

Proposed Regulation Order**REGULATION TO REDUCE EMISSIONS OF FLUORINATED GASES FROM SEMICONDUCTOR OPERATIONS**

Adopt new sections 95320 to 95326, Title 17, Subchapter 10, Article 3, Subarticle 2, California Code of Regulations, to read as follows:

[Note: All of the following text is draft language to be finalized and added to the California Code of Regulations after adoption by the Air Resources Board.]

§ 95320 Purpose

The purpose of this regulation is to reduce fluorinated gas emissions from the semiconductor industry pursuant to the California Global Warming Solutions Act of 2006 (Health & Safety Code, sections 38500 et.seq.).

§ 95321 Applicability

This regulation applies to an owner or operator of a semiconductor or related devices operation that uses fluorinated gases or heat transfer fluids. This includes, but is not limited to, the manufacturing of diodes, zeners, stacks, rectifiers, integrated microcircuits, transistors, solar cells, light-sensing devices, and light-emitting devices.

§ 95322 Definitions

(a) For the purposes of this article, the following definitions apply:

- (1) "Alternative Chemistries" means the substitution of a fluorinated gas in the chamber cleaning or etching process to increase utilization efficiency and reduce the carbon dioxide equivalent emissions.
- (2) "Calendar Year" means the time period from January 1 through December 31.

- (3) “Carbon Dioxide Equivalent” or “CO₂e” means a measure for comparing carbon dioxide with other greenhouse gases, based on the quantity of those gases multiplied by the appropriate global warming potential (GWP) factor.
- (4) “CO₂e Emissions Limit” means the maximum allowable kilograms of CO₂e emissions per square centimeter of wafers manufactured in a calendar year.
- (5) “Chamber Cleaning” means the process of using fluorinated gases to remove excess materials from chemical vapor deposition chamber walls to prevent contamination of wafers to be processed.
- (6) “Chemical Vapor Deposition (CVD)” means deposition of thin films on wafers by placing the wafers in a mixture of gases, including nitrogen or other gas used as a carrier, which react at the surface of the wafers.
- (7) “Equipment” means any article, machine, or other contrivance, or combination thereof, which may cause the issuance or control the issuance of fluorinated gas emissions in etching or CVD chamber cleaning processes.
- (8) “Etching” means a chemical reactive process for selectively removing material on a wafer using fluorinated, ionized gases.
- (9) “Fluorinated Gases” means a compound that contains fluorine and exists in a gaseous state at 25 degrees Celsius and 1 atmosphere of pressure. Fluorinated gases include, but are not limited to:
- (i) hexafluoroethane (C₂F₆),
 - (ii) octofluoropropane (C₃F₈),
 - (iii) octafluorocyclopentene (C₅F₈),
 - (iv) tetrafluoromethane (CF₄),
 - (v) trifluoromethane (CHF₃),
 - (vi) difluoromethane (CH₂F₂),
 - (vii) octofluorocyclobutane (c-C₄F₈),
 - (viii) octofluorotetrahydrofuran (C₄F₈O),
 - (ix) hexafluoro-1,3-butadiene (C₄F₆),
 - (x) carbon fluoride oxide (COF₂),
 - (xi) fluorine (F₂),
 - (xii) nitrogen trifluoride (NF₃), and
 - (xiii) sulfur hexafluoride (SF₆).
- (10) “Global Warming Potential (GWP)” means the radiative forcing impact of one mass-based unit of a given greenhouse gas relative to an equivalent unit of carbon dioxide over a given period of time.

(11) “Global Warming Potential Value” or “GWP Value” means the global warming potential value of a chemical or compound as specified in the IPCC: 1995 Second Assessment Report (SAR), Table 2.14, in Climate Change 2007: The Physical Sciences Basis, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, which is incorporated by reference herein.

If Table 2.14 does not contain a SAR 100-year GWP Value for a specific chemical or compound, then the 100-year GWP Value in Table 2.14 for that chemical or compound must be used.

(12) “Heat Transfer Fluid” means a fluorinated fluid which prevents a device, such as a semiconductor, from overheating by removing excess heat produced during a manufacturing process.

(13) “Permitting Agency” means any air pollution control district or air quality management district.

(14) “Process Optimization” means the practice of using end-point detectors and/or process parameter variation to achieve optimum gas usage to reduce excess fluorinated gas emissions.

(15) “Semiconductor Operation” means a process or operation performed to manufacture semiconductor devices or related solid state devices. It may include, but is not limited to, the manufacturing of diodes, zeners, stacks, rectifiers, integrated microcircuits, transistors, solar cells, light-sensing devices, and light-emitting devices.

(16) “Wafer” means a thin, usually round, slice of a material from which integrated circuits, or chips, are made.

(17) “Wafer Surface Area” means the entire surface area of one side of a wafer, or multiple wafers, and includes wafers that do not pass owner or operator inspection.

§ 95323 Standards

(a) Except as provided in section 95323(b), an owner or operator of a semiconductor operation must meet the emission standards in Table 1 by January 1, 2012. The Tier 1 emission standard shall apply to an owner or operator of a semiconductor operation that begins operation after January 1, 2009.

(1) Emissions Calculation Method

Fluorinated gas emissions are expressed in CO₂e units. The kilograms of fluorinated gas emissions are determined using the Tier 2b calculation method in the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories, incorporated by reference herein. The IPCC 1995 Second Assessment Report (SAR) provides the GWP values used to calculate fluorinated gas emissions, with the exception of NF₃ which is based on the GWP value from the IPCC Fourth Assessment Report.

An owner or operator of a semiconductor operation may request that the permitting agency approve the use of an alternative destruction removal efficiency (DRE) value that exceeds the default DRE value in the Tier 2b calculation method. An alternative DRE must be based on independent third party measured results for the emission control equipment used by the operation.

The kilograms of fluorinated gas emissions from CVD chamber cleaning and etching are converted to million metric tons of CO₂ equivalent (MMT CO₂e) using the following formula:

$$\text{Total Fluorinated Gas Emissions in MMT CO}_2\text{e} = \sum E_i(\text{GWP}_{100})_i / 10^9$$

Where:

E = the kilograms of fluorinated gas emitted using the Tier 2b method

i = the fluorinated gas

GWP₁₀₀ = the GWP of the fluorinated gas

10⁹ = the number of kilograms per million metric ton

Total fluorinated gas emissions in MMT CO₂e are converted to kilograms of CO₂ equivalents per square centimeter (Kg CO₂e/cm²) using the following formula:

$$\text{Emissions in Kg CO}_2\text{e/cm}^2 = (\text{MMT CO}_2\text{e})(10^9) / \sum[(\pi r_n^2 Wf_n)/100]$$

Where:

10⁹ = the number of kilograms per million metric ton

π = 3.1416

r_n = one half the diameter in millimeters of a given size wafer

n = diameter of a wafer in millimeters

Wf_n = the number of wafers of a given size manufactured in the calendar reporting year

100 = the number of square millimeters per square centimeter

Table 1
Emission Standards for Semiconductor Operations
Effective January 1, 2012

<u>CVD Chamber Cleaning and Etching Processes</u>	
<u>Wafer Surface Area Production</u> <u>(Million Square Centimeters Per Calendar Year)</u>	<u>Maximum Emissions Limit Per Square Centimeter for a Calendar Year</u> <u>(Kg CO₂e/cm²)</u>
<u>Tier 1: >37.7</u>	<u>0.2</u>
<u>Tier 2: >3.7 and ≤ 37.7</u>	<u>0.3</u>
<u>Tier 3: ≤3.7</u>	<u>0.5</u>

- (b) The emission standards in Table 1 shall not apply to a semiconductor operation that emits 0.0008 million metric tons or less of CO₂e per reporting calendar year.
- (c) The owner or operator of a semiconductor operation that is installing equipment to meet the emission standards in Table 1 must submit a permit application to the permitting agency no later than March 1, 2011.

§ 95324 Reporting Requirements

(a) Initial emissions reporting requirement

The owner or operator of a semiconductor operation must submit an initial emissions report pursuant to the requirements in section 95324(b) to the permitting agency no later than March 1, 2011. This report must quantify the monthly and annual emissions from semiconductor operations conducted during the 2010 calendar year.

(b) Annual emissions reporting requirements

The owner or operator of a semiconductor operation must submit an annual report to the permitting agency by March 1st of each calendar year that quantifies CO₂e emissions occurring in the previous calendar year.

The annual report must include, but may not be limited to, all of the following in subsections (b)(1) through (b)(11).

- (1) the company name, address, telephone number, designated contact person and e-mail address for the contact person;
- (2) the monthly and annual amounts, in kilograms, of each of the following fluorinated gases used for CVD chamber cleaning and etching;
 - i. hexafluoroethane (C₂F₆),
 - ii. octofluoropropane (C₃F₈),
 - iii. octafluorocyclopentene (C₅F₈),
 - iv. tetrafluoromethane (CF₄),
 - v. trifluoromethane (CHF₃),
 - vi. difluoromethane (CH₂F₂),
 - vii. octofluorocyclobutane (c-C₄F₈),
 - viii. octofluorotetrahydrofuran (C₄F₈O),
 - ix. hexafluoro-1,3-butadiene (C₄F₆),
 - x. carbon fluoride oxide (COF₂),
 - xi. fluorine (F₂),
 - xii. nitrogen trifluoride (NF₃), and
 - xiii. sulfur hexafluoride (SF₆).
- (3) the monthly and annual square centimeters of wafers manufactured;
- (4) the use of process optimization, alternative chemistries, or equipment to reduce fluorinated gas emissions and estimated emissions reductions in CO₂e per square centimeter of wafer manufactured;

- (5) monthly and annual CO₂e emissions determined in accordance with section 95323 (a)(1);
 - (6) the volume of fluorinated heat transfer fluids used in the manufacturing of semiconductors;
 - (7) the volume of fluorinated heat transfer fluids purchased;
 - (8) whether the heat transfer fluid was added to an existing cooling system, used to fill a new system, or both;
 - (9) the volume of heat transfer fluid added to an existing cooling system or used to fill a new system;
 - (10) the specific brand name of the heat transfer fluid used; and
 - (11) a certification statement from the owner or operator that the information provided is true, accurate and complete.
- (c) The owner or operator of a semiconductor operation shall report emission control equipment breakdowns, malfunctions, and failures in accordance with the permitting agency's requirements.
- (d) The owner or operator of a semiconductor operation that emits less than 0.0008 MMT CO₂e per calendar year is not subject to the reporting requirements in section 95324(b)(3) and (b)(4).

§ 95325 Record Keeping Requirements

(a) Purchase and delivery records

The owner or operator of a semiconductor operation must maintain monthly records that clearly document all purchased quantities and delivered dates, of the fluorinated gases and fluorinated heat transfer fluids as defined in section 95322. All records required by this subsection (a) must be readily accessible on site for inspection and review by the permitting agency or the Air Resources Board at the semiconductor operation for at least three calendar years. If so requested by the permitting agency or the Air Resources Board, the owner or operator must provide copies of the records to the permitting agency or the Air Resources Board.

(b) Emission control equipment malfunctions and failures

The owner or operator of a semiconductor operation must maintain monthly records of the occurrence, date of occurrence, duration, cause (if known), and

action taken for each equipment malfunction and/or failure. All records must be maintained for at least three calendar years.

§ 95326 Severability

Each part of this section is deemed severable, and in the event that any part of this section is held to be invalid, the remainder of this section shall continue in full force and effect.