Electronics Manufacturing

Subpart I, Greenhouse Gas Reporting Program

Under the Greenhouse Gas Reporting Program (GHGRP) rule, 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 etching processes, heat transfer fluid use, and other source categories (e.g., carbon dioxide [CO_2] from stationary combustion facilities) must report fluorinated greenhouse gas emissions from all electronics manufacturing processes and any other source categories located at the facility for which methods are defined in the rule. Owners and operators are required to collect emission data; calculate GHG emissions; and follow the specified procedures for quality assurance, missing data, recordkeeping, and reporting per the requirements of 40 CFR Part 98 Subpart I – Electronics Manufacturing.

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 Greenhouse Gases Must Be Reported?

All electronics manufacturing facilities must report:

- Fluorinated GHG emissions from electronic manufacturing 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 Greenhouse Gas Reporting Program rule.

How Must Greenhouse Gas Emissions Be Calculated?

A facility that engages in production processes covered by subpart I and meets the reporting threshold must determine the total annual emissions of each fluorinated GHG emitted by electronics manufacturing production processes from each fab (as defined in §98.98) at the facility, including each input gas and each by-product gas. Facilities may use either default gas utilization rates and by-product formations or the stack test method to determine their emissions for all process types and sub-types.

If a facility manufactures semiconductors, they will calculate annual emissions of each input gas and of each by-product gas using Equations I-6 and I-7.

If a facility manufactures MEMS, LCDs, or PVs, they will calculate annual fab-level emissions of each fluorinated GHG used for the plasma etching and chamber cleaning process types using default utilization and by-product formation rates as shown in Table I-5, I-6, or I-7 of this subpart, as appropriate, and by using Equations I-8 and I-9.

If a given fab at a facility uses less than 50 kg of a fluorinated GHG in one reporting year, they may calculate emissions as equal to the fab's annual consumption for that specific gas as calculated in Equation I-11, plus any by-product emissions of that gas calculated using equations I-6, I-7, I-8 or I-9.

Facilities must calculate the annual fab-level N_2O emissions from all chemical vapor deposition processes and from the aggregate of all other electronics manufacturing production processes. For fabs that use less than 50 kg of N_2O in one reporting year, a facility may calculate fab emissions as equal to annual consumption for N_2O.

A checklist for data that must be monitored is available at: https://www.epa.gov/ghgreporting/subpart-i-monitoring-checklist.

What Information Must Be Reported?

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

- Annual manufacturing capacity of each fab.
- For facilities that manufacture semiconductors, the diameter of wafers processed at each fab.
- Annual emissions, on a fab basis, of each fluorinated GHG emitted from each process type and process sub-type, N_2O-using process, and HTF application, and the calculation method used.
- Annual production in terms of substrate surface area (e.g., silicon, PV-cell, glass) for each fab, indicating specification of the substrate.
- For the fab-specific apportioning model used to apportion fluorinated GHG and N_2O consumption:
    - The identification of the quantifiable metric used in the fab-specific engineering model to apportion gas consumption for each fab, and/or an indication of direct measurements that were used in addition to, or instead of, a quantifiable metric.

    - The start and end dates selected under §98.94(c)(2)(i).
    - Certification that the gas(es) you selected under §98.94(c)(2)(ii) for each fab corresponds to the largest quantity(ies) consumed, on a mass basis, of fluorinated GHG used at the fab during the reporting year for which you are required to apportion.
    - The result of the calculation comparing the actual and modeled gas consumption.
- If a facility is required to apportion fluorinated GHG consumption between fabs, certification that the gas(es) selected correspond to the largest quantity(ies), consumed on a mass basis, of fluorinated GHG used at the facility during the reporting year for which apportioning is required.
- Where missing data procedures were used to estimate inputs into the fluorinated heat transfer fluid mass balance equation, the number of times missing data procedures were followed in the reporting year and the method used to estimate the missing data.
- If the facility includes emissions from research and development activities, report the approximate percentage of total GHG emissions, on a metric ton CO_2e basis, that are attributable to research and development activities, using the following ranges: less than 5 percent, 5 percent to less than 10 percent, 10 percent to less than 25 percent, 25 percent to less than 50 percent, 50 percent and higher.

Abatement

- Inventory and description of all abatement systems through which fluorinated GHGs or N_2O flow at the facility and for which destruction or removal efficiency is claimed, including:
    - The number of abatement systems controlling emissions for each process sub-type, or process type, as applicable, for each gas used in the process sub-type or process type.
    - The basis of the destruction or removal efficiency being used (default or site specific measurement according to §98.94(f)(4)(i)) for each process sub-type or process type and for each gas.
- For all abatement systems through which fluorinated GHGs or N_2O flow for which controlled emissions are reported:
    - Certification that all abatement systems at the facility have been installed, maintained, and operated in accordance with the site maintenance plan for abatement systems that is developed and maintained in facility records.
- If default destruction or removal efficiency values are used in the facility emissions calculations, certification that the site maintenance plan for abatement systems for which emissions are being reported contains manufacturer's recommendations and specifications for installation, operation, and maintenance for each abatement system.
- If default destruction or removal efficiency values are used in the facility emissions calculations, certification that the abatement systems for which emissions are being reported were specifically designed for fluorinated GHG or N_2O abatement, as applicable. Facility must support this certification by providing abatement system supplier documentation stating that the system was designed for fluorinated GHG or N_2O abatement, as applicable.
- Facility must report an effective fab-wide destruction or removal efficiency value for each fab at the facility.

Stack Systems

- For all stack systems for which a facility calculates fluorinated GHG emissions according to the procedures specified in §98.93(i)(3), certification that facility has included and accounted for all abatement systems and any respective downtime in emissions calculations.

- If applicable, for fab-level emissions of fluorinated GHG using the stack test methods, the facility must report the following for each stack system:
    - The date of any stack testing conducted during the reporting year, and the identity of the stack system tested.
    - An inventory of all stack systems from which process fluorinated GHG are emitted. For each stack system, indicate whether the stack system is among those for which stack testing was performed as per §98.93(i)(3), or not performed as per §98.93(i)(2).

Triennial Reports

- If the semiconductor manufacturing facility emits more than 40,000 metric ton CO_2e of GHG emissions, based on the most recently submitted annual report (beginning with the 2015 reporting year), prepare and submit a triennial (every 3 years) technology assessment report to the Administrator (or an authorized representative) that meets the requirements specified. Any other semiconductor manufacturing facility may voluntarily submit this report to the Administrator.
    - The first report must be submitted with the annual GHG emissions report that is due no later than March 31, 2017, and subsequent reports must be delivered every 3 years no later than March 31 of the year in which it is due.
    - The report must include the information described below:
        - It must describe how the gases and technologies used in semiconductor manufacturing using 200 mm and 300 mm wafers in the United States have changed in the past 3 years and whether any of the identified changes are likely to have affected the emissions characteristics of semiconductor manufacturing processes in such a way that the default utilization and by-product formation rates or default destruction or removal efficiency factors of this subpart may need to be updated.
        - It must describe the effect on emissions of the implementation of new process technologies and/or finer line width processes in 200 mm and 300 mm technologies, the introduction of new tool platforms, and the introduction of new processes on previously tested platforms.
        - It must describe the status of implementing 450 mm wafer technology and the potential need to create or update default emission factors compared to 300 mm technology.
        - It must provide any utilization and byproduct formation rates and/or destruction or removal efficiency data that have been collected in the previous 3 years that support the changes in semiconductor manufacturing processes described in the report. For any utilization or byproduct formation rate data submitted, the report must include the input gases used and measured, the utilization rates measured, the byproduct formation rates measured, the process type, the process subtype for chamber clean processes, the wafer size, and the methods used for the measurements. For any destruction or removal efficiency data submitted, the report must include the input gases used and measured, the destruction and removal efficiency measured, the process type, and the methods used for the measurements.
        - It must describe the use of a new gas, use of an existing gas in a new process type or sub-type, or a fundamental change in process technology.
    - If the report indicates that GHG emissions from semiconductor manufacturing may have changed from those represented by the default utilization and by-product formation rates, or the default destruction or removal efficiency values in this subpart, the report must lay out a

data gathering and analysis plan focused on the areas of potential change. The plan must describe the elements below:

- The testing of tools to determine the potential effect on current utilization and by-product formation rates and destruction or removal efficiency values under the new conditions.
- A planned analysis of the effect on overall facility emissions using a representative gas-use profile for a 200 mm, 300 mm, or 450 mm fab (depending on which technology is under consideration).
- Multiple semiconductor manufacturing facilities may submit a single consolidated 3-year report as long as the facility identifying information in §98.3(c)(1) and the certification statement in §98.3(c)(9) is provided for each facility for which the consolidated report is submitted.

When and How Must Reports Be Submitted?

Annual reports must be submitted 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. Annual reports must be submitted electronically using the electronic Greenhouse Gas Reporting Tool (e-GGRT), the GHGRP's online reporting system. Additional information on setting up user accounts, registering a facility and submitting annual reports is available at https://ccdsupport.com/confluence/.

When Can a Facility Stop Reporting?

There are several scenarios under which a facility may discontinue reporting. These scenarios are summarized in the Subpart A Information Sheet as well as in an FAQ.

For More Information

For additional information on Subpart I, visit the Subpart I Resources webpage. For additional information on the Greenhouse Gas Reporting Program, visit the Greenhouse Gas Reporting Program Website, which includes information sheets on other rule subparts, data previously reported to the Greenhouse Gas Reporting Program, training materials, and links to frequently asked questions.

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 Greenhouse Gas Reporting Program.