e.g., silicon) to selectively remove portions of material;
- Processes in which chambers used for depositing thin films are cleaned periodically using plasma-generated fluorine atoms and other reactive fluorine-containing fragments from fluorinated and other gases;
- Processes in which wafers are cleaned using plasma generated fluorine atoms or other reactive fluorine-containing fragments to remove residual material from wafer surfaces, including the wafer edge;
- Processes in which the chemical vapor deposition process or other production processes use N_2O; and
- Processes in which fluorinated GHGs are used as heat transfer fluids (HTF) to cool process equipment, to control temperature during device testing, to clean substrate surfaces and other parts, and for soldering (e.g., vapor phase reflow). Heat transfer fluids commonly used in electronics manufacturing include those sold under the trade names "Galden®" and "Fluorinert™."

Facilities that use these processes include, but are not limited to those that manufacture micro-electro-mechanical systems (MEMS), liquid crystal displays (LCDs), photovoltaic cells (PV), and semiconductors (including light-emitting diodes).

What GHGs Must Be Reported?

All electronics manufacturing facilities must report:

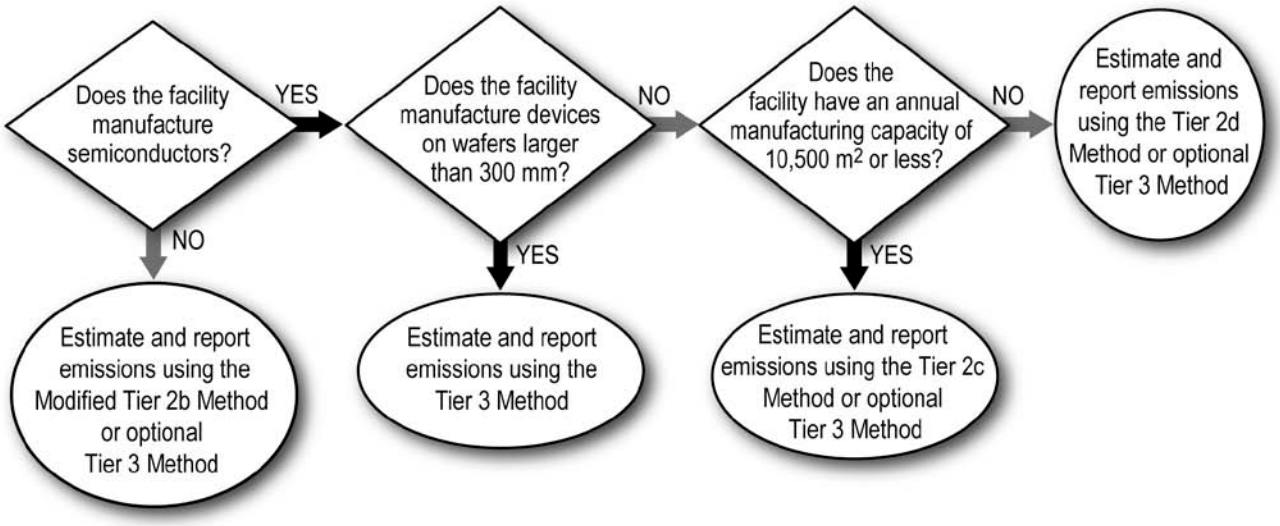
- Fluorinated GHG emissions from etching and cleaning production processes and HTF use.
- N_2O emissions from chemical vapor deposition (CVD) and other production processes.
- Controlled emissions of GHGs from abatement systems, if applicable.
- CO_2, methane (CH_4), and N_2O emissions from each stationary combustion unit by following the requirements of 40 CFR part 98, subpart C (General Stationary Combustion Sources). The

information sheet on general stationary fuel combustion sources (subpart C) summarizes the requirements for calculating and reporting emissions from these units.

Fluorinated GHGs include hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), nitrogen trifluoride (NF_3), hydrofluoroethers (HFEs), and others as defined in §98.6 of the final Mandatory Reporting of GHGs Rule (74 FR 56260; October 30, 2009).

How Must GHG Emissions Be Calculated?

A facility that engages in production processes covered by subpart I and meets the reporting threshold must determine the emission estimation method to be used according to the following decision tree:



Modified Tier 2b:
- For two process types (plasma etching and chamber cleaning) calculate emissions using default emission factors provided in the final rule.

Tier 2c:
- For five process types/sub-types (plasma etching, wafer cleaning, and the three chamber cleaning process sub-types: in-situ plasma, remote plasma, and in-situ thermal), use default emission factors provided in the final rule.

Tier 2d:
- For four process types/sub-types (wafer cleaning, and the three chamber cleaning process sub-types: in-situ plasma, remote plasma, and in-situ thermal), use default emission factors provided in the final rule.
- For the plasma etching process type develop emission factors for each recipe or set of similar recipes.

Tier 3:
- For all production processes that use fluorinated GHGs develop emission factors for each recipe or set of similar recipes.

- For an input gas, calculate emissions using the amount of fluorinated GHG input consumed in the process type, process sub-type or recipe and the process utilization for the fluorinated GHG.
- For a byproduct gas, calculate emissions using the amount (kg) of fluorinated GHG generated as a byproduct per kg of input gas and the annual emissions of by-product fluorinated GHG formed.
- For N_2O emissions from CVD and from all other production processes such as chamber cleaning, calculate emissions using the amount of N_2O consumed in CVD or other production processes and the utilization factor for the process.
- Calculate gas consumption for fluorinated GHGs and N_2O using:

- The amount of input gas stored on site at the beginning and end of the year.
- The acquisitions of input gas throughout the year.
- The disbursements of gas through sales or other transactions.

- Apportion gas consumption for fluorinated GHGs and N_2O to process types, process sub-types, and recipes using recipe-specific, process sub-type-specific, or process type-specific gas apportioning factors.

- Account for the fraction of fluorinated GHGs or N_2O destroyed by abatement systems using:
  - The fraction of fluorinated GHG or N_2O used and destroyed in applicable process units.
  - The amount of gas consumed for a process type, process sub-type, or recipe, as applicable.
  - The destruction or removal efficiency by gas, and uptime of each abatement system.

- For fluorinated GHG emissions from heat transfer fluids, calculate the annual emissions using a mass-balance approach that accounts for the following operational parameters:
  - The density of fluorinated heat transfer liquid.
  - The decrease in the amount of fluorinated GHG stored on site and net amount purchased.
  - The amount properly recovered, stored, and sent off site for recycle or destruction.
  - The nameplate capacity of any newly installed or retired units.

When Does Reporting Begin?

Facilities subject to subpart I must begin monitoring GHG emissions on January 1, 2011 in accordance with the methods specified in subpart I. For 2012 only, the GHG report must be submitted to EPA by September 28, 2012. This reporting deadline applies to all subparts being reported by the facility. If your subpart I facility submitted a GHG annual report for reporting year 2010 under another subpart (e.g., subpart C for general stationary fuel combustion), then by April 2, 2012 you must notify EPA through e-GGRT that you are not required to submit the second annual report until September 28, 2012 (the notification deadline according to 4 CFR 98.3(b) is March 31, 2012, however, because this date falls on a Saturday in 2012, the notification is due on the next business day).

Starting in 2013 and each year thereafter, reports must be submitted to EPA by March 31 of each year, unless the 31st is a Saturday, Sunday, or federal holiday, in which case the reports are due on the next business day.

What Information Must Be Reported?

In addition to the information required by General Provisions at 40 CFR 98.3(c) of the rule, each annual report must include the following information:

- Annual manufacturing capacity of a facility.
- For facilities that manufacture semiconductors, the diameter of wafers processed at a facility.
- Annual emissions of each fluorinated GHG emitted from each process type, individual recipe, N_2O-using process, and heat transfer fluid (HTF) application and calculation method used.
- Annual production in terms of substrate surface area (e.g., silicon, PV-cell, LCD glass).
- When using factors for fluorinated GHG process utilization and by-product formation rates other than the defaults provided, the following must be reported, as applicable:
  - The recipe-specific utilization and by-product formation rates for each individual recipe (or set of similar recipes) and/or facility specific N_2O utilization factors.
  - Certification that the recipes included in a set of similar recipes are similar.

    - Certification that the measurements for all reported recipe-specific utilization and by-product formation rates and/or facility-specific N_2O utilization factors were made using the International SEMATECH guidelines if measurements were made prior to January 1, 2007.
    - Source of the recipe-specific utilization and by-product formation rates and/or facility-specific N_2O utilization factors and certification that those factors are representative of the reporting facility's process(s).
- Annual consumption for each fluorinated GHG and N_2O, including where less than 50 kg of a particular fluorinated GHG or N_2O is used during the reporting year. For all fluorinated GHGs and N_2O for which emissions are not calculated, details on that chemical must be reported.
- All inputs used to calculate gas consumption for each fluorinated GHG and N_2O used.
- All inputs used to calculate disbursements for each fluorinated GHG and N_2O used, including all facility-wide gas-specific heel factors used for each fluorinated GHG and N_2O. If the facility used less than 50 kg of a particular fluorinated GHG during the reporting year, facility-wide gas-specific feel factors do not need to be reported for those gases.
- Annual amount of each fluorinated GHG consumed for each recipe, process sub-type, or process type, as appropriate, and the annual amount of N_2O consumed for each chemical vapor deposition and other electronics manufacturing production processes.
- Mass of each fluorinated GHG and N_2O consumed annually, all inputs used to calculate the mass of gas consumed, and all inputs used to calculate gas disbursements, including heel factors.
- All apportioning factors used to apportion fluorinated GHG and N_2O consumption.
- For the facility-specific model used to apportion fluorinated GHG and N_2O, the quantifiable metric (s) used in the model, calendar dates selected, certification of largest gas consumption selection, and results of the validation check with actual gas consumption must be reported.
- The fraction of each fluorinated GHG or N_2O used in a process that is fed into tools connected to an abatement system.
- The fraction of each fluorinated GHG or N_2O destroyed or removed in abatement systems connected to process tools as well as all inputs and calculations used to determine the inputs used to calculate the fraction of input gases destroyed or removed in these abatement systems.
- Inventory and description of all abatement systems through which fluorinated GHGs or N_2O flow, including the number of devices of each manufacturer, model numbers, manufacturer claimed destruction or removal efficiencies (DRE), if any, and record of DRE measurements over their in-use life. The inventory of abatement systems must describe the tools with model numbers and process details for which these systems treat exhaust.
- For each abatement system through which fluorinated GHG or N_2O flow at the facility for which controlled emissions are reported, the following information must be reported:
    - Certification that each abatement system has been installed, maintained, and operated in accordance with manufacturers' specifications.
    - All inputs and results of calculations made accounting for the uptime.
    - The default DRE values or properly measured DREs for each abatement system.
    - Certification that the abatement systems for which emissions are being reported were specifically designed for fluorinated GHG and N_2O abatement.
    - If properly measured DREs or class averages of DREs are used, a description of the class, system manufacturer, calculation used to determine class average, and the random selection method must be reported; the total number of systems in the class and systems in the class for which DRE was measured also must be reported.
- Inputs to the HTF mass-balance equation used to calculate fluorinated GHG emissions.
- The number of times missing data procedures were followed in the reporting year, the methods used to estimate the missing data, and the estimates of those data.
- A brief description of each best available monitoring method (BAMM) used, the parameter measured or estimated using the method, and the time period during which the BAMM was used.

EPA has temporarily deferred the requirement to report data elements in the above list that are used as inputs to emission equations (76 FR 53057, August 25, 2011). For the current status of reporting requirements, including the list of data elements that are considered to be inputs to emissions equations, consult the following link: http://www.epa.gov/climatechange/emissions/CBI.html

For More Information

This document is provided solely for informational purposes. It does not provide legal advice, have legally binding effect, or expressly or implicitly create, expand, or limit any legal rights, obligations, responsibilities, expectations, or benefits in regard to any person. The series of information sheets is intended to assist reporting facilities/owners in understanding key provisions of the rule. They are not intended to be a substitute for the rule.

Visit EPA's Web site (www.epa.gov/climatechange/emissions/ghgrulemaking.html) for more information and additional information sheets, or go to www.regulations.gov to access the rulemaking docket EPA-HQ-OAR-2009-0927.