SIA | SEMICONDUCTOR INDUSTRY ASSOCIATION

US SEMICONDUCTOR CONCERNS RE EPA'S PROPOSED GREENHOUSE GAS REPORTING RULE
U.S. EPA DOCKET ID NO. EPA-HQ-OAR-2008-0508

Summary

The EPA proposed GHG reporting rule will substantially increase semiconductor company costs and threaten competitiveness without producing reliable emissions measurement data. SIA has offered an alternative approach that would yield reliable data without incurring substantial cost or risking US industry competitiveness.

The Semiconductor Industry Association (SIA) represents more than 85 percent of semiconductor production in the United States. The US semiconductor industry employs approximately 200,000 people and is the nation's second-leading export sector.

Semiconductor Industry Uses of Perfluorocompounds (PFCs)

- PFCs are used to etch circuits on silicon and for certain cleaning operations. These uses are 'critical,' *i.e.*, these chemicals provide unique functionality, with no reliable substitute chemicals available.

- The industry turned to PFCs as part of the transition away from CFCs in the early 1990s. Recognizing that PFCs have high global-warming potential, the industry quickly began to develop approaches to reduce process emissions.

Semiconductor Industry Efforts to Reduce PFC Gas Emissions

- In 1996, SIA member companies partnered with EPA to form the "PFC Emission Reduction Partnership for the Semiconductor Industry (Partnership)". This partnership, formalized in a Memorandum of Understanding (MOU), has been replicated in other semiconductor-producing countries under the auspices of the World Semiconductor Council (WSC).

- In 1998 the Partnership established a goal to reduce PFC emissions by a total of 10 percent (absolute, not normalized) by 2010 as compared to a 1995 baseline.

- The industry has exceeded the target. As of 2008, the industry's emissions were 31 percent below the baseline.

Fluorinated Gas Measurement in the Semiconductor Industry

- Continuous emissions monitoring systems (CEMS) are not appropriate to measure semiconductor manufacturing emissions. Consolidated exhausts make it impossible to isolate individual gas emissions and oftentimes the gas concentrations are below the detection level of the most advanced CEM equipment. Thus, the inadequate data results do not justify the cost of implementing CEMs.

- Recognizing this fact, the UN's Intergovernmental Panel on Climate Change (IPCC) has developed several different tiers of emissions estimation methodologies (Tiers 1, 2a, 2b, and 3). All tiers are based on engineering modeling, but differ in the degree of on-site verification and tailoring versus 'default' engineering estimates. All of the IPCC methods, however, are designed to produce 'conservative' estimates – *i.e.*, an emissions value that are higher than CEMS likely would yield, even assuming CEMS could product accurate results.

- Most US semiconductor companies currently use the IPCC's Tier 2a and 2b methods. Tier 2b has been demonstrated to produce more conservative – higher – emissions estimates than Tier 3.

<u>Semiconductor Industry Concerns Re Proposed Rule</u>

- EPA's proposed rule would impose requirements for "precision" measurement that go well beyond even the IPCC's Tier 3 methodology and that embody a fundamental misunderstanding of current semiconductor manufacturing operations. Indeed, the proposed rule assumes a much greater degree of instrumentation and process- and tool-specific gas consumption monitoring than exists today in the semiconductor industry. As a result, many aspects of the Proposal are neither technically nor economically feasible.

  - The proposal would require large facilities to use Tier 3 process-specific emissions factors developed based on a particular method, which most facilities do not currently have. Such factors cannot be developed without conducting costly emissions characterization and interrupting manufacturing operations.

  - The proposal would require gas consumption information to be gathered on an individual process basis with Mass Flow Meters (MFMs) calibrated to +\- one percent accuracy. Gas flow data -- generated at a state-of-the-art fabrication operation with digital devices as a means to regulate process input and safeguard process integrity -- are not easily marshaled and converted to annual, process-specific gas consumption measurements. Indeed, even where such conversion is feasible, doing so would require significant development resources to design data marshalling software that interfaces with the facility's current complex systems. Moreover, older generation facilities do not have MFM's with digital capability, and to change out these MFMs would entail an enormous expenditure and pose logistical challenges.

  - The proposal would require testing to measure destruction and removal efficiency (DRE) factors of all abatement devices, rather than relying on manufacturer-provided or facility-measured DRE factors as is the practice today. As a result, the proposal would require testing of all abatement devices being counted for GHG control. In-house capability to perform such testing generally does not exist, and engaging a third party to do so would prove costly and result in significant delays, given the small number of testing entities.

  - The proposal would require tracking of heat transfer usage on a per unit basis. A typical fabrication operation contains hundred of such units, making such a requirement impractical as well as unnecessary. A mass balance method keyed to purchase and offsite shipment can provide reliable and accurate information for F-GHG reporting purposes.

- The proposal would require submission of competitively-sensitive emissions-related data unparalleled to that required by any current Clean Air Act programs. It is not clear whether the Agency would have sufficient legal authority under the Act to protect these data as Confidential Business Information.

- SIA commissioned a Survey of the GHG Reporting Proposal by the independent entity -- International Sematech Manufacturing Initiative (ISMI) -- with whom U.S. EPA itself has partnered on emissions reporting method development. As this Survey indicates, the extensive operational and infrastructure changes necessary to comply with the proposal, where technically feasible, would far exceed the $3.6 million estimated by U.S. EPA and instead would run into the tens of millions. Moreover, under no circumstances could these changes occur in the reporting timeframe specified in the Proposal.

  - The abatement testing alone would cost $17 million and extend over 450 weeks.

  - For a large facility to obtain the Tier 3 measurements would cost at least $13 million and could cost as much as $77 million, with 2,200 weeks of testing.

  - The gas consumption costs are equally astronomical: $65 million for infrastructure installation and $20 million for annual operation thereafter.

  - The proposal's exceedingly high compliance costs would come at a time when the U.S. semiconductor industry is experiencing serious economic challenges, and would not result in palpable gains in reliability and accuracy.

SIA Alternative Approach to Address Concerns

- Require the use of equipment-specific Tier 3 emissions factors derived from manufacturer-provided or facility- measured data, where such data are available, and where not, allow the use of "Tier 2b" factors developed by the IPPC after analysis of an extensive set of measured data obtained from equipment suppliers.

  - Tier 2b is not "business as usual" for many US fabs, which typically use Tier 2a today.

  - Tier 2b enables accurate engineering estimates where multi-tool gas distribution is employed.

  - Tier 2b would allow use of IPCC default DRE factors for existing equipment and either manufacturer-provided or facility-measured factors for new equipment.

- Require the use of facility-specific gas consumption factors (as opposed to the current practice of relying on default "heel" factors).

  - Such facility-specific gas consumption factors will have greater accuracy than default factors.

  - Rather than incurring significant equipment and re-piping costs, this alternative would allow facilities to use total gas purchase data with facility-specific cylinder residual factors.

- Other elements of SIA Alternative Approach:
  - Allow mass balance for heat transfer fluids.
  - Allow default factors for abatement devices designed for GHG reduction.
  - Allow a six month (not a three month) reporting timeframe.

<u>Conclusion</u>

- In sum, SIA's alternative -- by requiring all companies to use IPCC Tier 2b and to develop facility-specific gas consumption factors -- will yield conservative emissions measurements without imposing excessive costs on the semiconductor industry. The viability of this alternative underscores that the enormous costs of the EPA proposed GHG reporting rule, in the name of greater "precision", simply can not be justified, particularly given that:
  - Greenhouse gas emissions from the semiconductor industry are less than 0.1 percent of the U.S. inventory of greenhouse gas emissions;
  - Perfluorocarbons are critical to the semiconductor manufacturing process; and
  - The proposal would impose greenhouse gas reporting burdens far exceeding other regions of the world, and thereby, would place the domestic semiconductor industry -- the country's second-leading export sector and a source of approximately 200,000 high-paying jobs -- at a distinct competitive disadvantage.

SIA | SEMICONDUCTOR INDUSTRY ASSOCIATION

June 9, 2009

SUBMITTED ELECTRONICALLY

Environmental Protection Agency
EPA Docket Center (EPA/DC)
Mailcode 6102T
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Re: EPA Docket ID No. EPA-HQ-OAR-2008-0508

Dear Sir or Madam:

Attached please find the comments by the Semiconductor Industry Association (SIA) on the U.S. Environmental Protection Agency's Mandatory Reporting of Greenhouse Gases; Proposed Rule, 74 Fed. Reg. 16448 (Apr. 10, 2009). SIA greatly appreciates the opportunity to comment on this Proposed Rule.

Sincerely,

Thomas P. Diamond

Thomas P. Diamond CIH
Director, Environmental, Health & Safety
Semiconductor Industry Association

cc: Julie Hatcher, Latham & Watkins
Carole Cook, U.S. EPA

COMMENTS BY THE SEMICONDUCTOR INDUSTRY ASSOCIATION ON U.S. EPA'S MANDATORY REPORTING OF GREENHOUSE GASES; PROPOSED RULE, 74 FED. REG. 16448 (APR. 10, 2009) EPA DOCKET ID NO. EPA-HQ-OAR-2008-0508

C. **Analysis of Nitrous Oxide Survey Data, 09065015A (Jun. 9, 2009)**

I. EXECUTIVE SUMMARY

The Semiconductor Industry Association (SIA) appreciates this opportunity to submit comments on U.S. EPA's Mandatory Reporting of Greenhouse Gases; Proposed Rule, 74 Fed. Reg. 16448 (Apr. 10, 2009) [hereinafter "GHG Reporting Proposal" or "Proposed Rule"]. SIA is a trade association uniting companies responsible for more than 85 percent of U.S. semiconductor production.

Our industry's small -- but essential -- uses of perfluorocompound gases (PFCs) and fluorinated heat transfer fluids appear to have been targeted by the Proposed Rule for reporting obligations that extend well beyond U.S. EPA's "PFC Emission Reduction Partnership for the Semiconductor Industry". Notably, under this Partnership, SIA and its member companies have worked cooperatively with U.S. EPA for over ten years, not only to report annual emissions, but also to craft a worldwide program that has achieved – and will continue to achieve -- substantial emissions reductions.

There is a significant disconnect between the Proposed Rule's greatly expanded reporting obligations and our industry's longstanding cooperative relationship with U.S. EPA. We respect U.S. EPA's desire to create a robust GHG Reporting scheme and appreciate its need in so doing to obtain more information than semiconductor manufacturers have been providing under the Partnership.

Yet, the Proposed Rule would not merely seek more information to assure the accuracy, reliability and verifiability of the emissions data that has been supplied by industry under the Partnership. Instead, it would effectively reject Intergovernmental Panel on Climate Change (IPPC) emissions assessment methods that are now being used by our industry and that have been recognized – by U.S. EPA itself and numerous other countries – to produce sound emissions data in favor of an approach that goes well beyond not only the Tier 2 -- but also even the Tier 3 -- method.

Our careful analysis of the Proposed Rule indicates that U.S. EPA has based this approach on fundamental misconceptions about current semiconductor manufacturing technologies and practices. Notably, the independent entity -- International Sematech Manufacturing Initiative (ISMI) -- with whom U.S. EPA itself has partnered on emissions reporting method development -- performed surveys at SIA' request during the Proposed Rule comment period. The ISMI Survey Reports, appended to our comments today, demonstrate the accuracy of SIA's analysis as to these fundamental misconceptions, including, among others:

⇒ ***Process-Specific Gas Utilization and By-Product Emission Factors***. The Preamble to the Proposed Rule asserts that large semiconductor facilities already use Tier 3 methods or have the data required to do so. As the ISMI

Survey Report demonstrates, this assertion is incorrect: Only one large company uses Tier 3; the remainder of Survey participants rely on Tier 2a, 2b or a combination. Fifty percent of companies defined as "large" by the Proposed Rule do not have Tier 3 data in their possession, and even among facilities with some such data, seventy-five percent indicate that it was not generated in accordance with the 2006 ISMI Guideline specified in the Proposed Rule. Indeed, only ten percent of all emissions characterizations, according to Survey respondents, were generated pursuant to this Guideline.

⇒ ***Gas Consumption By Process Tool***. The Proposed Rule asserts that gas consumption information is gathered on an individual process basis in the normal course of business, commonly with Mass Flow Meters (MFMs) calibrated to +\- one percent accuracy. This assertion rests on a fundamental misunderstanding: Gas flow data -- generated at a state-of-the-art fabrication operation with digital devices as a means to regulate process input and safeguard process integrity -- are not easily marshaled and converted to annual, process-specific gas consumption measurements. Indeed, even where such conversion is feasible, doing so would require significant development resources to design data marshalling software that interfaces with the facility's current complex systems. Moreover, older generation facilities do not have MFM's with digital capability, and to change out these MFMs would entail an enormous expenditure and pose logistical challenges. As the ISMI Survey bears out, over 60 percent of respondents have some bulk gas distribution feeding multiple processes, with no process-based tracking; 80 percent estimate consumption based on gas purchases and default heel factors; some respondents weigh cylinders to +\- one percent accuracy and calculate heel factors. Only one respondent uses MFMs to measure some gas usage.

⇒ ***Abatement Devices***. The Proposed Rule would require testing of all abatement devices being counted for GHG control. It is important to recognize that in-house capability to perform such testing generally does not exist, and engaging a third party to do so would prove costly and result in significant delays, given the small number of testing entities. As the ISMI Survey Report indicates, 72 percent of facilities employ GHG-specific Point of Use (POU) abatement, with 75 percent of those facilities not now possessing such test data, but instead using defaults or manufacturer-supplied measurements. Moreover, the Survey indicates less than one percent of all abatement has been tested using the draft U.S. EPA protocol specified in the Proposed Rule.

⇒ ***Costs***. As the ISMI Survey bears out, the compliance costs of the Proposed Rule would far exceed the $3.6 million estimated by U.S. EPA and instead would run into the tens of millions. The abatement testing alone would cost $17 million and extend over 450 weeks. For a large facility to obtain the Tier 3 measurements would cost at least $13 million and could cost as much as

$77 million, with 2,200 weeks of testing. The gas consumption costs are equally astronomical: $65 million for infrastructure installation and $20 million for annual operation thereafter. The Proposed Rule's exceedingly high compliance costs would come at a time when the U.S. semiconductor industry is experiencing serious economic challenges, and more to the point, would not result in palpable gains in reliability and accuracy. Indeed, this cost burden far outweighs the benefits given the: (a) the *de minimis* amount of emissions associated with PFC use in the semiconductor industry; (b) the critical nature of F-GHGs in the semiconductor manufacturing process; (c) successful and ongoing efforts by the industry to significantly reduce our PFC emissions without any regulatory mandate; and (d) the fact that no semiconductor PFC emissions limitations are present or likely in other regions of the world, creating a significantly un-level competitive playing field

SIA respectfully submits that due to the foregoing fundamental misconceptions, the Proposed Rule lacks the adequate factual basis and legal predicate to support a reporting approach that extends beyond IPCC emissions assessment methods currently in use by SIA members participating in the Partnership. We accept, however, that U.S. EPA has a legitimate interest in obtaining more information than has been provided through the Partnership, and moreover, that semiconductor manufacturing facilities should employ the Tier 3 method, where the measurement data are in their possession and representative.

To this end, SIA would propose the following GHG Reporting approach as a viable alternative to the Proposed Rule's costly, burdensome and -- for many facilities – sometimes infeasible approach. Our alternative approach consists of the following key elements:

1. ***No Distinction Among "Large" and Other Facilities***. The distinction in the Proposed Rule between "large" facilities and other facilities – appears based on the premise that all larger facility 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. Moreover, this premise contradicts the emission reduction incentives developed under the Partnership, which does not distinguish between facility capacity in mandating emissions reductions. SIA believes, therefore, that the GHG Reporting Rule should apply to semiconductor manufacturing facilities that exceed the general, de minimis threshold established in the Proposed Rule of facility that emits 25,000 metric tons CO_{2E} or more per year.

2. ***Require Use of Tier 3 Measurement Data Where In Possession of Facility***. SIA acknowledges that the Tier 3 method was developed as part of a progression to rely increasingly on measured data. In our discussions with EPA, it seems apparent that the Agency understood equipment suppliers would generate much of these data over time as companies constructed new fabrication operations. As the ISMI Survey demonstrates, the current reality is far different: Most facilities do not have such data in their possession. Where they do, however, SIA agrees that the facility should use such data as long as representative of its processes and reflective of accepted analytical practices. Such practices would, of course, include the ISMI 2006 Guideline, but SIA does not believe that it is appropriate to mandate this Guideline. Where a facility does not have such Tier 3 data in its possession, SIA agrees that the facility should ultimately utilize the Tier 2b method. It is critical, however, given that this step may require significant and time-consuming resource investment that all facilities be given the first reporting year to rely on emissions reporting methods that are consistent with the IPCC 2006 report and, if applicable, have been utilized by the facility under the Partnership or other federal and state programs.

3. ***Mandate Gas-Specific Consumption Factors, Where Feasible***. As noted above, the Proposed Rule would mandate measurement of gas consumption based on MFMs with accuracy to +\- one percent accuracy. But in doing so, the Proposed Rule misunderstands how the industry currently uses MFMs and does not recognize the enormous expense and time -- potentially in the tens of millions and over several years -- that compliance with such a requirement would necessitate. SIA acknowledges, however, that while the industry currently relies on default heel factors from the 2006 IPCC Report, it is appropriate to require, unless infeasible, that a facility 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. As detailed in our comments, such a Gas-Specific Consumption Factor will have greater accuracy than default factors.

4. ***Allow Mass Balance For Heat Transfer Fluids***. The Proposed Rule would require tracking of heat transfer usage on a per unit basis. A typical fabrication operation contains hundred of such units, making such a requirement impractical as well as unnecessary. A mass balance method keyed to purchase and offsite shipment can provide reliable and accurate information for F-GHG reporting purposes.

5. ***Allow Default Factors for Abatement Devices Designed for Fluorinated Greenhouse Gas Reduction***. The Proposed Rule would require testing of each abatement device in order to take into account its GHG emission reductions, despite the impracticality -- in terms of cost and time -- of testing the hundreds of point of use POU devices at a typical facility. SIA recognizes the importance of using test data, where available, but would submit that where a device has been designed for GHG reductions, default factors reflect test data with sufficient accuracy and that testing should be required only for new models of abatement systems. Moreover, periodic testing is not necessary as long as a facility operates equipment properly.

6. ***Provide A Six Month (not a three month) Reporting Timeframe***. The Proposed Rule would require reporting for the prior calendar year three month after year-end. This three month timeframe is insufficient to collect, analyze, prepare and certify data for submission to U.S. EPA. Notably, other reporting programs with less complexity, such as the Toxic Release Inventory Program, allow a six month timeframe. SIA would urge EPA to adopt this same six month timeframe.

SIA follows below with comments that detail our concerns with the Proposed Rule and our alternative for taking the logical next step in the over ten-year Partnership with U.S. EPA by providing reliable GHG emissions data in a cost-effective manner. Our comments attach a redlined version of the Proposed Rule that reflects revisions designed to achieve our alternative as well as the three ISMI Survey Reports that fully supports it.

II. SEMICONDUCTOR INDUSTRY BACKGROUND

SIA is a trade association representing the U.S. semiconductor industry, uniting companies responsible for more than 85 percent of semiconductor production in the U.S. SIA is dedicated to maintaining our Nation's world leadership in semiconductor technology while at the same time helping its members to provide safe working conditions in production facilities and to protect the environment. Collectively, the semiconductor industry employs a domestic workforce of approximately 200,000 people, and is our Nation's second-largest exporting industry. More information about the SIA can be found at www.sia-online.org.

The semiconductor industry uses a number of gases classified as perfluorocompounds, or "PFCs," also referred to as F-GHGs in the Proposed Rule, in both etching circuits on silicon wafers and for chamber cleaning processes in wafer fabrication equipment. Our PFC uses are absolutely essential as these materials have unique properties based on the nature of fluorine and silicon chemistry and thus are critical for various aspects of our manufacturing process. There are currently no substitutes for our unique process applications. The industry also has limited heat transfer uses. Our overall GHG emissions are small relative to the total estimated U.S. inventory.

Based on EPA's most recent greenhouse gas emissions inventory, semiconductor emissions of F-GHGs (defined as perfluorocarbons within the GHG Inventory), SF6 and HFCs comprise only 0.07% of the total US inventory of greenhouse gases.

In the early 1990's scientific studies indicated that PFC gases had high Global Warming Potentials (GWPs). As a result, SIA member companies began to consider approaches for stewardship, recognizing world concern that PFCs have global warming potential. After engaging in dialogue with EPA over a number of months, SIA member companies joined with EPA to form the "PFC Emission Reduction Partnership for the Semiconductor Industry." This Partnership was formalized in a 1996 Memorandum of Understanding (MOU) under which the participating companies agreed to: (1) endeavor to reduce the absolute and normalized rate of PFC emissions from U.S. semiconductor manufacturing operations; (2) share non-confidential information about technologies for reducing PFC emissions; (3) implement a comprehensive system for reporting their PFC emissions to EPA; and (4) undertake a research and development effort to determine whether it would be appropriate for the industry to set specific goals for PFC reduction. The semiconductor industry has consistently applied its reduction efforts to a "basket" of gases relevant to our operations, including not only perfluorocarbons (CF4, C2F6), SF6, and HFCs (e.g. CHF3), but NF3 and other materials.

About the time the 1996 MOU with EPA was being finalized, the U.S. semiconductor manufacturers also entered into discussions with manufacturers worldwide, which led to the formation of the World Semiconductor Council (WSC) in 1996.[1] Initially, the WSC included the semiconductor industry associations of the United States (SIA) and Japan (JSIA), Europe (ESIA) and Korea (KSIA), with Taiwan (TSIA) and China (CSIA) joining later. The WSC's member associations currently represent about 85% of the world's semiconductor manufacturing capacity.

One of the first cooperative projects undertaken by the WSC was the adoption, in 1999, of a voluntary global PFC emission reduction program with a goal of reducing absolute emissions to 10% below each association's baseline emission level by the year 2010. The WSC voluntary agreement represented the first time that an international industry sector had joined together in a cooperative effort to address the issue of global climate change.

With no controls, global semiconductor PFC emissions were projected to increase by a factor of more than seven between 1995 and 2010, due to worldwide increases in semiconductor manufacturing to meet the demands of today's technology-driven economy. However, as a result of the global emission reduction program, current worldwide emissions are instead only slightly above

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1 The WSC's website is available at: http://www.semiconductorcouncil.org.

baseline levels, and the WSC expects the 10% reduction goal to be achieved by 2010 if not earlier. Furthermore, it is expected that new programs will be developed within the WSC to continue this effort into the next decade.

Semiconductor manufacturers have been able to reduce PFC emissions by taking a number of actions including:

⇒ Process optimization, to minimize the amount of PFCs needed to make semiconductors;

⇒ Where possible, replacing PFCs with alternative compounds;

⇒ Employing alternative manufacturing processes, to minimize PFC emissions; and

⇒ Improving PFC abatement systems.

Since our baseline year of 1995, the SIA MOU participants have already reduced their PFC emissions by 32%. In the 2008 reporting year, the participating companies reported PFC emissions totaling 0.59 MMTCE (million metric tons of carbon equivalents). We are interested in assisting EPA to meet its intended goals, which are noted in the preamble to the Proposed Rule:

To these ends, we have identified the following goals of the mandatory reporting system:

⇒ obtain data that is of sufficient quality that it can be used to support a range of future climate change policies and regulations;

⇒ balance the rule coverage to maximize the amount of emissions reported while excluding small emitters; and

⇒ create reporting requirements that are consistent with existing GHG reporting programs by using existing GHG emission estimation and reporting methodologies to reduce reporting burden, where feasible."

SIA intends to work cooperatively with the Agency – as we have in the past under the voluntary MOU program – to give our full support to its implementation of this mandate. Based on our review of the Proposed Rule, however, we have significant concerns relating to burden, cost, regulatory necessity and confidentiality. Fundamentally, the Proposed Rule would seek an extensive amount of information for the apparent purpose of verifying the accuracy of our industry's PFC emissions levels. In our view, this amount of information – much of which is not currently or readily available - imposes unnecessary burdens and costs given that a far less extensive information set should meet EPA's need.

SIA believes that the burden far outweighs the benefits given: (a) the de minimis amount of emissions associated with PFC use in the semiconductor industry; (b) the critical nature of PFCs in the semiconductor manufacturing process; and (c) successful and ongoing efforts by the industry to significantly reduce our PFC emissions without any regulatory mandate. The reporting burden of this Proposed Rule is far greater than what exists in other regions of the world, potentially a competitive disadvantage for U.S. firms.

The Proposed Rule is impossible to implement for reporting year 2010. In recognition of the importance to establishing this baseline data, SIA has proposed an alternative that can be implemented for reporting year 2010.

III. ISSUES RAISED BY THE PROPOSED RULE'S REPORTING APPROACH AND SIA'S RECOMMENDED ALTERNATIVE APPROACH FOR OBTAINING RELIABLE EMISSIONS DATA IN A TECHNICALLY SOUND, LEGALLY VALID AND COST EFFECTIVE MANNER

The Proposed Rule's requirements are predicated on erroneous assumptions about semiconductor industry tools and practices. For example, the Proposed Rule states that companies routinely track gas usage by mass flow measurements. Company practices, in fact, differ significantly from the Proposed Rule's requirements. Furthermore, compliance with the Proposed Rule will cost much more than was estimated by the EPA.

SIA believes that with some data collection improvements, existing emissions estimating methods can meet the data needs of the Proposed Rule. SIA also has additional concerns about the Proposed Rule reporting requirements and the impacts on both the protection of sensitive business information and competitiveness of the U.S. industry given the intense global pressures of semiconductor markets.

To provide the EPA with evidence to support these claims and specific examples to highlight the disconnects in the Proposed Rule's assumed industry practices and actual practices, SIA collaborated with the International SEMATECH Manufacturing Initiative (ISMI) to conduct 3 comprehensive surveys of GHG benchmarking and technical data across a representative sampling of the industry. The ISMI Survey Reports are provided with these comments.

SIA presented testimony outlining our concerns at the public hearing, and then provided further details at a meeting with EPA representatives on May 15, 2009. At that meeting, SIA reviewed some preliminary data from the ISMI surveys and sought to gain a fuller understanding EPA's assumptions of industry practices and to identify specific questions to address in our comments.

SIA's comments below key off of the discussion at the May 15th meeting. We present a more fulsome summary of the ISMI Survey results (and append the Survey Reports to our comments); provide responses to specific EPA requests and questions; present alternative approaches for data collection and reporting as required by the Proposed Rule; and address other areas of concern raised by the Proposed Rule.

A. Gas Consumption Determination

1. Issues Raised by Proposed Rule

The Proposed Rule states that "Gas consumption by process is often gathered as business as usual" and that "Electronics manufacturers commonly track fluorinated GHG consumption using flow metering systems calibrated to +/-1% or better accuracy ...." (p16498) The Proposed Rule also states that measurement devices (scales or mass flow metering systems) must be calibrated using NIST traceable standards or other manufacturer recommended methods at least annually. (p 16650)

Most fabrication operations ("fabs") do not currently track gas consumption by tools as many have bulk gas distribution feeding multiple tools and/or cylinders feeding both etch and CVD processes. While most fabs utilize scales (compressed liquefied gases) and pressure measurement devices (high pressure gases) to determine when cylinders or bulk containers must be changed (i.e., trigger point for change-out), it is not currently common practice to track this information and quantify total gas consumption over a period of time, particularly by tool or process given the gas distribution configurations.

These scales and pressure measurement devices are not calibrated per ISO 9000 Quality Standards for calibration and are not calibrated using NIST traceable standards or other methods that would be considered true calibration. In many cases, calibration of a measurement device would involve removing it from service and possibly even disconnecting it from a tool, rendering it inoperable. This is not acceptable because semiconductor fabs operate continuously. As with other process sensitive parameters in our industry, performance verification is conducted for these scales and pressure measurement devices as needed since the trigger point for change-out is a highly critical measurement to ensure that the integrity of the gas delivery to the tools is not compromised (change-out indication too late) and that costly gas is not unused (change-out indication too soon)

Further explanation is provided in the ISMI ETC Greenhouse Gas Facility Survey Results. Fabs do commonly use mass flow controllers to meter gas flow to a process tool, but most of these flow controllers do not have the data output and logging capability to accumulate gas flow to a tool over a period of time. Few of these mass flow controllers have a rated accuracy of +/- 1% and they are not calibrated per Proposed Rule requirements.

2. ISMI Survey Results Regarding Gas Usage Consumption

The GHG Facility Survey results indicate that 80% of the respondents estimate gas consumption based on purchases and an assumed heel factor. No respondent uses mass flow controllers with +/- 1% accuracy for tracking gas consumption. The estimated minimum average cost to install infrastructure to comply with the gas consumption tracking requirements of the rule as proposed is $0.72 million per fab with an estimated annual operating cost of $0.22 million per fab. Based on an estimated 91 semiconductor facilities that would be subject to the Proposed Rule, the total estimated minimum cost for the industry to comply with the gas consumption data requirements is $65 million for infrastructure installation and $20 million for annual operating costs.

Details on current industry practices for gas consumption tracking as well as details on the basis for these cost estimates are provided in the Survey.

3. SIA's Proposed Alternative Approach

The EPA requested a description of how companies could better quantify gas usage by process area compared to what is currently done through Tier 2a methodology. The SIA offers this proposed alternative for usage estimation combining measured gas-specific cylinder residual ("heel") factors with engineering estimates of gas usage by etch and chamber cleans. This improved accuracy of gas consumption tracking should be sufficient and further QA/QC of gas usage data should not be required with this alternative. This improved accuracy will also serve to meet the goals of the Proposed Rule.

FLUORINATED GHG USAGE DETERMINATION
SIA PROPOSED ALTERNATIVE

Gas consumption can be tracked using usage records for each gas. A heel factor must be applied to each cylinder or bulk container of each gas to account for the residual amount of gas remaining in the container when changed. A gas-specific heel factor will be determined initially for each gas container type using the following method. The weight of the gas in the incoming cylinder is very consistent for each gas container type. A cylinder change-out is triggered by either the weight of the gas measured by scale or the measured pressure, depending on the gas. The gas remaining in the cylinder is determined either by the measured weight or the calculated weight based on the measured pressure using the Ideal Gas Law (PV=ZnRT) with the appropriate compressibility factor (Z) for the gas. The total usage is the difference in the weight of the cylinder when installed and when changed. Using this known residual weight of the container, a gas specific heel factor for each container type used (cylinder or bulk) is determined (residual amount percentage of the total amount). This gas-specific heel factor is then applied to each of the cylinders or bulk containers used to determine the net amount of each gas used by the facility. Table 1 illustrates how this gas-specific heel factor can be calculated. This methodology offers significant accuracy improvement in gas consumption estimates compared to use of a default heel factor by accounting for what can be substantial relative differences in change-out trigger points from gas to gas and from one facility to another, due to differences in tool and process sensitivity. Use of facility determined gas specific heel factors is sufficiently reliable relative to direct measurement of all gas usage because container change-out based on established trigger points is consistently executed in semiconductor fabs as a result of simultaneous requirements to protect processes from excursions and to make maximum cost-effective use of raw materials. Furthermore, costly installation of gas distribution and measurement infrastructure is not required

Table 1 – Calculation of Gas-Specific Heel Factors

Gas	Pressure (psig)	weight (lb)	Change trigger (psig or lb)	Heel Factor %
C2F6		95	7 lb	7%
C4F8		16	1 lb	6%
C4F8		88	5 lb	6%
CHF3		70	17.6 lb	25%
CF4	1800		180 psig	10%
NF3 etch	1450		85/60 psig	6% / 4%
NF3 CVD	1450		40 psig	3%
SF6		50	12 lb	24%
N2O		60	12 lb	20%

The heel is the amount of gas remaining in the cylinder when the cylinder is changed. Where pressure triggers the cylinder change, the weight can still be determined as can the gas-specific heel factor (pressure corresponds directly to weight).

Once the total amount of each gas used by the facility is determined, the amount of each gas used in each process type (etch and chamber cleans) can be reasonably approximated using engineering estimates where gas distribution systems feed multiple tools and processes. First all of the tools that use a particular gas are determined and sorted by process type (etch and chamber cleans). The total usage of a particular gas is then apportioned between etch and chamber clean processes by using knowledge of factors such as process recipes, typical flow rates and times, groups of similar tools running similar processes, and the average utilization or throughput of individual tools or groups of similar tools.

This proposed alternative provides a reliable estimate of GHG emissions for any facility currently using Tier 2a or Tier 2b methods using the default heel factor. Gas-specific heel factors are likely more accurate than the 2006 IPCC default heel factor of 10%. Not only do the heel factors vary for each gas, they can vary for each facility depending on the gas distribution configuration. Using engineering methods to estimate gas usage by CVD and Etch where gas usage is not tracked by process type improves the precision of the emissions estimates over emissions calculated using only Tier 2a.

B. Applying Emissions Factors

1. Issues Raised by Proposed Rule

The most stringent semiconductor-related requirements of the Proposed Rule are imposed on "Large Facilities" that process more than 10,500 m^2 of silicon on an annual basis. Part of EPA's justification for the capacity-based approach is that it would allow facilities to "quickly determine whether or not they must report under the rule". However, in the semiconductor industry, large facilities do not inherently have higher emissions of F-GHGs. Beginning with the second generation of 200 mm fabs, remote NF3 chamber cleaning and extensive use of point-of-use abatement has resulted in significantly lower emissions than earlier fabs. These PFC reduction techniques were also adopted in many 300 mm fabs, which comprise the largest volume operations in the industry today.

In fact, there are examples of 300 mm fabs operating today with F-GHGs emissions are well under the 25,000 tpy CO2e threshold used as a criterion for the Proposed Rule. EPA should exempt semiconductor facilities from the detailed reporting requirements of the Proposed Rule if they can demonstrate through the application of IPCC Tier 2 or Tier 3 methods that their PFC emissions are below the 25,000 tpy threshold. The threshold was selected by EPA in order to exclude "small facilities that do not contribute significantly to overall GHG emissions". SIA believes that this logic should apply equally to "Low-emission facilities" regardless of the volume of silicon they process. To support the completeness of the national GHG inventory, those "Low-emission facilities" could continue to participate in a reporting scheme analogous to that used in the current PFC Reduction Partnership for the Semiconductor Industry. This would also serve as a strong incentive for continuation of the voluntary emission reduction efforts the industry has successfully pursued over the last fifteen years, especially for large facilities that would incur significant new costs for reporting under the Proposed Rule.

The Proposed Rule requires IPCC Tier 3 methodology for large facilities requiring process-specific data on gas utilization and by-product formation. The Proposed Rule states that "information on ... gas utilization, by-product formation ... for each process is readily available from tool manufacturers and can also be experimentally measured on-site at the facility" and that "We [EPA] estimate that the Tier 3 approach would not impose a significant burden on facilities because large facilities are already using Tier 3 methods and/or have the data to do so readily available..." (p 16498). The Proposed Rule also states that "The guidance prepared by International SEMATECH Technology Transfer #0612485-A-ENG (December 2006) must be followed when preparing gas utilization and by-product formation measurements." (p 16498)

For large facilities, the Proposed Rule calls for "process-specific utilization and by-product formation factors" (p. 16648), however the Proposed Rule does not define "process-specific."

2. ISMI Survey Results Regarding Emissions Factors

The GHG Facility Survey results indicate that only one U.S. company is estimating GHG emissions via IPCC Tier 3. All other responding companies use Tier 2a, 2b, or some combination of tiers. Half of the responding large facilities have no data for Tier 3 estimations.

The GHG Facility Survey results indicate that the average number of unique process platforms (defined as specific tool models using a specific PFC for either CVD chamber clean or etch) for a large facility is 37 per fab while the average number of unique process recipes run (using PFC gases) is 455 per fab. The minimum cost estimate to develop Tier 3 emission factors for the average large fab ranges from $0.43 million over 12 weeks if testing is required on a per platform basis. If each individual process recipe must be characterized, the minimum cost for an average fab increases to $2.7 million per fab testing over 76 weeks. The total minimum estimated cost for the EPA estimated 29 large facilities to develop Tier 3 data is $13 million - $77 million over 360-2,200 weeks of testing. Given the amount of emissions characterization required by the proposed rule and the limited number of suppliers capable of providing testing services, it is unclear how these process-specific emissions factors could be developed for the estimated 29 large facilities.

3. SIA's Proposed Alternative Approach

The EPA requested that the semiconductor industry offer a proposed alternative methodology that would meet the objectives. The SIA offers this proposed alternative applying emissions factors that, in effect, do not differentiate facilities by their rated capacity (i.e., "Large" or "Small" facility). Note that point of use abatement and DRE factor determination is addressed in Section 3 of the SIA Comments.

METHOD FOR APPLYING EMISSION FACTORS SIA PROPOSED ALTERNATIVE

Facilities will use process-specific Tier 3 factors for their gas utilization and by-product formation provided that:

⇒ they already have physical possession of those factors either from tool suppliers or through their own measurement methodologies consistent with the ISMI 2006 Guideline; and

⇒ they conclude -- based on their professional judgment -- that those factors are representative of their particular process.

For facilities that do not have process-specific Tier 3 factors in their physical possession, the 2006 IPCC Tier 2b default emission factors will be an approved alternative for process platforms and toolsets for 300mm wafers or smaller. The amount of each gas used by each process will be determined using the proposed alternative method for Fluorinated GHG Usage Determination. According to this method, engineering estimates will be used to approximate the amount of each gas used by tools/processes that have process-specific Tier 3 factors to calculate the emissions from those tools/processes. From these engineering estimates, the amount of each gas used in CVD and Etch by tools/processes that do not have company-specific Tier 3 factors will then be used to calculate the remainder of the emissions using IPCC Tier 2b default emission factors.

The 2006 IPCC Tier 2b methodology is a globally accepted method for estimating GHG emissions for a facility. The Tier 2b factors were developed using 190 distinct measured emission factors for CVD chamber cleaning and etch processes and are considered to be sufficiently accurate for developing an inventory of GHG emissions. [Draft Report - Emission Factors for Semiconductor Manufacturing: Sources, Methods and Results, February 2006] Given that a typical facility has many tools using these gases in hundreds of different process recipes, a facility is, in effect, an inventory.

While individual Tier 2b emission factors can be subject to the relative errors estimated by IPCC, application of numerous emission factors across hundreds of process recipes results in an overall facility emissions inventory with substantially lower relative error. Error in the total inventory tends somewhat toward overestimation of emissions due to the asymmetric error distribution of some of the component emission factors. Although Tier 3 emission factors are more specific in their application than Tier 2b factors, they are subject to the same type of relative error. Due to the complexity of semiconductor manufacturing, Tier 3 factors must necessarily represent a range of process recipes for a particular tool and process platform, rather than one unique set of process conditions.

In this context, SIA would emphasize that given most facilities do not currently use Tier 3 methodology, limited data representative of manufacturing conditions exist upon which to base an estimate of the improved accuracy of Tier 3 emissions calculations. The only actual comparisons known to SIA are reported below and demonstrate only a modest difference in the results of the methods. Any benefit gained from Tier 3 reporting on the grounds that it is more precise (and not an overestimate) is far outweighed by the high cost of gathering the Tier 3 data as opposed to using the Tier 2b default values.

In evaluating how a facility would apply Tier 3 factors, SIA would highlight the important question of what constitutes a separate "process" that requires its own specific set of Tier 3 factors. As SIA and EPA have discussed, it is not technically appropriate nor workable from a regulatory standpoint to regard each and every individual "recipe" for operating a tool or a set of tools as separate "process. On the other hand, the dividing line for what constitutes a separate "process" requiring its own, if available, Tier 3 factors, is a complex one that depends upon professional engineering judgment.

In particular, Section 98.92 of the Proposed Rule appropriately identifies the different types of semiconductor manufacturing processes that may employ F-GHGs: (1) plasma etching; (2) chamber cleaning; (3) chemical vapor deposition or CVD; and (4) heat transfer fluid use. An individual facility, depending upon the age, nature and configuration of its fabrication operations may have multiple equipment platforms for running each of these four processes, but little variability in the operational parameters for those platforms; as a result, the facility would essentially have only four "processes" for Tier 3 factor purposes. On the other hand, enough variation may exist between platforms running a particular type of process, such as might be the case where one platform runs on older tools and another runs on the newer tools, that each platform would qualify as a separate "process" requiring its own, if available, Tier 3 factors.

SIA requests the opportunity to discuss further with U.S. EPA the "process" definitional question pertaining to the use of Tier 3 factors, where available and representative. This question, as noted above, is complex, and yet, is pivotal to understanding the scope and feasibility of any enforceable regulatory regime that would require, if available and representative, the use of Tier 3 factors to calculate emissions.

4. <u>Additional Reliability and Accuracy Considerations Supporting SIA's Proposed Alternative Method for Applying Emissions Factors</u>

a. <u>ISMI Survey Results</u>

As part of the GHG Facility Survey participation, one respondent provided additional data from an analysis completed to compare results of 2006 IPCC Tier 2a, 2b, and 3 methods for three 200 mm fabs over 3 years and three 300 mm fabs (one for 1 year and two for 3 years each). These 16 data sets show that Tier 2a and Tier 2b produce a very similar result with Tier 2a averaging +2% higher (standard deviation 9%). When comparing Tier 3 to Tier 2a and 2b, Tier 3 yielded an estimated 10 % and 11% lower, respectively (standard deviation 3% and 8%). The IPCC methods for the electronics industry require use of 100-year time horizon global warming potentials (GWP100) to calculate CO2 equivalent emissions. As noted in the IPCC Fourth Assessment Report, uncertainties of GWP100 are ±35% (IPCC 4th ARWG1, Ch.2, p.214). The largest difference between methods is less than one-third of the uncertainties of GWP100.

b. **Proven Reliability and Accuracy of Tier 2b Factors**

As stated above, the IPCC Tier 2b factors are widely recognized as a reliable basis for estimating emissions. The Chicago Climate Exchange (CCX), a voluntary market-based emission reduction and trading system that requires participants to establish emissions baselines and track their progress towards emission reductions goals, recognizes the reliability of Tier 2b factors. This is noteworthy as the exchange could not credibly buy or sell emission reduction credits if the participants were not required to use reliable emissions estimation methods. Similarly, the Climate Registry, a nonprofit collaboration of U.S. states and Canadian provinces that has developed standards to calculate, verify, and report greenhouse gas emissions, recognizes the IPCC Tier 2b method as an accepted protocol. The Chicago Climate Exchange, and the Climate Registry have been cited with approval by the Government Accountability Office. See High Quality Greenhouse Gas Emissions Data are a Cornerstone of Programs to Address Climate Change, Statement of John Stephenson, Director, Natural Resources and Environment, Government Accountability Office, February 24, 2009. 74 Fed. Reg. 16448, 16478, fn 61 (April 10, 2009).

Using reliable gas usage by process estimations along with Tier 2b default factors should satisfy the intent of the Proposed Rule, particularly considering the inherent uncertainty (+/-35% or greater) in the modeled global warming potentials themselves, which continue to change over time and are used in the emissions estimations. In addition, assuming that governments are moving towards market-based approaches to GHG management, the relatively small uncertainties that may remain should be left to the markets to resolve.

Transitions to new wafer sizes represent the best opportunity to consistently introduce new equipment requirements. The industry is currently in the process of developing tools for the next wafer size - 450 mm. According to ISMI, "IC makers wish to work with suppliers of wafer fab equipment to achieve capability for pilot lines in 2012 and prepare for manufacturing their products on 450 mm wafers", while initial new facility ramp-up may occur in the 2014-2015 timeframe. Note that detailed technology goals will be defined by individual companies' business requirements. The introduction of production-ready 450 mm tools represents the most appropriate transition point for consistent application of Tier 3 factors. As with current emissions estimation processes used by the industry, data for a supplier's baseline process should be considered representative of company-specific processes.

C. POU Abatement - Verification of DRE

1. Issues Raised by Proposed Rule

The Proposed Rule refers to abatement systems as "a point-of-use (POU) abatement system whereby a single abatement system is attached to a single process tool or single process chamber of a multi-chambered tool" (p.16649).

This definition does not include multi-chamber POU abatement devices (which are commonly used in the industry) and larger non-POU abatement systems. Although it is conventional to operate abatement equipment at the point-of-use, there is no physical imperative that necessitates abatement be conducted directly at the individual point of use. In fact, at least one facility currently operates GHG abatement equipment at the "FAB level". It is important that the ruling not be prescriptive to the point where it impedes future advances in abatement technology. The SIA requests that the EPA strike the implied restriction to POU abatement, and replace it with a less restrictive terminology, perhaps "abatement".

The Proposed Rule does not allow for default DRE factors to be applied where abatement systems have not been tested. The 2006 IPCC Guidelines for National Greenhouse Gas Inventories provides default DRE factors for POU abatement devices that can be used when the abatement units are designed specifically to abate F-GHGs and when they are used within the manufacturer's specified process window and in accordance with maintenance schedules. The technical experts who developed the IPCC Guideline for the electronics industry believed that a properly maintained abatement device would maintain DREs over time and did not require periodic testing (IPCC 2006, Vol. 3, 6.20). Furthermore, although Proposed Rule uses the 2006 IPCC Guideline for estimating emissions, it does not allow the Guideline's default abatement DRE factors to be used.

The EPA proposes two alternative methods for verifying the DRE of the equipment (p. 16499), and indicates that either method may be followed. The first EPA method would require facilities (or their equipment suppliers) to test the DRE of the equipment using an industry standard protocol (such as the ISMI Guideline), such as the one under development by EPA (not yet published). The second EPA method would require facilities to buy equipment that has been tested by an independent third party using the protocol under development by EPA. SIA would like to propose that the ISMI Guideline can be used as an alternative to the draft EPA Protocol. In light of potentially contradictory wording on page 16649 of the Federal Register, the SIA wishes to clarify that "Third party" testing should not be required for owners and operators, or equipment suppliers who follow the industry standard test protocols as referenced above.

The Proposed Rule is unclear with regard to the conditions under which a particular piece of abatement equipment would actually require testing. The SIA proposes that industry work in collaboration with abatement equipment manufacturers to establish feed composition limits and other process conditions within which a particular model of abatement equipment will be assured of specified DRE values for a given F-GHG. Via this approach, testing will be conducted upon each model type, but it will not be necessary to test individual abatement devices, unless the process conditions for the particular application falls outside the established capabilities of the abatement device. In the interim period, while industry establishes the "process window" within which abatement equipment can be reliably operated to achieve a specified DRE, the SIA proposes that the IPCC emissions factors be employed. Given that the intent of the Proposed Rule is to provide accurate accounting of GHG emissions, the SIA believes that it is not appropriate to deny accounting for emissions reductions during the interim period. To do so would grossly overstate emissions.

The Proposed Rule indicates that facilities pursuing DRE verification would be required to operate and maintain abatement equipment in a manner that is consistent with the manufacturers specifications (p. 16650). Likewise, the Proposed Rule would limit equipment lifetimes to durations that are pre-specified by manufacturers. SIA is opposed to this requirement, given that well-maintained equipment can last indefinitely. Moreover, such a policy is subject to abuse and otherwise inappropriate. Instead, the SIA proposes the following alternate wording with regard to the maintenance and operation of abatement equipment:

⇒ All abatement equipment must be maintained in good working order and operated properly.

⇒ Facilities using GHG abatement equipment shall operate the equipment within the manufacturer's specified limits, or within alternate limits that have been supported by the testing protocols as described above.

The Proposed Rule solicits comments regarding the influence of feed composition on the DRE of CF4. SEMATECH has conducted extensive studies on the influence of process operating conditions on the DRE of CF4 and other F-GHGs. These reports are available through SEMATECH, and are summarized in the 2005 State of Technology Report provided to the EPA. These studies measured emissions at maximum process recipe flows simultaneous through all inlets to selected abatement devices (including thermal oxidation, plasma, and adsorption), and indicate that while CF4 can be formed as a by-product during the abatement of higher molecular weight fluorinated hydrocarbons; under proper operating conditions the CF4 abatement is robust.

2. <u>Results of the ISMI Survey Regarding Abatement</u>

The results of the GHG Facility Survey indicate that 50% of the respondents with abatement have not characterized abatement DRE. These respondents use either defaults or DRE measurements provided by suppliers. Only one respondent has characterized the majority of their installed POU abatement units. Based on the prescriptive testing methods required by the rule, the estimated average cost for a fab to comply is $0.24 million over 7 weeks. This cost is greater for a fab with >100 units. Based on an estimated 66 fabs having POU abatement, the minimum total industry cost to comply with abatement testing is $17 million over 450 weeks of testing.

Detailed information on abatement testing and basis of the cost estimates are provided in the Survey Report.

3. SIA's Proposed Alternative Approach

The SIA offers this proposed alternative for DRE measurement of abatement devices that will provide sufficiently accurate and representative DRE factors for companies to be able to apply the factors to their emissions (where applicable) to reflect emissions reductions due to these devices. This alternative also meets the objectives of the Proposed Rule (as outlined in Section 2 of SIA Comments) when combined with the SIA proposed alternatives for gas usage determination in Section 1 and the alternative for applying emissions factors in Section 2.

VERIFICATION OF DRE
SIA PROPOSED ALTERNATIVE

Where representative abatement systems have not been tested by an industry standard protocol, facilities that have abatement systems that are specifically designed to abate F-GHGs will apply the 2006 IPCC default DRE factors. "Third party" testing will not be required for owners and operators or equipment suppliers who follow industry standard test protocols for representative system testing to determine DRE factors. For new models of abatement systems, testing will be conducted initially either by the supplier or by the owner/operator when the system is acquired or put into service.

Individual unit testing will not be required where DRE values for a given GHG have been established for specified process conditions for a particular model of abatement equipment where the process conditions are consistent with the conditions for which the DRE values were established. The established DRE values for a particular model will be used for all systems of that model.

To ensure that the established DRE for a given model of abatement equipment does not degrade, all abatement equipment must be maintained in good working order and operated properly. Facilities using GHG abatement equipment shall operate the equipment within the manufacturer's specified limits, or within alternate limits that have been supported by the testing protocols as described above. No periodic testing is required.

D. N2O Emissions

1. Issues Raised by Proposed Rule

The Proposed Rule states that the methodology for N2O emissions during etching and chamber cleaning "...assumes N2O is not converted or destroyed during etching or chamber cleaning, due to lack of N2O utilization factors during etching and chamber cleaning and any data on N2O by-product formation."

(p16499). SIA would like to note that the primary use of N2O as a process gas is neither in etching or chamber cleaning. N2O is used mostly in the actual chemical vapor deposition process, not the CVD chamber clean, and by nature of the CVD process, some of the N2O is consumed. The EPA has requested comment on utilization factors for N2O - but for etching and chamber cleaning operations.

2. ISMI Survey Results Regarding N2O Emissions

N_2O is used in a variety of semiconductor processes in both older and newer generation tool sets. Survey respondents provided little emissions characterization data for older generation tools; the majority of data is for 300 mm tools. The survey did not attempt to determine the quantity of N_2O used in the various processes but instead focused on collecting Utilization Efficiency (UE) data. The average of all measured UE is approximately 43%.

3. SIA's Proposed Alternative Approach

N2O EMISSIONS
SIA PROPOSED ALTERNATIVE

Companies will apply any measured N2O emission factor where those factors were measured using methods consistent with the 2006 ISMI Guideline. Companies can use a conservative default emission factor of 60%. Where companies have a measured DRE for N2O abatement, this DRE can be used in the emissions estimation.

E. Emissions of Heat Transfer Fluids

1. Issues Raised by Proposed Rule

The Proposed Rule would require companies to compile a detailed mass balance to estimate emissions of each fluorinated heat transfer fluid. The proposed method requires inventory of all fluorinated heat transfer fluid (F-HTF) equipment, quantity of charge, disposition of HTFs, etc. A facility can have hundreds of individual units containing HTFs. Requiring an inventory of these units and their nameplate capacity is burdensome. While purchases of F-HTFs are typically tracked individually, many facilities combine these materials with mixed wastestreams for efficiency in recycling and/or waste disposal. It is also not certain that F-HTFs are a significant contribution to a facility's CO2e emissions. Several are not volatile and should not be assumed to be emitted to the atmosphere if not accounted for by material tracking. Some F-HTFs do not have an estimated GWP (so CO2e estimation is not possible).

2. ISMI Survey Results Regarding F-HTF

The F-HTF Survey results indicate that companies use at least 17 different F-HTFs with ambient vapor pressures ranging from 6 – 30,000 + Pascals. Four of the fluids reported have exceptionally low (<400 Pa) vapor pressures. The F-HTFs are used primarily in closed loop chillers in process tools, such as etch, CVD, implant and device testing tools. The majority of the companies do not quantitatively track the usage, recycling, and disposal of the fluids

3. SIA's Proposed Alternative Approach

EMISSIONS OF HEAT TRANSFER FLUIDS SIA PROPOSED ALTERNATIVE

Companies will conduct a simple annual mass balance for each F-HTF used at their facility that has a documented IPCC 4th Assessment GWP and a vapor pressure greater than 400 Pa at 25C. The amount of each F-HTF reported as usage would be at a maximum the total amount purchased. Where companies track the amount of F-HTFs placed into service in a new tool or where they track any amount shipped offsite for disposal, the amount of each F-HTF reported as usage would be the total amount purchased less any amount put into service for a new tool and less any amount shipped offsite for disposal or recycling. If the amount of F-HTF shipped offsite for recycle or disposal is not tracked by individual F-HTF, the individual amount for each of the F-HTFs shipped offsite would be determined using engineering estimates – or proportioned according to the amount of each F-HTF purchased.

For those F-HTFs that do not have a documented IPCC 4th Assessment GWP, a CO2e emissions equivalent will not be calculated and will not be included in the facility total CO2e emissions. For those F-HTFs that do have a documented IPCC 4th Assessment GWP, the CO2e emissions for each of these F-HTFs will be estimated by the following calculation and *will be included in the overall facility total CO2e emissions*:

CO2e [F-HTFi] = Usage as defined above [F-HTFi] * GWP100[F-HTFi]

F. Reporting Threshold and *De minimis* Emissions

The Proposed Rule does not allow for any *de minimis* reporting level. *A company could use a certain F-GHG in a very small amount* that would be difficult and burdensome to track. Reporting requirements of GHG emissions should establish a *de minimis* threshold of CO2e per chemical that does not require tracking in the total facility inventory.

DE MINIMIS EMISSIONS SIA PROPOSED ALTERNATIVE

A company may exclude from emissions calculations any F-GHG that comprises less than five percent of the total usage of F-GHGs where:

a) The de minimis amount of the F-GHG used in etch comprises less than 5% of the total usage of all F-GHG compounds in etch.

b) The de minimis amount of the F-GHG used in CVD chamber cleaning comprises less than 5% of the total usage of all F-GHG compounds in CVD chamber cleaning.

c) The de minimis amount of the F-HTF used comprises less than 5% of the total usage of all F-HTF compounds.

IV. OTHER ISSUES AND CONCERNS RAISED BY THE PROPOSED RULE

A. Potential For Significant U.S. Competitiveness Impacts

U.S. semiconductor manufacturing operations face tremendous competition from non-U.S.-based operations, including overseas foundry operations. No other "Country or Region" regulations require such detailed GHG emissions reporting as does the Proposed Rule:

⇒ No requirement to report usage and/or emissions by gas/process

⇒ No requirement for company-specific emissions characterization or such rigorous gas usage measurements

⇒ No abatement testing requirements

⇒ No expense to comply with U.S rule and no risk of revelation of confidential or competitive information

Clearly, "leakage" could result as U.S. companies migrate their manufacturing operations to other countries/regions which is not the intent of the Proposed Rule.

B. Importance of Confidentiality Protections for Competitively Sensitive Business Information

GHG gas usage and emissions by process is considered highly sensitive by the semiconductor industry. This information can provide specific knowledge of proprietary device design and manufacturing processes.

Furthermore, facility production data and specific GHG usage and emissions data can be used to inappropriately "characterize" manufacturing operations:

⇒ Provides customers and competitors an incomplete picture of manufacturing efficiencies

⇒ Influences prospective customer decisions based on perceived efficiencies and pricing

⇒ Reveals customer or supplier sensitive product information

The Proposed Rule would require reporting not only of F-GHG "emission data," but also of highly proprietary information that does not constitute "emission data" in any legal, technical or practical sense of the term. Indeed, due to ambiguities in the Proposed Rule's use of the term "process," it is possible to read the Proposed Rule as requiring semiconductor manufacturers to submit process "recipe" parameters that qualify as their closely-guarded trade secrets. The Proposed Rule also would seek various types of highly-proprietary information that may either be relevant to verifying emissions or even could be used in calculating emissions. Yet, this information likewise does not constitute "emission data," as it is not "necessary" for determining emissions, given the availability of other, less intrusive means to do so.

In the final analysis, SIA urges U.S. EPA to clarify that it does not intend to ask for process recipe information and to adopt our alternative approach to emissions reporting that would rely less on highly proprietary information. Moreover, to the extent that such information still may get used in calculations under SIA's alternative approach, U.S. EPA should not require its submission, but instead, should require that a facility maintain such information as part of its compliance record.

This section first explains EPA's rules for determining whether data submitted under the Clean Air Act are "emission data" subject to public disclosure or, conversely, confidential business information ("CBI") that is not "emission data" and is therefore protected from public disclosure. This section then addresses each of the proposed data elements that the Proposed Rule would require to be submitted, and explains whether each element is "emission data" or CBI that should not be disclosed to the public.

1. <u>No Definition of "Emission Data"</u>

The Proposed Rule provides no definition of "emission data" and no discussion of what, if any, information required to be submitted under the Rule would properly be considered non-emission data. Rather, the Proposed Rule contains only a brief paragraph in the Preamble that cites to the Clean Air Act and EPA's confidentiality regulations. The Preamble states:

> EPA would protect any information claimed as CBI in accordance with regulations in 40 CFR part 2, subpart

B. However, note that in general, emission data collected under CAA sections 114 and 208 cannot be considered CBI.

74 Fed. Reg. 16463.[2] This statement recites the general rule under the Clean Air Act that "emission data" is not considered CBI and is therefore subject to public disclosure. However, the remainder of Proposed Rule provides no indication as to whether all the information requirements of § 98.96 are considered by EPA to be "emission data." As explained below, much of the information the Proposed Rule would require to be submitted is not "emission data" under EPA regulations.

2. Emission Data Are Only Those "Necessary for Determining Emissions"

EPA regulations define "emission data" as, in relevant part:

> (A) Information *necessary to determine* the identity, amount, frequency, concentration or other characteristics . . . of any emission . . .;
>
> (B) Information *necessary to determine* the identity, amount, frequency, concentration, or other characteristics . . . of the emissions . . .; and
>
> (C) A general description of the location and/or nature of the source to the extent *necessary to identify* the source and distinguish it from other sources . . . .

40 C.F.R. Section 2.301(a)(2)(i) (emphasis added). As explained below, this definition has been interpreted narrowly by the federal courts to mean that, where information is not strictly "necessary" to determine emissions -- *i.e.*, where emissions can be determined using alternative means not relying on confidential information -- that information does not qualify as "emission data" under EPA regulations.

In *RSR Corp. v. Environmental Protection Agency*, 588 F. Supp. 1251 (N.D. Tex. 1984), to meet Clean Air Act reporting requirements, RSR submitted certain documents to EPA -- including an air emissions inventory data form, a federal Air Pollutant Emissions Report, and an EPA inspection/monitoring report -- under a claim of confidentiality. *Id.* at 1253. After reviewing these documents, EPA determined that they were the only means of calculating emissions through a

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[2] A footnote to this paragraph in the Preamble references EPA's 1991 guidance document "Disclosure of Emission Data Claimed as Confidential Under Sections 110 and 114(c) of the Clean Air Act." 56 Fed. Reg. 7042 (Feb. 14, 1991). This document provides examples of information EPA considers "emission data," but it does not address information of the sort included in the Proposed Rule and is therefore of limited use for determining which information might be considered non-emission data.

material balance calculation and therefore constituted "emission data" not protected from disclosure. *Id.* at 1254. RSR challenged the EPA determination on the basis that, in the explanation of its decision, EPA indicated that other data could potentially have been used to calculate emissions, and therefore the information at issue was not strictly "necessary" to calculate emissions. *Id.* at 1256.

The Court agreed with RSR, finding that EPA's decision was arbitrary and capricious, and thus improper, because EPA had not "considered and examined all relevant factors and alternatives" so that "release of information claimed to be proprietary could be avoided unless required by statute." *Id.* In reaching this conclusion, the court focused on the word "necessary" in the definition of emission data at 40 C.F.R. § 2.301(a)(2)(i), holding that, in order for the information claimed as CBI to be truly "necessary" to determine emissions, EPA was required to show that no alternative methods for determining emissions existed that would avoid publication of confidential information. *Id.* Thus, where alternative means existed that would have allowed EPA to determine emissions without revealing CBI, the information considered CBI by the company was not "necessary" to determine emissions, and was not "emission data." *See also NRDC v. Leavitt*, 2006 U.S. Dist. LEXIS 13326 (D.D.C. Mar. 14, 2006) (citing *RSR* and adopting a similarly strict interpretation of the "necessary to determine" requirement).[3]

Accordingly, the only two federal cases to have squarely addressed the meaning of "emission data" under the Clean Air Act 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.

3. <u>EPA's Regulatory Definition of Confidential Business Information</u>

Under EPA regulations at 40 C.F.R. part 2, subpart B, in determining whether particular business information is entitled to confidential treatment, EPA must assess whether:

> (a) The business has asserted a business confidentiality claim which has not expired by its terms, nor been waived nor withdrawn;
>
> (b) The business has satisfactorily shown that it has taken reasonable measures to protect the confidentiality of the

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[3] Note also that EPA's 1991 guidance document "Disclosure of Emission Data Claimed as Confidential Under Sections 110 and 114(c) of the Clean Air Act" provides a list of information EPA considers "emission data" that does not include information of the sort included in the Proposed Rule. 56 Fed. Reg. 7042.

> information, and that it intends to continue to take such measures;
>
> (c) The information is not, and has not been, reasonably obtainable without the business's consent by other persons (other than governmental bodies) by use of legitimate means (other than discovery based on a showing of special need in a judicial or quasi-judicial proceeding);
>
> (d) No statute specifically requires disclosure of the information; and
>
> (e) Either--
>
> (1) The business has satisfactorily shown that disclosure of the information is likely to cause substantial harm to the business's competitive position; or
>
> (2) The information is voluntarily submitted information (see Sec. 2.201(i)), and its disclosure would be likely to impair the Government's ability to obtain necessary information in the future.

40 C.F.R. § 2.208.

Much of the information that would require reporting by the Proposed Rule is: 1) highly-guarded within the industry; 2) would not qualify as "emission data" subject to disclosure requirements; and 3) would harm the companies' competitive position if disclosed, and thus falls squarely within the realm of information to be treated as CBI under EPA's regulations. The confidentiality of each of the data elements that would be required by the Proposed Rule is discussed below.

4. <u>Analysis of Data Elements that Would Be Required by the Proposed Rule</u>

Under § 98.96, the Proposed Rule would require the reporting of a variety of information, some of which is properly considered "emission data," but some of which is instead highly-proprietary information that may be relevant to the calculating or verifying emissions, but does not itself constitute "emission data." Each of the data elements for which reporting would be required under § 98.96 of the Proposed Rule is discussed below.

a. <u>§ 98.96(a): Emissions of each F-GHG emitted from all plasma etching processes, all chamber cleaning, all chemical vapor deposition processes, and all heat transfer fluid use, respectively.</u>

Although reporting of F-GHG on a facility-wide basis would clearly be "emission data" appropriate for public disclosure under EPA's regulations and federal case law, the Proposed Rule calls for reporting of emission data on a process-specific basis. It is unclear from the repeated use of the term "processes" in this section whether the Proposed Rule may require semiconductor manufacturers to submit information that could be used to identify closely-guarded process "recipe" parameters. Competition within the semiconductor industry is based heavily on innovation and the development of new and faster products. Accordingly, semiconductor manufacturers invest considerable time and money in research and development perfecting the combination of gases (a "recipe" parameter) used in each production process for each product. As such, the combination of gases used in a particular process is a highly-guarded secret within the industry and always treated as CBI. The publication of F-GHG emissions by process can provide specific knowledge of proprietary device design and manufacturing processes that would compromise the trade secret nature of this information. SIA would like EPA to clarify that the Proposed Rule does not ask for reporting of process recipe information and to adopt SIA's proposed alternative approach to emission reporting that would rely on less sensitive information.

b. § 98.96(b): The method, mass of input F-GHG gases, and emission factors used for estimating F-GHG emissions.

The method and emission factors used for estimating F-GHG emissions are parameters used in the estimation of emissions and as such are not "emission data" in the practical or legal sense. Nor is this information a highly-guarded trade secret needing protection from public disclosure. On the contrary, the process-specific mass of input F-GHG gases is a highly-proprietary, key parameter of a company's process "recipes"; as a result, disclosure of this information would likely cause substantial competitive harm. Moreover, given the alternative, less intrusive means of determining emissions proposed by SIA in these comments, this information is not "necessary" to determine emissions. SIA therefore requests that EPA adopt SIA's proposed alternative approach to emission reporting that would require the submission of less sensitive information. If, however, EPA retains this reporting requirement, SIA requests that the Proposed Rule be modified to acknowledge that the mass of input F-GHG gas data are not "emission data" under EPA regulations and hence are not subject to public disclosure.

c. § 98.96(c): Production in terms of substrate surface area (e.g., silicon, PV-cell, LCD).

Facility production capacity and specific F-GHG usage and emission data can be used to inappropriately "characterize" semiconductor manufacturing operations because it can:

⇒ provide customers and competitors an incomplete picture of manufacturing efficiencies

⇒ influence prospective customer decisions based on perceived efficiencies and pricing; and

⇒ reveals customer or supplier sensitive product information.

Accordingly, facility production capacity is highly-proprietary CBI that is never released outside of individual companies. This information also is not "emission data" in the practical sense of the term, nor, given the alternative proposed by SIA that eliminates the use of "low," "medium," and "high," emission facilities, is it "necessary" to determine emissions, and thus does not qualify as "emission data" under EPA regulations. SIA therefore requests that EPA adopt SIA's proposed alternative approach to emission reporting that would require the submission of less sensitive information. If, however, EPA retains this reporting requirement, SIA requests that the Proposed Rule be modified to acknowledge that facility production data are not "emission data" under EPA regulations and hence are not subject to public disclosure.

d. **<u>§ 98.96(d): Factors used for gas process utilization and by-product formation, and the source and uncertainty for each factor.</u>**

This information is used in the calculation of emissions, but does not itself constitute "emission data" under EPA's regulations. Although this information is not necessarily considered CBI, SIA has proposed an alternative to calculating emissions that does not rely on this information and requests that EPA adopt its proposed alternative.

e. **<u>§ 98.96(e): The verified DRE and its uncertainty for each abatement device used, if you have verified the DRE pursuant to § 98.94(c).</u>**

Similarly, DRE is used in the calculation of abatement, and therefore emissions, but itself "emission data" under EPA's regulations and would not necessarily be considered CBI by manufacturers. Nonetheless, SIA has proposed that, rather than verifying DRE on a tool-by-tool basis, the semiconductor industry work in collaboration with abatement manufacturers to establish DRE values for a given F-GHG for each model of equipment. SIA requests that EPA adopt its proposed alternative.

f. **<u>§ 98.96(f): Fraction of each gas fed into each process type with abatement devices.</u>**

Similar to the mass of input F-GHG data, the fraction of each gas fed into each process type is used in the calculation of abatement, and therefore emissions, but is not itself "emission data" under EPA's regulations. In addition, this information could potentially be used (in particular with other gas usage information) to discern proprietary information about manufacturing processes and recipes. SIA therefore requests that the Proposed Rule be modified to explicitly acknowledge that the fraction of gas fed into each process type with abatement device is not "emission data" under EPA regulations and hence is not subject to public disclosure.

g. § 98.96(g): Description of abatement devices, including the number of devices of each manufacturer and model.

The description and number of abatement devices used by each facility is clearly not "emission data" in the legal or practical sense of the term. Moreover, this information could reveal confidential information about the types and number of different manufacturing processes that occur in each facility. Therefore, SIA requests that, if EPA retains this requirement, the Proposed Rule be modified to explicitly acknowledge that the number and types of abatement devices used at each facility is not "emission data" under EPA regulations and hence are not subject to public disclosure.

h. § 98.96(h): For heat transfer fluid emissions, inputs in the mass-balance Equation.

The inputs to the mass-balance equation for F-HTFs is information used in the calculation of emissions, but not itself "necessary" to determine emissions and therefore not "emission data" under EPA regulations. In addition, certain of the inputs to the mass balance equation, such as the nameplate capacity of equipment that contains F-HTF is sensitive CBI that could reveal information about specific production processes and capacities. SIA has proposed a less burdensome alternative method based on an annual mass balance for F-HTF used at each facility and requests that EPA adopt this alternative proposal. If EPA retains its proposed H-HTF reporting requirement, SIA requests that the Proposed Rule be modified to explicitly acknowledge that F-HTF mass balance inputs are not "emission data" under EPA regulations and hence are not subject to public disclosure.

i. § 98.96(i): Example calculations for F-GHG, N2O, and heat transfer fluid emissions.

As explained above, providing the input variables necessary to perform example calculations for F-GHG, N_2O and F-HTF emissions would reveal certain CBI that is not "emission data." We therefore request that EPA adopt SIA's proposed alternative approaches to emission reporting. If, however, EPA retains the proposed reporting requirements and requires sample calculations, SIA requests that the Proposed Rule be modified to explicitly acknowledge that any CBI information provided with such calculations is not "emission data" under EPA regulations and hence is not subject to public disclosure.

j. § 98.96(j): Estimate of the overall uncertainty in the emissions estimate.

An estimate of overall uncertainty in the emissions estimate is not "emission data" in a practical or legal sense. Also, this parameter is not defined in the Proposed Rule, so it is not clear what information EPA contemplates would be submitted to provide such an estimate. To the extent that that providing such an estimate entail the submission of CBI to perform the calculation SIA requests that the Proposed Rule be modified to explicitly acknowledge that any CBI information provided with such an estimate is not "emission data" under EPA regulations and hence is not subject to public disclosure.

5. The Information Requirements of the Proposed Rule Would Put U.S. Companies at a Competitive Disadvantage with Companies in Other Countries

Finally, SIA notes that the reporting requirements of the Proposed Rule, if not granted confidentiality, could place U.S. companies at a competitive disadvantage with companies in other countries that provide significantly more confidentiality protection. For example, Canada's F-GHG reporting rules do not allow the publication of any information of that could be used to identify specific facilities, and reporting emitters are required to report only emissions of GHGs show public disclosure will not affect the competitive position of any reporting emitter.[4] Requiring U.S. companies to disclose information that can provide specific knowledge of proprietary devices and processes to foreign-based companies, where no such requirement exists in the other countries, would place the entire U.S. semiconductor industry at a competitive disadvantage to foreign semiconductor industries.

C. Inadequacies of the Regulatory Impact Assessment

The GHG Reporting Proposal imposes significant new costs on the industry that are not accounted for by EPA in their regulatory impact assessment. The first year compliance costs will be 26 to 44 times greater than estimated by EPA and subsequent year compliance costs are >10 times higher than EPA's estimate. The cost to benefit ratio appears excessive given that the Proposed Rule requires much larger industry expenditures than estimated by EPA for only a modest improvement in accuracy of emissions estimates. Moreover, these expenditures do not result in any reduction of greenhouse gas emissions, which is the ultimate goal of both the industry and EPA.

The semiconductor industry has demonstrated a significant commitment to reducing process greenhouse gas emissions through process optimization, development and implementation of new chamber clean processes and chemistries, and adoption of lower global-warming impact etch gases. The industry and its suppliers have also deployed significant resources developing and installing abatement technologies and evaluating the effectiveness of capture-recovery systems. The industry has also worked through the WSC to establish a common global process for GHG emissions tracking method and a reduction goal, ensuring that different regions of the world are subject to similar

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4 *See* http://www.ghgreporting.gc.ca/F-GHG-GES/page21_4.aspx.

requirements and no region is at a competitive disadvantage. The impact of the Proposed Rule on the semiconductor industry has been underestimated by EPA. The Proposed Rule would impose significant costs that would result in only an incremental improvement in the accuracy of emissions estimates for the semiconductor industry. The most significant costs would be associated with tracking of gas consumption, verification of POU abatement DRE, and use of IPCC "Tier 3" factors for large facilities.

The Proposed Rule contains stringent requirements for tracking gas consumption that would require ALL reporting facilities to undertake costly infrastructure modifications. EPA erroneously assumes that that manufacturing facilities "monitor gas consumption using equipment (e.g., flow meters) that is already in place..." (RIA Cost Appendix, p.21). Based on this assumption, no capital or operating and maintenance (O&M) costs have been included in the estimate. Based on the survey conducted by ISMI, the total minimum industry cost for installing infrastructure to track gas consumption as required by the Proposed Rule is estimated to be $65 million. Annual O&M costs to calibrate and maintain gas consumption monitoring systems is estimated at $20 million per year.

To claim DRE for POU abatement, abatement units must be tested by the user or a third party using the draft EPA protocol. The EPA's estimated cost for the industry to comply with POU abatement device testing is $1.359 million per year, while the estimated minimum cost based on ISMI survey data is $17 million per year.

The EPA assumes that large facilities already have the "Tier 3" data needed to comply with the Proposed Rule and, therefore, would incur no additional cost for compliance. For the large facilities, the cost to comply with the requirements for Tier 3 is estimated at $13 million to $77 million. Initial compliance with the Proposed Rule would require an estimated 16 to 51 years of third-party testing; ongoing POU abatement evaluations will require a minimum of 8.7 years of third-party testing each year (assuming the third party can test three process platforms, six process recipes, or three POU abatement devices per week). The requirement for large facilities to utilize the IPCC Tier 3 methods is the most costly aspect of the Proposed Rule. However, the Tier 3 method offers only an incremental improvement in accuracy over Tier 2 methods. This improvement comes at a considerable cost, and given the systemic uncertainty in these calculations (based on inherent uncertainties of GWPs), it is not clear that these incremental improvements justify the significantly higher costs.

D. Comments On General Provisions

1. No Effect on Regulatory Status of GHGs

EPA should include language in the rule as adopted that ensures GHG reporting requirements do not automatically trigger other CAA obligations. To that end, the final GHG reporting rule should expressly state that the rule does not constitute an "actual control" on GHG emissions and that the rule does not and will not cause GHGs to become "subject to regulation" for purposes of Prevention of Significant Deterioration permitting in CAA Title I, Subtitle C. Similarly, the rule as adopted should expressly state that GHG reporting under the rule is not an "applicable requirement" under Title V of the CAA.

(Respectfully copied in concurrence of the comments submitted by the Texas Industry Project)

2. "Once-In, Always-In" or Sunset Provision

On page 16462, EPA has requested public comments on possible options for continued annual reporting to EPA for facilities that initially meet the GHG reporting threshold of 25,000 metric tons per year of CO2 equivalent GHG emissions but that subsequently fall below the GHG reporting threshold in following years. Annual reporting requirements for facilities that no longer meet the reporting threshold is an additional, unnecessary regulatory burden and subjects the facility to potential enforcement action.

SIA PROPOSED SOLUTION ALTERNATIVE

Facilities that fall below the GHG reporting threshold due to consistent facility decreases in GHG emissions or facility closures should be required to report that fact to EPA in the applicable reporting year on a separate EPA form that must be submitted, signed and certified by the designated representative in accordance with usual GHG Reporting Form. After the submission of the separate EPA form, no other GHG Reports would be due from the facility unless and until the GHG reporting threshold is subsequently exceeded by the facility.

(Respectfully copied in concurrence of the comments provided by the Arizona Chamber of Commerce and Industry.)

3. Report Certification (Electronic Signature)

On page 16615, EPA has proposed under 40 CFR § 98.4(e) that:

(e) *Certification of the GHG emissions report.* Each GHG emission report and any other submission under this part shall be submitted, signed, and certified by the designated representative in accordance with 40 CFR § 3.10. This section at 40 CFR § 3.10 titled

"What are the requirements for electronic reporting to EPA?" provides:

(a) A person may use an electronic document to satisfy a federal reporting requirement or otherwise substitute for a paper document or submission permitted or required under other provisions of Title 40 only if:

(1) The person transmits the electronic document to EPA's Central Data Exchange, or to another EPA electronic document receiving system that the Administrator may designate for the receipt of specified submissions, complying with the system's requirements for submission; and

(2) The electronic document bears all valid electronic signatures that are required under paragraph (b) of this section.

(b) An electronic document must bear the valid electronic signature of a signatory if that signature would be required under Title 40 to sign the paper document for which the electronic document substitutes, unless EPA announces special provisions to accept a handwritten signature on a separate paper submission and the signatory provides that handwritten signature.

SIA suggests that the designated representatives can accomplish signed electronic execution in one of two ways:

⇒ Print the document, sign it, and scan it back in.

⇒ Scan a copy of the designated representative's signature and paste it in the document.

SIA PROPOSED ALTERNATIVE

The EPA confirms that either execution method is acceptable as required under 40 CFR § 3.10 for purposes of execution and the electronic submission of the GHG Report.

(Respectfully copied in concurrence of the comments provided by the Arizona Chamber of Commerce and Industry.)

4. **Indirect Emissions**

Rule should not have any requirements to report indirect emissions (electricity consumption).

5. **Amended Annual Reports**

Under proposed 40 CFR § 98.3(b)(1), (b)(2) and (b)(3), facilities or suppliers are required to submit GHG emission reports to EPA by March 31, 2011 for the calendar year ending in 2010 and beyond. These GHG annual emission reports are required to be verified by the facility under 40 CFR § 98.3(c)(8) which states, "A signed and dated certification statement provided by the designated representative of the owner or operator, according to the requirements of § 98.4(e)(1)." Under proposed 40 CFR § 98.4(e)(1), the required certification statement of the GHG annual emissions report must be verified and includes personal affirmation language and even recognizes that significant penalties [civil or criminal] may be imposed upon the designated representative of the owner or operator for submitting false statements. EPA must recognize that even with a facility's best efforts, these GHG annual emission reports may include inaccurate estimates or calculations which in retrospect may need to be withdrawn or revised by a facility. For example, see proposed regulations at 40 CFR § 98.2(f) which states:

> Such owners and operators must reevaluate the applicability to this part to the facility or supplier (which reevaluation must include the revising of any relevant emissions calculations or other calculations) whenever there is any change to the facility or supplier that could cause the facility or supplier to meet the applicability requirements of paragraph (a) of this section. Such changes include but are not limited to process modifications, increases in operating hours, increases in production, changes in fuel or raw material use, addition of equipment, and facility expansion.

Other EPA programs require annual reporting (i.e., the Emergency Planning and Community Right to Know Act of 1986 (EPCRA) Section 313) and that most companies go to great lengths to comply with EPA regulations prior to submitting annual reports and certifying the results. Under other similar EPA programs, EPA has recognized that changes in calculations, facility facts and human errors do occur and EPA has provided an administrative process where a facility can submit a "Withdrawal" or "Voluntary Revision" of the annual EPA reporting form. Similar to the proposed GHG annual emission report, EPCRA has a certification statement.

SIA PROPOSED ALTERNATIVE

Amend the proposed GHG regulations to provide for the administrative withdrawal or revision of the GHG annual emission report. Develop appropriate GHG regulations and EPA forms for submitting Voluntary Revisions or Voluntary Withdrawals of GHG annual reports required under 40 CFR § 98.3(b)(1), (b)(2) and (b)(3). (See EPA EPCRA Forms for example).

(Respectfully copied in concurrence of the comments provided by the Arizona Chamber of Commerce and Industry.)

6. <u>EPA Enforcement Policy</u>

On page 16595 and 16596, EPA has identified a number of violations subject to EPA enforcement. The proposed GHG rule at 40 C.F.R. § 98.8 provides:

> Any violation of the requirements of this part shall be a violation of the Clean Air Act. A violation includes, but is not limited to, failure to report GHG emissions, failure to collect data needed to calculate GHG emissions, failure to continuously monitor and test as required, failure to retain records needed to verify the amount of GHG emission, and failure to calculate GHG emissions following the methodologies specified in this part. Each day of a violation constitutes a separate violation.

EPA has cited Clean Air Act § 307(d)(1)(V)[5] "[S]uch other actions as the Administrator may determine." as legal authority for the captioned GHG regulations, and the mandatory reporting of GHG. As such, violations of the proposed GHG emission reporting rules would be enforced as violations of the Clean Air Act under § 113 and §§ 203-205.[6] EPA enforcement actions should be legally justifiable, uniform and consistent, and the enforcement response should be appropriate for the violations committed and the equitable facts surrounding the identified reporting violation.

SIA appreciates that the Proposed Rule, when finalized, would be legally enforceable. We would urge EPA, however, 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 a regime with guidance to

5 42 U.S.C. § 7607(d)(1)(V)(2008).

6 42 U.S.C. § 7413 and 42 U.S.C. § 7522-7524 (2008).

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.[7]

7. Report Verification

On page 16476, EPA has requested public comment on possible options for verification of GHG Emissions Reports. EPA identified three alternative approaches to verification: (1) self-certification without independent verification, (2) self-certification with third-party verification, and (3) self-certification with EPA verification. The SIA's position is that the third-party verification approach places unnecessary, additional costs on facilities: (1) Reporters would need to hire and pay verifiers, at a significant exposure to each reporting facility, (2) reporters would incur costs to assemble and provide the verifiers detailed supporting data for the emission estimates, (3) the delay associated with the proposed and final EPA regulations associated with third-party verification and the subsequent EPA qualification of third-party verifiers would extend the initial reporting period beyond the EPA proposed date of March 31, 2011 for the calendar year 2010.

SIA PROPOSED ALTERNATIVE

Report verification should be based on the EPA's current position and the final adoption of Option 3 identified as "self-certification with EPA verification."

(Respectfully copied in concurrence of the comments provided by the Arizona Chamber of Commerce and Industry.)

8. Reporting Timeframe

EPA should allow facilities more time than the current three (3) months to report prior calendar year data. That period is insufficient to collect, analyze, prepare, and certify data for submission to EPA. Other reporting programs allow longer time intervals for reporting – EPA's Toxic Release Inventory allows six (6) months and California's mandatory GHG reporting program allows five (5) months.

SIA PROPOSED ALTERNATIVE

Reporting timeframe should be six months.

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7 Incentives for Self-Policing; Discovery, Disclosure and Prevention of Violations; Notice, 65 Fed. Reg. 19618 (Apr. 11, 2000).

V. REDLINE VERSION OF PROPOSED RULE THAT REFLECTS SIA'S PROPOSED ALTERNATIVE

Sec. 98.2 Do I need to report?

* * *

(vi) ~~Electronics~~Any electronics-Semiconductor, microelectronicmetchinical system (MEMS), and liquid crystal display (LDC) manufacturing ~~facilities with an annual production capacity that exceeds any of the thresholds listed in this paragraph.~~facility that emits 25,000 metric tons CO_{2E} or more per year.

~~(A) Semiconductors: 1,090 m² silicon.~~

~~(B) MEMS: 1,020 m² silicon.~~

~~(C) LDC: 235,700 m² LCD.~~

* * *

Sec. 98.3 What are the general monitoring, reporting, recordkeeping and verification requirements of this part?

* * *

(b) *Schedule*. Unless otherwise specified in subparts B through PP, you must submit an annual GHG emissions report no later than ~~March~~ July ~~3~~1 of each calendar year for GHG emissions in the previous calendar year.

* * *

SUBPART I--ELECTRONICS MANUFACTURING

Sec. 98.90 Definition of the source category.

(a) The electronics source category consists of any of the processes listed in paragraphs (a)(1) through (5) of this section. Electronics manufacturing facilities include but are not limited to facilities that manufacture semiconductors, liquid crystal displays (LCD), microelectromechanical systems (MEMs), and photovoltaic (PV) cells.

(1) Each electronics manufacturing production process in which the etching process uses plasma-generated fluorine atoms, which chemically react with exposed thin films (e.g., dielectric, metals) and silicon to selectively remove portions of material.

(2) Each electronics manufacturing production process in which chambers used for depositing thin films are cleaned periodically using plasma-generated fluorine atoms from fluorinated and other gases.

(3) 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.

(4) Each electronics manufacturing production process in which the chemical vapor deposition process uses nitrous oxide.

(5) Each electronics manufacturing production process in which fluorinated GHGs are used as heat transfer fluids (HTFs) to cool process equipment, control temperature during device testing, and solder semiconductor devices to circuit boards.

Sec. 98.91 Reporting threshold.

You must report GHG emissions under this subpart if your facility contains an electronics manufacturing process and the facility meets the requirements of either Sec. 98.2(a)(1) or (2).

Sec. 98.92 GHGs to report.

(a) You shall report emissions of nitrous oxide and fluorinated GHGs (as defined in Sec. 98.6). The fluorinated GHGs that are emitted from electronics production processes include but are not limited to those listed in Table I-1 of this subpart. You must report:

(1) Fluorinated GHGs from plasma etching.

(2) Fluorinated GHGs from chamber cleaning.

(3) Nitrous oxide from chemical vapor deposition.

(4) Fluorinated GHGs from heat transfer fluid use.

(b) You shall report CO2, N2O and CH4 combustion-related emissions, if any, at electronics manufacturing facilities. For stationary fuel combustion sources, follow the calculation procedures, monitoring and QA/QC methods, missing data procedures, reporting requirements, and recordkeeping requirements in subpart C of this part.

Sec. 98.93 Calculating GHG emissions.

(a) Only for the initial report submitted by your facility after the effective date of this regulation, you may employ any method for calculating F-GHG emissions consistent with:

(1) IPCC 2006, 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan; and

(2) the method you have been using, if any, to report under an existing federal or state program, such as the U.S. EPA "PFC Emission Reduction Partnership for the Semiconductor Industry".

For all subsequent reports, you must follow all requirements for calculating F-GHG emissions set forth in this regulation, except that you may petition the Administrator for a variance from these requirements as follows:

(i) Your petition must contain information sufficient to demonstrate that

(I) An alternative for calculating GHG emissions produces reliable information; and

(II) Adherence to the requirements of this regulation will pose undue hardship on your facility as a result of either the cost or the infeasibility of complying with those requirements.

(ii) Your petition shall be deemed granted within ninety (90) days of filing, unless the Administrator responds, in writing, with a finding that the Petition does not make a sufficient demonstration and explains the reasons for this finding.

(~~a~~b) You shall calculate annual facility-level F-GHG emissions of each F-GHG from all etching processes using Equations I-1 and I-2 of this section, except that you may exclude from such calculation any F-GHG which comprises less than five percent of the total of all F-GHG compounds being used by your facility in all etching processes:

[GRAPHIC] [TIFF OMITTED] ~~TP10AP09.034~~

Where:

etchEi = Annual emissions of input gas i from all etch processes

Eij = Annual emissions of input gas i from etch process j (metric tons), calculated in equation I-5.

[GRAPHIC] [TIFF OMITTED] TP10AP09.035

Where:

etchBEk = Annual emissions of by-product gas k from all etch processes (metric tons).

BEkij = Annual emissions of by-product k formed from input gas i during etch process j (metric tons), calculated in equation I-6.

(bc) You shall calculate annual facility-level F-GHG emissions of each F-GHG from all CVD chamber cleaning processes using Equations I-3 and I-4 of this section, except that you may exclude from such calculation any F-GHG which comprises less than five percent of the total of all F-GHG compounds being used by your facility in all CVD processes.

[GRAPHIC] [TIFF OMITTED]
and I-4 of this section:
[GRAPHIC] [TIFF OMITTED] TP10AP09.036

Where:

cleanEi = Annual emissions of input gas i from all CVD cleaning processes (metric tons).

Eij = Annual emissions of input gas i from CVD cleaning process j (metric tons), calculated in equation I-5.

[GRAPHIC] [TIFF OMITTED] TP10AP09.037

Where:

cleanBEk = Annual emissions of by-product gas k from all CVD cleaning processes (metric tons)

BEkij = Annual emissions of by-product k formed from input gas i during CVD cleaning process j (metric tons), calculated in equation I-6.

(cd) You shall calculate annual facility-level F-GHG emissions for each etching process and each chamber cleaning process using Equations I-5 and I-6 of this section. using data as specified below, except you may exclude from such calculation any F-GHG that which comprises less than five percent of the total of all F-GHG compounds being used by your facility in all etching processes

(1) Process-specific Process Utilization and By-product Formation Factors

(1) Semiconductor facilities that have an annual capacity of greater than 10,500 m\2\ silicon shall use process-specific process utilization and by-product formation factors determined as specified in Sec. 98.94(b).

(2) All other electronics facilities shall use the default emission factors for process utilization and by-production formationi) To the extent any facility has Measured Process-specific Process Utilization and By-product Formation Factors in their physical possession, that facility shall determine whether such Factors satisfy the specifications in Sec. 98.94(b), and if so, then use such Factors in its annual facility-level F-GHG emissions calculation.

(ii) To the extent any facility does not have Process-specific Process Utilization and By-product Formation Factors in their physical possession that satisfy the specifications in Sec. 98.94(b), that facility shall use the Factors shown in Tables I-2, I-3, and I-4 of subpart I for semiconductor and MEMs, LCD, and PV manufacturing, respectively.

(2) Gas-Usage Based on Gas-Specific Heel Factors

(i) Absent a demonstration of infeasibility pursuant to Sec. 98.93(a)(2)(ii), each facility shall calculate a Gas-Specific Heel Factor for each cylinder type (*i.e.*, single, group or bulk cylinder) on a per gas basis as follows:

(I) This Gas-Specific Heel Factor shall be calculated based on the weight of the gas in the cylinder provided by the gas supplier (commonly referred to as the "tag weight") and the trigger point used by the facility for changing out the cylinder (commonly referred to as the "Change-out Trigger").

(II) The Change-out Trigger may, depending upon the gas and equipment configuration, be based on measured weight of the cylinder or the measured pressure of the cylinder. Where the Change out Trigger is based on measured pressure, such Trigger shall be converted into calculated weight using the Ideal Gas Law (PV = ZnRT), with the appropriate compressibility factor (Z) for the gas in order to calculate the Gas-Specific Heel Factor.

(III) The Gas-Specific Heel Factor must be calculated only once for each cylinder type on a per gas basis, but shall be re-calculated in any situation, whether temporary or permanent, where the facility uses a Change-out Trigger that differs by more than 1 percent from the Trigger used to calculate the Factor.

(ii) In the event calculating a Gas-Specific Heel Factor is infeasible, a facility shall:

(I) document the reasons for infeasibility and retain such documentation on file; and

(II) utilize the default heel factor of 10 percent specific in the 2006 IPCC Report.

[GRAPHIC] [TIFF OMITTED] TP10AP09.038

Where:

Eij = Annual emissions of input gas i from process j (metric tons).
Cij = Amount of input gas i consumed in process j, (kg).

Uij = Process utilization rate for input gas i during process j.

aij = Fraction of input gas i used in process j with abatement devices.

dij = Fraction of input gas i destroyed in abatement devices connected to process j (defined in Equation I-11). This is zero unless the facility verifies the DRE of the device pursuant to Sec. 98.94(c) of Subpart I.

0.001 = Conversion factor from kg to metric tons.
[GRAPHIC] [TIFF OMITTED] TP10AP09.039

[[Page 16649]]

Where:

BEkij = Annual emissions of by-product k formed from input gas i during process j (metric tons).
Bkij = Kg of gas k created as a by-product per kg of input gas i consumed in process j.

Cij = Amount of input gas i consumed in process j (kg).

aij = Fraction of input gas i used in process j with abatement devices.

dkj = Fraction of by-product gas k destroyed in abatement devices connected to process (j). This is zero unless the facility verifies the DRE of the device pursuant to Sec. 98.94(c) of Subpart I.

0.001 = Conversion factor from kg to metric tons.

(de) You shall report annual N2O facility-level emissions during chemical vapor deposition using Equation I-7 of this section.

[GRAPHIC] [TIFF OMITTED] TP10AP09.040

Where:

E(N2O) = Annual emissions of N2O (metric tons/year).

CN2O = Annual Consumption of N2O (kg).

0.001 = Conversion factor from kg to metric tons.

(ef) For facilities that use heat transfer fluids, you shall report the annual emissions of fluorinated GHG heat transfer fluids ~~using Equation I-8 of this section.~~(F-HTFs) on a mass balance basis as specified below, except that you may exclude from such reporting any F-HTF which comprises less than five percent of the total of all F-HTFs being used by your facility in all processes:

~~[GRAPHIC] [TIFF OMITTED] TP10AP09.041~~

~~Where:~~

~~EHi = Emissions of fluorinated GHG heat transfer fluid i, (metric tons/year).~~

~~Density = Density of heat transfer fluid i (kg/l).~~

~~Iio = Inventory of heat transfer fluid i at the end of previous reporting period (l).~~
(i) To the extent the facility does not track amounts of F-HTFs placed into service and shipped offsite for disposal, then annual usage of each individual F-HTF shall be reported based on total amount of that F-HTF purchased by the facility.

~~Pit = Net purchases of heat transfer fluid i during the current reporting period (l).~~
(ii) Where such tracking occurs on an individual F-HTF basis, then annual usage of each individual F-HTF shall be reported based on the total amount of that F-HTF purchased less any amount put into service into a piece of equipment and less any amount shipped offsite for disposal or recycling.

~~Nit = Total nameplate capacity [charge] of equipment that contains heat transfer fluid i and that is installed during the current reporting period.~~

(iii) Where such tracking occurs on an aggregated F-HTF basis, then annual usage of each individual F-HTF shall be reported based on engineering estimates and purchase information.

Rit = Total nameplate capacity [charge] of equipment that contains heat transfer fluid i and that is retired during the current reporting period.

(iv) For any individual F-HTFs with a documented IPCC 4th Assessment GWP and a vapor pressure greater than 400 Pa at 25C, a facility will estimate and report the CO2e based on the following equation:

Iit = Inventory of heat transfer fluid i at the end of current reporting period (l).

$$CO2e_{[H-FTFi]} = Usage_{[H-FTFi]} * GWP100_{[H-FTFi]}$$

Dit = Amount of heat transfer fluid i recovered and sent off site during current reporting period, (l).

0.001 = Conversion factor from kg to metric tons.

(v) For any individual F-HTFs without a documented IPCC 4th Assessment GWP or with a vapor pressure lower than 400 Pa at 25C, a facility is not required to calculate or report a CO2e emissions equivalent or to include the F-HTF in its total CO2e emissions.

Sec. 98.94 Monitoring and QA/QC requirements.

(a) You must estimate gas consumption according to the requirements in paragraph (a)(1) or (a)(2) of this section for each process or process type, as appropriate. (1) Monitor changes in container mass and inventories for each gas using weigh scales with an accuracy and precision of one percent of full scale or better. Calculate the gascalculate the consumption using Equation I-9 of this section. based on the Gas-Specific Heel Factors determined pursuant to Sec. 98.93(a)(2)(i), except as provided in Sec. 98.93(a)(2)(ii).

[GRAPHIC] [TIFF OMITTED] TP10AP09.042

Where:

Ci = Annual consumption of input gas i (metric tons/year).

IBi = Inventory of input gas i stored in cylinders or other containers at the beginning of the year, including heels (kg).

IEi = Inventory of input gas i stored in cylinders or other containers at the end of the year, including heels (kg).

A = Acquisitions of that gas during the year through purchases or other transactions, including heels in cylinders or other containers returned to the electronics production facility (kg).

D = Disbursements of gas through sales or other transactions during the year, including heels in cylinders or other containers returned by the electronics production facility to the gas distributor (kg).

0.001 = Conversion factor from kg to metric tons.

(~~2) Monitor the mass flow of the pure gas into the system using flowmeters. The flowmeters must have an accuracy and precision of one percent of full scale or better. (b) If you use fluorinated GHG utilization rates and by-product emission factors other than the defaults in Tables I-2, I-3, or I-4 of Subpart I, you must use fluorinated GHG utilization rates and by-product emission factors that have been measured using the International SEMATECH Manufacturing Initiative's Guideline for Environmental Characterization of Semiconductor Process Equipment. You may use fluorinated GHG utilization rates and by-product emission factors measured by manufacturing equipment suppliers if the conditions in paragraph (b)(1) and (2) of this section are met.~~ b) To the extent any facility has Measured Process-specific Process Utilization and By-product Formation Factors in their physical possession, you must use such Factors if the conditions in either paragraph (b)(1) or (2) of this section are met.

(1) The Measured Process-specific Process Utilization and By-product Formation Factors reflect measurements performed *in situ* at your facility (by you, a third party or the manufacturing equipment supplier ~~has measured the GHG utilization rates and by-product emission factors using~~) based on measurement practices consistent with good analytical techniques, such as practices consistent with the International SEMATECH ~~Guideline.~~ Manufacturing Initiative's Guidelines for Environmental Characterization of Semiconductor Process Equipment ("SEMATECH Guideline"); or

~~(2) The conditions under which the measurements were made are representative of your facility's F-GHG emitting processes.~~

(2) The Measured Process-specific Process Utilization and By-product Formation Factors have been provided to you by the manufacturing equipment supplier along with a statement that such Factors are based on measurement practices consistent with good analytical techniques, such as practices consistent with the SEMATECH Guideline, and you have a reasonable basis to conclude that such measurements were performed under conditions consistent with the manner in which your facility is using the equipment in question.

(c) If your facility employs abatement devices and you wish to reflect the emission reductions due to these devices in Sec. 98.93(c), you must ~~verify~~

theeither qualify to rely on the 2006 IPCC default destruction or removal efficiency (DRE) pursuant to paragraph (c)(1) of this section of the devicesor you must verify DRE using the methods in either paragraph (c)(1) or (2) of this section.

(1) ExperimentallyFor any abatement device that is a device model in existence as of the effective date of this regulation, you may rely on the 2006 IPCC DRE as long as:

(i) You maintain the device in good working order and operate it properly; and

(ii) You do not have in your possession testing data for that model of device which satisfies the specifications in 98.94(c)(2).

(2) For any abatement device that is a device model not in existence until after the effective date of this regulation, you must rely on testing data to determine the effective dilution through the abatement device and measure abatement DRE. You can rely on testing data supplied by the manufacturer of that model as long as your facility operates the device within the manufacturer's specified gas flow and mix limits. Alternatively, you can rely on testing data generated experimentally during actual or simulated process conditions by following the procedures of this paragraph.as long as your facility operates the device within the alternate limits supported by those data. These testing data, whether from the manufacturer or generated experimentally, should be consistent with the following measurement guidelines:

(i) Measure the concentrations of F-GHGs exiting the process tool and entering and exiting the abatement system under operating process and abatement system conditions that are representative of those for which F-GHG emissions are estimated and abatement-system DRE is used for the F-GHG reporting period.\1\

\1\ Abatement system means a point-of-use (POU) abatement system whereby a single abatement system is attached to a single process tool or single process chamber of a multi-chamber tool.

(ii) Measure the dilution through the abatement system and calculate the dilution factor under the representative operating conditions given in paragraph (c)(i) of this section by using the tracer method. This method consists of injecting known flows of a non-reactive gas (such as krypton) at the inlet of the abatement system, measuring the time-averaged concentrations of krypton entering ([Kr]in) and exiting ([Kr]out) the abatement system, and calculating the dilution factor (DF) as the ratio of the time-averaged measured krypton concentrations entering and exiting the abatement system, using equation I-10 of this section.

[[Page 16650]]

[GRAPHIC] [TIFF OMITTED] TP10AP09.043

(iii) Measure the F-GHG concentrations in and out of the device with all process chambers connected to the F-GHG abatement system and under the production and abatement system conditions for which F-GHG emissions are estimated for the reporting period.\2\

\2\ Most process tools have multiple chambers. For combustion-type abatement systems, the outlets of each chamber separately enter the destruction-reactor because premixing of certain gaseous mixtures may be conducive to fire or explosion. For the less-frequently used plasma-type POU abatement systems, there is one system per chamber.

(iv) Calculate abatement system DRE using Equation I-11 of this section, where it is assumed that the measurement pressure and temperature at the inlet and outlet of the abatement system are identical and where the relative precision ([egr]) of the quantity ci-out*DF/ci-in shall not exceed 10 percent (two standard deviations) using proper statistical methods.

[GRAPHIC] [TIFF OMITTED] TP10AP09.044

Where:

dij = Destruction or removal efficiency (DRE)

ci-in = Concentration of gas i in the inflow to the abatement system (ppm).

ci-out = Concentration of gas i in the outflow from the abatement system (ppm).
DF = Dilution Factor calculated using Equation I-10.

(v) The DF may not be obtained by calculation from flows other than those obtained by using the tracer method described in paragraph (ii) of this section.

~~(2) Install abatement devices that have been tested by a third party (e.g., UL) according to EPA's Protocol for Measuring Destruction or Removal Efficiency (DRE) of Fluorinated Greenhouse Gas Abatement Equipment in Electronics Manufacturing. This testing may be obtained by the manufacturer of the equipment.~~

(d) Abatement devices must be operated within the manufacturer's specified ~~equipment lifetime and~~ gas flow and mix limits or alternate limits supported by testing data and must be maintained in good working order ~~according to the manufacturer's guidelines~~.

(e) You shall adhere to the QA/QC procedures of this paragraph when estimating F-GHG and N2O emissions from cleaning/etching processes:

(1) You shall follow appropriate the QA/QC procedures, such as ~~in~~ the International SEMATECH Manufacturing Initiative's Guideline for Environmental Characterization of Semiconductor Process Equipment when estimating facility-specific gas process utilization and by-product gas formation.

(2) You shall follow the QA/QC procedures in the EPA DRE measurement protocol when estimating abatement device DRE.

~~(3) You shall certify that abatement devices are maintained in accordance with manufacturer specified guidelines.~~

(3~~4~~) You shall certify that gas consumption is tracked to a high degree of precision as part of normal facility operations and that further QA/QC is not required.

(f) You shall adhere to the QA/QC procedures of this paragraph when estimating F-GHG emissions from heat transfer fluid use:

(1) You shall review all inputs to Equation I-4 of this section to ensure that all inputs and outputs to the facility's system are accounted for.

(2) You shall not enter negative inputs into the mass balance Equation I-4 of this section and shall ensure that no negative emissions are calculated.

(3) You shall ensure that the beginning of year inventory matches the end of year inventory from previous year.

~~(g) All flowmeters, scales, load cells, and volumetric and density measures used to measure quantities that are to be reported under Sec. 98.92 and Sec. 98.96 shall be calibrated using suitable NIST-traceable standards and suitable methods published by a consensus standards organization (e.g., ASTM, ASME, ASHRAE, or others). Alternatively, calibration procedures specified by the flowmeter, scale, or load cell manufacturer may be used. Calibration shall be performed prior to the first reporting year. After the initial calibration, recalibration shall be performed at least annually or at the minimum frequency specified by the manufacturer, whichever is more frequent.~~

(h g) All instruments (e.g., mass spectrometers and fourier transform infrared measuring systems) used to determine the concentration of fluorinated greenhouse gases in process streams shall be calibrated just prior to DRE, gas utilization, or product formation measurement through analysis of certified standards with known concentrations of the same chemicals in the same ranges (fractions by mass) as the process samples. Calibration gases prepared from a high-concentration certified standard using a gas dilution system that meets the requirements specified in Test Method 205, 40 CFR Part 51, Appendix M may also be used.

Sec. 98.95 Procedures for estimating missing data.

(a) For semiconductor facilities that have an annual capacity of greater than 10,500 m^2 silicon, you shall estimate missing site-specific gas process utilization and by-product formation using default factors from Tables I-2 through I-4 of this subpart. However, use of these default factors shall be restricted to less than 5 percent of the total facility emissions.

(b) For facilities using heat transfer fluids and missing data for one or more of the parameters in Equation I-8, you shall estimate heat transfer fluid emissions using the arithmetic average of the emission rates for the year immediately preceding the period of missing data and the months immediately following the period of missing data. Alternatively, you may estimate missing information using records from the heat transfer fluid supplier. You shall document the method used and values estimated for all missing data values.

(c) If the methods specified in paragraphs (a) and (b) of this section are likely to significantly under- or overestimate the value of the parameter during the period when data were missing (e.g., because the monitoring failure was linked to a process disturbance that is likely to have significantly increased the F-GHG emission rate), you shall develop a best estimate of the parameter, documenting the methods used, the rationale behind them, and the reasons why the methods specified in paragraphs (a) and (b) of this section would lead to a significant under-or overestimate of the parameter. ***Sec. 98.96 Data reporting requirements.***

In addition to the information required by Sec. 98.3(c), you shall include in each annual report the following information identified below for each electronics manufacturer. Not all of this information constitutes publicly available "emissions data", and therefore, you should submit the information, when appropriate and justified, with the requisite confidentiality demonstration pursuant to 40 C.F.R. part 2, subpart B.

(a) Emissions of each GHG emitted from all plasma etching processes combined, all chamber cleaning processes combined, all chemical vapor deposition processes combined, and all heat transfer fluid use combined, respectively.

(b) The method, mass of input F-GHG gases, and emission factors used for estimating F-GHG emissions.

(c) ~~Production in terms of substrate surface area (e.g., silicon, PV-cell, LCD). (d) Factors used for gas process utilization and by-product formation~~Any Process-specific Utilization and By-product Formation Factor used in determining emissions, and the source and uncertainty for each ~~factor~~such Factor.

(~~e) The verified~~d) Any default factors used in determining emissions.

(d) The DRE ~~and its uncertainty~~used for each abatement device ~~used, if you have verified the DRE pursuant to Sec. 98.94(c)~~.

[[Page 16651]]

~~(f) Fraction of each gas fed into each process type with abatement devices.~~

~~(g) Description of abatement devices, including the number of devices of each manufacturer and model.~~

(~~h~~e) For heat transfer fluid emissions, inputs in the mass-balance Equation.

(~~i~~f) Example calculations for F-GHG, N2O, and heat transfer fluid emissions.

~~(j) Estimate of the overall uncertainty in the emissions estimate.~~

Sec. 98.97 Records that must be retained.

In addition to the information required by Sec. 98.3(g), you must retain the following records:

(a) Data used to estimate emissions including all spreadsheets and copies of calculations used to estimate emissions.

~~(b) Documentation for the values used for GHG utilization rates and by-product emission factors, including documentation that these were measured using the the International SEMATECH Manufacturing Initiative's Guideline for Environmental Characterization of Semiconductor Process Equipment.~~

(b) Documentation of the determination required in Sec. 98.94(b) for any use of Measured Process-specific Process Utilization and By-product Formation Factors.

(c) The date and results of the initial and any subsequent tests of emission control device DRE, including the following information:

(1) Dated certification, by the technician who made the measurement, that the dilution factor was determined using the tracer method.

(2) Dated certification, by the technician who made the measurement, that the DRE was calculated using the formula given in Sec. 98.94(c)(1)(iv).

(3) Documentation of the measured flows, concentrations and calculations used to calculate DF, relative precision ([egr]), and DRE.

(d~~) The date and results of the initial and any subsequent tests to determine process tool gas utilization and by-product formation factors. (e~~) Abatement device calibration and maintenance records.

Sec. 98.98 Definitions.

All terms used in this subpart have the same meaning given in the Clean Air Act and subpart A of this part.

Table I-1 of Subpart I--GHGs Typically Used by the Electronics Industry

Product type	F-GHGs Used during manufacture
Electronics............	CF4, C2F6, C3F8, c-C4F8, c-C4F8O, C4F6, C5F8, CHF3, CH2F2, NF3, SF6, and HTFs (CF3-(O-CF(CF3)-CF2)n-(O-CF2)m-O-CF3, CnF2n+2, CnF2n+1(O)CmF2m+1, CnF2nO, (CnF2n+1)3N)

Table I-2 of Subpart I--Default Emission Factors for Semiconductor and MEMs Manufacturing

Process gases	Factors						
	Etch 1-Ui	CVD 1-Ui	Etch BCF4	Etch BC2F6	CVD BCF4	CVD BC3F8	

CF4	0.7	0.9	NA	NA	NA	NA
C2F6	0.4*	0.6	0.4*	NA	0.1	NA
CHF3	0.4*	NA	0.07*	NA	NA	NA
CH2F2	0.06*	NA	0.08*	NA	NA	NA
C3F8	NA	0.4	NA	NA	0.1	NA
c-C4F8	0.2*	0.1	0.2	0.2	0.1	NA
NF3	NA	0.02	NA	NA	[dagger] 0.02	NA
Remote NF3	0.2	0.2	NA	NA	[dagger] 0.1	NA
SF6	0.2	NA	NA	NA	NA	NA
C4F6a	0.1	NA	0.3*	0.2*	NA	NA
C5F8a	0.2	0.1	0.2	0.2	0.1	NA
C4F8Oa	NA	0.1	NA	NA	0.1	0.4

Notes: NA denotes not applicable based on currently available information.
* Estimate includes multi-gas etch processes.
[dagger] Estimate reflects presence of low-k, carbide and multi-gas etch processes that may contain a C-containing FC additive.

Table I-3 of Subpart I--Default Emission Factors for LCD Manufacturing

Process gases	Factors				
	Etch 1-Ui	CVD 1-Ui	Etch BCF4	Etch BCHF3	Etch BC2F6
CF4	0.6	NA	NA	NA	NA
C2F6	NA	NA	NA	NA	NA
CHF3	0.2	NA	0.07	NA	0.05

CH2F2..........................	NA	NA	NA	NA	NA
C3F8...........................	NA	NA	NA	NA	NA
c-C4F8..........................	0.1	NA	0.009	0.02	NA
NF3 Remote......................	NA	0.03	NA	NA	NA
NF3............................	NA	0.3	NA	NA	NA
SF6............................	0.3	0.9	NA	NA	NA

Notes: NA denotes not applicable based on currently available information.

[[Page 16652]]

Table I-4 of Subpart I--Default Emission Factors for PV Manufacturing

Process gases	Factors				
	Etch 1-Ui	CVD 1-Ui	Etch BCF4	Etch BC2F6	CVD BCF4
CF4............................	0.7	NA	NA	NA	NA
C2F6...........................	0.4	0.6	0.2	NA	0.2
CHF3...........................	0.4	NA	NA	NA	NA
CH2F2..........................	NA	NA	NA	NA	NA
C3F8...........................	NA	0.1	NA	NA	0.2
c-C4F8..........................	0.2	0.1	0.1	0.1	0.1
NF3 Remote......................	NA	NA	NA	NA	NA
NF3............................	NA	0.3	NA	NA	NA
SF6............................	0.4	0.4	NA	NA	NA

Notes: NA denotes not applicable based on currently available information.

VI. ATTACHMENTS: ISMI SURVEYS

A. Results of the ISMI ESH Technology Center Greenhouse Gas Facility Survey, 09065012A (Jun. 9, 2009)

B. Results of the ISMI Fluorinated Heat Transfer Fluids Survey, 09065014A (Jun. 9, 2009)

C. Analysis of Nitrous Oxide Survey Data, 09065015A (Jun. 9, 2009)

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ATTACHMENT A

Results of the ISMI ESH Technology Center Greenhouse Gas Facility Survey

International SEMATECH Manufacturing Initiative

Technology Transfer #09065012A-TR

Results of the ISMI ESH Technology Center Greenhouse Gas Facility Survey

Technology Transfer #09065012A-TR
International SEMATECH Manufacturing Initiative
June 8, 2009

Abstract: This report from the International SEMATECH Manufacturing Initiative (ISMI) ESH Technology Center (ESHT001) presents the results and analysis of a greenhouse gas facility survey of ISMI and Semiconductor Industry Association (SIA) members. The purpose was to gather facility-specific data on the impact on fab operations of Environmental Protection Agency's proposed Mandatory Greenhouse Gas (GHG) Reporting Rule published in the Federal Register on April 10, 2009. Results of other surveys in this series are in Technology Transfers #09065014A-TR and #09065015A-TR.

Keywords: Greenhouse Effect, Government Regulations, Emissions Monitoring

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Table of Contents

List of Figures

List of Tables

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- The authors and contributors do not undertake any obligation to update or publicly release any revisions to forward-looking statements to reflect events, circumstances or changes in expectations after the date of this report.

Acknowledgments

The author wishes to acknowledge the members of the ISMI Greenhouse Gas Working Group and SIA PFC Committee for their participation in the survey.

1 EXECUTIVE SUMMARY

In support of the industry's response to the U.S. Environmental Protection Agency (EPA) proposed rule Mandatory Reporting of Greenhouse Gases, the International SEMATECH Manufacturing Initiative (ISMI) and the Semiconductor Industry Association (SIA) developed and sent to their members a series of surveys to collect technical data on greenhouse gases (GHGs). The first survey gathered facility-specific data on the impact of the proposed rule on semiconductor manufacturing facilities.

Twenty-one responses were received from companies representing 58% of total U.S. silicon area production capacity. Survey respondents included 25 of the EPA's estimated 29 large fabs.

Results showed that the industry is not currently collecting significant portions of the data required by the proposed rule. The rule also requires that the industry spend large amounts of money and devote significant resources to track process GHG emissions. The final year compliance costs will be 26X to 44X greater than estimated by the EPA, and it is not clear whether the required data will be more accurate than what is already being generated.

2 BACKGROUND

The EPA's Mandatory Reporting of Greenhouse Gases was published in the Federal Register on April 10, 2009, beginning the 60-day comment period. The preamble explains the EPA's basis for the proposed rule. Subpart I outlines specific requirements for semiconductor manufacturing facilities. After reviewing the preamble and proposed rule, semiconductor industry members felt strongly that accurate data reflecting industry practice and assessing the cost impact of the rule must be collected and analyzed by a third party. ISMI's Environment, Safety, and Health Technology Center was asked to develop surveys, collect survey responses, and complete data analysis for ISMI and SIA members. Data analysis has been completed independent of the SIA to preserve respondent confidentiality.

3 SURVEY OVERVIEW

The survey consisted of the following parts:

- Background: Brief overview of the proposed rule and its requirements.
- Definitions of the terms used in the rule and survey.
- Part 1: General Facility Information
- Part 2: Information to Scope the Size and Cost of Fluorinated GHG and Nitrous Oxide (N_2O) Emissions Characterization Efforts—Data was used to estimate the potential scope and cost impact of process and point-of-use (POU) abatement emissions characterization that would be required of the industry under the proposed rule.
- Part 3: Information on Perfluorocompound (PFC) and N_2O Gas Distribution and Measurement of Gas Usage—Data was used to determine the way process GHGs are distributed in semiconductor fabrication lines (fabs), and methods by which gas consumption is currently tracked and the installation and operational costs to comply with the gas consumption measurement requirements of the rule.

- Part 4: Combustion Related Emissions
- Part 5: Recordkeeping and Reporting Requirements

The report compares the proposed requirements with industry practice in estimating GHG consumption, characterizing GHG POU abatement, and estimating GHG emissions. Recordkeeping and reporting practices are also summarized; however, N_2O and combustion-related emissions are not addressed.

4 SURVEY RESPONSES

Twenty-one responses were received from the U.S., representing 12 companies and 32 fabs. The respondents make up 58% of total U.S. production capacity based on silicon area (*World Fab Watch*, February 2009) and represent one-third of the EPA's estimated 91[1] semiconductor fabs that must report under the proposed rule. Under the proposed rule, large fabs (i.e., annual production capacity $\geq$10,500 m^2 silicon) have more stringent reporting requirements than other fabs (annual production capacity <10,500 m^2 silicon but $\geq$1,080 m^2 silicon); 71% of respondents were large facilities and the remaining 29% were not considered large but will still be required to report. The large facility respondents represent 9 companies, 17 facilities, and 25 fabs or 86% of the EPA's estimated 29 large U.S. fabs.

Responses were also received from four facilities located outside the U.S.; however, the survey results discussed herein are for U.S. respondents only.

4.1 Estimating Gas Consumption

4.1.1 Proposed Rule Requirements and Implications

The proposed rule requires the subject semiconductor facilities to

- Monitor changes in container mass and inventories using weigh scales with ±1% full scale accuracy or better

  or

- Monitor the mass flow of pure gas into the system using flowmeters with ±1% full scale accuracy or better (April 10, 2009 FR, p.16649).

Scales and flowmeters must be calibrated using suitable National Institute of Standards and Technology (NIST)-traceable standards and suitable methods published by a standards organization or, alternatively, calibration procedures specified by the manufacturer. The scales and flowmeters must be recalibrated at least annually or at a frequency specified by the manufacturer, whichever is more frequent (April 10, 2009 FR, p.16650).

Because emissions must be estimated by process type (CVD or etch), gas consumption must be tracked using Tier 2b methods at a minimum. Large facilities may be required to track consumption at the process equipment level. If flowmeters (e.g., MFCs) are used, software modifications or additional software to total the gas flow is required.

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[1] Clarified with D. Ottinger on May 27, 2009, that EPA compliance estimates are based on number of fabs, not facilities. EPA estimates the rule will apply to 91 fabs and 29 fabs are large fabs under the rule.

4.1.2 Survey Questions

The additional required resources to track gas consumption according to the proposed rule will vary among fabs based on existing infrastructure (e.g., process gas distribution systems and gas consumption monitoring methods).

Figure 1 shows the survey questions asked to determine gas supply infrastructure and the expected cost to comply with the proposed rule's gas consumption monitoring requirements.

1. **How are CVD and etch gases distributed within your facility (check all that apply):**
   - ☐ **Individual gas cylinders feed individual process chambers**
   - ☐ **Cylinders feed multiple like process chambers (etch-only or CVD-only)**
   - ☐ **Bulk distribution systems feed multiple process types and chambers**
   - ☐ **Other (please describe)**
2. **Please indicate how gas consumption is monitored at your facility (check all that apply):**
   - ☐ **Estimated based on purchases and assuming a heel factor**
   - ☐ **Measured by weighing cylinders before and after each cylinder change on scale with 1% accuracy/precision or better**
   - ☐ **Measured with mass flow controllers with 1% accuracy/precision or better**
   - ☐ **Measured by weighing cylinders before and after each cylinder change on scale with less than 1% accuracy/precision**
   - ☐ **Measured with mass flow controllers with less than 1% accuracy/precision**
   - ☐ **Other (please describe)**
3. **What is or would be the additional cost to your facility (installation costs), for compliance with the gas consumption measurement requirements of the proposed rule (include cost of scales, distribution modifications, MFCs, data collection systems, etc.). Please provide answer in $US Dollars.**
4. **What is or would be the additional cost to your facility (operating costs), for compliance with the gas consumption measurement requirements of the proposed rule? (e.g. calibration by NIST or manufacturer recommended procedure, software/hardware maintenance, general preventive maintenance, data collection and analysis costs) Please provide answer in $US Dollars.**
5. **Provide any additional comments regarding installation and/or operating costs.**

Figure 1 Survey Questions to Determine Gas Supply Infrastructure and Compliance Cost of Gas Consumption Monitoring Requirements

4.1.3 Survey Results and Analysis

Respondents use a variety of methods to distribute gases to process equipment; 11 of 21 use more than one method within their fab(s). Two respondents use only individual gas cylinders to feed individual process chambers; neither gathers gas consumption data by process but, instead, estimates consumption based on gas purchases, assuming a 10% heel as described in the 2006 Intergovernmental Panel on Climate Change (IPCC) guideline (IPCC2006, Vol.3, 6.16). Eight respondents use only bulk distribution systems or large cylinders to feed multiple process types and chambers; seven of these respondents estimate gas consumption based on gas purchases and assumed heel factor.

As seen in Figure 2, 81% of respondents monitor gas consumption by tracking purchases and assuming a heel factor; 24% use scales with ±1% accuracy to track some gas consumption. None of the respondents use mass flow controllers (MFCs) with ±1% accuracy as required by the proposed rule.

Figure 2 Gas Consumption Monitoring

The survey revealed several EPA misperceptions about the industry and its gas consumption tracking.

EPA Statement	Industry Practice
"Information on gas consumption by process is often gathered as business as usual..." (p16498).	62% of respondents have some bulk gas distribution feeding multiple tools and process types; 67% have some cylinders feeding multiple chambers and processes. For these respondents, consumption is not tracked by process.
"...electronics manufacturers commonly track fluorinated GHG consumption using flow metering systems calibrated to ±1 percent or better accuracy" (p16498).	80% estimate consumption based on purchases and assumed heel factor. 25% track by weighing some cylinders to ±1% accuracy. One respondent measures some usage with MFCs. None use MFCs with ±1% accuracy.

Although the industry uses MFCs within process equipment, they regulate gas flow rates and do not track gas consumption, which would require new or modified software. Additionally, respondents indicated that, although newer (<5 year old) process equipment may contain digital MFCs with ±1% full scale accuracy, much of the current installed base of process equipment is equipped with analog MFCs. These analog MFCs are not accurate to ±1% full scale and do not provide the digital output required by most control systems.

Survey respondents provided additional comments about how they currently track gas usage[2]:

- Scales are adjusted to zero without the cylinder on them. Using our cylinders weights (40 and 200lbs), scales are spanned to >60% full scale. The weights are verified themselves against the dock shipping scale (which is in the company cal program).
- The true weight of the gas is listed on the incoming cylinder spec. When the cylinder pressure reaches the fixed changeout pressure, it is changed. At this fixed pressure, the remaining quantity in the cylinder is known (PV = nRT) and is provided by the gas supplier.
- From a gas supplier supporting a respondent facility: We… do not calibrate our scales in the classical sense. We routinely conduct a performance verification during every cylinder change where we track the cylinder depletion using mass or scales. Historically, the term calibrate would refer to a quantitative method of generating a multipoint or 2-point calibration curve in which a know[n] mass or volume material is measured against a know[n] instrumental or equipment response. The equipment response is then adjusted to reflect the known values for the calibration curve. For the case of a scale a two point zero and span calibration reflects a linear relationship between mass and mV or mA output. Early in 2001 the ISO movement also required standards traceability, certifications, tamper proofing and records keeping. We do not have the manpower, facilities, or equipment to fully comply with the ISO requirements. As a result, we provide performance verifications and not calibrations. Our method of performance verification is very similar to calibration however it will not include requirement associated with tracking. certifications, tamper proofing or records keeping. We do use a 2-point, zero and span process in which we zero the scale by manually adjusting the zero potentiometer and span the scale by placing a know[n] traceable mass on the scale usually 25 lbs. and adjust the span potentiometer to read the correct value. Equipments … which require a true "calibration" are periodically certified by a 3rd party supplier of that service.

Respondents also expressed concern about implementing the gas consumption tracking requirements under the proposed rule. MFC manufacturers suggest that MFCs with ±1% accuracy be removed and shipped back to the manufacturer for annual calibration, requiring process equipment to be shut down and spare MFCs to be stocked. Respondents indicated that newer tools regulate flow with digital MFCs but that software changes are required to allow total consumption to be tracked. For older process equipment, some were able to estimate the cost of installing MFCs on each gas line at each tool and a data tracking system; others said they could not retrofit older equipment because of insufficient space.

Additionally, respondents indicated the following problems with the gas consumption tracking requirements[3]:

- Gas supplier indicates ±1% accuracy can't be achieved. Could probably get ±2% accuracy with new controllers, valves and monitoring systems.

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[2] Responses are quotes from the survey with company names omitted.
[3] Responses are quotes from the survey with company names omitted.

- The gas systems engineer is not really sure if we can get that accuracy [±1%]... We have one MFC that is capable of ±2% precision/accuracy.
- Calibration would require evacuating the gas lines and purging all PFCs directly to the environment and would shut down all tools connected to the bulk system, significantly impacting production in our factories.
- If this is included in final rule, there is not enough time to implement changes to begin measuring at this level by Jan 1st to comply with 2010 adoption. Gas supplier indicates ±1% accuracy can't be achieved.
- Scales are basically of no value for cylinders with non-liquid gases.
- Review of a sample of PFC gas distribution systems indicated that 40%–50% of existing systems would need to be modified to segregate gas usage by process and platform for Tier 3 emissions inventory. Cost is for purchase and installation of additional gas distribution infrastructure only, and does not include cost of scales, or of equipment down time and lost production. It is likely that the systems could not be satisfactorily reconfigured, even at this high cost, due to the space constraints of the pre-existing fab layout.
- Most MFCs are calibrated to a Nitrogen standard – it was estimated that 95%+ of MFCs in our factories. You would have to have a correction factor for each MFC in each GHG. This is not done and characterizing this for each individual MFC if possible would be a multi-year and continual process as MFCs are recalibrated and replaced on an ongoing basis.
- Facility wide mass balance similar to acceptable EPA emissions inventory practices and air permit inventory requirements would be less costly.

4.1.4 Basis for Process GHG Consumption Cost Estimates

Survey respondents were given the requirements of the proposed rule for GHG consumption tracking and asked to estimate installation and annual operational costs. They reviewed their current fab infrastructure and identified requirements for scales or MFCs. Most also included the cost to modify equipment software or to install a gas consumption tracking system. Respondents did not include the costs associated with production downtime to make the required modifications. Twenty respondents provided installation costs estimates; 15 provided annual operational cost estimates.

Nineteen respondents provided descriptions of the basis for their cost estimates.

Method used by 1 respondent

- "Installation cost estimate includes
  - New and spare MFCs to be purchased
  - Labor cost to install new MFCs
  - Labor and material costs for wiring from the MFCs to hardware
  - Hardware to collect gas consumption data

- Contingency money for the unexpected operating cost estimate includes
  - Outsourced calibration services
  - Labor to install/reinstall MFCs for calibration."

Method used by 1 respondent

- "Cost estimate is to replace ~500 MFCs that do not have +/-1% accuracy on process tools, install system to communicate and maintain all tracking data, and develop a PFC-specific software program to manage data. Estimate ~$1400/MFC plus 1 hour to install. $400,000 to install tracking system; $15,000 to install PFC-specific software program to manage data. Vendor has been located who performs calibrations. Rate for this service is $480 per MFC."

Method used by 1 respondent

- "Measuring gas usage with flow meters and data management system: $600K to $1200K. Assumes replacement of 50%–100% of MFCs would be required to comply with proposed rule. (Does not include any cost for equipment downtime or lost production.) Assumes $250K–$400K data management expense. Measuring gas usage by weighing cylinders: up to $1500K. Review of a sample of PFC gas distribution systems indicated that 40%–50% of existing systems would need to be modified to segregate gas usage by process and platform for Tier 3 emissions inventory. Cost is for purchase and installation of additional gas distribution infrastructure only, and does not include cost of scales, or of equipment down time and lost production. It is likely that the systems could not be satisfactorily reconfigured, even at this high cost, due to the space constraints of the pre-existing fab layout."

Method used by 3 respondents

- Basis for estimate
  - "Replace any existing MFCs that are not rated for ±1% accuracy with new
  - Purchase a supply of backup MFCs (estimated to be 50% of the current inventory) that can be installed while others are being calibrated throughout the year
  - Process data and prepare reports
  - Hire one full-time employee whose sole job function is the calibration of MFCs at each of our facilities
  - Wage data estimated based on rates referenced by EPA
  - Develop software queries to totalize flows from existing monitoring data."

Method used by 1 respondent

- Basis for estimate
  - "Replace any existing MFCs that are not rated for ±1% accuracy with new

- Purchase a supply of backup MFCs (estimated to be 50% of the current inventory) that can be installed while others are being calibrated throughout the year
- Process data and prepare reports
- Develop software queries to totalize flows from existing monitoring data. Assume annual calibrations will be done by nearby facility."

Method used by 3 respondents

- "Estimate to install scales under all cylinders: 1 cylinder x (scale + programming/labor) = $1,835.00. Total conversion (70 cylinders) = $128,450 plus initial calibration costs and need to add some spare scales...total ~$150K if we stay with the 40 and 200 lb weight scenario. We would add a few extra scales for rotations. NOTE: Scales are basically of no value for cylinders with non-liquid gases. That is where we use the pressure transducers."

Method used by 1 respondent

- "We estimated our costs based on what it would take to install flow meters with a ±1% accuracy. Our cost estimate is based on installing flow meters on each HFC line, feeding each tool. The data comes from vendor quotes for equipment and labor. The estimate includes the cost of the meter, the labor costs to install the meter, and costs to install hardware and software to track the flow meters. This estimate did not include any annual costs to maintain the equipment. Nor did the estimate include any costs associated with down time of Fab tools."

Method used by 3 respondents

- "$1000 to $1500 per MFC operating cost is an estimate with the majority of the cost in providing MFCs capable of accuracy continuously in compliance. Cost data assumes a third party is needed to calibrate MFCs."

Method used by 1 respondent

- "Assume tool MFCs required at $1000 per MFC and that centralized data system costs $25,000. Cost data assumes a third party is needed to calibrate MFCs."

Method used by 1 respondent

- "MFCs have to be shipped out for calibration. Estimate basis:
  - $2,000 per MFC (purchase, install, and miscellaneous materials) with no digital output for tracking
  - $6,000 per MFC (purchase, install, and miscellaneous materials) with digital output for tracking
  - From $364,000 to $1,032,000. Assume $700,000 is good estimate."

Method used by 1 respondent

- "Estimate provided by our gas management company. Company says upgrades can get to a bulk gas accuracy of 2–3%. These upgrades will cost $143,000/fab and $50,000/year/site. These are only costs to improve bulk gas measurements as technology to measure at a tool level currently does not exist."

Method used by 1 respondent

- "Mass flow meters would be the least expensive option. MFMs would be installed on PFC sticks that go to each tool. MFMs will then be ethernetted together to a new central computer. Cost of tool downtime to install MFMs not accounted for. Maintenance costs assume MFMs are sent offsite annually for calibration. Spare MFMs are required to allow swaps for calibration."

Method used by 1 respondent

- "The fab was not designed to and cannot provide the data necessary to comply with this regulation. Processes have not been characterized for gas use and emissions. Rule requires massive renovation of gas distribution system, new hardware and software to monitor MFCs, and replacement of existing MFCs."

4.1.5 Estimated Cost for an Average Fab to Comply with Gas Consumption Tracking Requirements

The cost for an average fab to comply with the gas consumption tracking requirements was calculated by summing the estimated cost responses and dividing by the number of fabs represented by the total. When respondents provided a cost range, the minimum value of the range was used so that the calculated average cost represents an estimated minimum average cost. The average cost to install infrastructure to comply with the gas consumption tracking requirements of the proposed rule is $0.72 million per fab; the estimated annual operating cost is $0.22 million per fab.

4.2 Point-of-Use Abatement

4.2.1 Proposed Rule Requirements and Implications

The proposed rule defines abatement as "…a point-of-use (POU) abatement system whereby a single abatement system is attached to a single process tool or single process chamber of a multi-chamber tool." This definition does not include multi-chamber POU abatement devices (which are commonly used in the industry) and larger non-POU abatement systems. If a facility uses POU abatement and wishes to claim reductions, the proposed rule requires that destruction or removal efficiency (DRE) be verified experimentally following a procedure outlined in the rule to measure dilution through the abatement system (April 10, 2009 FR, p.16649–50). Alternatively, the facility can, "Install abatement devices that have been tested by a third party (e.g., UL)" following EPA's *Protocol for Measuring Destruction or Removal Efficiency of Fluorinated Greenhouse Gas Abatement Equipment in Electronics Manufacturing* (draft protocol). The majority of abatement devices currently installed in U.S. fabs have not been tested according to this draft protocol.

The frequency of abatement testing is not explicitly defined in the proposed rule; however, the Regulatory Impact Analysis (RIA) cost estimate addresses testing frequency by stating "[e]ach abatement device would be tested once every three years."

The 2006 IPCC *Guidelines for National Greenhouse Gas Inventories* provides default DRE factors for POU abatement devices. The guidelines state that factors can be used only if the abatement devices

- "Are specifically designed to abate FCs [fluorocompounds]
- Are used within the manufacturer's specified process window and in accordance with specified maintenance schedules
- Have been measured and has [sic] been confirmed under actual process conditions using a technically sound protocol which accounts for know measurement errors including, for example, CF4 byproduct formation during C2F6 as well as the effect of dilution, the use of oxygen or both in combustion abatement technologies." (IPCC2006, Vol.3, 6.20)

The technical experts who developed the IPCC guideline for the electronics industry believed that a properly maintained abatement device would maintain DREs over time and did not require periodic retesting. Although the proposed rule uses the 2006 IPCC guideline as the basis for estimating emissions, it does not allow the guidelines' default abatement DRE factors to be used.

4.2.2 Survey Questions

Figure 3 shows the survey questions asked to ascertain the impact of the proposed rule's abatement testing requirements.

1. Approximately how many PFC-specific abatement devices (capable of abating PFCs in CVD and etch) will you need to test if you want to claim DRE?
2. What percentage of the PFC POU abatement devices at your facility have been characterized by your company with a standard industry methodology that accounts for dilution of PFCs in the POU abatement device or by a third party using the draft EPA protocol?
3. What percentage of the PFC POU abatement devices at your facility have been characterized by your abatement supplier with a standard industry methodology that accounts for dilution of PFCs in the POU abatement device?
4. What methodology was used to characterize performance of POU abatement devices?
   - ☐ Emissions not characterized; using default emission factors
   - ☐ 2001 ISMI Guideline
   - ☐ 2006 ISMI Guideline
   - ☐ Draft EPA Protocol
   - ☐ Epson Method
   - ☐ Facility has no POU abatement installed
   - ☐ Other (e.g. internal testing, info from suppliers - please specify)

Figure 3 Survey Questions on Characterization of Abatement Devices

4.2.3 Survey Results and Analysis

POU abatement for process GHG emissions is currently used by 10 of 21 survey respondents representing 21 of the 29 respondent fabs. Survey respondents have 1111 GHG POU abatement devices currently installed in fabs. Eleven of the 21 (28% of respondent fabs) do not use POU abatement to reduce emissions. For fabs that will be operating when the proposed rule takes effect, the survey indicates that the average number of abatement devices per fab with abatement is 61; the high is 158. Here again, the survey revealed several EPA misperceptions about industry practice.

EPA Statement	Industry Practice
"...we propose an emission estimation method that would account for destruction by abatement equipment only if facilities verified the performance of their abatement equipment..." (April 10, 2009 FR, p.16498)	50% of all respondents with abatement have not characterized abatement DREs; of those 25% use defaults 25% use DRE measurements provided by suppliers Only one respondent has characterized the majority of its installed POU abatement units.
"...install abatement devices that have been tested according to EPA's Protocol by a third party (e.g., UL)..." (April 10, 2009 FR, p.16650)	<<1% of currently installed POU devices have been tested using the EPA's draft protocol.

Less than 1% of installed abatement devices have been tested using EPA's draft protocol, which has not yet been published. The preamble and proposed rule imply that, if a facility conducts POU abatement testing instead of using a third party, the facility must test all abatement devices (not just a representative process-specific sample). The survey did not address the cost of this testing. Testing will likely require extensive use of third parties because most companies do not have equipment or personnel to conduct in-house testing. Very few third parties in the U.S. have experience characterizing semiconductor process emissions or testing semiconductor POU abatement devices (UL, the example cited by the EPA, is not one of them); still fewer have experience testing in an operating manufacturing fab.[4] Only a single third party is known to have experience using the EPA draft protocol.

4.2.4 Basis for Cost Estimate: Compliance with POU Abatement Testing Requirements

Survey data were used to calculate the average number of abatement devices per fab for those fabs so equipped. This number was multiplied by the testing cost to calculate an average total POU abatement testing cost per fab. If respondents provided a range for the number of abatement devices, the minimum of the range was used in calculations to ensure that the reported costs were a minimum.

The following assumptions were made:

- Emissions testing would be conducted by a third party
- Estimates would be based on testing one-third of the installed POU abatement devices because the proposed rule allows testing of a "random sample" (April 10, 2009 FR, p.16499) when testing is conducted by a third party

[4] Feedback of ISMI Greenhouse Gas Working Group Members.

- Third-party testing would cost $35,000/week based on testing three POU abatement devices per week (including set-up, testing and data analysis according to the EPA draft protocol, and report generation).

4.2.5 Estimated Cost for an Average Fab to Comply with POU Abatement Testing Requirements

The average cost per fab to test POU abatement devices is $0.24 million over 7 weeks. A fab with 158 POU devices will spend $0.62 million over 18 weeks to test 53 devices. These costs for testing one-third of all devices would also equal the average cost per year if each abatement device must be tested once every three years as stated in the RIA cost estimate. Given the lack of experienced third parties, it is unlikely that most semiconductor facilities would be able to meet the POU abatement testing requirements of the proposed rule unless they develop in-house analytical capabilities (i.e., hire personnel and acquire analytical instrumentation). The proposed rule requires those facilities that use in-house capabilities to test 100% of their POU abatement devices (April 10, 2009 FR, p.16499), an approach the preamble acknowledges is likely to be more costly than third-party testing (April 10, 2009 FR, p.16499). For these reasons, industry POU abatement testing costs are likely to be significantly greater than the minimum estimates above.

4.3 Estimating Emissions

4.3.1 Proposed Rule Requirements and Implications

The proposed rule establishes production capacity-based reporting thresholds rather than emissions-based thresholds (April 10, 2009 FR, p.16497). Semiconductor production facilities with production capacity >1,080 m^2 silicon must report. Large semiconductor facilities (production capacity >10,500m2 silicon) are required to estimate emissions using an approach based on the IPCC Tier 3 (company-specific emission factors) while all other semiconductor facilities must use an approach based on the IPCC Tier 2b method (process-specific default emission factors) (April 10, 2009 FR, p.16498). Both approaches require gas consumption data by process that the EPA believes "is often gathered as business as usual" (April 10, 2009 FR, p.16498). EPA further contends that "…DRE for each process is readily available from tool manufacturers…" (April 10, 2009 FR, p.16498). The proposed rule requires that gas utilization and byproduct formation measurements as required by the Tier 3 method be conducted using the *Guideline for Environmental Characterization of Semiconductor Process Equipment* (2006 ISMI Guideline).

4.3.2 Survey Questions

Figure 4 shows the survey questions asked to ascertain the impact of the proposed rule's process emissions estimating requirements.

4.3.3 Survey Results and Analysis

Respondents were asked what methodology they currently use to estimate process GHG emissions. Results are shown in Figure 5.

1. What emissions estimating methodology do you currently use to estimate your process GHG emissions?
   - ☐ IPCC 2006 Tier 1 (aggregate default based on silicon area processed)
   - ☐ IPCC 2006 Tier 2a (default emission factors by process gas)
   - ☐ IPCC 2006 Tier 2b (default emission factors by process gas and process type)
   - ☐ IPCC 2006 Tier 3 (process specific emission factors)
   - ☐ Don't currently estimate
   - ☐ Combination of Tiers or Other (please specify)

For large facilities:

2. Approximately how many "unique process platforms running varying PFC gases" in representative processes does your facility have?
3. What is the approximate maximum number of unique PFC-using recipes with varying process conditions run in your facility?
4. What methodology was used to characterize process emissions and byproducts?
   - ☐ Emissions not characterized; using default emission factors
   - ☐ 2001 ISMI Guideline
   - ☐ 2006 ISMI Guideline
   - ☐ Epson Method
   - ☐ Other (please specify)

Figure 4 Survey Questions on Emissions Characterization Methodology


1. What emissions estimating methodology do you currently use to estimate your process GHG emissions?

	Response Percent	Response Count
IPCC 2006 Tier 1 (aggregate default based on silicon area processed)	0.0%	0
IPCC 2006 Tier 2a (default emission factors by process gas)	28.6%	6
IPCC 2006 Tier 2b (default emission factors by process gas and process type)	19.0%	4
IPCC 2006 Tier 3 (process specific emission factors)	4.8%	1
Don't currently estimate	9.5%	2
view Combination of Tiers or Other (please specify)	38.1%	8

Figure 5 Percentage of Respondents Using Various Estimating Methods

One responding company uses the IPCC Tier 3 method. Two respondents do not currently track process GHG emissions. The operation for one of those respondents is "large" as defined by the proposed rule (>10,500 m^2 silicon); however, the facility has only one PFC-using process tool and, thus its process GHG emissions are low. The second respondent is not an SIA member and is therefore not a party to the voluntary PFC Reduction/Climate Partnership for the Semiconductor Industry. Thirty-eight percent of respondents are using a combination of tiers to estimate emissions; the majority uses a combination of Tiers 2a and 2b.

Most of the respondents do not track gas consumption by process. Those that do report emissions by process (i.e., are using Tiers 2b or 3) apply engineering estimates to determine the split of gas consumption between chemical vapor deposition (CVD) and etch.

The survey highlighted several EPA misperceptions about the impact of requiring large facilities to estimate emissions using a Tier 3-like approach.

EPA Assertion	Industry Practice
Large semiconductor facilities are already using Tier 3 methods. (April 10, 2009 FR, p.16498)	Only one U.S. company is estimating emissions using IPCC Tier 3. Others use Tier 2a, 2b, or a combination.
Large facilities have the data required to use Tier 3. (proposed rule requires use of 2006 ISMI guideline) (April 10, 2009 FR, p.16498)	50% of large companies do not have any data required to use Tier 3. For 75% of the responding companies with some emissions data, the data were not generated with ISMI's 2006 guidelines (instead earlier versions of industry guidelines were used). Only 10% of all emissions characterizations used ISMI's 2006 guidelines.

While the proposed rule requires ISMI's 2006 guidelines to be used to develop utilization and byproduct emission factors, the survey shows that only 10% of all process emissions characterizations were based on those guidelines; much of the data were generated using earlier versions of ISMI and industry guidelines. The Tier 3 requirement is based on process emissions data being "…readily available from tool manufacturers…" (April 10, 2009 FR, p.16498). When required by purchase specifications, process equipment manufacturers may provide baseline process emissions characterizations to semiconductor companies purchasing new equipment. Growth in U.S. semiconductor manufacturing capacity has slowed in recent years, and since the 2006 guideline was published, only three large volume manufacturing fabs have been built in the U.S. (*SEMI World Fab Watch*, May 2009). Process equipment manufacturers have little motivation to characterize baseline emissions from tool sets that are already in manufacturing fabs.

For large facilities, the proposed rule calls for the use of "process-specific utilization and byproduction formation factors" (April 10, 2009 FR, p.16648); however, it does not define "process-specific." Large facility respondents representing 15 fabs provided data on the approximate number of unique process platforms and unique perfluorocompound (PFC)-using recipes run in their fabs. "Unique process platform" was defined in the survey as specific tool models using a specific PFC for either CVD chamber cleans or etch, with examples provided. "Unique PFC-using recipes with varying process conditions" was defined as the estimated total number of different process platforms running different PFC gases, gas flow rates, gas ratios, process times, and/or stabilization times in the fab. "Unique process platforms" and "unique PFC-using recipes" can serve as a lower and upper bound, respectively, for the range of process emission characterizations required of large facilities. An average number of unique process platforms and PFC-using recipes was calculated by adding the number of process platforms or recipes reported by each respondent and dividing by the total number of fabs represented by the responses. When respondents provided a range, the lower end of the range was used to calculate the average so that a minimum estimate was generated. For large fabs, the average number of unique process platforms was 37, while the average number of unique process recipes was 455.

4.3.4 Basis for Cost Estimate: Large Facility Process-specific Emission Factors

Because the EPA does not define "process-specific," the scope of emissions characterization efforts required by large facilities is uncertain. A minimum cost estimate was developed for the average large facility to comply with rule requirements to develop process-specific utilization and byproduct formation factors. The following assumptions were made:

- Emissions testing would be conducted by a third party because most semiconductor facilities do not have the qualified personnel or equipment to conduct in-house testing;
- Third-party testing would cost $35,000/week
  - For estimating the cost of process emissions testing on a per platform basis, assume a third party can test three unique process platforms per week (including set-up, testing, data analysis, report generation).
  - For estimating the cost of process emissions testing on a per unique recipe basis, assume the third party can test six process recipes per week (including set-up, testing, data analysis, report generation).

4.3.5 Estimated Cost for an Average Large Facility to Develop Process Emission Factors

The cost to develop Tier 3 emission factors for an average large fab ranges from $0.43 million over 12 weeks if testing is required on a per platform basis. If each individual process recipe must be characterized, the cost for the average large fab rises to $2.7 million over 76 weeks. Few third parties have experience testing semiconductor process equipment emissions in a manufacturing fab. Given the amount of emissions characterization required by the proposed rule and the lack of experienced third parties, it is unclear how EPA's estimated 29 large manufacturing fabs will develop process-specific emission factors in the timeline outlined in the proposed rule.

4.4 Comparison of IPCC Methodologies (Supplementary Data from One Survey Respondent)

The preamble states, "The use of the IPCC Tier 3 method and standard site-specific DRE measurement would provide the most certain and practical emission estimates for large facilities" (April 10, 2009 FR, p.16498). One survey respondent provided additional data from an analysis to compare the results of the 2006 IPCC Tier 2a, 2b and 3 methods for three 200 mm fabs over 3 years and three 300 mm fabs (one for 1 year and two for 3 years each). Figure 6 presents the results of 16 sets of comparison data.

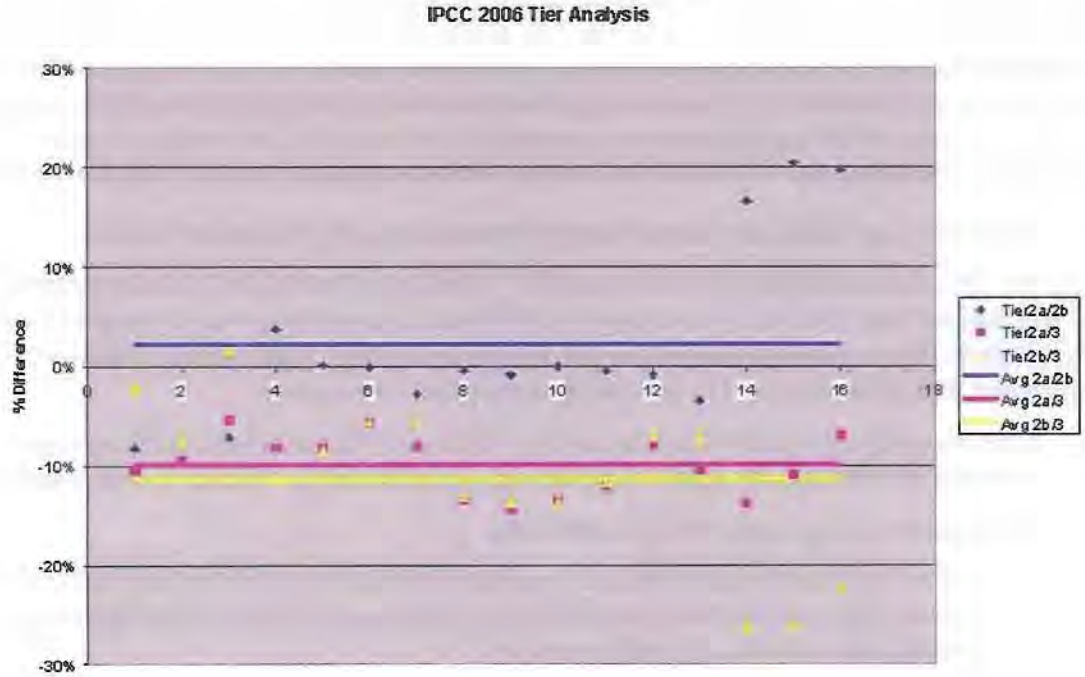

Figure 6 2006 IPCC Tier Analysis for Six Fabs

The data sets show that Tier 2a and Tier 2b produce similar results with Tier 2a averaging +2% higher (standard deviation 9%). Compared to Tier 2a and 2b, Tier 3 yielded an estimated 10% and 11% lower, respectively (standard deviation 3% and 8%). The IPCC methods for the electronics industry require 100-year time horizon global warming potentials (GWP100) to calculate CO_2 equivalent emissions. As noted in the IPCC Fourth Assessment Report, uncertainties for GWP100 are ±35% (IPCC 4th ARWG1, Ch.2, p.214). The greatest difference among methods is less than one-third of the uncertainties for GWP100.

The Tier 3 method offers only incremental improvement in accuracy over the Tier 2 methods; this improvement is small compared to the overall uncertainty in these calculations due to the uncertainties in the GWP100.

4.5 Recordkeeping and Reporting

The proposed rule lists several data reporting requirements for semiconductor facilities that could be made available to the public. Survey respondents were asked to indicate whether the data elements listed are currently available for each facility and which elements they consider Confidential Business Information (CBI). Table 1 lists those data elements that >50% of the respondents do not currently have available or consider CBI.

Table 1 Required Data that Majority of Respondents Do Not Have Available or Consider CBI

Rule required data that >50% of respondents do not currently have available or that >50% consider to be Confidential Business Information (CBI).

Required Data	Data Available (% of All Respondents)	Data Not Available (% of All Respondents)	CBI
GHG emissions for all plasma etching	45%	55%	55%
GHG emissions for all chamber cleaning	45%	55%	55%
GHG emissions for all CVD processes	20%	80%	55%
GHG emissions for all HTF use	5%	95%	10%
Mass of each gas fed into each process type	25%	75%	95%
Production capacity (m2 Si)	95%	5%	90%
Emission control technology DREs and their uncertainties	10%	90%	30%
Fraction of gas fed into each process type w/ emissions control technologies	30%	70%	70%
Description of abatement controls	45%	55%	5%
Inputs to mass balance calculations (for heat transfer fluids)	25%	75%	10%

5 IMPACT ASSESSMENT

The impact of the proposed rule on the semiconductor industry has been underestimated by EPA.

EPA Proposed Rule	Estimated Industry Costs
The rule contains stringent requirements for tracking gas consumption that require ALL reporting facilities to undertake costly infrastructure modifications.	EPA estimates the rule applies to 91 semiconductor fabs. Based on survey results, the minimum estimated total industry cost to comply with gas consumption data requirements is $65 million for infrastructure installation and $20 million for annual operating costs.
To claim DRE for POU abatement, abatement units must be tested by the user or a third party using the EPA protocol.	The survey indicates 72% of fabs use GHG-specific POU abatement. Assuming 66 fabs (72% of 91 fabs) use abatement, the minimum estimated total industry cost to comply with POU abatement testing is $17 million over 450 weeks of testing.
Large semiconductor facilities are already using Tier 3 methods or have data available to perform Tier 3.	The minimum estimated cost for the EPA-estimated 29 large facilities to develop Tier 3 data is $13 million to $77 million over 360 to 2,200 weeks of testing.

EPA erroneously assumes that that manufacturing facilities "monitor gas consumption using equipment (e.g., flowmeters) that is already in place…" (RIA Cost Appendix, p.21). Based on this assumption, The EPA does not include capital or operating and maintenance (O&M) costs in the estimate. The total minimum industry cost for installing infrastructure to track gas consumption as required by the proposed rule is $65 million. O&M costs to calibrate and maintain gas consumption monitoring systems is $20 million per year. The EPA's estimated cost for the industry to comply with POU abatement device testing is $1.359 million per year, while the estimated minimum cost based on survey data is $17 million per year. The EPA assumes that large facilities have the data to comply with the proposed rule and, therefore, incur no cost for compliance; for the large facilities, the cost to comply with the requirements for Tier 3 is $13 million to $77 million. Initial compliance with the proposed rule requires an estimated 16 to 51 years of third-party testing; ongoing POU abatement evaluations will require a minimum of 8.7 years of third-party testing each year (assuming the third party can test three process platforms, six process recipes, or three POU abatement devices per week).

In 1999, the members of the World Semiconductor Council (WSC) approved a goal to reduce aggregate absolute emissions of PFCs from semiconductor manufacturing facilities by 10% or more from baseline levels by 2010. They also agreed to use IPCC Tier 2 methods to estimate emissions so that a common methodology would be used across all regions and data would be comparable. Based on the survey responses from the four non-U.S. located respondents, semiconductor facilities in other countries are not subject to requirements comparable to those in the proposed rule.

6 CONCLUSIONS

ISMI's survey to gather facility-specific data on the impact of the proposed rule on fab operations resulted in 21 responses from companies representing 58% of total U.S. silicon area production capacity. Survey respondents included 25 of the EPA's estimated 29 large fabs.

Much of the EPA's basis for the proposed rule is contradicted by survey data:

- Contrary to the EPA's assertion, the industry is *not* currently collecting or equipped to collect significant portions of the data required by the proposed rule.
- The EPA assumes the industry will incurs no capital or O&M costs under the proposed rule. This assumption is incorrect. The minimum estimated industry capital cost to comply with gas consumption tracking requirements is $65 million and O&M costs are $20 million per year
- Analysis of the survey data indicates the industry's first year compliance costs will be $95–159 million, 26X to 44X greater than the EPA's estimated $3.6 million (RIA, p. 4-124). Ongoing compliance costs are estimated to be a minimum of $37 million per year. Note that the survey-based cost estimate is a minimum that does not include the costs associated with production downtime. It also does not include the costs to comply with requirements for fluorinated heat transfer fluids, combustion related emissions reporting, or reporting and recordkeeping requirements.

In its requirements for gas consumption tracking, process emissions characterization, and POU abatement testing, the proposed rule goes beyond the requirements of the IPCC Tier 2b and 3 methods. Based on responses received by the four respondents not located in the U.S., semiconductor facilities in other countries are not subject to requirements that are comparable to those in the proposed rule.

The proposed mandatory GHG reporting rule requires that the industry spend large amounts of money that the EPA does not accounted for in its regulatory impact assessment. The first year compliance costs will be 26X to 44X greater than estimated by the EPA, and subsequent compliance costs are >10X the EPA's estimate.

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ATTACHMENT B

Results of the ISMI Fluorinated Heat Transfer Fluids Survey

International SEMATECH Manufacturing Initiative

Technology Transfer #09065014A-TR

Results of the ISMI Fluorinated Heat Transfer Fluids Survey

Technology Transfer #09065014A-TR
International SEMATECH Manufacturing Initiative
June 8, 2009

Abstract: This report from the ESHT001 project presents the results of a fluorinated heat transfer fluids survey of International SEMATECH Manufacturing Initiative (ISMI) and Semiconductor Industry Association (SIA) members. The purpose was to gather data on the use, volatility, purchase and waste tracking, and status of emission measurements of fluorinated heat transfer fluids. Results of other surveys in this series collecting technical data on greenhouse gases are in Technology Transfers #09065012A-TR and #09065015A-TR.

Keywords: Greenhouse Effect, Government Regulations, Fluids

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Table of Contents

List of Tables

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- Portions of this report contain forward-looking statements that are based on the authors' and contributors' current expectations, estimates, projections and assumptions. These statements are based on assessment of uncertain factors and therefore are not guarantees of future events and outcomes. Actual future results may differ materially from what is forecast. All forward-looking statements speak only as of the submission date of this report.
- All related written and oral forward-looking statements attributable to the authors, contributors, ISMI, SIA or any person acting on behalf of those entities are qualified by the cautionary statements in this section.
- The authors and contributors do not undertake any obligation to update or publicly release any revisions to forward-looking statements to reflect events, circumstances or changes in expectations after the date of this report.

Acknowledgments

The author wishes to acknowledge the members of the ISMI Greenhouse Gas Working Group and SIA PFC Committee for their participation in the survey.

1 EXECUTIVE SUMMARY

In support of the industry response to the U.S. Environmental Protection Agency (EPA) proposed mandatory greenhouse gas (GHG) reporting rule, the International SEMATECH Manufacturing Initiative (ISMI) Environment, Safety, and Health Technology Center was asked to develop surveys, collect survey responses, and analyze data for ISMI and Semiconductor Industry Association (SIA) members. A total of three surveys were conducted. Responses have been collected independent of the SIA to preserve respondent confidentiality. Reported herein are results of a survey on the use, volatility (i.e., vapor pressure at room temperature), purchase and waste tracking, and status of emissions measurements of fluorinated heat transfer fluids.

Fourteen companies participated, providing 37 separate responses.

Results showed that the semiconductor industry uses at least 17 different fluorinated heat transfer fluids with ambient vapor pressures ranging from 6 to 30,000+ Pascals. Four fluids may be candidates for exemption from the proposed regulation due to their exceptionally low vapor pressure.

The fluids are mostly used in closed-loop chillers for processes such as etch, chemical vapor deposition (CVD), implant, and device testing.

Most companies do not quantitatively track usage, recycling, and disposal of these fluids. Only two companies track the quantity of fluids lost in spills and leaks, and four track the quantity of fluids recycled or disposed off site. Off-site disposal usually consists of high temperature incineration or fuel blending. Currently, one company has tested for traces of these fluids in fab air, finding that concentrations are below 5 ppb.

2 SURVEY OVERVIEW

The survey asked the following questions:

- Do you operate processes that use fluorinated heat transfer fluids? If so, which ones do you use?
- What is the name of the process?
- What is the vapor pressure of each fluorinated heat transfer fluid?
- Are spills, leaks, material recycling, and waste disposal being tracked to complete a mass balance for the fluorinated heat transfer fluids used?
- Has fab air sampling been done? If so, what were the results?

3 RESULTS

Fourteen companies participated in the survey, providing data for 37 separate responses (two of them overseas). Based on the survey, the fluorinated heat transfer fluids are almost exclusively used in point-of-use (POU) chillers for etch, CVD, implant, and automatic testing. A few companies mentioned that in some isolated cases these fluids are used for resist stripping (wet tool), chamber cleaning, and leak testing. One respondent that uses the fluorinated heat transfer fluids in a process abates emissions with the house thermal oxidizer

Table 1 lists the fluorinated heat transfer fluids used and their corresponding vapor pressures in Pascals (Pa) and psia. 3M and Solvay Solexis are the main suppliers of the fluids. Based on the survey, the most popular are marked by a pound sign (#). The vapor pressures range from a low of 6 Pa to a high of 30,324 Pa. However, one company reported vapor pressures ranging from 800–55,000 Pa, with the most widely used compounds in the 800–2000 Pa range. The vapor pressure of water was included in the table for comparison only.

Table 1 Names of Heat Transfer Fluids Used and Their Vapor Pressures

Heat Transfer Fluid	Vapor Pressure @ 20–25°C	
Name	Pascals	psia
3M Fluorinert FC 40 # &	400	0.058
3M Fluorinert FC 77 #	5,600	0.81
3M Flourinert FC 3283 #	1,867	0.27
3M HFE 7100 #	26,931	3.90
3M HFE 7200 #	14,532	2.10
3M HFE 7300	5,585	0.81
3M HFE 7500 &	6	0.0009
*Galden HT – 70 #	18,798	2.72
*Galden HT - 90	13,332	1.93
*Galden HT – 110 #	2,266	0.33
*Galden HT – 200 &	<133	0.019
DuPont HFC - 134a **	655,405	95
ZT - 130	NA	
ZT – 180 &	266	0.0386
*Galden D02 - TS	NA	
*Galden D02 - TSX	NA	
*Galden PFS 2	30,324	4.39
WATER (for comparison only)	*2493*	*0.36*

* offered by Solvay Solexis
** liquefied gas with boiling point of -26.5°C
# most popular fluids based on number of survey responses
& recommend exclusion from regulation due to very low vapor pressure

One company pointed out that the Global Warming Potentials (GWPs) of fluorinated heat transfer fluids range from 55–9,400, whereas an EPA report published in 2006 (EPA 430-R-06-901) states that the GWPs range from >6,000–9,000.

Most fluorinated heat transfer fluid use is associated with the replacement of electrostatic chucks (ESCs), which are cooled directly by the fluorinated heat transfer fluid. When the tool is opened and the ESC removed, some fluorinated heat transfer fluid is "lost" and later replaced by topping off the chiller reservoir. The "lost" material is collected either separately or, more typically, blended with other mixed solvent waste. Then, the solvent waste is shipped off site for incineration or use as fuel in cement production. In most cases, spills are wiped up and the "solvent"-contaminated wipes are collected in covered waste cans as hazardous waste and sent off site for high temperature thermal oxidation (i.e., incineration); however, the quantity of the waste is not tracked.

Most companies have records for only purchases of fluorinated heat transfer fluids. Just two companies track the quantity of fluids lost in spills and leaks. Four companies track the quantity of fluids recycled or disposed off site. None of the companies seem to attempt a comprehensive mass balance for the fluids.

One company provided data from airborne emission measurements (Appendix A), which detected fluorinated heat transfer fluids in very low concentrations in the air of several different semiconductor manufacturing fabs. Twenty-one samples were collected and analyzed by thermal desorption followed by gas chromatography and mass spectrometry. The concentrations ranged from about 1–99 ng/L (in the form of fluoroalkyl ethers). Using the ideal gas law to convert from ng/L to ppb shows that the calculated air concentrations for these measurements are all below 5 ppb.

Using the data for several commonly used fluorinated heat transfer fluids, a calculation was made to estimate how quickly these fluids would evaporate after a spill or leak (Appendix B). A 4 ft^2 spill 1/8 inch deep would contain about 4.68 pounds of fluid. To evaporate that much material would take 1 to 94 hours, depending on the molecular weight and vapor pressure of the fluid. If one assumes that a leak of that size would not go unnoticed in a 3-hour period, given the cleanliness of semiconductor manufacturing fabs, the whole spill would go unnoticed and ultimately evaporate if only one fluid spilled.

4 CONCLUSIONS

The survey of 37 responses from 14 companies showed that the semiconductor industry uses at least 17 different fluorinated heat transfer fluids with ambient vapor pressures ranging from 6 to 30,000+ Pascals. Four of the fluids reported have exceptionally low (<400 Pa) vapor pressures.

The fluids are mostly used in closed-loop chillers for processes such as etch, CVD, implant, and device testing.

The majority of companies do not quantitatively track usage, recycling, and disposal of these fluids. Currently only two companies track the quantity of fluids lost in spills and leaks, and only four companies track the quantity of fluids recycled or disposed off site. Off-site disposal usually consists of high temperature incineration or fuel blending.

So far, just one company has tested for traces of these fluids in fab air, finding that concentrations are below 5 ppb.

Appendix A –Testing Fab Air Samples for the Presence of Hydrocarbons

In 2006, one U.S. semiconductor manufacturing company tested several fabs for air contaminants, including traces of fluorinated hydrocarbons.

A.1 Sampling and Analysis

The sampling and analysis consisted of the following. Pumps set at a preset flow rate of 100 mL/min. pulled fab air through stainless steel tubes packed with multiple beds of proprietary adsorbents. The air was typically sampled in three locations in the fab over a 23-hour period.

After sampling, the sealed tubes were shipped to an analytical laboratory where they were analyzed by thermal desorption followed by gas chromatography and mass spectrometry. The test method was designed to analyze for semi-organic compounds in the n-heptane (boiling range ~100°C) to n-octacosane (boiling range ~430°C) range. Each compound detected was identified by a search of a Wiley library of 275,000 mass spectra or, when no matches were found, by the analyst's interpretation or best estimate of the most probable compound or class of compounds.

A.2 Results

Table A-1 summarizes the relevant results identified as fluoralkyl ethers. The typical spectrum for each sample contains many more compounds that were not fluorinated. The organic compounds are classified into three boiling ranges: low boiling (C7–C10), medium boiling (>C10–C20, and high boiling (>C20). The values are shown here as supporting evidence of the presence of larger molecules that may originate from the fluorinated heat transfer fluids.

A.3 Conclusion

As can be seen from Table A-1, the concentration of fluoroalkyl ethers in the air ranged from <0.1 to 99.8 ng/L.

If one assumes that in 2006 the air make-up rate in a typical fab was 200,000 scfm, then the quantity of fluorinated heat transfer fluids lost in the fab exhaust air is approximately 700 lbs/yr for a worst case concentration of 5 ppb. This would be 10% of the ~7000 lbs/year (based on 500 gallons) of fluorinated heat transfer fluids that the EPA estimates a typical fab loses in a year (EPA 430-R-06-901).

A.4 Sample Calculations

The data in Table A-1 indicate that the highest concentration detected was 99.8 ng/L (say 100 ng/L). This can be converted to ppb as follows: 100 ng × 0.08206 (atm x L)/(moles × °K) × 296K / (1.0 atm × 500 g/mole) = 4.9 ng/g or ppb.

If one assumes the air make-up rate for a typical fab is 200,000 scfm and, in turn, that much air is exhausted from the fab carrying 4.9 ppb of fluoroalkyl ether emissions, the loss of fluorinated hydrocarbons to the atmosphere can be calculated as follows: 4.9 ppb × 200,000 scfm × 500 lbs/lbmole × 60/(1E+09 × 359 ft^3/lbmole) = 0.082 lbs/hr or 717 lbs/year.

Table A-1 Air Samples Taken in High Volume Manufacturing Fabs in 2006

	Concentration			
	Fluoroalkyl ether	C7-C10	>C10-C20	>C20
Sample #	ng/L	ng/L	ng/L	ng/L
1	4.8	39.5	39	1.4
2	61.6	57.6	23.4	0.7
3	99.8	74.7	23.6	0.6
4	24.7	42.1	4.9	0.5
5	16.3	15.0	4.1	<0.1
6	18	16.3	3.8	0.2
7	56.7	43.7	5.3	0.1
8	1.8	19.3	19.4	0.9
9	1.2	13.3	11.5	1.4
10	1.0	20.2	17.8	1.5
11	1.2	23.7	17.8	1.7
12	<0.1	2.0	0.8	0.1
13	<0.1	8.5	6.4	0.4
14	29	34.3	10.8	0.6
15	24.1			
16	35.4			
17	22.9			
18	15.5			

Appendix B – Estimate of the Time to Evaporate a 4 ft^2 by 1/8" Deep Spill

B.1 Conclusions

- A spill of 4 $ft^2 \times$ 1/8" deep = 4.68 lbs (assumed density of 1.8 g/cc).[1]
- The amount evaporated in 3 hours ranges from 0.15 to 13.47 lbs for these commonly used fluorinated heat transfer fluids.
- The time to evaporate a 4 ft^2 spill ranges from 1 to 94 hours, depending on the vapor pressure and molecular weight of the fluid.
- Since the POU chillers that use fluorinated heat transfer fluids have closed systems, it is reasonable to assume such spills are rare.
- A 4 ft^2 spill would most likely be discovered and cleaned up in 3 hours.

Table B-1 Estimate of the Time to Evaporate a 4 ft^2 by 1/8" Deep Spill

Heat Transfer Fluid	MW lb/lb-mole	Mass Transfer Co. K (feet/sec)	Surface Area (ft^2)	Vapor Press. (psia)	Ideal Gas Constant (psi-ft^2/R/lb-mole)	Temp. (° R)	Est. Evaporation (lbs/hr)	Evaporation in 3 hours (lbs)	Time to Evaporate 4ft^2 Spill (hrs)
FC-77	415*	0.0016	4	0.81	10.73	529	1.36	4.08	3.4
FC-3283	521*	0.0014	4	0.27	10.73	529	0.50	1.50	9.4
HT-70	410*	0.0016	4	2.7	10.73	529	4.49	13.47	1.0
HT-110	580*	0.0014	4	0.33	10.73	529	0.68	2.04	6.9
HT-200	870*	0.0012	4	0.019	10.73	529	0.05	0.15	93.6

*(according to EPA Burton report 430-R-06-901)

[1] Sample calculation: $4ft^2 \times 1/8"$ spill= $4 \times 0.125/12$ (ft^3) $\times$ 28.32 (L/ft^3) $\times$ 1000 (cc/L) $\times$ 1.8 (g/cc)/454 (g/lb) = 4.68 lbs.

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ATTACHMENT C

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MANUFACTURING INITIATIVE

Analysis of Nitrous Oxide Survey Data

International SEMATECH Manufacturing Initiative

Technology Transfer #09065015A-TR

Analysis of Nitrous Oxide Survey Data

Technology Transfer #09065015A-TR
International SEMATECH Manufacturing Initiative
June 8, 2009

Abstract: This report from the ESHT001 project presents the results of a survey on the use of nitrous oxide in semiconductor manufacturing by International SEMATECH Manufacturing Initiative (ISMI) and Semiconductor Industry Association (SIA) members. The data were gathered to deveop a response to the U.S. Environmental Protection Agency (EPA) proposed mandatory greenhouse gas (GHG) reporting rule. Results of other surveys in this series are in Technology Transfers #09065012A-TR and #09065014A-TR.

Keywords: Greenhouse Effect, Government Regulations, Nitrous Oxide

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Table of Contents

List of Tables

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Acknowledgments

The author wishes to acknowledge the members of the ISMI Greenhouse Gas Working Group and SIA PFC Committee for their participation in the survey.

1 EXECUTIVE SUMMARY

The U.S. Environmental Protection Agency (EPA) proposed Mandatory Reporting of Greenhouse Gases rule was published in the Federal Register on April 10, 2009, beginning the 60-day comment period. The preamble explains the EPA's basis for the proposed rule. Subpart I outlines specific requirements for semiconductor manufacturing facilities. The proposed rule requires electronics manufacturing facilities to report "nitrous oxide emissions from chemical vapor deposition" (April 10, 2009 FR, p. 16648). It further requires facilities to report annual nitrous oxide (N_2O) consumption as emissions (April 10, 2009 FR, p. 16649). The International SEMATECH Manufacturing Initiative (ISMI) Environment, Safety, and Health Technology Center conducted a survey of ISMI and Semiconductor Industry Association (SIA) members to identify the semiconductor manufacturing processes that use N_2O and the utilization efficiency (UE) for those processes.

2 SURVEY QUESTIONS

The survey asked for the following information:

- Do you manufacture or operate chemical vapor deposition (CVD) process equipment that uses N_2O? If so, what is the name of the process?
- What is the wafer diameter for this equipment (in mm)?
- What is the general name for the process?
- Have you characterized the N_2O emissions from the process?
- What methodology was used to characterize the N_2O emissions and process byproducts?
- Please provide the percentages (of total) that each methodology was used to characterize process emissions and byproducts.
- What was the measured N_2O utilization efficiency? (please provide answer as w/w% with indicator of accuracy of measurement (+/-))

3 SURVEY RESULTS

Seventeen companies submitted 37 responses (34 U.S., 3 overseas).

3.1 Processes that Use N_2O

The survey identified N_2O use in the following semiconductor manufacturing processes:

- Chemical vapor deposition (nitride, polysilicon glass, oxide, etc.)
- Diffusion (oxidation, nitridation, etc.)
- Rapid thermal processing
- Chamber seasoning

3.2 Emissions Characterization

Respondents reported using N_2O in 150 mm, 200 mm, and 300 mm process tool sets; however, no emissions characterization data were available for 150 mm processes and only one data set was provided for 200 mm processes. Only two of the responding companies have N_2O emissions characterization data. Characterization data were collected using either the 2001 or the 2006 *ISMI Equipment Environmental Characterization Guideline*. Both guidelines describe the protocol for quantitative measurements of tool emissions using quadrupole mass spectrometry or fourier transform infrared mass spectrometry. Two other companies estimated utilization efficiency using a stoichiometric and material balance approach. One company estimated N_2O UE after abatement and assumed a 99% destruction or removal efficiency (DRE) in the abatement device.

3.3 Utilization Efficiency

Eleven respondents reported the N_2O utilization efficiencies shown in Table 1. Responses 1 through 8 are measured data while 9 through 11 are estimated. The measured utilization efficiencies range from 1–20% for a 200 mm process (response 7) to a high of 83.5% for a 300 mm process. The average measured UE is 40%. Results 1–6 and 8 were from 300 mm tool sets. For responses 7 and 8, the mid-point of the range was used to calculate the overall average. The large difference between responses 7 and 8 is attributed to the method by which N_2O is supplied to certain 200 mm tools compared to 300 mm tools. If only the 300 mm results are considered, the average UE is 43%.

Table 1 N_2O Utilization Efficiency

Utilization			
Fab	Efficiency (%)	Accuracy (± %)	Comments
1	18	10	*
2	18	N/A	*
3	13.95	3.26	*
4	33.1	0.39	* deposition
4	54.1	1.37	* seasoning
5	83.5	4.92	*
6	64.7	0.73	* deposition
6	34.6	0.11	* seasoning
7	1 to 20	N/A	200 mm tools
8	50–80	N/A	*
9	44	N/A	estimated
10	99	N/A	estimated after abatement with burners
11	100	N/A	estimated

* process in 300 mm tool

4 CONCLUSIONS

N_2O is used in a variety of semiconductor processes in both older and newer generation tool sets. Survey respondents provided little emissions characterization data for older generation tools; the majority of data is for 300 mm tools. The survey did not attempt to determine the quantity of N_2O used in the various processes but instead focused on collecting UE data. The measured UE of N_2O varies widely from a low of 1–20% in characterized 200 mm processes to a high of 83.5% for a 300 mm process. The average of all measured UE is ~40%. If only 300 mm results are considered, the average measured UE is 43%.

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