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# SEMICONDUCTOR INDUSTRY ASSOCIATION PETITION FOR RECONSIDERATION AND REQUEST FOR STAY PENDING RECONSIDERATION OF SUBPART I OF THE FINAL RULE FOR MANDATORY REPORTING OF GREENHOUSE GASES

## DOCKET NO. EPA-HQ-OAR-2009-0927

# I. INTRODUCTION AND SUMMARY

## A. Reconsideration Is Mandated Under The Circumstances

**The Semiconductor Industry Association ("SIA")[1] petitions EPA for reconsideration of the Final Subpart I of the mandatory reporting rules for greenhouse gases.[2] We do so pursuant to Section 307(d)(7)(B) of the Clean Air Act[3], which mandates that EPA "shall" grant reconsideration for "objections" "impracticable" to raise during the rulemaking and of "central relevance."[4]**

**SIA has more than ample grounds to obtain reconsideration of the Final Subpart I under Clean Air Act Section 307(d)(7)(B)'s 2-part "impracticable" and "central relevance" test. Our specific "objections" span the following variety of Subpart I provisions:**

- ⇒ **The Section 98.96(c) provision for larger facilities to develop "recipe-specific utilization and by-product formation rates".**
- ⇒ **The Section 98.94(c) provision for apportionment model validation.**
- ⇒ **The lack of a provision that differentiates between production and research and development operations.**
- ⇒ **The Section 98.91(b) equation for calculating annual manufacturing capacity.**
- ⇒ **The Section 98.93(g) equation for calculating abatement device "uptime".**
- ⇒ **The Section 98.94(b)(5) provision for re-calculating the facility-wide gas specific heel factor where a trigger point for change out differs by more than 5 percent.**

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1 SIA is a trade association for the U.S. semiconductor industry, uniting companies responsible for more than 85 percent of U.S. semiconductor production. SIA is dedicated to maintaining our Nation's world leadership in semiconductor technology, while at the same time supporting its members' workplace safety and environmental protection efforts. Collectively, the semiconductor industry employs a domestic workforce of approximately 200,000 people, and is our Nation's largest exporting industry over the last five years. More information about the SIA can be found at www.sia-online.org.

2 Mandatory Reporting of Greenhouse Gases: Additional Sources of Fluorinated GHGs; Final Rule, 75 Fed. Reg. 74,774 (Dec. 1, 2010), Subpart I to be codified at 40 C.F.R. § 98.90, et seq. (hereinafter "Final Subpart I" or "Final Rule").

3 42 U.S.C. § 7607(b)(1).

4 At the same time, SIA is filing Petition for Review of the Final Rule with the United States Appellate Court of Appeals for the District of Columbia Circuit pursuant to Section 307(b)(1) of the Clean Air Act, 42 U.S.C. § 7607(b)(1), and Rule 15(a) of the Federal Rules of Appellate Procedure.

⇒ **The Section § 98.95(g)(4)(i) provision for accuracy and precision of +/- 1 percent for all flowmeters, weigh scales, pressure gauges and thermometers used for measurement.**

⇒ **The § 98.93(b) provision requiring calculation of N2O emissions from "each chemical vapor deposition process and other electronics manufacturing production processes".**

⇒ **The § 98.96(c)(3) provision requiring reporting of N2O emissions from "each chemical vapor deposition process and from other N2O-using manufacturing processes."**

⇒ **Section 98.94(a) provisions for Best Available Monitoring Methods extensions.**

**Our objections also extend to EPA's Economic Impact Analysis ("EIA"). Data gathered by the independent International Sematech Manufacturing Initiative ("ISMI") demonstrates that the EIA suffers from clear errors, mistaken assumptions and methodological flaws. As a result, it is legally insufficient to support the Final Subpart I as rational, adequately explained agency decision-making.**

**Although this Petition covers these objections to the EIA as well as our specific objections pertaining to the above-listed Final Subpart I provisions, SIA devotes the most attention to the Section 98.96(c) "recipe-specific utilization and by-product formation rates" provision. We do so for two reasons.**

**First, it is urgent -- given the Final Subpart I became effective several weeks ago -- for SIA to detail our "objection" that this provision, as currently written, is technically infeasible to comply with at many facilities.**

**Second, it is imperative -- given our members' strong desire to reach agreement with EPA on an alternative to the Final Subpart I and begin compliance with that alternative as soon as possible -- for SIA to amplify our "objection" that any GHG emissions compliance regime based on individual recipe-by-individual recipe measurement is simply not viable. Indeed, such a regime goes to the heart of the semiconductor fabrication process, and as a result, would:**

⇒ **threaten to compromise the millions (and in some cases billions) of dollars worth of intellectual property that comprises a company's recipe portfolio;**

⇒ **hamper innovation by requiring technology upgrades, advancements and innovations to occur within the regime's constraints;**

⇒ **not be amenable to adoption as an international standard; and**

⇒ **result in inordinate initial and ongoing expense.**

**For these and other reasons, an individual recipe-by-individual recipe approach lacks sufficient legal and policy rationality, especially when alternative, higher process level approaches exist, such as the process category-based approach identified by SIA during our recent informal discussions with EPA, that would avoid such problems.**

### B. A Stay During Reconsideration Is Essential To Avoid Steps Towards Compliance With A Final Subpart I That Will Require Fundamental Revision

**Section 307(d)(7)(B) of the CAA authorizes EPA to stay the effectiveness of a final rule during the reconsideration process for a period not to exceed three months.[5] EPA precedent clearly establishes that a stay is warranted where the reconsideration process is likely to result in an Agency decision to modify substantive compliance obligations. Moreover, EPA has regularly used the formal rulemaking process to grant stays of much longer than three months during reconsideration.**

**SIA's "objections" detailed in this Petition demonstrate the necessity of a stay to avoid steps towards compliance with a Final Subpart I that will require fundamental revision. Final Subpart I suffers from serious flaws relating to the infeasibility of compliance with a recipe-based emission reporting requirement; the incompatibility of a recipe-based emission reporting requirement to the semiconductor manufacturing process; the serious confidentiality concerns relating to the sharing of intellectual property inherent to a recipe-based reporting requirement; and the grossly understated compliance costs contained in EPA's EIA. As such, Section 307(d)(7)(B) mandates reconsideration, and it would be inappropriate from both a legal and policy standpoint to have Final Subpart I continue to apply in its current form during the reconsideration process.**

**Indeed, leaving Final Subpart I in effect while EPA undergoes a formal reconsideration process to address the feasibility, practicality, confidentiality and cost issues raised by SIA would create the result of requiring compliance with a set of requirements that may differ significantly from the requirements promulgated at the conclusion of the reconsideration process. Moreover, the Final Subpart I BAMM provisions would only exacerbate this unjust result.**

**By requiring tangible, fully documented, Final Rule requirement-by-Final Rule requirement steps toward full compliance, the BAMM provisions would impose significant burdens and may create additional legal vulnerabilities. These provisions have been designed for a wholly different purpose and simply**

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[5] 42 U.S.C. § 7607(d)(7)(B).

**do not offer a viable alternative to a stay in a situation where a final rule requires fundamental revisions.**

## II. THE "RECIPE-SPECIFIC UTILIZATION AND BY-PRODUCT FORMATION RATES" PROVISION -- WHICH REQUIRES MEASUREMENT OF EACH DIS-"SIMILAR" "INDIVIDUAL RECIPE" -- PROVIDES MORE THAN AMPLE GROUNDS TO MANDATE RECONSIDERATION

On December 1, 2010, EPA published the Final Subpart I, which includes, among others, a provision requiring larger manufacturing facilities to quantify

> "each fluorinated GHG emitted from each ***individual recipe*** (including those in a set of ***similar recipes***), or process sub-type" for all plasma etch processes[6] based on "measurements" of "recipe-specific utilization and by-product formation rates"[7].

As the highlighted text indicates, this requirement centers around measuring fluorinated GHG or "F-gas" emissions on an individual recipe-by-individual recipe basis for all plasma etch processes, with the ability to utilize a single set of measurements for all "similar recipes."

Neither the original Proposal nor the Re-proposal contained -- or even discussed in a concrete conceptual fashion -- any type of individual recipe-by-individual recipe measurement approach. Instead, as detailed below, both proposals would have required measurement at a much higher process platform level. By contrast, a recipe approach delves so deeply into the semiconductor fabrication process -- and constitutes such a substantial departure from higher level measurement -- that it simply is not a logical outgrowth of either the original Proposal or Re-proposal which SIA could have anticipated, let alone raised "objections" to, during the rulemaking.

Indeed, the Final Subpart I's "recipe-specific utilization and by-products formation rates" provision rests on two definitions -- the "individual recipe" and "similarity" of recipes -- that EPA simply never put forward even as concepts in either proposal.[8] As detailed in Section II.B.1. below, these definitions render

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[6] 40 C.F.R. § 98.96(c)(2). (Hereinafter, all references to sections shall refer to Title 40 of the Code of Federal Regulations unless otherwise noted).

[7] § 98.94(d).

[8] While reference was made during the rulemaking process to several potential alternative approaches, including one that would have been based on recipes, such an approach was mentioned only briefly, and EPA provided no analysis or discussion of how such recipe-based reporting would be implemented, or the consequences of such a program to the semiconductor industry. In particular, EPA never proposed definitions for "individual recipe" or "similar," the two fundamental terms upon which EPA's recipe-based approach is founded, and never addressed such an approach in its Economic Impact Assessment for Subpart I. Thus, there was never any indication during the

**the Final Rule, as currently written, technically infeasible to implement at many facilities. Beyond that, however, a compliance regime based on individual recipe-by-individual recipe emissions measurement goes to the heart of the semiconductor fabrication process, and as a result, is not viable in the long term because it would:**

⇒ **threaten to compromise the millions (and in some cases billions) of dollars worth of intellectual property that comprises a company's recipe portfolio;**

⇒ **hamper innovation by requiring technology upgrades, advancements and innovations to occur within the regime's constraints;**

⇒ **not be amenable to adoption as an international standard; and**

⇒ **result in inordinate initial and ongoing expense.**

**For these and other reasons, an individual recipe-by-individual recipe approach lacks sufficient legal and policy rationality, especially when alternative, higher level approaches exist that would avoid such problems.**

**These circumstances mandate reconsideration under Clean Air Act Section 307(d)(7)(B)'s 2-part "impracticality" and "central relevance" test.** [9] **Certainly, it was impractical for SIA to have raised "objections" to an approach never proposed and that deviated so sharply from approaches that were proposed. Moreover, even assuming the appropriateness of EPA's recent "central relevance" test characterization in the GHG endangerment finding context -- as requiring an "objection" which "provides substantial support for the argument that the regulation should be revised"**[10] **-- the technical infeasibility of**

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rulemaking process that the final Subpart I reporting program would be entirely based on recipes, nor was there a level of discussion regarding a recipe-based program of sufficient detail and complexity to support its forming the basis of the final rule.

[9] Pursuant to Clean Air Act Section 307(d)(7)(B), "the Administrator ***shall*** convene a proceeding for reconsideration of the rule" if (1) "the person raising an objection can demonstrate to the Administrator that it was impracticable to raise such objection [during the comment period] or if the grounds for such objection arose after the period for public comment (but within the time specified for judicial review)" and (2) "such objection is of central relevance to the outcome of the rule." 42 U.S.C. § 7607(d)(7)(B) (emphasis added).

[10] Last year, EPA denied a petition for reconsideration of its GHG endangerment finding, and in doing so, provided a new interpretation of Section 307(d)(7)(b)'s "central relevance" standard. EPA's Denial of the Petitions To Reconsider the Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 75 Fed. Reg. 49,556, 49,561 (Aug. 13, 2010) ("In EPA's view, an objection is of central relevance to the outcome of the rule only if it provides substantial support for the argument that the regulation should be revised. … It requires that the objection be of such substance and merit that it can be considered central to the outcome of the rulemaking.") According to EPA, under this standard, "it is not enough that the objection or error be of central relevance to the issues involved in the rulemaking. … Instead, the

compliance based on the current "individual recipe" and "similarity" of recipes definitions clearly satisfies this characterization of the test.

### A. <u>Neither The Original Proposed Subpart I Nor the Re-Proposal Included Any Type Of Individual Recipe-by-Individual Recipe Measurement Approach, And Therefore, During the Rulemaking, SIA Had No Reason To Anticipate -- Let Alone Sufficient Grounds For "Objection" To -- Such An Approach</u>

#### 1. <u>Original Proposal</u>

EPA's original Proposed Subpart I[11] would have required all large semiconductor facilities[12] to rely on "***process-specific*** process utilization and by-product formation factors" measured using "The International SEMATECH Manufacturing Initiative's [ISMI] Guidelines for Environmental Characterization of Semiconductor Process Equipment" (herinafter "ISMI Guidelines").[13] A facility would have been permitted to rely on factors measured by an equipment supplier under "conditions representative of [its] . . . F-GHG emitting ***processes***".[14]

The original Proposal did not define the terms "processes" or "process-specific." In context, however, these terms plainly referred to what in industry parlance is a "unique process platform" -- *i.e.,* a specific tool model using a specific F-gas for either etch or CVD chamber clean[15] -- and not to the hundreds

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objection has to be of central relevance "to the outcome of the rule" itself." <u>Id</u>. SIA does not believe that this interpretation is legally defensible, as it could support a denial of reconsideration in circumstances where a petitioner does not quibble with the central aspects of a complex rule, but nevertheless, has demonstrated that various subsidiary provisions of the rule are incorrect factually or legally invalid. Putting that aside, however, SIA believes that it has demonstrated central relevance as to the Final Subpart I's individual recipe-by-individual recipe measurement provision even under this interpretation.

11 Mandatory Reporting of Greenhouse Gases, Proposed Rule, 74 Fed. Reg. 16,448 (Apr. 10, 2009) [hereinafter "Proposed Subpart I" or "original Proposal"].

12 This concept, defined as those facilities with an annual manufacturing capacity of greater than 10,500 m2 of substrate, was consistent from Proposed Subpart I to Re-proposed Subpart I, and remained unchanged in Final Subpart I.

13 Proposed Subpart I, at 16,648 (§ 98.93(c)(1)). Note, the ISMI Guidelines referred to by reference in Final Subpart I have been superseded by a more recent version: Guideline for Environmental Characterization of Semiconductor Process Equipment – Revision 2, International SEMATECH Manufacturing Initiative, Technology Transfer #06124825B-ENG (2011), <u>available at</u>: http://www.sematech.org/docubase/document/4825beng.pdf.

14 <u>Id</u>. at 16,649 (§ 98.94(b)(1) & (2)).

15 <u>See</u> Results of the ISMI ESH Technology Center Greenhouse Gas Facility Survey, Technology Transfer #09065012A-TR (June 8, 2009) at p. 15, included as an attachment to Comments of the Semiconductor Industry Association on U.S. EPA's Mandatory Reporting of Greenhouse Gases; Proposed Rule, Docket No. EPA-HQ-OAR-2008-0508.0498.1 (June 9, 2009).

of individual recipes that a facility may run over the course of a year on its process platforms.

In particular, the original Proposal's Preamble made clear that EPA aimed, with the process-specific factors, to mandate an approach for the largest facilities based on the IPCC Tier 3 method and to allow other facilities to rely on the IPCC Tier 2b method:

> *Fluorinated GHG Emissions.* Under the proposed rule, large semiconductor facilities (defined as facilities with annual capacities of greater than 10,500 $m_2$ silicon) would be required to estimate their fluorinated GHG emissions from etching and cleaning using an approach based on the IPCC Tier 3 method, and all other facilities would be required to use an approach based on the IPCC Tier 2b method.[16]

As the 2006 IPCC Guidelines cited in the original Proposal[17] explain, the Tier 2b method entails segregating F-gas usage into two basic process categories -- etch and chamber clean -- and using default emission factors, whereas Tier 3 method involves developing "process specific parameters" through measurement of a "specific 'Process' (e.g., silicon nitride etching or plasma enhanced chemical vapour deposition (PECVD) tool chamber cleaning)."[18] The IPCC Guidelines, therefore, do not describe the Tier 3 method in terms of individual recipe-by-individual recipe measurement, but instead, make clear that Tier 3 occurs at a process subcategory or platform level. Likewise, the ISMI Guidelines that would have been codified into regulation by the original Proposal do not contemplate individual recipe-by-individual recipe measurement, but instead, refer to using the "equipment supplier's baseline process recipe" as "the basis for the tool environmental characterization."[19]

SIA's comments and course of discussion with EPA also indicate that neither Party understood the original Proposal as being one that would – or might -- require Tier 3 measurement down to the individual recipe-by-individual recipe level. Indeed, our comments and several extensive presentations to the

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16 Proposed Subpart I, at 16,498.

17 Id. at 16,464, n. 41. See Intergovernmental Panel on Climate Change, 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 3, Ch. 6 [hereinafter "2006 IPCC Guidelines"] at p. 6.11, available at: http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_6_Ch6_Electronics_Industry.pdf.

18 2006 IPCC Guidelines at p. 6.13.

19 ISMI Guidelines at 6.

Agency[20] provided an impact assessment based on the estimated number of unique "process platforms" -- an average of 37[21] -- which is vastly different than an impact assessment that SIA would have performed had it understood the original Proposal could or might morph into any kind of individual recipe-by-individual recipe measurement approach which implicates a company's portfolio of hundreds to thousands of recipes with intellectual property value in the hundreds of millions to billions of dollars. Moreover, EPA appears to have shared SIA's understanding of the original Proposal, given that, at no point, did EPA suggest it was considering an individual recipe approach, and indeed, never finalized the Proposal, but instead, as discussed below. issued a Re-Proposal that took the process platform approach to a more macro level.

### 2. Re-Proposal

In October of 2009, EPA finalized many of the GHG reporting subparts, but deferred Subpart I to perform additional analysis of information submitted and to evaluate a range of alternative "data collection procedures and methodologies."[22] Based on such further analysis and evaluation, EPA issued a Re-proposed Subpart I in April 2010.[23]

The Re-proposal would have replaced the "process-specific process utilization and by-product formation factors" measurement approach of the original Proposal with a set emission factors for 9 process categories: four etch categories (oxide etch, nitride etch, silicon etch, and metal etch); three chamber clean categories (*in situ* plasma, remote plasma, and *in situ* thermal); and two wafer clean categories (bevel cleaning and ashing).[24] As such, the Re-proposed Subpart I would have required large facilities to report emissions based on nine default emission factors rather than the average of 37 that SIA's impact assessment indicates would have been required under Proposed Subpart I. Thus, the Re-proposal actually moved to a set of more general process reference points as compared to the original Proposal.

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20 Comments of the Semiconductor Industry Association on U.S. EPA's Mandatory Reporting of Greenhouse Gases; Proposed Rule, Docket No. EPA-HQ-OAR-2008-0508.0498.1 (June 9, 2009).

21 SIA's comments include a survey performed by ISMI which reported an average of 37 unique "processes" at each large facility, with an average cost of developing emission factors for these unique processes of $430,000 per facility. See Results of the ISMI ESH Technology Center Greenhouse Gas Facility Survey, Technology Transfer #09065012A-TR (June 8, 2009) at p. 15, included as an attachment to Comments of the Semiconductor Industry Association on U.S. EPA's Mandatory Reporting of Greenhouse Gases; Proposed Rule, Docket No. EPA-HQ-OAR-2008-0508.0498.1 (June 9, 2009).

22 Mandatory Reporting of Greenhouse Gases; Final Rule, 74 Fed. Reg. 56,260, 56,302 (Oct. 30, 2009).

23 Mandatory Reporting of Greenhouse Gases: Additional Sources of Fluorinated GHGs; Proposed Rule, 75 Fed. Reg. 18,652 (Apr. 12, 2010) [hereinafter "Re-proposed Subpart I" or Re-proposal"].

24 Re-proposed Subpart I at 18,662.

**Indeed, as indicative of this point, SIA filed extensive comments on Re-proposed Subpart I, explaining that the data being requested for the emissions factors in the 9 process categories generally did not exist and that the apportionment model would result in greater uncertainty and a larger margin of error than IPCC Tier 2b. We offered an alternative "Refined Method" that entailed apportionment across five process categories (instead of the nine process categories under Re-proposed Subpart I), but otherwise mirrored its alternative from comments on the original proposal. Our comments included a further ISMI impact assessment which indicated an average cost of approximately $180,000 per facility for developing emission factors for the nine Refined Method categories. The gross disparity of this $180,000 per facility estimate -- versus the first year per facility estimate of $1.93 million for compliance with the Final Subpart I individual recipe measurement approach (see Section III.B.2.a. below) -- underscores SIA's obvious understanding that the Re-proposal did not encompass any type of individual recipe measurement approach.**

**Moreover, this understanding was clearly reasonable: EPA did not propose regulatory language -- or otherwise sketch out in the Preamble in any substantive fashion -- that a final Subpart I might depart from the process platform focus of the original Proposal and the process sub-category approach of the Re-proposal to require some type of individual recipe-by-individual recipe measurement approach. As detailed in the sections that follow, such a recipe approach delves deeply into the semiconductor fabrication process and constitutes such a substantial departure from measurement at the process level that it simply is not a logical outgrowth of either the original Proposal or Re-proposal.[25]**

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**[25] See Environmental Integrity Project v. EPA, 425 F.3d 992, 996 (D.C. Cir. 2005) ("an agency's final rule may differ only insofar as the latter is a "logical outgrowth" of the former" (citing Shell Oil Co. v. EPA, 950 F.2d 741 (D.C. Cir. 1991)). See also Northeast Maryland Waste Disposal Auth. v. EPA, 358 F.3d 936, 952 (D.C. Cir. 2004) ("A rule is a logical outgrowth if interested parties "should have anticipated" that the change was possible, and thus reasonably should have filed their comments on the subject during the notice-and-comment period") (citing City of Waukesha v. EPA, 320 F.3d 228, 245 (D.C. Cir. 2003)); Int'l Union, United Mine Workers v. MSHA, 407 F.3d 1250, 1259 (D.C. Cir. 2004) (citing Kooritzky v. Reich, 17 F.3d 1509, 1513 (D.C. Cir. 1994)) (The "logical outgrowth" doctrine does not extend to a final rule that finds no roots in the agency's proposal because "something is not a logical outgrowth of nothing,", nor does it apply when "the final rule is "surprisingly distant" from the proposed rule"); Chamber of Commerce of the United States v. SEC, 443 F.3d 890, 900 (D.C. Cir. 2006) (citing Assn of Data Processing Service Orgs, Inc. v. Bd. of Governors of Fed'l Reserve System, 745 F.2d 677, 684 (D.C. Cir. 1984)) ("In essence, the question [of whether a final rule is a "logical outgrowth"] is whether "at least the most critical factual material that is used to support the agency's position … [has] been made public in the proceeding and exposed to refutation. By requiring the "most critical factual material" used by the agency be subjected to informed comment, the [Administrative Procedure Act] provides a procedural device to ensure that agency regulations are tested through exposure to public comment").**

**B. SIA's Objections To The "Recipe-Specific Utilization and By-Product Formation Rates" Provision Are Of "Central Relevance" To The Outcome Of the Final Subpart I**

**1. The Provision, As Currently Crafted In The Final Subpart I, Is Not Technically Feasible To Comply With At Many Facilities**

The Final Subpart I defines "individual recipe" as follows:

> "*Individual recipe* means a specific combination of gases, under specific conditions of reactor temperature, pressure, flow, radio frequency (RF) power and duration, used repeatedly to fabricate a specific feature on a specific film or substrate."[26]

This definition presumes that an "individual recipe" has two stable components: (1) a "specific combination of gases" "used repeatedly" (2) "under specific conditions of reactor temperature, pressures, flow, radio frequency (RF) power and duration." Such presumption is one root cause of Subpart I's technical feasibility issues.

In particular, only a limited portion of semiconductor ("s/c") etch recipes still in use today would satisfy such presumption of stable components. The vast majority of today's recipes -- which consist of multiple, complex and variable steps -- would not. As explained below, therefore, this definition, if applied as written to the majority of today's s/c etch recipes, could render each step in a complex recipe a separate Subpart I "individual recipe." The implications of this proposition -- *i.e.,* the proposition that each-s/c-etch-recipe-step-is-a-separate-Subpart I-"individual recipe" -- are profound, given that a complex recipe may involve upwards of 20 or more steps and that manufacturing facilities may run hundreds to thousands of such recipes per year.

A semiconductor manufacturer has a portfolio of s/c etch recipes, with many such recipes consisting of multiple, complex process steps. For example, it is not uncommon for a single s/c etch recipe to have 20, and sometimes as many as 50, process steps. For each process step, the recipe will specify both a varying "combination of gases" and as many as 15 or 20 distinct "specific conditions."[27]

Notably, both the "combination of gases" and "specific conditions" can -- and often will -- vary as between each of the 20+ process steps within a s/c etch recipe itself. The Final Subpart I's "individual recipe" definition, therefore, does not accord, if applied as written, with what the semiconductor industry regards

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26 § 98.98.

27 Exhibit A, is an example of a representative plasma etch process recipe. This example, which is based on an actual SIA member company recipe, illustrates the multiplicity, complexity and variation between and among each step of a s/c etch recipe.

as a complex s/c etch recipe; instead, the definition could be understood to define each step within such a recipe as a separate "individual recipe."

The technical infeasibility of this proposition -- *i.e.,* the proposition that each-s/c-etch-recipe-step-is-a-Subpart I-"individual recipe" -- becomes apparent when one considers that a manufacturer's s/c etch recipe portfolio numbers in the hundreds to thousands of recipes, with new recipes being added each year. To illustrate the technical infeasibility issues, it is useful to consider one of the largest s/c etch recipe portfolios of an SIA member company facility.[28]

This member's portfolio consists of 10,000 active s/c etch recipes spread among that member's R&D and manufacturing activities integrated in a single facility. The portfolio undergoes adjustment each year, with the addition of approximately 2,000 new recipes and the modification of another approximately 2,000 recipes. This member runs, on average, 3,000 recipes from its portfolio in its manufacturing operation each year. Even assuming conservatively that those 3,000 s/c etch recipes consist of 20 steps each, and putting aside portfolio adjustments, a strict application of Subpart I's "individual recipe" definition could result in those 3,000 s/c etch recipes translating to as many as 60,000 "individual recipes" for which Subpart I could require "measurements" of "recipe-specific utilization and by-product formation rates."

The infrastructure, equipment and personnel do not currently exist in most facilities to perform such step-by-step "measurements" within a s/c etch recipe. Even if it did, however, the tracking and measurement burden goes well beyond any rational level, especially in light of Subpart I's "similar with respect to recipes" definition, which, if applied as written, could cause those 60,000 "individual recipe" steps, using the above example, to multiply well beyond that number.

In particular, Subpart I provides that

> "***Similar, with respect to recipes***, means those recipes that are composed of the same set of chemicals and have the same flow stabilization times and where the documented differences, considered separately, in reactor pressure, individual gas flow rates, and applied radio

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28 It should be recognized that recipe portfolios have inherent intellectual property value in the billions of dollars. Although Subpart I does not require a company to submit its recipes per se to EPA, it does require that various recipe-related information be provided to EPA as "backup" for the Recipe-Specific Utilization and By-Product Formation Rates being measured and applied by a facility. Notably, this backup information is highly sensitive and could be used in some cases to reverse engineer or otherwise compromise the recipes in question. Neither Subpart I nor the Confidential Business Information Proposal (which was based on the Re-proposed rule that did not have this the Recipe-Specific Utilization and By-Product Formation Rates requirement) recognize the enormous intellectual property worth of a recipe portfolio, let alone provide adequate trade secret protections.

frequency (FR) power are less than or equal to plus or minus 10 percent."[29]

This definition would allow each Subpart I "individual recipe" step within a s/c etch recipe to qualify as "similar" -- and thereby to rely on a common "measurement" of "recipe-specific utilization and by-product formation rates" -- as long as those "individual recipe" steps all (1) utilize "the same set of chemicals" and "flow stabilization times" and (2) have "documented differences" of other "specific conditions" "less than or equal to plus or minus 10 percent."

SIA appreciates that EPA intended to streamline compliance with this "similar" definition. But, the definition -- analogous to the difficulties created by application of the "individual recipe" definition as written -- will have precisely the opposite impact due to two technical realities:

(1) Many s/c etch recipe steps may define some or all "specific conditions" in terms of an acceptable range. Moreover, that defined range often will vary by more than "plus or minus 10 percent."[30]

(2) Each set of "specific conditions" in many s/c etch recipe steps, whether or not defined as a range, may undergo adjustment -- either on an automated basis while being run or before the next run through a technical assessment -- and this adjustment may result in a more than "plus or minus 10 percent" variation from how the s/c etch recipe defines that step on paper.[31]

The foregoing technical realities indicate that this "similar, with respect to recipes" definition could mean that a step within a s/c etch recipe might morph into a new Subpart I "individual recipe" on a rolling basis because either

(1) the step itself contemplates variation beyond the "plus or minus 10 percent" "similar" benchmark, and such variation occurs in one or more of the step's "specific conditions" while the step of the recipe is being run, or

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29 § 98.98.

30 See Exhibit A, which is an example recipe, consisting of 26 process steps. Many of the process conditions within those 26 steps are defined by the recipe in terms of a range, and for more than 50 percent of those conditions, such range exceeds the "plus or minus 10 percent" limitation in the Final Subpart I's "similar" definition.

31 Small variations in the condition of the wafer and the etch chamber as well as other factors can cause the feature being etched onto the wafer to vary from targeted dimensions. State-of-the-art semiconductor manufacturing facilities currently rely on an automated process controls infrastructure that allows for in-situ adjustment based on desired outcome. Older facilities also engage in adjustment by assessing recipe performance over time. Notably, for future generations of semiconductor wafer technology with nanoscale feature sizes, automated process controls will be essential to assuring that the process achieves the desired set-points. As a result, in the future, the industry will be moving away from the current "cookbook" recipe system to one that entails constant in-situ tweaks and adjustments to address process conditions.

(2) the automated or other technical process adjustments to the s/c etch recipe, either while being run or subsequent to the run, have the effect of evolving one or more of the step's "specific conditions" beyond the "plus or minus 10 percent" "similar" benchmark.

This morphing phenomenon, of course, would pose significant technical infeasibility issues. Indeed, it would result in multiplying, using the example above, the 60,000 annual "individual recipe" steps into new and further "individual recipes," each of which would require its own separate "measurement." It seems apparent to SIA that EPA did not anticipate or intend to create these technical feasibility issues.

### 2. Even If Re-crafted, An Individual Recipe Measurement Approach Intrudes So Deeply Into The Manufacturing Process That It Does Not Constitute A Rational Basis For Regulation

#### a. Technical Impracticality

Even if EPA were to modify the Final Subpart I's "individual recipe" and "similarity" definitions to address the foregoing technical infeasibility issues, SIA believes that an individual recipe-by-individual recipe measurement approach is technically impractical for several reasons.

##### (1) The Approach Would Require Ongoing Annual Measurement Of Hundreds of Recipes

The ISMI preliminary impact assessment commissioned by SIA incorporates an assumption that, although not strictly consistent with the regulatory text, appears to reflect EPA's regulatory intention – *i.e.*, the assumption that Subpart I's "individual recipe" definition refers in all cases to an entire s/c etch recipe (and not, in the case of a complex s/c etch recipe, to each step of that recipe). Even doing so, however, does not render Subpart I technically viable.

ISMI requested survey respondents to estimate how much of their s/c etch recipe portfolio would qualify as "similar" (1) as it appears "on paper" and (2) assuming that all steps within each recipe qualify as one "individual recipe." As indicated on page 8 of the attached ISMI impact assessment report, s/c etch recipes, even "on paper," will not be amenable to reasonable grouping under the Subpart I's "plus or minus 10%" "similar" benchmark.

In particular, ISMI received estimates representing the recipe portfolios of 22 large facilities. These estimates indicate that only 3 of the 22 facilities would have less than 200 dis-"similar" recipes; of the 19 facilities with over 200 dis-"similar" recipes, 3 facilities would have over 500, one over 800, and another was not even able to count its dis-"similar" recipes but believes it will easily exceed 800.[32] Notably, companies typically introduce new recipes each year. So, these numbers would grow over time. Moreover, as discussed in Sections II.B.2.c. and III.B. below, the initial and ongoing compliance costs associated with such a regime are exorbitant, particularly in light of the industry's small contribution to the overall GHG emissions inventory and as compared with other industrial sectors.

(2) **The Approach Would Intrude Too Deeply Into The Semiconductor Fabrication Process**

The "fabrication" of a semiconductor device entails a repetitive patterning process in which materials are selectively deposited, modified, or removed from a wafer surface, to produce the complex three dimensional structures that comprise integrated circuits. Two of the most common wafer fabrication steps involve the use of fluorinated gases ("F-gases"):

1. The deposition of thin films of conductors, insulators and other materials is commonly performed using a process known as chemical vapor deposition, or "CVD," in which the film of deposition material gets deposited not only on the targeted area of the wafer, but also over the entire interior surface of the CVD tool processing chamber. Consequently, the interior surfaces of the CVD tool chamber must be periodically cleaned by flowing F-gases into the chamber and creating a plasma condition.

2. Similarly, the process known as "etching" typically involves the selective removal of materials from precisely controlled regions on the wafer surface.[33] The most commonly used form of etching is "plasma etch,"[34] in which source gases – typically F-gases – are excited using radio frequency (RF) energy to create a plasma which releases ions, electrons and chemically reactive neutral molecular species, including fluorine radicals. The combined forces of chemically reactive species and physical bombardment by ions provides a framework for selectively etching targeted film materials.

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32 This facility was unable to provide ISMI an estimate because: 1) there was insufficient time to classify its extensive inventory of etch recipes into sets of "similar" recipes; and 2) the +/- 10 percent variation "similarity" criterion was subjective and difficult to apply.

33 Semiconductor fabrication involves several additional processes, including "patterning" or "lithography," in which the geometry of the region within which materials are deposited, modified, or etched is defined using light and a chemical process called "photolithography." Additionally, a material's electrical or physical properties may be modified through various chemical "doping" processes. Also, the CVD chamber is cleaned periodically between fabrication cycles. However, due to Final Subpart I's requirement for semiconductor etch recipe-specific emission factors, this Petition addresses only the etch process.

34 Etching a deep trench through a stack of different materials is one major application of plasma etch, though not the only one.

**Plasma etching typically takes place in what are known as Reactive Ion Etch ("RIE") tools. To accomplish effective etching, RIE engineers must balance three processes that occur simultaneously within the plasma reactor:**

- ⇒ **Chemical etching, which involves chemical reactions between components of the feed gas that become reactive under the plasma conditions so that they combine selectively with targeted film materials to produce volatile reaction products that can be swept out of the RIE chamber. Etching tends to be isotropic (*i.e.*, it occurs in all directions) and so does not create vertical side walls in the growing trench.**

- ⇒ **Sputtering, which involves dislodging molecules from the surface of a material with a beam of highly energetic, but chemically inert, ions. Sputtering is largely a directional process.**

- ⇒ **Protection, which involves adding feed gas components to the RIE that polymerize on the sidewalls of the trench and protect the walls from being etched by the plasma. This helps to counteract the otherwise isotropic etching to produce vertical sidewalls.**

**Balancing these three processes generally requires the use of multiple gases (and combinations of gases) over a sequence of multiple steps within a single recipe. Furthermore, in many modern RIE applications the etch process recipe calls for etching though layered stack materials, each of which serves a separate, critical function in the integrated circuit structure, and therefore reacts differently to particular F-gases (or combinations of gases) in a plasma. In this type of multilayer application, as the etching progresses deeper into the wafer, different materials are encountered, requiring often very different F-gases (or combinations thereof) to optimize the etch process.**

**The etch process is further complicated by the need to protect the vertical sidewalls of a deepening trench from isotropic etching. As etching progresses through the layers of different materials within a wafer, layers that previously comprised the floor of the trench become the sidewalls. As a result, where at one point in the etch process the objective was to supply a combination of gases in the RIE tool that optimizes removal of a particular material from the floor of the trench, at the next moment, the objective is to supply a combination of gases that protects that same layer from being etched (because it is now part of the sidewall) while at the same time optimizing the removal of the new layer of material exposed on the floor of the trench. Moreover, as the trench deepens, the composition of the sidewalls increases in complexity as new layers are exposed and become a part of the sidewalls. As etching progresses through the layered structure, therefore, the combination of gases in the RIE tool must be frequently adjusted so that it reacts adequately with the new layer of material exposed at the floor of the trench, while simultaneously protecting the constantly changing sidewalls.**

For example, within each step, a recipe may specify as many as 15 or 20 distinct "specific process parameter conditions," such as chamber pressure, RF power, and temperature, that are optimized for the materials exposed (both on the floor and the sidewalls) at a specific time. As mentioned above, due to the complexity of excavating through the layers of materials, it is not uncommon for a single etch recipe to have 20, and sometimes as many as 50, separate process steps.[35] To manufacture multiple products, and to support research and development activities, a semiconductor manufacturer typically maintains a large portfolio of etch recipes, with many such recipes consisting of multiple, complex process steps.

A key objective in the manufacturing of integrated circuits is to make the wafer features very consistent. Small variations in the condition of the incoming wafer, the etch chamber, and other factors can cause the etched feature to vary from the targeted dimensions. Automated Process Control ("APC") provides a means of adjusting the etch recipe, on-the-fly, so that critical dimensions like line width, film thickness, depth, and profile, can be monitored and the recipe adjusted as necessary to maintain the wafer features within defined set points.

Some advanced facilities utilize an APC infrastructure that can automatically modify any and all etch recipe parameters, as necessary, to control wafer feature etching. In this sense, the etch recipe represents a starting condition, or "base recipe" that can be modified over the course of an individual etch recipe execution, or alternatively, modified from wafer-to-wafer. The use of APC represents an industry trend away from the use of "cookbook" recipes, which have higher potential for error as chamber conditions change; to highly instrumented APC systems that enable recipe adjustment based on the desired outcome. Under APC, some parameters are automatically varied by greater than a factor of 2 from their starting value, and thus would cause a given "base recipe" to morph from one group of "similar" recipes to another.

Together, the varied elements described above -- each of which is often customized either through mechanical means or, increasingly, on an automated basis -- make up a single etch recipe as understood by the semiconductor

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[35] Page 12 of Exhibit A illustrates the multiplicity, complexity and variation between and among steps of an actual semiconductor etch recipe used by an SIA member company. Each row corresponds to a particular etch condition parameter (e.g., flow of a specific gas, chamber pressure, upper and lower RF power), existing for a specific time period during the etch process. Each column represents one of 26 separate combinations of conditions, or steps, in the recipe. In each step in the recipe, one or more parameters is "active," which activity is denoted by the corresponding cell in the table being highlighted with a color. The letters in each cell in the table represent a particular value, or range of values, for each active parameter. The active parameters, and those parameter's values, at a specific time result in the "combination of gases" and the "specific conditions" for that step. As demonstrated by the table, both the "combination of gases" and "specific conditions" can -- and often will -- vary as between each of the 20-plus process steps within a s/c etch recipe itself.

industry. To ground a GHG emissions reporting regime on individual recipe measurement would require that the regime be designed both (1) to take into account all of the foregoing varied elements that make up a single etch recipe and (2) to account for the continued advancement, upgrades and innovations in semiconductor fabrication technology. SIA submits that designing such a regime – which would need to intrude deeply into the heart of the fabrication process – is not technically practical, and moreover, is not reasonable, when higher level alternatives exist that can satisfy EPA's stated goals of improving precision and accuracy over the IPCC Tier 2b method.

#### b. Threats To Intellectual Property

Individual recipes are among the most closely-guarded trade secrets in the semiconductor industry,[36] and several courts have acknowledged that semiconductor chip manufacturing processes and design are protectable as trade secrets.[37] To remain globally competitive, a semiconductor company must innovate on a constant basis to bring new and faster products to market. Accordingly, semiconductor manufacturers invest considerable time and money in research and development to perfect the recipes used in the fabrication process. Each company's recipe portfolio has an inherent intellectual property value in the hundreds of millions to billions of dollars.

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36 Indeed, throughout this Rulemaking, SIA has repeatedly raised concerns over the ability to maintain the confidentiality of its members' intellectual property. See Comments by the Semiconductor Industry Association on U.S. EPA's Proposed Rule: Mandatory Reporting of Greenhouse Gases, EPA Docket ID No. EPA-HQ-OAR-2008-0508-0498.1 (June 9, 2009); see also Comments of the Semiconductor Industry Association on U.S. EPA's Proposed Rule: Mandatory Reporting of Greenhouse Gases; Additional Sources of Fluorinated GHGs, EPA Docket No. EPA-HQ-OAR-2009-0927-0131.1 (June 11, 2010). EPA's decision in the Final Subpart I to require emission data to be reported on a recipe-specific basis exacerbates the confidentiality concerns previously raised about disclosing emission data by process.

37 See e.g., Taiwan Semiconductor Mfg. Co. v. Semiconductor Mfg. Int'l Corp., 2004 U.S. Dist. LEXIS 29717 (N.D. Cal. Apr. 21, 2004)(court acknowledged that semiconductor manufacturing process could be trade secret, but determined it had no jurisdiction over non-U.S. plaintiff's claim of misappropriation); Uniram Tech., Inc. v. Taiwan Semiconductor Mfg. Co., 2007 U.S. Dist. LEXIS 67862 (N.D. Cal. Sept. 5, 2007) (court ruled on motion and allowed plaintiff to proceed with claim that defendant misappropriated trade secrets by divulging semiconductor manufacturing process details to third parties); Silicon Image, Inc. v. Analogix Semiconductor, Inc., 2007 U.S. Dist. LEXIS 96073 (N.D. Cal. Dec. 20, 2007) (court recognized silicon chip register design as potentially subject to trade secret protection); Silicon Image, Inc. v. Analogix Semiconductor, Inc., 2007 U.S. Dist. LEXIS 96073 (N.D. Cal. Dec. 20, 2007) (court recognized silicon chip register design as potentially subject to trade secret protection); Metron Tech. Distrib. Corp. v. Discreet Indus. Corp., 189 Fed. Appx. 3 (2d Cir. N.Y. 2006)(court granted injunction preventing defendant from producing replacement parts for semiconductor manufacturing tool because tool design was a trade secret that defendant had misappropriated).

**Final Subpart I, although it does not mandate the submission of any full recipe, does require reporting of certain recipe-specific information. As explained below, this information could provide enough specific knowledge of proprietary device designs and manufacturing processes to allow for reverse engineering of individual recipes and otherwise would compromise the trade secrets within a company's recipe portfolio.[38]**

**In particular, Section 98.96 of the Final Subpart I requires facilities to report the following information:**

⇒ **Type of each gas used for each set of similar recipes;[39]**

⇒ **Recipe-specific utilization and byproduct rates (*i.e.*, emission factors);[40]**

⇒ **The film or substrate that was etched or cleaned and the feature type that was etched for each recipe in Part 98.96(f)(1);[41]**

⇒ **Quantity of each gas used for each set of "similar" recipes, to be reported on an annualized basis;[42]**

⇒ **All apportioning factors used to apportion F-gas and N2O consumption;[43] and**

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[38] In the semiconductor industry, reverse engineering involves starting with a known product and working backwards to discover the process by which it was developed and manufactured. People v. Gopal, 171 Cal. App. 3d 524, 533, (1985) (citing Kewanee Oil v. Bicron, supra, criminal conviction of misappropriation of trade secrets concerning semiconductors affirmed). It can be an arduous and expensive process that entails the purchase of a competitor's chips, the cutting of chip cross-sections and the analysis of elemental materials through sophisticated atomic-level analytical techniques, stripping layers, photographing the circuitry of each layer through a scanning electron microscope, dissecting the chip to discover the layout design, constructing an electrical schematic of the circuitry, and then drawing inferences about the technical process used to make the device. Id.

The information implicated by the Final Subpart I reporting requirements (*e.g.*, chemical identities, amounts, emitted, apportionment by process type, facility-wide consumption, annual gas consumption) is the type of information that could aid a competitor by short circuiting the time, effort, and money necessary to conduct reverse engineering or to conduct its own research and development. Moreover, these specific details would not necessarily be discernable, even from sophisticated reverse engineering. And, the details at issue here are not for sale or otherwise available to the competition at a price. Keeping the details of valuable processes secret is critical to maintaining a competitive edge. This type of information clearly qualifies as trade secret. People v. Gopal, 171 Cal. App. 3d 524, 539 (1985) (information that would substantially reduce reverse engineering time is a trade secret).

[39] § 98.96(c)(2).

[40] § 98.96(f)(1).

[41] § 98.96(f)(2).

[42] § 98.96(k).

⇒ **Identification of the quantifiable metric used in a facility-specific engineering model to apportion gas consumption.**[44]

**The level of intellectual property inherent in the foregoing information is significant. Essentially, SIA understands these reporting requirements to require that a company reveal the quantity of gas being used (1) for each type of "film" being etched (*e.g.*, oxide, nitride) and (2) for each "feature" within that film (*e.g.*, gate, deep trench).[45] As result, a company would be revealing information about its process and particular recipes used in that process which it, in many cases, has never shared publicly and which it regards as intellectual property. For example, a company would need, under these information requirements, to reveal that in its 300 millimeter fabrication process, for a specific group of "similar" recipes it uses X kg of SF6 and Y kg of CHF3 to etch silicon nitride layers in gate stack in year 2010.**

**In addition, Final Subpart I would require each facility to maintain recipe-specific records in order to document compliance with the requirements of the Rule and make such records available to EPA. In particular, Section 98.97(b) of the Rule requires the following records be kept by any facility that estimates emissions using recipe-specific emission factors, *i.e.*, "large" facilities:**

> **(1) "Complete documentation and final report for measurements for recipe specific [emission factors]"; and**
>
> **(2) "Documentation that recipe-specific [emission factors] developed for your facility are measured for recipes that are similar to those used at your facility, as defined in § 98.98. The documentation must include, at a minimum, recorded to the appropriate number of significant figures, reactor pressure, flow rates, chemical composition, applied RF power, direct current (DC) bias, temperature, flow stabilization time, and duration."[46]**

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43 § 98.96(l).

44 § 98.96(m)(i).

45 As defined in Section 3.1 of EPA's Technical Support Document, a "film" is the material being etched, e.g., oxide, nitride, etc., while "feature" refers to the structure within which the film occurs, e.g., gate, deep trench, etc. See U.S. Environmental Protection Agency Office of Air and Radiation, Technical Support Document for Process Emissions from Electronics Manufacture (e.g., Micro-Electro-Mechanical Systems, Liquid Crystal Displays, Photovoltaics, and Semiconductors): Proposed Rule for Mandatory Reporting of Greenhouse Gases, Revised, November 2010 ("Technical Support Document").

46 § 98.97(b).

Of particular concern to SIA and its members is that these records could become subject to inquiries as to their content and sufficiency not only by EPA in an enforcement context, but also by local residents and other private citizens in future permitting and related contexts (*e.g.*, a Freedom of Information Act Request or through discovery in a citizen suit filed under the Clean Air Act).[47] Etch recipes are considered trade secrets and, as such, are tightly controlled. Most semiconductor companies – even very prolific patentees – opt to protect their recipes as trade secrets, rather than through patents, which require disclosure of the recipe. If these records are made public, they could loose their status as trade secrets, allowing competitors to reverse engineer recipes, thereby compromising the value of information worth up to several billion dollars to each company.

The loss of trade secret protection for semiconductor etch recipe information through its public disclosure via the Final Rule could amount to a regulatory taking of intellectual property.[48] It does not appear that EPA (or the Office of Management and Budget) has undertaken any analysis of this potential erosion of private intellectual property value. In addition to this potential takings issue, disclosure of recipe information may also present national security concerns at those semiconductor facilities that are designated Trusted Foundries by the U.S. National Security Agency.[49]

Moreover, EPA has not yet finalized its position on what information submitted under the Reporting Rule constitutes "emissions data" that are not subject to confidential treatment under the CAA. Section 114(c) of the Clean Air Act provides that "records, reports or information" submitted to EPA in connection with a rulemaking or "standards" development or as part of an ongoing compliance requirement or through an investigation or enforcement proceeding may be maintained as confidential so long as they do not constitute "emissions data."[50] Under EPA's regulations, the determination of which information is "emissions data" has been made on a case-by-case basis based on information submitted by individual emission sources.[51]

In July 2010, EPA published a proposal (hereinafter "Proposed CBI Rule") that, if finalized, will constitute EPA's prospective determination of which

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47 As of July 1, 2011, many semiconductor facilities will be subject to the CAA's Prevention of Significant Deterioration permitting under the GHG "Tailoring Rule." See Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule; Final Rule, 75 Fed. Reg. 31,514 (June 3, 2010).

48 Trade secrets have long been recognized as property protected by the United States Constitution and other laws. Ruckelshaus v. Monsanto Co., 467 U.S. 986 (1984) (environmental data can be trade secret; unauthorized disclosure is a taking).

49 See http://www.nsa.gov/business/programs/tapo.shtml.

50 42 U.S.C. § 7471(c).

51 See 40 C.F.R. § 2.301 et seq.

**information required to be submitted under Subpart I will qualify as "emissions data" and, therefore, will not be eligible for confidential treatment under the Rule.[52] The Proposed CBI Rule identifies which information EPA will consider "emissions data" by reference to specific sections in Subpart I. At the time of its publication in July 2010, the Proposed CBI Rule referred to the information requirements of Subpart I as they existed then; this was the Re-Proposed Subpart I, which, as described in Section II(B)(1)(a) above, required submission of information, including emission factors under § 98.96(d), only for certain process categories, and not on a recipe-specific basis. Therefore, the determination of which data submitted under Subpart I constitute "emissions data" was made by EPA without any evaluation of the Final Subpart I's recipe-specific reporting regime.**

**If EPA were to persist in its position articulated in the Proposed CBI Rule, much of the information underlying the Final Subpart I's emissions calculations,[53] including the recipe-specific emissions factors, would constitute "emissions data," thereby making recipe-specific information vulnerable to public disclosure even more broadly outside the enforcement and permitting contexts described above. Although SIA commented on the Proposed CBI Rule,[54] it was obviously impracticable for SIA to comment on the Proposed CBI Rule as it would ultimately apply -- *i.e.*, to the submission of recipe-specific emission factors.**

**The mere fact that the Final Subpart I would probe so deeply into the semiconductor fabrication process as to create such vulnerabilities to intellectual property underscores why an individual recipe-based approach is not sound for the long term, even if EPA were to address the definitional and other issues to render the Final Subpart I technically feasible. In addition, EPA utterly failed to recognize and address these intellectual property threats when promulgating the Final Subpart I, and therefore, EPA must grant reconsideration on this issue to rectify these serious gaps in its legal and policy analysis.**

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52 **See Proposed Confidentiality Determinations for Data Required Under the Mandatory Greenhouse Gas Reporting Rule and Proposed Amendment to Special Rules Governing Certain Information Obtained Under the Clean Air Act, 75 Fed. Reg. 38,959 (July 7, 2010).**

53 **See EPA, "Data category assignments for reporting elements to be reported under 40 CFR part 98 and its amendments," pp. 18-21, available at http://www.epa.gov/climatechange/emissions/downloads10/CBI_Data-Category.pdf).**

54 **See Comments of the Semiconductor Industry Association on EPA's Proposed Confidentiality Determinations for Data Required Under the Mandatory Greenhouse Gas Reporting Rule and Proposed Amendment to Special Rules Governing Certain Information Obtained Under the Clean Air Act, EPA Docket No. EPA-HQ-OAR-2009-0924-0043.1 (Sept. 7, 2010).**

c. **Exorbitant Costs**

Section III.B. below addresses the full range of economic impacts of the Final Subpart I not considered by EPA due to flawed assumptions underlying its Economic Impact Assessment. However, an additional element of technical impracticality of an individual recipe-by-individual recipe measurement approach pertains to its exorbitant costs. Thus, we review those exorbitant costs briefly in this context.

As explained in Section III.B. below, SIA engaged ISMI to survey large facilities to determine the true burden to the semiconductor industry of complying with a recipe-based measurement approach. This survey requested companies to assume compliance with the Final Subpart I was technically feasible and would require measurement testing of all dis-"similar" recipes. Notably, ISMI estimated -- using conservative assumptions which likely underestimate costs -- $56 million to perform such testing in the first year, and $18 million per year in subsequent years, not even taking into account production downtime.[55] These costs dwarf EPA's estimates,[56] which as detailed in Section III.B., rely on flawed assumptions.

As further evidence of the exorbitance -- and therefore of technical impracticality -- of an individual recipe-based measurement approach, SIA has performed a comparison of the costs of this approach along with total compliance costs for other industry sectors subject to GHG reporting.

EPA's estimate of compliance costs for all sectors, which SIA determined by totaling estimates provided in the September 2009 Regulatory Impact Assessment (RIA)[57] for the initially finalized GHG reporting rule and in the Preambles for subsequently finalized GHG reporting subparts,[58] is approximately $165 million in the first year, and $95 million per year in subsequent years. Thus, based on ISMI's estimate, the cost to the

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55 See 2010 ISMI Analysis: Impact of Final Mandatory Reporting Rule Subpart I on U.S. Semiconductor Facilities (Jan. 22, 2011) [hereinafter "ISMI Report"], Table 3 at p. 11 and p. 22.

56 EPA estimated approximately $256,000 in the first year and $985,000 per year in subsequent years. See Appendix A to ISMI Report, "EPA Subpart I Cost Tables from Shaun Ragnauth," Table 4. EPA's estimate is roughly 218 times lower than ISMI's estimate of $56 million to perform such testing in the first year, and more than 18 times lower than ISMI's estimate of $18 million per year in subsequent years.

57 EPA, Regulatory Impact Analysis for the Mandatory Reporting of Greenhouse Gas Emission Final Rule (GHG Reporting): Final Report (September 2009) [hereinafter "RIA"], see Table 5-2. (The RIA covers the subparts finalized in October 2009 and not those subparts that were deferred until later dates, including Subpart I).

58 See 75 Fed. Reg. 39,736, 39,753 (Jul. 12, 2010)(Subparts T, FF, II and TT); 75 Fed. Reg. 74,458, 74,477 (Nov. 30, 2010)(Subpart W); and 75 Fed. Reg. 74,774, 74,809 (Dec. 1, 2010)(subparts I, L, DD, QQ, SS).

**semiconductor industry to develop dis-"similar" individual recipe-specific emissions factors equates to more than one-third (34%) of EPA's estimate of first year costs for all sectors, and almost one-fifth (18%) of subsequent annual costs for all sectors. This cost proportion would appear wholly unreasonable, especially given that the semiconductor industry's F-gas emissions comprise only 0.08% of the total GHG emissions inventory.[59]**

**A per ton CO2e[60] analysis further underscores this point. EPA has estimated both the first year and subsequent annual costs for Subpart I compliance at $0.33/ton. EPA already has acknowledged that these estimated Subpart I costs are the highest CO2e per ton compliance costs of any GHG reporting subpart by a substantial margin.[61] That margin grows to an untenable level, however, when applying ISMI's cost estimates for the Recipe-Specific Utilization and By-Product Formation Rates requirement alone.**

**In particular, applying the ISMI first and subsequent year cost estimates of $56 million and $17 million respectively per year to EPA's emissions estimate for the semiconductor industry of 5.7 million tons CO2e,[62] the per CO2e ton cost of complying with only the s/c etch recipe aspect of Subpart I would be $9.80/ton in the first year, and $2.98/ton per year in subsequent years. These costs are 35 and 20 times greater than the next highest sectors' first year and subsequent year per ton costs,[63] and 122 and 60 times more than the first year and subsequent year averages for all sectors. In view of the ISMI numbers likely underestimating costs and only being for partial compliance, it is clear that the Final Subpart I would require the U.S. semiconductor industry to incur**

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59 **EPA's estimate of the total U.S. GHG emissions inventory is 6,956.8 million metric tons CO2e, compared to its estimate of s/c industry F-gas emissions of 5.7 million metric tons Co2e. See EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2008 (April 2010) (U.S. EPA # 430-R-10-006) [hereinafter "2010 Inventory"] at pp. ES-3 and 4-69.**

60 **CO2e stands for "CO2 equivalents," a unit that adjusts all GHG emissions to the global warming potential of CO2, thereby allowing direct comparison of the global warming effects of different GHGs and mixtures of GHGs.**

61 **Indeed, EPA has estimated that average first year and subsequent year compliance costs for all industry sectors combined at, respectively, $0.08/ton and $0.05/ton. These average costs amount to a fraction of EPA's estimated first year and subsequent annual Subpart I costs – i.e., the average first year cost is 1/4th of EPA's estimated Subpart I compliance costs, and the average subsequent annual cost is 1/6th of EPA's estimated Subpart I compliance costs.**

62 **See 2010 Inventory at p. 4-69.**

63 **The next most costly sectors on a per ton CO2e basis are the fluorinated gas production industry (Subpart L) at $0.28/ton in first year costs, and the pulp and paper manufacturing industry (Subpart AA) at $0.15/ton in subsequent years.**

compliance costs lacking any reasonable proportion to the industry's emissions.[64]

## III. RECONSIDERATION ALSO IS NECESSARY TO ADDRESS OTHER ASPECTS OF THE FINAL SUBPART I

### A. The Apportionment Model Validation Requirement -- Which Appeared For The First Time In The Final Rule -- Imposes Significant Burdens Neither Evaluated By EPA Nor Consistent With The Model's Purpose, And Reconsideration Is Necessary To Rectify This Gap In Agency Decision-making

The apportionment model verification requirement clearly mandates reconsideration under Clean Air Act Section 307(d)(7)(B)'s 2-part "impracticality" and "central relevance" test.[65] Certainly, it was impractical for SIA to have raised "objections" to a model verification requirement never proposed or mentioned as a possibility in the Re-Proposal. Moreover, as evidenced by SIA's "objections" to the verification requirement detailed below, EPA did not recognize the significant burdens when evaluating the verification requirement's utility. This obvious gap between cost and utility in the Agency's decision-making more than satisfies the "central relevance" prong.

The Final Subpart I incorporates the requirement from the Re-proposal for each large manufacturing facility to develop a facility-specific gas apportionment engineering model.[66] As explained in the Re-proposal, EPA decided to allow this engineering model, rather than retaining the actual gas usage measurement requirement from the original Proposal, to eliminate the need for installation of numerous high-precision scales and mass flow meters to track gas usage, and thereby, reduce burdens.[67] SIA supported the reduced burdens in our comments on the Re-Proposal, but the Final Subpart I imposes a model verification requirement that did not appear in the Re-Proposal. Unfortunately, this requirement, as SIA understands it, requires a significant amount of gas usage measurement, and therefore, imposes costs and other

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64 Note that if the same cost per ton CO2e were borne by all sectors, the total economic impact to U.S. industry would be approximately $70 billion in the first year only ($56 million/0.08% = $70 billion), which would make the Reporting Rule the most costly regulation in history.

65 See Note 9 supra.

66 See § 98.94(c).

67 Re-proposed Subpart I, at 18,654 (referring to EPA's re-proposal of "different methodologies [including the gas apportioning method] that provide improved emissions coverage at a lower cost burden to facilities as compared to the initial proposal."). See also Final Subpart I, at 74,786 (referring to revisions to the gas apportioning method as an example, the Preamble to the Final Subpart I states "EPA has made every effort to reduce burden to the industry while maintaining requirements that it has determined are necessary to obtain facility-specific emission estimates").

burdens[68] well beyond what EPA anticipated and that undermine the model's purpose of reducing burdens.

In particular, the original Proposed Subpart I would have required the use of high-precision (+/- 1%) scales and mass flow meters at large facilities to track (*i.e.*, apportion) gas consumption on a process-by-process basis.[69] In response to public comments regarding the extreme cost of process-by-process gas consumption measurement, EPA replaced this measurement requirement in the Re-proposal with a requirement that each facility must develop facility-wide gas-specific heel factors,[70] and then apply those heel factors to an engineering model that apportions gases among the nine process categories (for which EPA intended to develop emission factors) based on a "quantifiable metric" of gas usage (*e.g.*, wafer passes).[71]

Final Subpart I retains the requirement that large facilities develop a facility-specific engineering model, but gas apportioning now must occur to individual recipes, to match the recipe-specific emission factors. In addition, the Final Subpart I introduced a new requirement that each facility's engineering model be verified by comparing the model's results to measured gas usage data for the F-gas used in the largest quantities, on a mass basis, at the facility during the reporting year for both plasma etch and chamber clean processes.[72]

In its Economic Impact Analysis,[73] EPA assumed facilities already had in place the hardware and other infrastructure required for model verification. This assumption is not correct.

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68 See Subpart I EIA, Section 4.3. As explained in Section III.B.3.a. below, based on an industry survey, ISMI has estimated these costs to be approximately $9 million in the first year, and $29 million per year thereafter.

69 Original Proposed Subpart I, at 16,525.

70 A "heel'' is the amount of gas that remains in a shipping container (i.e., gas cylinder) after it is discharged or off-loaded, and is needed to calculate the amount of gas used (by subtracting the heel from the amount of gas present in the container before use). These new heel factors were to replace, and provide more accuracy than, the IPCC's ten percent default heel factor.

71 Re-proposed Subpart I, at 18,700-01. "Wafer starts" is a measure of the number of silicon wafers that begin the fabrication process in a given time period. Each wafer may make more than one "pass" through a fabrication tool during processing, and not all wafers started are finished. "Wafer passes" is a measure of the total number of passes all wafers make, whether finished or not, through a fabrication tool.

72 § 98.94(c)(2). For plasma etch processes, modeled data must be within five percent of measured gas usage data. § 98.94(c)(2)(iii). No criterion is provided for chamber clean.

73 See EPA, Economic Impact Analysis for the Mandatory Reporting of Greenhouse Gas Emissions, F-Gases: Subparts I, L, DD, QQ, §: Final Report (November 2010) [Hereinafter "Subpart I EIA"], Section 4.3.

**Moreover, during the re-proposal period, EPA made informal requests to semiconductor manufacturers for information on modeled vs. actual gas usage to investigate uncertainty associated with different apportionment modeling approaches. In response, EPA received data from at least one SIA member demonstrating that, for a single tool running two simple recipes, the difference between modeled and actual gas usage was 6.4%. Based on this simple example, one would assume that if this requirement were to be extrapolated across all the tools in a facility, running a variety of complex recipes, that the level of uncertainty would remain the same or increase, and would not decrease. As this example indicates, at least some and possibly many facilities would require mass flow meters for all tools to satisfy the +/- five percent verification requirement, thereby nullifying the burden reduction intended by the model requirement.**

**As detailed more fully in Section III.B. below, ISMI has gathered information which confirms many facilities will need to make significant equipment and other expenditures in order to have the capability to measure and collect the gas usage data required for model verification. ISMI has estimated $98,900 per facility in first year annualized capital costs and $319,000 per facility per year in subsequent years, including annualized capital costs and O&M costs.[74] Applying this per-facility figure, first year costs are approximately $2.9 million for the 29 large facilities and $6.1 million for the 62 non-large facilities, for an industry total of $9 million. Subsequent year costs associated with verification are even greater -- $9.3 million per year for the 29 large facilities and $19.7 million per year for the 62 small facilities, for an industry total of approximately $29 million per year thereafter. These ISMI estimates for the model verification alone are significantly higher than EPA's estimate of total compliance costs with all Final Subpart I requirements of $2.9 million (first year) and $5.4 million (each subsequent year).**

### B. Due To Clear Errors, Mistaken Assumptions and Methodological Flaws, EPA's Economic Impact Analysis So Grossly Underestimates Costs That It Is Legally Insufficient To Support The Rationality Of The Final Subpart I

**The Final Subpart I EIA drastically underestimates compliance costs for various requirements, including the "Recipe-Specific Utilization and By-Product Formation Rates" provision, and fails to account for costs altogether as to other requirements, such as abatement destruction and removal efficiency ("DRE") testing. As a result, the EIA underestimates the actual compliance costs by a more than a factor of 40 in the first year and more than 15 in subsequent years. Such a gross cost underestimate indicates a clear error in judgment, and therefore, the legal insufficiency of the EIA in particular -- and of EPA's Final**

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**74 See ISMI Report, Tables 2 and 3, pp. 10-11. The cost is assumed to be the same for large and non-large facilities.**

Subpart I analysis and decision-making more generally -- under the Administrative Procedure Act ("APA") "arbitrary and capricious" standard.[75]

It is well established under this standard that an agency must demonstrate a "rational" basis when promulgating a regulation[76] and that this rationality requirement extends to an agency's cost analysis developed in support of such regulation.[77] Courts will not sustain an agency decision where "the agency failed to consider relevant factors or made a clear error in judgment."[78] That is the situation here: as detailed below, EPA's assessment of the costs and other burdens posed by the Final Subpart I reflects clear errors, mistaken assumptions and methodological flaws, and as a result, is insufficient to support the rationality of Final Subpart I.[79]

### 1. Role of ISMI to Perform Regulatory Impact Assessments At SIA's Request

EPA has estimated that the total costs to comply with Subpart I for the entire electronics industry, which in addition to semiconductor manufacturing facilities includes facilities that manufacture micro-electromechanical systems

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75 See 5 U.S.C. § 706(2)(A) (a court "shall hold unlawful and set aside agency action, findings, and conclusions found to be— (A) arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law").

76 See e.g., FCC v. Nat'l Citizens Comm. for Broadcasting, 436 U.S. 775, 802 (1978) (citing Citizens to Preserve Overton Park v. Volpe, 401 U.S. 402, 413-16 (1971))("[Regulations] . . . may be invalidated by a reviewing court under the 'arbitrary or capricious' standard if they are not rational…."); Motor Vehicle Mfrs. Ass'n v. State Farm Mut. Auto. Ins. Co., 463 U.S. 29, 43 (1983)(an agency "must examine the relevant data and articulate a satisfactory explanation for its action including 'a rational connection between the facts found and the decision made.'")(internal citations omitted); Eagle-Picher Industries, Inc. v. EPA, 759 F.2d 905, 921 (D.C. Cir. 1985) ("Under the arbitrary and capricious standard we look to see if the agency has examined relevant data and has articulated a rational explanation for its action.")

77 See e.g., City of Portland v. EPA, 507 F.3d 706, 713 (D.C. Cir. 2007) ("Nothing we say in this opinion implies. . . that. . .we will tolerate rules based on arbitrary and capricious cost-benefit analyses").

78 Larouche's Comm. for a New Bretton Woods v. FEC, 439 F.3d 733, 737 (D.C. Cir. 2006) (internal citations and quotations omitted).

79 EPA's flawed economic analysis also violates core regulatory principles embodied in Executive Order (E.O.) 12866. E.O. 12866 requires that all "significant" federal regulations, such as the Reporting Rule, be based on a "reasoned determination that the benefits of the intended regulation justify its costs." See Executive Order 12866 of September 30, 1993--Regulatory Planning and Review (58 Fed. Reg. 51,735, Oct. 4, 1993), Section 6. On January 18, 2011, President Obama issued an E.O. that is "supplemental to and reaffirms the principles…and definitions" of E.O. 12866. The January 18, 2011 E.O. directs each agency to "propose or adopt a regulation only upon a reasoned determination that its benefits justify its costs" and, further, to "quantify anticipated and future benefits and costs as accurately as possible." See Improving Regulation and Regulatory Review - Executive Order, Section 1(c).

**("MEMS"), liquid crystal displays ("LCDs"), and photovoltaic ("PV") cells, are $2.9 million in the first year and $5.4 million per year in subsequent years.[80] As detailed in this section, surveys of semiconductor manufacturing facilities performed by the International Sematech Manufacturing Initiative ESH Technology Center ("ISMI") indicate that, if one assumes that compliance with Final Subpart I as written is technically feasible, the actual costs to the semiconductor industry alone would be greater than $119 million in the first year and more than $82 million per year in subsequent years. As such, EPA's EIA underestimates actual compliance costs to the semiconductor industry by a factor of more than 40 in 2011 and by a factor of more than 15 in subsequent years.**

**To determine the true burden to the semiconductor industry of complying with Final Subpart I, SIA engaged ISMI to estimate actual compliance costs for the industry. ISMI is a consortium of semiconductor device manufacturers and equipment and materials suppliers located in the U.S., Asia and Europe, whose expert staff engineers have for decades advised the semiconductor industry in its collective efforts to identify and implement the most cost-effective and environmentally friendly semiconductor manufacturing processes and procedures. As part of this collective effort, ISMI has developed and published several evaluations of industry F-gas emission reduction efforts as well as numerous guideline documents for the environmental characterization – including F-gas emissions – of semiconductor process equipment.[81] For each stage of the Subpart I rulemaking process – proposed, re-proposed, and final – ISMI has performed a survey of SIA member companies to gather the information needed to estimate the actual costs of compliance with each iteration of Subpart I.**

**The estimates of semiconductor industry compliance costs presented below are based on information gathered in two surveys conducted by ISMI in 2010. The first survey, conducted in spring 2010,[82] collected information on compliance costs associated with certain components of the Re-proposed Subpart I that also appear in the Final Rule.[83] The second ISMI survey,**

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80 See Final Subpart I, Table 12. See also Subpart I EIA, Table 5-10.

81 Over the last 20 years, ISMI has: published many evaluations of industry F-gas emission reductions through abatement, recycling, alternative chemistry and process optimization; developed several F-gas test plan templates and environmental characterization guidelines (1995, 2001, 2006, 2009 ); and prepared several State-of-Technology reports for the industry (white paper-1994, baseline-1995, state-of technology-1998, 2005).

82 ISMI, 2010 ISMI Semiconductor Greenhouse Gas (GHG) Reporting Rule Survey Results (June 15, 2010), Technology Transfer #10065097A-TR.

83 These components include costs associated with: development of facility-specific and gas-specific heel factors; development of facility-specific gas apportioning models; abatement system testing DRE testing; and collection of information on heat transfer fluids.

conducted in November 2010, gathered information on compliance costs associated with the "new" (*i.e.*, previously un-proposed) provisions of Final Subpart I, in particular the costs associated with the development of recipe-specific emission factors. The November 2010 survey gathered information from 11 SIA member companies, representing 24 of the 29 large facilities covered under Subpart I. ISMI's report of compliance costs for Final Subpart I is included as Exhibit B to this Petition.

As detailed in the section that follow, EPA's EIA concluded that the costs to industry of the testing needed to develop recipe-specific emission factors at large facilities totaled approximately $256,000 in the first year and $985,000 per year in subsequent years.[84] EPA's estimate is roughly 218 times lower than ISMI's estimate of $56 million to perform such testing in the first year, and more than 18 times lower than ISMI's estimate of $18 million per year in subsequent years.[85]

### 2. Recipe-Specific Emission Factor Measurement Costs

#### a. Mistaken Assumptions

Several mistaken assumptions underlie EPA's gross underestimate of the costs associated with conducting recipe-based emission factor testing. A comparison of the assumptions underlying the EPA versus ISMI cost estimates for this requirement is presented below:

| COST COMPONENT | EPA ASSUMPTION | ISMI ASSUMPTION |
|---|---|---|
| Number of facilities | 29 large facilities must comply with the recipe-specific emission factor development requirement | Same |
| Number of etch recipes requiring "measurement" | Did not calculate costs on a per testing unit (*i.e.*, etch recipe) basis | Assumed testing required of 313 recipes at each of 29 facilities in first year; for subsequent years, assumed testing required of 40 new and 56 significantly changed recipes per year<br><br>Basis for assumption: ISMI survey found average of 313 dis-"similar" recipes per facility, with |

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84 See Appendix A to ISMI Report, "EPA Subpart I Cost Tables from Shaun Ragnauth," Table 4.

85 See ISMI Report, Table 2 at p. 10.

86 ISMI survey respondents reported estimates and uncertainties for dissimilar etch recipes run, new recipes introduced, and recipes changes on an annual basis. Reported uncertainties for dissimilar recipes ranged from 0 to 20% with an average of 8%.

| | | |
|---|---|---|
| | | a low of about 60 and a high of nearly 900; ISMI survey also collected company estimates on new dis-"similar" recipes introduced per year and dis-"similar" recipe changes per year[86] |
| Equipment | Assumed all 29 large facilities already have necessary testing equipment<br><br>Basis for assumption: Not explained in the record. | Assumed 24 of 29 large facilities do not currently have equipment and will require installation of analytical instrumentation; however, due to lack of information regarding equipment costs, lack of process testing expertise within large facilities, and assumption that facilities will hire 3rd party to conduct testing, did not include this cost in estimate.<br><br>Basis for assumption: ISMI survey demonstrates only 5 of 24 facilities surveyed have analytical instrumentation required for testing. |
| Personnel | Assumed each company (irrespective of number of facilities) would utilize 3 in-house technical engineers for 2,000 hours each at a rate of $55.20/hr<br><br>Basis for assumption: Not explained in the record | Adopting EPA's stated cost to perform DRE testing, assumed that experienced 3rd parties are available to conduct testing at a cost of $35,000/week and that a dedicated etch engineer at each facility will work with the 3rd party full time; ISMI survey indicates considerably higher personnel costs in the industry, with a typical engineer's rate in the $80-100 range; nevertheless, ISMI applied EPA's $55.20/hr rate to this etch engineer for consistency<br><br>Basis for assumption: ISMI survey demonstrates that only one company has employees trained to run etch recipe tests pursuant to 2006 ISMI Guidance specified in Subpart I and (and most do not have the equipment necessary to perform the |

Because estimates of future new and changed recipes are speculative, the reported uncertainties ranged from 0 to 50% with the average increasing to 25%. <u>See</u> ISMI Report at p. 4.

| | | |
|---|---|---|
| | | testing). |
| Timing | Did not calculate costs on a per testing unit (*i.e.*, etch recipe) basis, and therefore, does not appear to have made any timing assumptions for recipe testing. | Assumed 2006 ISMI Guideline mandated by Subpart I is stringently followed, including fluorine balance and documentation requirements; further assume testing is conducted 8 hours per day, 5 days per week and that six process recipes can be characterized per week including data gathering, data analysis, documentation, and development of recipe-specific emission factors. |
| Production Downtime | Not included; does not appear to have been considered. | Assumed that during testing, an etch process chamber is down 10-12 hours per day (8 for testing and 2-4 hours for process re-qualification); industry first year operating expense losses estimated at $21.8 million (***over and above $56 million estimated compliance costs***), and this $21.8 million does not account for lost opportunity costs. |

As the forgoing comparison indicates, EPA makes several mistaken assumptions regarding the costs of recipe-specific emission factor development.

First, EPA's cost estimate was performed on a "per-company" basis and therefore does not differentiate among companies with one manufacturing facility and companies with several facilities. At a minimum, given that the reporting entity under Subpart I is a facility, and not a company, EPA's cost estimate should be determined on a per-facility basis.

Second, EPA's EIA assumed, erroneously and with no explanation, that facilities already have the necessary testing equipment to develop emission factors internally.[87] As a consequence, EPA's cost estimate included no capital expense related to the purchase of such equipment, and instead assumed that the cost of testing for each company would consist of the wages paid to a total of three employees to complete the testing across all facilities. This assumption is incorrect.

[87] See Subpart I EIA, p. 4-14.

**As the ISMI survey shows, only five of 24 facilities surveyed have the equipment needed to perform the testing necessary to develop recipe-specific emission factors. More importantly, however, only one company has a limited number of personnel with the technical expertise needed to perform this testing. The testing needed to develop emission factors is technically complex and requires specific training and experience in the operation of specialized testing equipment. Any errors during testing can result in the release of process gases that can cause facility-wide production interruptions. As such, emission factor testing can be performed accurately and safely only by highly-trained specialists – specialists that all but one company do not have in-house. Because of the lack of technical experts and excessive testing requirements, the ISMI survey found that *all* companies would hire outside, third party consultants that have both the necessary equipment and the personnel with the expertise needed to develop recipe-specific emission factors.**

**Accordingly, ISMI's estimates of the costs to perform recipe-specific emission factor testing assume that each of the 29 large facilities will hire a third party consultant to test the average of 313 dis-"similar" recipes currently in use at each facility (first year), and the average of 96 dis-"similar (40 new and 56 significantly changed) recipes put into service each year.[88] To arrive at the cost of testing this number of recipes, ISMI applied EPA's estimated rate of $35,000 per week to hire a third party consultant and assumed, based on its experience, that the consultant could develop six emission factors per week, working eight hours per day, five days per week.[89] The time required to complete testing at each facility is then 313 recipes/6 recipes per week = 52 weeks of testing in the first year, and 96 recipes/6 recipes per week = 16 weeks of testing in each subsequent year.**

**Based on survey responses, ISMI also assumed that a dedicated in-house etch engineer would be assigned to work full time (*i.e.*, eight hours per day, five days per week) with the third party consultant to operate the process chamber as required during testing. Although the survey found that such engineers cost upwards of $80 per hour, ISMI conservatively applied EPA's assumed wage of just $55.20 per hour. The need for an in-house engineer, at EPA's assumed wage, added $2,208 per week to the cost of testing.**

**At a total rate of $37,208 per week, ISMI estimated the costs of testing needed to develop recipe-specific emission factors at each facility to be approximately $1.93 million in 2011, and $619,000 per year thereafter. Multiplying by 29 total "large" facilities, ISMI determined the actual costs to the semiconductor industry of emission factor testing to be approximately $56 million in the first year, and $18 million per year thereafter. Thus, ISMI's estimates of the true costs of emission factor testing alone exceed EPA's**

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88 **<u>See</u> ISMI Report at pp. 5 and 8.**

89 **<u>See</u> ISMI Report at p. 21.**

estimates of the costs to the entire electronics industry by a factor of 19 in the first year, and by a factor of more than three in subsequent years.

#### b. Methodological Flaws

The basic unit that determines the per-facility cost of developing recipe-specific emission factors is the number of etch recipes for which such emission factors must be developed. Yet nowhere in its cost estimate does EPA attempt to quantify the number of separate etch recipes in use at each facility that will require the development of such emission factors. Nor does EPA's EIA address the cost of such testing per recipe or the time needed to perform emission factor testing for each recipe. EPA's EIA is fundamentally flawed because its estimate of the costs of testing to develop recipe-specific emission factors is not founded upon the basic unit responsible for determining total costs – the number of non-"similar" etch recipes in use at each facility.

In contrast, ISMI's estimates of $56 million for emission factor testing in the first year and $18 million per year in subsequent years are based on the companies' estimate of the number of dis-"similar" recipes in use at each facility that will require development of a separate emission factor. These estimates assume, as they must, that etch recipes can be rigorously defined and grouped as "similar." Yet as explained in Section II above, this assumption does not accord with either the technical realities at a majority of semiconductor manufacturing facilities using complex, multi-step recipes or with Subpart I's current definitions of "individual recipe" and "similar, with respect to recipe."

EPA's estimate of the costs of emission factor testing also ignores the cost to facilities associated with taking process tools offline to perform the testing. During testing, each etch chamber must be taken out of production for 10-12 hours (8 hours to conduct testing and 2-4 hours to re-qualify the chamber for manufacturing). Based on information gathered in the survey, ISMI estimates that the total costs to industry of etch tool downtime during testing will be an additional $21.8 million in the first year, and $3.91 million per year thereafter.[90] When accounting for the costs of tool downtime, the costs to industry of developing recipe-specific emission factors rise to approximately $78 million in the first year, and $22 million per year thereafter. Thus, the full costs associated with the development of emission factors exceed EPA's estimate of the total costs to the entire electronics industry by a factor of almost 27 in the first year, and more than four in subsequent years.

### 3. Additional Costs Associated with Final Subpart I And Not Included In EPA's EIA

As described in the preceding section, EPA dramatically underestimates Subpart I compliance costs for the semiconductor industry due to erroneous

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90 See ISMI Report § 4.7 and Table 5 at p. 14.

assumptions made about the costs that would be involved in developing recipe-specific emission factors. EPA's EIA also is fundamentally flawed because it fails to include a number of additional costs associated with compliance with other Subpart I requirements. These costs add significantly to the semiconductor industry's total cost of compliance.

a. **Costs of Developing Heel Factors Necessary to Apply the Gas Apportioning Engineering Model and of Gas Apportionment**

As noted above, application of the gas apportioning engineering model requires each facility to develop facility-wide gas-specific heel factors to provide an ongoing measure of gas consumption. However, EPA failed to include the cost of heel factor development in its EIA.[91] Using EPA's methodology and standard labor costs, and industry-reported estimates of capital and O&M costs, ISMI has determined that the cost to the industry of developing such heel factors is approximately $4.2 million in 2011 and $4.2 million per year in subsequent years.[92]

EPA also fails to account for the costs facilities will incur in actually apportioning gases once the engineering model is developed. ISMI has determined the cost to the semiconductor industry of apportioning gases, including the installation of infrastructure necessary to divide and track gas usage and annual O&M costs to be more than $14 million per year, both in the first year and each year thereafter.[93] The failure to account for heel factor development and gas apportioning costs, which total more than $18 million per year, further contributes to flawed and legally deficient nature of EPA's EIA.

b. **Costs Associated with Point-of-Use Abatement Testing**

Under Final Subpart I, any facility that employs point-of-use ("POU") abatement devices, and wishes to reflect emission reductions due to these devices in its emission calculations, must either: 1) use a "properly measured" destruction or removal efficiency ("DRE") value[94] for each device; or 2) use a

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91 See Appendix A to ISMI Report, "EPA Subpart I Cost Tables from Shaun Ragnauth," Table 4.

92 See ISMI Report, Table 4 at p. 12.

93 Id. The ISMI estimate covers combined large and non-large facility costs because it assumes gases are apportioned only to process categories, as is required of non-large facilities which must follow EPA's Tier 2c requirements. See § 98.93(a)(2)(i). Therefore, apportionment costs are likely underestimated for the entire industry. Total industry costs break down to $4.5 million per year for the 29 large facilities, and $9.6 million per year for the 62 non-large facilities. See ISMI Report, Tables 2 and 3.

94 See § 98.94(f)(3) and (4). "DRE" means the efficiency of an abatement system to destroy or remove fluorinated GHGs, N2O, or both (see § 98.98) and is represented as a percentage of such gases destroyed or removed.

default DRE value of 60 percent.[95] Because DRE measurement is not required by the Final Rule, EPA considers this an "optional" cost and did not include it in its estimate of total costs.[96] Accordingly, EPA assumes companies will account for absolutely no abatement in its emissions estimates. As explained below, however, it is unreasonable to assume that companies will not account for abatement in their emission reports. Moreover, DRE values for POU abatement devices often exceed 90 percent,[97] such that relying on EPA's default DRE value would result in the loss of 30 percent or more of potential credit for emissions abatement.

EPA excludes abatement testing costs from its EIA on the grounds that such costs are "optional" because a facility can rely on a default DRE of 60 percent. Such an exclusion of abatement testing costs, when parsed logically, rests on the following presumption: As a general rule, semiconductor manufacturing facilities that have already invested in abatement will forego getting credit for the high DRE levels of 90 percent or greater achieved by such abatement – and instead rely on default DRE factors that may overstatement emissions by at least 30 percent or more -- in order to save abatement testing costs. This presumption is absurd on at least two levels.

First, it is absurd in light of the semiconductor industry's public commitment under the PFC Partnership to tangible emissions reductions – a commitment which has been embraced in other regions around the world and which some companies have satisfied, at least in part, through abatement technology. To believe that companies which have relied on abatement to satisfy this commitment would be willing simply to back away from it and publicly report emissions 30 percent or more above the levels actually being achieved defies logic, particularly when doing so may conflict with past public statements.

Second, it is absurd in light of the central purpose of the Reporting Rule – which is to "to obtain comprehensive and accurate GHG data relevant to future climate policy decisions, including potential regulation under the CAA.[98] Indeed, it is not reasonable for EPA to expect that a company with abatement would be willing to overstate its emissions by 30 percent or greater, and thereby potentially trigger major source permitting or other regulatory requirements under EPA's GHG regulatory regimes, simply to avoid abatement testing expenditures.

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95 See § 98.94(f).

96 Subpart I EIA at p. 4-14.

97 See 2006 IPCC Guidelines Table 6.6 at p. 6.12.

98 See Regulating Greenhouse Gas Emissions Under the Clean Air Act, Advance Notice of Proposed Rulemaking, 73 Fed. Reg. 44,354, 44,400 (Jul. 30, 2008). See also Proposed Subpart I, at 16,455 ("Accurate and timely information on GHG emissions is essential for informing some future climate change policy decisions."

Indeed, the ISMI Report indicates that the large facilities surveyed have or will install more than twice the number of POU abatement systems as EPA estimated,[99] and most companies plan to install additional abatement systems in the future. To prevent the loss of 60 percent or more of emissions abatement credit, these facilities generally plan to use "properly measured" DRE values, rather than rely on the 60 percent default DRE. Where many companies have already invested in abatement devices, and more plan additional investments, it is simply unreasonable for EPA to assume that companies will take no credit for DRE testing. Therefore, ISMI's estimate takes into account the costs of POU abatement system DRE testing.

Although excluded from its total cost estimate, EPA does provide a per-facility estimate of POU abatement testing costs of $71,766 per facility, per year.[100] EPA's estimate assumes: that large facilities have on average 50 tools with abatement devices; that (as required by Subpart I) 20 percent of (*i.e.*, ten) devices per year would require testing; and that a third party consultant can test 5 units per week at a weekly rate of $35,000.[101] This estimate, like EPA's estimates for other requirements, is based on faulty assumptions and thus greatly underestimates the actual cost of complying with this requirement.

In its survey, ISMI found that large facilities have on average 104 abatement devices – more than twice EPA's estimate – requiring an average of approximately 21 devices to be tested each year.[102] In addition, based on industry experience with testing and data analysis, ISMI determined that only three abatement devices can be tested per week, significantly less than EPA's estimate of five.[103] Using the average large facility figures, and assuming EPA's weekly rate of $35,000 for a third party testing company, ISMI estimated actual costs of DRE testing to be $242,000 per facility per year – almost seven times EPA's estimate. Therefore, the cost to the industry of DRE testing to the 29 large facilities will be an additional $7 million in the first year and in each year thereafter.[104]

The DRE costs summarized above should not be considered "optional" and should be included in EPA's estimate of the total cost to the semiconductor

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99 See ISMI Report at p. 13.

100 Subpart I EIA at p. 4-14.

101 Id.

102 See ISMI Report, Section 4.6 at p. 13. Indeed, three facilities surveyed have more than 250 units each, and will need to test more than 50 units per year.

103 See International SEMATECH Manufacturing Initiative, 2010 ISMI Semiconductor Greenhouse Gas (GHG) Reporting Rule Survey Results, Technology Transfer #10065097A-TR, EPA Docket No. EPA-HQ-OAR-2009-0927-0157 (June 15, 2010) at p. 23.

104 ISMI's survey indicated that 95% of abatement devices are or will be installed at large facilities. Therefore the entire $7 million per year is attributed to large facilities.

industry. Therefore, the failure to account for the significant costs of DRE testing also contributes to the flawed and legally deficient nature of EPA's EIA.

### c. Capital and O&M Costs for Non-Large Facilities to Comply with EPA's Tier 2c Methodology

Under the Final Rule, non-large facilities must estimate emissions using EPA's "Tier 2c" estimation methodology,[105] which requires such facilities to estimate GHG emissions from five process categories, "the etching process type, the chamber cleaning process type and its associated sub-types (in-situ plasma, remote plasma, in-situ thermal), and the wafer cleaning process type."[106] However, EPA's economic analysis also does not account for the true costs to the 62 non-large facilities of complying with EPA's "Tier 2c" estimation methodology.[107] ISMI estimated that the costs to small-facilities of complying with Tier 2c requirements are more than $18.6 million per year, which is more than 15 times greater than EPA's estimate of $1.2 million per year.[108] ISMI determined that EPA underestimates the total cost because it failed to account for capital. EPA's, failure to account for the true capital and O&M costs to non-large facilities of complying with Tier 2c methodology further adds to the flawed and legally deficient nature of EPA's EIA.

### 4. Compliance Costs for Subpart I Are Unreasonably High When Compared to the Compliance Costs for Other Subparts and Relative to the Semiconductor Industry's GHG Emissions

The costs to the semiconductor industry of complying with Subpart I are unreasonably high, as demonstrated by a comparison to other sectors' compliance costs. As noted above, SIA determined EPA's estimate of compliance costs for all industry sectors combined by totaling estimates provided in the September 2009 Regulatory Impact Assessment ("RIA") for the initially finalized GHG reporting rule[109] and in the Preambles for subsequently finalized GHG reporting subparts.[110] Based on these documents, EPA's estimate of costs for all industry sectors combined is approximately $165 million in the first year and $95 million per year in subsequent years. Thus, ISMI's estimate of first year costs to the semiconductor industry ($119 million) equates to almost three quarters (72 percent) of EPA's estimate of first year costs for all sectors.

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105 See § 98.92(2)(i).

106 Final Subpart I at 74,784.

107 See § 98.92(2)(i).

108 See ISMI Report, Table 2 at p. 10.

109 RIA, Table 5-2.

110 See 75 Fed. Reg. 39,736, 39,753 (Jul. 12, 2010)(Subparts T, FF, II and TT); 75 Fed. Reg. 74,458, 74,477 (Nov. 30, 2010)(Subpart W); and 75 Fed. Reg. 74,774, 74,809 (Dec. 1, 2010)(subparts I, L, DD, QQ, SS).

Similarly, ISMI's estimate of annual costs to the semiconductor industry ($82 million) are more than 86 percent of EPA's estimate of annual costs for all sectors combined. Thus, the proportion of total compliance costs borne by the semiconductor industry is wholly unreasonable by any standard of comparison, particularly given the small fraction – 0.08 percent – of the total U.S. GHG emissions inventory accounted for by semiconductor industry emissions.[111]

An analysis of sector-by-sector compliance costs per ton CO2e of GHG emissions further underscores this point. EPA estimated the per-ton costs of compliance for both the first year and subsequent years to be $0.33 per ton.[112] EPA already has acknowledged that these estimated Subpart I costs are the highest CO2e per ton compliance costs of any GHG reporting industry by a substantial margin.[113] That margin grows to an untenable level, however, when applying ISMI's cost estimates for the semiconductor industry.

Specifically, applying ISMI's estimated first year and annual costs of $119 million and $82 million per year to EPA's estimate of GHG emissions for the semiconductor industry of 5.7 million tons CO2e,[114] the per-ton CO2e cost to the semiconductor industry of Subpart I would be $20.87/ton in the first year, and $14.39/ton in subsequent years. These costs are 74 and 95 times greater than the next most costly sectors' first year and subsequent year per-ton costs,[115] and 260 and 288 times greater than the first year and subsequent year averages for all sectors. In view of the ISMI estimates of actual per-ton costs, it is clear that the Final Subpart I would require the semiconductor industry to incur compliance costs lacking any reasonable proportion to the industry's emissions. For this reason too, Final Subpart I is unreasonable and cannot be justified.

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111 EPA's estimate of the total U.S. GHG Inventory and semiconductor industry emissions are 6,956.8 million metric tons and 5.7 million metric tons CO2e, respectively. See 2010 Inventory at pp. ES-3 and 4-69.

112 See Final Subpart I, Table 12. Inexplicably, the figures in the Final Subpart I Federal Register Notice differs from the per-ton CO2e costs for Subpart I provided in the Subpart I EIA, which are $0.52 for the first year and $0.96 per year for subsequent years. See Subpart I EIA, Table 5-10. (Moreover, the text preceding Table 5-10 lists yet a third figure for subsequent year costs – $0.36 per year. The comparison in this petition is conservatively based on the lowest per-ton costs reported by EPA in the Preamble to the Final Subpart I Federal Register Notice.)

113 Indeed, based on EPA's estimates, average first year and subsequent year compliance costs for all industry sectors combined are, respectively, $0.08/ton and $0.05/ton. These average costs amount to a fraction of EPA's estimated first year and annual Subpart I costs – i.e., the average first year cost for all sectors is 1/4 of EPA's estimated Subpart I compliance costs, and the average annual cost is just 1/6 of EPA's estimated Subpart I compliance costs.

114 See 2010 Inventory at p. 4-69.

115 The next most costly sectors on a per-ton CO2e basis are the fluorinated gas production industry (Subpart L) at $0.28/ton in first year costs (see 75 Fed. Reg. 74,809), and the pulp and paper manufacturing industry (Subpart AA) at $0.15/ton in subsequent years. See RIA, Table 5-2.

## 5. Summary of Clear Errors, Mistaken Assumptions and Methodological Flaws

The table below summarizes key elements of ISMI's and EPA's estimates of semiconductor industry Subpart I compliance costs, both in absolute dollar amounts and as cost per-ton $CO_2e$ emitted.

**Summary of ISMI vs. EPA Cost Estimates**

| | First Year | Subsequent Years |
|---|---|---|
| EPA estimate of all Subpart I compliance costs for entire electronics industry | **$2.9 million** | **$5.4 million** |
| ISMI estimate of semiconductor industry's cost to comply with the elements of Subpart I that were included in EPA's EIA | > $81 million | > $42 million |
| ISMI estimate of additional cost to semiconductor industry to comply with elements of Subpart I that were not included in EPA's EIA | $38 million | $40 million |
| ISMI Estimate of Total semiconductor industry costs | **> $119 million** | **> $82 million** |
| Factor by which EPA total cost underestimates actual total cost to semiconductor industry determined by ISMI | **41 x** | **15 x** |
| | | |
| EPA estimate of average cost to other industries per ton CO2e emissions | **$0.08/ton** | **$0.05/ton** |
| ISMI estimate of cost to semiconductor industry per ton CO2e emissions | **$20.87/ton** | **$14.39/ton** |
| Factor by which ISMI estimate of per-ton cost to semiconductor industry exceeds EPA estimate for all industries | **260 x** | **288 x** |

As the forgoing summary illustrates, EPA's estimate of costs for the entire electronics industry are approximately 41 times below ISMI's estimate of the semiconductor industry's actual first year costs, and 15 times below actual costs in subsequent years. Moreover, at 260 times (first year) and 288 times (subsequent years) the average for all industries, the per-ton costs to the semiconductor industry are far above what can be considered a reasonable and proportionate burden. The sheer magnitude of the actual costs to the semiconductor industry, and EPA's dramatic underestimate of those costs, clearly demonstrate the deeply flawed nature of EPA's EIA for Subpart I.

As explained in the ISMI Report, the flaws in the Subpart I EIA are the result of several erroneous assumptions made by EPA that result in either: 1) greatly undervaluing the costs of complying with certain aspects of Final Subpart I; or 2) failing altogether to include the costs of complying with other requirements. The most significant among these erroneous assumptions result in EPA's substantial underestimate of the costs that would be incurred in developing recipe-specific emission factors at large facilities. Putting aside the technical infeasibility of a recipe-based approach, ISMI estimated that the full costs of developing recipe-specific emission factors, including the costs to perform testing and lost productivity due to tool shutdowns, are $78 million in the first year, and $22 million per year thereafter. These figures dwarf not only EPA's estimates for the development of recipe-specific emission factors ($256,000 in 2011 and $985,000 per year in subsequent years), but also EPA's estimate of compliance costs for the entire electronics industry ($2.9 million in 2011 and $5.4 million per year thereafter).

Thus, the foundation of Final Subpart I's emission reporting requirement for large facilities not only is technically infeasible, but rests upon a fatally flawed EIA. Such a fundamentally flawed analysis provides no reasonable basis to support Subpart I as finalized and is therefore legally insufficient to support the rationality of Final Subpart I required under the APA.

### C. Other Final Subpart I Provisions Also Require Revision, And Therefore, Reconsideration

#### 1. The Final Subpart I Has Several Additional Definitional and Technical Issues that Require Reconsideration

The Final Subpart I includes various provisions that raise additional technical and definitional issues which -- due to their significance -- likewise warrant reconsideration.

##### a. Final Subpart I's Recipe-Based Approach is Incompatible with Research And Development

To remain globally competitive, semiconductor companies must bring new products to market on a rapid basis, which requires robust research and development ("R&D") efforts aimed at innovating new manufacturing processes and new recipes. This R&D activity, by its very nature, is iterative, and therefore, entails frequent recipe changes during process design. Indeed, the number of unique recipes for an R&D activity at a facility can easily run into the thousands per year. While Subpart I does provide an R&D exemption, some facilities integrate their R&D processes into their manufacturing facilities to better consider process manufacturability, thereby exacerbating the impact of tracking operations at the recipe level.

The Final Subpart I's recipe-specific factors requirement imposes unique technical infeasibility burdens on R&D activities due to the sheer number of recipes, coupled with the constantly changing process conditions that are necessary for R&D innovation. Notably, neither the original Proposal or Re-proposal contemplated such unique burdens, and in promulgating the Final Subpart I, EPA never recognized, let alone developed a justification, for imposing them.

**b. Using "Maximum Designed Substrate Starts" to Determine Facility Size Misstates a Facility's Actual Manufacturing Capacity**

The Final Subpart I allows a facility to rely on Tier 2c emissions factors for its etch processes, unless its annual manufacturing capacity exceeds 10,500 $m^2$ of substrate, in which case the facility must measure recipe-specific factors.[116] The equation in Section 98.91(b) for calculating maximum capacity includes as factor "Wx" the "maximum designed substrate starts of a facility in month x". As explained in the Preamble, this factor results in determining "100 percent of annual manufacturing capacity of a facility . . . by summing the area of maximum designated substrate starts of a facility per month over the reporting period."[117]

The maximum capacity calculation, as set forth in the Final Subpart I, rests on two assumptions (1) a facility has a full complement of equipment that corresponds to its design and (2) this full complement of equipment is utilized to a maximum degree. Due to many factors, including ramping of production (both up and down) to meet market demand and retooling for new products, these assumptions do not reflect reality at most facilities most of the time. It is possible, therefore, that a facility may trigger the recipe-specific factors reporting requirement based on the Final Subpart I's annual capacity measure, even through the facility's actual capacity during the year falls below the triggering threshold.

SIA believes that a more appropriate definition of manufacturing capacity would correlate to a facility's actual current equipped capacity, as opposed to assuming full utilization of potential capacity. Using such a definition would ensure that facilities in production transition do not trigger excessive burdens. For example, it would be inappropriate to require full recipe-based emissions reporting for a facility that is just gearing up production, and whose actual production capacity is well below the designed capacity of the facility, which may or may not ever be reached.

**c. EPA's Definition of Abatement System "Uptime" Differs Substantially From Industry Use.**

The Final Subpart I requires facilities to calculate the "uptime" of any installed abatement system by:

> taking the ratio of (1) The total time during which the abatement system is in an operational mode with fluorinated GHGs or N2O flowing through production process tool(s) connected to that abatement system, to

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116 § 98.93(a)(2)(ii).

117 Final Subpart I at 74,781; See § 98.91(b) (factor "W").

(2) the total time during which fluorinated GHGs or N2O are flowing through production process tool(s) connected to that abatement system.[118]

This definition is consistent with that contained in the Re-proposal and was designed to ensure that "the abatement system … was properly installed, operated, and maintained."[119] However, as EPA explicitly noted in the Final Subpart I, "[m]ost commenters opposed EPA's proposed procedures to account for abatement system uptime" and "EPA's proposed procedures may not reflect actual practices at most facilities."[120] Indeed, EPA's definition of uptime differs substantially from how uptime is actually measured in the semiconductor industry, and SIA members estimate it will take up to two years for facilities to put the necessary equipment in place to comply with EPA's definition.

Furthermore, the industry method of determining uptime actually yields a more accurate result than the method adopted by EPA. Because process tools, by definition, are not running during either planned downtime or preventative maintenance, the semiconductor industry estimates "uptime" by measuring and tracking "unplanned downtime. " Semiconductor facilities could collect this data with little additional effort. Because of the unnecessary burden of adopting EPA's definition of uptime for abatement systems, SIA urges EPA to reconsider this definition as well.

d. <u>Requiring Facilities to Recalculate Gas-Specific Heel Factors If the Trigger Point for Cylinder Change-Out Differs by More than 5 Percent from the Previously Used Trigger Point Is Likely Not Feasible in All Instances</u>

The Final Subpart I requires facilities to "re-calculate a facility-wide gas-specific heel factor if you use a trigger point for change out for a gas and container type that differs by more than 5 percent from the previously used trigger point for change out for that gas and container type."[121] While this requirement seems reasonable on its face, adhering to the technical specifications of this requirement in practice raises compliance difficulties.

For example, under this requirement, if the trigger point used by a facility for a 20-pound cylinder is 2 pounds, then any change in that trigger point of more than 0.1 pounds would require a facility to "recalculate a facility-wide gas-specific heel factor," and any deviation in the actual change out point of more than 0.4 pounds would require handling as an exceptional circumstance. While

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[118] <u>Id</u>. at 74,774, 74,790; <u>See</u> § 98.93(g).

[119] Re-Proposed Subpart I at 18,666, (FN. 15).

[120] Final Subpart I at 74,790.

[121] Final Subpart I at 74,824; <u>See</u> § 98.94(b)(5).

**SIA has previously acknowledged that "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,"[122] there are some situations where achieving this level of accuracy is not feasible for some semiconductor manufacturing facilities. Reconsideration would provide an opportunity for EPA to rectify this technical infeasibility issue.**

#### e. <u>Final Subpart I's Requirement that Measurements Be Accurate to Within One Percent May Not Be Achievable In Practice</u>

**The Final Subpart I requires accuracy and precision of +/- 1 percent for "[a]ll flowmeters, weigh scales, pressure gauges, and thermometers used to measure quantities that are monitored under this section or used in calculations" required by the Rule.[123] As noted in Petitioners' comments to the original Proposal, despite EPA's assumptions that "[g]as consumption by process is often gathered as business as usual" and that "[e]lectronics manufacturers commonly track fluorinated GHG consumption using flow metering systems calibrated to +/-1% or better accuracy ....,"[124] it is not currently common practice for facilities to track information relating to gas consumption for individual tools or to quantify total gas consumption over a period of time.[125] While the majority of new facilities and new equipment will be able to meet the 1 percent accuracy requirement, as SIA noted in their comments to the Re-proposed Subpart I, many older facilities do not have the ability to measure within 1 percent precision.[126] However, as noted, "the majority of those [older] facilities have accuracies of 2 to 4 percent."[127]**

**In promulgating the Final Subpart I, EPA persisted with this accuracy requirement, despite SIA's comments and data demonstrating the technical feasibility issues it poses for certain facilities. SIA urges EPA to reconsider it now so that the requirement better reflects the existing technical capabilities of all segments of the semiconductor industry.**

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122 **Comments of the Semiconductor Industry Association on U.S. EPA's Mandatory Reporting of Greenhouse Gases; Proposed Rule, Docket No. EPA-HQ-OAR-2008-0508.0498.1, p.4 (June 9, 2009).**

123 **Final Subpart I at 74,826; <u>See</u> § 98.95(g)(4)(i).**

124 **74 Fed. Reg. 16,488, 16,498 (Apr. 10, 2009).**

125 ***See* Comments of the Semiconductor Industry Association on U.S. EPA's Mandatory Reporting of Greenhouse Gases; Proposed Rule, Docket No. EPA-HQ-OAR-2008-0508.0498.1, p. 9 (June 9, 2009).**

126 ***See* Comments of the Semiconductor Industry Association on U.S. EPA's Mandatory Reporting of Greenhouse Gases; Additional Sources of Flourinated GHGs; Proposed Rule, Docket No. EPA-HQ-OAR-2009-0927-, p. 17 (June 11, 2010).**

127 ***Id.***

f. **<u>Final Subpart I's Data Collecting and Reporting Requirements for N2O Emissions Appear to Contradict the Rule's "Facility-Level N2O Emissions" Concept</u>**

**Final Subpart I requires facilities to calculate "annual *facility-level N2O emissions*" on: 1) "a *facility-specific* N2O utilization factor averaged over all N2O-using chemical vapor deposition processes"; or 2) default utilization factors specified by EPA in the Final Rule.[128] Thus, the Final Rule embraces calculation and reporting of N2O emissions from CVD processes on a facility-wide basis. However, the Final Rule also states that facilities "must calculate annual facility-level N2O emissions from *each chemical vapor deposition process* and other electronics manufacturing production processes"[129] and, likewise, to report N2O emitted from "*each chemical vapor deposition process* and from other N2O-using manufacturing processes. . . ."[130] The requirements that N2O emissions be calculated and reported for "each chemical vapor deposition process" and for "other N2O-using manufacturing processes" suggest that apportioning of gas usage to each process may be required – at least for CVD and possibly other processes – in order to report emissions from each process. This would be contrary to the "facility-level" reporting concept for N2O emissions. Therefore, SIA requests that EPA clarify the language regarding the N2O calculation and reporting requirements.**

2. **<u>Final Subpart I's BAMM Provisions</u>**

**The Final Subpart I Best Available Monitoring Method ("BAMM") provisions differ significantly from the Re-proposal as well as the general BAMM provisions in the Final Subpart A, finalized in October of 2009.[131] As discussed in Section IV below, BAMM, as conceived in Final Subpart I, is unsuitable as an alternative to a stay during reconsideration. Putting aside this unsuitability, however, the Final Subpart I BAMM provisions also raise substantive compliance issues, and therefore, SIA also objects to the provisions and seeks reconsideration of them.**

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128 § 98.93(b). (emphasis added).

129 <u>Id</u>. (emphasis added).

130 § 98.96(c)(3) (emphasis added).

131 The original Proposed Rule (for all subparts) solicited comment on whether to allow BAMM for reporting of 2010 emissions, and proposed no actual BAMM standards or procedures. <u>See</u> 74 Fed. Reg. 16,471. Section 98.3(d) of the October 2009 Final Rule for the originally finalized subparts (74 Fed. Reg. 56,260) allowed BAMM to be used for the first three months of 2010 as of right, and required a petition to extend BAMM until December 31, 2010, with no possibility for extension beyond that. The April 2010 Subpart I Re-proposal (75 Fed. Reg. 18,652) did not modify BAMM for the semiconductor industry from its form in October 2009 Final Rule. The Re-proposal simply referred to the general BAMM provision in § 98.3(d), but replaced references to the year "2010" with "2011." <u>See</u> § 98.94(a), 75 Fed. Reg. at 18,700.

As discussed below, the substantive compliance issues include (1) the retroactive calculation requirement, which is not feasible in practice; (2) the individual requirement-by-requirement BAMM request process, which is unreasonably cumbersome; (3) the documentation requirement, which is excessive; and (4) the "unique and extreme circumstances" provision, which is vague and illogical, given it allows only a 1-year extension, and yet, covers circumstances, such as "technical infeasibility", that may not be resolvable ever, let alone in a one year timeframe. SIA's objections based on these issues certainly could not have been raised during the rulemaking, given that these issues grow out of wholly new aspects of the Final Subpart I BAMM provisions not included in the Re-proposal or the Final Subpart A that applies to other industries.[132] Moreover, these issues may compromise a facility's ability to obtain BAMM for as long as and as widely as it needs and otherwise may create legal vulnerability; therefore, SIA's objections clearly satisfy the "central relevance" reconsideration standard.

#### a. <u>The Recalculation Obligation Is Not Feasible In Practice</u>

Unlike the Final Subpart A BAMM provisions applicable to other industry sectors,[133] the Final Subpart I BAMM provisions require a semiconductor manufacturer, at the end of the BAMM period, to recalculate and resubmit all emissions in full compliance with Final Subpart I.[134] SIA does not believe that this retroactive recalculation obligation is feasible in practice for many of Subpart I's provisions.

Take the recipe-specific factors provision as one example. To recalculate emissions retroactively in full compliance with this provision would necessitate that all facilities develop and implement individual recipe-by-individual recipe tracking sufficient to allow a "cross-walk" of the subsequently measured, dis-"similar" recipe factors to previously run recipes. Development of such a

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132 As noted, the Re-proposed Subpart I referred to the general BAMM provision in § 98.3(d), but replaced references to the year "2010" with "2011." <u>See</u> § 98.94(m), Re-proposal at 18,717. As such, it would have allowed BAMM for the first three months of 2011 as of right, and would have required a petition to extend BAMM until June 31, 2011, with no possibility for extension beyond that. It did not propose the recalculation and resubmission of emission estimates, or the possible one-year extension of BAMM for "unique and extreme circumstances." The Final Subpart A that applies to other industries allows BAMM until March 31, 2010, and for an additional three months upon approval of a request submitted by January 31, 2010. <u>See</u> § 98.3(d). Subpart A does not require recalculation and resubmission of emissions, nor did it allow possible extension of BAMM beyond June 31, 2010.

133 <u>See</u> § 98.3.

134 Pursuant to § 98.94(a)(2) and (3), a facility granted an extension through December 31, 2011 must include recalculated 2011 emissions in its 2012 emission report due in March 2013. Pursuant to § 98.94(a)(4), a facility granted an extension beyond December 31, 2011 for "unique and extreme circumstances" must include recalculated 2012 emissions in its 2013 emission report due in March 2014.

tracking mechanism raises technical feasibility issues of the same ilk as discussed in Section II.B. of this Petition.

Moreover, the timing for a facility to develop this recipe tracking is far too short for any resolution of these technical feasibility issues. Indeed, the Final Subpart I was published on December 1, 2010 and became effective on January 1, 2011. As of the December 31, 2010 effective date, therefore, a facility would need some form of recipe tracking in place. It is patently unreasonable for EPA to have expected that a facility can accomplish all of the following in the one month period between December 1, 2010 (when the Final Rule was published) and December 31, 2010 (when the Final Rule became effective): (1) review and comprehend wholly new requirements in the Final Subpart I never included in the original Proposal or Re-proposal, (2) resolve complex technical feasibility issues and then, (3) implement a recipe tracking system that may entail modifications to software and equipment downtime.

b. **The BAMM Request Process Is Unreasonably Burdensome**

The Final Subpart I Rule specifies that each BAMM request (1) provide a "list of specific items of monitoring instrumentation and measuring services for which the request is being made and the locations where each piece of monitoring instrumentation will be installed" and (2) identify "the specific rule requirements for which the instrumentation or measurement service is needed."[135] The BAMM provisions, therefore, mandate that a request be made on a Final Rule requirement-by-Final Rule requirement basis.

That the burdens posed by this "requirement-by-requirement" mandate are unreasonable becomes apparent in light of two additional Subpart I BAMM provision mandates:

First, each BAMM request must include the following extensive -- and in some respects excessive -- documentation for each requirement:

⇒ a "description of the reasons why the needed equipment could not be obtained, installed, or operated or why the needed measurement service could not be provided before July 1, 2011";[136]

⇒ "supporting documentation" such as "the date the monitoring equipment was ordered, investigation of alternative suppliers, and the dates by which alternative vendors promised delivery or installation, backorder notices or

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135 §§ 98.94(a)(2)(ii)(A) and (B) and § 98.94(a)(3)(ii)(A).

136 § 98.94(a)(2)(ii)(C).

**unexpected delays, descriptions of actions taken to expedite delivery or installation, and the current expected date of delivery or installation";[137]**

- ⇒ **"written correspondence to and from at least three [measurement] service providers stating that they will not be available to provide the necessary services before July 1, 2011";[138] and**

- ⇒ **"the specific actions the owner or operator will take to comply with monitoring requirements by January 1, 2012."[139]**

**Second, the foregoing documentation must be assembled in an unreasonably compressed timeframe. Indeed, for all Final Subpart I requirements other than the recipe-specific factors, a facility must submit its BAMM request by February 28, 2011 – just three months after the Final Rule's publication date. The June 30, 2011 BAMM request deadline for the recipe-specific factors requirement likewise is not realistic given the serious technical infeasibility issues posed by this requirement.**

**Moreover, the unreasonableness of these deadlines is further underscored by the reality that the same individuals who have been involved throughout this rulemaking and who are instrumental in pursuing solutions upon reconsideration are the same individuals who would need to analyze the Final Subpart I as it applies to their respective facilities, amass the necessary information and prepare the BAMM requests. In the final analysis, therefore, the expectation that these individuals must -- in the first six months after the Final Rule's effective date -- accomplish the following is simply not reasonable: (1) analyze existing systems; (2) identify parameters for which BAMM is required; (3) compile documentation of attempts to meet the Final Rule's requirements before the June 30, 2011 deadline as well as steps that the facility will take to comply with monitoring requirements before 2012; (4) prepare BAMM extension requests; and (5) work towards mutually acceptable solutions and alternatives upon reconsideration of the Final Subpart I .**

#### c. <u>The Information Needed to Support a "Unique and Extreme Circumstances" Extension Request is Unnecessary and Unreasonable</u>

**The Final Subpart I allows facilities to request an extension of BAMM for an additional 12 months beyond December 31, 2011 under "unique and extreme circumstances, which include safety, technical infeasibility, or inconsistency with other local, State or Federal regulations" although EPA states in the Final Rule that it "does not anticipate approving the use of [BAMM] beyond December**

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137 § 98.94(a)(2)(ii)(D).

138 § 98.94(a)(2)(ii)(E).

139 § 98.96(a)(2)(ii)(G) and § 98.94(a)(3)(ii)(B).

31, 2011."[140] A request for this "unique and extreme circumstances" extension requires submission of essentially the same information as a request for the initial extension through December 31, 2011, although EPA "reserves the right to require that the owner or operator provide additional documentation."[141]

This "unique and extreme circumstances" provision is not logical in terms of plain language or in application. The provision allows a one year extension from full compliance with the Final Subpart I, but the reasons that would support such extension simply do not correlate with a one-year timeframe, and indeed, not any timeframe in that the reasons may bear out that full compliance simply may never be realistic at certain facilities. In particular, if a facility can not comply with the Final Subpart I due to technical infeasibility or other significant issues, such as the imperative of federal, state or local law that conflicts with the Final Subpart I, then these matters may never be resolvable, let alone in a one-year timeframe.

## IV. EPA MUST STAY THE FINAL SUBPART I TO AVOID UNREASONABLY REQUIRING U.S. SEMICONDUCTOR MANUFACTURERS TO INCUR SIGNIFICANT BURDENS TOWARDS COMPLIANCE WITH A RULE THAT CLEARLY REQUIRES REVISION

### A. Agency Precedent Recognizes The Appropriateness Of A Stay Where A Regulation Will Require Revision To Substantive Requirements

In cases in which EPA is reconsidering final agency action – and where the reconsideration process is likely to result in requirements which differ from the rule under reconsideration – EPA has clearly established through a range of Agency precedent that to require compliance with the mandates of the existing rule would be inappropriate.

Section 307(d)(7)(B) of the CAA authorizes EPA to stay the effectiveness of a final rule during the reconsideration process for a period not to exceed three months.[142] EPA has broadly interpreted this authority,[143] and moreover, has also regularly used the formal rulemaking process to grant stays of much longer than three months during its reconsideration of a final rule.

For example, in a 2008 rulemaking involving VOC performance standards in the Synthetic Organic Chemicals Manufacturing Industry (SOCMI) and

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140 § 98.94(a)(4).

141 § 98.94(a)(4)(i)(F).

142 42 U.S.C. § 7607(d)(7)(B).

143 See Prevention of Significant Deterioration (PSD) and Nonattainment New Source Review (NSR); Reconsideration of Inclusion of Fugitive Emissions; Proposal for Additional Stay, 75 Fed. Reg. 6823 (Feb. 11, 2010).

**Petroleum Refineries source categories, EPA granted an additional open-ended stay of its final rule until after reaching a final decision on issues raised in industry's petition for reconsideration.[144] Importantly, the issues involved in that rulemaking largely centered on definitions promulgated by EPA that differed between the proposed rule and what was ultimately finalized, a situation that created "unique compliance issues" that "warrant a limited stay pending reconsideration."[145]**

**In another recent rulemaking, EPA granted an additional 18 month stay to a final rule which had compelled the inclusion of fugitive emission requirements in the federal Prevention of Significant Deterioration ("PSD") program.[146] In its adoption of the additional stay, EPA noted that extending its initial stay would "allow sufficient time for EPA to propose, take comment on, and issue a final action on issues associated with the inclusion of fugitive emissions."[147]**

**In a number of its rulemakings, EPA has further reinforced the idea that enforcement of final agency action should be stayed in cases where EPA is reconsidering a rule and where the reconsideration process is likely to result in compliance requirements that differ significantly than what is required under the rule as finalized. This standard was directly applied in a rulemaking where the State of Georgia challenged its inclusion on a list of states which were found to be significantly contributing to nonattainment of EPA's ozone national ambient air quality standard (NAAQS) for downwind areas and requiring NOx reductions consistent with the level specified in EPA's NOx SIP Call regulations.[148] In explaining its decision to stay its NOx reduction requirements for the State of Georgia, EPA stated that because it expected that "the State of Georgia will likely no longer be subject to the NOx SIP Call requirements, ... the State of Georgia should not continue implementation efforts for the NOx SIP Call Rule while EPA initiates notice-and-comment rulemaking that will address the issues raised."[149] Indeed, EPA has formally noted that the issuance of a stay during the reconsideration process "reliev[es] affected facilities of the burdens of**

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**144 Standards of Performance for Equipment Leaks of VOC in the Synthetic Organic Chemicals Manufacturing Industry; Standards of Performance for Equipment Leaks in Petroleum Refineries; Interim Final Rule; Stay, 73 Fed. Reg. 31,372 (June 2, 2008).**

**145 Id. at 31,374.**

**146 Prevention of Significant Deterioration (PSD) and Nonattainment New Source Review (NSR); Inclusion of Fugitive Emissions; Final Rule; Stay, 75 Fed. Reg. 16,012 (Mar. 31, 2010).**

**147 Id. at 16,013.**

**148 Stay of the Findings of Significant Contribution and Rulemaking for Georgia for Purposes of Reducing Ozone Interstate Transport; Final Rule, 70 Fed. Reg. 51,591 (Aug. 31, 2005).**

**149 Id. at 51,592.**

demonstrating compliance with the standard during the rulemaking on rescission."[150]

Furthermore, EPA's justifications for the appropriateness of such extended stays directly address the feasibility and cost of complying with requirements likely to change during the reconsideration process. In proposing a stay involving National Emission Standards for Hazardous Air Pollutants (NESHAP), for example, EPA stated that the stay was "necessary to avoid wasteful and unwarranted expenditures on installation of emission controls which will not be required if the subcategories are delisted."[151] In finalizing the stay in that instance, EPA added to its justification:

> "Without a stay, all turbines … would have been required to comply immediately with the emission standards for new sources. This would have caused some sources … to make immediate expenditures on installation and testing of emission controls, even though such controls will not be required if we issue a final rule to delete these subcategories. … [W]e consider it inappropriate … to mandate such expenditures until after a final determination has been made whether or not these subcategories should be delisted. Such expenditures would be wasteful and unwarranted if we take final action to delist these subcategories.[152]

Similarly, during a process of delisting a substance (caprolactam) from the list of hazardous air pollutants (HAP) under the CAA, EPA suspended the listing of caprolactum for purposes of determining the applicability of title V operating permit requirements. EPA's decision to delist caprolactum effectively stayed the applicability of the CAA reporting requirements during the rulemaking. In so doing, EPA determined that

> Retention … of permit application requirements which will no longer exist after the delisting process has been completed would result in unnecessary private and public expenditures on preparation, submission, and processing of such applications, and would yield no environmental benefits. Because retention of the

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150 National Emission Standards for Radionuclear Emissions from Federal Facilities Other Than Nuclear Regulatory Commission Licensees and Not Covered by Subpart H (40 CFR part 61, subparts H and I); Final Rule; Stay, 56 Fed. Reg. 37,158 (Aug. 5, 1991).

151 National Emission Standards for Hazardous Air Pollutants for Stationary Combustion Turbines; Proposed Rule, 69 Fed. Reg. 18,338 (Apr. 7, 2004).

152 National Emission Standards for Hazardous Air Pollutants for Stationary Combustion Turbines; Final Rule; Stay, 69 Fed. Reg. 51,184, 51,185 (Aug. 18, 2004).

> listing … during the rulemaking to delist would be burdensome and costly, and would not effectuate the objectives of the Act, and because it would be impracticable and contrary to the public interest to defer administrative relief until after the rulemaking has been completed, EPA has determined that there is good cause to immediately suspend the listing of caprolactam for this limited purpose.[153]

As such, in cases where EPA has entered into the process of reconsidering a final rule, and where reconsideration is likely to result in significant changes to the rule, EPA has established clear precedent that favors staying the effectiveness of the rule under reconsideration.

### B. SIA's "Objections" Detailed In This Petition for Reconsideration Demonstrate The Necessity of a Stay To Avoid Steps Towards Compliance With A Final Subpart I that Will Require Fundamental Revision

As demonstrated above, Final Subpart I suffers from serious flaws relating to the infeasibility of compliance with a recipe-based emission reporting requirement; the incompatibility of a recipe-based emission reporting requirement to the semiconductor manufacturing process; the serious confidentiality concerns relating to the sharing of intellectual property inherent to a recipe-based reporting requirement; and the grossly understated compliance costs contained in EPA's economic analysis. As such, reconsideration of Final Subpart I is required under Section 307(d)(7)(B) of the CAA and it would be inappropriate from both a legal and policy standpoint to have Final Subpart I continue to apply in its current form during the reconsideration process. Leaving Final Subpart I in effect while EPA undergoes a formal reconsideration process to address the feasibility, practicality, confidentiality and cost issues raised by SIA would create the result of requiring compliance with a set of requirements that are likely to differ significantly from the requirements promulgated at the conclusion of the reconsideration process.

Moreover, a decision to stay the effectiveness of Final Subpart I during EPA's reconsideration of the rule is amply supported by EPA precedent. The issues raised in this Petition are clearly analogous to many of the issues involved in previous rulemakings in which EPA stayed the requirements of a final rule pending reconsideration. As detailed above, one of SIA's objections to Final Subpart I is the fact that EPA's definition of the terms "individual recipe" and "similar, with respect to recipes" – terms that had not been included in proposed Subpart I and Re-proposed Subpart I – make compliance with the requirements

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153 Hazardous Air Pollutant List; Proposed Modification, 60 Fed. Reg. 48,081, 48,084-85 (Sept. 18, 1995).

of Final Subpart I infeasible. The use of these definitions creates "unique compliance issues" that "warrant a limited stay pending reconsideration."[154]

Similarly, if the requirements of Final Subpart I remain in effect, SIA member companies will be forced to make significant expenditures and to take steps that will interfere with the ongoing semiconductor manufacturing process, including the idling of equipment, arranging for third party contractors to assist with emissions testing and installing measurement equipment and other infrastructure to validate emission factors on a recipe-specific basis and perform and verify gas usage apportionment. EPA has in the past determined that such expenditures would be "wasteful and unwarranted" and concluded that it would be "inappropriate … to mandate such expenditures until after a final determination has been made."[155]

In sum, the actions necessary to comply with the existing Final Subpart I during reconsideration would be both "burdensome and costly[and, therefore,] … it would be impracticable and contrary to the public interest to defer administrative relief until after the rulemaking has been completed."[156] Moreover, EPA certainly could address the public interest in obtaining GHG emissions data during the period of reconsideration. As SIA's participation in the PFC Partnership demonstrates, our member companies have been long committed to working cooperatively with the Agency.[157] SIA would hope to begin discussions as soon as possible on interim approaches that would apply during the reconsideration and that would result in EPA receiving emissions data for the 2011 reporting year.

EPA should therefore grant an immediate three-month discretionary stay of Final Subpart I's requirement to measure and report GHG emissions on a recipe-specific basis – and extend that stay, if necessary, for the duration of the reconsideration process until alternative GHG reporting requirements have been adopted. Such a decision would be consistent with past precedent in similar rulemakings and is necessary to avoid costly and burdensome attempts to comply with requirements which are likely to change at the conclusion of the reconsideration process.

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154 Standards of Performance for Equipment Leaks of VOC in the Synthetic Organic Chemicals Manufacturing Industry; Standards of Performance for Equipment Leaks in Petroleum Refineries; Interim Final Rule; Stay, 73 Fed. Reg. 31,372, 31,374 (Jun. 2, 2008).

155 National Emission Standards for Hazardous Air Pollutants for Stationary Combustion Turbines; Final Rule; Stay, 69 Fed. Reg. 51,184 at 51,185 (Aug. 18, 2004).

156 Hazardous Air Pollutant List; Proposed Modification, 60 Fed. Reg. 48,081 at 48,085 (Sept. 18, 1995).

157 Indeed, since 1995, SIA member companies have voluntarily reported estimated F-gas emissions to EPA pursuant to a pair of Memorandums of Understanding. See http://www.sia-online.org/cs/issues/environmental_management.

### C. SIA's "Objections" Also Satisfy The Higher Standard For A Judicial Stay Of Regulation

As further indication of an EPA stay being fully justified, SIA's "objections" to the Final Subpart I also satisfy the well-settled -- and higher -- judicial stay standard. The Handbook of Practice and Internal Procedures of the United States Court of Appeals for the District of Columbia Circuit outlines a four part test for evaluating a motion to stay Agency action:

> (1) the likelihood that the moving party will prevail on the merits;
>
> (2) the prospect of irreparable injury to the moving party if relief is withheld;
>
> (3) the possibility of substantial harm to other parties if relief is granted; and
>
> (4) the public interest.[158]

SIA "objections" clearly meet all prongs of this test.

As to the first prong -- "likelihood of success on the merits" -- as amply demonstrated in Sections II. and III. above, SIA is raising objections of central relevance to the Final Subpart I's outcome that were impracticable to raise during the rulemaking. Given the technical infeasibility of the recipe-based factors provision alone, a high degree of likelihood exists that the Final Subpart I will require revisions (and therefore, SIA, so-to-speak, has a high likelihood of "success on the merits").

As to the second prong -- "prospect of irreparable injury" -- the profound CBI and other difficulties created by the Final Subpart I's deep intrusion into the heart of semiconductor manufacturing process more than satisfy the irreparable injury prong. The exorbitant cost of attempting to comply with Final Subpart I only adds to the very real prospect of irreparable injury, especially given the need for modifications to the rule. Moreover, as noted above, implementation of the Final Rule could jeopardize the NSA "Trusted Foundry" status of certain semiconductor facilities and create national security concerns resulting in irreparable injury.

As to the third prong -- "substantial harm to others" -- this is a Reporting Rule, and not a limitation on GHG emissions, and because SIA remains committed to working with EPA to develop meaningful emission reporting

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158 D.C. Circ. Handbook (2010) at 32 (citing Washington Metropolitan Area Transit Comm'n v. Holiday Tours, Inc., 559 F.2d 841 (D.C. Cir. 1977); Virginia Petroleum Jobbers Ass'n v. Federal Power Comm'n, 259 F.2d 921 (D.C. Cir. 1958)).

requirements for the semiconductor industry, the possibility of substantial harm to other parties if relief is granted is non-existent.

As to the final prong -- the "public interest" -- there is little public interest in forcing SIA member companies to expend significant costs and endure substantial burdens in attempting to comply with a standard that is in the process of being amended. Rather, the effectiveness of Final Subpart I should be stayed to allow EPA to develop, through the notice-and-comment process, GHG emission requirements for the semiconductor industry that better comport to the realities of the manufacturing process and with which it is feasible to comply.[159] Moreover, as discussed above, EPA and SIA could develop an interim approach for emissions reporting during reconsideration. Thus, staying the Reporting Rule will not deprive EPA of emissions data for the semiconductor industry or cause any substantial harm to the public interest.

### D. BAMM Is Not A Legally Viable Alternative To A Stay

The use of Best Available Monitoring Methods (BAMM) as a substitute for a stay of the Final Subpart I's GHG emission reporting requirements is precluded by BAMM's structure. While BAMM is a useful tool for an individual facility to defer strict compliance obligations with a particular Final Subpart I provision for a discrete period of time, various elements of BAMM make it unsuitable for an industry-wide deferral of obligations pending modification of the Rule during the reconsideration process.

Some of these elements include the facility-by-facility framework of BAMM; the limited range of circumstances for which BAMM may be used beyond the one year deferral period; the requirement that facilities document their efforts to comply with very same requirements of the Final Subpart I that are central to this reconsideration Petition; and the unique retroactive application of Subpart I such that facilities using BAMM must then recalculate and resubmit 2011 emissions even though doing so is infeasible, impracticable, jeopardizes

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[159] Significantly, in an earlier rulemaking, EPA specifically weighed the use of a similar (though slightly different) standard in determining whether to grant a stay at the Administrative level. See Revocation of Pesticide Food Additive Regulations; Final Rule, 61 Fed. Reg. 39,528 (July 29, 1986). In this rulemaking, which accompanied a proposal to revoke acceptable tolerances for certain pesticides allowed in processed food under the Federal Food, Drug, and Cosmetic Act (FFDCA), EPA explicitly stated that it was "consider[ing] the criteria set out in the Food and Drug Administration's regulations regarding stays of administrative proceedings." Id. at 39,540 (citing 21 C.F.R. 10.35) Under FDA's rules, a stay will be granted if it is determined that: (1) The petitioner will otherwise suffer irreparable injury; (2) The petitioner's case is not frivolous and is being pursued in good faith; (3) The petitioner has demonstrated sound public policy grounds supporting the stay; and (4)The delay resulting from the stay is not outweighed by public health or other public interests. Id. EPA also noted that, "[u]nder FDA's criteria, EPA may also grant a stay if EPA finds such action is in the public interest and in the interest of justice." Id. For many of the same reasons listed above, it is reasonably clear that Petitioners meet this standard as well.

**confidential business information and involves exorbitant and unreasonable costs inherent in any attempt to comply. As such, BAMM is a poor fit for dealing with the concerns raised by in this petition.**

### **1. <u>BAMM Is A Facility-Specific Tool That Is Unsuitable For An Industry-Wide Deferral Of Obligations Pending Modification Of The Final Subpart I</u>**

**As structured under the Final Subpart I, the use of BAMM is only allowed on a facility-by-facility basis.[160] Indeed, the entire treatment of BAMM throughout the Final Subpart I envisions it not as an industry-wide remedy for shortcomings in the Rule itself, but rather as a mechanism to allow *individual facilities* more time to fully comply with the requirements of the Final Subpart I.**

**Specifically, BAMM allows individual facilities to defer compliance with Final Subpart I only until June 30, 2011.[161] To gain an extension beyond this initial six-month deferral, an individual facility must petition EPA *almost immediately* – by February 28, 2011 – and provide "detailed explanations and supporting documentation as to why a further deferral of compliance is necessary.[162] Such a petition must include "evidence that it is not reasonably feasible to acquire, install, or operate a required piece of monitoring equipment in a facility, or to procure necessary measurement services from providers by July 1, 2011."[163]**

**The BAMM provision's insistence that individual facilities demonstrate not only why it is not feasible to comply immediately with the requirements of the Final Subpart I in the stated timeframe, but also to explain how each facility ultimately will comply -- as opposed to a stay which would allow EPA to address industry-wide compliance difficulties -- highlights the inadequacy of any attempt to use BAMM as a substitute for addressing the industry-wide flaws in the Final Subpart I. A situation in which EPA has already begun the process of reconsidering such requirements and developing an alternative GHG emission reporting framework with which it is feasible to comply would only serve to reinforce this point.**

**BAMM's separate deadlines and deferments relating to the development of recipe-specific emission factors further underscore the inherent tension in attempting to use the facility-specific provisions of BAMM to address industry-wide objections to the reporting requirements of Final Subpart I. The provision that facilities have until June 30, 2011 to request an additional six months of BAMM where compliance is delayed for reasons associated with the use of**

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160 Final Subpart I, at 74,783 (Dec. 1, 2010).

161 <u>Id</u>.

162 <u>Id</u>.

163 <u>Id</u>.

recipe-specific emission factors again is predicated on the assumption that it is only individual facilities -- as opposed to the industry as a whole -- that would have difficulty in complying with the recipe-specific reporting requirements of the Final Subpart I.

As a result of this flawed assumption, EPA requires an individual facility seeking a BAMM extension "to provide reasons why it is not reasonably feasible to obtain, install, or operate the needed equipment, or to procure necessary measurement services, before December 31, 2011.[164] Yet, by the time this BAMM request is due, the Final Subpart I, including the recipe-based factors requirement, may already be under reconsideration. It is illogical to require individual facilities to demonstrate their inability to comply with a final rule that the industry has marshaled evidence to demonstrate suffers from fundamental flaws, especially when EPA has that rule under reconsideration to evaluate such evidence.[165]

### 2. BAMM's Requirement That Facilities Make Every Effort To Comply With A Rule That Requires Fundamental Change Will Result In Unnecessary Costs And Undue Burdens For The Semiconductor Industry

BAMM's requirement that facilities attempt to comply with the requirements of the Final Subpart I embodies the presumption that such compliance is feasible. Indeed, the entire thrust of SIA's argument is that such compliance is infeasible, as well as impracticable, overly burdensome, prohibitively and unreasonably costly, and that attempting to comply would result in the loss of intellectual property. An effort by EPA to impose BAMM -- with its requirement that facilities attempt to comply with the Final Subpart I throughout the BAMM process -- is as flawed as the Rule itself.[166] Furthermore,

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164 Id.

165 EPA's justification that individual facilities demonstrate why they will not be able to comply with the requirements of the Final Subpart I by December 31, 2011 instead of July 1 "because recipe-specific emission factors may be measured at any time during the reporting year," Id., evidences a fundamental lack of understanding that facilities do not run all recipes at all times. This lack of understanding, while perhaps not directly relevant to the inappropriateness of BAMM as a remedy, provides additional support for Petitioners' central argument that the reporting requirements of the Final Subpart I are contrary to the actual manufacturing process as used in the semiconductor industry – a fault that results in the infeasibility of the Final Subpart I.

166 In this way, the substantive concerns raised with BAMM as a potential remedy differ in fundamental ways from the procedural concerns raised in the petition for reconsideration filed by the petroleum industry on other subparts of the Mandatory GHG Reporting Rule. See "The American Petroleum Institute and the National Petrochemical and Refiners Association's Petition for Reconsideration, Request for Stay, and Request for Additional Relief Regarding The Final Rule For Mandatory Reporting of Greenhouse Gases" (Dec. 28, 2009). Specifically, the petroleum industry was effectively asking for clarification on a "relatively narrow field of issues," Id., and an extension of the

this requirement would result in the same exorbitant expenses and overly burdensome interference with the semiconductor manufacturing process that SIA raises as grounds for reconsideration. Indeed, even assuming that compliance is feasible, complying with just the requirements of BAMM would force facilities to pursue limited qualified emissions testing resources and to procure and install measurement instrumentation and other necessary equipment -- all of which may be made redundant as a result of the reconsideration process. BAMM is therefore an unworkable approach to dealing with the flaws of the Final Subpart I as a whole.

Under BAMM, a facility "must recalculate and resubmit 2011 emissions with their report for the 2012 reporting year.[167] In providing an example of how it understands and intends the BAMM process to work,[168] EPA draws attention to just how inappropriate BAMM is to the present situation. While such an approach may be practical in instances where compliance is ultimately feasible,[169] and where the deferral of compliance allowed for under BAMM enables a facility "to obtain, install, or operate the needed equipment, or to procure necessary measurement services" necessary to meet the requirements of a Rule, an attempt to apply BAMM to a situation involving a Rule that requires fundamental change would require stretching BAMM beyond any recognizable form.[170]

BAMM's "unique and extreme circumstances" extension also fails to provide a mechanism to address the systemic technical and economic infeasibility issues being raised in this petition. EPA explicitly states that it "does not anticipate approving the use of BAMM beyond December 31, 2011."[171]

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compliance deadlines, a situation under which the use of BAMM may be appropriate; in this case, however, Petitioners argue that the recipe-specific emission reporting requirements make compliance with Final Subpart I infeasible, among other objections of central relevance to the outcome of the Rule. The distinction is highly significant. While it might be reasonable to require compliance with a final rule while EPA clarifies a "relatively narrow field of issues," it is inappropriate to require compliance with infeasible reporting requirements while a new reporting regime is developed. Thus, while BAMM may be appropriate in other contexts, the objections raised in this petition that go to the very heart of the Final Subpart I's compliance requirements make BAMM unsuitable.

167 Final Subpart I, at 74,784.

168 "For example, such a facility having been granted BAMM may use a default etch emission factor to calculate and report its 2011 emissions. This facility must then recalculate and report its 2011 emissions with its 2012 report." Id.

169 Even in instances where compliance is ultimately feasible, if the "needed equipment or… services" include the means to apportion gas usage (e.g., collection of data from mass flow meters), then the gas usage data cannot be apportioned retroactively. Thus, it would be impossible to recalculate and resubmit 2011 emissions in compliance with the Final Rule, even if emission factors were available.

170 Final Subpart I, at 74,783.

171 Id. at 74,784.

The only caveat listed to this firm statement is that "EPA reserves the right to approve any such requests submitted by June 30, 2011 for unique and extreme circumstances which include safety, technical infeasibility, or inconsistency with other local, State or Federal regulations."[172] To qualify for this "unique and extreme circumstances" extension, an individual facility would be required to submit all the same documentation necessary for its 2011 BAMM request as well as "describ[ing] the unique and extreme circumstances which necessitate the extended use of BAMM."[173] In other words, in order to qualify for any extension of BAMM beyond December 31, 2011, an individual facility must provide EPA with "evidence that it is not reasonably feasible to acquire, install, or operate a required piece of monitoring equipment in a facility, or to procure necessary measurement services from providers,"[174] and "describe the unique and extreme circumstances which necessitate the extended use of BAMM,"[175] *all by June 30, 2011,* and again, all on an *individual facility* basis. Finally, even with this convoluted process, EPA still insists that facilities ultimately comply with the emission reporting requirements of the Final Subpart I. In light of these requirements, it seems clear that BAMM as conceptualized is wholly unsuitable for the industry-wide objections that require reconsideration of the Final Subpart I.

### 3. BAMM Fails To Provide Genuine Compliance Relief, And Thereby, Creates Legal Issues And Vulnerabilities

To request BAMM so as to defer compliance, a facility must attempt to comply with the Final Subpart I, even though EPA has been presented with evidence calling the validity of the Final Rule into serious question and based on that evidence is engaged in a reconsideration dialogue with SIA. This situation may create legal vulnerabilities of several types, including:

⇒ Semiconductor companies would enter into contractual commitments for equipment and services that they are advocating should not be needed. Moreover, these commitments may come "due" in terms of delivery, payment and installation before EPA can complete the reconsideration and Final Rule revision process.

⇒ Semiconductor companies would be obligated to make statements to EPA about their respective intent to comply with a Final Subpart I that SIA and its members believe is not technically feasible in certain respects and is otherwise not economically viable. Indeed, while SIA remains committed to working with EPA to develop meaningful emission reporting requirements for the semiconductor industry, the BAMM provisions would require individual

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172 Id.

173 Id.

174 Id. at 74,783

175 Id. at 74,784

**SIA member companies to affirm their compliance intent. To insist that facilities do so during the reconsideration process creates the potential for argument regarding the genuineness of both such statements and the documentation underlying them.**

**⇒ Without a stay, EPA is representing to the public that the Final Subpart I remains applicable, including its BAMM provisions. Section 304(a) of the CAA authorizes "any person" to bring suit "against the Administrator where there is alleged a failure of the Administrator to perform any act or duty under this chapter which is not discretionary with the Administrator."[176] While it is clear that nothing in the statute compels EPA to exercise its enforcement discretion under the CAA,[177] two elements in the present case suggest that using BAMM as a substitute for granting a stay of the Final Subpart I's requirements may be problematic.**

**1. The BAMM provisions were promulgated through notice and comment rulemaking. As a result, any material deviations from the provisions could rise to the level of a rulemaking that requires its own notice and comment process.[178]**

**2. Section 307(d)(7)(B) limits ability of the Administrator to grant a stay during the reconsideration process "for a period not to exceed three months". Any perception that EPA is using BAMM as a mechanism to stay the reporting requirements of the Final Subpart I, and thereby circumvent the statutory limits on its discretion, could also give rise to a judicial challenge. Similar challenges have been upheld in the past.[179]**

**Because of the uncertainty and potential legal exposure created by using BAMM beyond the specific limitations as set out in the Final Subpart I, SIA strongly contends that BAMM is inappropriate to the present situation, and**

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[176] 42 U.S.C. § 7604(a).

[177] See, e.g., Heckler v. Chaney, 470 U.S. 821 (1985)

[178] See Nat'l Ass'n of Home Builders v. U.S. Army Corps of Engineers, 417 F.3d 1272 (D.C. Cir. 2005) (court determined that the issuance of nationwide permits that authorized certain discharges into U.S. waters – something that could not otherwise be done under the governing statute without first obtaining an individual permit – effectively granted permittees the right to bypass certain requirements of the statute and was tantamount to the Corps issuing a rule); see also Croplife America v. EPA (329 F.3d 876 (D.C. Cir. 2003) (court held that EPA had effectively promulgated a rule when it announced that it would no longer consider certain studies in its regulatory decision-making, even though such studies had long been submitted by applicants – and accepted by EPA – as evidence of a pesticide's safety).

[179] See, e.g., NRDC v. EPA, 489 F.3d 1364 (D.C. Cir. 2007) (striking down EPA's extension of compliance deadlines where specific statutory language required a shorter compliance timeframe).

**should not be used as a substitute for the more appropriate action of directly staying the requirements of the Final Subpart I while EPA reconsiders the Rule.**

## V. CONCLUSION

For the reasons cited above, SIA urges EPA to reconsider those elements of the Reporting Rule that are listed in Sections II and III, above. As appropriate, EPA is urged to stay the effectiveness of those provisions of the Reporting Rule that are subject to reconsideration.

Dated: January 31, 2011

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# EXHIBIT A

# What does a typical etch recipe look like and how does it vary ?

| STEP | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Step Completion Cond. | Stability | E/P | Over | Ramp | E/P | Over | Ramp | Time | Ramp | Time | E/P | Over | Ramp | Time | T/E | Ramp | T/E | Ramp | Time | E/T | Ramp | Time | T/E | Ramp | Time | T/E |
| Detect Unit | 11(B) | 1(A) | 11(B) | 11(B) | 2(A) | 11(B) | 11(B) | 11(B) | 11(B) | 11(B) | 3(A) | 11(B) | 11(B) | 11(B) | 3(A) | 11(B) | 1(A) | 11(B) | 11(B) | 4(A) | 11(B) | 11(B) | 5(A) | 11(B) | 11(B) | 5(A) |
| Step Process Time | 01:00.0 | 00:30.0 | 00:50.0 | 00:02.0 | 00:45.0 | 00:57.0 | 00:02.0 | 00:02.0 | 00:03.0 | 00:02.0 | 01:00.0 | 00:50.0 | 00:04.0 | 00:02.0 | 00:28.0 | 00:02.0 | 00:11.0 | 00:02.0 | 00:02.0 | 01:00.0 | 00:03.0 | 00:02.0 | 00:10.0 | 00:02.0 | 00:02.0 | 00:11.0 |
| Step Lower Limit Time | 00:00.1 | 00:10.0 | 00:00.1 | 00:15.0 | 00:10.0 | 00:00.1 | 00:31.0 | 00:31.0 | 00:31.0 | 00:31.0 | 00:10.0 | 00:00.1 | 00:31.0 | 00:00.1 | 00:00.1 | 00:00.1 | 00:00.1 | 00:00.1 | 00:00.1 | 00:00.1 | 00:00.1 | 00:00.1 | 00:00.1 | 00:00.1 | 00:00.1 | 00:00.1 |
| Over Etch | 0 | 0 | 25 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Process Data | On | On | On | On | On | On | On | On | On | On | On | On | On | On | On | On | On | On | On | On | On | On | On | On | On | On |
| Ramp Control | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| Chamber Pressure | a | b | c | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w | x | y | z |
| Upper RF Power | 0 | a | b | c | d | e | f | g | h | i | j | k | l | m | n | o | p | q | 0 | 0 | 0 | r | s | t | 0 | 0 |
| Lower RF Power | 0 | a | b | c | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w | x | y |
| Upper HV Voltage | 0 | a | b | c | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| H2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CH2F2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | s | t | 0 | 0 | 0 |
| NH3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | \ | 0 | 0 | 0 |
| CHF3 | 0 | 0 | 0 | a | b | c | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CF4 |  |  |  |  |  |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | d | e | f | 0 | 0 | 0 | g | h | 0 | 0 | 0 |
| O2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| O2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | a | b | c | d | e | 0 | f | g | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C4F6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C4F8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |  |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NF3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CO | 0 | 0 | 0 | 0 | 0 | 0 |  |  |  |  |  |  |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CO2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |  |  |  |  |  |  |  |  |
| Ar | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |  |  | 0 | 0 | 0 | 0 | 0 | 0 |  |  | 0 | 0 | 0 |
| N2 | 0 | 0 | 0 | 0 | 0 | 0 |  |  |  |  |  |  |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Wafer Cooling | On | On | On | On | On | On | On | On | On | On | On | On | On | On | On | On | On | On | On | On | On | On | On | On | On | On |
| Edge He Pressure | a | a | a | a | a | a | a | a | a | a | a | a | a | a | a | a | a | a | a | a | b | cc | cc | dd | a | a |
| Cent. He Pressure | f | f | f | f | f | f | f | f | f | f | f | f | f | f | f | f | f | f | f | f | f | gg | h | f | f | f |
| Temperature | a | b | c | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w | x | y | z |
| Ignition Step Dly Tim | 00:00.0 | 00:00.0 | 00:00.0 | 00:00.0 | 00:00.0 | 00:00.0 | 00:00.0 | 00:00.0 | 00:00.0 | 00:00.0 | 00:00.0 | 00:00.0 | 00:00.0 | 00:00.0 | 00:00.0 | 00:00.0 | 00:00.0 | 00:00.0 | 00:00.0 | 00:00.0 | 00:00.0 | 00:00.0 | 00:00.0 | 00:00.0 | 00:00.0 | 00:00.0 |
| Ignition Step Top Pw | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ignition Step Btm Pw | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Program No. Send | Disable | Disable | Disable | Disable | Disable | Disable | Disable | Disable | Disable | Disable | Disable | Disable | Disable | Disable | Disable | Disable | Disable | Disable | Enable | Enable | Enable | Disable | Disable | Disable | Enable | Enable |
| Upper Program No. | a | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | b | b | a | 0 | 0 | 0 | cc | cc |
| Lower Program No. | dd | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | d | d | d | 0 | 0 | 0 | ee | ee |
| Gas Control | Control | Control | Control | Control | Control | Control | Control | Control | Control | Control | Control | Control | Control | Control | Control | Control | Control | Control | Control | Control | Control | Control | Control | Control | Control | Control |
| Center Flow Ratio | k | k | k | k | l | l | k | k | k | k | k | k | k | k | k | z | z | z | k | k | k | k | k | k | k | k |

- This chart illustrates a typical multistep recipe used at an advanced 300mm Fab
- The colored bars indicate when a particular parameter is active, and letters are used to indicate when the parameter values are changing over time.
- This particular recipe employs 9 different gases, several of which are used at very different flow rates over the course of the 26 step recipe duration.
- Some of the recipes employed at the Fab where this recipe is used, have more than 40 steps, and the tool control systems have just been modified so that they will now handle as many as 100 steps.

# EXHIBIT B

# ISMI Analysis of the Impact of Final Mandatory Reporting Rule Subpart I on U.S. Semiconductor Facilities

**International SEMATECH Manufacturing Initiative**
**Technology Transfer #11015139A-TR**

# ISMI Analysis of the Impact of Final Mandatory Reporting Rule Subpart I on U.S. Semiconductor Facilities

## Technology Transfer #11015139A-TR
## International SEMATECH Manufacturing Initiative
## February 1, 2011

**Abstract:** This report presents an analysis of the feasibility of complying with the U.S. Environmental Protection Agency's Mandatory Reporting of Greenhouse Gases (GHG): Additional Sources of Fluorinated GHGs Final Rule (final rule) Subpart I was published in the Federal Register (FR) on December 1, 2010. The analysis is based on the International SEMATECH Manufacturing Initiative' s(ISMI) Semiconductor Etch Individual Recipe-specific Emission Factor Scoping Survey, November 2010, as well as ISMI GHG surveys in 2009 and spring 2010.



**Keywords:** Factory Cost Analysis, Government Regulations, Resources Management

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# 1 EXECUTIVE SUMMARY

The U.S. Environmental Protection Agency's Mandatory Reporting of Greenhouse Gases (GHG): Additional Sources of Fluorinated GHGs Final Rule (final rule) Subpart I was published in the Federal Register (FR) on December 1, 2010. When establishing the final rule, the EPA has significantly underestimated the cost to

- Develop gas-specific, container-specific heel factors
- Develop models to apportion gas use among process categories and specific recipes
- Determine etch recipe-specific emission factors for large semiconductor facilities
- Estimate emissions using final rule Tier 2c
- Collect data required to be reported/retained for fluorinated heat transfer fluids

The EPA's estimate of industry burden did not account for costs associated with the following:

- Verifying the apportioning model with actual data
- Testing point-of-use (POU) abatement devices
- Recordkeeping/reporting required for abatement devices
- Etch process tool downtime for required emissions characterizations

Semiconductor facilities cannot implement portions of the rule as the EPA envisions:

- Facilities cannot complete emissions testing in a short timeframe.
- Facilities use fluorinated greenhouse gas (F-gas) in multiple process categories and sub-categories, necessitating the installation of infrastructure that EPA did not realize is required and did not account for in its estimate of industry burden.
- As the International SEMTECH Manufacturing Initiative (ISMI) presented on December 10, 2010, plasma etch processes and recipes do not fit the EPA's understanding and the rule's basis.

Compliance costs are significantly higher than the EPA estimates. ISMI estimates semiconductor industry's first year compliance costs are 40X higher than the EPA's total electronics industry estimate and 15X higher than their subsequent year estimate.

The 5% verification of apportioning is a new requirement. The industry is uncertain about whether compliance is feasible. Processes vary by more than 5%; therefore, the validation of the model compared to a measured consumption is likely infeasible.

Final rule reporting and recordkeeping requirements further raise significant intellectual property (IP) concerns within the industry. The requirements do not achieve the stated goal of increased accuracy while balancing burden. The EPA should consider less intrusive and more cost-effective alternatives.

# 2 BACKGROUND

The Final Rule Preamble and Response to Public Comments explains the EPA's basis for the final rule; Subpart I specifies compliance requirements for semiconductor manufacturing facilities. The EPA published an Economic Impact Analysis (EIA) [1] that documents its cost analysis method and an estimate of the semiconductor industry's cost to comply with the final rule. EPA economist Shaun Ragnauth provided additional details about the EPA cost assessment [2].

To determine the impact of the final rule on U.S. semiconductor operations, the Semiconductor Industry Association (SIA) asked ISMI's Environment, Safety, and Health (ESH) Technology Center to conduct a survey of ISMI and SIA members to understand the feasibility and cost of implementing the final rule requirement that large facilities develop recipe-specific etch emission data. ISMI collected and analyzed the survey data independent of the SIA to preserve the respondents' confidentiality. The SIA also requested that ISMI review the final rule, EIA, and previously collected data to identify impacts of the final rule. Additionally, in response to a request by Dina Kruger of the EPA, ISMI compared the industry-estimated burden and EPA-estimated burden to comply with Subpart I. This report presents an analysis of the feasibility of complying with the final rule and of the cost for U.S. semiconductor facilities.

# 3 ETCH RECIPE-SPECIFIC EMISSION FACTORS AND APPORTIONING

## 3.1 Background

### 3.1.1 EPA 2009 Proposed Rule

In the initial proposed Mandatory Reporting Rule Subpart I published in the Federal Register on April 10, 2009, the EPA proposed that large fabs develop "process-specific" utilization and byproduct formation factors from etch and chemical vapor deposition (CVD) chamber cleaning using an approach based on the Intergovernmental Panel on Climate Change (IPCC) Tier 3 method. Implementation of the Tier 3 method requires process emissions testing. In the proposed rule, EPA did not define the term "process-specific."

### 3.1.2 2009 ISMI Findings

In the 2009 report, *ISMI ESH Technology Center Greenhouse Gas Facility Survey* [3] (2009 ISMI report), ISMI stated that the range of process-specific factors could be bounded by the number of "unique process platforms" as a lower bound and "unique PFC-using recipes" as an upper bound. ISMI defined unique "PFC-using recipes" as the estimated total number of different process platforms running different PFC gases, gas flow rates, gas ratios, process times, and/or stabilization time. ISMI noted that large fabs do not have the equipment or personnel to conduct in-house emission testing and that third-party testing would be required. ISMI also assumed that the third party could test six process recipes per week (including set-up, testing, data analysis, and report generation) at a cost of $35,000 per week. The 2009 ISMI survey found that the average number of unique process recipes was 455 per large fab and, "If each individual process recipe must be characterized, the cost for the average large fab rises to $2.7 Million over 76 weeks" [4].

### 3.1.3 2010 Final Subpart I Requirements

The final Subpart I requires large semiconductor facilities to estimate process F-gas emissions using Tier 2d, which consists of a combination of EPA default emission factors for CVD chamber cleaning and wafer clean processes and "directly measured recipe-specific emission factors" [5] for each etch recipe or "set of similar recipes [6]." "Similar" is narrowly defined as "…those recipes that are composed of the same set of chemicals and have the same flow stabilization times and where the documented differences, considered separately, in reactor pressure, individual gas flow rates, and applied radio frequency (RF) power are less than or equal to plus or minus 10% [7]." Recipe-specific emission factors must be developed using the *2006 ISMI Guideline for Environmental Characterization of Semiconductor Process Equipment* (2006 ISMI GL) for measurements made after January 1, 2007. Fabs must report the film or substrate etched/cleaned and the feature type [8] and must maintain documentation of reactor pressure, flow rates, chemical composition, applied RF power, DC bias, temperature, flow stabilization time, and duration [9].

## 3.2 Etch Survey Overview

The SIA asked the ISMI ESH Technology Center to conduct a survey to determine the impact on large U.S. semiconductor facilities of the individual recipe-specific etch emission factor requirement. The Semiconductor Etch Individual Recipe-specific Emission Factor Scoping Survey, November 2010, consisted of the following parts:

- Purpose: Identification of the impact of the individual recipe-specific etch emissions factor requirement on large U.S. fabs to give the SIA legal and policy specialists a basis for deciding what path to take about the final rule.
- Background: Brief overview of the rule and its requirements, definitions of plasma etch processing type, individual recipe and similar recipes, and the rule requirements for large facilities.
- Part 1: General information to identify respondent, facility, and wafer size.
- Part 2: Questions to ascertain the scope and impact of etch recipe-specific requirements.

Teleconferences also were held with SIA and ISMI members to ensure that respondents understood the final rule definitions of "individual recipe" and "similar." This clarification was necessary to ensure that etch recipe data reflected those recipes that require testing under the final rule.

## 3.3 Etch Survey Results

The EPA estimates that 11 semiconductor companies operate 29 large fabs in the U.S [1]. The ISMI ESH Technology Center received responses from 24 large fabs currently operating or being built in the U.S. by 11 semiconductor companies. The responding fabs process various wafer sizes, an indication that different manufacturing equipment and varying degrees of automation are likely to be used in the large facilities (Table 1).

**Table 1 Respondents Categorized by Wafer Size**

| Fab Wafer Size | Number of Respondents |
|---|---|
| 150 mm | 2 |
| 200 mm | 8 |
| 300 mm | 14 |

The survey found the following:

- None of the respondents has developed process emission factors in strict adherence to the 2006 ISMI GL; moreover, ISMI has issued an update to the guideline (2009 ISMI GL) and the 2006 version is no longer available on ISMI's website (a fact previously brought to EPA's attention).
- Only 5 of the 24 respondents have a Fourier transform infrared spectrometer (FTIR) at the facility that could potentially be used to conduct the required etch emissions characterizations; however, because such instruments are typically configured for stack monitoring, they would need to be modified to characterize process emissions. The ISMI GL requires analysts to conduct a fluorine volume closure based on input amounts and outlet measurements. Because FTIRs cannot measure homonuclear diatomics, fluorine must be quantified by using additional analytical equipment such as a quadrupole mass spectrometer or fluorine chemiluminescence detector (method added to the 2009 ISMI GL).
- Only one company has any personnel with the technical training and experience to conduct the required etch emissions testing.

Respondents reported the number of individual etch recipes that are run annually. For many semiconductor fabs, determining the number of recipes and their similarity is a time-intensive process that requires process engineering expertise and manual review of each recipe on the etch tool's computer. ISMI asked respondents to provide an uncertainty estimate because the limited amount of time between the EPA's issuance of the pre-publication version of the rule and ISMI's deadline for data submittal required that some respondents estimate numbers of recipes. Figure 1 shows the number of dissimilar etch recipes run annually in each fab with error bars indicating the uncertainty.

Twenty-two fabs were able to quantify the number of dissimilar etch recipes they run in a 12-month period. Fabs must test on average 313 dissimilar recipes. One fab reported running more than 10,000 individual etch recipes per year, more than 3,000 of which are production recipes; however, this fab's data is not included in the analysis because it was unable to sort and categorize the recipes. ISMI asked respondents to quantify the number of recipe changes and new recipes they introduce each year. The survey found the average large fab makes 56 etch recipe changes and introduces 40 new recipes per year.

Reported uncertainties for dissimilar recipes ranged from 0 to 20% with an average of 8%. Because estimates of future new and changed recipes can be more speculative, the reported uncertainties ranged from 0 to 50% with an average of 25%.

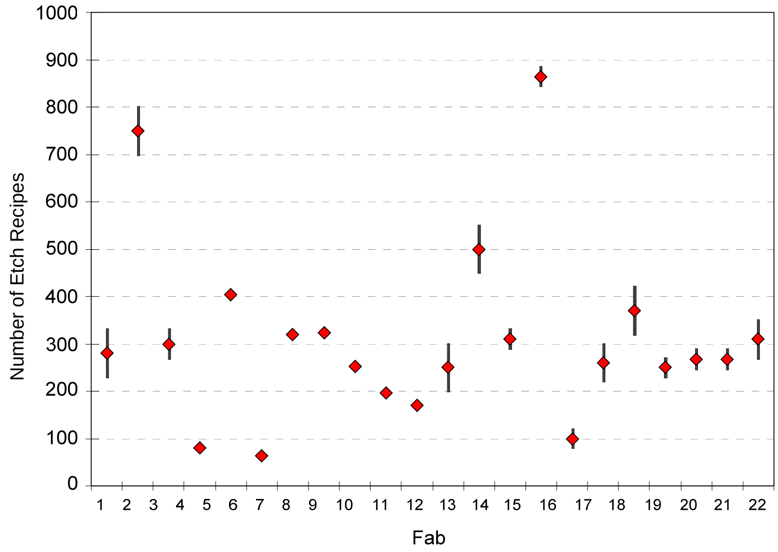



**Figure 1 Number of Dissimilar Recipes Per Fab**

## 3.4 EPA Misconceptions About Plasma Etch

The EPA finalized etch recipe-specific characterization requirements assuming that etch recipes account for 30% of all facility processes [10] when in fact they account for 97% (Figure 2).

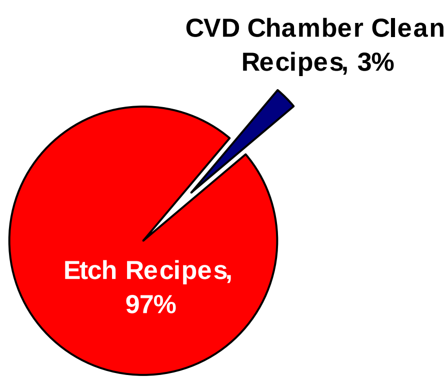
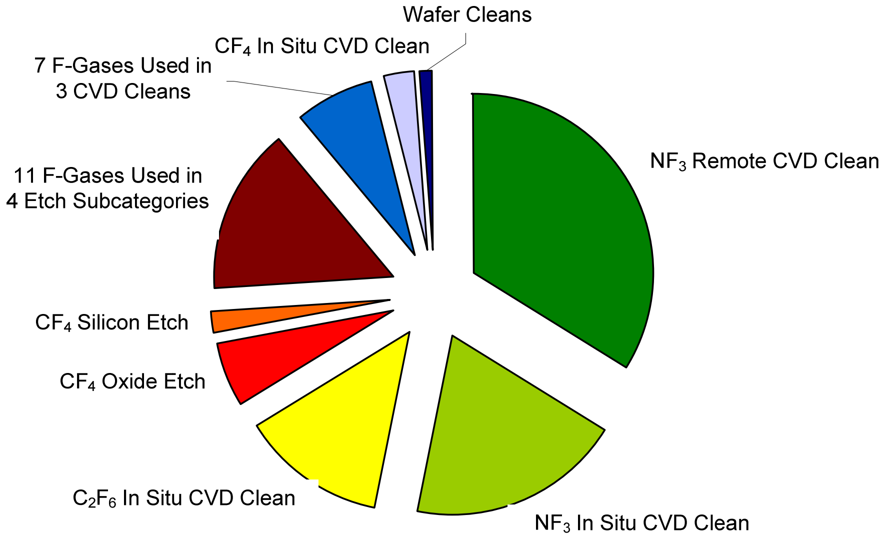



**Figure 2 Percent of Total F-Gas Using Recipes Attributable to Etch or CVD Chamber Clean**

This misconception may be due to a misinterpretation of data ISMI shared with EPA indicating that 24% of F-gas is used in etch and 75% in CVD chamber cleans [11]. Two survey respondents provided additional information on the number of chamber clean recipes using F-gas that they run in their fabs. Although etch F-gas usage accounts for less than 25% of the total industry F-gas use, etch recipes are 97% of the F-gas recipes run in these fabs.

The EPA believes that etch uses a greater percentage of overall F-gas and requires validating the apportioning model for etch because, “reportable gases used for etching rank second and third in total quantities of usage industry-wide....” [12] In spring 2010, ISMI surveyed SIA and ISMI member companies, asking respondents to apportion 2009 F-gas consumption into the EPA's nine proposed rule refined method subcategories (Figure 3). Data limitations required the use of best engineering judgment to apportion usage.

The EPA's belief that etch usage is ranked second and third is wrong. As seen in Figure 3, CVD chamber cleaning consumes the largest amount of F-gas; etch F-gas uses are ranked fourth (6% of the total) and sixth (2% of the total).




Note: Based on percent Kg use data from ISMI 2010 survey previously shared with EPA on May 19, 2010, and in SIA comments.

**Figure 3 Percent of Total F-Gas Use by Process Subcategory**

Based on the compiled results, categorical semiconductor F-gas usage is ranked according to percentage of total usage:

1. $NF_3$ for remote CVD clean ~34%
2. $NF_3$ for in-situ CVD clean ~19%
3. $C_2F_6$ for in-situ CVD clean ~13%
4. $CF_4$ for oxide etch ~6%
5. $CF_4$ for In-situ CVD clean ~3%
6. $CF_4$ for silicon etch ~2%

## 4 COMPARISON OF ISMI AND EPA SUBPART I COST ANALYSES

During the December 10, 2010, meeting between the EPA and SIA, Dina Kruger, Director of the Climate Change Division, asked that ISMI's cost data be compared to EPA's cost tables. The methodology and results of that comparison are as follows.

The cost and basis for the EPA's estimate of Subpart I compliance costs can be found in the following sources:

- Overall Industry Cost: 40 C.F.R. Part 98, Table 12
- Explanation of Cost Basis: Economic Impact Analysis for the Mandatory Reporting of Greenhouse Gas Emissions, F-Gases: Subparts I, L, DD, QQ, SS Final Report, published November 2010
- Labor and Capital Costs: F-Gas Rule-Subpart I Cost Tables (Appendix A) sent via email attachment from Shaun Ragnauth to Laurie Beu on December 16, 2010
  - Table 1. Labor Costs: Semiconductor Mfg (Tier 2b)
  - Table 2. Labor Costs: Semiconductor Mfg (Tier 2c)
  - Table 3. Labor Costs: Semiconductor Mfg (Tier 2d)
  - Table 4. Capital and O&M Costs: Semiconductor Mfg (Tier 2d)

ISMI's cost estimate is based on the following data sources:

- ISMI spring 2010 semiconductor industry greenhouse gas (GHG) survey. The survey itself was shared with the EPA; results are summarized in the 2010 ISMI Semiconductor GHG Reporting Rule Survey Report [13]. Part 6 of the survey asked respondents to estimate the labor burden and capital and operations and maintenance (O&M) costs required to comply with the following rule requirements:
  - Development of heel factors using measuring devices with 1% full scale accuracy and precision
  - Apportioning F-gas consumption by process category or individual process using EPA proposed method based on wafer passes
  - Apportioning GHG usage and estimating emissions and byproducts using
    - IPCC Tier 2b defaults (differentiating between etch and CVD process categories)
    - An alternative method (i.e., Updated IPCC Method defaults) with five process subcategories (this method corresponds to the Final Rule Tier 2c categories)
    - Proposed rule Refined Method defaults (nine process subcategories)
  - Collecting all data required to be reported/retained for POU abatement
  - Collecting all data required to be reported/retained for fluorinated heat transfer fluids
- ISMI November 2010 etch survey data quantifying etch recipes to be tested under the final rule
- ISMI spring 2010 survey data on the number of abatement devices installed per fab to allow abatement testing costs to be estimated
- ISMI 2009 survey data on estimated costs associated with apportioning F-gas using mass flow controllers (MFCs) and weigh scales as specified in the 2009 proposed rule

## 4.1 ISMI Estimate Assumptions

ISMI compiled the survey data and estimated industry costs using the following:

- To be consistent with EPA's estimate, 91 total U.S. semiconductor facilities are assumed to be subject to Subpart I. Of those, 62 are non-large facilities and 29 are large facilities.
- Non-large facilities use final rule Tier 2c defaults (defaults in 5 process sub-categories)
- Etch recipe-specific emissions testing is an expense incurred in the year in which testing is required. The average large facility tests 313 recipes in the first year and 96 in subsequent years.
- All abatement devices are installed in large facilities.
- For consistency with EPA estimates, all capital expenditures are assumed to have a 10-year lifetime. Capital costs are annualized at a 7.5% interest rate.
- The EPA methodology for estimating labor costs is used. The labor categories areLegal, Managerial, Technical, and Clerical. While survey respondents indicated that wage rates for the highly technical semiconductor industry are considerably higher than those used in the EPA Economic Impact Assessment (EIA), the EPA wage rates were used so that the data were comparable.
- Third-party analysts conduct etch emissions and POU abatement testing at a cost of $35,000/week (EPA assumes one week of testing costs $35,000 [14]).

## 4.2 Cost Comparison: Non-large Semiconductor Facilities

Using survey responses, ISMI estimated the costs for non-large facilities to comply with the following requirements of the final rule:

1. Development of facility-specific, container-specific heel factors based on residual weight or pressure with ±1% full scale accuracy.
2. Apportionment of process GHG usage by process category using EPA's proposed method based on wafer passes.
3. Estimating emissions and byproducts in three chamber clean sub-categories (in situ plasma, remote plasma, and thermal), etch, and wafer cleans. This method is the same as EPA Tier 2c that non-large semiconductor facilities must use to estimate emissions under the final rule.
4. Collecting all data required to be reported/retained for fluorinated heat transfer fluids (F-HTF).

ISMI believes these elements are equivalent to what EPA included in its Table 2. Labor Costs: Semiconductor Mfg (Tier 2c), which serves as the basis for EPA's non-large facility cost estimate. Industry first-year and subsequent year costs for the non-large facilities are calculated by multiplying the average costs by 62 facilities.

The ISMI and EPA non-large facility cost estimates are shown in Table 2. Non-large facility compliance costs are 15X greater than EPA estimates. The amount of labor required to comply with the rule is significantly higher than EPA estimates; moreover, the EPA assumes that non-large facilities incur no capital or O&M costs. As previously reported to the EPA in 2010, ISMI's spring 2010 survey finds EPA's assumption to be erroneous. It is not clear why EPA did not update its final cost estimate to include capital and O&M costs.

### 4.3 Cost Comparison: Large Semiconductor Facilities

When developing an estimate for compliance, ISMI estimated the costs for large facilities to comply with the following requirements:

1. Development of facility-specific, container-specific heel factors based on residual weight or pressure with ±1% full scale accuracy
2. Apportionment of process GHG usage by process category using EPA's proposed method based on wafer passes
3. Developing etch recipe-specific emission factors
4. Collecting all data required to be reported/retained for fluorinated heat transfer fluids (F-HTF).

ISMI believes these elements are the same as those included in the EPA Table 3 (Labor Costs: Semiconductor Mfg (Tier 2d)) and EPA Table 4 (Capital and O&M Costs: Semiconductor Mfg (Tier 2d)), which serve as the basis for the EPA's large facility cost estimate. Table 3 summarizes ISMI's and the EPA's large facility cost estimates.

For equivalent cost elements as included in the EPA estimate, ISMI finds large facility first-year compliance costs are 57X greater than the EPA's estimates while subsequent year costs are 15X greater. The largest discrepancy between the ISMI and EPA estimates is in developing etch recipe-specific emission factors. ISMI finds first-year compliance costs are 220X greater than the EPA estimates, while subsequent year costs are 17X greater. A detailed explanation of the differences is in Appendix B. Although ISMI's estimate for apportioning gas usage is 4X greater than the EPA's total estimated cost for large facility compliance, it is likely an underestimation of actual costs. When ISMI survey respondents provided data (spring 2010), the EPA's proposed rule did not require recipe-specific emissions estimates. Consequently, large facilities based their estimates on apportioning gas usage to a limited set of process categories, not on installing the infrastructure required to apportion gas usage and estimate emissions based on hundreds of process recipes.

## Table 2 Non-large Facility Costs

*ISMI Cost Estimate Based on EPA Cost Elements*

| | Labor Burden (per Facility/Entity Average) | | | | | Instrumentation Burden For Monitoring Data (per Facility/Entity Average) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average Legal Cost (hours x $101/hr) | Average Manager Cost (hours x $71.03) | Average Technical Cost (hours x $55.30) | Average Clerical Cost (hours x $29.65) | Total Average Labor Costs | Average Capital Costs | Eqpt. Lifetime (years) | Annualized Capital Costs | Average Annual O&M Costs | Average Other Annual Costs | First Year Non-large Facility Industry Sub-totals [1] | Total Subsequent Year Non-large Facility Industry Sub-totals [1] |
| 1. Developing facility-wide gas-specific, container-specific heel factors per fab using measuring devices with 1% full scale accuracy and precision.[2] | $51 | $218 | $5,630 | $127 | $6,025 | $25,167 | 10 | $3,583 | $35,767 | $933 | $2,871,128 | $2,871,128 |
| 2. Apportioning process GHG usage by process category or individual process using EPA proposed method based on wafer passes.[2] | $88 | $460 | $88,072 | $16,792 | $105,411 | $152,083 | 10 | $21,653 | $29,067 | $0 | $9,680,099 | $9,680,099 |
| 3. Estimating emissions and by-products by specific process type - Updated IPCC Method defaults (5 categories). | $74 | $426 | $19,679 | $975 | $21,153 | $260,750 | 10 | $37,125 | $32,000 | $333 | $5,617,917 | $5,617,917 |
| 4. Collecting all data required to be reported/retained for heat transfer fluid estimate.[2] | $30 | $180 | $5,768 | $403 | $6,382 | $0 | | | $1,333 | $0 | $478,329 | $478,329 |
| ISMI Estimate: Total Average Cost per Facility | $242 | $1,283 | $119,149 | $18,296 | $138,971 | $438,000 | | $62,361 | $98,167 | $1,267 | $18,647,473 | $18,647,473 |

*ISMI and EPA Total Estimated Non-large Facility Costs (Average x 62 facilities)*

| | Legal | Manager | Technical | Clerical | Total Labor | Total Capital | | Annualized Capital Costs | O&M Costs | Other Costs | First Year Totals | Subsequent Year Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ISMI Estimate**: Non-large Semiconductor Emissions Estimating, Reporting & Recordkeeping Total (average x 62 facilities) | $15,029 | $79,565 | $7,387,250 | $1,134,360 | $8,616,204 | $27,156,000 | | $3,866,403 | $6,086,334 | $78,533 | $18,647,473 | $18,647,473 |
| **EPA Estimate**: Non-large Facilities [From EPA Table 2] (average x62 facilities) | $1,628 | $100,672 | $1,096,195 | $40,351 | $1,238,846 | 0 | | 0 | 0 | 0 | $1,238,846 | $1,238,846 |

[1] Assume 62 non-large facilities — ISMI Estimated Cost (yellow)
[2] Average of all survey responses — EPA Estimated Cost (grey)

# Table 3 Large Facility Costs

| *ISMI Large Facility Cost Estimate Based on EPA Cost Elements* | Labor Burden (per Facility/Entity Average) | | | | | Instrumentation Burden For Monitoring Data (per Facility/Entity Average) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average Legal Cost (hours x $101/hr) | Average Manager Cost (hours x $71.03) | Average Technical Cost (hours x $55.20) | Average Clerical Cost (hours x $29.65) | Total Average Labor Costs | Average Capital Costs | Eqpt. Lifetime (years) | Annualized Capital Cost | Average Annual O&M Costs | Average Other Annual Costs | First Year Large Facility Industry Sub-totals [1] | Subsequent Year Large Facility Industry Sub-total [1] |
| 1. Developing facility-wide gas-specific, container-specific heel factors per fab using measuring devices with 1% full scale accuracy and precision.[2] | $51 | $218 | $5,630 | $127 | $6,025 | $25,167 | 10 | $3,583 | $35,767 | $933 | $1,342,947 | $1,342,947 |
| 2. Apportioning process GHG usage by process category or individual process using EPA proposed method based on wafer passes*.[2] | $88 | $460 | $88,072 | $16,792 | $105,411 | $152,083 | 10 | $21,653 | $29,067 | $0 | $4,527,788 | $4,527,788 |
| 3. Developing etch recipe-specific emission factors** [3] | | | $114,816 | | | | | $1,820,000 | $618,333 | | $56,109,664 | $17,959,947 |
| 4. Collecting all data required to be reported/retained for heat transfer fluid estimate.[2] | $30 | $180 | $5,768 | $403 | $6,382 | $0 | | | $1,333 | $0 | $223,734 | $223,734 |
| ISMI Estimate: Total Average Cost per Facility | $169 | $857 | $214,286 | $17,322 | $117,818 | $177,250 | | $1,845,236 | $684,500 | | $62,204,134 | $24,054,417 |
| *EPA Large Facility Cost Estimate* | | | | | | | | | | | | |
| EPA Estimate for Emissions Estimating, Reporting & Recordkeeping [From EPA Table 3] | $762 | $2,477 | $18,307 | $780 | $21,590 | 0 | 0 | 0 | 0 | 0 | $626,110 | $626,110 |
| EPA Estimate for Etch Emission Factor Development [Table 4, "Equipment" cost x 11 large companies] | | | | | | | | $23,311 | $66,240 | | $256,421 | $985,061 |
| EPA Estimate for Apportioning Model Development [Table 4, "Performance Testing" costs x 11 large companies +(0.5*18 half price fabs)] | | | | | | | | $10,840 | $20,710 | | $216,800 | $631,000 |

| *ISMI and EPA Total Estimated Large Facility Costs* | Legal | Manager | Technical | Clerical | Total Labor | Total Capital | | Annualized Capital Costs | O&M Costs | Other Costs | First Year Totals | Subsequent Year Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ISMI Estmate: Large Semiconductor Emissions Estimating, Reporting & Recordkeeping Totals (avg. x 29 facilities)** | **$4,891** | **$24,856** | **$6,214,306** | **$502,324** | **$3,416,714** | **$5,140,250** | | **$53,511,856** | **$19,850,500** | **$27,067** | **$62,204,134** | **$24,054,417** |
| **EPA Estimate: Large Facility Costs (all 29 large facilities)** | **$762** | **$71,828** | **$530,889** | **$22,631** | **$626,110** | | | **$473,221** | **$1,616,061** | | **$1,099,331** | **$2,242,171** |

* Under-estimate of actual cost: In original survey, large facilities did not base estimate on requirement for apportioning F-gas use to individual etch recipes.
Estimate does not include installation of sample ports and facilization requirements to support testing.

** First year labor listed as average technical labor; subsequent year labor is 17.67 weeks @ technical labor rate; first year testing cost listed as Annualized Capital Cost; Subsequent year testing costs listed as O&M

[1] Assume 29 large facilities — (yellow) ISMI Estimated Cost
[2] Average of all survey responses — (grey) EPA Estimated Cost
[3] Nov. 2010 survey

## 4.4 Cost Comparison Summary

Table 4 summarizes ISMI's estimate of the semiconductor industry cost to comply with the cost elements that ISMI believes are included in EPA's Subpart I cost estimate. EPA's estimate for the electronics industry is also listed in the table.

**Table 4 ISMI Estimated Cost for Elements Included in EPA Subpart I Cost Estimate**

| | First Year Cost (Millions $) | Subsequent Year Cost (Millions $) |
|---|---|---|
| **ISMI Estimate for EPI Cost Elements** | | |
| Developing facility-wide gas-specific, container-specific heel factors per fab using measuring devices with 1% full-scale accuracy and precision [2]. | 4.2 | 4.2 |
| Apportioning process GHG usage by process category or individual process using EPA proposed method based on wafer passes [2]. | > 14 | > 14 |
| Development and recordkeeping for etch recipe specific emission factors [1]. | 56 | 17 |
| Estimating emissions and by-products by specific process type – Updated IPCC Method defaults (5 categories). | 5.6 | 5.6 |
| Collecting all data required to be reported/retained for heat transfer fluids [2]. | 0.7 | 0.7 |
| ISMI estimated cost: Total semiconductor industry costs for EPA cost elements | **> 80** | **> 42** |
| EPA Estimated Subpart I – Total Electronics Industry [3] | 2.9 | 5.4 |

[1] ISMI November 2010 Survey.

[2] ISMI Estimate applying EPA costs to 29 large facilities and 62 non-large facilities.

[3] 40 C.F.R. §98, Table 12.

The disparity between actual industry cost and the EPA's estimate is based on the EPA's mistaken assumptions about the industry.

| EPA Assumption | Industry Actual Conditions |
|---|---|
| No capital or O&M required for heel factors, non-large facility apportioning, emissions estimating, and heat transfer fluid requirements. | As reported previously, both non-large and large facilities incur capital and O&M expenditures for these cost elements. |
| Large facility etch emissions testing costs are capitalized. | Emissions testing is an expense incurred in the year that testing occurs. |

The EPA's basis for estimating large facility costs to comply with etch recipe-specific emissions estimating requirements are flawed (see Appendix B), resulting in significant underestimation of the actual cost. The EPA additionally underestimates the labor burden for all elements of the rule. When including the same cost elements, ISMI finds the semiconductor industry's cost to comply with Subpart I is more than 28X greater in the first year and more than 8X greater in subsequent years than the EPA's estimates for the entire electronics industry to comply with the rule.

### 4.5 Compliance Costs: Additional Cost Elements Not Considered by EPA

The EPA's Subpart I cost estimate does not account for significant cost elements that are required to comply with the final rule or to provide the most accurate emissions estimate according to final rule requirements. The EPA does not include costs associated with the following:

- Verification of the apportioning model
- Abatement system testing and recordkeeping/reporting
- Etch process tool downtime

### 4.6 Abatement System Testing and Recordkeeping/Reporting

In the final rule and EIA, the EPA continues to underestimate the number of abatement devices in large fabs. EPA assumes 50 etch chambers per fab are equipped with abatement with 10 requiring testing each year under the rule's 20% requirement [15]. ISMI previously reported results quantifying the number of POU F-gas abatement systems in operation and subject to Subpart I requirements [13]. This information was shared with the EPA on May 19, 2010, and as an attachment to the SIA comments on the re-proposed rule. The 2010 ISMI report stated

> *The 20 large fab respondents have installed or plan to install 2076 POU units. According to the EPA's 20% testing rule, the 20 fabs will have to test on average 415 units annually, averaging out to 21 units per fab, more than twice the 10 units the EPA estimates per "large" facility.*[18]

ISMI determined that three large fabs each have more than 250 abatement devices installed. These fabs are required to test 50 units per year under the EPA's random sampling abatement system testing program (RSASTP). The cost to test abatement devices according to RSASTP is significant:

> *If the average number of POU abatement devices for the 20 large fabs respondents is extrapolated to the 29 "large" facilities identified by the EPA, then the total annual cost to the U.S. industry will rise to $7.024million or 4.4X the burden estimated by EPA. ISMI believes this is an appropriate yet conservative estimate of total industry costs; the number will likely further increase in the future if some of the 61 fabs currently not in the "large" category decide to install POU abatement. For the large fabs that reported 250 installed POU abatement devices, the annual cost to test 50 units (20% of the total) would be approximately $600,000 and take 17 weeks.* [18]

ISMI estimates the semiconductor industry cost to test abatement devices according to the final rule requirements will be $7.024M annually (assuming that 29 large facilities have all the F-gas abatement installed in the industry). Although the EPA estimated the cost to comply with the F-gas abatement testing requirements, it does not include these costs in its final economic analysis "since direct measurements of DREs are optional" [13]. The final rule allows industry to use a default DRE of 60% in lieu of testing; however, facilities that have installed F-gas abatement did so with the intent of achieving a >90% DRE. The 60% default significantly overestimates emissions from these facilities. In discussions with ISMI on January 20, 2011, the EPA indicated that it did not include any costs associated with abatement because reporting controlled emissions is optional under the final rule. Given the EPA's intent to obtain more accurate facility-level emissions estimates, the EPA should acknowledge the cost of achieving the level of accuracy required by the final rule by including the cost to implement RSASTP in the industry economic impact analysis. The EPA should also acknowledge the cost of implementing the rule's less expensive and less accurate option of applying the default DRE.

### 4.7 Etch Process Tool Downtime

Semiconductor fabs typically operate 24 hour/day, 7 days/week. During testing, each etch chamber must be taken out of production for 10–12 hr (8 hr to conduct testing and 2–4 hr to requalify the chamber for manufacturing). One semiconductor manufacturer provided information that the cost of etch tool downtime is $1.5M/year based solely on maintenance, operations, and depreciation expenses. ISMI estimates the total first-year cost of etch tool downtime for large fabs will be an additional $21.8M and the cost in subsequent years will be $3.91M/year.

### 4.8 Cost Summary: Additional Cost Elements

Table 5 summarizes semiconductor industry cost elements that the EPA did not include in its Subpart I compliance estimate.

ISMI estimates the semiconductor industry will incur $38M in the first year and $40M in subsequent years to comply with requirements that the EPA did not include in their cost estimate.

**Table 5 Additional Semiconductor Industry Subpart I Cost Elements**

| | First Year Cost (Millions $) | Subsequent Year Cost (Millions $) |
|---|---|---|
| Infrastructure to verify apportioning model with actual data* [1]. | 9 | 29 |
| Collecting data required to be reported/retained for POU abatement devices. | 0.34 | 0.34 |
| Testing POU abatement units [2]. | 7 | 7 |
| Cost of equipment downtime for etch emissions testing. | 22 | 3.9 |
| ISMI Estimated Cost Total: Additional Semiconductor Industry Costs | **38** | **40** |

*Infrastructure cost estimate based on 2009 Proposed Rule requirements for MFCs and weight scales—cost may be lower depending on EPA's interpretation of the final rule's requirements. Capital costs are annualized over 10 years at 7.5%. Capital equipment require annual calibrations (O&M) and other upkeep.

[1] ISMI Technology Transfer #09065012A-TR, June 2009.

[2] ISMI Technology Transfer #10065097A-TR, June 2010.

## 5 CONCLUSIONS

- **Compliance with final rule requirements is not feasible by 2011**

  The Preamble states, "… EPA expects all electronics manufacturing facilities will be prepared to fully comply with this rule's requirements no later than year-end 2011." This expectation is unreasonable:

  – The industry cannot complete etch emissions testing requirements in the stated timeframe.

    - Based on ISMI's survey results, the industry would need to undertake more than 1500 weeks of testing to develop recipe-specific etch emission factors.

- Testing requires highly specialized knowledge to work safely with semiconductor process equipment and emissions without risking human injury or an unintended fab shutdown. Insufficient equipment and experienced personnel would require testing to be outsourced. Very few third parties have the knowledge and experience to safely and accurately test F-gas emissions in a fab manufacturing environment.

– Both non-large and large facilities must purchase capital items, the cost of which is not included in the EPA's Subpart I cost estimate, and must incur annual O&M expenses that the EPA does not acknowledge.

– Verification of the apportioning model requires that actual measured data be used. If the industry had the infrastructure to collect the measured data, models would not be required. The industry's ability to comply with the verification requirement is uncertain.

– Resources are not available to conduct abatement testing. The EPA acknowledges that abatement testing will be outsourced; however, the same scarce resources required to test etch process emissions are required for an additional 200 weeks (4 years) of abatement testing.

- **EPA has greatly underestimated the actual cost of compliance**

  The EPA estimates the total electronics industry cost to comply with all aspects of Subpart I is $2.9M the first year and $5.4M per year in subsequent years. ISMI estimates that that first year-compliance costs for the semiconductor industry alone are more than 40X greater than the EPA's estimate for the entire electronics industry while subsequent year costs are more than 15X greater, as shown in Table 6.

**Table 6 Semiconductor Industry Cost to Comply with Subpart I**

| | First Year Cost (Millions $) | Subsequent Year Cost (Millions $) |
|---|---|---|
| ISMI Estimated Cost: Total Semiconductor Industry Costs for EPA Cost Elements | > 81 | > 42 |
| ISMI Estimated Cost Total : Other Semiconductor Industry Costs | 38 | 40 |
| ISMI Estimated Total Semiconductor Industry Costs* | > 119 | > 82 |
| EPA Estimated Subpart I: Electronic Industry Cost | 2.9 | 5.4 |

*ISMI estimate under-estimates total industry cost.

ISMI's estimate is likely an underestimate of actual industry costs because the industry burden data ISMI collected in spring 2010 does not reflect the more onerous large facility requirements of the final rule. Additionally, semiconductor industry wage rates are significantly higher than those used by the EPA and by ISMI in an effort to be consistent with the EPA cost methodology.

- **Data reporting and recordkeeping requirements raise intellectual property (IP) concerns**

  The etch recipe portfolio is intellectual property that can be worth billions of dollars to a semiconductor company. The final rule requires fabs to report the film or substrate etched/cleaned and feature type (40 C.F.R. §98.96) and to maintain documentation of reactor pressure, flow rates, chemical composition, applied RF power, DC bias, temperature, flow stabilization time, and duration (40 C.F.R. §98.97). These reporting and data retention requirements raise significant IP concerns.

- **The final rule does not appropriately balance accuracy with burden**

  To achieve more accurate facility level emissions estimates, the final rule requires an extraordinary effort and cost to develop heel factors, apportion F-gas usage, and estimate emissions; however, to balance accuracy and cost, the EPA introduces a large source of error in the estimate by not recognizing abatement DRE. The EPA provided a 60% default in the final rule, use of which requires certification of the device designs and uptime tracking; however, the EPA chose not to include use of the default in its estimate of burden because accounting for POU abatement DRE is not a requirement of the final rule. The final rule fails to recognize the significant investment by semiconductor manufacturers in POU abatement technology under the EPA voluntary agreement. For large fabs with a large installed base of abatement devices, excluding abatement DRE from the emissions estimate could result in a 90% or greater overestimate of actual F-gas emissions. If the EPA's goal is a more accurate estimation of emissions, then DRE must be included. The EPA, however, considers the cost to comply with the DRE requirements to be excessive. Not including DRE obviates all the effort and cost associated with the required elements of the final rule. It would seem that either of these alternatives is untenable.

  The final rule's requirements do not achieve the stated goal of increased accuracy while balancing burden. The EPA should consider less intrusive and more cost-effective alternatives.

# 6 REFERENCES


[1] "Economic Impact Analysis for the Mandatory Reporting of Greenhouse Gas Emissions F-Gases: Subparts I, L, QQ, SS," U.S. EPA, November 2010.

[2] Appendix F – Gas Rule-Subpart I Cost Tables; from document sent by email from Shaun Ragnauth to Laurie Beu on 12/16/2010.

[3] *Results of the ISMI ESH Technology Center Greenhouse Gas Facility Survey*, International SEMATECH Manufacturing Initiative, Technology Transfer #09065012A-TR, June 2009.

[4] 2009 ISMI Facility Survey Report, p15.

[5] 40 CFR 98 Preamble, p. 74782

[6] 40 C.F.R. §98.93

[7] 40 C.F.R. §98.98

[8] 40 C.F.R. §98.96

[9] 40 C.F.R. §98.97

[10] EIA 4-10

[11] "Results of 2010 ISMI Greenhouse Gas (GHG) Survey and Technical Analysis" presentation to EPA, slide 12; May 19, 2010.

[12] 40 C.F.R. §98 Preamble, p.74791.

[13] *2010 ISMI Semiconductor Greenhouse Gas (GHG) Reporting Rule Survey Results*, International SEMATECH Manufacturing Initiative, Technology Transfer #10065097A–TR, June 15, 2010.

[14] “Mandatory Greenhouse Gas Reporting Rule: EPA’s Response to Public Comments, Subpart I – Electronics Manufacturing”, p.85, U.S. EPA, November 2010.

[15] EIA, pp 4-14 to 4-15.

[16] EIA, 4-14.

[17] EIA Table 4-1

## Appendix A – EPA Subpart I Cost Tables (from Shaun Ragnauth)

### Table A-1 Labor Costs: Semiconductor Manufacturing (Tier 2b)

| Activity | Labor Rates (per hour) | | | | | | | | Labor Cost per Year per Reporting Unit/Facility | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Lawyer | | Industrial Manager | | Industrial Engineer/ Technician | | Administrative Support | | | |
| | $101.00 | | $71.03 | | $55.20 | | $29.65 | | | |
| | First Year | Subsq. Year | First Year | Subsq. Year | First Year | Subsq. Year | First Year | Subsq. Year | First Year | Subsq. Year |
| Planning | | | | | | | | | $0 | $0 |
| QA/QC | | | | | | | | | $0 | $0 |
| Recordkeeping | | | 2.39 | 2.39 | 24.7 | 24.7 | 5.7 | 5.7 | $1,702 | $1,702 |
| Sampling[a] | | | 11.17 | 11.17 | 186.49 | 186.49 | 11 | 11 | $11,413 | $11,413 |
| Reporting[b] | 0.26 | 0.26 | 14.26 | 14.26 | 28.82 | 28.82 | 10.14 | 10.14 | $2,931 | $2,931 |
| Total | 0.26 | 0.26 | 27.82 | 27.82 | 240.01 | 240.01 | 26.84 | 26.84 | $16,046 | $16,046 |

Note: The data presented in this table are found in Section 4 of the Economic Impact Analysis for the F-Gas rule. This table was developed using the labor categories and hourly rates in Table 4-3 on page 4-10 of the EIA in conjunction with Table 4-4: Responsibilities for Regulation Compliance by Labor Category Per Facility Category on pages 4-11 – 4-13 of the EIA.

All values are in 2006$.

[a]Includes labor hours for PFC emission estimates (fluorinated GHGs and $N_2O$), and heat transfer fluid estimates.

[b]Includes labor hours for reporting PFC emissions and heat transfer fluid estimates.

### Table A-2 Labor Costs: Semiconductor Manufacturing (Tier 2c)

| Activity | Labor Rates (per hour) | | | | | | | | Labor Cost per Year per Reporting Unit/Facility | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Lawyer | | Industrial Manager | | Industrial Engineer/ Technician | | Administrative Support | | | |
| | $101.00 | | $71.03 | | $55.20 | | $29.65 | | | |
| | First Year | Subsq. Year | First Year | Subsq. Year | First Year | Subsq. Year | First Year | Subsq. Year | First Year | Subsq. Year |
| Planning | | | | | | | | | $0 | $0 |
| QA/QC | | | | | | | | | $0 | $0 |
| Recordkeeping | | | 2.39 | 2.39 | 24.7 | 24.7 | 5.7 | 5.7 | $1,702 | $1,702 |
| Sampling[a] | | | 6.21 | 6.21 | 266.78 | 266.78 | 6.11 | 6.11 | $15,347 | $15,347 |
| Reporting[b] | 0.26 | 0.26 | 14.26 | 14.26 | 28.82 | 28.82 | 10.14 | 10.14 | $2,931 | $2,931 |
| Total | 0.26 | 0.26 | 22.86 | 22.86 | 320.30 | 320.30 | 21.95 | 21.95 | $19,980 | $19,980 |

Note: The data presented in this table are found in Section 4 of the Economic Impact Analysis for the F-Gas rule. This table was developed using the labor categories and hourly rates in Table 4-3 on page 4-10 of the EIA in conjunction with Table 4-4: Responsibilities for Regulation Compliance by Labor Category Per Facility Category on pages 4-11 – 4-13 of the EIA.

All values are in 2006$.

[a]Includes labor hours for PFC emission estimates (fluorinated GHGs and $N_2O$), and heat transfer fluid estimates.

[b]Includes labor hours for reporting PFC emissions and heat transfer fluid estimates.

## Table A-3 Labor Costs: Semiconductor Manufacturing (Tier 2d)

| Activity | Labor Rates (per hour) | | | | | | | | Labor Cost per Year per Reporting Unit/Facility | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Lawyer | | Industrial Manager | | Industrial Engineer/Tech | | Administrative Support | | | |
| | $101.00 | | $71.03 | | $55.20 | | $29.65 | | | |
| | First Year | Subsq. Year | First Year | Subsq. Year | First Year | Subsq. Year | First Year | Subsq. Year | First Year | Subsq. Year |
| Planning | | | | | | | | | $0 | $0 |
| QA/QC | | | | | | | | | $0 | $0 |
| Recordkeeping | | | 2.39 | 2.39 | 24.7 | 24.7 | 5.7 | 5.7 | $1,702 | $1,702 |
| Sampling[a] | | | 18.18 | 18.18 | 246.14 | 246.14 | 10.32 | 10.32 | $15,183 | $15,183 |
| Reporting[b] | 0.26 | 0.26 | 14.30 | 14.30 | 60.80 | 60.80 | 10.30 | 10.30 | $4,703 | $4,703 |
| Total | 0.26 | 0.26 | 34.87 | 34.87 | 331.64 | 331.64 | 26.32 | 26.32 | $21,588 | $21,588 |

Note: The data presented in this table are found in Section 4 of the Economic Impact Analysis for the F-Gas rule. This table was developed using the labor categories and hourly rates in Table 4-3 on page 4-10 of the EIA in conjunction with Table 4-4: Responsibilities for Regulation Compliance by Labor Category Per Facility Category on pages 4-11 – 4-13 of the EIA.

All values are in 2006$.

[a]Includes labor hours for PFC emission estimates (fluorinated GHGs and $N_2O$), and heat transfer fluid estimates.

[b]Includes labor hours for reporting PFC emissions, heat transfer fluid estimates, and DRE certification.

## Table A-4 Capital and O&M Costs: Semiconductor Manufacturing (Tier 2d)

| Activity | Cost Categories | | | | Total Reporting per Unit/Facility Cost (2006$) | |
|---|---|---|---|---|---|---|
| | Capital Cost (2006$) | Equipment Lifetime | Annualized Capital Cost (2006$/year)[a] | O&M Costs (2006$/year)[b,c] | First Year | Subsq. Years[d] |
| Equipment (selection, purchase, installation)[e] | $125,628 | | $23,311 | $66,240 | $23,311 | $89,551 |
| Performance testing[f] | $76,138 | | $10,840 | $20,710 | $10,840 | $31,550 |
| Recordkeeping | | | | | $0 | $0 |
| Travel | | | | | $0 | $0 |
| Sampling costs | | | | | $0 | $0 |
| Total | $201,766 | | $34,151 | $86,950 | $34,151 | $121,100 |

Note: The data presented in this table are found in Section 4 of the Economic Impact Analysis for the F-Gas rule. This table was developed using the labor categories and hourly rates in Table 4-3 on page 4-10 of the EIA in conjunction with the capital and O&M costs text outlined on pages 4-14 and 4-15 of the EIA.

All values are in 2006$.

[a] Based on a 7% interest rate.

[b] Software capital cost for the whole industry is based on the assumption that each company would pay the full software development cost (2,000 labor hours at an Industrial Engineer rate for fluorinated GHG tracking for one of its facilities and each subsequent facility would pay half. O&M cost represents 500 industrial engineer labor hours to revise and make adjustments in subsequent years and the assumption that each company would pay the full software O&M cost (500 hours) for one facility and each subsequent facility would pay half.

[c] 1st year EF testing is based on 3 full-time technical staff at 2,000 hours/yr and on the assumption that no new equipment is needed for testing. O&M cost for EF testing is based on 20% of the initial costing, assuming revisions/adjustments to the EF need to be made in subsequent years.

[d] Facilities are allowed to use Best Available Monitoring Methods (BAMM) for emission factors during year 2.

[e] Capital cost includes cost for emission factor testing. Emission factor testing cost is assumed to be a company cost (each company will test once for all facilities it owns).

[f] Performance testing cost includes costs for developing emissions tracking software for fluorinated GHGs.

## Appendix B – Recipe-Specific Etch Emission Factors Cost Comparison

The EPA underestimates the burden to develop etch recipe-specific emission factors because the EPA's estimates are based on invalid assumptions.

| EPA Assumption | Industry Actual Conditions |
|---|---|
| "Industry capital costs for emission factor development was assumed to be incurred per company …" [14]. EPA assumes cost is independent of number of fabs operated. | Final rule calls for development of recipe-specific emission factors. Number of dissimilar recipes is the quantifiable unit on which to base a cost estimate. Because companies manufacture different products in each fab on different wafer sizes using different process equipment, costs are incurred on a per fab basis rather than per large company. |
| Cost for emission factor development assumed based "… on labor costs associated with three technical engineers (2000 hours each)…"[13] | Because fabs do not have the personnel to test etch emissions, testing will be outsourced to a 3rd party. An etch engineer must participate in testing to run the process during testing. |
| "… facilities will already have the necessary equipment to develop emission factors…"[13] | Nineteen of 24 large fabs surveyed do not have equipment necessary to characterize etch emissions. |

The EIA does not specify how many recipes the EPA estimates each entity must test to develop recipe-specific etch emission factors. It is also not clear why the EPA assumes facilities have the equipment and personnel to conduct etch emissions testing because abatement destruction or DRE testing requires the same equipment and expertise and the EPA "assumed that the facilities outsource the DRE measurement…." [13]

The EPA considered emission factors for etch processes to be capital and operating and maintenance (O&M) expenditures. It categorized initial testing as a capital expenditure and annualized the cost over some unspecified number of years [13]. In fact, the semiconductor industry treats emissions testing expenditures as expenses. As explained by one industry ESH manager,

> *For existing operations, the only items that fall under the "capital" category are new physical installations and improvements to physical assets that are greater than about $5K. For something to be considered "capital" it has to add value to your asset and have a depreciation period similar to type (i.e., buildings type to be in the 15 year range etc.) Almost all other ongoing costs, such as repair, maintenance, testing, permitting, consulting work, etc., are categorized as "expense."*

For the 23 currently operating U.S. semiconductor facilities surveyed, etch recipe-specific emission factors will be determined for an installed base of process equipment and, therefore, would not be considered a capital cost. Costs are realized in the year during which emission characterizations occur; thus, emission factor development cost should not be annualized but instead be counted as a first year cost.

Based on survey data for dissimilar etch recipes run annually, recipe changes, and new recipes, ISMI estimated the first year and subsequent year costs to meet the final Subpart I requirements for recipe-specific etch emission factors (Table B-1).

**Table B-1 Estimated Cost to Develop Recipe-Specific Etch Emission Factors**

<table>
<tr><th></th><th>First Year Cost to Develop Etch Recipe-Specific Emissions Factors (Millions $)</th><th>Subsequent Year Cost to Test New Dissimilar Etch Recipes (Millions $)</th><th>Subsequent Year Cost to Test Changed Dissimilar Etch Recipes (Millions $)</th><th>Total Subsequent Year Cost (Millions $)</th></tr>
<tr><td>ISMI Survey Respondent Average</td><td>1.9</td><td>0.25</td><td>0.35</td><td>0.59</td></tr>
<tr><td>ISMI Estimated Industry Total Assuming 29 Large Fabs</td><td>56</td><td>7.2</td><td>10</td><td>17</td></tr>
<tr><td>EPA Estimated Cost Per Company [Source: Table A-4]</td><td>0.023</td><td colspan="2">0.07</td><td>0.09</td></tr>
<tr><td>EPA Estimated Industry Cost (per company cost × 11)</td><td>0.26</td><td colspan="2">0.63</td><td>0.99</td></tr>
</table>

ISMI based the estimates on the following assumptions:

- Twenty-nine large facilities must conduct testing.
- For first year compliance, each large fab must test an average of 313 recipes. In subsequent years, these fabs will each test 40 new and 56 changed etch recipes per year.
- The 2006 ISMI GL is stringently followed including fluorine balance and documentation requirements.
  - Six process recipes can be characterized per week including data gathering, data analysis, documentation, and development of recipe-specific utilization and byproduct formation factors.
- Third-party analysts conduct testing at a cost of $35,000/wk (EPA assumes one week of testing costs $35,000 [16]).
- A dedicated etch engineer works with the analysts to run the process chamber as required during testing. Although survey respondents indicate that technical semiconductor industry wage rates are considerably higher than those used in the EIA, ISMI used the same technical labor rate of $55.20/hr that the EPA assumed [17].
- Testing is conducted 8 hr/day, 5 day/week.
- ISMI did not capitalize or annualize the testing costs because the expense is incurred in the year during which testing occurs (assumed to be the first year for the development of etch emission factors for existing recipes and each subsequent year for testing new and revised recipes).

ISMI estimates the average large facility will spend $1.9M the first year to develop etch recipe-specific emission factors and $0.59M in subsequent years to update the factors. ISMI conservatively estimates the industry cost for emission factor development is $56M. This is likely an underestimate of total industry cost for the following reasons:

- To ensure an estimate consistent with EPA's assessment of the industry, ISMI used 29 large facilities as the basis for the cost estimate. A review of the November 2010 SEMI World Fab Watch database identifies 33 large fabs are located in the U.S. operated by 18 companies.
- Semiconductor etch process engineer wage rates are higher than the $55.20 hourly rate used by EPA. One semiconductor company provided data indicating the fully burdened hourly wage rate for a semiconductor facilities engineer is $88/hour. While facilities engineers typically earn less than fab process engineers, $88/hour is closer to actual industry costs than $55.20.
- Sample ports must be installed on each etch chamber exhaust line to facilitate testing. Additionally, analysts require access to resources not available at each testing location (e.g., power, exhaust, house gases, etc.) and facilitization costs will be incurred. Because of time constraints, ISMI did not quantify these costs; they are therefore not included in ISMI's estimate.

Even with ISMI's conservative assumptions, the EPA has significantly underestimated the cost for large facilities to develop etch recipe-specific emission factors. First-year compliance costs are 220X greater than EPA estimates; subsequent year costs are 17X greater.

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