EPA United States Environmental Protection Agency

Mandatory Greenhouse Gas Reporting Rule: EPA's Response to Public Comments

Subpart I - Electronics Manufacturing

Subpart I – Electronics Manufacturing

U.S. Environmental Protection Agency
Office of Atmospheric Programs
Climate Change Division
Washington, D.C.

FOREWORD

This document provides responses to public comments on the U.S. Environmental Protection Agency's (EPA's) Proposed Mandatory Greenhouse Gas Reporting Rule: Additional Sources of Fluorinated GHGs: Subpart I, Electronics Manufacturing. EPA published a Notice of Proposed Rulemaking in the Federal Register (FR) on April 12, 2010 (75 FR 18652). EPA received comments on this proposed rule via mail, e-mail, and at a public hearing held in Washington D.C. on April 20, 2010. Copies of all comments submitted are available at the EPA Docket Center Public Reading Room. Comments letters and transcripts of the public hearings are also available electronically through http://www.regulations.gov by searching Docket ID EPA-HQ-OAR-2009-0927.

EPA prepared this document in multiple sections, with each section focusing on a different broad category of comments on the rule. In light of the large number of comments received and the significant overlap between many comments, this document does not respond to each comment individually. Rather, EPA summarized and provided a single response to each significant argument, assertion, and question contained within the totality of comments. Within each comment summary, EPA provides in parentheses one or more lists of Docket ID numbers for commenters who raised particular issues; however, these lists are not meant to be exhaustive, and EPA does not individually identify each and every commenter who made a certain point in all instances, particularly in cases where multiple commenters expressed essentially identical arguments.

EPA's responses to comments are generally provided immediately following each comment summary. In some cases, EPA provided responses to specific comments or groups of similar comments in the preamble to the final rulemaking. Rather than repeating those responses in this document, EPA has referenced the preamble.

Comments were assigned to specific section of this document based on an assessment of the principal subject of the comment; however, some comments inevitably overlap multiple subject areas. For this reason, EPA encourages the public to read the other sections of this document relevant to their interests.

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List of Acronyms

BAU	Business As Usual
CAA	Clean Air Act
CBI	Confidential Business Information
CEMS	Continuous Emissions Monitoring System
CFR	Code of Federal Regulations
CVD	Chemical Vapor Deposition
DRE	Destruction or Removal Efficiency
Electronics Manufacturing TSD	Technical Support Document for Process Emissions from Electronics Manufacture (e.g., Micro-Electro-Mechanical Systems, Liquid Crystal Displays, Photovoltaics, and Semiconductors): Proposed Rule for Mandatory Reporting of Greenhouse Gases[1]
EPA	U.S. Environmental Protection Agency
EPA DRE Protocol	EPA's Protocol for Measuring Destruction or Removal Efficiency of Fluorinated Greenhouse Gas Abatement Equipment in Electronics Manufacturing (EPA 430-R-10-003)
Final MRR	Final Rule, Mandatory Reporting of Greenhouse Gases, October 30, 2009 (74 FR 56260)
Fluorinated GHG	Fluorinated Greenhouse Gas
F-HTF	Fluorinated Heat Transfer Fluid
FTIR	Fourier Transform Infrared Spectroscopy
GAO	U.S. Government Accountability Office
GHG	Greenhouse Gas
GWP	Global Warming Potential
HAP	Hazardous Air Pollutants
HTF	Heat Transfer Fluid
IPCC	Intergovernmental Panel on Climate Change
ISMI	International SEMATECH Manufacturing Initiative
ITRI	Industrial Technology Research Institute
ITRS	International Technology Roadmap for Semiconductors

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[1] This is the REVISED November 2010 version unless otherwise noted as the March 22, 2010 version.

JETIA	Japan Electronics and Information Technology Industries Association
LED	Light-Emitting Diode
MES	Manufacturing Execution Software
MFC	Mass Flow Controller
MOU	Memorandum of Understanding
MtCOe	Metric tons of Carbon Dioxide Equivalents
NDIR	Nondispersive Infrared
NIST	National Institute of Standards and Technology
NODA	EPA’s Notice of Data Availability; Default Emission Factors for Semiconductor Manufacturing Refined Process Categories, May 2010 (75 FR 26904)
Pa	Pascal (unit of pressure)
PFC	Perfluorocompound
POU	Point of Use
PV	Photovoltaic
RFID	Radio Frequency Identification
RSASTP	Random Sampling Abatement System Testing Program
R&D	Research and Development
SIA	Semiconductor Industry Association
SIP	State Implementation Plan
TFT-FPD	Thin-Film-Transistor Fat Panel Display
Tier 1	2006 IPCC Tier 1 Method (Volume 3, Chapter 6)
Tier 2b	2006 IPCC Tier 2b Method (Volume 3, Chapter 6)
Tier 3	2006 IPCC Tier 3 Method (Volume 3, Chapter 6)
VOCs	Volatile Organic Compounds

1. Definition of the Source Category

Comment Summary 1-a: One commenter (0110) proposed that if light-emitting diode (LED) production is to be included in the final rule, the emissions should be calculated using the Modified Tier 2b Method[2] since the number and amount of fluorinated greenhouse gases (fluorinated GHGs) used is much lower in LED production than in semiconductor manufacturing.

Response 1-a: In the final rule (§98.90), EPA clarified that under the electronics manufacturing source category, semiconductors include, among others, light-emitting diodes (LEDs). EPA made this clarification because LEDs are semiconductor light sources—when a LED is switched on, electrons are able to recombine with holes within the device, releasing energy in the form of light whose color is governed by the nature of the semiconductor. Many LEDs are manufactured on a wafer (usually different than silicon) using methods that are similar to the manufacture of integrated circuits.[3] Therefore, facilities that manufacture LEDs must use either the Tier 2c method[4] or the Tier 2d method,[5] as appropriate, consistent with all other facilities that manufacture semiconductor devices.

EPA's information on LED manufacturing facilities is limited and the commenter did not provide any quantitative information to support the claim that the number and amount of fluorinated GHG used in LED production is much lower than in semiconductor manufacturing. EPA has concluded that it has no information to support subdividing semiconductor manufacturers into different distinct semiconductor device types, each required to use a different emission estimation method.

Comment Summary 1-b: One commenter (0095) stated that the proposed rule as written did not distinguish between electronics manufacturing facilities and facilities that manufacture the equipment used to manufacture electronics (tool research and development [R&D] facilities). The commenter asserted that such facilities may engage in plasma etching, chamber cleaning, and CVD processes as part of their R&D activities, but are not engaged in "production processes" as the wafers are not completely manufactured but go through limited semiconductor processes. The

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[2] EPA proposed in the Modified Tier 2b method in the April 2010 proposal for other Electronics Manufacturing facilities including those that manufacture LCDs, MEMS, and PV.

[3] For reference that many LEDs are produced on single wafer see: http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/perkins_fairfax09.pdf.

[4] Under the final rule, semiconductor manufacturing facilities that manufacture devices on wafers measuring 300 mm or less in diameter and that have an annual manufacturing capacity equal to or less than 10,500 m^2 of substrate are required to estimate and report their emissions using the Tier 2c method. See preamble section D, Electronics Manufacturing, (Subpart I), section 1 ("Summary of the Final Rule") for a detailed discussion on the Tier 2c method.

[5] Under the final rule, semiconductor manufacturing facilities that manufacture devices on wafers measuring 300 or less mm in diameter and that have an annual manufacturing capacity greater than 10,500 m^2 of substrate are required to estimate and report their emissions using the Tier 2d method. See preamble section D, Electronics Manufacturing, (Subpart I), section 1 ("Summary of the Final Rule") for a detailed discussion on the Tier 2d method.

commenter asserted that it would be challenging to calculate greenhouse gas (GHG) emissions based on manufacturing capacity or wafer starts because these metrics are not relevant for R&D facilities. The commenter also noted that semiconductor R&D facilities contribute minimally to the overall GHG emissions from electronics manufacturing sources. To this end, the commenter argued that R&D facilities should be exempt from the proposed rule to help facilitate the development of new technologies.

Response 1-b: Under the final rule, per §98.90(a), facilities that engage in the following production processes are covered under the electronics manufacturing source category:

(1) Electronics manufacturing production process in which the etching process 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;

(2) Electronics manufacturing production process 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;

(3) Electronics manufacturing production process 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;

(4) Electronics manufacturing production process in which the chemical vapor deposition (CVD) process or other manufacturing processes use N_2O; and

(5) Electronics manufacturing production process in which fluorinated GHGs are used as heat transfer fluids (HTFs) 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).

If a facility engages in the covered processes listed above and they meet the threshold per §98.91(a), it is required to estimate and report their emissions under subpart I (Electronics Manufacturing), with the exception of emissions from R&D activities.

Under the Final Mandatory Reporting Rule (Final MRR), R&D activities (as defined in 40 CFR 98.6) are not considered to be part of any source category subject to the rule. If a facility engages in R&D activities, the facility is not required to report the emissions from that R&D activity. See the preamble to the Final Mandatory Reporting Rule (Final MRR) for a more detailed discussion on the exemption for R&D activities (74 FR 56285, October 2009). Pursuant to 40 CFR 98.6, "Research and development means those activities conducted in process units or at laboratory bench-scale settings whose purpose is to conduct research and development for new processes, technologies, or products and whose purpose is not for the manufacture of products for commercial sale, except in a de minimis manner."

2. Reporting Threshold

Comment Summary 2-a: One commenter (0128) supported the reporting threshold of 25,000 $MtCO_2e$ (metric tons of carbon dioxide equivalents) per year, which would embrace roughly 96 percent of emissions from semiconductor facilities.

Response 2-a: EPA thanks the commenter for their input. EPA is maintaining the 25,000 $MtCO_2e$ per year reporting threshold for electronics manufacturing facilities in the final rule (see §98.91). See preamble section D, Electronics Manufacturing (subpart I), section 1, for a summary of the reporting threshold for electronics manufacture and the preamble to the Final MRR (74 FR 56272) for additional responses to comments on EPA's selection of a 25,000 $MtCO_2e$ per year reporting threshold.

2.1 Threshold Applicability Equations

Comment Summary 2.1-a: One commenter (TRANS-DC-02) asserted that proposed Equation I-1 appears flawed, as it lacks a step to convert process emissions to CO_2 equivalents based on global warming potential (GWP).

Response 2.1-a: EPA thanks the commenter for their input. In the final rule, EPA has corrected the threshold applicability equation, Equation I-1, as well as Equations I-2 and I-3, to include a GWP term (a gas-appropriate GWP as provided in Table A-1 to subpart A of part 98) used to convert process emissions to CO_2 equivalents.

Comment Summary 2.1-b: One commenter (TRANS-DC-02) asserted that the proposed threshold applicability determination equation for semiconductor facilities (Equation I-1) was a potential to emit calculation based on 100 percent of the manufacturing capacity of a facility, as opposed to an actual emission calculation that should serve as a reporting trigger.

Response 2.1-b: EPA agrees with the commenter that the threshold applicability equation for semiconductor facilities is based on a facility's potential to emit. EPA is finalizing this requirement for the following reasons: 1) Calculating a facility's potential emissions is relatively simple and less burdensome than calculating actual emissions; and 2) Studies indicate facilities using fluorinated GHG abatement systems may underestimate their actual emissions due to widespread overestimation of these systems' fluorinated GHG destruction or removal efficiencies (DRE) (see the preamble to the proposed rule (75 FR 18652, April 2010) for a more detailed discussion on EPA's rationale for not permitting a facility to account for destruction by abatement systems in the threshold applicability calculation).

Although the threshold applicability equations for subpart I are based on potential to emit, the cease-reporting provisions in the Final MRR allow facilities, regardless of their applicability threshold, to cease reporting based on the facility's actual emissions as submitted in their annual report. See the preamble to the October 2009 final rule for a more detailed discussion and responses to comments related to the provisions to cease reporting (74 FR 56276, October 2009).

Comment Summary 2.1-c: One commenter (0110) asserted that “full planned design capacity” (used in the threshold applicability equations) is ambiguous, because actual capacity fluctuates due to process changes made in a fab and varying manufacturing levels spurred by the dynamic nature of the industry.

Another commenter (0095) asserted that the 2006 IPCC Tier 1 (“Tier 1”) method does not specify whether the manufacturing capacity is based on the volume of wafers manufactured or the number of wafer passes. The commenter also stated that it was unclear whether wafers that are processed without the use of GHGs were to be included in manufacturing capacity. Lastly, the commenter noted that a semiconductor facility may also use wafers for processes that do not use GHGs.

Response 2.1-c: In the final rule, in §98.91,EPA has modified the term “full designed capacity” from the April 2010 proposed rule to be “100 percent of annual manufacturing capacity.” For further clarity, EPA also provided a new equation, Equation I-5 in the final rule in §98.91, for facilities to use when determining this capacity value in threshold applicability calculations. Equation I-5 will be used to determine 100 percent of annual manufacturing capacity of a facility by summing the area of maximum designed substrate starts of a facility per month over the reporting period.

In addition, also for further clarification in §98.98, EPA defined the term “maximum designed substrate starts” as the maximum quantity of substrates, expressed as surface area that could be started each month during a reporting year, if the facility were fully equipped as defined in the facility design specifications and if the equipment were fully utilized.

In response to the commenter who asserted that it was unclear whether manufacturing capacity would include wafers used for processes that do not use fluorinated GHGs, EPA is requiring all substrate starts, regardless of their manufacturing fate, be included as part of the maximum designed substrate starts. This requirement is being adopted to simplify and minimize the burden associated with the threshold applicability determination and to make the results of the determination more conservative.

Comment Summary 2.1-d: One commenter (0128) supported the exclusion of emission reductions from abatement technologies in calculations to determine whether a facility meets the reporting threshold. The commenter asserted that given EPA’s statement that manufacturers’ estimates of abatement system efficacy is often inaccurate, leading to overstated system efficiencies resulting from improper installation, maintenance, or operation, EPA is correct to exclude the use of abatement systems in determining threshold applicability.

Response 2.1-d: EPA thanks the commenter for their input. EPA is finalizing a method for the threshold applicability determination that excludes emission reductions from abatement technologies. See the Electronics Manufacturing TSD available in the docket (EPA-HQ-OAR-2009-0927) for a discussion supporting this exclusion.

2.2 Alternative Methods for Determining Threshold Applicability

Comment Summary 2.2-a: As an alternative to EPA's proposed threshold applicability calculation, a commenter (0110) proposed applying Tier 1 emission factors to annual fluorinated GHG consumption for threshold determination in a manner similar to that of photovoltaic (PV) manufacturing.

Response 2.2-a: EPA disagrees with the commenter that proposed to allow facilities to determine their threshold applicability by applying Tier 1 emission factors to annual fluorinated GHG consumption. The method suggested by the commenter is not a valid or plausible method. Tier 1 emission factors are based on the known capacity of a facility; these emission factors have units of the mass of gas emitted per area (m^2) of substrate produced. To apply an emission factor with these units to a gas consumption number, also in the units of mass of gas, would result in an emission estimate that does not physically or mathematically make sense. EPA would like to clarify that the threshold determination method for PV facilities is based upon gas consumption and gas appropriate GWPs, not gas consumption and Tier 1 emission factors.

Comment Summary 2.2-b: One commenter (0095) asserted that semiconductor facilities should be permitted to use the 2006 IPCC Tier 2b Method ("Tier 2b") for threshold determination instead of the Tier 1 Method, provided that the facility uses abatement systems. As an alternative, the commenter suggested that facilities be allowed to use an alternative destruction removal efficiency (DRE) value that exceeds the default IPCC DRE value based on section 98.94 of the proposed rule. The commenter asserted that the Tier 1 methodology does not distinguish between the volume of wafers manufactured or the number of wafer passes.

The commenter asserted that the use of the Tier 2b method should be allowed since the Tier 2b method is more accurate for evaluating actual emissions. The commenter argued that the use of the Tier 2b methodology for threshold determination would be consistent with the requirements of AB32 Greenhouse Gas Emission Reduction, California Air Resources Board (reference: California Code of Regulations, Title 17, Subchapter 10, Article 4, Subarticle 2).

Response 2.2-b: EPA does not agree with the commenter that the threshold applicability requirements in the final rule should be modified. EPA is not modifying the applicability threshold requirements because, as compared to the Tier 2b method, the Tier 1 method is relatively simple and less burdensome to determine whether or not a facility is required to report. Further, EPA is not permitting the use of DREs in the threshold applicability determination for reasons previously stated in the preamble to the April 2010 proposed rule (75 FR 18659). Please see the preamble to the April 2010 proposed rule (75 FR 18659, April 2010) for a more detailed discussion on EPA's rationale for not permitting a facility to account for destruction by abatement systems in the threshold applicability calculation. Please also see response to comment 2.1-c for information on the how EPA has clarified the threshold applicability determination using the Tier 1 method in the final rule.

2.3 De Minimis Threshold and Other Exemptions

Comment Summary 2.3-a: Five commenters (0089, 0099, 0110, 0123, and 0131) noted facilities routinely employ small quantities of chemicals used as HTFs and for other uses. The commenters expressed concern EPA has not established a de minimis standard for reporting. Two commenters (0123 and 0110) recommended a de minimis level be established for calculation and reporting emissions from the use of HTFs. Another commenter (0099) asserted that establishing a de minimis threshold for HTFs would be "consistent with the refrigerant management requirements found in 40 Code of Federal Regulations (CFR) part 82 which apply to the most detailed tracking requirements only to refrigerant units containing more than 50 pounds of refrigerant." Other commenters (0089, 0131) expressed similar sentiments.

One commenter (0089) asserted that the definition of "fluorinated greenhouse gas" found in 40 CFR 98.6 is broad and using this definition without a de minimis value below which reporting is not required may cause problems. Two commenters (0089 and 0099) noted that companies often experiment with a variety of chemicals before high volume manufacturing, and requiring that emissions factors be developed, and emissions reported will present a significant burden for a small amount of emissions. These commenters (0089 and 0099) stated that it is also likely that there are many gases for which a GWP value has not been established. One commenter (0089) asserted that the requirements be revised to require reporting for only those fluorinated GHGs which are used in excess of 100 pounds and that have an established GWP. The commenter also suggested that the same criteria be applied to the gas consumption reporting required in §98.96(f)**.**

One commenter (0099) proposed that EPA include provisions to allow facilities to exclude from emissions calculations any fluorinated GHG that does not have an established GWP or comprises less than 5 percent of total usage of fluorinated GHGs where: 1) The de minimis amount of the fluorinated GHG used in etch comprise less than 5 percent of the total usage of all fluorinated GHG compounds in etch, 2) the de minimis amount of the fluorinated GHG used in CVD chamber cleaning comprises less than 5 percent of the total usage of all fluorinated GHG compounds in CVD chamber cleaning, 3) the de minimis amount of the fluorinated HTF comprises less than 5 percent the total usage of all fluorinated HTFs compounds.

Similarly, another commenter (0131) proposed that EPA include provisions to allow facilities to exclude from emissions calculations any fluorinated GHGs that comprises less than 5 percent of the total usage of fluorinated GHGs where: 1) The de minimis amount of the fluorinated GHG used in etch comprises less than 5 percent of the total usage of all fluorinated GHG compounds in etch, 2) the de minimis amount of the fluorinated GHG used in CVD chamber cleaning comprises less than 5 percent of the total usage of all fluorinated GHG compounds in CVD chamber cleaning, 3) the de minimis amount of the fluorinated GHG used in wafer cleaning comprises less than 5 percent of the total usage of all fluorinated GHG compounds in wafer cleaning, 4) the de minimis amount of the fluorinated HTF comprises less than 5 percent the total usage of all fluorinated HTFs compounds.

Response 2.3-a: EPA does not agree with the comments that a de minimis threshold should be established for either HTF emissions or process fluorinated GHG emissions. When EPA published the Final MRR, EPA determined de minimis provisions were not necessary because a de minimis provision would compromise the quality and usefulness of the data collected (74 FR 56260, October 2009). For additional background on EPA's decisions to exclude de minimis provisions, please see response to comments in the preamble to the Final MRR (74 FR 56278-56279, October 2009) and also ''Reporting Methods for Small Emission Points (De Minimis Reporting)'' (EPA–HQ–OAR– 2008–0508–0048).

With respect to the comments that reporting emissions from chemicals that facilities use in small quantities to experiment is burdensome, EPA recognizes that it may be burdensome for facilities to develop facility-wide gas-specific heel factors and emission factors for fluorinated GHGs and N_2O that are used in small quantities. In response, consistent with the Final MRR, in §98.93, EPA has made changes to the calculation requirements that further reduce any need for de minimis reporting provisions by allowing simpler methods for fluorinated GHGs and N_2O that are used in small quantities. For any fluorinated GHG used in production processes or N_2O for which a facility consumes 50 kg or less during a reporting year, the facility has the option to assume that the amount of that gas emitted is equal to the amount of that gas consumed. To determine the amount of gas consumed, EPA is allowing facilities to assume that the gas-specific heel factor is equal to zero. EPA has provided this option only for fluorinated GHG process gases and N_2O. EPA has not made any modifications to the reporting requirements for HTFs because EPA concludes that the mass balance method is simple and will effectively capture all emissions of HTFs.

With respect to commenter's assertion that EPA should adopt a de minimis threshold for HTFs because it is "consistent with the refrigerant management requirements found in 40 Code of Federal Regulations (CFR) part 82 which apply the most detailed tracking requirements only to refrigerant units containing more than 50 pounds of refrigerant," EPA does not agree that it should adopt a threshold designed for a specific existing program. While EPA is not opining on the commenter's characterization of 40 CFR part 82, EPA does not agree with the commenter's suggestion because the purpose of this rule is to collect data for use in developing future GHG policies and programs. Collecting accurate data of GHG emissions is important to the future value of the data for informing policy decisions and designing new GHG policies and programs. Receiving data on emissions from HTFs will provide EPA with comprehensive information on all emissions, including quantities and sources, from electronics manufacturing facilities.

In response to the commenters' suggestion that only chemicals with established GWPs should be reported, EPA does not agree. EPA acknowledges there may be cases where a facility is required to report fluorinated GHG emissions for which GWPs have not yet been assigned in either IPCC or World Meteorological Organization (WMO) Scientific Assessments (i.e., fluorinated GHGs for which Table A–1 of 40 CFR part 98, subpart A does not provide GWPs). As acknowledged by commenters, Table A-1 of 40 CFR part 98, subpart A is not a complete listing of current or potential fluorinated GHGs; the IPCC and WMO lists on which it is based reflect only the facts that the listed materials have been synthesized, their atmospheric properties investigated, the results published, and the publications found by the IPCC and WMO Assessment authors. Table A–1 omits some fluorinated GHGs, and it unavoidably omits future fluorinated GHGs that have not yet been synthesized. Given the radiative chemical properties of the carbon-fluorine bond, any fluorocarbon emitted into the atmosphere may have a significant GWP. However, the lack of GWPs for some fluorinated GHGs will not impede reporting because EPA is requiring that emissions be reported on a mass basis rather than a CO_2e basis.

Reporting of fluorinated GHGs that do not appear in Table A–1 of 40 CFR part 98, subpart A will provide valuable information on types of fluorinated GHGs being used in electronics manufacturing. Further, this information can be used to assess the volume of emissions for which GWPs have not been evaluated and to help prioritize the evaluation of GWPs. For more responses to comment on the definition of "fluorinated GHG" and the reasons why EPA is requiring facilities to report fluorinated GHGs that do not appear in Table A-1, please see the preamble to the Final MRR (74 FR 56348, October 2009).

EPA anticipates that as GWPs are evaluated or reevaluated by the scientific community, the Agency will update Table A–1 of 40 CFR part 98, subpart A through notice and comment rulemaking. EPA may also, through rulemaking, establish a more proactive process for ensuring that GWPs are appropriately evaluated or reevaluated. Please also see the Response to Comment Document for OO available at http://www.epa.gov/climatechange/emissions/downloads09/documents/SubpartOO-SuppliersofIndustrialGHGs.pdf.

Comment Summary 2.3-b: One commenter (0131) stated that "small electronics manufacturing processes with wafer production capacities of less than 1,080 m^2 emit less than 5% of the 25,000 metric ton CO_2e reporting threshold for this rule. However, some of these small processes are located at large integrated manufacturing facilities that have on-site power generating utilities (e.g. Boilers for generating heat and electricity). GHG emissions from combustion operations at these facilities typically exceed the 25,000 tons CO_2e threshold and, therefore, bring the entire facility into the reporting rule, including the small electronics manufacturing process." The commenter proposed revisions to the regulatory text of subpart I, section 98.91, to exclude electronics manufacturing processes with a production capacity of 1,080 m^2 or less.

Response 2.3-b: EPA does not agree with the commenter's proposed regulatory text revisions that exclude reporting emissions from processes with production capacities of 1,080 m^2 or less. Any facility that engages in the production processes defined in the electronics manufacture source category and exceeds the 25,000 $MtCO_2e$ threshold, with both process and combustion emissions, must report fluorinated GHG and N_2O emissions and consumption for all of the process covered by the electronics manufacture source category. [6] EPA does not agree that particular processes at a facility should be excluded from facility reporting because this would provide EPA with an incomplete picture of actual facility emissions. EPA has also concluded that it is necessary to include combustion emissions in the threshold determination because many electronics manufacturing facilities emit GHGs from both manufacturing processes and combustion sources. It is important to EPA that both process and combustion emissions are considered in threshold determinations so EPA can gain a more complete picture of total U.S. emissions to inform future policy and regulatory decisions.

In the final rule electronics manufacturing facilities that meet or exceed the 25,000 metric tons of CO_2e threshold must report, which is consistent with most other subparts of the rule. Please see the preamble to the Final MRR for more details on the appropriateness of this threshold for the MRR, and how this threshold was selected (74 FR 56271, October 2009).

In response to the commenter's concern that small electronics manufacturing processes may be brought into the GHG Reporting Program, and this will impose some level of regulatory burden, EPA points to the fact that efforts have been made to help simplify reporting requirements for relatively smaller emissions sources. First, the rule excludes small facilities through the application of the 25,000 metric tons of CO_2e threshold. This threshold balances the number and size of reporter with the coverage of emissions. Second, reporters must report only the emissions from sources for which calculation methods are provided in the rule. Calculation methods are generally not included for smaller sources of emissions (e.g., coal piles on industrial sites). In some cases, where a source category includes relatively small emission sources, the rule provides simplified emissions calculation methods for those sources. Given that EPA has taken steps to simplify emissions monitoring methods in this rule, EPA has concluded that reporting cutoffs, such as the production capacity cutoff proposed by the commenter, are not necessary.

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[6] As defined in §98.6, a facility means any physical property, plant, building, structure, source, or stationary equipment located on one or more contiguous or adjacent properties in actual physical contact or separated solely by a public roadway or other public right-of-way and under common ownership or common control, that emits or may emit any greenhouse gas. Operators of military installations may classify such installations as more than a single facility based on distinct and independent functional groupings within contiguous military properties.

3. GHGs to Report

Comment Summary 3-a: One commenter (0099) asserted that the definition of GHGs is much broader than the Kyoto basket of gases. The commenter further stated that the definition of fluorinated GHGs is very broad and potentially includes many materials that have not been quantified. The commenter further noted that it is unclear whether accurate measurement methods (or GWP values) even exist for these compounds. The commenter suggested that initially the rule should focus on the Kyoto Protocol basket of gases and NF_3.

Another commenter (0108) suggested that EPA's online GHG emissions reporting tool must easily accommodate mass emissions reporting in an uncomplicated manner for HTFs and fluorinated GHGs like C_5F_8 for which calculation of CO_2e is not possible because GWPs were not published in subpart A, Table A-1.

Response 3-a: The definition of fluorinated GHG was promulgated in the Final MRR, and EPA did not revisit it in this rulemaking. For response to comments regarding the definition of "fluorinated GHG" please see the preamble to the Final MRR (74 FR 56348, October 2009). Please also see the Response to Comment Document for OO available at http://www.epa.gov/climatechange/emissions/downloads09/documents/SubpartOO-SuppliersofIndustrialGHGs.pdf.

In regards to the commenters' concerns about GWPs that may not exist or be published, please see response to comment 2.3-a.

EPA acknowledges the commenter's concern about the reporting tool. While EPA is currently developing the reporting tool, at this time, EPA does not anticipate that reporting emissions from gases that do not have GWPs will be a problem because semiconductor manufacturing facilities are required to report emissions on a mass basis as opposed to a CO_2e basis. Please see the preamble to the Final MRR for more information on the electronic reporting tool (74 FR 56282, October 2009).

4. Emissions Calculation Methods

4.1 Gas Consumption

Comment Summary 4.1-a: Five commenters (0099, 0110, 0112, 0123, and 0131) did not support the proposed gas inventory requirements as part of determining overall gas consumption. Three commenters (0099, 0112, and 0131) expected that, year-to-year, the total inventory of each gas would not vary widely. Commenters (0099, 0110, 0112, 0123, and 0131) also suggested that if gas usage for a previous reporting year is “under-reported” or “over-reported,” the usage for the following reporting year would account for the deficit or excess amount.

One commenter (0110) stated that site purchase and inventory records are typically used to track gas usage. The commenter asserted that this standard practice is widely accepted for criteria pollutants under the Clean Air Act (CAA) and for emissions accounting under state implementation plans (SIPs) approved by EPA. The commenter noted that these methods are also used for compliance and enforcement of emission limitations under the CAA, and that they believe that a similar approach can be used for estimating and reporting GHG emissions. In line with these sentiments, another commenter (0131) suggested that only purchase records showing acquisitions and disbursements, combined with heel factors, be utilized to determine consumption; the commenter asserted that cylinders changed out prematurely do not need to be accounted for separately from purchase records.

Response 4.1-a: EPA does not agree with the commenters that asserted purchase records would be sufficient for tracking gas consumption, or that only purchase records showing acquisitions and disbursements combined with heel factors should be utilized to determine consumption; as opposed to purchase records, gas inventories, and facility-wide gas-specific heel factors. In the final rule, EPA is maintaining the requirement for facilities to determine the amount of gas consumed based on a mass balance method, which utilizes an inventory of gas at a facility. The use of this method, which involves an inventory of gas stored in containers in the beginning and end of the reporting year, ensures that any fugitive emissions that may arise from gas handling are accounted for, and that fluctuations in gas consumption from year-to-year at facilities are accounted for. While commenters note that year-to-year the total inventory of each gas would not vary widely, information was not provided to EPA to verify this statement.

With respect to the commenter that asserted chemical use should be tracked using site purchase and inventory records, similar to how emissions are calculated for other CAA requirements and under SIPs approved by EPA, it is important to clarify that the purpose of this rule differs from those regulatory programs. In contrast to other regulatory programs which generally focus on whether a facility's emissions are below a specified limit, this rule focuses on establishing each facility’s annual GHG emissions in metric tons per year with the goal of gathering accurate facility-level data. EPA plans to use such data to inform future policy and regulatory decisions. EPA has concluded that the gas consumption requirements in subpart I help ensure that this goal is achieved.

Comment Summary 4.1-b: In response to EPA's request for comment on how to account for the amount of gas in containers in service in an annual inventory, commenters did not support determining the quantity of gas in partially used in-service cylinders at the end of the reporting year, citing a significant amount of burden and difficulty in complying with this proposed requirement with little improvement in calculation certainty. One commenter (0131) cited burden as an issue in particular because a facility may have hundreds of gas cylinders in service.

Response 4.1-b: EPA agrees with commenters that the additional amount of labor and difficulty required to inventory the quantity of gas in partially used in-service cylinders at the end of a reporting year is not justified by any gains in accuracy. To reduce burden, EPA has modified the rule to allow facilities to account for the total quantity of gas in containers in service at the end of a reporting year as if the in-service containers were full. Facilities must also then account for this same quantity in the inventory of gas stored in containers at the beginning of the subsequent reporting year. EPA understands that any "under-reporting" or "over-reporting" that is a consequence from this modification will be balanced out in subsequent reporting years. EPA believes this modification will have a minimal effect on the accuracy of emission estimates.

4.1.1 Facility-Wide Gas Specific Heel Factors

Comment Summary 4.1.1-a: Two commenters (0099 and 0131) proposed that in lieu of using heel factors, EPA should permit facilities to determine gas consumption by tracking individual containers. The commenters stated that tracking individual gas containers will provide consumption estimates that are as accurate as EPA's proposed method of using heel factors.

Response 4.1.1-a: EPA is not clear as to what the commenters are suggesting. If the commenters are suggesting that gas containers can be tracked but that the heels of gas containers should not be accounted for, EPA does not agree. By tracking individual cylinders and not accounting for cylinder heels, as opposed to using facility-wide gas-specific heel factors to estimate gas consumption, the estimates will not be accurate. As one commenter (0112) explained, "The heels that are returned to the manufacturer represent 4.3 percent of the total gas used." Therefore, in not accounting for heels in gas consumption estimates, a facility would be knowingly over-estimating gas consumption. This conflicts with EPA's intention to gather accurate facility-level information. In addition, EPA understands that many electronics manufacturing facilities already estimate gas consumption based on purchase records and a default factor. According to one commenter (0131), 81 percent of semiconductor facilities that participated in the 2009 ISMI survey used purchase records and a default heel factor to estimate gas consumption. EPA also understands that in business as usual (BAU) facility operations, mass-based or pressure-based trigger points for change out are used to determine when gas containers are to be changed. EPA is therefore requiring these trigger points for change out be used to calculate facility-wide gas-specific heel factors for each gas container type, based on trigger points established as part of facility operations, rather than permitting facilities to track individual containers.

Comment Summary 4.1.1-b: One commenter (0095) requested clarification on the average facility-wide gas-specific heel factor and whether it is a monthly or yearly average.

Response 4.1.1-b: EPA is requiring gas consumption to be determined based on knowledge of the actual amount of each gas consumed during the reporting period by determining a gas and facility-specific heel factor for each container type used during a reporting year. This approach does not require the facility to develop a monthly or annual average heel factor; rather, EPA is requiring the facility to develop a facility-wide, gas-specific heel factor that is based on the concept of a "constant" facility-wide gas-specific “trigger point for change out.” This trigger point for change out denotes a specific amount of gas in a cylinder--an amount that requires the cylinder to be exchanged, typically for a full cylinder, at or just before the trigger amount is reached. That triggering amount, along with the initial full mass of a gas container, may be used to calculate heel factors throughout a reporting period provided the trigger point does not change by more than 5 percent. If the trigger point should change by more than 5 percent, then the new trigger point is to be used to calculate gas consumption for the remainder of that reporting period. The amount of gas consumed for a reporting year would be the sum of a gas consumed for each period in a reporting year during which the trigger point for change out did not vary by more than 5 percent. EPA believes this method is appropriate and reliable because for a "constant" trigger amount, the corresponding heel will also be constant provided cylinders of the size for that trigger are filled to the same amount. EPA understands that it is the practice of gas suppliers to fill cylinders of the same size and the same gas with identical amounts.

Comment Summary 4.1.1-c: Four commenters (0099, 0100, 0112, and 0131) supported the use of site-specific gas heel factors in conjunction with purchase records. One commenter (0112) asserted that the use of facility-wide gas-specific heel factors at their facilities increased the accuracy of the estimated gas consumed by 5.9 percent, and increased the accuracy of the emission calculations. Two commenters (0099 and 0131) asserted that the use of site-specific gas heel factors would greatly improve the accuracy of gas usage determinations over the IPCC default heel factor of 10 percent. One commenter (0131) asserted that using site-specific heel factors eliminates the costly installation of gas distribution and measurement infrastructure.

Response 4.1.1-c: EPA thanks the commenters for their input. EPA is finalizing the requirement to use facility-wide gas-specific heel factors.

Comment Summary 4.1.1-d: One commenter (0108) suggested that EPA “…not mandate the development and use of site-specific and gas-specific cylinder heel factors for ‘relatively smaller’ semiconductor facilities. Rather, allow the optional use of 0.00 (0 percent) as the heel factor [i.e., all of a cylinder’s gas is used, none returned to the supplier], and for ‘relatively smaller semiconductor facilities’ who may ultimately choose to install large numbers of cylinder scales to develop accurate cylinder heel factors, allow the use of the IPCC and industry-standard cylinder heel factor of 0.10 (10 percent) through reporting year 2013 to spread the cost over three years.” The commenter noted that in order to comply with the proposed requirements of the rule, it will have to purchase additional scales. These purchases would have to occur over a short timeframe, and the company has not budgeted for them. The commenter was therefore open to either option stated above, recognizing the first would overstate GHG emissions.

Response 4.1.1-d: EPA does not agree with either of the commenter's suggestions. Heels vary among gases and container sizes and shapes and so using either 0 or the IPCC default heel factor will result in less accurate estimates of gas consumption and emissions. In addition, the use of heel factors that are specific to a facility will account for the differences in gas usage practices between facilities. Use of the commenter's suggestions would conflict with EPA's intention to gather accurate facility-level information

EPA understands that in normal facility operations, mass-based or pressure-based trigger points for change out are used to determine when gas cylinder/containers are to be changed. EPA anticipates that facilities should be able to implement practices in accordance with EPA's heel factor requirement for the first year of data collection and reporting.

A facility may use Best Available Monitoring Methods (BAMM) for the first six months of the first data collection year without submitting a request to the Administrator. Under the BAMM provisions in the final rule for subpart I in §98.94(a), facilities must use the calculation methods prescribed by the rule, but BAMM is permitted for any parameter for which it is not reasonably feasible to acquire, install, or operate a required piece of monitoring equipment in a facility or to procure necessary monitoring services from providers. For more information on the use of BAMM, please see the preamble section D, Electronics Manufacturing (subpart I), section 1 ("Summary of the Final Rule").

Comment Summary 4.1.1-e: One commenter (0131) stated that according to a 2009 International SEMA TECH Manufacturing Initiative (ISMI) survey, 80 percent of respondents currently estimate gas consumption based on purchase records and an assumed heel factor. Therefore, the rule would require facilities to change their current practices to determine facility-wide gas-specific heel factors.

Response 4.1.1-e: EPA thanks the commenter for its input. EPA understands that the requirement for facility-wide gas-specific heel factors may require new practices to be instituted at electronics manufacturing facilities. However, EPA is finalizing the requirement for facilities to develop and use facility-wide gas-specific heel factors. EPA is not allowing facilities to use an assumed or default heel factor because heels may vary among gases and container sizes and shapes. Therefore, applying a broad default or assumed value to every gas container will lead to estimations that may not accurately represent the facility's actual gas consumption, and hence the facility's emissions. (See the Electronics Manufacture TSD available in the docket (EPA-HQ-OAR-2009-0927) for more details). See response to comment 4.1.1-d for more discussion regarding why for facility-wide gas-specific heel factors are required in the final rule.

Comment Summary 4.1.1-f: One commenter (0131) provided the following response to EPA's request for comment in a meeting on May 19, 2010 on requiring the gas supplier to measure and track cylinders: "While this may be practical at some facilities at additional cost, Semiconductors Industry Association (SIA) believes this would not be practical in most cases. Specific 'used' cylinders may not be uniquely identified once they are removed from service such that their correlation of their incoming weight to their outgoing weight may not be possible. Furthermore, suppliers often pick up used cylinders from customers in multi-facility trips, also known as 'milk runs'. This would convolute the requirement to weigh specific cylinders for specific customers when they return to the supplier location. In any case, this would require the establishment of an 'on and off' facility tracking system for which facilities and supplier protocols are not currently equipped or staffed. Most certainly all costs for this tracking would be incurred ultimately by the facility, thus avoiding no part of the cost and burden associated with gas usage tracking as proposed."

Response 4.1.1-f: EPA thanks the commenter for this information. EPA has not modified the rule to require gas suppliers to measure and track cylinders. Please see the preamble section D, Electronics Manufacturing (subpart I), section 1 ("Summary of the Final Rule"), for a summary of the gas consumption requirements in the final rule.

Comment Summary 4.1.1-g: One commenter (0131) suggested that unless it is infeasible, facilities should develop a "heel factor specific to each type of cylinder and for each gas type based on the point established as the trigger for changing out the cylinder."

Response 4.1.1-g: EPA agrees that facilities should develop a heel factor specific to each type of cylinder and for each gas type based on the point established as the trigger for changing out the cylinder. EPA does not anticipate there would be any circumstance in which this would be infeasible for a facility. Therefore, EPA is maintaining the requirement that facilities must estimate gas consumption based on facility-wide gas-specific heel factors. See response to comment 4.1.1-a and 4.1.1-d for more discussion on the required gas consumption methods using facility-wide gas-specific heel factors.

4.1.1.1 Accuracy and Precision of Measuring Instruments

Comment Summary 4.1.1.1-a: One commenter (0107) presented a technology that it believes can provide a cost-effective and efficient measurement of a gas container's heel with 1 percent accuracy or better. The integrated pressure sensing technology monitors the container's contents with pressure transducing and active Radio Frequency Identification (RFID) technologies. The commenter requested confirmation by EPA that the proposed technology satisfies the requirements of the proposed rule and can be used for compliance with the final rule.

Response 4.1.1.1-a: EPA thanks the commenter for supplying this information about its technology. Provided that measurement instrumentation used by a facility to measure the residual weight or pressure of a cylinder, which in turn is used to determine facility-wide gas specific heel factors, meets the one percent of full scale accuracy and precision requirement, the use of that instrumentation is permitted under the rule.

Comment Summary 4.1.1.1-b: One commenter (0107) stated that according to its understanding, many electronics manufacturing facilities do not have the ability to meet the required precision requirements to measure gas containers heels. The commenter stated that it will be costly for many companies to install flowmeters in the timeframe required to prepare to comply with the rule.

Three other commenters (0099, 0112, and 0131) opposed the requirement that all instrumentation must have accuracy and precision of 1 percent full scale or better, citing in some cases the infeasibility to comply and the burden to obtain instrumentation to meet EPA's requirement. One commenter (0112) asserted that a significant portion of its equipment has accuracies of 2 percent to 5 percent, while others can reach 1 percent accuracy. One commenter (0131) provided the following information: "The majority of new fabricators and new equipment will be able to meet the 1 percent requirement ... According to the 2010 Supplemental ISMI Survey, 74 percent of the respondents have measurement devices that meet the 1 percent accuracy/precision requirement while 26 percent may not. Of this 26 percent, the measurement devices used likely have an accuracy/precision in the 2-4 percent range. This 26 percent of facilities can be expected to incur additional capital costs to meet this instrumentation requirement." The commenter (0131) also stated that no respondents utilize flow meters with an accuracy of 1 percent for tracking gas consumption. In order to meet the requirement, commenters asserted that they will have to incur costs of purchasing and installing new equipment. The commenters proposed the use of a 5 percent accuracy requirement as provided in the general provisions of the Final MRR. In addition to the proposed 5 percent requirements; a commenter (0099) suggested that the performance of the instrumentation would be verified using methods consistent with an industry accepted practice at least annually.

Another commenter (0110) expressed appreciation that the April 2010 proposed rule no longer included the requirement for flowmeters and scales to be calibrated using National Institute of Standards and Technology (NIST)-traceable standards; however, the commenter is concerned that the 1 percent of full scale accuracy and precision requirement for instrumentation is still included in the rule. The commenter asserted that a significant burden exists with little environmental benefit in requiring measurement devices with accuracies to 1 percent or less.

Response 4.1.1.1-b: EPA is not requiring the use of flowmeters to comply with gas consumption requirements of the final rule. The commenter (0107) may have misunderstood the proposed gas consumption requirements, and this misunderstanding may have led it to make incorrect assumptions about the costs and technical challenges associated with the rule.

Further, it is possible that some commenters may have misunderstood the proposed precision and accuracy requirement. EPA proposed to require an accuracy and precision to be achieved on an instrument's full scale basis, as opposed to the more stringent true value basis. In other words, for a scale capable of measuring 300 pounds, regardless of the amount of gas being weighed on the scale, the final rule requires that the measured weight of gas must be accurate within +/- 3 pounds. Where as an accuracy based on the true weight of the gas in the cylinder would vary depending on the amount of gas in the cylinder.

EPA has concluded that it is feasible for facilities to comply with the accuracy and precision requirement to achieve +/-1 percent of full scale or better for measurement instrumentation as part of determining gas containers heels, and is therefore not modifying it as commenters suggested. As some of the commenters asserted (0112 and 0131), many facilities already will be able to meet the +/-1 percent of full scale or better accuracy and precision requirement. "According to the 2010 supplemental ISMI survey, 74 percent of respondents have measurement devices that meet the 1 percent accuracy/precision requirement while 26 percent may not."[7] If a facility needs to procure new instrumentation that achieves 1 percent of full scale or better accuracy and precision, EPA believes there is sufficient time to obtain the appropriate instrumentation. Further, EPA evaluated various types of scales that were available, and their ranges of achievable accuracy and precision. Through this evaluation EPA concluded that instrumentation was available that meets the accuracy and precision requirements.

EPA acknowledges that the general provisions of the Final MRR allows for different accuracy for measurement instrumentation. However, this requirement is not comparable to what is being required in subpart I. The subpart I accuracy and precision requirement to achieve one percent of full scale or better is consistent with some other subparts covering fluorinated GHGs being finalized at this time. For example, subpart SS, which covers the manufacture of electric transmission and distribution equipment, requires facilities to achieve the same 1 percent of full scale accuracy and precision. EPA has concluded given the very high GWPs and often long atmospheric lifetimes of many fluorinated GHGs, it is important to gather gas consumption and hence emission information to a high degree of accuracy.

Comment Summary 4.1.1.1-c: One commenter (0089) stated, "While we understand the need to quantify this material accurately, we don't believe the 1 percent requirement is achievable or necessary. Some of the cylinders containing covered materials may hold as little as ten pounds of material when full. The amount of material remaining

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[7] See EPA-HQ-OAR-2009-0927-0131.

when the cylinder is changed may be as little as one pound or less. Therefore, this would require ensuring that the residual mass may vary by no more than 0.01 lbs each time the cylinder is changed. Not only is such a small quantity insignificant in terms of total emissions, but it is doubtful equipment can be found that can consistently measure to this level. Many existing gas cabinet scales are maintained to an accuracy of 1 percent or even better at full scale. However, this same accuracy as a percent of mass will not be achieved when the cylinder is consumed all the way down to the residual heel and only a fraction of the initial mass remains. Some very large containers are actually weighed with truck scales, which usually have increments of 10 or 20 lbs. The same point is true when cylinders are monitored by pressure instead of mass. Commonly used pressure transducers are accurate to 1 percent of full scale, or sometimes better. Again, this percent accuracy will not be achieved when only a fraction of the full scale mass remains and it will not be possible to manage residual heels within 1 percent consistently. Intel suggests that a more reasonable requirement is that cylinder changes be maintained within a limit of +/- 10 percent, or +/- 5 lbs. mass, whichever is higher."

Response 4.1.1.1-c: It is possible that the commenter may have misunderstood the proposed precision and accuracy requirement. The April 2010 proposed preamble states: "We are proposing that all flowmeters, weigh scales, pressure gauges, and thermometers used to measure quantities that are monitored or used in calculations in this proposal have an accuracy and precision of 1 percent *of full scale or better*." (75 FR 18661, April 2010). In the final rule, EPA is requiring an accuracy and precision to be achieved on a full scale basis, as opposed to the more stringent true value basis, as the commenter described. Please see response to comments 4.1.1.1-b for information on the required accuracy and precision for measurement instruments, and responses in section 4.1.1.3 on heel factor recalculation requirements.

4.1.1.2 Exceptional Circumstance

Comment Summary 4.1.1.2-a: Five commenters (0099, 0110, 0112, 0123, and 0131) opposed the requirement to measure residual weight and pressure of a gas container in an exceptional circumstance. One commenter (0112), who stated that an exceptional circumstance is unlikely, proposed making measurement optional. In this instance, the facility would decide whether the extra burden of tracking and measurement is worth the cost relative to any inaccuracy gained from over-estimating gas usage, and hence emissions. Two commenters (0110 and 0123) stated that a difference of 20 percent from a trigger point may be in some cases such a small difference that it may be beyond the capacity of measurement equipment. These two commenters also stated that exceptional circumstances will happen so infrequently that not accounting for them would have a minimal effect on overall reporting accuracy and would not justify the increased tracking effort. Therefore, the two commenters suggested that the exceptional circumstance requirement be eliminated. One commenter (0131) reported that only 6 percent of 1,000 cylinder changes in a typical year would be considered to be under an exceptional circumstance. Two commenters (0099 and 0131) asserted that the burden of additional manual tracking of exceptional circumstance gas containers would be unwarranted given the unlikely event of underreported gas usage.

One commenter (0131) presented the following information: “The 2010 Supplemental ISMI Survey asked about exceptional circumstances for cylinder changes differing from the trigger point. Of the respondents, only one facility reported that because they currently track all cylinders, they could track these exceptional cylinder changes. According to this company, however, exceptional cylinder changes occur very infrequently (facility reported 6 percent or less). The typical reasons for changing out a cylinder at a different point are customer request and engineering development activities. Given the sensitive nature of semiconductor processes, cylinders would rarely – if ever – be changed 20 percent past the trigger point by any facility; they would only be changed prematurely – or before the trigger point had been reached. A facility can change out 1,000 or more cylinders of fluorinated GHG and N_2O per year. Each cylinder changed out 20 percent prematurely would have to be specifically removed from the purchase record accounting and the calculation of Equation I-10, measured, and tracked manually. The burden of this independent tracking is not warranted given that under-reporting of gas usage is highly unlikely.”

Response 4.1.1.2-a: EPA does not agree with the commenters’ assertions and suggestions. EPA appreciates the information provided by the commenter (0131) on one company’s actual experience with tracking exceptional circumstances, but EPA can not make broad conclusions about the industry based on one company’s experience. EPA is finalizing the requirement that where a container is changed in a exceptional circumstance (a point that differs by more than 20 percent from the trigger point for change out used to calculate the facility-wide gas-specific heel factor for that gas container type), rather than using a heel factor, a facility must weigh that container or measure the pressure of that container with a pressure gauge.

Given that facilities will have to track cylinders to some degree to adhere to other gas consumption requirements of the rule and that the occurrence of exceptional circumstances, as stated by commenters, is infrequent, quantifying the exceptional circumstance cylinders should not impose a high level of burden on facilities. Additionally, EPA does not agree that it should be optional to track exceptional circumstances because this may result in undesirable inconsistencies among methods facilities are using to estimate gas consumption. It would be most beneficial to EPA to analyze emissions and trends using data and information that has been consistently developed (where feasible). The commenters who asserted that a difference of 20 percent from a trigger point may be in some cases such a small difference that it may be beyond the capacity of measurement equipment provided no supporting evidence of this. For all of the aforementioned reasons, EPA is maintaining the exceptional circumstance requirement in the rule. It is a means to gather accurate facility-level information and should impose minimal burden on facilities because exceptional circumstances are infrequent.

In regards to the commenter who stated that the under-reporting of gas usage is highly unlikely, EPA would like to clarify that the requirement to weigh or measure the pressure of a cylinder that is changed in an exceptional circumstance applies not only to instances where a cylinder is changed 20 percent past a trigger point. The requirement applies to instances where a cylinder is changed at any point that differs (over or under) by more than 20 percent from a trigger point for change out. A primary goal of this rule is to gather accurate (i.e., neither under or over-reported) facility-level emissions. EPA has determined that this requirement contributes to meeting that goal.

4.1.1.3 Recalculation of Facility-Wide Gas-Specific Heel Factors

Comment Summary 4.1.1.3-a: Five commenters (0089, 0099, 0112, 0123, and 0131) opposed the 1 percentage point threshold for recalculating heel factors. As an alternative, four commenters (0099, 0112, 0123, and 0131) recommended that heel factors should be recalculated if a trigger point for change out used to establish a heel factor differs by 5 percent or more of full weight or pressure or from the current trigger value. Another commenter (0089) suggested that cylinders be maintained at within a limit of +/- 10 percent or +/- 5 lbs. mass, whichever is higher. One commenter (0112) noted that changes in the production process and experimentation often produce trigger changes of a few percent, but that a recalculation would be burdensome. The commenter explained, “The heels that are returned to the manufacturer represent 4.3 percent of the total gas used. A 1 percent increase in the trigger point will only represent an increase in usage (assuming the trigger point was reduced by 1 percent) of .4 percent, an extremely small number. Setting an adjustment factor of 5 percent change in the trigger point arguably will only increase use by 0.2 percent across the facility assuming that all changes increased the gas utilized from the cylinder. In fact, the majority of the trigger changes result in a decrease in the gas used from the cylinder because of quality concerns generated by maximizing the use of gas in the cylinders.” Two commenters (0099 and 0131) explained, “In the course of minor operational modifications, a facility may adjust a certain trigger point for a single cylinder or a small quantity of cylinders by a small amount to determine the effect on the process. This may be a temporary or permanent adjustment – and may only be for a small number of cylinders of that gas type. In some of these instances, the percentage change from the original trigger point may exceed the 1 percent requirement to recalculate, but may not result in any significant change in the amount of residual gas in the cylinder due to the amount of gas contained in the cylinder. A facility-wide gas-specific heel factor recalculation requirement of 5 percent of trigger point may be more reasonable and practical and would likely be representative of any significant change. It would also reduce the burden of tracking multiple facility-wide gas-specific changes (and the intervals during which the change applied) that may only be temporary.”

Response 4.1.1.3-a: EPA has taken into consideration all the commenters’ concerns. In particular, EPA understands commenters’ concerns about the burden associated with tracking minor modifications to facility processes. EPA appreciates commenters’ various suggestions about how to modify the heel factor recalculation requirement, and has decided to accept the suggestion to modify the requirement to be based on a 5 percent change in trigger point as opposed to the previously proposed 1 percent.

Specifically, in the final rule, EPA has finalized a provision which requires facilities to re-calculate a facility-wide gas-specific heel factor if a trigger point for change out for a gas and container type differs by more than 5 percent from the previously used trigger point for change out for the gas and container type. EPA has determined that this modification will help to balance the burden imposed on facilities with EPA's goal of obtaining accurate, facility-level data. Requiring heel factor recalculation at a 5 percent change helps reduce burden by excluding recalculations for minor operational modifications that may be made to investigate process performance while it also captures any substantial changes in gas consumption practices.

Comment Summary 4.1.1.3-b: Two commenters (0110 and 0123) requested more specificity in the heel factor recalculation requirement in order to better understand the meaning and benefit of it.

Response 4.1.1.3-b: In the final rule, EPA has clarified the language around the recalculation requirement to better articulate the requirement by making some editorial changes to the regulatory text. EPA is finalizing § 98.94 (b)(5) as follows:

> *You must re-calculate a facility-wide gas-specific heel factor if you use a trigger point for change out for a gas and container type that differs by more than 5 percent from the previously used trigger point for change out for that gas and container type.*

EPA is finalizing the requirement for facilities to recalculate facility-wide gas specific heel factors as a means for EPA to ensure that facilities are accurately estimating gas consumption even as facilities' operations change over time. Please see response 4.1.1.3-a for a more detailed discussion regarding the final requirements for heel factor recalculation.

Comment Summary 4.1.1.3-c: One commenter (0095) requested guidance on how far back in time to go in order to recalculate a heel factor, if the heel factor differs by more than 1 percent from the previous heel factor.

Response 4.1.1.3-c: Because EPA is requiring facilities to rely on facility-specific trigger point for change out for developing heel factors and because a change-out factor may be used provided it has not changed by more than 5 percent, there is no need to go back in time to recalculate a heel factor. Please see response to comment 4.1.1-b on the requirements for calculating heels factors.

4.1.2 Apportioning Gas Consumption to Process Categories with a Facility-Specific Engineering Model Based on an Activity Indicator

Comment Summary 4.1.2-a: One commenter (0131) asserted the following: “The results of the supplemental 2010 ISMI survey clearly indicate that using wafer pass as the required metric to apportion gas usage is not appropriate for a variety of reasons.” The commenter stated that fab tracking systems and tool recipe data based on wafer pass tracking are not readily available, and recipe mixes are very complex and dynamic, with different types and ranges of recipes varying literally on a daily basis due to changes in production mix. The commenter asserted that “wafer pass, therefore, may not be viable as a required quantifiable indicator for all facilities. The ISMI assessment of semiconductor facilities in the United States has indicated that each facility is unique in terms of its wafer size, process technologies and product mix, gas distribution systems, and production management systems. As such, there is no ‘one size fits all’ approach to apportion gas use and estimate perfluorocarbon (PFC) process emissions.” Two commenters (0099 and 0112) also asserted that wafer passes was not feasible as a quantifiable indicator due to the complexity and variability of process recipes.

In a similar sentiment, another commenter (0110) asserted, “In the case of etch processes in particular, it is common to have an etch process start on one film type and finish on a different film in the same wafer pass; i.e., oxide, nitride, polysilicon in a single wafer move. Etch recipes in particular vary from part to part and film type/stack, and are modified quite frequently, so re-establishing gas consumption for each new etch recipe would be burdensome. Over the period of development and production of a single part type, hundreds of unique recipe changes are expected to occur.”

One commenter (0131) further proposed the following: “Apportionment must occur based on at least one quantifiable indicator and engineering judgment. A facility may determine the most appropriate indicator based on its configuration and processes…Flexibility to choose indicators facility-by-facility by process category will provide more accurate estimates now and the option to implement improved methods later when new technologies develop.” The commenter provided several example methodologies for apportioning gas consumption. In summary the commenter stated, “In all cases, the facility develops a location-specific fluorinated GHG gas use monitoring and calculation plan detailing the specific data collection processes, apportionment methodologies, and calculation and modeling processes used to determine actual facility gas use and emissions. The specific quantifiable indicators used should not be prescribed by this Rule.” Another commenter (0099) also expressed similar sentiments.

One commenter (0112) supported the “Refined Process” concept, but recommended a modified approach to apportioning gas consumption. The commenter argued that basing the method on wafer passes is not feasible and would cause a facility to have to make substantial investments in upfront and operating costs. The commenter stated, “The proposal for apportioning fluorinated GHG (PFC) use across process types and the number of proposed process categories does not take into account the limited capabilities of the majority of the U.S. semiconductor manufacturing facilities to monitor, report, and segregate PFC gas use based on process data and wafer passes." The commenter recognized that there is no one-size-fits-all approach to apportion gas usage but provides a detailed process by which it may occur at their facility. The commenter (0112) provided details on alternative apportioning methodologies for EPA to consider, but maintains that the best approach for apportioning gas consumptions is for a facility to develop site-specific methods.

Four commenters (0099, 0100, 0110, and 0131) presented similar sentiments that a facility should be permitted to use a Facility-Wide Apportioning Protocol based on appropriately selected quantifiable indicators for a facility's process tool capabilities and configurations and engineering judgment. Two commenters (0099 and 0131) asserted that most facilities will need to employ more than one quantifiable indicator in facility-specific engineering models to accurately apportion gas consumption. The commenters also asserted that some facilities may already have facility management software which obtains process and tool information that may be used in models to apportion gas consumption.

Response 4.1.2-a: EPA understands commenters' concerns with the proposed method to apportion gas consumption based on wafer pass and is sensitive to the burden and the potential limitations on operational flexibility this may have on facilities. EPA has therefore modified the gas apportioning requirements for the final rule (see §98.94(c)).

EPA will permit the use of facility-specific engineering models based on a quantifiable metric selected by the facility (such as wafer passes or wafer starts) to apportion gas consumption. In the final rule, facilities are required to develop an engineering model that utilizes measurable process information to develop apportioning factors. EPA does not specify the quantifiable metric that must be used in these models; rather, EPA is allowing reporters the flexibility to select the most appropriate quantifiable metric on which to base the facility-specific engineering model, provided model documentation and verification requirements are met. EPA has concluded that the gas apportioning methods provided in the final rule should accommodate approaches suggested by the commenter. See the preamble section D, Electronics Manufacturing (subpart I), section 3 ("Summary of Comments and Responses"), for a more detailed response to comments on apportioning gas consumption.

Comment Summary 4.1.2-b: One commenter (0122) stated that they employ the IPCC Tier 2b methods in their emissions reporting for their operations in Europe. In this regard, the commenter noted that they routinely track PFC use for CVD chamber cleaning (using in-situ NF_3 cleaning, coupled with POU abatement) and etch processes (also coupled with POU abatement) based on configurations of equipment at the facility. However, the commenter stated that there is no mechanism to apportion PFC use and emissions to specific etch subcategories because it would be very difficult to collect such data and match it to specific calculation of PFC gas consumption.

Response 4.1.2-b: EPA does not agree with the commenter that it is too difficult to calculate emissions from more than one broad etch category. EPA has concluded that it is feasible for facilities to apportion gas consumption to more than just two broad etch and clean categories using the methods EPA has prescribed in the final rule. EPA understands that while some semiconductor facilities may not already have the necessary mechanisms in place to track and record the necessary information to apportion gas consumption, in the final rule, EPA is permitting a method that allows facilities to select and use the quantifiable metric that works best for a particular facility.

Wafer pass counts in modern fabs, for example, may be available through the manufacturing execution software (MES) that comes with process equipment. MES is capable of tracking the activities associated with each piece of manufacturing equipment. In older fabs that may not employ MES, wafer pass counts are available through process flow information for each product manufactured. While wafer pass count information is available, EPA understands that it may not be routinely gathered for gas apportioning purposes. Instead, it may be gathered at the request of facility and product line managers for purposes of managing work in process load, reducing fab cycle time, reducing product cycle time, identifying and removing process bottlenecks, etc. For estimating gas usage, it appears wafer pass counts would be collected either electronically or physically and used to develop the apportioning model. For an expanded explanation of this example, please see the Electronics Manufacturing TSD available in the docket (EPA-HQ-OAR-2009-0927).

EPA understands that facilities may incur a cost to implement the mechanism necessary to track and record already existing quantifiable metrics, such as wafer pass or wafer starts, to apportion gas consumption; however, EPA has made efforts in the final rule to balance the burden imposed on facilities with EPA's goal of obtaining accurate, facility-level data. EPA has accounted for such costs in the Economic Impact Analysis (see sections 4 & 5 of the Economic Impact Analysis available in the docket, EPA-OAR-2009-0927).

Please see the preamble section D, Electronics Manufacturing (subpart I), section 3 ("Summary of Responses to Comments and Responses"), for the response to comments on apportioning gas consumption. Please also see response to comment 4.1.2-a for apportioning gas consumption using facility-specific engineering models based on quantifiable metrics

Comment Summary 4.1.2-c: One commenter (0110) questioned EPA's statement in the proposal that engineering judgment was not acceptable in estimating apportioned gas usage. The commenter stated that at its facilities, engineering judgment and other factors are used for air toxics and priority pollutants to fulfill other regulatory requirements (e.g., reporting of annual emissions of criteria pollutants and hazardous air pollutants), and the commenter questioned why engineering judgment is not also acceptable for apportioning in the GHG MRR.

Response 4.1.2-c: While EPA is not opining on the requirements of other regulatory programs, in contrast to those requirements that generally focus on whether a facility's emissions are below a specified limit, this rule focuses on establishing each facility's annual GHG emissions in tons per year. For this reason, EPA is finalizing certain requirements in this rule to ensure that EPA receives accurate facility-level emissions data.

EPA is not allowing the use of "engineering judgment" to develop apportioning factors because, unlike quantifiable metrics, engineering judgment is subjective and could cause apportioning factors to vary. This presents an issue for multiple reasons. First, without the use of a quantifiable metric on which to base gas apportioning factors, it is not possible for EPA to verify the method by which gas consumption is apportioned to process recipes, sub-types, or types. EPA must be able to verify the data being used to calculate emissions. Second, engineering judgment is not always accurate, precise, or repeatable. Third, changes in staff responsible for developing apportioning factors (e.g., staff turnover, staff reassignments, changes in priorities, or some combination thereof within a facility) may lead to unintended variations in gas consumption calculations, and hence emission estimates.

As a result, the use of engineering judgment to apportion gas consumption to process recipes, sub-types, or types, as opposed to the use of an engineering model based on a quantifiable metric, would lead to increased uncertainty in reported emissions. EPA is permitting the use of considerable engineering knowledge in the design of a facility's apportionment model because the quality of that knowledge will be tested based on empirical data via the required performance verification of the model. An engineering model that apportions gas consumption based on tool-specific activity records or logs is preferred to engineering judgment based on general technical knowledge of processes utilized at a facility because tool-specific activity is quantifiable. Please see response to comment 4.1.2-a for additional details on the methodology in the final rule for apportioning gas consumption using facility-specific engineering models based on quantifiable metrics.

Comment Summary 4.1.2-d: One commenter (0089) expressed its support of the use of facility-specific engineering models to apportion gas consumption, and asserted that the way the rule was proposed prohibits the use of some valid approaches. The commenter noted that a 2006 IPCC Tier 3 Method (Tier 3) is used at its facility in which gas usage is measured at a broader facility level and then apportioned down appropriately based on knowledge of process recipes. Specifically, the commenter stated, "The actual apportionment quantifying the portion of material used in a given group of process steps is estimated based on knowledge of the process recipe. Intel's factories typically manufacture one or two different product lines, each of which has a tightly defined set of process steps required, and a recipe for each of these steps that specifies the amount of chemical used. The factories also track the number of wafer starts of each different process the facility is running. The recipe information detailing the use breakdown is combined with the number of wafer starts for each process run to develop an overall estimate of material used on different process steps. While the number of wafer passes is a factor in determining the amount of chemical an operation uses, it is not an indicator that is ultimately tracked. This method definitely relies on some quantifiable indicators such as total fab gas usage and total wafers manufactured. However, the apportioning of gas among process steps also involves some engineering judgment. The gas use in those individual steps is not actually measured, but is assumed to be proportional to the amounts specified in the process recipes." The commenter suggested that the use of knowledge of process operations gas consumption should be allowed, even where that use is not specifically measured at the tool level.

Response 4.1.2-d: In the proposed rule, EPA would have required facilities to use wafer pass as the quantifiable indicator with which to apportion the facility's gas consumption. At the time the rule was proposed, the information available to EPA about methods to apportion gas consumption was limited. To this end, in that proposal, EPA also stated that it recognized that facilities may use other types of quantifiable indicators of gas-usage activity to develop facility-specific engineering models to estimate gas consumption, and requested information about other quantifiable indicators.

It is unclear how the commenters specific suggestions to allow for the use of both knowledge of process operations and engineering judgment as a means for apportioning gas usage would actually be implemented in that is unclear what quantitative information would be tracked or measured and used. Therefore it is not feasible for EPA to finalize the suggested method in the rule. However, based on this comment, other information received in the public comment period, and additional analyses, EPA has modified the gas apportioning requirements in the final rule to provide more flexibility. In the final rule, a facility has the option to choose the quantifiable metric from which to base their facility-specific gas apportioning model provided the facility documents and verifies the model. The method for gas apportioning in the final rule will ensure that facility-specific models result in apportioning factors that are precise and accurate. Please see the preamble section D, Electronics Manufacturing (subpart I), section 3 ("Summary of Comments and Responses"), for the response to comments on apportioning gas consumption. Please also see response to comment 4.1.2-a for additional details on the methodology in the final rule for apportioning gas consumption using facility-specific engineering models based on quantifiable metrics.

Comment Summary 4.1.2-e: One commenter (0095) asserted that for a semiconductor R&D facility, it will be difficult to apportion gas consumption for the Refined Method because one bulk cylinder may support multiple chambers of process tools on which multiple refined process categories may be run. The commenter stated that determining the amount of gas fed into each process category is therefore difficult because gas utilization varies between chambers depending on business needs, customer demands, and concept and feasibility studies for new processes.

Response 4.1.2-e: EPA is clarifying in the final rule that if a facility engages in R&D activities, they are not required to report the emissions from that activity. Please see response to comment 1-b for a more detailed discussion on the exemption for R&D activities. Please also see the preamble section D, Electronics Manufacturing (subpart I), section 3 ("Summary of Comments and Responses"), for the response to comments on apportioning gas consumption.

Comment Summary 4.1.2-f: One commenter (0110) stated that while it meters gas that is going to processes using mass flow controllers (MFCs), their current operations do not log and record flow data. The commenter asserted that to log and record this data would be burdensome.

Response 4.1.2-f: Although facilities may utilize flow meters to apportion gas consumption, EPA is not requiring gas consumption to be apportioned based on information gathered from flow meters. In the final rule, EPA has provided a flexible method for facilities to develop apportioning factors. These flexible requirements are intended to reduce the burden associated with apportioning gas consumption that more stringent requirements, such requiring the measurement of mass flow of gases using mass flow meters, may impose.

Please see response to comment 4.1.2-a for additional details on the methodology for apportioning gas consumption finalized in the rule. Please also see also the preamble section D, Electronics Manufacturing (subpart I), section 3 ("Summary of Comments and Responses"), for additional response to comments on apportioning gas consumption.

4.2 Emission Estimation Methods for Semiconductor Facilities

Comment Summary 4.2-a: One commenter (0122) stated that semiconductor manufacturing processes change frequently, with ongoing improvements to current methodologies requiring installation of new or modified equipment on a regular basis. The commenter further stated that larger-scale migrations to the next "technology node"- representing the ever-smaller features created on the silicon wafer—typically happen as often as every two years. The commenter asserted that when EPA postponed finalizing the electronics portion of the GHG Reporting Rule, the Agency recognized the difficulties and complexities inherent in estimating emissions in the semiconductor manufacturing sector. The commenter further stated, "There are currently no agreed-upon methods for quantifying and reporting PFC emissions from semiconductor and other electronics facilities, other than those developed under the IPCC."

Response 4.2-a: EPA's goal for this rule differs from the goal of the IPCC 2006 Guidelines. EPA's goal for this rule is to require facilities to report as accurate as practical, facility-level emissions, while the IPCC methods are intended for voluntary reporting of country-level emissions inventories. In addition, since the IPCC methods were developed (based on information collected prior to 2006), the industry has moved from manufacturing 200 mm to 300 mm substrates (with higher gas flows), has reduced feature size 3-fold with a corresponding 20 percent increase in number of levels manufactured (resulting in more etching and chamber cleaning), and adopted new etching and chamber cleaning methods to achieve the required technical and economic performance (requiring the use of updated emission factors).

The emissions estimation methods for electronics manufacturing facilities required in the final rule may be viewed generally as an extension from and building upon the IPCC's methods; however EPA's required methods are more distinct in terms of applicability and level of detail. EPA has improved upon the IPCC methods in several ways. First, the number of emitting categories (process types/sub-types) has been expanded from the IPCC methods. Second, the emission factors in the final rule have been updated, to the extent possible based on information available to EPA, from the IPCC Tier 2b factors. Third, EPA has also finalized methods for estimating gas consumption in this rule that are improvements over the IPCC gas consumption estimation methods (e.g., the use of facility-wide, gas specific heel factors, as opposed to a default factor – see section 4.1.1). And lastly, EPA has also made improvements over the IPCC methods in regards to accounting for controlled emissions; the IPCC methods utilized a default DRE that was based on anecdotal information rather than the direct in-fab measurements EPA used to develop its default value for DRE (see section 5.2). These updates and improvements in emission estimation methods, moving forward from the IPCC methods, are crucial for gathering accurate facility-specific emissions data in an industry that is constantly evolving, and will enable EPA to collect data for use in developing future GHG policies and programs.

Please see response to comments 4.2.3-a and b for more discussion on why EPA is not finalizing the Tier 2b for semiconductor manufacturing facilities. Please also see the preamble section D, Electronics Manufacturing (subpart I), section 3 ("Summary of Comments and Responses"), for a more detailed response to comments on emission estimation methods for semiconductor facilities and apportioning gas consumption.

4.2.1 Refined Method

Comment Summary 4.2.1-a: One commenter (0122) stated that it is highly uncertain whether the Refined Method would actually reduce uncertainty in emissions calculations. The commenter also argued that because a mature foundry fab requires the use of a variety of process flows and varying recipes to be run at any one time, the complexity and cost associated with the Refined Method is not warranted. One commenter (0110) suggested that the goal of the proposed Refined Method is good, but that it does not accomplish its goal and imposes a significantly greater burden on industry. The commenter also asserted that any increase in accuracy from using the Refined Method in comparison to the Tier 2b method is minimal. Two commenters (0099 and 0131) stated that the Refined Method stems from a deeply flawed uncertainty analysis and misunderstandings or incorrect assumptions of current industry processes. The commenters asserted that the Refined Method would result in significant capital and ongoing compliance costs. One commenter (0099) also stated that "It [the Refined Method] would not achieve EPA's stated objective to obtain ‘information…relevant to implementing the existing CAA’ that ‘produces a more representative and accurate emissions estimate’ (75 FR 18655 and 18663, April 2010).” The commenter argued that further data collection under the Refined Method should not be pursued.

Another commenter (0108) stated that it does not have the necessary data available to comply with the Refined Method, and that compliance would be unnecessarily burdensome. The commenter also expressed concern that the Refined Method would not lead to accurate results. The commenter stated that, “In the very early 1990’s when crafting Microchip’s emissions profiles for its first (Tempe Fab 2) air permit we attempted to use a process gas flow recipe-based methodology to estimate gas usage tool by tool and per wafer. The result significantly underestimated overall gas usage compared to the quantity issued from raw material stockrooms because gases flowed for a variety of calibration and maintenance procedures where wafers were not processed; gas flow rate and duration for these procedures were not consistent over time. The recipe did not adequately characterize total gas usage. Only a per-gas inventory-based approach was accurate.”

Response 4.2.1-a: It is unclear how the commenter (0108) implemented a method to use a process gas flow recipe-based methodology to estimate gas usage tool by tool and per wafer because the commenter did not provide any supporting or detailed information. It is also not clear how the commenter quantified “significantly underestimated gas usage,” or how the commenter arrived at this conclusion. Based on the limited information the commenter provided pertaining to their experience in using a process gas flow recipe-based methodology to estimate gas usage, at this time EPA can not compare the method the commenter attempted to use, and the methods EPA is requiring to apportion gas consumption in the final rule. As such, EPA can also not draw inferences about the robustness or accuracy of the method described. Please see section 4.1.2 and the preamble section 3 (“Summary of Comments and Responses”), for a more detailed response to comments on apportioning gas consumption.

Please see the preamble section D, Electronics Manufacturing (subpart I), section 3 (“Summary of Comments and Responses”), for a more detailed response to comments on emission estimation methods for semiconductor facilities and apportioning gas consumption. Please also see sections 8 and 10 for more information on the costs associated with the rule and the uncertainty associated with the Refined Method, respectively.

Comment Summary 4.2.1-b: One commenter (TRANS-DC-03) noted their shared interest with EPA in accurate, reliable data, and system-wide accuracy. The commenter encouraged EPA to ensure that the Refined Method does indeed provide accurate data.

Response 4.2.1-b: EPA has determined that the methods provided in the final rule effectively balance EPA’s objectives of obtaining accurate, facility-level data against burden to industry. Please see response to comment 4.2.1-a on the Refined Method and the preamble section D, Electronics Manufacturing (subpart I), section 3 (“Summary of Comments and Responses”), for a more detailed response to comments on emission estimation methods for semiconductor facilities.

4.2.1.1 Other Methods of Categorizing Processes

Comment Summary 4.2.1.1-a: One commenter (0112) responded to EPA’s request for comment on the use of feature-based or filmed-based apportioning instead of process-type categories and asserted that categorization by etch type is the most effective approach as multiple categories for etch processes are developed.

Response 4.2.1.1-a: EPA appreciates the commenter’s input. However, in the final rule, EPA is not requiring a method to estimate emissions for semiconductor manufacturers that is based on plasma etching sub-types (please see response to comment 4.2.1-a).

It is unclear what the commenter’s preference for “etch type” is referring to, that is, it is unclear if the commenter is associating etch-type with either film-based or feature-based etching sub-types. Nonetheless the methods EPA has included in the final rule are not based on etching sub-types in this rule. However, EPA maintains that estimating emissions based on process sub-types for etch with robust default emission factors would result in more accurate facility-level emission estimates as compared to estimating emissions using a single broad etch process type. This is because the variability in processes would be captured with more granular etch process sub-types. In future years EPA may evaluate the recipe-specific emission factors received through the final rule to determine whether a sufficiently robust data set exists to establish default emission factors for process sub-types for plasma etching. In the future, EPA may consider requiring the semiconductor facilities that will be using a default emission factor for the etch process type under the final rule to estimate and report emissions using an approach based on multiple etch and chamber clean process sub-types similar to the Refined Method EPA proposed in April 2010.

At this time, EPA does not have enough data and information to determine if etch sub-types established in the future would be feature-based or film-based. For this reason, in the final rule, EPA is requiring facilities that develop recipe-specific emission factors for etch recipes to identify these factors by both the film and substrate that was etched and the feature type that was produced. EPA plans to consider such information received as a result of this final rule in potential future actions.

4.2.1.2 Draft Default Emissions Factors for Refined Process Categories

Comment Summary 4.2.1.2-a: Two commenters (0099 and 0131) noted that “emission factor coverage on the multiple etch categories is inadequate and data quality is not sufficient to support the differentiation of etch processes into multiple categories…The overarching issue is that both the number and accuracy of the available etch emissions factors is not adequate to support refinement of the etch category for this rule."

Response 4.2.1.2-a: EPA agrees with commenters that the available data at the time of the proposal was insufficient to support establishing default emission factors for etch process sub-types. EPA did not receive enough additional data during the comment period to address this insufficiency.[8] Accordingly, EPA is finalizing provisions in the rule that do not establish default emissions factors for etch sub-types. EPA can not make any assertions about the quality of the data at this time given limited information, and the commenter who noted that the data quality was not sufficient did not provide information supporting their claim. Please see the preamble section D, Electronics Manufacturing (subpart I), section 3 ("Summary of Comments and Responses"), for the response to comments on emission estimation methods for semiconductor facilities.

Comment Summary 4.2.1.2-b: One commenter (0131) requested to be provided with the background data used to generate the Refined Method emission factors.

Response 4.2.1.2-b: EPA made available to the public all of the underlying data used to generate the Refined Method emission factors in Table 5 of the report *Draft Emission Factors for Refined Semiconductor Manufacturing Process Categories* (EPA-HQ-OAR-2009-0927-0073). In the aforementioned report, EPA was also transparent about the details on the methods and assumptions that were used when developing the proposed Refined Method emission factors.

Comment Summary 4.2.1.2-c: One commenter (0110) noted a lack of understanding between EPA and industry regarding the availability of emission factor data to support the Refined Method. Two other commenters (0099 and 0131) asserted that for the majority of GHG usage (72 percent), the emission factors are unchanged compared to the Tier 2b emission factors. The commenters asserted that this highlights the appropriateness of using the Tier 2b factors at this point in time. One of the commenters (0131) also supported the use of the Tier 2b emission factors by stating, "The 2006 IPCC Tier 2b methodology is a globally accepted method for estimating GHG emissions for a semiconductor manufacturing facility. The Tier 2b factors were developed using 190 distinct measured emission factors for CVD chamber cleaning and etch processes and are accurate for developing an inventory of GHG emissions."[9,10]

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[8] In its proposed rule (75 FR 18652, April 2010), EPA published a range of values for each emission factor for the nine proposed process categories. EPA proposed a range of values because it had not received sufficient data to select a specific value within each range. Based on additional information received after publication of the proposed rule, EPA published a Notice of Data Availability where it made available to the public draft default emission factors for semiconductor manufacturing refined process categories (75 FR 26904, May 2010). As of publication of the final rule, EPA has not received additional data (i.e., utilization and by-product formation rates).

[9] This commenter supported the use of a mix of the IPCC Tier 2b factors and EPA NODA factors for the "Alternative Refined Method."

Response 4.2.1.2-c: Based on industry public statements, EPA understood that equipment manufacturers were measuring emissions and emission factors by virtue of device manufacturer equipment purchase requirements, augmented by ISMI Guidelines for Emissions Characterization. EPA learned, however, through the development of its Notice of Data Availability; Default Emission Factors for Semiconductor Manufacturing Refined Process Categories, May 2010 (NODA) that this was not the case, and that few additional emission factor measurements had been made (since the start of the 2006 IPCC process in 2004) by either equipment manufacturers or device manufacturers.

In light of the lack of available data for some categories, EPA has not established emission factors for all of the proposed Refined Method process categories. Although EPA agrees that many of the emission factors proposed for the Refined Method in the May 2010 NODA have not substantially changed from the IPCC Tier 2b factors, EPA has published default emission factors that improve upon the IPCC Tier 2b factors because they reflect a more recent and robust set of data. Please see response to comment 4.2.3-a and b on why EPA is not finalizing the Tier 2b method for semiconductor manufacturing facilities.

EPA used industry data provided in cooperation with Semiconductor Equipment and Materials International to develop the published factors in the May 2010 NODA.[11] The data EPA received were data that had been previously used to establish the 2006 IPCC emission factors, as well as additional and more recent emission factor data that were not available during the 2006 IPCC factor development. Because the data set EPA used to develop the emission factors presented in the May 2010 NODA is more robust, EPA elected to publish updated default factors using the data presented in the May 2010 NODA as opposed to allowing the use of the IPCC Tier 2b factors.

Comment Summary 4.2.1.2-d: Two commenters (0099, 0131) noted that an emission factor development process similar to the AP-42 process could be utilized in the future if EPA wants to establish revised emission factors and improve the accuracy of the data. As an alternative, the commenters also suggested that EPA and industry engage in a memorandum of understanding (MOU) "to develop and execute a voluntary, cooperative plan…to develop emissions factors, with defined uncertainties, to model and determine the degree of refinement that can be achieved in the uncertainty of the emissions calculations." One commenter (0131) also stated, "…it is not appropriate to include such emission factors in the text of the Re-Proposed Rule itself, since modifying or adding new emission factors as new tools and processes are adopted, or as emissions factors for existing tools are refined, would be hampered by the formal rulemaking that would be required to modify the text of the Rule. Moreover, the short period of time between the Rule proposal and finalization simply does not provide sufficient opportunity to develop appropriate emission factors."

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[10] This commenter supported the use of a mix of the IPCC Tier 2b factors and EPA NODA factors for the "Alternative Refined Method."

[11] See Appendix C of the Electronics Manufacture TSD (Mar. 22, 2010) and the May 2010 NODA and accompanying report for more details.

Response 4.2.1.2-d: EPA appreciates the industry's offer to work with EPA to develop emission factors; however, in general, EPA disagrees with commenters' suggestions. While EPA is not ruling out the possibility of using the AP-42 process as a means to update emission factors for electronics manufacturing in the future, EPA is not finalizing such a process at this time. EPA has determined that at this time it is most appropriate to develop and update emission factors for electronics manufacturing through the Mandatory Reporting Rule regulatory framework. The objective of the Mandatory GHG Reporting Program is to obtain facility-specific data to use in developing future GHG policies and programs. To serve its intended purpose, EPA believes that the data must be collected according to consistent methodologies that are prescribed in the rule.

Similarly, EPA is not ruling out the possibility of engaging with the industry to develop emission factors for electronics manufacturing through an MOU. However, for purposes of meeting EPA's goals for this rule, EPA has determined that it is most appropriate to develop and update emission factors for electronics manufacturing through a regulatory framework where facilities are required to use consistent methodologies.

Please also see the preamble to the Final Rule for additional discussion on how the GHG Reporting Program relates to EPA and U.S. government climate change efforts and to other State and Regional Programs (74 FR 56265-56266, October 2009). In addition, please refer to the preamble to the proposed rule on Mandatory Reporting of Greenhouse Gases: Additional Sources of Fluorinated GHGs (75 FR 18655, April 2010).

4.2.1.2.1 Frequency and Process of Updates

Comment Summary 4.2.1.2.1-a: One commenter (0128), who supported the adoption of the Tier 3 method, insists that EPA commit to frequently reviewing and updating default factors if EPA continues to rely on less accurate default emission factors. The commenter acknowledged the release of the draft emission factors published in EPA's NODA. The commenter encouraged EPA to make all of the data underlying the emission factors available to the public for independent verification and review of the data and emission factors.

Response 4.2.1.2.1-a: EPA believes that, where feasible, it is important to provide the public with an opportunity to review the underlying data that EPA uses to develop emission factors. All of the underlying data that was used to establish the default emission factors published in the final rule for semiconductor manufacturing were made available to the public in Table 5 of the report to the May 2010 NODA (Draft Emission Factors for Refined Semiconductor Manufacturing Process Categories, EPA-HQ-OAR-2009-0927-0073). Please see the Electronics Manufacture TSD (Mar. 22, 2010) for more details on how the data was obtained.

In addition, in future years, EPA may evaluate the recipe-specific emission factors received through this final rule to determine whether a sufficiently robust data set exists to establish default emission factors for plasma etching process sub-types. In the future, EPA may consider requiring the semiconductor facilities that will be using a default emission factor for the etch process type under this final rule to estimate and report emissions using an approach based on multiple etch and chamber clean process sub-types similar to the Refined Method EPA proposed in April 2010.

4.2.2 IPCC Tier 3 Method

Comment Summary 4.2.2-a: One commenter (0089) asserted that the final rule should make clear that facilities that use Tier 3 methods are not required to report emissions under the process categories as proposed, but that instead they will be able to use the process steps defined at that facility.

Response 4.2.2-a: In the final rule, EPA is not requiring that emissions estimated using the Tier 3 method be reported under specific process sub-types.

It is unclear how the commenter is defining a process step, however in the final rule, the Tier 3 method consists of calculating and reporting emissions using recipe-specific emission factors for all production processes that use fluorinated GHGs. As required in the final rule, emission factors must be developed for each individual recipe or set of similar recipes used at a facility and emissions must be calculated and reported for each recipe (including those in a set of similar recipes) using the recipe-specific factors. Facilities must then aggregate emissions calculated for each individual recipe or set of similar recipes for each of three process types defined by the rule– plasma etching, chamber cleaning, and wafer cleaning.

4.2.2.1 300 mm and Smaller Wafer Technologies

Comment Summary 4.2.2.1-a: One commenter (0131) did not support requiring the use of IPCC Tier 3 methodology. The commenter, who supported the use of the Tier 2b emission factors (see comment summary 4.2.1.2-c), asserted that most facilities do not use a Tier 3 method, and therefore there is a limited data set that is representative of manufacturing conditions on which to base the assertion that the Tier 3 method results in improved accuracy of emission estimates.

Response 4.2.2.1-a: While EPA is not requiring semiconductor manufacturing facilities manufacturing wafers 300 mm or smaller to estimate emissions from all production processes that use fluorinated GHGs using recipe-specific emission factors because it is mindful of the burden this may impose, EPA continues to maintain that the Tier 3 method will result in the most accurate facility-specific emission estimates. For example, the IPCC 2006 Guidelines state “When using Tier 3 method for semiconductor and TFT-FPD manufacturing, the resulting estimates of emissions will be more accurate than the Tier 2a, 2b or Tier 1 methods, on the order of ± 30 percent (95 percent confidence interval).” The IPCC 2006 Guidelines are a consensus document, and were prepared with substantial input from and agreement among industry experts. To balance burden and the need for accurate facility level data in the final rule, EPA is requiring only semiconductor manufacturing facilities that manufacture wafers that are 300 mm or smaller, to calculate and report their etch process emissions using directly measured recipe-specific emission factors.

Because EPA does not want to prohibit facilities from gathering more accurate data, the final rule allows any semiconductor manufacturing facility that manufacturers wafers that are 300 mm or smaller to use the Tier 3 method to estimate and report emissions for all processes that use fluorinated GHGs if they elect to do so (see §98.93(a)(3)).

Please see the preamble section D, Electronics Manufacturing (subpart I), section 3 ("Summary of Comments and Responses"), for the response to comments on emission estimation methods for semiconductor facilities.

Comment Summary 4.2.2.1-b: One commenter (0110) stated that it had not determined any emission factors through testing, and that based on their review of the record and the SIA/ISMI Facility results presented to EPA, only one company in the US estimates emissions using a Tier 3 methodology. The commenter further stated that it received limited information from their equipment supplier in regards to developing emission factors. The commenter noted that one major U.S. equipment supplier had provided the company with over ten emission characterization reports based on one recipe. The commenter stated, "In light of the uncertainties of EPA's proposal and the enormous complexity of our facilities, however, it isn't clear how this information would be utilized to develop factors if we were required to do so for hundreds of recipes in multiple facilities across an entire company." The commenter argued that given the challenges involved in obtaining site-specific data for such complex facilities and that the Tier 2b average emission factors established by the IPCC are conservative, the Tier 2b factors should be allowed for large facilities.

Response 4.2.2.1-b: EPA does not agree with the commenter that semiconductor manufacturing facilities should be allowed to estimate and report emissions using the 2006 IPCC Tier 2b method. While the 2006 IPCC Guidelines are a consensus document, and were prepared with substantial input from and agreement among industry experts, the Guidelines were prepared with the intention of serving national GHG emissions inventorying purposes. The Tier 3 method requires facility-specific emission information; however other methods such as the Tier 2b method do not. The Guidelines specifically state that the IPCC Tier 2b factors presented were "developed specifically for this guidance." In using the IPCC Tier 2b factors in a facility-level emission estimation method uncertainty assessment, EPA found that the IPCC Tier 2b factors are likely to understate facility emissions, not result in conservative emission estimates (see the Electronics Manufacture TSD, Appendix C for more details) as the commenter asserted. Further, because the IPCC Tier 2b factors are simple averages, EPA has no basis on which to infer that the IPCC Tier 2b factors would overstate emissions.

EPA acknowledges that at this time, semiconductor facilities may not have characterized emissions from all production processes that use fluorinated GHGs. To this end, EPA has structured the final rule to minimize the burden imposed on facilities in conducting direct measurements. For example, EPA is requiring only direct measurement for the etching process type. In addition, EPA is requiring only the largest facilities to estimate and report their etch emissions using recipe-specific emission factors. Lastly, EPA is allowing any factors that were developed for one individual recipe to be applied to similar recipes (as defined in the final rule).

In the final rule, EPA has specified that when reporting recipe-specific emission factors, reporters must identify the film or substrate that was etched/cleaned and the feature type that was etched. Reporting emission factors in this manner will give EPA the opportunity to evaluate various options for developing default emission factors for future use.

It is important to note that in the final rule facilities are allowed to use BAMM for the first six months of data collection for any parameter, such as recipe-specific emission factors, for which it is not reasonably feasible to acquire, install, or operate a required piece of monitoring equipment or to procure necessary measurement services. Facilities are also given the opportunity to apply for extensions for the use of BAMM through the full first year of data collection. Please see the preamble section D, Electronics Manufacturing (subpart I), section 1 ("Summary of the Final Rule") for more information on the BAMM provisions for electronics manufacturing facilities. Please also see the preamble section D, Electronics Manufacturing (subpart I), section 3 ("Summary of Comments and Responses"), for a more detailed response to comments on emission estimation methods.

Comment Summary 4.2.2.1-c: One commenter (0128) was concerned that switching from the Tier 3 method to the Refined Method will result in less accurate emissions data for cleaning and etching in semiconductor facilities. The commenter stated, "We encourage EPA to require Tier 3 reporting for these processes given the need for accurate data and the significant emissions from this sector. The Tier 3 approach relies on facility-specific emissions data on gas consumption, gas utilization, by-product formation, and DRE rather than default emission factors.[12] EPA concluded that use of the Tier 3 method would result in the most accurate estimates amongst the methods presented by the IPCC.[13] By contrast, the Tier 2b is inherently less accurate because it relies on default values for gas consumption, gas utilization, by-product formation, and DREs, and only distinguishes between two broad process types – etching and cleaning – rather than the roughly 450 process categories examined under Tier 3. The Refined Method represents a middle ground of sorts, achieving improved accuracy vis-à-vis the Tier 2b method by expanding on the two process types to include emissions factors

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[12] See 2006 IPCC Guidelines for National Greenhouse Gas Inventories at 6.11; see also EPA, Technical Support Document (Updated) for Process Emissions from Electronics Manufacture (Mar. 22, 2010) ("Electronics Manufacture TSD") at page 11.

[13] Electronics Manufacture TSD (Mar. 22, 2010) at page 12.

specific to nine different refined process categories.[14] While the Refined Method yields emissions estimations that are approximately twice as accurate as the Tier 2b approach, the Method nonetheless produces estimates that suffer from a high degree of uncertainty.[15] EPA assigned an absolute uncertainty of + 27,000 MtCo$_2$e to the typical semiconductor facility with emissions of around 113,000 MtCO$_2$e, meaning that a facility's reported emissions could differ from actual emissions by as much as 24 percent.[16] Such a degree of uncertainty is unacceptably high given the availability of a more accurate reporting method.

While we believe EPA should require Tier 3 reporting for all semiconductor facilities, at minimum, EPA should rely on Tier 3 estimation for 'large facilities,' as it did in its initial proposal. As EPA initially concluded, large facilities have the capability to easily collect this data, and as subsequent comments confirmed, at least one facility already does.[17] Further proof of the feasibility of Tier 3 estimation is this proposal's requirement that facilities producing large wafers – greater than 300mm in diameter – employ Tier 3 reporting. We strongly support this requirement and encourage EPA to ensure consistent facility-level data by at least applying the Tier 3 requirement to large facilities producing other sizes of wafer as well. At an absolute minimum, any facility that is currently using Tier 3 reporting should be required to report that data to EPA."

Response 4.2.2.1-c: EPA agrees that the use of the Tier 3 method will result in the most accurate facility-specific emission estimates. However, EPA is mindful of the burden associated with requiring the Tier 3 method to estimate and report emissions from all production processes that use fluorinated GHGs. In the final rule, there are the two methods for estimating emissions for facilities that manufacture semiconductors, depending on the annual manufacturing capacity of the facility. One method, the Tier 2d method, which is required for the largest semiconductor facilities, requires recipe-specific emission factors to be used to estimate emissions for only the etching process type; other emissions would be estimated using EPA-provided default factors (a partial Tier 3 approach). The other method, the Tier 2c method, relies only on EPA-provided default emission factors. In these methods, both of which move beyond the Tier 2b method, EPA is balancing the burden placed on industry in implementing a full Tier 3 method against the goal of collecting accurate facility-level information. In addition, EPA has also provided facilities with the option to use the Tier 3 method to estimate emissions from all production process that use fluorinated GHGs in lieu of any other method required by the rule. Please see response to comment 4.2.1-a and the preamble section D, Electronics Manufacturing (subpart I), section 3 ("Summary of Comments and Responses"), for the response to comments on emission estimation methods for semiconductor facilities.

EPA is also finalizing the requirement for semiconductor manufacturing facilities that fabricate devices on wafers measuring greater than 300 mm in diameter, regardless of their manufacturing capacity, to calculate and report all of the emissions from

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[14] 75 FR 18656.
[15] See footnote 14.
[16] See footnote 14.
[17] See footnote 14.

processes that use fluorinated GHGs using directly-measured recipe-specific emission factors (i.e., the Tier 3 method). As EPA stated in the preamble to the April 2010 proposed rule, by including this requirement only for the wafers larger than 300 mm, “we anticipate a reduction in burden because emission factors (i.e., gas utilization and by-product formation rates) can be developed over a number of years as semiconductor manufacturers begin to transition to 450 mm tools and develop the estimating and reporting infrastructure. The commissioning process for new tools is an ideal opportunity for emission factor development and/or verification.”

4.2.2.2 Greater than 300 mm Wafer Technologies

Comment Summary 4.2.2.2-a: One commenter (0131) asserted that industry transitions to new wafer sizes are the best opportunity to introduce new equipment requirements. The commenter asserted that the most appropriate introduction point for consistent application of Tier 3 factors is with the introduction of production-ready 450 mm tools.

Response 4.2.2.2-a: EPA agrees with the commenter that semiconductor manufacturing facilities that manufacture wafers greater than 300 mm in size should be required to calculate and report emissions using the Tier 3 method, and in §98.93(a)(4) EPA is finalizing this requirement in the final rule. Please see response to comment 4.2.2.1-c and response to comments in section 4.2.2.2 for a more detailed discussion on EPA’s rationale for requiring semiconductor manufacturing facilities that fabricate devices on wafers measuring greater than 300 mm in diameter (e.g., 450 mm) to calculate and report emissions based on the 2006 IPCC Tier 3 method.

Comment Summary 4.2.2.2-b: One commenter (0110) noted that the adoption of the Tier 3 methodology is a large addition to the overwhelming costs associated with an upgrade to a 450 mm facility. The commenter noted that, depending on the scope of testing, costs could be six or seven figures per facility and add weeks or months to complete. The commenter cited a tool manufacturer that would be willing to perform emission factor testing as a customer service provided the customer was willing to pay extra. The commenter stressed that, in the current economic downturn that has affected the semiconductor industry, testing would consume financial resources needed for a facility to operate. The commenter noted that the U.S. Government Accountability Office (GAO) has cited with approval the measuring, monitoring, and reporting standards of the EPA Climate Leaders, Chicago Climate Exchange, and the Climate Registry, none of which require Tier 3 estimation methods. [18]

Response 4.2.2.2-b: EPA does not agree with the commenter that requiring semiconductor manufacturing facilities that manufacture wafers greater than 300 mm to calculate and report emissions using the Tier 3 method is overly burdensome and costly. For example, one commenter (0122) stated that the total capital budget for a

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[18] U.S. Government Accountability Office (GAO). *High Quality Greenhouse Gas Emissions Data are a Cornerstone of Programs to Address Climate Change.* February 24, 2009. http://www.gao.gov/new.items/d09423t.pdf.

new facility designed to fabricate 300 mm wafers using 28 nanometer technologies is $4.5 billion. Recognizing that this commenter is providing information that includes new construction costs, the information can still be used for general comparison purposes (note, EPA expects that the capital costs of a 450 mm plant to be much more than a 300 mm plant). EPA expects that the costs of Tier 3 measurements relative to the capital costs of a 450 mm fab are small (see sections 4 & 5 of the Economic Impact Analysis (EIA), available in the docket, EPA-HQ-OAR-2009-0927).[19]

The industry transition to 450 mm wafers presents an opportunity, consistent with historical industry practices, reflected in International Technology Roadmap for Semiconductors (ITRS)[20] to move the industry forward in terms of emission estimation practices. As operations are being upgraded and constructed, consistent, robust, and accurate practices can be established. Other commenters have supported this idea as well.

EPA acknowledges the GAO has identified examples of reporting standards that do not require the use of the Tier 3 method; however, the goals of this final rule are different from that of the GAO document. The purpose of the final rule is to collect facility-specific emissions data for use in developing future GHG policies and programs. Collecting accurate data of GHG emissions is important to the future value of the data for informing policy decisions and designing new GHG policies and programs. EPA has concluded that the requirements finalized in this rule accomplish that goal while at the same time balance burden to the industry. Please also see the preamble to the Final Rule (74 FR 56265, October 2009) for additional discussion on how the GHG Reporting Program relates to EPA and U.S. government climate change efforts and other State and Regional Programs.

Comment Summary 4.2.2.2-c: One commenter (0095) proposed that R&D facilities should be allowed to utilize the IPCC Tier 2b methodology instead of the IPCC Tier 3 methodology for estimating emissions from fabricating devices on wafers that are greater than 300 mm. The commenter suggested this because it would not be financially viable for an R&D facility to do emissions testing for a process that is in the concept and feasibility phase.

Response 4.2.2.2-c: EPA is clarifying that if a facility engages in R&D activities, they are not required to report the emissions from that activity. Please see response to comment 1-b for a more detailed discussion on the R&D activity exemption.

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[19] For comparison EPA estimated that the Tier 2d method, which requires direct recipe-specific measurements for all etch process at a large semiconductor facility will cost $23,407.

[20] ITRS (2010) *International Technology Roadmap for Semiconductors 2009*. This and earlier editions and updates are available at http://www.itrs.net/Links/2009ITRS/Home2009.htm.

4.2.3 Alternative Methods for Calculating Emissions from Semiconductor Facilities

Comment Summary 4.2.3-a: One commenter (0095) stated that electronics manufacturing facilities should be allowed to utilize the IPCC Tier 2b methodology provided that "…affected tools have point-of-use abatement units for perfluorinated compounds and DRE published by the abatement unit vendors for PFCs be equal to or above those of the IPCC Guidelines." Other commenters (0108 and 0110) noted that the Tier 2b methodology provides adequate granularity/accuracy with an appropriate level of investment for "relatively smaller" and large semiconductor facilities. One of these commenters (0110) specifically stated that the Tier 2b should be allowed "given the challenges involved in obtaining site-specific data for such complex facilities."

Response 4.2.3-a: EPA does not agree with the commenters that the IPCC Tier 2b method should be allowed for semiconductor manufacturing facilities (with or without requiring that each tool has a POU unit attached). Although the Tier 2b method may be less costly to implement, EPA does not agree that the Tier 2b method (based on two broad process types) provides adequate granularity/accuracy for any semiconductor manufacturing facility because it does not capture variability in processes, nor does it account for emissions from wafer cleaning.

Please see the preamble section D, Electronics Manufacturing (subpart I), section 3 ("Summary of Comments and Responses"), for the response to comments on emission estimation methods for semiconductor facilities.

For more information on EPA's rationale for not allowing the use of DREs published by abatement unit vendors or the IPCC defaults, please see response to comments in section 5.2., and also see the preamble section D, Electronics Manufacturing (subpart I), section 3 ("Summary of Comments and Responses").

Comment Summary 4.2.3-b: One commenter (0122) supported retaining a single etch category at this time for which a Tier 2b emission factor would be used for estimating and reporting emissions. In a similar regard, three commenters (0099, 0100, and 0131) stated that electronics manufacturing facilities should be allowed to utilize an "Alternative Refined Method" based on 5 process categories – etch, in-situ plasma CVD chamber clean, remote plasma CVD chamber clean, in-situ thermal CVD chamber clean, and wafer cleans. The commenters stated that this methodology would improve the accuracy of emissions estimates and also make gas apportioning less burdensome. The commenters (0099 and 0100) suggested that reporters should use the IPCC Tier 2b and/or EPA NODA emission factors for these five process categories.

Response 4.2.3-b: EPA has decided, in part, to accept commenters' suggestions to retain a single etch process type, with no relating process sub-types. EPA determined that the available emission factor data is sufficient to establish default emissions factors for multiple chamber clean process sub-types, but insufficient to support establishing default emission factors for multiple etch process sub-types. Therefore facilities that manufacture semiconductors are required to use either default emission factors (the Tier 2c method) or recipe-specific emission factors (the Tier 2d method) for the etch process type. In the final rule, for the Tier 2c method, EPA is requiring facilities to use EPA developed default emission factors for the etch process type, as opposed to using the IPCC Tier 2b factors as suggested by commenters. The EPA published default emission factors were developed with a more robust set of data than that used to develop the IPCC Tier 2b emission factors. See response to comment 4.2.1-a and the preamble section D, Electronics Manufacturing (subpart I), section 3, for the response to comments on emission estimation methods for semiconductor facilities.

Comment Summary 4.2.3-c: Two commenters (0099 and 0131) supported the use of Tier 3 emission factors for the Alternative Refined Method if a facility has the Tier 3 factors and if the Tier 3 factors meet the following 2 specifications: (1) Factors are "either from tool suppliers and already in their physical possession or through a facility's own measurement methodologies consistent with the ISMI Guidelines"; and (2) Facilities "conclude that – based on their professional judgment - factors are representative of their particular process."

Response 4.2.3-c: EPA agrees with the commenters who suggest that Tier 3 emission factors should be allowed if a facility has them, but only if the facility has Tier 3 factors that represent all production processes that use fluorinated GHGs. EPA is not allowing the use of a hybrid method, or a method using facility-developed default emission factors for process types or sub-types. This means that a single facility must choose between using only default emission factors and using recipe-specific emission factors for all process types; hybrid methods using both default emission factors and recipe-specific factors within the same reporting year are not permitted. This restriction will enable EPA to analyze emissions and trends using a consistent set of data. The only exception is where a facility is required to use a method using default emission factors but no defaults are provided in Tables I-3, I-4, I-5, I-6, or I-7 for a particular fluorinated GHG and process type or sub-type combination. Where defaults are not provided, a facility must either use utilization and by-product formation rates of 0 or, in that particular instance, use directly measured recipe-specific emission factors measured using the 2006 ISMI Guidelines, International SEMATECH #06124825A-ENG, with limited exceptions. [21]

EPA does not agree with commenters that EPA should allow facilities to estimate emissions using emission factors that were measured with a facility's methods that could be consistent with the ISMI Guidelines. Rather, in the final rule EPA is requiring that facilities measure their recipe-specific emission factors using the methods specified in the 2006 ISMI Guidelines or the 2001 ISMI Guidelines provided that measurements were made prior to January 1, 2007. By requiring the use of the Guidelines, as opposed to allowing facility to use their own methods independently judged as consistent with the Guidelines, EPA can ensure that the methods for developing

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[21] EPA is permitting facilities to use emission factors measured using the 2001 ISMI Guidelines, International SEMATECH #01104197A-XFR, provided the emissions factors were measured prior to January 1, 2007. Documentation for the measurements is required.

emission factors are being used throughout industry are consistent. This will provide EPA with emissions information that can be analyzed and compared across the industry. See response to comment 5.1-a for more details on why EPA is requiring measurements to be made using the ISMI Guidelines.

EPA does not agree facilities should be allowed to conclude based on professional judgment that emission factors used are representative of their own processes, as this method does not provide EPA with any means to verify emissions data being reported. Professional judgment is subjective and depends on the values of the person making the judgment. This may create inconsistencies between facilities when applying the Tier 3 method for fluorinated GHG emissions, particularly given the high variability in the quantities and types of fluorinated GHGs in the vast number of recipes used throughout the industry. Instead, EPA is requiring facilities who obtain Tier 3 emission factors from third parties to ensure, and to provide supporting documentation, that the emission factors provided are for recipes that are similar to those used at the facility.[22] Please see the Electronics Manufacture TSD, Appendix D for more details supporting the definition of “similar recipe.”

Comment Summary 4.2.3-d: Two commenters (0099 and 0131) suggested two alternative measurement approaches for fluorinated GHGs and N_2O; these included the development of an accurate facility-wide emission factor using statistical parameters and the use of “factory modeling” for new facilities based on representative process steps and gas consumption. Specifically, the commenters suggested that a facility-wide emission factor could be established by:

“a) Characterization of the facilities final exhaust using an approved protocol (e.g. 2006 ISMI, 2010 EPA protocol)
    i) Sampling would include sufficient final exhaust data to understand the variability and develop an average factor and uncertainty range
    ii) The method could contain a requirement to retest and establish new emission factors if gas usage increased by 20 percent
b) Develop an average emission factor with uncertainties comparable to other acceptable methods utilizing the final exhaust data
    i) Use mass balance to quantify constituents below methods detection limits
c) Calculate emissions over time by applying this average emission factor to actual gas consumptions (i.e. emissions = gas consumption * EF)”

The commenters described “factory modeling” as the following: “Factory modeling may be possible for new factories if the appropriate software is integrated into new systems. With the appropriate capability built into new tools, it may become possible to track tool level gas consumption and develop emission factors for a representative sample of

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[22] In the final rule, a similar recipe is defined as those recipes that have identical chemical compositions and where differences, considered separately, in reactor pressure, individual gas flows, applied RF power, and flow stabilization time, relative to equipment manufacturers’ best known method or a facility’s process of record, are less than or equal to plus or minus 10 percent.

process steps. Total emissions could then be expressed as a function of chemical use multiplied by the average emission factors.

As measurement technologies are likely to improve over time, we believe it is important that the final rule contain flexibility that would allow for the use of alternative methods without future rule change."

The commenters stated that it provided these alternatives because they believe in the importance of flexibility in the final rule to allow alternative methods without future modifications to the rule.

Response 4.2.3-d: EPA agrees that the final rule should provide flexible approaches, but only where the methods provide accurate facility-specific emissions data. If an alternative method is developed that is not included in the final rule and EPA determines that it meets the goals of the GHG Reporting Program then in the future, EPA may consider updating the Electronics Manufacturing subpart to allow the use of such an alternative methodology.

EPA is not finalizing the methods the commenters provided as options because the commenters did not provide sufficient details for EPA to effectively evaluate the accuracy or feasibility of the methods.

4.3 CEMS (Continuous Emissions Monitoring System(s))

Comment Summary 4.3-a: One commenter (0074) states that the use of Fourier transform infrared (FTIR) spectroscopy, as used in continuous emissions monitoring systems(CEMS), is a technology that is well established and mature. The commenter noted that technology is currently being used in both the electronics industry and the fluorinated GHG manufacturing industry. About using FTIR for CEMS, the commenter asserted that "the hardware and software are readily configurable to a range of applications, and the sampling equipment is sufficiently resistant to the corrosive components expected in these process gas streams (e.g., HF, F_2) that they operate for months at a time with little or no evidence of damage." The commenter goes on to present multiple applications and various locations in a facility where FTIR CEMS can be used to "cost-effectively monitor GHG gases as required."

Response 4.3-a: EPA appreciates the information on FTIR CEMS provided by the commenter. In the final rule, EPA is not providing for the use of CEMS for measuring process emissions from electronics manufacturing facilities. Although the use of CEMS is well established for measuring emissions from single steady flow stacks, such as stack emissions from stationary combustion, information available at this time about the technical feasibility, accuracy and costs of estimating emissions from electronics manufacturing using CEMS is limited. CEMS-like emissions monitoring technologies, such as FTIR are being evaluated for this sector, but they are still in the developmental stages. For these reasons EPA is not including a CEMS method in the rule for electronics manufacturing at this time.

EPA welcomes information on using CEMS to measure GHG emissions from the electronics manufacturing industry. In future years, given more information about the feasibility, implementation methods, and costs of CEMS, and the accuracy of estimating emissions from CEMS, EPA may consider updating the rule to allow for the use of this technology for electronics manufacturing.

Comment Summary 4.3-b: Four commenters (0089, 0110, 0112, and 0131) asserted that CEMS are not appropriate for quantifying fluorinated GHG emissions from semiconductor manufacturing. According to the commenters, requiring the use of CEMS is unnecessary, potentially not feasible, and not economically justified. The commenters provided EPA with their insight about using CEMS in the electronics manufacturing sector. These commenters stated that CEMS have historically been used to measure single pollutants in steady-state processes in stack exhaust streams. This presents an issue for semiconductor manufacturing because these facilities typically use 8-10 different fluorinated GHGs which then flow into an exhaust stream and have 20-30 stacks (for a large facility). While FTIR has been used for short-term discrete measurements of the mix of fluorinated GHGs used at a semiconductor manufacturing facility, FTIR has not been used widely for CEMS, and it presents many inherent difficulties in terms of technology and cost. One commenter (0089) stated that "Requiring the use of CEMS would require the semiconductor manufacturing industry to invest significant resources to develop and demonstrate some type of continuous monitoring technology that would ultimately still yield inaccurate results in place of the currently established conservative approaches." Another commenter (0131) also supported the previous statement by stating, "even if FTIR could be adapted for CEMS, the results would be extremely inaccurate." Another commenter (0110) supported the continued use of emissions factors and a material balance over CEMS.

Response 4.3-b: It is unclear to EPA how the commenter (0131) arrived at the conclusion that the results of using FTIR CEMS would be inaccurate, given that CEMS is not widely used throughout industry and EPA is unaware of robust studies comparing the use of CEMS to other emission estimation methods. EPA would welcome any further information on which the commenter based the aforementioned assertion, and is interested in further study on the use of CEMS, based on FTIR or other techniques.

At this time EPA agrees that it is not appropriate to require CEMS to estimate fluorinated GHG emissions in the electronics manufacturing industry. Please see response to comment 4.3-a on the use of CEMS. However EPA is not ruling out the possibility of the use of CEMS in for estimating emissions in the electronics manufacturing source category in the future. Despite the limited information available about the use of CEMS for electronics manufacturing (as discussed in comment response 4.3-a) work to establish the use of CEMS for electronics manufacturing is ongoing, as detailed in one commenter's (0074) submission.

4.4 N_2O

Comment Summary 4.4-a: One commenter (0131) supported the inclusion of nitrous oxide (N_2O) in inventory requirements and views it as an improvement in accuracy of emission reporting when using the IPCC Tier 2b method.

Response 4.4-a: EPA agrees with the commenter that the inclusion of N_2O in the facility emissions estimate is an improvement over using the IPCC Tier 2b method to estimate facility emissions, as the IPCC does not provide default N_2O emission factors, and hence the IPCC Tier 2b method does not include estimating emissions from the use of N_2O.

Comment Summary 4.4-b: One commenter (0112) asserted that EPA should allow facilities to develop a facility-specific factor for N_2O utilization through facility testing and measurement in CVD and other processes where N_2O is used.

Response 4.4-b: EPA agrees with the commenter that facility-specific N_2O factors should be allowed. In the final rule, in §98.93(b), EPA is allowing facilities to develop facility-specific N_2O utilization factors for CVD and for other N_2O-using production processes. If a facility elects to use facility-specific N_2O utilization factors, one must be developed for each CVD and for other N_2O-using processes. Further, the measurements must be made using the 2006 ISMI Guidelines, with limited exceptions.[23]

4.4.1 Default N_2O Utilization Factors

Comment Summary 4.4.1-a: One commenter (0112) accepted EPA's proposal for a utilization factor of 0.2 for N_2O CVD processes, given a lack of detailed data available to justify a higher utilization factor for CVD and other processes. The commenter stated that N_2O is highly reactive and is likely to quickly degrade in the processes. The commenter further stated that it expects utilization rates to be higher than 20 percent, but that there is a lack of data to justify a higher utilization factor for CVD or other N_2O using processes.

Response 4.4.1-a: EPA thanks the commenter for their support. EPA agrees that at this time there is a lack of data to justify a default N_2O factor for CVD higher than 0.2. To this end, in §98.93(b), EPA is finalizing the proposed default utilization factor of 20 percent for N_2O for CVD. EPA is maintaining the proposed default factor of 0 for other N_2O-using manufacturing processes. For more information regarding the N_2O default factors included in the final rule, please see response to comment 4.4.1-b.

Comment Summary 4.4.1-b: One commenter (0131) noted that it provided data in their comments to the initial proposed rule to support a 40 percent default factor for CVD processes. The commenter supported the use of 40 percent for CVD as it is a conservative default factor. Two commenters (0110 and 0131) also proposed the same 40 percent default factor to be applied for other N2O-using processes.

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[23] See footnote 21.

Response 4.4.1-b: EPA does not agree with the commenters that a 40 percent default factor should be applied for CVD processes or for other N_2O-using processes. EPA appreciates the information that one commenter submitted previously on N_2O utilization rates; however, EPA is maintaining the proposed utilization factors of 20 percent for CVD and 0 percent for all other N_2O-using processes as discussed in the following paragraph. [24]

While the information the commenter supplied to EPA about N_2O utilization was considered in determining the default utilization factors that were proposed and now being finalized, EPA did not accept the commenter's suggested 40 percent for several reasons (which were also noted in the preamble to the proposed rule). First, the industry survey on which the 40 percent was based was comprised for the most part of measured utilization factors that were largely from newer 300 mm manufacturing equipment. EPA did not consider the 40 percent as representative because N_2O utilization of older manufacturing equipment, such as 150 mm and 250 mm tools, was not fully represented. In addition, the information provided did not fully identify the specific processes from which the average N_2O utilization factor was calculated. Since the majority of N_2O is used in CVD processes and given the lack of information available about the actual utilization of N_2O in other manufacturing processes, EPA only considered the 40 percent value provided by the commenter in finalizing the CVD N_2O utilization factor.

Commenters did not provide any additional quantitative information on N_2O utilization factors to support their claims. To this end, EPA was not able to evaluate additional emission factors to develop alternative default emission factors for N_2O. In the future, based on additional information on N_2O utilization rates, EPA may consider updating the N_2O default emission factors.

Comment Summary 4.4.1-c: One commenter (0095) proposed that EPA should publish a default utilization factor of at least 50 percent for a CVD process because N_2O utilization efficiency is relatively high since SiH_4 and N_2O are relatively reactive with each other.

Response 4.4.1-c: EPA does not agree with the commenter. While N_2O and SiH_4 are relatively reactive, if N_2O is used in any amount that exceeds the stochiometric amount of N_2O that will react with SiH_4, that excess amount of N_2O will be unused and emitted. Information is not currently available to EPA that would support utilization factor higher than 20 percent at this time. Further, EPA did not receive additional data from the

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[24] EPA proposed a range of 0 percent to 40 percent for the default utilization factor for N_2O for CVD. EPA determined the upper bound of this range through information collected in an industry survey presented in a comment received in response to the initial rule proposal. This industry survey concluded that on average the utilization of N_2O for all processes at a fab is ~40 percent. EPA selected the lower bound to be conservative. EPA is finalizing the midpoint of this range, 20 percent, as the default CVD N_2O utilization factor. EPA proposed a default utilization factor of 0 for other N_2O-using processes due to a lack of information regarding other processes for which N_2O is used and N_2O utilization data in those processes.

commenter to support the higher value. Please see response to comment 4.4.1-b for more discussion on the default N_2O factors.

Comment Summary 4.4.1-d: One commenter (0100) proposed that EPA should provide default emissions factors for all processes using N_2O.

Response 4.4.1-d: In the final rule EPA is including two default emission factors for N_2O- using processes: 20 percent for N_2O CVD processes and 0 percent for other N_2O-using processes. See response to comment 4.4.1-b for additional details on the N_2O utilization default emission factors.

4.5 Heat Transfer Fluids

Comment Summary 4.5-a: One commenter (0108) suggested that EPA should not require the use of the detailed mass balance for HTFs (proposed Equation I-12) for the "relatively smaller semiconductor facilities." The commenter alternatively proposed the optional use of an emission factor of 1.0 for simplicity ("i.e., all heat transfer fluid replacement from raw materials stockrooms and heat transfer fluid sent offsite in equipment but not returned would be considered emitted"). The commenter suggested that these losses are too low to significantly contribute to a facility's CO_2e calculations, especially given that the particular fluids used do not have a published GWP in subpart A. The commenter argued further that to calculate these emissions would be disproportionally resource intensive compared to any benefit in accuracy. Another commenter (0089) expressed that many of the heat transfer uses occur in closed loop systems that do not require periodic addition of refrigerant or other onsite service. The commenter asserted that requiring that an inventory be kept identifying when such units arrive and leave the site is an unnecessary burden that provides no real information about emissions. The commenter argued that the fluorinated heat transfer tracking requirements should focus on consumptive uses of fluorinated liquids such as thermal testing that actually generate emissions.

Response 4.5-a: EPA does not agree with the commenters. HTFs are widely used in semiconductor manufacturing, regardless of facility size.[25] Further, EPA does not agree that these emissions from the use of HTFs are too low to significantly contribute to total facility emissions in CO_2e as there is not enough quantitative evidence available to support this conclusion, and the commenter didn't provide any quantitative detail to support their claim. As stated in 3M's July 2009 Solid State Technology article *Reduction of PFC emissions from heat transfer fluids*,[26] "A fab's PFC heat transfer liquid emissions are a significant and growing portion of its total PFC emissions." In a 3M presentation at the 2010 IHTESH conference the following is also stated, "It is estimated that a fab's PFC/PFPE liquid emissions can be 15-50 percent of its gaseous

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[25] Please see "Uses and Emissions of Liquid PFC Heat Transfer Fluids from the Electronics Sector (EPA 430-R-06-901), available at http://www.epa.gov/semiconductor-pfc/documents/pfc_heat_tranfer_fluid_emission.pdf.

[26] Please see http://www.electroiq.com/index/display/article-display/365819/articles/solid-state-technology/semiconductors/materials/2009/07/reduction-of-pfc-emissions-from-heat-transfer-fluids.html.

PFC emissions."[27] Given EPA's goals for this rule, EPA believes that it is important to accurately capture the emissions from HTFs as part of overall facility emission estimates. Applying a factor of 1.0 for simplicity as the commenter suggested does not achieve those goals.

Although in the final rule facilities must report emissions of HTFs in absolute mass, not in CO_2e, EPA may convert the absolute reported HTF emissions to CO_2e for comparison purposes across the industry and national GHG emissions. In an EPA report (EPA 430-R-06-901)[28], EPA estimates that HTFs have GWPs that range from >6,000-9,000 and some are long-lived pollutants, persisting in the atmosphere as long as 3200 years.[29] In addition, a commenter (0131) provided input that HTF GWPs range from 55-9,400. EPA does not consider these GWPs insignificant.

If in the commenter's assertion that HTFs are used in closed loop systems, the commenter is also asserting that there are no emissions associated with the use of HTFs, EPA does not agree. There is very limited information available about the actual emissions of HTFs. Facilities often top off HTFs used in "closed loop systems" (e.g., chillers or heat exchangers) without tracking the exact amount that is lost (see EPA 430-R-06-901).[30] Some facilities may collect some portion of the lost material and then ship it off site, although this quantity is typically not tracked. Additionally, with the use of HTFs, there are often losses that occur due to evaporation or leaks, which are also not tracked by facilities. As stated in the 2006 IPCC Guidelines, "3M, a manufacturer of a popular HTF estimates that a vintage 2000 manufacturing plant may lose 1,900 litres/year via evaporation. Manufacturers of testing equipment that use heat transfer fluids report loss rates of approximately 30 litres/year/system for newer designs that reduce evaporative losses and 50 litres/year/system for older designs."

While a facility may actually emit a small amount of HTFs in one reporting year, such as 30 liters/year, given that facilities for the most part do not actually track HTF losses, the actual amount of HTFs that facility emits may vary in the next year due to any changes in evaporation or if any leaks occur. For these reasons, EPA is maintaining its requirement for facilities to use a simple mass balance method, which utilizes inventory quantities, to estimate HTF emissions. The use of this method ensures that emissions due to losses, evaporation, and leaks are accounted for in a manner that is less burdensome than direct measurement and equipment testing. The mass balance method, unlike the methods the commenters suggested, will provide accurate information about the actual quantity of HTFs that are being emitted. This method also

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[27] Liaw, William, Weli Lin and Phillip Tuma. Low GWP Alternatives to PFC/PFPE Heat Transfer Fluids As a Means to Decrease Facility Greenhouse Gas Emissions. 3M Electronics Markets Material Division. Presented at the 2010 IHTESH conference. HsinChu, Taiwan, 2010. Available in the docket EPA-HQ-OAR-2009-0927.

[28] See footnote 25.

[29] Tuma, Phillip and Lew Tousignant. Reducing Emissions of PFC Heat Transfer Fluids. 3M. Presented in the EHS Challenges and Analytical Methodologies session at the SEMI Technical Symposium: Innovations in Semiconductor Manufacturing during SEMICON®West, July 16, 2001. Available at: http://multimedia.3m.com/mws/mediawebserver?66666UuZjcFSLXTtlXfVM8TtEVuQEcuZgVs6EVs6E666666--.

[30] See footnote 25.

allows EPA to compare varying emissions of HTFs consistently across facilities. In the final rule, any facilities reporting under the Mandatory Greenhouse Gas Reporting Rule and engaging in production processes which use fluorinated GHGs as heat transfer fluids 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) are required to use the mass balance method specified in subpart I ((see §98.93(h)) for estimating and reporting HTF emissions.

Comment Summary 4.5-b: One commenter (0089) stated that the definition of fluorinated HTFs should be more explicit to clarify reporting requirements and to focus on materials and uses most likely to generate emissions. The commenter noted that it is unclear whether the reporting of emissions would be required for fluorinated liquids used in applications other than heat transfer. The commenter stated that tracking requirements should focus on consumptive uses of fluorinated liquids such as thermal testing that do generate emissions. Another commenter (0131) also asserted that HTFs are not only used to transfer heat. These other uses of HTFs are not expected to result in a significant amount of emissions, and using the mass balance method may not be warranted. The commenter suggested that facilities should not be required to report emissions from the use of HTFs used for purposes other than transferring heat unless the usage exceeds a de minimis value of 20 kg. The commenter also suggested facilities only be required to report HTFs with vapor pressures that exceed 400 Pa and have an assigned IPCC AR4 GWP value. (See also the de minimis reporting threshold section 2.3)

Response 4.5-b: In regards to the commenter who suggested that EPA should focus on the uses of HTFs most likely to generate emissions, EPA does not agree with this suggestion. All uses of HTFs may generate emissions. To single out certain uses of HTFs to be reported will give EPA an incomplete picture of actual HTF emissions. EPA also disagrees that is unclear whether HTFs used in all applications must be reported. As stated in the rule for subpart I, HTFs are defined as fluorinated GHGs used for temperature control, device testing, and soldering in certain types of electronic manufacturing production processes. HTFs used in the electronics sector include perfluoropolyethers, perfluoroalkanes, perfluoroethers, tertiary perfluoroamines, and perfluorocyclic ethers. HTFs commonly used in electronics manufacturing include those sold under the trade names "Galden® " and "Fluorinert™." Electronics manufacturers may also use these same fluorinated chemicals to clean substrate surfaces and other parts. By defining HTFs in this manner, EPA intends to capture HTFs that are used for transferring heat and for other uses such as cleaning substrates. EPA appreciates the input from the commenter who suggested a de minimis value of 20 kg for HTFs with vapor pressures that exceed 400 Pa and have an assigned IPCC AR4 GWP value. However, EPA does not agree with the suggestion as discussed in responses to comments in Section 2.2.

Comment Summary 4.5-c: One commenter (0131) suggested a mass balance method that is keyed to purchase and offsite shipment for HTFs.

Response 4.5-c: EPA appreciates the commenter's suggestion, however EPA did not modify the mass balance that facilities are required to use to determine HTF emissions in the final rule. EPA does not believe that the method the commenter suggested will accurately capture HTF emissions because it is not a complete mass balance method as required in the final rule. The commenter's suggested method does not take into account the complete picture of the use of HTFs in a facility, as it appears the commenter is neglecting to account for the inventory of HTFs stored onsite at the beginning and end of the reporting year. All purchases of HTFs may not be used in a reporting year, and in this instance a mass balance method that accounts only for purchases and offsite shipments, as opposed to accounting for the inventory of HTFs stored on-site as well, may result in an overestimation of HTF emissions.

Requiring beginning and end of year inventories is also a QA/QC measure for EPA and a facility. If end of year inventories do not equal beginning of the subsequent year inventories it is a signal that inventorying or emission estimations methods may not have been carried out properly.

Please see response to comment 4.5-a for additional information on EPA's rationale for finalizing methods for estimating emissions form HTFs.

Comment Summary 4.5-d: One commenter (0131) suggested alternative variable definitions for the HTF mass balance equation, as it found some of the definitions to be confusing. The commenter also identified an error in the units assigned to variables in the equation.

Response 4.5-d: EPA appreciates the commenter's suggestions. EPA has accepted two of the commenter's proposed definitions of variables, for the variable I_{io} and for I_{it}. These variable definitions have been revised as follows:

I_{io} = Inventory of fluorinated heat transfer fluid i (in containers, not equipment) *in containers other than equipment* at the beginning of the reporting year *(in stock or storage)*.

I_{it} = Inventory of fluorinated heat transfer fluid i (in containers, not equipment) *in containers other than equipment* at the end of current reporting year *(in stock or storage)*.

EPA has not revised other variable definitions in the HTF mass balance equation because EPA does not agree that the commenter's suggestions improve the clarity of the definitions. In the final rule, EPA corrected the unit assignment error for the input of the mass balance equation.

5. Monitoring and QA/QC Requirements

5.1 Use of the 2006 ISMI Guidelines

Comment Summary 5.1-a: One commenter (0089) proposed that the requirement to use the 2006 ISMI guidelines for developing site-specific emission factors apply only from the effective date of the final rule onward. The commenter proposed that emission factors and DRE values developed prior to the final rule's effective date be "grandfathered" in by not requiring adherence to the 2006 ISMI Guidelines. The commenter noted that many site-specific emission factors were developed from testing prior to 2006 and thus would not qualify. The commenter asserted that this would discourage the use of the Tier 3 method under this regulation. Furthermore, the commenter asserted that tests performed more recently may not meet the requirement since prior documentation may be lacking to verify the use of the 2006 ISMI Guidelines, as there was no regulatory requirement in place previously that would have required facilities to maintain this documentation. The commenter asserted that retesting process tools in accordance with 2006 ISMI Guidelines would likely take years.

Response 5.1-a: This rule's reporting requirements are prospective only. For facilities to use historical emissions measurements, EPA needs to verify that appropriate QA/QC procedures were followed for any measurements made and factored into emission estimation methods, regardless of when the measurements occurred, to ensure the quality of the data being used to estimate emissions. In general, EPA designed these requirements with the expectation that the measurements would be made in future. However, to provide more flexibility for facilities that have already made Tier 3 measurements prior to the publication of the rule, EPA is allowing facilities to use measurements made in the past if sufficient supporting documentation is available.

EPA is understanding of the burden that requiring only the use of the 2006 ISMI Guidelines may impose on facilities that have already developed Tier 3 emission factors prior to the publication of the final rule. Therefore, for measurements made to develop recipe-specific factors prior to January 1, 2007, EPA is permitting facilities to use factors developed in accordance with the 2001 ISMI Guidelines in the final rule. This flexibility will allow facilities to use measurements made prior to the publication of the 2006 ISMI Guidelines.

EPA is not, however, allowing facilities to report measurements that were not made using either the 2006 or 2001 ISMI Guidelines. Requiring the use of the 2006 or 2001 ISMI Guidelines, which were developed by and within the industry, is the means for EPA to ensure that measured emission factors are robust, consistent, repeatable, and precise. By requiring that emission factors be measured using the 2001 or 2006 ISMI Guidelines, EPA is relying on the only established industry practices for quantitatively characterizing emissions under conditions of actual wafer processing.[31] DRE values developed prior to publication of the EPA's DRE Protocol can be utilized as long as

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[31] According to the authors listed to the antecedent guidelines, the Guidelines were not only developed among industry experts. ISMI sought and secured the expertise of NIST, a federal technology agency, in developing its guidelines for characterizing emissions.

documentation demonstrates compliance with the principles and requirements of the Protocol.

For additional responses to comment on the required use of EPA's DRE Protocol see section 5.2.4.1. For more information on the required documentation for historical emission measurements made using the 2001 or 2006 ISMI Guidelines please see response to comment 7-b.

5.2 Controlled Emissions from Abatement Systems

Comment Summary 5.2-a: One commenter (0112) asserted that facilities should be able to receive credit for the performance of the PFC gas destruction systems in which they have invested.

Response 5.2-a: EPA's final rule does not prohibit a facility from accounting for a fluorinated GHG and N_2O abatement systems' properly measured performance. EPA is requiring facilities to adhere to methods that will help ensure controlled emissions are accurately reflected in facilities' total emission estimates. Based on the information available to EPA at this time, EPA is providing facilities with two options, with various levels of associated burden, to account for the use of abatement systems. In using either method to account for the use of abatement systems (i.e., either EPA's default DRE or properly measured DREs), facilities must ensure that abatement systems are properly installed, operated, and maintained, and that facilities account for abatement system uptime. For more details on the importance of these components and discussion on why they are required to receive credit for the use of abatement systems, see the preamble to the April 2010 proposed rule (75 FR 18667, April 2010). Please also see sections 5.2.1 and 5.2.2 for information on proper installation, operation, and maintenance of abatement systems and accounting for abatement system uptime, respectively.

One of the methods provided in the rule to account for the use of fluorinated GHG and N_2O abatement systems, the use of EPA's default DRE, strikes an appropriate balance between being conservative and being representative where equipment is properly operated and maintained. The second method, using properly measured DREs, requires gradual testing of all abatement systems, and retesting individual abatement systems over time. While this may be more burdensome than using a default DRE, it offers facilities an option to more accurately reflect the use of fluorinated GHG and N_2O abatement systems. For more discussion on the use of properly measured DREs, please see the preamble to the April 2010 proposed rule (75 FR 18668, April 2010), as well as section 5.2.4.

Comment Summary 5.2-b: One commenter (0112) proposed that facilities be allowed to calculate fluorinated GHG emissions based upon gas used multiplied by 1 minus the DRE for destruction systems without having to adjust for utilization if the facility so chooses. The commenter asserted that this will result in conservative reporting of emissions, would simplify the emissions calculations, and would avoid unnecessary process analysis work.

Response 5.2-b: EPA does not agree with the commenter's suggestion that emissions can be estimated using only the amount of fluorinated GHGs consumed and a DRE, without taking into account gas utilization in the process tool. Although EPA agrees that the method proposed by the commenter will result in an overestimation of emissions, it would be inconsistent with a goal of this rule in having facilities report accurate emissions. In some cases, the amount of gas utilized in a process may be as much as 90 percent or higher'[32] not accounting for this in estimating emissions will lead to known and preventable inaccuracies in data reported to EPA. EPA intends to use the accurate facility specific information gathered by this program to inform future policy design and regulatory decisions. EPA has concluded that the method suggested by the commenter is not sufficient for this purpose.

5.2.1 Proper Installation, Operation, and Maintenance

Comment Summary 5.2.1-a: One commenter (0128) strongly supported EPA's emphasis on ensuring proper installation, operation, and maintenance of abatement systems. The commenter noted that the variability in DREs is partially attributable to installation and maintenance practices. The commenter asserted that independent inspection and maintenance is essential to ensure that default DREs bear some relationship to real emissions.

Response 5.2.1-a: EPA appreciates the commenter's support for the required certification of properly installed, operated, and maintained abatement systems. However, EPA does not agree with the commenter's assertion that independent inspection and maintenance is essential for ensuring that default DREs reflect actual emissions. While independent inspections may be effective, requiring independent inspection and maintenance would be burdensome for facilities. Therefore, to reduce burden, EPA is permitting facilities to self-certify proper installation, operation, and maintenance by documenting that the abatement systems are installed, operated, and maintained in accordance with abatement system manufacturers' specifications.

Comment Summary 5.2.1-b: Two commenters (0110 and 0123) asserted that on-site, independent inspection of abatement system installation, operation, and maintenance is unnecessary and burdensome, particularly on an annual basis. The commenters suggested that facilities be allowed to self-certify proper installation, operation, and maintenance of abatement systems as self-certification is allowed for compliance and enforcement for similar permit conditions under the CAA.

Two other commenters (0099 and 0131) stated that third-party quality assurance and inspection of abatement systems is unnecessary. The commenters asserted that certification by a responsible company official is consistent with other programs and

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[32] As demonstrated in Table 5 of the report Draft Emission Factors for Refined Semiconductor Manufacturing Process Categories (EPA-HQ-OAR-2009-0927-0073).

appropriate for fluorinated GHG reporting. The commenters expressed concern that restricting the facility to only the abatement equipment manufacturers' maintenance specifications would not allow for future improvement in operational and maintenance procedures, and that the requirement, which restricts facilities to staying within abatement systems manufacturer installation, operation and maintenance specifications, may not allow competition for maintenance contracts.

Response 5.2.1-b: While independent inspections may be effective, EPA has determined that requiring independent inspection and maintenance would be more burdensome for facilities. EPA is therefore permitting facilities to self-certify proper installation, operation, and maintenance by providing documentation that abatement systems are installed, operated, and maintained in accordance with abatement system manufacturers' specifications. EPA does not find it plausible that requiring facilities to follow manufacturers' specifications would preclude further improvements in O&M procedures or practices. Facilities may adopt additional measures as long as they do not conflict with the rule requirements. Additionally, no part of the requirement specifically limits to whom a facility may award maintenance contracts. Please see response to comment 5.2.1-a.

5.2.2 Accounting for Abatement System Uptime

Comment Summary 5.2.2-a: One commenter (0131) confirmed that facilities may be able to monitor abatement system operations, but the commenter also cited ISMI survey findings that additional labor and cost will be required to install and maintain monitoring systems to track uptime. The commenter proposed: "That EPA allow for a facility specific monitoring systems and to calculate uptime as the percent of the total abatement operation and included in the fraction of input gas in Eqs. I-7 and I-8 and multiplied by the DRE in the equation."

Response 5.2.2-a: EPA maintains that applying a DRE value that is not discounted for abatement system uptime would result in an underestimation of total facility emissions as abatement systems are not fully operational for 100 percent of the reporting year. For example, the time during which a system is by-passed, undergoing maintenance, or not operating with O_2-flow (in the case of a CF_4 combustion system) should not be taken into account[33] when estimating and reporting controlled emissions as this would result in a mis-estimation of controlled emissions. EPA is providing two new equations in the final rule (Equations I-14 and I-15) to which facilities must adhere when calculating uptime of an abatement system, and when accounting for uptime in the DRE values applied to estimate emissions. EPA is not specifying the methods that a facility must use to monitor the parameters required to calculate uptime of abatement systems (the total time each abatement system is in operational mode and fluorinated

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[33] An exception to this is time during which exhaust flows are passed through a redundant abatement system that is in the same abatement system class (discussed below) as the primary abatement system. Such time may be included in the uptime of the primary system. A redundant abatement system is defined as a system that is specifically designed, installed and operated for the purpose of destroying fluorinated GHGs and N_2O gases. A redundant abatement system is used as a backup to the main fluorinated GHGs and N_2O abatement system during those times when the main system is not functioning or operating in accordance with design and operating specifications.

GHGs or N_2O are flowing through the connected process tools and the total time fluorinated GHGs or N_2O are flowing through process tools connected to each abatement system). See response to comments in section 5.2.2 and the preamble section D, Electronics Manufacturing (subpart I), section 3, for the response to comments on uptime.

Comment Summary 5.2.2-b: Two commenters (0089 and 0112) indicated that it is reasonable for EPA to require consideration of abatement unit uptime, but that the specific procedures outlined in the rule may not reflect actual practices of facilities. The commenters stated that their POU abatement devices are interlocked with fab tools, so that the tools will shut down at abatement device failure or at the end of the wafer run. In either case, the commenters asserted that the tool cannot be further operated until the abatement device is operational. One commenter (0112) proposed, "An option for tracking abatement device uptime for systems with a tool interlock by reporting the number of times an abatement unit failure occurred. Where the tool shuts down when the abatement device fails, no adjustment to the emissions calculations would be needed. For those situations where the tool continues to run, a process could be worked out estimate the additional gas emissions per chamber process for tool type and the calculated emissions increased by that quantity of additional emissions times the number of times the tool failed. If possible, the rule should allow companies to do a significance test and establish a minimal number of failures below which the additional emissions are not significant (say a half a percent of the total emissions for a specific gas)." One commenter (0089) asserted that a viable method for determining uptime for interlocked abatement tools should involve documenting that tools are in fact interlocked and documenting instances where failure occurred during processing.

Two other commenters (0110 and 0123) stated that their POU abatement systems are typically configured that if the abatement system is down or operating abnormally, the system will either shut down gas to the process tool or divert flow to a redundant abatement system. The commenters asserted that allowance of this method ensures proper abatement and accurate emissions estimates without additional costs associated with tracking and recording abatement system uptime parameters. The commenters suggested that significant additional costs would be incurred to otherwise modify or upgrade operational controls and data acquisition systems.

Response 5.2.2-b: EPA is not modifying uptime requirements as suggested because EPA expects that facilities with interlocked abatement systems should be able to easily monitor and account for uptime of abatement systems using the methods provided in this rule. EPA is also not modifying the uptime requirements to accommodate one commenter's suggestion of developing and establishing a significant test for determining the number of systems failures for which emissions would be insignificant. Such a test may be practical, however EPA does not have and the commenter did not offer any data regarding the nature or support for such a test.

EPA is not permitting facilities to use the methods suggested by the commenters as this would allow the use of multiple methods to monitor and account for uptime. Where feasible, EPA would like to ensure that facilities are using consistent methods in estimating emissions because this will create a consistent basis on which to compare industry emissions and will also reduce EPA's administrative burden. EPA is requiring detailed monitoring and reporting of uptime because this information will allow EPA to carry out emissions verification to ensure the consistency and accuracy of data collected under this rule. See response to comment 5.2.2-a on requiring facilities to account for uptime and the preamble section D, Electronics Manufacturing (subpart I), section 3 ("Summary of Comments and Responses"), for the response to comments on uptime and interlocked abatement systems.

5.2.2.1 Semi E-10 Standard

Comment Summary 5.2.2.1-a: One commenter (0093) argued that: "the abatement system uptime calculation described in the proposed rule does not comply with SEMI E10-0304^E, which does not include the concept of co-dependent uptimes of different equipment (e.g., abatement systems and associated manufacturing tool(s)) in any of its metrics. Based on the classification of time periods (e.g., productive time) listed and assuming that these time periods have the same definitions as in SEMI E10-0304E, the commenter asserted that the calculation is very similar to, but is not the same as, the operational uptime formula defined in SEMI E10-0304E paragraph 6.3.3." The commenter asked that references to SEMI E10-0304E in the rule should be removed and that the appropriate calculation and its individual terms be completely defined within the EPA document unless the EPA determines that one of the SEMI E10-0304E formulas may be used. The commenter proposed that EPA edit the original language of Proposed subpart I, Section 98.94(f)(2) to read as follows:

"(2) You shall take into account and report the uptime of abatement systems when using destruction or removal efficiencies to reflect emission reductions. Abatement system uptime is expressed the total time the abatement system is operating when greenhouse gas(es) is flowing in process tool divided by the total time during which the process tool is flowing greenhouse gas(es). This calculation must be done for each greenhouse gas and combination of process tool(s) and abatement system(s), and can be summed into one value for each greenhouse gas for each facility.

The uptime calculation must be performed for each greenhouse gas, and it shall be ensured that abatement devices are operating in a mode appropriate to abate that specific greenhouse gas. For example, the abatement device may be capable of destroying SF_6 to 90 percent, but only 60 percent for CF_4. If the abatement device has been put into bypass during maintenance, this does not count as uptime, regardless of any activity on the process tool."

Response 5.2.2.1-a: EPA modified the procedures for calculating and accounting for uptime by removing reference to SEMI E-10-0304^E because EPA agrees with the commenter that SEMI E-10-0304^E does not fit appropriately in the rule. EPA has taken the concept presented by the commenter in the suggested regulatory text and has modified it accordingly to fit within the regulatory text of the final rule. In the final rule, EPA is requiring facilities to calculate an abatement system's uptime by taking the ratio of (1) The total time during which the abatement system is in an operational mode when fluorinated GHGs or N_2O are flowing through production process tool(s) connected to that abatement system, to (2) the total time during which fluorinated GHG or N_2O in which fluorinated GHGs or N_2O are flowing through production process tool(s) connected to that abatement system (see §98.98). Further, EPA has defined operational mode as the time in which an abatement system is being operated within the range of parameters as specified in the operations manual provided by the system manufacturer (see §98.98). Please also see the preamble section D, Electronics Manufacturing (subpart I), section 3 ("Summary of Comments and Responses"), for response to comments on uptime.

5.2.3 EPA Default DRE Value

Comment Summary 5.2.3-a: One commenter (0128) stated that it recognizes that abatement systems often have a high DRE and are an important factor in accurate accounting of overall emissions. However, the commenter raised concerns with EPA's proposal and stated that the abatement estimation flexibilities in the proposal do not accurately capture abatement systems' DREs. The commenter was also concerned that EPA's default DRE is based upon a small sample size of diverse abatement technologies, and that existing IPCC and industry DRE factors also are inadequate. Therefore, the commenter encouraged EPA to permit reporters to rely only on properly measured DREs to better account for variability in installation, operation, and maintenance practices.

Response 5.2.3-a: EPA maintains that the use of properly measured DREs will result in more accurate emission estimates; however, EPA finalized provisions to permit facilities to use a default DRE as a means to reduce burden on facilities that are properly equipped and would like to account for controlled emissions due to the use of abatement systems. EPA developed the default DRE with the best and only information available to the Agency at this time.[34] The data available to EPA are limited today and additional data were not made available by way of the public review and comment process. EPA agrees with the commenter that IPCC and industry default DRE factors are inadequate for purposes of this rule (see response to comment 5.2.3-c and the Electronics Manufacture TSD for a discussion on why EPA is not permitting the use of IPCC and manufacturer provided default DREs).

Comment Summary 5.2.3-b: Six commenters (0099, 0110, 0112, 0122, 0123, and 0131) asserted that the proposed default factor of 60 percent for the DRE of all abatement systems is overly conservative (low) and would over-state emissions from facilities with abatement systems. Two commenters (0099 and 0131) appreciated EPA's approach to establish and provide default DRE values for abatement systems. However, one commenter (0131) noted that the proposed 60 percent default factor is based on the destruction of CF_4, and should not apply to other fluorinated GHGs where

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[34] The 60 percent default DRE value was calculated using data from measurements assured to properly account for the effects of dilution. In addition, the tested systems were properly installed, operated, and maintained.

emissions would be significantly overstated. One commenter (0122) specifically argued that because of the low value of the default DRE, the practical value of investments in abatement technology will be reduced, and it may be a disincentive for voluntary adoption of abatement technologies. Other commenters (0099 and 0131) stated that the 60 percent default value penalizes semiconductor manufacturers who have voluntarily employed POU devices under the EPA and industry voluntary MOU and other GHG-reduction programs.

Response 5.2.3-b: EPA's default DRE was developed based on the only publicly data which properly accounted for the effects of dilution available to EPA at this time. While commenters asserted that EPA's default DRE value is too low, EPA did not receive any further information or data in the public comments that would lead EPA to revise this value. In regards to the commenters that stated the 60 percent default value penalizes semiconductor manufacturers who have voluntarily employed POU devices under the EPA and industry voluntary MOU and other GHG-reduction programs, EPA does not agree. Although EPA is unsure exactly to which "other GHG-reduction programs" the commenter is referring, in contrast to other regulatory programs that generally focus on whether a facility's emissions are below a specified limit, this rule focuses on establishing each facility's annual GHG emissions in tons per year. For this reason, EPA is finalizing certain requirements in this rule to ensure that EPA receives accurate facility-level emissions data. Please also see the preamble section D, Electronics Manufacturing (subpart I), section 3 ("Summary of Comments and Responses"), for response to comments on the default DRE value.

In light of the widely reported variability in fluorinated GHG abatement system performance,[35] and in order to provide a default DRE option in the final rule, EPA had to rely on data obtained through the EPA DRE measurement program (mainly CF_4 DREs). Please see the Electronics Manufacture TSD for more information on the data used for and the development of the EPA default DRE. Please also see response to comment 5.2.3-c on why EPA is not relying on manufacturer or the IPCC default DRE.

Because some facilities have already adopted abatement technologies as a means to reduce fluorinated GHG emissions, EPA does not agree that the default DRE will reduce the practical value of investments in abatement technologies, be a disincentive for the use of abatement technologies, or penalize those who have voluntarily adopted abatement technologies at their facilities. The default DRE is provided in this rule to offer facilities an option, alternative to properly measuring abatement system DREs which is also provided in the final rule, to account for the performance of installed abatement systems.

Comment Summary 5.2.3-c: Two commenters (0099 and 0112) proposed that a facility be allowed to use a manufacturer's certified destruction factor discounted by 10

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[35] Beu, L. (2005). "Reduction of Perfluorocarbon (PFC) Emissions: 2005 State-of-the-Technology Report", TT#0510469A-ENG, International SEMATECH Manufacturing Initiative (ISMI), December 2005. Available at: http://www.epa.gov/highgwp/semiconductor-pfc/documents/final_tt_report.pdf

percent to account for potential field conditions and result in the application of DREs that are more accurate. One commenter (0112) stated that this would be consistent with EPA's proposal in 2009 where EPA allowed the use of manufacturer's DRE data generated using the EPA abatement systems testing protocol.

Another commenter (0131) proposed the following in relation to the use of default DREs: "Provide additional default factors for C_2F_6 and the other fluorinated GHGs that are easier to abate. Allow the use of manufacturer's certified DREs discounted by 10 percent to account for differences between field and lab certification conditions. Discounted manufacturer's DREs would account for both the installed equipment's capability and the slight reductions in DREs resulting from use under field conditions. Note, EPA's 2009 proposal allowed the use of manufacturer's DRE data generated using the EPA abatement systems testing protocol. Systems processing CF_4 emissions would continue to use the EPA 60 percent default DRE. Allow facilities to calculate emissions using the average DRE for a gas or gas type determined by testing a representative sample of abatement units. These methods will result in the application of more accurate DREs." Another commenter (0099) expressed the same sentiments regarding the use of other default DREs for fluorinated GHGs that are easier to abate and to the use of manufacturer DREs.

Two commenters (0110 and 0123) suggested it is contradictory that EPA is not permitting the use of IPCC default factors or supplier provided DRE values and EPA is also requiring abatement systems to be installed, operated, and maintained in accordance with manufacturers' recommendations. Facilities should be permitted to use IPCC and manufacturer DRE values (which commenter 0110 asserted are based on measurement data). Another commenter (0122) added that there is substantial experience in the industry that point of use (POU) abatement devices achieve DREs from 95-99 percent, notwithstanding some examples of poorly installed or operated equipment. The commenter stated that it is therefore reasonable to rely on the guarantees of abatement system manufacturers regarding the performance of their equipment, along with the appropriate diligence to ensure proper installation and monitoring of field operations.

Response 5.2.3-c: In the original April 2009 proposal, EPA did propose to permit a third party (e.g., Underwriters Labs) to test abatement equipment on behalf of the manufacturer of the abatement equipment; testing would be done on representative samples of the abatement equipment in order to verify the DRE of abatement equipment. Under this approach, electronics manufacturing facilities would have been required to buy equipment that had been certified under this third-party testing. EPA does not agree that the commenter's suggested method to use manufacturer guaranteed DREs discounted by 10 percent is consistent with the approach proposed in the April 2009 rule for two reasons. First, EPA's proposal did not mention discounting manufacturer supplied DREs, and the commenter did not provide EPA with any independently determined data supporting the selection of the discount value of 10 percent. The 10 percent discount appears arbitrary and was not accompanied by any empirical data. Second, the commenter did not specify if manufacturer supplied DRE must be developed consistently and properly to account for the effects of dilution (e.g., using EPA's DRE Protocol). A t the time of the original proposed rule (April 2009) EPA's DRE Protocol had not yet been completed, but EPA proposed that all abatement system testing be performed with an industry standard or protocol, or using a consistent approach, such as the in-development EPA DRE Protocol, to ensure dilution would be properly accounted for. However, EPA is not aware of any abatement system manufacturers who have used the EPA DRE Protocol to develop manufacturer claimed DREs.

EPA does not support the use of manufacturer supplied DREs even with proper installation and monitoring of abatement systems. Manufacturer supplied DREs may result in emissions estimates that are not representative of actual facility operations because the DRE itself may have been incorrectly measured due to a failure to account for the effects of dilution (e.g., CF_4 can be off by as much as a factor of 20 to 50 and C_2F_6 can be off by a factor of up to 10 [Burton, 2007].) This understanding is supported by industry assessments as presented in Beu, 2005. Please see the April 2010 preamble (75 FR 18668, April 2010) and the Electronics Manufacture TSD for the reasons why abatement system manufacturer supplied DREs are not permitted in the final rule.

EPA also does not support the use of the IPCC default DRE in this rule because the IPCC default DRE was chosen by consensus prior to EPA developing its DRE testing program. The IPCC default DRE was based on anecdotal information rather than the direct in-fab measurements EPA used to develop its default value for DRE. The uncertainties associated with the IPCC default DRE helped spur EPA to embark on its DRE measurement program with its industry Partners.

EPA acknowledges that the 2009 proposal would have allowed for abatement system manufacturers to develop DREs using the EPA DRE Protocol. However, EPA has reassessed this requirement and is not allowing the use of any abatement equipment manufacturer supplied DREs because EPA has concluded that DREs developed in out-of-fab settings may not be representative of DREs achieved during full production, in-fab conditions. Abatement device manufacturer-specified installation, operation, and maintenance practices are based upon the testing and development of abatement systems in controlled settings that are not experimentally established as representative of actual fab environments. When using these systems in actual fab settings, ensuring the proper installation, operation, and maintenance of abatement systems may not guarantee that the abatement system will perform as abatement manufacturers intended, or that the manufacturer supplied DRE will be achieved. EPA's in-fab DRE testing revealed that abatement system performance was well below promises provided by abatement systems manufacturers. Additionally, EPA has no information that supports claims that continual maintenance in accordance with abatement system manufacturer supplied schedules will ensure that abatement systems will meet their designed expectations indefinitely. Therefore, EPA is not permitting the use of manufacturer supplied DREs in any instance, including instances where facilities adhere to manufacturer specifications and instances where the manufacturer developed their guaranteed DREs using the EPA DRE Protocol. Please see response to comments 5.2.3-b and c for more details on EPA's default DRE. Please also see the preamble section D, Electronics Manufacturing (subpart I), section 3, for the response to comments on the default DRE and properly measured DREs.

5.2.3.1 System Certification

Comment Summary 5.2.3.1-a: Two commenters (0089 and 0108) requested further explanation of the proposed certification of abatement systems. One commenter (0108) requested clarification on who certifies the two apparent certification types (proper installation, operation, and maintenance, and abatement system design), how often the certification must occur, in what form and containing what specific information, and whether EPA envisions third-party certification. The commenter was concerned that a foreign manufacturer of abatement systems may be reluctant to participate in a design certification scheme by a foreign regulatory agency. One commenter (0089) was uncertain whether existing abatement equipment would require certification. The commenter suggested that certain technologies (e.g., thermal destruction) that have been widely used for PFCs could be considered “certified” if they meet certain key operating parameters (e.g., combustion temperature).

Response 5.2.3.1-a: In the final rule, EPA is requiring any facility that wants to account for the use of abatement systems to certify and document that their abatement systems (either those previously installed or newly installed) are or have been properly installed, operated, and maintained. A facility must show this by self-certifying the proper installation, operation, and maintenance, and providing EPA with documentation that proves that abatement systems are/were installed, operated, and maintained in accordance with the manufacturers' specifications. Alternately, if a facility elects to use the EPA default DRE value, a facility must certify that the abatement system, either existing or new, for which the default DRE is being applied, is designed specifically to abate fluorinated GHG and N_2O. EPA clarified in the final rule that a facility must support its certification that the abatement system is designed specifically for fluorinated GHG and N_2O abatement by documenting and reporting the abatement system supplier’s specifications for the system (see §98.96(q)). A facility may provide this certification without the involvement of third parties. Therefore, because adhering to this certification only requires a facility to obtain the design specifications of abatement systems, which should be part of BAU documentation that is provided when a facility purchases a system, EPA does not foresee the need to involve foreign manufacturers in facility self-certification. EPA does not agree with one commenter’s suggestion that certain technologies (e.g., thermal destruction) that have been widely used for PFCs could be considered “certified” if they meet certain key operating parameters, as the method suggested by the commenter would complicate the verification of the proper installation, maintenance, or design of systems. Further, while manufacturers of thermal destruction systems cite the importance of temperature in determining DRE performance, peer review comments on the EPA DRE Protocol (see response to comments on the DRE Protocol, available in docket EPA-HQ-OAR-2009-0927) noted the difficulties in knowing and measuring what this temperature is for installed systems. Because of these concerns, EPA removed temperature as a parameter to decide whether a system was capable of abating CF_4, for example. See the section 5.2.1 and the Electronics Manufacture TSD for more discussion on proper installation, operation, and maintenance.

5.2.4 Proper Measurement of Abatement DRE

Comment Summary 5.2.4-a: One commenter (0128) encouraged EPA to finalize a rule that relies exclusively on direct measurement for DRE factors. The commenter asserted that direct measurement of abatement efficiency maximizes accuracy and can better account for variability across facilities in installation, maintenance, and operation.

Response 5.2.4-a: Although direct, proper measurement of DREs will more accurately reflect the use of abatement systems, as well as account for variability among abatement systems, EPA is mindful of the burden direct measurement may impose on a facility. To reduce burden, EPA is maintaining the option in the final rule for facilities to report controlled emissions from the use of fluorinated GHG and N_2O abatement systems, using a default DRE provided that the systems are certified as being designed to abate fluorinated GHGs and N_2O. See section 5.2.3 for more details on the default DRE provided in the rule. Additionally, as a way for EPA to ensure that variability due to installation, operation, and maintenance practices is reduced, facilities that use EPA's default DRE are also required to verify the proper installation, operation and maintenance of the abatement systems for which the default DRE is being applied. The same verification is also required when using properly measured DREs.

Comment Summary 5.2.4-b: One commenter (0089) expressed concern that DREs obtained from abatement system testing performed prior to the publication of the EPA DRE Protocol are not permitted to be used. The commenter asserted that a default DRE would have to be used until a facility could complete new tests. The commenter suggested that DREs obtained from prior testing should be permitted, provided that a facility can show that the testing methods used were substantially similar to the method in the EPA DRE Protocol. The commenter also suggested that semiconductor processes that have been previously validated and tested by the abatement manufacturer should be exempt from additional emission testing for DRE re-validation, provided that the units are operated, maintained, and serviced according to the manufacturer's specifications.

Response 5.2.4-b: Facilities are allowed to use previously measured DREs. A facility may use previously measured DREs provided the facility can demonstrate that the measurements were made in accordance with the EPA's DRE Protocol. Facilities may demonstrate this by providing documentation of compliance with the principles and requirements of the Protocol.

See response to comments in section 5.2.4.2 for a discussion of the required use of the RSASTP. See the response to comment 5.2.3-c about using abatement system manufacturer supplied DREs for abatement systems that are properly installed, operated, and maintained in accordance with manufacturers' specifications.

5.2.4.1 EPA's DRE Protocol

Comment Summary 5.2.4.1-a: One commenter (0131) restated its comments, and made some new comments on the EPA DRE Protocol made in a prior public peer review process and again urged EPA to accept them. The commenter also asserted that FTIR is already an acceptable approved EPA method (e.g., EPA Method 320, or EPA Method 301 validation) to characterize other air emissions without the need for additional analytic equipment (e.g., Quadrapole Mass Spectroscopy). Another commenter (0099) supported these comments as well.

Response 5.2.4.1-a: Most of the comments from commenter 0131 on the EPA DRE Protocol were previously submitted to EPA as part of the two public peer review processes EPA undertook for the DRE Protocol. EPA responded to these comments during that process. The comments and responses are available in the docket EPA-HQ-OAR-2009-0927. The new comments commenter 0131 submitted on the DRE Protocol are addressed in Appendix B of this document.

The use of an FTIR without the use of additional analytical equipment, such as a QMS, is an acceptable means to measure DREs only in certain instances. EPA is allowing the use of an FTIR without the use of a QMS in certain cases. In the DRE Protocol, EPA permits the use of an FTIR in place of a QMS when tracer gases, such as CF_4 and SF_6, are used in place of an inert gas to measure dilution (provided the abatement system which is being tested does not abate the tracer gas (CF_4 or SF_6)). The DRE Protocol does not permit, however, the use of an FTIR in place of a QMS for measuring dilution with tracers that are inert because, although a method that uses FTIR-measurable gases may become available, no robust in-fab measurements exist today that demonstrate the veracity of such a method.

Comment Summary 5.2.4.1-b: One commenter (0112) recommended that EPA allow facilities to use CF_4 as a tracer gas to determine dilution in abatement testing. The commenter asserted that the use of CF_4 will offer flexibility to the facility performing the testing, since CF_4 destruction during low-fire temperatures will be minimal, resulting in a conservative assessment of destruction efficiency.

Response 5.2.4.1-b: EPA does not wholly prohibit the use of CF_4 as a tracer in the DRE Protocol, and hence in the rule. Specifically, with respect to measuring systems that do not abate CF_4 and/or SF_6, EPA's DRE Protocol states, "In such systems, CF_4 or SF_6 can be used in place of an inert gas since their DREs are zero percent. Table 2 provides a list of acceptable gases for measuring total abatement system flows, along with their use conditions." As discussed in this excerpt, EPA's DRE Protocol does not permit the use of either CF_4 or SF_6 as tracer gases in abatement systems that are designed to abate these gases. EPA does prohibit the use of CF_4 as a tracer in fluorinated GHG abatement systems operating in "low fire" because reviewers of early drafts of EPA's DRE Protocol made repeated claims that one could not be certain that some abatement of CF_4 was not occurring, which would bias dilution and hence DRE measurements. For more discussion on the use of CF_4 as a tracer gas please see the responses to comments on the DRE Protocol, available in docket EPA-HQ-OAR-2009-0927.

Comment Summary 5.2.4.1-c: One commenter (0112) proposed the use of a performance based standard, rather than a technology based standard, for testing of destruction unit efficiency. A performance based standard would be better able to accommodate evolving technology, such as nondispersive infrared sensor (NDIR), which may include those that are more cost effective and capable. The commenter asserted that proscribing an FTIR methodology for DRE testing limits the use of current and future improvements in monitoring technologies and will limit cost-effectively meeting EPA's monitoring requirements.

Response 5.2.4.1-c: The final rule requires the use of the EPA DRE Protocol, which is based on the use of some technologies such as QMS or FTIR used to measure DREs, as opposed to other technologies such as NDIR which may be used to monitor the performance of abatement systems. The final rule does not specifically prohibit or require facilities to use technologies such as NDIR to monitor the performance of abatement systems. Please see the responses to comments on the DRE Protocol, available in docket EPA-HQ-OAR-2009-0927 for EPA's previous response to comments on the use of NDIR from the Protocol's public peer review process.

5.2.4.2 Random Sampling Abatement System Testing Program

Comment Summary 5.2.4.2-a: One commenter (0112) supported allowing facilities that have undertaken Random Sampling Abatement System Testing Program (RSASTP) for abatement devices to use actual tested values on the tested units and the average destruction value for all other units. The commenter asserted that this enables accurate representation of PFC gas emissions.

However, the commenter proposes the following approach to testing and certifying the performance of abatement equipment as an alternative that is less burdensome: "Facilities should be required to test 20 percent of the abatement fleet at a facility for the first two years of the reporting requirements. If the two years of testing verifies that the abatement systems are performing within 10 percent of the manufacturer's specification, the facility should be allowed to certify that its abatement devices are being maintained in accordance with a documented maintenance plan based on, but not necessarily in complete conformance with, the manufacturer's recommended maintenance procedures, and reduce the testing frequency as described below. In the third year and beyond, the facility shall perform a single test of a randomly selected abatement unit for each abatement system class to verify continued performance. This will provide the base data to demonstrate the current performance of abatement systems while enabling facilities to perform less frequent testing to demonstrate system performance in recognition that the properly maintained units are expected to perform to their specifications."

Two other commenters (0099 and 0131) proposed a similar, but less detailed, alternative approach to the RSASTP: a facility should instead be able to use the average DRE based on performance testing data. The commenters also propose: "A facility can provide test data for an abatement system class to certify annual emissions. Upon completion of two (2) years of random testing of at least two (2) abatement systems by class at a facility, the DRE by class should be able to be certified in subsequent years." A commenter (0131) went on to state, "In addition, the facility would be expected to perform the required system maintenance."

One of the commenters (0131) further asserted that periodic testing is not necessary when the facility operates abatement equipment properly. The commenter stated that where a device has been designed for GHG reduction, default factors reflect test data with sufficient accuracy, and thus testing should be required only for new models, not variants of existing systems.

Response 5.2.4.2-a: EPA appreciates one commenter's support of the RSASTP. EPA considered the commenters' suggested alternatives to the RSASTP; however, in the final rule EPA is maintaining that facilities using properly measured DREs must adhere to the RSASTP (see §98.94(f)(4). EPA developed the RSASTP, in the absence of data about abatement system time to failure or DRE performance drift, to provide an efficient and relatively reliable device measurement scheme when compared to requiring a facility to test annually all abatement systems used. The RSASTP still allows EPA to ensure a facility has measured DREs accurately and at least once every five years. This is an essential part of the RSASTP because abatement system performance varies greatly depending on a variety of abatement device and process parameters such as temperature, flow, and exhaust composition. Facilities develop and ultimately use new processes potentially every year, and the parameters of these processes vary. Given this, by requiring the gradual testing and retesting of abatement systems over time through the RSASTP, EPA can ensure properly measured DREs, and DRE class averages used at a facility will accurately reflect controlled emissions. Please see the preamble section D, Electronics Manufacturing (subpart I), section 3 ("Summary of Comments and Responses"), for the response to comments on the RSASTP and section 5.2.3 for details on the use of default DREs.

Comment Summary 5.2.4.2-b: One commenter (0122) noted that, for a facility under construction, the commenter plans to utilize approximately 200 POU abatement devices (some that do not solely abate PFCs). The commenter expected that for this facility, approximately three models of device will be represented, depending on how the rule defines a "model," because models often encompass multiple configurations. The commenter estimated testing costs for 20 percent of these devices, in accordance with the RSASTP, to be in excess of $500,000 annually. The commenter asserted this testing requirement is expensive and redundant because (1) testing would serve to validate equipment with which industry has substantial field experience, and (2) given the small number of abatement equipment models expected to be deployed at a facility, multiple tests would be required to be done on the same abatement systems under the

RSASTP. The commenter indicated that, given these costs, a broader application of the default DRE factor may be expected, resulting in emission over-estimates.

Response 5.2.4.2-b: EPA does not agree that the RSASTP is expensive and redundant. EPA has concluded that more in-fab direct measurement of DREs, beyond what has already been done, is necessary, because, as shown in EPA's DRE testing program, in some cases installed abatement system DREs for popular and difficult to abate gases like CF_4 and C_2F_6 do not achieve guaranteed DRE provided by abatement manufacturers. The RSASTP provides a much less burdensome device measurement scheme than requiring a facility to test all abatement systems used annually, but still allows EPA to ensure a facility has measured DREs accurately and at least once every five years. EPA has determined that this testing frequency is necessary for all abatement systems used, regardless of the model, because the RSASTP anticipates reliable maintenance periods and useful lifetimes of abatement systems. Also, it is necessary to test every system used at a facility, regardless of the model of system, because it is well known across the industry that abatement system performance varies greatly depending on the type of abatement device and process parameters such as temperature, flow, and exhaust composition.[36] As stated by many commenters, facilities develop and ultimately use new processes potentially every year, and the parameters of these processes vary. Therefore, gradual testing over a five year period is not redundant as DREs between the same abatement system models may vary between years depending on the process exhaust fed into the abatement systems, which may also cause RSASTP class average DREs to vary between years. See the preamble section D, Electronics Manufacturing (subpart I), section 3, for the response to comments on the RSASTP. See response to comments in section 5.2.3 on the application of default DREs.

Comment Summary 5.2.4.2-c: Two commenters (0123 and 0110) asserted that the frequency of required testing using the RSASTP is burdensome and unnecessary. Further, the commenters asserted that new abatement systems that are installed, operated, and maintained according to the manufacturer's recommendations should not require annual testing.

The commenters believed the use of manufacturer specified DRE values and less frequent testing was sufficient, because facilities may have a small number of abatement systems (e.g., facilities that have three abatement systems) and for new processes that become part of production, new abatement systems associated with these new classes could require annual testing. For these types of facilities commenters believed that instead of testing 20 percent or 3 abatement systems in each year as in the proposed RSASTP, that abatement systems be tested on a set schedule. One commenter (0123) proposed once every three years, and the other commenter (0110) proposed testing a maximum of once every five years.

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[36] Beu, L. (2005). "Reduction of Perfluorocarbon (PFC) Emissions: 2005 State-of-the-Technology Report", TT#0510469AENG, International SEMATECH Manufacturing Initiative (ISMI), December 2005. Available at: http://www.epa.gov/highgwp/semiconductor-pfc/documents/final_tt_report.pdf.

Response 5.2.4.2-c: EPA does not agree with commenters who asserted the RSASTP is burdensome and unnecessary, provided abatement systems are designed and operated to abate fluorinated GHGs. EPA's DRE provisions address the dearth of published data on abatement system DRE performance for systems designed to abate fluorinated GHGs and the variability in those DRE values over time, under in-fab conditions. Commenters did not provide EPA sufficient information or data to mitigate concerns regarding the varying performance of abatement systems over time. See response to comment 5.2.4.2-b and see the preamble section D, Electronics Manufacturing (subpart I), section 3 ("Summary of Comments and Responses"), for the response to comments on the RSASTP and discussion on why EPA is requiring the RSASTP. See also responses to comments in section 5.2.3 on why EPA is not allowing the use of manufacturer specified DREs.

Comment Summary 5.2.4.2-d: One commenter (0089) asserted that testing of 20 percent of units each year is burdensome at large fabrication sites that may have more than 100 individual devices in operation. Testing can negatively affect manufacturing as most tools would need to be taken offline during the testing period. As an alternative, the commenter proposed: "Destruction removal efficiency testing should only be required on a representative portion of identical POU devices. This initial testing can be used to characterize the key operating parameters (e.g., operating temperature, residence time, etc.) the device must meet in order to achieve the efficiency measured during the test. The unit, and similar units, can then be assumed to be achieving this efficiency as long as it can be documented that they are operating within the key parameters, without a need for ongoing testing. This approach is consistent with the methods that state and local air pollution control agencies have used for years to establish DRE for control devices on other pollutants. Intel has many control devices in place at its fabs to treat volatile organic compounds (VOCs) or hazardous air pollutants (HAPs). The DRE for those devices is typically established in a manner similar to that described above, without the need for ongoing testing, or even for testing each individual unit." The commenter asserted that EPA at least implicitly endorses this approach because the permits under which these sites operate are considered "federally enforceable" for purposes of maintaining emissions below major source thresholds. Another commenter (0131) also asserted that the testing frequency requirements are excessive and a cost burden given that EPA has not provided data to support annual testing beyond what is required for other EPA regulations.

Response 5.2.4.2-d: EPA does not agree with the commenter that testing 20 percent of units a year is an excessive burden for large facilities. EPA acknowledges that tools do need to be offline for a portion of the time required for DRE testing, but it is not plausible that a facility will be running tools 100 percent of the available time. During downtime periods, abatement systems attached to such tools may be tested. Given that the RSASTP requires testing of an abatement system essentially once every five years, there should be points within that period where tools are offline that DRE testing can be done. Through EPA's experience in the DRE measurement program, EPA has found that testing can be done within the constraints of manufacturing environments and that manufacturing schedules can accommodate a period for testing without adverse effects.

EPA considered the commenters' suggested alternatives to the RSASTP; however, in the final rule EPA is maintaining that facilities using properly measured DREs must adhere to the RSASTP. See the preamble section D, Electronics Manufacturing (subpart I), section 3 ("Summary of Comments and Responses"), for the response to comments on the RSASTP. Please also see response to comment 5.2.4.2-a and 5.2.4.2-b for more discussion on the required use of the RSASTP.

The testing frequency required through the RSASTP is aligned with the purpose and goal of the GHG Reporting Program which, in contrast to other regulatory programs with different goals, is to collect accurate facility-level GHG emission information to inform future policy and regulatory decisions. Please see response to comment 4.1.2-c for more discussion on the relationship between this rule and air quality regulations.

Comment Summary 5.2.4.2-e: One commenter (0095) noted that it is not clear whether the RSASTP is intended to include only processes that have not yet gone through emission testing, or if it also includes processes that have already been tested. The commenter suggested that semiconductor processes that have been validated and tested by the abatement manufacturer should be exempt from additional emission testing for DRE re-validation, provided that the abatement units are operated, maintained, and serviced according to the manufacturer's specification.

Response 5.2.4.2-e: EPA is not permitting the use of measurements made previously by an abatement system manufacturer, as discussed in response to comment 5.2.4.2-b. EPA is permitting only measurements made at a facility using the EPA DRE Protocol to be used to account for the use of abatement systems. EPA is allowing the use of these measurements if a facility has conducted DRE measurements using the EPA DRE Protocol published in March of 2010. Please see the preamble section D, Electronics Manufacturing (subpart I), section 3 ("Summary of Comments and Responses"), for the response to comments on the RSASTP.

5.3 Other QA/QC Procedures

Comment Summary 5.3-a: One commenter (0112) asserted that EPA needs to provide more flexibility for facilities to develop inline calibration procedures for PFC gas flow measuring devices. The commenter stated that most of the mass flow controllers purchased have guaranteed performance accuracy within 1 percent. The commenter asserted it would be better if flow calibration was run less frequently and while the meters were installed on the tool; removing each mass flow controller for bench calibration introduces significant costs, downtime, and contamination exposure.

Response 5.3-a: In the final rule, EPA has removed the calibration requirement proposed in §98.94(i) (75 FR 18702, April 2010) because the calibration aspects of the 2006 ISMI Guidelines and the EPA DRE Protocol are sufficient for purposes of the rule.

Comment Summary 5.3-b: One commenter (0131) asserted that scales and pressure monitoring devices are not currently calibrated per ISO 9000 Quality Standards, NIST traceable standards, or other methods that would be considered "true calibration." In many cases, calibration of a measurement device would require removing it from service and possibly disconnecting it from the tool. The commenter asserted that this is unacceptable because facilities operate continuously and are subject to rigorous contamination control for replaced or removed equipment. Currently, performance verification is conducted on measurement devices as needed since the trigger point for change-out is a highly critical measurement to ensure that the integrity of gas delivery is not compromised.

Response 5.3-b: Please see response to comment 5.3-a for information on how EPA addressed calibration requirements in the final rule.

Comment Summary 5.3-c: One commenter (0089) suggested that the requirement for facilities to follow QA/QC procedures in the 2006 ISMI Guidelines and in EPA's DRE Protocol should be applicable only from the effective date of the rule forward. Facilities should not be required to retroactively show compliance with these procedures for measurements or testing done prior to the publication of the rule.

Response 5.3-c: This rule is not retroactive. This rule does not impose any new liability or obligation on the basis of past conduct and its emission reporting requirements are prospective only. For facilities to use historical emissions measurements, they must show compliance with QA/QC procedures for the appropriate ISMI Guidelines. EPA needs to verify that appropriate QA/QC procedures were followed for any measurements made and factored into emission estimation methods, regardless of when the measurements occurred, to ensure the quality of the data being used to estimate emissions. In general, EPA designed these requirements with the expectation that the measurements would be made in future, because according to an industry survey the majority of semiconductor manufacturers have not performed Tier 3 measurement testing.[37] However, to provide more flexibility for facilities that have already made Tier 3 measurements prior to the publication of the rule, EPA is allowing facilities to use measurements made in the past if sufficient supporting documentation is available. In the final rule EPA is permitting facilities to use measurements made in accordance with not only the 2006 ISMI Guidelines, but the 2001 ISMI Guidelines as well. For facilities to use historical measurements made with the 2001 ISMI Guidelines, EPA is requiring facilities to document that the QA/QC procedures from the 2001 ISMI Guidelines were followed. Please see response to comment 5.1-a for details on the required use of the 2001 or 2006 ISMI Guidelines.

Because the DRE Protocol was published recently (2010), in general EPA assumes that the first year of data collection for this rule would correspond to the first year of the

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[37] EPA is also unaware of any other type of electronics manufacturer (MEMS, LCD, PV) that have performed Tier 3 measurements.

RSASTP for many facilities. However if there are instances where a facility has DRE measurements made prior to the effective date of a rule, but within the time span of the required RSASTP (5 years) the facility would be permitted to use those measurements provided sufficient documentation is available to show that the QA/QC procedures in the DRE Protocol were followed, and the measurements were made using EPA’s DRE Protocol.

6. Data Reporting Requirements

Many comments on data reporting and confidential business information (CBI) were interrelated. Responses to comments may appear in this section 6 (Data Reporting Requirements) or in section 9 (Confidential Business Information).

Comment Summary 6-a: With respect to EPA's proposed requirement in §98.95(g) (that a facility calculates and reports the facility-wide consumption of gas based on the modeling calculations performed using engineering and process data), one commenter (0112) proposed that the required reported data be moved to recordkeeping. The commenter asserted that the calculations have a degree of uncertainty due to process and measurement variation, and thus the calculations will not directly match actual usage. The commenter stated that there is no reason to report this data and that the facility should maintain the data and have it available for inspection and discussion. The commenter also stated that the model will need to use statistical methods to reconcile use calculations based on process and fab data to actual gas use as determined by cylinder disbursements.

Response 6-a: With respect to the commenter's request that a facility should maintain data on the modeling calculation performed using engineering and process data as a recordkeeping requirement and not be required to report such data, this requirement as proposed is not being finalized in this rule. EPA has modified the procedures by which facilities are required to develop gas consumption apportioning factors, and is requiring that facilities submit to EPA specific information on the model (see §98.94(c)). The information that EPA is requiring facilities to submit about facility-specific engineering models to apportion gas consumption will provide EPA with data to verify the models. Thus, it is important that this information be reported to the Agency. For additional comment responses on the facility-specific engineering model, please see also the preamble section D, Electronics Manufacturing (subpart I), section 3 ("Summary of Comments and Responses.")

Comment Summary 6-b: One commenter (0089) asserted that submitting results of all test data for the Tier 3 approach is an unnecessary burden, and would likely provide EPA with more data than it can review. The commenter noted that a single fab may have 100 or more individual tool tests covering all processes steps and all covered fluorinated gases. In addition, the commenter asserted that this type of information is confidential business information (CBI). The commenter proposed that facilities that use the Tier 3 approach submit data on chemical use, emissions factors used, and a detailed summary explaining methods for apportioning chemical use amongst process steps with supporting documentation. The commenter proposed that actual copies of emission tests be maintained on site and available for inspection. These methods would be consistent with requirements for verifying emissions of regulated pollutants with state and local agencies.

Response 6-b: Although EPA is unsure exactly to which state and local agency requirements the commenter is referring, in contrast to other regulatory programs, this rule focuses on establishing each facility's annual GHG emissions in tons per year, not on whether a facility's emissions are below a specified limit. EPA considered reporting and recordkeeping requirements (see §98.96 and §98.97) and strived for a balance between information that is critical for analyzing and verifying reported emissions and minimizing reporting burden.

EPA concurs with the commenter's suggestion that the detailed Tier 3 emission measurement documentation should be retained onsite for inspection. EPA is requiring facilities to report data on gas usage, emission factors (utilization and byproduct formation rates), the type of film and feature that was etched, the source of the emission factor information for that recipe, and certification that the measurements were made using the 2006 ISMI Guidelines, or the 2001 ISMI Guidelines if measurements were made prior to January 1, 2007. Other information including documentation that measurements were made using the ISMI Guidelines must be retained as records. EPA is requiring reporting, rather than simply retention, of certain data in order to permit EPA to conduct an annual verification of the emissions quantities reported by each facility. Due to EPA resource constraints, it is unlikely that EPA would be able to make site visits annually to verify reports based on facility records. Without reporting of verification data, therefore, the frequency of verification would be lower, while the costs of such verification would be much higher. Nonetheless, EPA is aware of the commenters' concerns and may consider moving certain requirements from the reporting section to the recordkeeping section of the rule following further analysis.

With respect to the commenter's concern that Tier 3 test data is CBI, today's action does not address whether data reported under subpart I will be treated as CBI. EPA is addressing CBI issues in a separate rulemaking. EPA published a proposed confidentiality determination on July 7, 2010 (75 FR 39094) which addressed the CBI status of certain data elements. In that action, EPA proposed which specific data elements would be treated as CBI and which data elements must be available to the public under section 114 of the CAA. EPA has received comments on the proposal and is in the process of considering these comments. A final determination will be issued before any data is released, and the final determination will include all of the data elements under these subparts. (For more information on the CBI rulemaking, please see, http://www.epa.gov/climatechange/emissions/CBI.html#proposal).

Comment Summary 6-c: One commenter (0099) proposed that EPA only require facilities to submit annual emissions and the method of emissions calculations. Facilities would keep all other data elements on site and available for inspection. The commenter asserted, "this is consistent with management of the underlying emissions calculations data in other air quality and permitting programs."

Response 6-c: EPA does not agree with the commenter that it should only require facilities to submit annual emissions and the method of emissions calculation. Although EPA is unsure exactly to which other air quality and permitting programs the commenter is referring, in contrast to other regulatory programs, this rule focuses on establishing each facility's annual GHG emissions in tons per year, not on whether a facility's emissions are below a specified limit. EPA is requiring reporting, rather than simply retention, of certain information relating to the emissions calculation to permit EPA to verify the data reported by each facility. Since emission factors can vary significantly between processes, and hence facilities, it is important for EPA to have a high degree of granularity in reported emissions information to facilitate verification and evaluation of individual components of a reported emission estimate. Due to EPA resource constraints, it is unlikely that EPA would be able to make site visits annually to verify reports based on facility records. Without reporting of verification data, therefore, the frequency of verification would be lower, while the costs of such verification would be much higher. Nonetheless, EPA is aware of the commenters' concerns and may consider moving certain requirements from the reporting section to the recordkeeping section of the rule following further analysis. Please see Response 6-b for additional response to comments on data reporting requirements.

Comment Summary 6-d: One commenter (0095) requested clarification on whether production based on substrate area is based on the total number of fully processed wafers or on the number of wafer starts. The commenter requested this clarification because it asserted that certain semiconductor companies that appear to be covered by subpart I do not manufacture wafers and process wafers, but only partially process wafers for research and development (R&D) purposes.

Response 6-d: EPA is requiring semiconductor manufacturing facilities to use their full facility design capacity, in terms of substrate surface area (e.g., silicon), in the threshold determination calculation which is based on the 2006 IPCC Tier 1 method.[38] Under this approach, a facility's potential to emit determines whether the facility meets or exceeds the reporting threshold. As a result of using a facility's full annual design capacity in terms of substrate surface area, the distinction between processed wafers and partially-processed R&D wafers is not relevant to the threshold analysis. For data reporting, EPA is requiring facilities to provide the total substrate surface area processed. However, if the partial wafer processing was associated with R&D activities (as defined in 40 CFR 98.6), that substrate area should not be reported to EPA. Please see comment response 1-b for responses to comment on R&D activities.

Comment Summary 6-e: Two commenters (0089 and 0112) requested that annual surface area production be removed from reporting requirements because it is CBI and it does not actually affect emission results.

Response 6-e: EPA acknowledges the commenter's suggestion to shift annual substrate area processed per year from the reporting to the recordkeeping provisions. EPA carefully considered reporting and recordkeeping requirements and strived to balance its need for information that is critical for analyzing and verifying reported

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[38] See the preamble to the final rule for more information about the reporting threshold determination calculations.

emissions and the goal of minimizing reporting burden. EPA determined that a facility's annual substrate processed is an important manufacturing activity datum and that it should be retained as a data reporting requirement. Receiving this data will enable the Agency to track facility level emission intensity trends, identify reporting anomalies, and develop future GHG policies and programs. EPA is requiring reporting, rather than just retention, of certain data to allow EPA to annually verify the emission quantities reported by each facility. Due to EPA resource constraints, it is unlikely that EPA would be able to make site visits annually to verify reports based on facility records. Without reporting of verification data, therefore, the frequency of verification would be lower, while the costs of such verification would be much higher. Nonetheless, EPA is aware of the commenters' concerns and may consider moving certain requirements from the reporting section to the recordkeeping section of the rule following further analysis.

In regards to the commenter's assertion that substrate surface area processed is considered CBI, today's action does not address whether data reported under subpart I will be treated as CBI. Please also see comment responses in 6-b. Please also see comment responses in section 9 on CBI.

6.1 DRE Reporting

Comment Summary 6.1-a: Two commenters (0099 and 0131) were concerned that the proposed rule would require semiconductor manufacturers to generate a large amount of information pertaining to the abatement systems used at a facility for fluorinated GHG control. The commenters asserted that this requirement would prove quite costly and burdensome.

Response 6.1-a: To comply with the final rule requirements for reporting controlled emissions, facilities may have to generate new information pertaining to the use of abatement systems each year, and EPA recognizes that there is some associated burden. However, EPA has determined that such information is essential to verify reported controlled emissions.

For example, abatement system installation, maintenance, and testing are critical components of DRE performance. Therefore, it is important from a reporting perspective to ensure that proper documentation is developed and retained that would support the reported emissions of a given facility. In addition, information about abatement devices used at an electronics manufacturing facility will enable EPA to track emission trends from the industry to develop future GHG policies and programs.

Much of the documentation for using either the EPA default DRE or properly measured DREs can be efficiently developed and stored by reporting entities. For example, the DRE Protocol contains a simple and repeatable example template for certifying the measurement results. In addition, the bulk of the information required for abatement system certification and monitoring is a recordkeeping requirement that can efficiently be accomplished through electronic file (e.g., Microsoft Word or Excel and Adobe PDF) management and storage.

In addition, it is important to note that as a means to balance burden EPA has provided facilities with the option of reporting detailed information on measured DREs or using EPA's default DRE, the latter of which will require less information to be reported to EPA.

7. Records that Must be Retained

Comment Summary 7-a: One commenter (0112) asserted that invoices for gas purchases should only be required to be retained for 3 years. Longer retention times are unreasonable and likely to conflict with company internal recordkeeping requirements.

Response 7-a: EPA appreciates the commenter's concern regarding the length of record retention. Consistent with the Final MRR, under this rule facilities are required to retain records for three years. As EPA stated in the preamble to the Final MRR, "a three- year time period is sufficient to allow for EPA to audit and review of records needed to verify the emission data submitted in annual reports" (74 FR 56281, October 2009). It is important to note, in that final rule, EPA reduced the record retention requirements from five (as proposed) to three years. Please see the preamble to the Final MRR for responses to comments on record retention (74 FR 56281, October 2009).

Comment Summary 7-b: With respect to EPA's requirement for facilities to maintain records for testing done at a facility, including documentation to demonstrate that emissions measurements were made using the 2006 ISMI Guidelines and documentation that DREs were measured in accordance with EPA's DRE Protocol, one commenter (0089) suggested that these record keeping requirements should not apply retroactively. The commenter asserted that facilities that have conducted emissions measurement tests prior to the publication of the rule would be unable to comply. The commenter argued that this requirement would disallow the use of any measurements made before the effective date of the rule. The commenter expressed a similar concern regarding obtaining certification about the design purpose for abatement systems, citing that facilities would have to assume a DRE of zero if retroactive certification were required. (Note, in a similar regard, the commenter also asserted that the testing requirements for emissions characterization and DRE testing should only be applied to measurements going forward. Please see comment responses 5.1-a and 5.2.4-b for responses to comments on the required use of the EPA DRE Protocol and the ISMI Guidelines).

Response 7-b: This rule is not retroactive. It does not impose any new liability or obligation on the basis of past conduct and its emission reporting and recordkeeping requirements are prospective only. This rule does not require any facility to take into account reductions achieved by its abatement system in reporting its GHG emissions. To the extent a facility chooses this option, the facility may choose to use the default DRE or a properly measured DRE (i.e., DREs measured in accordance with EPA's DRE Protocol). Only in the latter instance must the facility maintain as a record a certification that the DRE was calculated according to methods in EPA's DRE Protocol. The other requirement referred to by the commenter applies only to facilities using facility-specific, recipe-specific utilization and by-product formation rates. In general, EPA designed these requirements with the expectation that the measurements would be made *in the future.* However, to provide more flexibility, EPA is allowing facilities to use measurements made in the past if sufficient supporting documentation is available.

EPA is not permitting emission factor and DRE measurements that have not been made in accordance with the requirements finalized in the rule to be “grandfathered” in as the commenter suggested. EPA’s final rule allows a facility to document and use historical emission measurement results provided the measurements were made using the 2006 ISMI Guidelines (or the 2001 ISMI Guidelines for measurements made prior to January 1, 2007) and abatement system DRE measurements, if made in accordance with the EPA DRE Protocol. If misplaced, the facility may have to locate historical test plans, log books, and other information pertaining to the measurement studies. With regard to the certification of design purpose for abatement systems where the default DRE will be used, this is a critical component of the DRE validation process. EPA understands that coordination with the abatement system vendor to obtain necessary documentation may be required. If the facility cannot obtain documentation that demonstrates that an abatement system is designed to destroy fluorinated GHGs and/or N_2O, then the facility cannot claim a reduction in emissions. If an abatement system vendor is claiming a DRE for a given system, then the vendor should be able to produce a system design certification. There is nothing retroactive about this requirement. EPA is not stating that the vendor must have prepared such a certification at the time of sale; the facility may request that the vendor prepare such a certification so that the facility may take advantage of the default DRE option under this rule. Please also see response to comments 5.1-a and 5.2.4-b on why EPA is requiring measurements to be made using the ISMI Guidelines and EPA’s DRE Protocol.

8. Cost Data/Burden

Comment Summary 8-a: One commenter (0124) asserted that the reporting burden for the electronics industry is still a concern. Reporting costs for the first year for the electronics manufacturing industry, \$0.51 per $MtCO_2e$, are higher than EPA's estimated average cost for all sources, \$0.04 per $MtCO_2e$. The commenter also asserted that due to the high GWP of many gases used in the electronics manufacturing sector and other fluorinated GHG-using sectors, facilities with small amounts of actual emissions may become subject to reporting under the MRR.

Response 8-a: EPA acknowledges certain sectors face different reporting costs per ton. EPA estimates the average reporting cost for the electronics manufacturing industry to be \$0.51 per ton. The wide variety of potent and often long-lived GHGs used by this sector naturally adds complexity to the monitoring and reporting methods. The cost per ton provides a comparison to other subpart in the mandatory reporting rule. While in some cases the per ton reporting costs are higher than other subparts, the overall goal of the GHG reporting is to provide a comprehensive and accurate reporting system. The cost effectiveness metric of cost per ton reported may not be the most appropriate means to evaluate the economic impact of the rule and is just one means of doing so. Another metric presented in the EIA is cost-to-sales ratios, which evaluates the compliance cost against average receipts for like facilities. EPA found the cost-to-sales ratio for this industry to generally be below 1 percent. More detail on this analysis is available in the Economic Impact Analysis in Section 5.3.1.

Comment Summary 8-b: One commenter (0112) asserted that the proposed rule would cost the company \$3-5 million in capital investments if major changes had to be made to estimate and apportion gas consumption. The commenter stated "that it will require \$3-5 million in capital investment if major changes have to be to distribution and/or metering systems to segregate distribution systems by process type and to meet the 1% accuracy requirement for measurement systems. Annual operating costs could approach \$1 million per year when including the cost of testing 20 percent of the emissions abatement devices, as our EFK facility will have over 200 abatement units installed." The commenter also asserted that "in aggregate, the rule drives capital investments of \$1.5 million to \$5 million and between \$500,000 and \$2,000 for ongoing operation and maintenance cost to comply with the requirements in the re-proposal of the GHG reporting rule for 'Additional Sources of Fluorinated Gases'."

Response 8-b: In the final rule, EPA has made efforts to balance burden to the industry while maintaining requirements that EPA has determined are necessary to obtain facility-specific emission estimates. Please see the preamble section D, Electronics Manufacturing (subpart I), section 3 ("Summary of Comments and Responses"), for the responses to comments which discuss burden-reducing efforts.

Although the commenter asserted that the proposed rule would result in significant costs, the commenter did not provide details on how their costs were estimated. EPA has updated the Economic Impact Analysis (EIA) to reflect the requirements finalized in the rule. For example, EPA has now included capital costs associated with apportioning gas consumption. For details on how EPA developed its final costs for this rule, see sections 4 & 5 of the EIA (available in the docket, EPA-HQ-OAR-2009-0927).

Please see response to comments in section 4.1.1.1 for a discussion on the accuracy and precision requirements in the final rule.

EPA is mindful of the costs associated with reporting controlled emissions by properly measuring the DRE of the abatement systems in accordance with EPA's DRE Protocol (the approach for which the commenter is basing their cost estimates). As a burden-reducing measure EPA has provided the RSASTP, which requires a facility to test 20 percent of its abatement systems in each reporting year, as opposed to requiring a facility to test every abatement system in each reporting year for properly measuring abatement system DREs. EPA estimates that the costs associated with properly measuring abatement system DREs would be $70,000 per year for a facility. This estimate assumes that a facility has 50 abatement systems total, and hence is testing 10 systems a year to comply with the RSASTP, where 5 systems can be tested in a week and one week of testing costs $35,000. This cost estimate is based on EPA experiences actually measuring the DREs of operational abatement systems. The cost EPA estimated for optional proper DRE measurement will vary, however, depending on the number of abatement systems a facility has. As another means to reduce burden associated with reporting controlled emissions, EPA has provided a default DRE factor that facilities may opt to use instead of properly measured DREs.[39] EPA has estimated that using the EPA default value is less costly than properly measuring the DRE of abatement equipment in accordance with EPA's DRE Protocol.

Comment Summary 8-c: One commenter (0122) estimated that testing 20 percent of abatement devices expected to be used at a facility currently under construction, to comply with the requirements of the RSASTP, would cost in excess of $500,000 per year. The commenter asserted that this testing would be unnecessarily expensive, highly redundant, and carry a significant cost and burden without corresponding benefits of improved data accuracy or reduced emissions. The commenter expected that given these costs, a broader use of default DRE factors would be seen, resulting in an over-estimation of emissions. The commenter asserted that the proposed rule as written presents challenges for a company that is currently making significant investments in emission reductions on a voluntary basis. The commenter indicated that the recordkeeping burden is excessive given the complexity of semiconductor manufacturing, the relatively low GHG emissions compared to the whole economy, and the industry's long history of proactive GHG emission reductions.

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[39] To report controlled emissions using the EPA default DRE value of 60 percent, a facility must certify that the abatement system for which they are reporting controlled emissions is installed, operated, and maintained in accordance with the manufacturers' specifications. In addition, the facility must also obtain documentation from the abatement system supplier certifying that the abatement system is specifically designed to abate fluorinated GHG and N_2O.

Response 8-c: EPA disagrees with the commenter's statement that the RSASTP would be highly redundant and would provide limited improvement in data accuracy or reduced emissions. EPA has concluded that there is a need for gradually testing all of the abatement systems within a single class of abatement systems and for retesting individual abatement systems over time. As EPA stated in the preamble to the April 2010 proposed rule (75 FR 18652, April 2010), some fluorinated GHGs, such as CF_4, are harder to destroy than others; thus, the performance of abatement systems with one fluorinated GHG cannot be assumed to apply to other fluorinated GHGs. It is well known across the industry that abatement system performance varies greatly depending on the abatement device and process parameters such as temperature, flow, and exhaust composition. Abatement system performance is also highly dependent on effective maintenance. By requiring the gradual testing and retesting of abatement systems over time through the RSASTP, EPA can ensure properly measured DREs, and DRE class averages used at a facility will accurately reflect controlled emissions.

Also, through the use of the RSASTP, EPA is reducing burden, for instance, for facilities that continually modify their processes. EPA is basing the RSASTP around classes, defined as abatement systems grouped by manufacturer model number(s) and by the gas which the system is used to abate; varying process parameters, such as flows, temperature, and exhaust composition, do not factor into the requirements of the RSASTP. EPA has provided facilities with the flexibility to use a default DRE value of 60 percent as a less burdensome option for reporting controlled emissions. (see section 5.2.3 for more discussion on the EPA default DRE.) EPA has included the cost associated with DRE measurement testing in the EIA. For details on how EPA developed its final costs for this rule, see sections 4 & 5 of the EIA (available in the docket, EPA-HQ-OAR-2009-0927).

EPA appreciates its industry Partners' efforts to reduce emissions under the PFC Reduction/Climate Partnership for the Semiconductor Industry, and EPA disagrees that this rule presents challenges for a company that is currently making significant investments in emission reductions on a voluntary basis. The rule is aimed at gathering accurate facility-level information, and gathering this information does not inhibit a company from reducing emissions or accounting for those controlled emissions in GHG reporting.

EPA acknowledges the commenter's concerns about the burden of data reporting and recordkeeping under the rule. EPA carefully considered reporting and recordkeeping requirements and strived for a balance between reporting burden and the need for information that is critical for analyzing and verifying reported emissions (see §98.96 and §98.97). Because emission factors can vary significantly between processes, EPA is requiring a high degree of granularity in reported emissions information to facilitate verification and evaluation of individual components of an emissions estimate. EPA has determined that each piece of information required to be reported or retained as a record is directly relevant to the development of reported emissions.

Comment Summary 8-d: One commenter (TRANS-DC-02-4) expressed appreciation that the proposed rule allows for an emission factor approach and is responsive to suggestions to allow gas usage heel factors based on cylinder-change triggers. However, the commenter indicated the proposed rule may impose an equal or greater burden compared to the original due to gas accounting in the nine process categories and N_2O. Additionally, the commenter noted that the reporting scheme may impose significant compliance burdens and costs due to necessary quantifiable indicators and the disqualification of engineering judgment.

Two other commenters (0123 and 0110) asserted that the EIA of the proposed rule shows a misunderstanding of current industry practices and data collection capabilities, severely underestimating the fiscal impacts. Specifically, the commenters raised concern with EPA's assumptions that information required by the Refined Method (i.e., gas consumption data and indicators of activity used to apportion gas consumption) is collected as part of BAU operations and that no capital costs are associated with rule compliance.

Response 8-d: EPA thanks the commenter for noting appreciation of the efforts EPA had made to balance burden for estimating gas consumption for the industry.

Although the EPA has not at this time finalized the Refined Method, which is based on nine process sub-types for estimating fluorinated GHG emissions,[40] the methods in the final rule (the Tier 2c and the Tier 2d) are similar to the Refined Method in that gas consumption must be estimated and apportioned to process types, sub-types, or recipes. EPA therefore considered the commenters' concerns that gas consumption and apportioning compliance costs for the Refined Method were underestimated in the proposed EIA. EPA revised the cost estimates for apportioning gas consumption for the final EIA to account for capital costs associated with tracking information to apportion gas consumption. EPA has concluded that its final cost estimates appropriately account for the compliance burden under this rule. Please see sections 4 & 5 of the EIA (available in the docket, EPA-HQ-OAR-2009-0927) for more details on the cost estimates and analysis.

The revised cost estimates represent the costs of the methods that facilities must use to apportion gas consumption in the final rule. The finalized methods are flexible, allowing facilities to develop apportioning factors based on a quantifiable metric of the facility's choosing, provided the method is described in writing, is repeatable, and is verified through comparison with actual gas consumption. This approach provides facilities flexibility in the choice of apportioning methods, thereby allowing facilities to develop what will be their most cost-effective approach, and assuring the high degree of data quality that EPA needs. Please see response to comment 4.1.2-a for more details on the revised gas apportioning methods and the preamble section D. Electronics Manufacturing (subpart I), section 3 ("Summary of Comments and Responses"), for

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[40] Please see response to comments in section 4.1.1 on the Refined Method and the preamble section D, Electronics Manufacturing (Subpart I), section 3 ("Summary of Comments and Responses"), for a more detailed response to comments on emission estimation methods for semiconductor facilities and apportioning gas consumption.

additional discussion on EPA's responses to comments regarding burden for apportioning methods.

Comment Summary 8-e: Five commenters (0099, 0110, 0122, 0123, and 0131) asserted that the rule puts U.S. companies at a disadvantage globally because of the high associated costs. One commenter (0123) asserted that relative to this competitive disadvantage, there is little environmental benefit. Another of the commenters (0099) states that the burden imposed by the rule may put pressure on U.S. companies to move overseas.

Response 8-e: While EPA appreciates the global competition inherent in the electronics industry, the Agency is establishing a reporting program with sufficient rigor as to allow for accurate quantification of U.S. GHG emissions to inform policy and regulatory decisions. From a global perspective, GHG emission inventory development and mitigation are priorities, and have been for many years in countries such as Japan and the European Union. Other key electronics manufacturing nations such as Taiwan and China actively view GHG emission inventory development and mitigation as important policy initiatives. Please see the preamble section D, Electronics Manufacturing (subpart I), section 3 ("Summary of Comments and Responses"), for the responses to comments which discuss burden-reducing efforts.

Comment Summary 8-f: One commenter (0089) supported accurate reporting of GHG emissions, but stressed that it is imperative to accomplish the reporting in a manner that does not result in unnecessary burden, especially when more streamlined approaches can produce comparable accuracy.

Response 8-f: EPA considered all comments associated with burden, and evaluated alternative methods for calculating controlled and uncontrolled GHG emissions for electronics manufacturing. EPA carefully explored alternative methods that would result in reduced burden on industry while ensuring the quality and breadth of reported data. In this final rule, EPA has made every effort to reduce burden to the industry while maintaining requirements necessary to obtain facility-specific emission estimates. For example, based on comments received, EPA revised the gas apportioning method to allow for the usage of quantifiable indicators other than wafer passes. As another means to reduce burden to the industry, EPA is requiring only the "largest" semiconductor manufacturing facilities to calculate and report emissions using directly measured recipe-specific emission factors, ensuring that burden is commensurate with potential to emit. In addition, the largest semiconductor manufacturing facilities are only required to directly measure etching process emissions. Only facilities that manufacture semiconductors using wafers measuring greater than 300 mm are required to use recipe-specific emission factors. This requirement takes advantage of the opportunity, consistent with historical industry practices, reflected in International Technology Roadmap for Semiconductors (ITRS)[41], to move the industry forward in

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[41] ITRS (2010) *International Technology Roadmap for Semiconductors 2009*. This and earlier editions and updates are available at http://www.itrs.net/Links/2009ITRS/Home2009.htm.

terms of emission estimation practices. As operations are being upgraded and constructed, consistent, robust, and accurate emission estimation practices can be established, and costs for these practices can be incorporated into BAU operating costs for a facility.

In general, while commenters characterized EPA's proposed requirements as burdensome and costly, the comments lacked sufficient quantitative detail or substantiation. However, in response to concerns that EPA did not fully account for compliance costs in its economic analysis, EPA did update its costs estimates to reflect the costs associated with the requirements finalized in the rule. EPA has concluded that its final cost estimates appropriately account for the compliance burden under this rule. For details on how EPA developed its final costs for this rule, please see sections 4 & 5 of the EIA (available in the docket, EPA-HQ-OAR-2009-0927). Please also see the preamble section D, Electronics Manufacturing (subpart I), section 3 ("Summary of Comments and Responses"), for additional discussion on EPA's responses to comments regarding burden.

Comment Summary 8-g: One commenter (0131) cited the 2010 ISMI survey and stated that the semiconductor industry would incur an estimated $2.6 million in capital expenditures and $22 million in annual labor and operations and maintenance costs for apportioning gas usage according to refined process categories.

Response 8-g: Please see response to comment 8-b and 8-d for a discussion on costs associated with the final rule and sections 4 & 5 of the EIA (available in the docket, EPA-HQ-OAR-2009-0927).   EPA notes that the commenter did not provide sufficient information on how the cost and burden estimates were developed. It is unclear to EPA how ISMI's survey respondents developed cost estimates for their facilities. See the preamble section D, Electronics Manufacturing (subpart I), section 3 ("Summary of Comments and Responses"), for additional discussion on EPA's responses to comments regarding burden.

Comment Summary 8-h: One commenter (0131) stated that for the semiconductor industry, migrating away from using default heel factors and meeting specific gas consumption tracking requirements would cause the industry to incur significant costs that are higher than EPA-estimated costs. The associated costs would be in excess of $3 million per year in labor and operations and maintenance costs and $3 million in capital expenditures in gas usage consumption tracking requirements. Two commenters (0110 and 0123) indicated concerns over capital costs associated with estimating gas-specific heel factors using equipment with an accuracy and precision of 1 percent of full scale or better.

Response 8-h: EPA understands that facilities may incur a cost to estimate gas consumption using the methods prescribed in the rule; however, EPA has made efforts in the final rule to balance the burden imposed on facilities with EPA's goal of obtaining accurate, facility-level data. For more details on burden please see response to comment 8-b and 8-d for and sections 4 & 5 of the EIA (available in the docket, EPA-HQ-OAR-2009-0927). Please see responses to comments in section 4.1.1 for EPA's responses to comments regarding heel factors. See the preamble section D, Electronics Manufacturing (subpart I), section 3 ("Summary of Comments and Responses"), for additional discussion on EPA's responses to comments regarding burden.

Comment Summary 8-i: Two commenters (0099 and 0131) cited the 2010 ISMI survey and stated that the semiconductor industry would incur costs of $7 million annually for compliance for abatement systems (not including lost production time), instead of the $1.61 million estimated by EPA. The commenters stated that this higher estimate results from an estimated cost of $242,000 per facility, in comparison to EPA's estimate of $70,000 per facility. The commenters also assumed that 29 facilities employ abatement devices and will have to incur these costs, as opposed to the 23 facilities which EPA assumed.

Response 8-i: In the final EIA, EPA revised the assumption about the number of large facilities from 23 to 29, per the commenter's suggestion. Please see response to comment 8-b and 8-d and sections 4 & 5 of the EIA (available in the docket, EPA-HQ-OAR-2009-0927). Please see response to comment 8-b for more discussion about the estimated DREs costs associated with the rule.

9. Confidential Business Information (CBI)

Comment Summary 9-a: One commenter (0131) asserted that the industry considers GHG usage and emissions by process to be highly confidential and sensitive. GHG usage and emissions by process can give away confidential information about device design and manufacturing processes. Two commenters (0099, 0131) asserted that this information, in conjunction with production information for a facility, may cause inappropriate characterization of a facility's manufacturing processes. One of the commenters (0131) argued that the information EPA is requiring to be reported under subpart I "does not constitute 'emissions data,' as it is not necessary for determining emissions, given the availability of other, less intrusive means to do so." The commenter went on to argue that there is no definition of "emissions data" under the GHG MRR, and "accordingly, the only two federal cases to have squarely addressed the meaning of 'emission data' under the CAA have held that the term 'necessary to determine' emissions is to be defined narrowly to include only data actually required to determine emissions. Data are not necessary to determine emissions, and therefore are not 'emission data,' if other methods of determining emissions that do not require the disclosure of CBI are available." Lastly, the commenter argued that the information EPA is requiring to be reported under subpart I is within the realm of information to be treated as CBI under EPA regulations at 40 CFR part 2, subpart B as it is "1) highly-guarded within the industry, 2) would not qualify as 'emissions data' subject to disclosure requirements, and 3) would harm the companies' competitive position if disclosed."

Response 9-a: EPA acknowledges the commenters' concerns regarding reported information that they consider to be CBI. EPA carefully considered reporting and recordkeeping requirements and strived for a balance between the need for information that is important for analyzing and verifying reported emissions, and industry's desire to protect certain information. At this time, EPA has determined emission factors and gas usage and emissions by process type, sub-type, or recipe are important pieces of information EPA is requiring to be reported under this rule because the information will provide a means for EPA to verify emission estimates. The data elements EPA is requiring to be reported in the final rule will permit annual verification of the emissions information and data reported by each facility EPA has determined that reporting this information is necessary for EPA to determine the emissions and ensure the consistency and accuracy of data collected under this rule. Please see response to comment 6-b on data reporting requirements. Please also see the preamble to the Final MRR for additional information on EPA's verification approach (74 FR 56282). Therefore EPA has not modified the data reporting requirements to exclude emissions and gas consumption by process sub-type.

Although it is not clear from the comment what less intrusive emission determination methods the commenter is referencing, EPA assumes the commenter may be referencing its suggested alternative methods for estimating emissions based on a facility-wide emission factor or factory modeling. However, because these methods have never been used in practice to EPA's knowledge, it is unclear how the implementation of such methods would look and the data that would be used to estimate emissions. It also is unclear what data EPA would need to be reported in order to verify emission estimates. Therefore, EPA has no basis for conclusions about whether the suggested methods would be more or less intrusive than those proposed or included in the final rule. EPA considered CEMS as a less intrusive emission estimation method in terms of data reporting, however as discussed in section 4.3, information available at this time about the technical feasibility, accuracy, and costs of estimating emissions from electronics manufacturing using CEMS is limited.

The final rule does not address whether data reported under subpart I will be treated as CBI. EPA is addressing CBI issues in a separate rulemaking. EPA published a proposed confidentiality determination on July 7, 2010 (75 FR 39094, July 2010) which addressed the CBI status of certain data elements. In that action, EPA proposed which specific data elements would be treated as CBI and which data elements must be available to the public under section 114 of the CAA. EPA has received several comments on the proposal and is in the process of considering these comments. Final determinations will be issued before any data is released, and the final determination will include all of the data elements under these subparts. For more information on the CBI rulemaking, please see, http://www.epa.gov/climatechange/emissions/CBI.html#proposal.

Comment Summary 9-b: While some commenters (0110, 0123, and 0131) acknowledged EPA's need to have the ability to verify emissions reports, many commenters raised issues with specific reporting elements of subpart I. Specifically, commenters argued that the majority of data required to be reported is not emissions data, and they questioned EPA's need for some data elements. As well, commenters argued that providing some of this information to the public would cause substantial competitive harm to semiconductor manufacturing companies or cause a facility's manufacturing operations to be inappropriately characterized. These elements, as well as who commented on them, are identified below.

1. substrate area production rates (0089, 0099, 0110, 0123, 0131) (commenters also expressed that these values do not affect emissions results);
2. emission factors and process utilization rates broken out by processes or process categories and the source (0089, 0095, 0131);
3. gas usage and emissions by process, process category, and/or process type (0099, 0100, 0110, 0123, 0131);
4. fraction of gas fed into each process type (0099, 0131);
5. apportioning factors (0131);
6. manufacturer and model number of each process tool (0099);
7. emissions from heat transfer fluid use (0131);
8. the method of emissions calculation used (0131);
9. description of individual processes or process categories used to estimate emissions (if process categories defined by EPA are not used) (0131);
10. facility-wide gas-specific heel factors (0131);
11. fraction of gas fed into each process type with abatement systems (0131);

12. description of abatement devices, including the number of devices of each manufacturer make and model, manufacturer guaranteed DREs, and record of DRE measurements made over its lifetime (0131);
13. all other information to be reported for abatement systems for which controlled emissions are being reported (0131);
14. inputs to the heat transfer fluid mass balance equation (0131); and
15. example calculations for fluorinated GHG, N_2O, and heat transfer fluid emissions (0131).

Multiple commenters (0089, 0123, 0099, and 0110) suggested that some of this information could be kept on site and made available for government inspection; one of the commenters (0089) asserts that this is consistent with the management for underlying emissions calculation data in other air quality and permitting programs. Two other commenters (0110 and 0123) suggested that, “Providing EPA with total emissions on a CO_2e basis and providing the remaining inputs, such as methods of emissions calculations, emission factors used, etc., should provide sufficient data.” One commenter (0131) suggested that EPA adopt a proposed alternative approach for emissions reporting that would rely on less sensitive information to be reported and that if EPA retains certain reporting elements they should explicitly acknowledge in the rule what is not considered “emissions data” under EPA regulations and hence will not be subject to public disclosure.

Response 9-b: Of the elements identified by commenters as sensitive and listed above as items 1-15, all elements other than item 15, “example calculations for fluorinated GHG, N_2O, and heat transfer fluid emissions” have been retained as reporting requirements in the final rule. Item 15 is not included in the final rule because EPA determined that this information would be redundant with other information EPA is requiring facilities to report for emission calculation verifications.

Although EPA is unsure exactly to which other air quality and permitting programs requirements the commenters are referring, in contrast to other regulatory programs, this rule focuses on establishing each facility’s annual GHG emissions in tons per year**,** not on whether a facility's emissions are below a specified limit. For this reason, EPA is requiring reporting, rather than simply retention, of certain data in order to permit EPA to conduct an annual verification of the emissions quantities reported by each facility.

Please see response to comment 9-a for details on the current CBI rulemaking and EPA’s need for required data reporting elements. No data will be released publicly until CBI determinations are made. For more information on the CBI rulemaking, please see, http://www.epa.gov/climatechange/emissions/CBI.html#proposal.

Please see response to comment 2.3-a and 4.5-a for more information about reporting of emissions on an absolute mass basis, as opposed to a CO_2e basis.

Comment Summary 9-c: One commenter (0099) supported the current rulemaking efforts by EPA to define CBI in the context of the EPA Greenhouse Gas Mandatory

Reporting Program. The commenter asserted that neither the 2009 final rule nor the April 2010 proposed rule adequately protects CBI against public disclosure because emissions data collected under CAA Section 114 is generally not considered CBI. Another commenter (0131) strongly urged EPA to move forward with this effort because “it is not legally appropriate for EPA to take the position that it can make ‘no promises’ at this time and to remain silent. The issue of trade secret protections goes to the heart of our business, and without any understanding whatsoever of EPA’s position on this issue, SIA does not have an adequate opportunity for comment on this aspect of the Re-Proposal.”

Response 9-c: Please see response to comment 9-a for details on the current CBI rulemaking and EPA’s need for required data reporting elements. No data will be released publicly until CBI determinations are made. For more information on the CBI rulemaking, please see, http://www.epa.gov/climatechange/emissions/CBI.html#proposal.

10. Uncertainty Analysis

Comment Summary 10-a: One commenter (0112) disagreed with the premise that the Refined Method will reduce uncertainty associated with emission estimates by a factor of two without imposing undue economic burden on the semiconductor industry. The commenter indicated that this premise is not supported by the analysis of the data provided by EPA in the re-proposal of the rule and associated documents. The commenter constructed a Monte Carlo model and submitted results to EPA, concluding that the analysis by EPA contains several flaws. The commenter contended that their analysis suggests that the paucity of etch emissions data does not justify or support dividing the current Tier 2b etch category into four separate categories. The commenter provided detailed descriptions of their model runs and concluded that using four etch categories does not reduce uncertainty by half. The commenter asserted that based on its analysis, the significant extra cost required to apportion gas use across four etch categories is not justified by the minimal improvement in certainty.

Response 10-a: EPA appreciates the work the commenter did to evaluate the uncertainty of the Refined Method. The analysis EPA conducted for the proposed rule was based on the information available to EPA at the time. Using new information received after the proposed rule (presented in the NODA) and in the public comment period, EPA performed another uncertainty analysis evaluating the Refined Method and four other emission estimation methods. From this analysis (see the Electronics Manufacture TSD, Appendix C) and in working to develop default factors for the Refined Method, EPA concluded that the emission factor information available for the etching process type is not sufficient at this time to establish four etch sub-types as proposed for the Refined Method. Therefore the Refined Method is not a method required in the final rule. Additionally, the limited information available does not make it possible to draw any meaningful conclusions about the certainty of various EPA-developed emission estimation methods and IPCC emissions estimation methods at this time. However, information gathered through the final rule will allow EPA to further assess alternative emission estimation methods.

To address the gap for etch data noted above, under the final rule, the “largest” semiconductor manufacturing facilities must calculate their etch process emissions using recipe-specific emission factors. In future years, EPA may evaluate the recipe-specific emission factors received through this final rule to determine whether a sufficiently robust data set exists to establish default emission factors for etching process sub-types. In the future, EPA may consider requiring the semiconductor facilities that will be using a default emission factor for the etch process type under this final rule to estimate and report emissions using an approach based on multiple etch and chamber clean process sub-types similar to the Refined Method EPA proposed in April 2010. At that time, EPA could reassess the certainty of the Refined Method.

As a means to reduce burden to industry on the whole, all other semiconductor facilities (i.e., those not classified as the “largest”) will utilize broad default emission factors for the etching process type, which were developed by EPA using the data published in Table 5 of the report, “Draft Emission Factors for Refined Semiconductor Manufacturing

Process Categories" (EPA-HQ-OAR-2009-0927-0073), to calculate emissions from a single etch process category, as opposed to four etch categories.

For the other process types considered in this rule, EPA developed default factors for the three chamber cleaning process sub-types (i.e., in-situ plasma, remote plasma, and in-situ thermal) and broad factors for the wafer cleaning process type using data presented in the NODA. Please refer the Electronics Manufacture TSD, Appendix B for more information on the development of the default factors. Please see section 8 for more discussion on the costs associated with the rule.

Comment Summary 10-b: One commenter (0099) asserted that if the uncertainty assigned to emission factors for the Refined Method was reduced in comparison to the uncertainty assigned to Tier 2b emission factors in the 2006 IPCC Guidelines, the uncertainty for emission factors for the Tier 2b method should be revised (improved) as well. This is because Refined Method emission factors are largely unchanged in comparison to the IPCC Tier 2b emission factors.

Response 10-b: Please see response to comment 10-a for information on the data available to EPA at the time of the April 2010 proposed rule. The information used to estimate emission factor uncertainties, as well as the emission factors themselves used for the analysis, was limited (see the March 22, 2010 Electronics Manufacture TSD, Appendix B for more details about the analysis). Based on the information, EPA had the uncertainty of each emission factor representing a refined process category that was calculated based on the standard deviation[42] of the emission factors measured for that process category in the 2006 IPCC dataset (see section B.2, page 25, of the March 22, 2010 Electronics Manufacture TSD). The exception was when a standard deviation couldn't be calculated because just one datum was available. In that case two runs were conducted. For one run, zero percent relative error was assumed around these factors and for the other run 10 percent relative error was assumed per the ISMI Guidelines. The difference in results between these two runs based on these different assumptions was inconsequential (see section B.3, page 28, of the March 22, 2010 Electronics Manufacture TSD).

Please see response to comment 10-a for discussion on the emission estimation methods for semiconductor facilities included in the final rule and on the updated uncertainty analysis. For detailed information on the updated uncertainty analysis please see Appendix C of the Electronics Manufacture TSD.

Comment Summary 10-c: One commenter (0131) presented the ISMI's supplemental survey regarding the Refined Method. The report, as attached by the commenter, indicated that the Refined Method would introduce even greater uncertainty than the IPCC Tier 2 method. One reason stated is that EPA's uncertainty analysis fails to

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[42] In the uncertainty analysis, the 95% confidence intervals presented in the 2006 IPCC Guidelines for the Tier 2b emission factors were divided by two so that they would be comparable to the uncertainties calculated for the emission factors for the refined process method, which are standard deviations.

account for the potential magnifying impact on uncertainty that can occur when the method establishes more categories for apportionment, due to the large amount of process recipes a facility would need to take into account during aggregated apportionment across many process tools.

The ISMI analysis identified the following problems that made the commenter question the validity of the analysis: “1. The uncertainties applied to the emissions factors used in the uncertainty analysis comparing the 9 category analysis to the Tier 2b categories analysis overstated the accuracy of the etch emissions factors. Specifically, the use of 10 percent uncertainty for emissions factors with only a single data point and no specified uncertainty overstates the certainty of the emissions factor value. 2. The gamma distribution truncated the distribution for emissions factors less than zero but an infinite distribution tail for emissions factors greater than 1 resulted in 2 to 3 percent of the runs emitting more gas than was used in the process. This distribution reflects a major problem in the analysis. 3. The gamma distribution did not fit well with some of the data where the value of Uij was high. A beta distribution provides a better fit to the available data and improves the Monte Carlo model output.” The commenter provided more information pertaining to the ISMI analysis.

Response 10-c: Although the Refined Method was not included in the final rule, the commenter’s concerns that apportioning gas consumption would introduce greater uncertainty to the emission estimates may also apply to other methods that require the apportioning of gas consumption beyond the Tier 2b method. However, the commenter does not provide quantitative evidence that such additional uncertainty would be introduced. In the uncertainty analysis that EPA performed for the April 2010 proposed rule, EPA explicitly stated that uncertainties around gas distributions were not considered; given the available information (please see response to comment 10-a and 10-b), it was not feasible for EPA to estimate uncertainties that may be introduced by apportioning gas consumption. EPA believes that the methods for apportioning gas consumption provided in the rule minimize any uncertainty that may be introduced by apportioning gas to multiple process types, sub-types, or recipes, because the apportioning factors must be developed based on quantifiable and documented metrics and facility-specific gas apportioning models must be verified.

EPA took into consideration the commenter’s concerns about the uncertainty analysis run for the proposed rule. In light of these comments and new information that EPA received, EPA performed an updated uncertainty analysis that utilized emission factors and uncertainties based on information presented in the report, “Draft Emission Factors for Refined Semiconductor Manufacturing Process Categories” (EPA-HQ-OAR-2009-0927-0073). The beta distribution, which EPA agrees has theoretical appeal because all physically impossible emission factors (*i.e.*, those outside of the range of zero to one) would not be permitted in a Monte Carlo simulation, was used in the new analysis as well. However, two reasons attributed to the paucity of information—1) a small number of emission factor estimates for each gas-process type other than the NF_3-remote plasma clean process type, and 2) the unavailability of representative facility-level gas usage data. These data gaps precluded EPA from drawing robust conclusions about the uncertainty associated with alternative methods for estimating emissions. The small number of measured emission factors for each gas-process type precluded assessments of the validity of the theoretically attractive beta distribution. A potentially important and unexpected finding was that the IPCC Tier 2b method understated emissions compared to a Tier 2b method developed using updated emissions factors obtained during EPA's NODA. While EPA does not consider this understatement of emissions established (because its based on a single distribution of facility-level gas usage), it cannot ignore the finding either (because the reason for this bias results from the new emissions factors being larger than the older emissions factors on which the IPCC Tier 2b default emission factors were developed). For more details on the uncertainty analysis, please see Appendix C of the Electronics Manufacture TSD.

11. Other Subpart I Comments

Comment Summary 11-a: One commenter (0122) noted that over the last 15 years, SIA companies have worked to create a global program for PFC reduction for semiconductor manufacturing. Given this effort, the high complexity of semiconductor manufacturing, and the fact that the sector has relatively low emissions[43] (0.07 percent of national U.S. emissions), the proposed rule presented an excessive reporting and record keeping burden for facilities.

Another commenter (0110) noted that GHG emissions from the semiconductor industry were 0.55 MMTCE in 2008, comprising 0.07 percent of the total U.S. inventory. The commenter asserted that the amount of emissions subject to the rule by the industry is small, and that the industry has committed to reducing emissions to 10 percent below baseline by 2010.

Response 11-a: While the emissions from the electronics sector represent a relatively small share of total GHG emissions in the U.S. and its industry Partners have reduced emissions under the PFC Reduction/Climate Partnership for the Semiconductor Industry, EPA concluded it was appropriate to include this sector in the GHG Reporting Program. As discussed in section II.D of the Final MRR (74 FR 56270), EPA included source categories in the Program that would provide information necessary to evaluate facility-specific emissions that exceed the selected emissions threshold across all sectors of the economy. Such data will inform the assessment of potential policies and programs that could be implemented under the CAA. EPA considered a variety of factors in including the electronics manufacturing sector in the Greenhouse Gas Reporting Program (GHGRP). First, the gases used in the electronics manufacturing industry have extremely high GWPs and are persistent when released to the environment. There is a great diversity and significant volume of fluorinated GHGs used in electronics manufacturing and the sector’s rapid growth indicates the potential for similar significant growth in future emissions. The collection of information through this rule will allow EPA to identify and monitor the current and future trends in emissions of the potent GHGs used in the electronics manufacturing sector to inform policy and regulatory decisions. Please see response to comments in section 8 for information about the burden associated with the final rule. Please also see the preamble section D, Electronics Manufacturing (subpart I), section 3 (“Summary of Comments and Responses”), for the responses to comments which discuss burden-reducing efforts.

Comment Summary 11-b: One commenter (0099) supported reporting and reducing PFC and GHG emissions and has a stated goal of helping to ensure that the final rule is based on the best available science without unnecessarily burdening manufacturers. Another commenter (0100) stated that a GHG inventory is an important first step toward reducing emissions but that emission inventory methodologies should quantify

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[43] Modern fabs, such as advanced 300 mm fabs, have relatively low emissions because they use both in-situ NF_3 chamber clean and POU abatement systems.

emissions reduction without diverting finite resources from reducing actual emissions. The commenter asserted that the Proposed Rule does not accomplish this.

Response 11-b: EPA appreciates the commenter's stated goal of supporting a final rule for the electronics sector that is based on the best available science without creating unnecessary burden. As already stated in this response to comment document, the EPA has made its best effort to balance the burden imposed on facilities with EPA's goal of obtaining accurate, facility-level data. The methods in the final rule ensure that information is reported that helps further EPA's understanding of the nature and magnitude of emissions from the electronics industry and will help inform future policy and regulatory actions. Please see response to comment 8-f addressing burden. In gathering accurate facility-level uncontrolled and controlled emissions information EPA will have an established and accurate baseline on which to use to help inform future policy and regulatory decisions, potentially ones about emission reduction activities. Without an accurate baseline, the true magnitude and benefit of emission reduction activities can not be assessed.

Comment Summary 11-c: One commenter (0110) supported reporting necessary emission data to EPA. Based upon a review of the proposed rule and the results of the ISMI survey, the commenter stated that the rule is unnecessarily complex and will result in unnecessary burden and costs to the industry. The commenter indicated that there are less burdensome monitoring and emission estimation alternatives that can be employed to achieve EPA's goals, based upon the commenter's experience with the EPA PFC Reduction/Climate Partnership for the Semiconductor Industry.

Response 11-c: There are emission estimation methods available for facilities that manufacture semiconductors that may be less burdensome than the methods finalized in the rule. However, EPA has concluded that these methods, such as the IPCC Tier 2b method, are not sufficient for meeting the goals of this rule (for a discussion on why, please see response to comment 4.2-a and response to comments in section 4.2.3). EPA is providing two methods in the final rule by which semiconductor facilities are required to estimate and report emissions, based on the annual manufacturing capacity of a facility. Both of these methods move beyond the Tier 2b method in terms of their expected level of accuracy but do not impose as much burden as is associated with a full Tier 3 method. The required methods, which are more granular than methods based on broad or no process types, help ensure that EPA is gathering accurate facility-wide information to inform future policy and regulatory decisions. Please also see response to comments 11-a and 11-b, as well as the response to comments on the cost associated with the final rule in section 8.

Comment Summary 11-d: One commenter (0112) stated that the MRR must strike a balance between investment toward lowering emissions and expenditures on reporting related infrastructure. The commenter asserted that the proposed rule goes well beyond what is necessary to develop the required emissions inventory at the facility level. After the close of the public comment period the commenter provided two proposals for modeling PFC gas use and emissions to promote dialogue between the industry and EPA. The commenter encouraged EPA to continue conversations with industry after the close of the comment period.

Response 11-d: EPA appreciates the information on modeling fluorinated GHG gas usage the commenter provided. From the examples the commenter provided, EPA gained further insight and understanding of plausible methods for apportioning gas consumption. In part based on the information provided by the commenter, EPA has modified the gas apportioning methods in the final rule. EPA has determined that the requirements finalized in the rule are appropriate and effectively balance EPA's objectives while minimizing burden to the industry. As stated throughout this section and the comment response document, EPA sought to strike a balance between accurate facility-level reporting and burden on industry to comply. EPA did not take into account costs associated with emission reduction activities because that is beyond the scope of the rule. Please also see response to comments 4.1.2- and 8-d for more discussion on gas consumption apportionment modeling methods finalized in the rule.

EPA thanks the commenter for the information provided to inform this rulemaking effort. EPA looks forward to continued collaboration with electronics manufacturers as the GHG Reporting Program advances.

Comment Summary 11-e: One commenter (0122) cited strong support for the comments submitted by the SIA on behalf of the U.S. semiconductor industry.

Response 11-e: Responses to SIA's comments (commenter 0131) have been provided in all sections (1 though 11) of this document. Each of SIA's comments, as with other commenters' comments, has been segregated by topic area within each section in this document.

Comment Summary 11-f: Two commenters (0099 and 0122) appreciated the changes in the re-proposed rule, which reduce many aspects of the overall reporting burden compared to the original proposal, and EPA's decision to postpone finalizing requirements for the electronics manufacturing sector. One commenter (0122) expressed ongoing concern that many aspects of the proposed rule increase burden on the industry without corresponding benefits of either improved data accuracy or reduced emissions.

Response 11-f: EPA appreciates the commenters' support of aspects of the April 2010 proposed rule that reduce overall reporting burden. In developing the final rule, EPA sought to achieve the goals of the rule and minimize burden imposed on industry. Details on steps taken to address burden are also provided in the various comment responses in the preamble section D, Electronics Manufacturing (subpart I), section 3 ("Summary of Response to Comments").

EPA does not agree that the rule does not provide the benefits of improved data accuracy. The information gathered through this rule will provide EPA with accurate facility-level information across many sectors in the U.S.; the rule does not seek to or require facilities to reduce emissions. This rule addresses gathering accurate emissions, which may or may not eventually lead to potential future emission reduction policy decisions.

Comment Summary 11-g: One commenter (0131) appreciated EPA's responsiveness to their comments on the original proposed rule. In particular, the commenter appreciated that the re-proposal would allow manufacturers to calculate emissions instead of requiring individual tool measurement or CEMS, neither of which the commenter believes is technically or economically feasible.

Response 11-g: EPA appreciates the commenter's support for the revised proposal but disagrees with the commenter's conclusion that tool measurements are not technically feasible. The emission estimation methods required in the final rule require the use of default factors as well as direct measurement of recipe-specific emission factors in some cases; direct measurement for recipe-specific factors is feasible. While it may be feasible to use CEMS, the information available at this time about the use of this technology for the electronics manufacturing sector is limited. Further, information about the uncertainty of emission estimates using CEMS also is limited. In future years, given more information about the feasibility of CEMS and the accuracy of estimating emissions from CEMS, EPA may consider providing provisions to allow for the use of CEMS. Please also see response to comment 4.3-a for more discussion of CEMS.

Comment Summary 11-h: One commenter (0131) stated that EPA should allow more than the required three months to report prior calendar year data, because three months is not sufficient to collect, analyze, prepare, and certify data for submission. The commenter noted that other programs allow longer time intervals, such as six months for EPA's Toxic Release Inventory and five months for California's mandatory GHG reporting program.

Response 11-h: EPA disagrees with the commenter that three months is not a sufficient timeframe to prepare data and reports for submission to EPA. In the Final MRR, EPA decided that a three month timeframe for compiling, reviewing, certifying, and submitting annual GHG reports is sufficient. For additional background on EPA's decision on the March submittal date for annual reports, please see the preamble to the October 2009 final rule (74 FR 56278-56279, October 2009).

Comment Summary 11-i: One commenter (0131) noted that the current proposed rule would appear to require gas-by-gas reporting of usage and emissions information by process category or sub-category on a mass basis without any CO_2e conversion. The commenter expressed concern about this approach and saw no indication of whether

EPA will make this information publicly available (to the extent not claimed as CBI) or will instead undertake to convert the data to CO_2e. If EPA intends to undertake the conversion, the commenters questioned what methodology and GWP factors will be used and how the resulting data will be displayed and explained to the public. The commenter proposed that CO_2e conversion be performed by the reporting entity using the latest IPCC GWPs.

Response 11-i: EPA is maintaining the requirement of gas-by-gas reporting of usage and emissions information on a mass basis. This practice of reporting GHGs on a mass basis allows interested readers to easily calculate CO_2e using current (or historical) GWP values, which have been adjusted over time to reflect improved scientific understanding. Reporting emissions by chemical mass eliminates one potential opportunity for calculation error and is very important to those investigating the concentration of pollutants in the atmosphere and environment. The gas-specific reporting and analysis will also help identify chemicals for which GWP values need to be determined. Please see response to comment 2.3-a for more details on the GWPs used in the MRR.

As EPA stated in the preamble to the proposed rule to determine the confidentiality status of data required to be reported under the MRR (75 FR 39102), "pursuant to CAA section 114(c), EPA must make available to the public data submitted under Part 98, except for data (other than emission data) that are considered confidential under CAA section 114(c). Accordingly, EPA intends to release Part 98 data after their submission to EPA in accordance with EPA's determinations of their confidentiality status in a final rule. Specifically, EPA intends to release Part 98 data that are determined in the final rule to be emission data or not otherwise entitled to confidential treatment under CAA section 114(c) (*i.e.,* ''non-CBI''). EPA intends to make much of such data available to the public through an EPA Web site. Data elements that we determine to be CBI under CAA section 114(c) would be published on the Web site only if they an be aggregated in a manner that would protect the confidentiality of these data elements (*e.g.,* production data determined to be CBI that is aggregated by source category)."

Comment Summary 11-j: One commenter (0131) urged EPA to "recognize the significant initial challenges that will be posed by any new GHG reporting regime. Not only will companies need to create new compliance systems, but EPA also likely will need to supplement any final rule creating, such as a regime with guidance, to address technical nuances or to clarify ambiguities. Consistent with EPA's existing enforcement policies and practice, therefore, SIA believes that enforcement should account for these initial challenges by using less aggressive mechanisms, such as the warning letter, and by encouraging industry to perform auditing and otherwise to take advantage of EPA's Self-Disclosure Policy."

Response 11-j: The enforcement provisions of the rule are critical to achieving EPA's objective of collecting accurate GHG emissions data in a timely manner. EPA has discretion to pursue a variety of informal and formal actions in order to achieve compliance.

EPA has implemented a compliance assistance e-mail and telephone hotline for answering questions and providing technical assistance. Compliance materials will be available for subpart I and are tailored to the needs of the electronics manufacturing sector. These materials might include, for example, fact sheets, information sheets, plain English guides, frequently asked question and answer documents, applicability tools, monitoring and recordkeeping checklists, and training on rule requirements and the electronic reporting system. Note that while EPA plans to issue compliance assistance materials, reporters should always consult the final rule to resolve any ambiguities or questions. For additional discussion of compliance and enforcement, including responses on EPA's approach to enforcement, please see the preamble to the Final MRR, section VI. Compliance and Enforcement (74 FR 56359, October 2009).

12. Relevant Comments from the April 2009 Proposed Rule on Electronics Manufacturing

12.1 Calculating GHG Emissions: Emission Estimation Methods for Semiconductor Facilities

Comment Summary 12.1-a: One commenter (0498) asserted that while “large semiconductor facilities” (those that have an annual manufacturing capacity of greater than 10,500 m^2 of substrate) are subject to the most stringent requirements under subpart I, they do not have inherently higher emissions of fluorinated GHGs. The commenter stated that the second generation of 200 mm fabs and 300 mm fabs have significantly lowered their emissions in comparison to older fabs by incorporating remote NF_3 chamber cleaning and POU abatement systems. The commenter (0498), as well as another commenter (0682), stated that “the distinction in the Proposed Rule between ‘large’ facilities and other facilities – appears based on the premise that all larger facilities will have newer technology – but this premise does not square with the current manufacturing realities. Within the semiconductor industry, a large facility may rely on older technology. Some facilities may contain multiple fabrication operations, with a mix of technology generations.” The two commenters (0498 and 0682) further stated that the distinction is contradictory to emission reduction incentives developed under the Voluntary EPA Partnership, which does not distinguish facilities by capacities in setting emission reduction goals. Therefore these commenters, as well as another commenter (1137), asserted that there should be no distinction between large and other semiconductor facilities and that the rule should apply to all facilities that emit more than 25,000 metric tons of CO_2e per year.

One commenter (0978) asserted that the use of square meters of silicon to establish the reporting threshold is inappropriate. The commenter stated that silicon wafer throughput is considered CBI and does not provide a meaningful assessment of GHG emissions— it is a metric that varies widely depending on the process and the facility. The commenter recommended that that the rule should apply to all facilities that emit more than 25,000 metric tons of CO_2e per year using pre-abatement PFC emissions as estimated by IPCC Tier 2 or 3 method. The commenter argued that this would provide an effective, easy metric at which to set a reporting threshold.

Response 12.1-a: In the final rule, for semiconductor facilities that manufacture wafers measuring 300 mm and less in diameter, EPA is requiring the use of one of two of the following methods for calculating and reporting emissions, depending on the facility’s manufacturing capacity: (1) A method for facilities that have an annual manufacturing capacity that is less than or equal to 10,500 m^2 of substrate (the Tier 2c method), and (2) a method for those that have an annual manufacturing capacity greater than 10,500 m^2 of substrate (the Tier 2d method).

While EPA acknowledges qualitative reports on second generation 200 mm wafer facilities adopting NF_3 remote plasma cleans and POU abatement systems as presented in comments, EPA is unaware of published studies that quantitatively document the market penetration of either NF_3 remote plasma source or point of use fluorinated GHG abatement systems in those facilities. EPA could not rely on generalizations about how industry practices, such as the use of NF_3 RPS and abatement systems, affect emissions that are not substantiated by consistent published data and supporting information from commenters. Therefore EPA selected a capacity-based emission estimation method distinction of 10,500 m^2 of substrate for the largest facilities because facilities above this threshold are expected to account for nearly two-thirds of potential emissions, while accounting for less than 20 percent of all facilities expected to report under subpart I. This distinction was part of EPA's initial April 2009 proposed rule (74 FR 16448, October 2009). By setting this distinction, EPA established an easily calculated metric[44] which can be used to determine which facilities must use the Tier 2c or Tier 2d methods in a consistent manner. EPA has concluded that the methods finalized in this rule effectively balance EPA's objectives with an appropriate level of burden to industry.

EPA does not agree that finalizing a distinction between reporting requirements for the larger and relatively smaller semiconductor manufacturing facilities is contradictory to emission reduction incentives developed under the EPA's PFC Reduction / Climate Partnership for the Semiconductor Industry because the Partnership and this rule have different purposes and goals. The purpose of this rule is to collect data for use in developing future GHG policies and programs. In contrast, the Partnership (a non-regulatory program) is designed to support the industry's voluntary efforts to reduce its high GWP GHG emissions. In the final rule, EPA is requiring reporting methods for semiconductor manufacturing facilities based on the facility's manufacturing capacity (representative of potential emissions), to effectively balance EPA's objectives in addressing relatively large uncertainties associated with abatement performance with an appropriate level of burden to the industry as a whole.

Please see the preamble section D, Electronics Manufacturing (subpart I), section 3, ("Summary of Response to Comments") for additional response to comments on the methodologies for semiconductor manufacturing facilities in the final rule and also on steps EPA has taken to reduce burden.

With respect to the commenter that asserted the use of silicon to determine threshold applicability is inappropriate, in the final rule, the threshold calculation to determine whether a facility is required to report under subpart I is emissions-based (as proposed in the April 2010 rule). The emissions-based threshold is different from the capacity-based threshold that was presented in the April 2009 proposed rule. EPA is retaining a capacity-based threshold for semiconductor facilities to determine which methodology they are required to follow to calculate and report their emissions (please see the first paragraph in this response for more information). EPA is not requiring the use of wafer throughput in that calculation; rather, the threshold applicability calculation uses the facility's annual manufacturing capacity.

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[44] In the final rule EPA has clearly specified the equations and information a facility must use to determine their annual manufacturing capacity.

In the final rule, all electronics manufacturing facilities that emit more than 25,000 metric tons per year of CO_2e are required to report under subpart I. Please see the preamble section D, Electronics Manufacturing (subpart I), section 1, for a summary of the reporting threshold for electronics manufacture, and the preamble to the Final MRR (74 FR 56272, October 2009) for further discussion on EPA's selection of a 25,000 MtCO_2e per year reporting threshold. Please also see response to comments on CBI in section 9.

Comment Summary 12.1-b: One commenter (0437) asserted that it is unclear, for the Tier 3 method, whether every process, every recipe, or every platform would have to be tested. The commenter requested clarification regarding how to address similar tools and processes used across multiple facilities. The commenter questioned whether testing would be required to be company-specific, facility-specific, or tool-specific. The commenter also requested clarification on the required testing frequency for the Tier 3 method and the trigger for testing. In a similar sentiment, another commenter (0498) also questioned what would constitute a separate process that would necessitate the development of a specific set of Tier 3 emission factors. The commenter asserted that it is neither technically appropriate nor workable from a regulatory standpoint to develop emission factors for every individual recipe used. Another commenter (0759) suggested if the same manufacturing processes were used in multiple company fabs, emission factors developed in one fab should be allowed to be applied for the same processes run in another fab. The commenter stated that because of the highly precise nature of the industry, the same manufacturing processes will be performed identically across different facilities; as such, the method suggested would accurately estimate emissions.

Response 12.1-b: In the final rule, EPA is clarifying that for methods which require the use of emission factors developed from direct measurements (i.e., both the Tier 2d and Tier 3 methods), factors must be developed for each recipe used at the facility. However, EPA recognizes that a facility may employ potentially hundreds of individual recipes. To this end, as a means to reduce burden for facilities that are required or elect to do recipe-specific measurements, EPA is introducing the term "similar," with respect to recipes, to refer to recipes that are composed of the same set of chemicals and have the same flow stabilization times and where the documented differences, considered separately, in reactor pressure, individual gas flow rates, and applied radio frequency (RF) power are less than or equal to plus or minus 10 percent. For purposes of comparing and documenting recipes that are similar, facilities may use either the best known method provided by an equipment manufacturer or the process of record, for which emission factors for either have been measured (see the Electronics Manufacturing TSD (EPA-HQ-OAR-2009-0927) for supporting information). Once a facility develops a set of recipe-specific emission factors for an individual recipe, it may apply those emission factors to "similar recipes." This provision allows a facility to make fewer measurements to develop the emission factors required for Tier 2d and Tier 3, thereby reducing burden in comparison to a more stringent approach which would require measurements for each and every individual recipe used at a facility. For additional information about the Tier 2d and 3 methods, please see the preamble section D, Electronics Manufacturing (subpart I), section 1 ("Summary of the Final Rule").

As another means to reduce burden, EPA is clarifying that in a given reporting year, a facility must develop new recipe-specific emission factors only for recipes which are not similar to any recipe used in a previous reporting year. Further, EPA is allowing facilities to use recipe-specific utilization and by-product formation rates measured by a third party, provided the measured recipes are similar recipes to those used at the facility.[45] For more information on similar recipes please see the Electronics Manufacture TSD. For additional responses to comment on burden, please see the preamble section D, Electronics Manufacturing (subpart I), section 3 ("Summary of Comments and Responses.")

Comment Summary 12.1-c: Three commenters (0437, 0498, and 0978), who supported the use of the Tier 2b method, stated that EPA's understanding of the availability of Tier 3 data from tool suppliers, and the current use of the Tier 3 method throughout industry, is incorrect. The commenters also asserted that the Tier 3 method would be excessively burdensome for facilities to implement.

One of the commenters (0498) asserted that the cost to implement the Tier 3 method at a large fab would range from $0.43 million to $2.7 million, and would require anywhere from 12 to 76 weeks of testing, depending on whether every process platform[46] or whether every individual recipe had to be tested. The cost to the EPA-estimated 29 "large facilities" was estimated to be $13 million to $77 million total, with an estimated 360 to 2,200 weeks of testing required. The commenter (0498) also asserted that given the limited number of testing service providers, it is unclear how Tier 3 factors could be developed for all large semiconductor facilities.[47] Another commenter (0978) stated that neither of its facilities currently have the capacity to track and record data in support of a Tier 3 method. The commenter estimated that $5 million in initial investments would be required to implement the Tier 3 method, including modifications and upgrade to equipment and software, and $1.5 million per year would be required in operating costs. The commenter (0978) was concerned that there would not be sufficient time to install required hardware and software systems to implement the Tier 3 method in order to comply with the rule; the commenter stated that to install the required hardware and software may take several years and may introduce risks into manufacturing processes.

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[45] In the final rule, recipe-specific utilization and by-product formation rates are required to be measured using the 2006 ISMI Guidelines. EPA is allowing recipe-specific utilization and by-product formation rates measured using the 2001 ISMI Guidelines provided they were measured prior to January 1, 2007. Documentation for the measurements is required.

[46] The commenter defined a process platform as specific tool models using a specific PFC for either CVD chamber clean or etch.

[47] In the April 2009 proposed rule, the largest semiconductor facilities (with annual manufacturing capacities of greater than 10,500 m^2) were required to use the Tier 3 method to estimate all etch and clean emissions.

Response 12.1-c: EPA has concluded that an emission estimation approach based on the IPCC Tier 3 method would result in the most accurate data. However, EPA is mindful of the burden that would be imposed by requiring all covered facilities to apply a Tier 3 method for all process emissions. To this end, EPA is not finalizing an approach that requires semiconductor manufacturing facilities to calculate and report using a Tier 3 method for all production processes that use fluorinated GHGs. In the final rule, only the largest semiconductor manufacturing facilities are required to calculate and report emissions for the plasma etching process type using directly measured emission factors (Tier 2d method).

Note, in the final rule, EPA is finalizing an approach that requires all semiconductor manufacturing facilities that fabricate devices on wafers measuring larger than 300 mm in diameter to calculate and report all production processes that use fluorinated GHGs using a Tier 3 method. As EPA stated in the April 2010 proposed rule, the commissioning process for new tools is an ideal opportunity for emission factor development and/or verification. Further, EPA stated, by including this requirement only for the wafers larger than 300 mm, "we anticipate a reduction in burden because emission factors (i.e., gas utilization and by-product formation rates) can be developed over a number of years as semiconductor manufacturers begin to transition to 450 mm tools and develop the estimating and reporting infrastructure. The commissioning process for new tools is an ideal opportunity for emission factor development and/or verification." To this end, EPA does not believe that requiring facilities that fabricate devices on wafers measuring larger than 300 mm in diameter to calculate and report emissions using a Tier 3 method is overly burdensome. For additional information about the methods finalized for semiconductor manufacturing facilities that fabricate devices on wafers measuring larger than 300 mm, please see the preamble section D, Electronics Manufacturing (subpart I), section 1 ("Summary of the Final Rule"), and section 4.2.2.2 more discussion of the required Tier 3 method for facilities fabricating devices on wafer measuring greater than 300 mm.

With respect to the comments on costs, EPA has updated its costs estimates to reflect costs associated with the requirements finalized in rule. EPA has concluded that its final cost estimates appropriately account for the compliance burden under this rule. For details on how EPA developed its final costs for this rule, please see Sections 4 & 5 of the Economic Impact Analysis (EIA) (available in the docket, EPA-HQ-OAR-2009-0927).

For details on steps EPA has taken to reduce the burden, please see the preamble section D, Electronics Manufacturing (subpart I), section 3, which contains the response to comments on emission estimation methods for facilities that manufacture semiconductors and response to comments on burden.

For those facilities that are required to calculate and report emissions for the plasma etching process type using recipe-specific factors, EPA is mindful of the time it may take facilities that are required to perform direct emission measurements to comply with the rule. To this end, EPA is allowing all facilities to use "best available monitoring methods" (BAMM) for the first six months of data collection (through June 30, 2011) for any parameter for which it is not reasonably feasible to acquire, install, or operate a required piece of monitoring equipment in a facility or to procure measurement services from necessary providers. EPA is also allowing facilities to apply for the extended use of BAMM for the remainder of the first year of data collection (through December 31, 2011). For example, if a facility is unable to procure the necessary measurement services by December 31, 2011 to measure all of its plasma etching emissions using recipe-specific emission factors, and EPA approves its BAMM request, it may use default etch emission factors to calculate and report its 2011 emissions. Under this scenario, the facility must then recalculate and report its 2011 emissions with its 2012 report. Please see the preamble section D, Electronics Manufacturing (subpart I), section 1, for more details on the BAMM provisions. Please also see response to comment 4.2.1.2-b for responses to comment related to the availability of Tier 3 data.

Comment Summary 12.1-d: Two commenters (0498 and 0682) asserted that facilities that possess Tier 3 measurement data should use the data to estimate emissions, provided the data are representative of facility processes and reflective of accepted analytical practices, such as the 2006 ISMI Guidelines (although both commenters argued that it is not appropriate to mandate the Guidelines). The commenters asserted that if a facility does not possess Tier 3 data, the Tier 2b method should be used.

One commenter (0437) asserted that the published Tier 2 default emission factors are objective and the use of Tier 2 factors for all covered facilities would increase regulatory certainty and reduce the risk of non-compliance. The commenter further stated that it is not clear that the Tier 3 method would necessarily be more accurate than the Tier 2b method. Another commenter (0978) also stated that the additional costs of the Tier 3 method, relative to the Tier 2b method, were not justified because of the limited increase in accuracy offered by the Tier 3 method.

In a similar sentiment, another commenter (0498) stated that the Tier 3 method offers only an incremental improvement in accuracy over the IPCC Tier 2 methods. The commenter supported this statement by presenting results from an analysis which compared emission estimates from multiple fabs resulting from the use of the 2006 IPCC Tier 2a, Tier 2b, and Tier 3 emissions estimation methods and the related uncertainties. The commenter asserted that due to the inherent uncertainties of GWP values used in estimating emissions with the IPCC methods, and the incremental improvements the Tier 3 method offers may not be justified by the associated costs.

One commenter (0498) presented the results of an industry survey that showed only one company using the Tier 3 method and all other companies who responded to the survey using the Tier 2a, 2b, or a combination of those methods.

One commenter (0759), who relies for the most part on its own developed emission factors, compared its own results to the results that would have been obtained if the commenter had used the Tier 2b method; the commenter found that on average the Tier 2b method overestimated emission by ~10 percent. This commenter asserted that if accuracy beyond the Tier 2b method is required, emissions testing should be phased in over time due to the large amount of tests that would be needed in order to comply. The commenter asserted that this phase-in approach is consistent with the approach used by EPA and state and local agencies for other regulated air pollutants, such as VOCs. The commenter argued that in many cases it is considered acceptable to use average AP-42 emission factors rather than emission factors measured directly on-site.

Response 12.1-d: The 2006 IPCC Guidelines state that the Tier 3 method is estimated to result in the least uncertain estimates amongst the methods presented by IPCC (please see response to comment 4.2.2.1-a for more discussion on the accuracy of the Tier 3 method). EPA agrees with the aforementioned statement and continues to maintain that the Tier 3 method will result in the most certain emission estimations. For this reason EPA does not want to prohibit the use of the Tier 3 method if a facility elects to do so; therefore EPA is permitting any facility covered under subpart I to use the Tier 3 method.[48] EPA is also requiring some facilities covered under subpart I (semiconductor facilities that manufacture wafers measuring 300 mm and less and that have an annual manufacturing capacity of greater than 10,500 m^2, and facilities that manufacture wafers measuring greater than 300 mm) to use the use recipe-specific emission factors (i.e., a partial or full Tier 3 method, respectively). Please see the preamble section D, Electronics Manufacturing (subpart I), section 3, (“Summary of Response to Comments”) for additional response to comments on the methodologies for semiconductor manufacturing facilities in the final rule and section 4.2.2.2 for discussion on the required used of the Tier 3 method for facilities manufacturing wafers measuring greater than 300 mm. For more discussion on why EPA did not finalize the Tier 2b method as proposed for semiconductor facilities please see response to comments 4.2.-a, 4.2.1.2-c and 4.2.3-a.

For facilities required or that elect to use recipe-specific emission factors (i.e., a full or partial the Tier 3 method), EPA has provided means to ease compliance with the rule and reduce the burden associated with emissions testing. For example, EPA is requiring only direct measurement for the etching process type for some facilities. In addition, EPA is requiring only the largest facilities (manufacturing wafers measuring 300 mm or less) to estimate and report their etch emissions using recipe-specific emission factors. Lastly, EPA is allowing any factors that were developed for one individual recipe to be applied to similar recipes (as defined in the final rule). EPA is also permitting the use of BAMM for any parameter, such as recipe-specific emission factors, that can not reasonably be measured within the first six months of data collection. Please see response to comment 12.1-c for more information on BAMM.

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[48] To ensure consistent methods of calculating and reporting emissions, EPA is prohibiting a facility from creating and using a hybrid method – a facility must use the appropriate methods required in the rule, or use recipe-specific emission factors to estimate all production processes that use fluorinated GHGs. This restriction will enable EPA to analyze emissions and trends using a consistent set of data. The only exception is where a facility is required to use a method using default emission factors but no defaults are provided in Tables I-3, I-4, I-5, I-6, or I-7 for a particular fluorinated GHG and process type or sub-type combination. Where default emission factors are not provided, a facility must either use utilization and by-product formation rates of 0 or, in that particular instance, use directly measured recipe-specific emission factors measured using the 2006 ISMI Guidelines with limited exceptions.

EPA disagrees with the commenter's (0498) argument that due to the inherent uncertainties of GWP values the incremental improvements the Tier 3 method offers may not be justified by the associated costs for two reasons. First, EPA is not requiring emissions to be estimated and reported on a CO_2e basis; emissions must be reported on an absolute mass basis. Second, EPA believes that any uncertainties in GWP values would affect any method used to estimate emissions in CO_2e, not only the Tier 3 method. For response to comments about the GWPs used in this rule please see response to comment 2.3-a.

The commenter (0498) did not provide EPA with the underlying data or assumptions used to further assess the uncertainty analysis presented in the comment. In regards to another commenter's (0759) analysis, which resulted in the conclusion that on average the Tier 2b method overestimated emission by ~10 percent, information and data supporting how the commenter arrived at conclusion was also not provided to EPA. Based on an uncertainty analysis performed by EPA for this final rule, which compared various emission estimation methods for one hypothetical fab, EPA found that the IPCC Tier 2b method understates emissions, which is contradictory to what the commenter (0759) concluded. The uncertainty analysis run by EPA also led to the conclusion that more emissions data, particularly data for the etching process type, is needed to allow for robust and meaningful results comparing various methods. Please see the Electronics Manufacturing TSD (available in the docket, EPA-HQ-OAR-2009-0927) for more information on the uncertainty analysis. The limited information available does not make it possible to draw upon any statistically significant results about the certainty of various EPA-developed emission estimation methods (e.g., the Refined Method, and the Tier 2c and Tier 2d methods) versus IPCC emission estimation methods at this time. However, information gathered through the final rule will allow EPA to further assess alternative emission estimation methods.

Also please see response to comment 4.1.2-c for more discussion on the relationship between this rule and air quality regulations.

12.2 Monitoring and QA/QC Requirements: Use of the 2006 ISMI Guidelines

Comment Summary 12.2-a: One commenter (0437) asserted that there may have been some misunderstanding in regards to EPA requiring the use of the ISMI Guidelines for emissions characterization. The commenter questioned EPA's requirement to use the ISMI Guideline for emissions testing in the rule, because it was developed for tool manufacturers as an "aspirational" guide and was "meant to provide considerable latitude" in characterizing equipment emissions rather than serve as "a complete emission test method...[or]...a complete equipment purchase standard". The commenter further argued that the ISMI Guideline is not a SEMI standard[49] nor widely

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[49] Per the commenter: "SEMI is the trade association for the tool manufacturing industry. According to SEMI, SEMI standards are voluntary technical agreements between suppliers and customers, aimed at improving product quality and reliability at a reasonable price and steady supply. SEMI standards purportedly cover every aspect of semiconductor manufacturing: Equipment Automation (Hardware and Software), Facilities, Gases, Materials, Microlithography, Packaging, Process Chemicals, and

used as such (to the extent of the commenter's understanding). Two other commenters (0498 and 0682), who supported the use of acceptable analytical practices such as the 2006 ISMI Guidelines in developing Tier 3 emission factors, stated that it is not appropriate to mandate the use of the Guidelines.

Response 12.2-a: EPA has concluded that requiring the use of the Guidelines is appropriate and beneficial for purposes of this rule. Therefore in the final rule EPA is requiring that recipe-specific emission factors be measured using the 2006 ISMI Guidelines, with limited exceptions.[50] By requiring that emission factors be measured using the 2001 or 2006 ISMI Guidelines, EPA is relying on the only established industry practices for quantitatively characterizing emissions under conditions of actual wafer processing rather than developing an alternative.[51] EPA has not proposed nor does it view the ISMI Guideline as an emissions compliance testing method or procurement standard, as one commenter asserted. Please also see section 5.1 on the required use of the 2006 ISMI Guidelines.

EPA does not agree that the ISMI Guidelines are "aspirational." The 2006 version of Guidelines explicitly state that: "The semiconductor industry has a responsibility to its employees and the community to minimize the environmental impact of its manufacturing processes and operations. To fulfill this responsibility, environmental performance goals have been set for its processes and operations. It is essential that equipment suppliers help the semiconductor industry achieve these goals. Consequently, equipment suppliers are expected to design their tools to minimize the consumption of chemicals, production of waste emissions, and usage of utilities such as energy and water. This document provides guidance to suppliers of process equipment and abatement devices on how to characterize the environmental performance of their tools and devices. The characterization must include the quantification of air emissions, liquid effluents, and solid waste generated by the process equipment (tool) or point-of-use (POU) abatement device."

The methods provided in the Guidelines specifically require that for all emissions measurements, among other things, those making the measurements (1) adhere to the use of two protocols that describe FTIR and QMS for the express purpose of measuring fluorinated GHG emissions, (2) adopt specific methods of calibration that stipulates a minimum number of calibration points, a calibration performance metric (slope of calibration curve), and performance standard <=5 percent of that slope, (3) adhere to specific methods for calculating utilization efficiency of process gases, (4) achieve a fluorine-volume closure standard of >90 percent unless a plausible explanation with supporting data is provided, and (5) document results of measurements in a standard reporting template. These and other practices provided in the Guidelines will result in robust emission factors that are developed in a consistent manner; a feature which

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Traceability. Guidelines are also developed to cover safety related issues. In addition, standards are published for Flat Panel Displays. The publication catalogue provides a listing of the available standards and guidelines. www.semI.org/en/Standards/P_000787."

[50] See footnote 21.

[51] According to the authors listed to the antecedent guidelines, the Guidelines were not only developed among industry experts. ISMI sought and secured the expertise of NIST, a federal technology agency, in developing its guidelines for characterizing emissions.

allows EPA to compare emissions across the industry as well as track trends in industry practices.

13. Other Changes

General changes: Sections of the proposed regulatory text were reorganized and editorial changes were made to improve clarity and readability in the final regulatory text.

General changes: The proposed regulatory text often referred to production, production process, process type, and process category. For clarity, in the final regulatory text the term “process category” was revised to be “process sub-type.” The new suite of terms results in a more understandable and consistent flow of process tiers - production processes, process types, and process sub-types.

To §98.90(a): This paragraph was revised to clarify that it is the manufacturing processes (i.e., those defined in §98.90(a)(1) through (5)) that trigger the applicability of subpart I rather than a specific product that is manufactured (e.g., semiconductors).

To §98.90(a): The proposed paragraph §98.90 (a)(4), which described the following production process, “Each electronics manufacturing production process in which some fluorinated compounds can be transformed in the plasma processes into different fluorinated compounds, which are then exhausted, unless abated, into the atmosphere,” was removed from the regulatory text because it was redundant with other production process descriptions and introduced a level of uncertainty regarding what is covered under the electronics manufacturing source category.

To §98.90(a)(5): This paragraph was revised to clarify that production processes for heat transfer fluids include cleaning substrate surfaces and other parts. In the April 2010 proposed rule, proposed in §98.98, the definition of heat transfer fluids included cleaning substrate surfaces and other parts. The definition was as follows:

> *Heat transfer fluids are fluorinated GHGs used for temperature control, device testing, and soldering in certain types of electronic manufacturing. Heat transfer fluids used in the electronics sector include perfluoropolyethers, perfluoroalkanes, perfluoroethers, tertiary perfluoroamines, and perfluorocyclic ethers. Heat transfer fluids commonly used in electronics manufacturing include those sold under the trade names ‘‘Galden®’’ and ‘‘FluorinertTM.’’ Electronics manufacturers may also use these same fluorinated chemicals to clean substrate surfaces and other parts.*

EPA has retained this definition of HTFs in the final rule,[52] and has aligned the description of process that uses HFTs in the source category with the HTF definition to include processes in which HTFs are used to clean substrate surfaces and other parts.

To §98.91: The calculations in this section of subpart I were restructured for clarity in calculating emissions for threshold applicability purposes.

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[52] In the final rule EPA removed reference to the trade names of HTFs in the definition. This edit did not change the meaning of and HTF in the final rule.

To §98.92(b): This paragraph was added to clarify that consumption of fluorinated GHGs and N_2O should be reported for all fluorinated GHG and N_2O using processes at a facility (see proposed §98.96(f), 75 FR 18702, April 2010). EPA is clarifying this point to ensure that the Agency will receive comprehensive information on use and emissions of GHGs from electronics manufacturing facilities so that EPA may stay fully informed of new and emerging uses of these potent GHGs. The trend in electronics manufacturing has been to continuously explore and commercialize innovative new uses for fluorine-based chemistries and processes. The complete reporting of all fluorinated GHG and N_2O consumption and uses will advise future policy decisions and allow EPA to adjust its emission calculation methods to accurately reflect current industry practice.

To §98.93: This section was restructured for clarity and flow. One example of a change made is that process types and process sub-types, previously defined in this section in the proposed regulatory text, were moved to §98.98, "Definitions."

To §98.93: Paragraph §98.93(a) was expanded and paragraph §98.93(a)(6) was added in this section to provide a facility that is using an emission estimation method based on default emission factors, methods to estimate emissions in instances where that facility uses a fluorinated GHG(s) for a particular process type or sub-type for which default emission factors are not available in Tables I-3, I-4, I-5, I-6, or I-7. Where default emission factors are not available, a facility has the option to either use utilization and by-product formation rates of zero or, in that particular instance, use directly-measured recipe-specific emission factors measured using the 2006 ISMI Guidelines, International SEMATECH #06124825A-ENG, with limited exceptions.[53] EPA understands that there are instances where a facility is engaging in a particular production process and a default emission factor is not provided in the Tables. For this reason, EPA added specific provisions for a facility to follow.

To §98.93(a)(3): This paragraph was added to allow any electronics manufacturing facility reporting under subpart I, regardless of the products it manufactures, to estimate and report emissions using recipe-specific emission factors (i.e. a method based on the IPCC Tier 3 method.). EPA made this change so that any electronics manufacturing facility may report using a methodology that results in the most accurate emission estimates.

To §98.93, Equation I-10: In the proposed rule, EPA required the aggregate amount of N_2O emitted at a facility to be reported. However, EPA notes that this was not consistent with how fluorinated GHG emissions were required to be reported; they were required to be reported by process type, not in aggregate amounts. Therefore, for consistency the noted equation, to calculate N_2O emissions (proposed Eq. I-9), was revised to require N_2O emissions from each CVD and other N_2O-using manufacturing process to be calculated and reported separately. This is different from the equation in the proposed regulatory text, which required all N_2O emissions to be summed and then reported as a total quantity. In requiring N_2O emissions to be reported for each CVD

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[53] See footnote 21.

and other processes EPA can gain information on N_2O consumption practices in the industry to help inform future regulatory and policy decisions.

To §98.93, Equation I-11: The definition of the input variable D_i in this equation, to calculate gas consumption (proposed Equation I-9), was corrected to account for all disbursements of input gases, not just disbursements of input gases in exceptional circumstances.

To §98.93, Equation I-12: This equation, to calculate disbursements of an input gas (proposed Equation I-11), was modified to account for an instance where a facility could have multiple facility-wide gas-specific heel factors for one input gas. This instance would occur where a facility may use multiple container sizes and types of one input gas.

To §98.93, Equation I-13: This equation was added to clarify the method facilities must use to calculate the amount of gas apportioned to recipes, process sub-types and process types (or CVD and other N_2O-using manufacturing processes), using apportioning factors developed with facility-specific gas consumption apportioning models.

To §98.94(b)(4): This paragraph was revised to clarify that for mass-based trigger points for change out, exceptional circumstances must be determined based on the net weight of gas in the container, excluding the tare weight of the container.

To §98.96 and §98.97: The reporting and recordkeeping requirements were revised in some instances to align with new methods provided in subpart I, for reporting clarity, and to ensure that EPA would collect necessary information for emissions data verification.

To §98.98: For clarity in complying with the subpart I requirements and to make the regulatory language simpler to follow, the following definitions were added to the final regulatory text: actual gas consumption, chamber cleaning (including definitions for the three chamber cleaning sub-types, in-situ plasma, remote plasma, and in-situ thermal), class, dominant gas, modeled gas consumption, plasma etching, process sub-type, process type, redundant abatement systems, repeatable, wafer cleaning, and wafer starts. In addition, the definition of uptime was modified to account for the changes made for calculating uptime in the final regulatory text.

To Table I-8: This table was created for consistency. Default emission factors for N_2O that were previously presented in proposed paragraphs §98.93(c)(1)(ii) and (c)(2)(ii) were moved out of the regulatory text and are now presented in Table I-8, Default Emission Factors for N_2O, consistent with the other default emission factors.

Appendix A: List of Commenters Sorted by Submission Number

Submission No.	Commenter	Organization
EPA-HQ-OAR-2008-0508-0437	Jay Hawkins	Micron Technology Inc.
EPA-HQ-OAR-2008-0508-0498	Thomas Diamond	Semiconductor Industry Association
EPA-HQ-OAR-2008-0508-0682	Laurie A. Lehmberg	Texas Instrument Incorporated
EPA-HQ-OAR-2008-0508-0759	Tim Higgs	Intel Corporation
EPA-HQ-OAR-2008-0508-0978	Jay M. Dietrich	IBM
EPA-HQ-OAR-2008-0508-1137	Robert N, Fielding	Freescale Semiconductor
EPA-HQ-OAR-2009-0927-0074	Joe Van Gompel	MIDAC Corp.
EPA-HQ-OAR-2009-0927-0089	Tim Higgs	Intel Corporation
EPA-HQ-OAR-2009-0927-0093	Sanjay Baliga	SEMI
EPA-HQ-OAR-2009-0927-0095	Nadia Wetzler	Applied Materials, Inc.
EPA-HQ-OAR-2009-0927-0099	Laurie A. Lehmberg	Texas Instrument Incorporated
EPA-HQ-OAR-2009-0927-0100	John D. Holmes	Freescale Semiconductor
EPA-HQ-OAR-2009-0927-0107	Mary K. Smickenbecker	Matheson Tri-Gas Inc.
EPA-HQ-OAR-2009-0927-0108	Alan P. Abbott	Microchip Technology
EPA-HQ-OAR-2009-0927-0110	Dale Eldridge	Micron Technology Inc.
EPA-HQ-OAR-2009-0927-0112	Jay M. Dietrich	IBM
EPA-HQ-OAR-2009-0927-0122	Reed M. Content	Global Foundries U.S., Inc.
EPA-HQ-OAR-2009-0927-0123	Bob Cartensen	Transform Manufacturing, LLC
EPA-HQ-OAR-2009-0927-0124	Mark Vickery	Texas Commission on Environmental Quality
EPA-HQ-OAR-2009-0927-0128	Pamela Campos	Environmental Defense Fund
EPA-HQ-OAR-2009-0927-0131	Thomas Diamond	Semiconductor Industry Association
Trans-DC-02	Thomas Diamond	Semiconductor Industry Association
Trans-DC-03	Peter Zalzal	Environmental Defense Fund

Appendix B: Additional Comments on the EPA DRE Protocol
(Submitted by SIA – EPA-HQ-OAR-2009-0927-0131)

The comments included below are only those that have not been previously submitted in the DRE Protocol peer review process. Comments received previously, and the EPA responses are available in the docket EPA-HQ-OAR-2009-0927.

Comment B-1 (General Comment): Why is it acceptable to use a tracer approach to determine tool effluent flow but not acceptable for abatement system effluent flow?

Agree with the consideration for a properly mixed sample which the tool pump provides at the tool effluent as well as the concern when dealing with non-ideal ducts (ones which may not contain laminar flow) as often at the abatement system effluents. The missing piece is the demonstration that the injected tracer is homogeneously mixed with the abatement system effluent flow. Propose to add a stratification test to the protocol in support of the post-abatement flow tracer method. This stratification test can be easily performed by stepping the FTIR sample probe across the abatement system effluent duct at depths of 25%, 50% and 75% (or more if desired) while measuring the tracer gas concentrations by FTIR. Should the concentrations be consistent at each depth into the abatement system effluent duct the tracer/effluent can be considered homogenously mixed and the flow determination can continue with the probe centered in the duct. Furthermore, the gases incorporated for tracers are also the same PFCs commonly monitored at these facilities, albeit absent of the particular process for flow determinations. Therefore, if the FTIR data is acceptable for concentration measurements used for DRE determinations it should be acceptable for flow determination by the process described above. Previous results have displayed very repeatable results at various tracer injection rates. Two other experiments comparing FTIR and QMS tracer studies for flow determination are planned for the next few months. One will be at a laboratory using a 4” mixing duct and a second in late June at a semiconductor facility. Another issue of concern is the stability of the QMS measurements during these tests. Previous testing results demonstrated very tight deviations using FTIR concentration results over multiple tracer release flow rates. With the inherent drift, ambient pressure inlet and calibration issues associated with the QMS (and alluded to in the protocol Section 2.2.4) it is a concern that the QMS will not be able to produce data quality equal to the FTIR approach.

Response B-1: EPA sought comment on the use of the DRE Protocol in the proposed rule for Electronics Manufacturing (75 FR 78652, April 2010),,but not on the actual content of the Protocol itself.

EPA began considering the need for a DRE measurement Protocol for the semiconductor industry in 2006 as part of the PFC Reduction/Climate

Partnership with the Semiconductor Industry. The Protocol development process included three DRE measurements studies at three different Partner facilities, from May 2007 through December 2008.[54] After the first two measurement studies and subsequent reports, EPA developed and shared the first draft of the DRE Protocol in November 2007 with national and international peer reviewers, including the ISMI GHG Working Group, Japan Electronics and Information Technology Industries Association (JEITA), Industrial Technology Research Institute (ITRI), and other industry consultants. After receiving and responding to all comments on the first draft of the Protocol, EPA engaged in a third DRE measurement study, which informed preparation of second draft of the Protocol. EPA then shared the second draft of the Protocol with peers in June 2009, and subsequently responded to all of the comments received on the second draft of the DRE Protocol. During these peer review processes, the original measurement methods and data treatment methods, together with the testing and reporting methodology (which incorporated a performance metric and performance standard) were demonstrated to be suitable and practical across three US fabs (older and newer). EPA received no peer comments that its methodologies were inappropriate or not supported by its data or current industry knowledge. The Protocol was then finalized, taking into account all of the published, in-fab DRE measurement information, in March 2010. This was just prior to the publication of the proposed subpart I (published in April 2010), for which development began in response to the FY2008 Consolidated Appropriations Act (H.R. 2764; Public Law 110–161).

EPA sponsored and developed the DRE Protocol in cooperation with its industry Partners. The Protocol builds on and augments industry emission characterization practices and guidance (e.g., ISMI 2001 and 2006 Guidelines) by focusing on proper DRE measurement (e.g., ensuring dilution is properly accounted for) whether in voluntary or regulatory circumstances. The publication of the DRE Protocol fills a void for technical guidance on proper measurement of abatement system DREs.

EPA viewed the publication of the DRE Protocol just prior to the April 2010 proposal of subpart I as beneficial for the industry because in seeing the measurement guidance that would be incorporated by reference in the final rule, EPA believed interested parties—especially non-Partners and the public—could comment on the use of the Protocol in the rule. EPA did not receive public comments on the rule arguing that requiring the use of the DRE Protocol would

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[54] For more information about the three studies, please see the following reports: *Developing a Reliable Fluorinated Greenhouse Gas (F-GHG) Destruction or Removal Efficiency (DRE) Measurement Method for Electronics Manufacturing: A Cooperative Evaluation with IBM* (EPA 430-R-10-004); *Developing a Reliable Fluorinated Greenhouse Gas (F-GHG) Destruction or Removal Efficiency (DRE) Measurement Method for Electronics Manufacturing: A Cooperative Evaluation with NEC Electronics, Inc.* (EPA 430-R-10-005); and *Developing a Reliable Fluorinated Greenhouse Gas (F-GHG) Destruction or Removal Efficiency (DRE) Measurement Method for Electronics Manufacturing: A Cooperative Evaluation with Qimonda* (EPA 430-R-08-017).

lead to DRE measurement practices that would not be robust or results that would be inaccurate.

The method the commenter is proposing, which EPA interprets as the same method included in Appendix B of the 2009 ISMI Guidelines and as what has been referred to as the JEITA method, had not been subject to an in-fab testing environment, nor had it been robustly compared to methods for measuring dilution using a QMS at the time the DRE Protocol was published. While there is theoretical reason to believe the method may work and should be capable of achieving the performance standard set in the Protocol, based on a call with peer reviewers of the DRE Protocol on February 25, 2010, it was evident that at the time of publication of the DRE Protocol additional research and documented in-fab testing was needed to demonstrate the validity of the suggested method. For these reasons, EPA did not include the “JEITA” method in Version 1 of the DRE Protocol. However EPA appreciates that testing of the suggested method is currently being planned or performed by industry, and would be open for discussion and review of any test results using the method. EPA welcomes more information about new qualified measurement methodologies that the Agency may consider incorporating into future versions of the Protocol. Please also see response to comment 5.2.4.1-a for more information about the use of an FTIR in place of a QMS for measuring dilution with tracers that are inert.

Comment B-2 (Section 1.3. Protocol Scope): Typo in Section 1.3, paragraph 3, 4th sentence should have the "the" removed between standard and relative.

Response B-2: EPA thanks the commenter for their input, and will correct the typo in future versions of the Protocol. EPA notes that this typo does not change the meaning of the sentence.

Comment B-3 (Section 2.1.1, Description of Experimental System): In Figure 1 consideration needs to be taken when low purge-flow pumps are employed. If the sample exhaust is not returned to the tool effluent downstream of the extraction location it will impact the DRE as the inlet mass loading will be lower than normal operation. This is only applicable when the extracted flow is not negligible compared to the tool effluent flow.

Response B-3: EPA interprets this comment to apply when measuring DRE while simultaneously measuring process gas effluent (PGE) and abatement gas effluent and when PGE sampling flow comprises an affecting portion of the total PGE flow. Under this condition, the charge into the abatement system is understated because in Fig. 1 the PGE sampling flow is returned to the facility’s waste stream post abatement (in the abatement system effluent).

Experienced metrologists should be aware of such a circumstance in part because of their experience. Because PGE concentrations are relatively high (1,000 ppm or higher), FTIR sampling cells are of small volume, meaning PGE sampling/extraction flows can be low. EPA's experience in the DRE measurement program is that PGE sampling/extraction flows are typically <0.5 LPM. PGE flows, however, are typically 30 - 40 LPM. So, even at 0.5 LPM extraction flow, less than 2 percent of the flow is not returned to the abatement system, which is inconsequential for DRE measurement. Even for the unusually low PGE flow of 10 LPM, the charge to the abatement system would be less than 5 percent for extraction flows <0.5 LPM.

Nonetheless, EPA agrees that metrologists should be aware of this rare circumstance, which is why the Protocol recommends that only experienced metrologists--experienced in FTIR and QMS practices in electronic manufacturing facilities-- be permitted to carry out DRE measurements.

Comment B-4 (Section 2.2.1, Method 1): In section 2.2.1 (DRE determination with plasma off) a specified flow of 120% of the process flow is stipulated to ensure the abatement system is tested under conditions that may occur during processing. The PFC concentrations will be much greater than normal as is (not being disassociated by a plasma).

Response B-4: During the EPA DRE measurement program, EPA used a flow of 120% of the process flow and found no issues in actual application. The use of 120% of the process flow for Method 1 is a suggested practice. Given the flexibility of the Protocol, a facility could depart from this practice provided there is plausible reason, and that this reason is documented.

Comment B-5 (Section 2.2.2, Method 2): Typo in 2.2.2, 2nd paragraph, 3rd sentence "…all operating chambers that are"

Response B-5: EPA thanks the commenter for their input, and will correct the typo in future versions of the Protocol. EPA notes that this typo does not change the meaning of the sentence.

Comment B-6 (Section 2.2.3, Equipment Needed): The suggestion of using a PFC that passes through the abatement system with DRE<5% to determine abatement system effluent flow forms a circular argument. Per the protocol, one must demonstrate that the abatement system DRE for the compound is <5% by QMS and tracer studies before using the PFC tracer approach.

Response B-6: The Protocol provides two plausible methods for demonstrating a DRE of less than 5% for tracer compounds other than noble gases (e.g., CF_4 or

SF_6): (1) the manufacturer of the POU abatement system provides results, based on the methods of this Protocol, that the DRE of the chemical tracer is <5% under the operating conditions being tested at the fab using the QMS and the noble gas tracer methodology or (2) in-fab tests showing <5% destruction of the chemical tracer on a POU abatement system (based on the QMS and noble gas tracer methodology of this Protocol for one abatement system in the fab) may be used on abatement system in the facility of the same make and model installed and operated in the same manner as the abatement system tested. Based on the methods suggested, for one abatement system a facility or POU manufacturer could use a QMS and the noble gas tracer methodology to demonstrate that for that particular abatement system the DRE of the fluorinated GHG tracer gas being used (e.g., CF_4 or SF_6) is less than 5%. This demonstration would then hold true for any abatement system in the same class as the tested system, and hence an approach using an fluorinated GHG tracer would be permitted for any system in that class. Therefore EPA does not agree that a circular argument is created as the DRE Protocol does not specify that the demonstration must be completed for every individual abatement system for which a facility or POU manufacturer wants to use suitable fluorinated GHG tracers.

Comment B-7 (Section 2.2.4, FTIR and QMS Protocols): Current version states scan times should be on the order of 3 seconds. Not all FTIRs have the capacity to scan at such a high rate. One of the systems we have collects 1 scan/1.7 seconds plus you have factor in the processing time. Also short scans will increase MDLs at the abatement system effluents.

Response B-7: The scan times identified in the Protocol are suggested scan times based on EPA experience. As such, a facility may use an FTIR that scans at a different rate and still adhere to the DRE Protocol provided all data is adjusted appropriately. The data treatment methods specified in the DRE Protocol correct for various scan rates using a method of weighted variances.

Comment B-8 (Section 2.2.5, Calibration Curve): Current version states the necessity to bracket (within the FTIR reference set for the particular compound) the observed concentration ranges and only considers absorption features between 0.1 and 1.0 absorbance units (a.u.). Although it is good practice, it is not always practical or necessary. Since most PFCs have broad absorption features they are linear over large concentration ranges. It is a fair assumption that the linear behavior can be extrapolated to concentrations ~50% greater than the largest reference should the compound exhibit linear behavior. In the last sentence of 2 paragraph of 2.2.5 it alludes to this by stating that all nonlinear curves must bracket the observed concentration range. Alternating cells at the tool effluent FTIR can eliminate the ability to observe byproducts. It is also cumbersome to switch between plasma off/on experiments to ensure that concentrations are bracketed or the 0.1-1.0 a.u. range is conserved.

Response B-8: The practices regarding the use of FTIRs specified in the DRE Protocol are suggested good practices. As such, a facility may deviate from the suggested practices if they can not be followed, provided the facility has a valid and documented reason for why, and the performance standard set by the DRE Protocol is maintained.

Comment B-9 (Section 2.2.5, Calibration Curve): The suggestion to only quantify over FTIR absorbance features between 0.1-1.0 absorbance units (a.u.) is rather restricting (Sections 2.2.4, 2.2.5 & 2.2.7). There are often numerous usable features outside this 0.1-1.0 range.

The lower bound of this range would be better represented by a factor offset based on the FTIR system noise, say absorbance features at a minimum of 1.5 times the system noise are acceptable for use. Common system noise levels are on the order of 10-3 and most of the time much better. Using 0.1 a.u. as the lower bound is requiring that absorbance features be 100 times (or more) your system noise to be usable. An illustration of this is depicted below in the FTIR reference for SO_2 (For illustration see EPA-HQ-OAR-2009-0927-0131). This SO_2 feature displayed is the band most often quantified. The peak absorbance is less than 0.1 a.u. (0.04 a.u.), but remains well above the system noise. The FTIR cell path length of 10.5m is common for semi-conductor sampling, therefore normalizing the SO_2 concentration to fall within the 0.1-1.0 range yields approximately 136 ppm required to quantify SO_2 using this absorbance feature.

Similarly, there is a lot of usable information to be gathered from absorbance features greater than 1.0 a.u. I feel a better representation of the upper bound would be features that are not opaque (totally absorbing) and quantify at no more 50% of the concentration of the largest reference in the particular compounds' set. Of course this only applies to linear absorbing compounds which the PFCs are. A skilled spectroscopist meteorologist) would know when this is appropriate. Furthermore, when determining the tool effluent flow, this is often the case as it is necessary to run the process recipe (per the protocol Section 2.2.1) with the tool plasma off. This is the case when determining tool utilization as well.

Granted SO_2 is not a GHG but it is a by-product of SF_6 processes. The protocol also does state that it is acceptable to go outside of this range so long as the reference set bracket it which is easy to do on the lower bound by adding a zero (or noise spectrum) to your reference set. However, looking forward, if this protocol is to be applied for other compounds this restrictive range may provoke an issue where good data could be non- acceptable.

Response B-9: The scope of the DRE Protocol is specifically focused on measuring fluorinated GHG abatement. Please see response to comment B-8 about suggested FTIR practices in the Protocol.

Comment B-10 (Section 2.2.6, Flow and Dilution Measurement): Same as 2.2.3 comment - The suggestion of using a PFC that passes through the abatement system with DRE<5% to determine abatement system effluent flow forms a circular argument. Per the protocol, one must demonstrate that the abatement system DRE for the compound is <5% by QMS and tracer studies before using the PFC tracer approach.

Response B-10: Please see response to comment B-6 about using a fluorinated GHG tracer approach.