

## **FINAL REGULATION ORDER**

### **Regulation to Reduce Greenhouse Gas Emissions from Semiconductor Operations**

Adopt new Article 4, Subarticle 2, Semiconductors and Related Devices, sections 95320 to 95326, title 17, California Code of Regulations, to read as follows:

Note: All of the text below is new language to be added to the California Code of Regulations (CCR).

#### **Subchapter 10. Climate Change**

#### **Article 4. Regulation to Achieve Greenhouse Gas Emission Reductions**

#### **Subarticle 2. Semiconductors and Related Devices**

#### **Semiconductors and Related Devices**

#### **§ 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.).

Note: Authority cited: Sections 38501, 38510, 38560, 38560.5, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38501, 38505, 38510, 38550, 38551, 38560, 38560.5, 39600, and 39601, Health and Safety Code.

#### **§ 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 processing of diodes, zeners, stacks, rectifiers, integrated microcircuits, transistors, solar cells, light-sensing devices, and light-emitting devices.

Note: Authority cited: Sections 38501, 38510, 38560, 38560.5, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38501, 38505, 38510, 38550, 38551, 38560, 38560.5, 39600, and 39601, Health and Safety Code.

**§ 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 "CO<sub>2</sub>e" 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) "CO<sub>2</sub>e Emissions Limit" means the maximum allowable kilograms of CO<sub>2</sub>e emissions per square centimeter of wafers processed 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 another 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:
  - (A) hexafluoroethane (C<sub>2</sub>F<sub>6</sub>),
  - (B) octafluoropropane (C<sub>3</sub>F<sub>8</sub>),
  - (C) octafluorocyclopentene (C<sub>5</sub>F<sub>8</sub>),
  - (D) tetrafluoromethane (CF<sub>4</sub>),
  - (E) trifluoromethane (CHF<sub>3</sub>),
  - (F) difluoromethane (CH<sub>2</sub>F<sub>2</sub>),
  - (G) octafluorocyclobutane (c-C<sub>4</sub>F<sub>8</sub>),
  - (H) octafluorotetrahydrofuran (C<sub>4</sub>F<sub>8</sub>O),

- (I) hexafluoro-1,3-butadiene (C<sub>4</sub>F<sub>6</sub>),
- (J) carbon fluoride oxide (COF<sub>2</sub>),
- (K) nitrogen trifluoride (NF<sub>3</sub>), and
- (L) sulfur hexafluoride (SF<sub>6</sub>).

(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: 1996 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 an operation performed to process semiconductor devices or related solid state devices. It may include, but is not limited to, the processing 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.

Note: Authority cited: Sections 38501, 38510, 38560, 38560.5, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38501, 38505, 38510, 38550, 38551, 38560, 38560.5, 39600, and 39601, Health and Safety Code.

**§ 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. An operation that is replacing CVD or etching tools that process 150 millimeter diameter wafers with tools that process 200 millimeter diameter or larger wafers must comply with the Table 1 emission standards by January 1, 2014.

The Tier 1 emission standard shall apply to an owner or operator of a semiconductor operation that processes more than 37.7 million square centimeters of wafer surface area per calendar year. The Tier 1 emission standard shall also apply to the owner or operator of a semiconductor operation that begins operation after January 1, 2010.

(1) Emissions Calculation Method

An owner or operator must express fluorinated gas emissions in CO<sub>2</sub>e 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 1996 Second Assessment Report (SAR) provides the GWP values used to calculate fluorinated gas emissions, with the exception of NF<sub>3</sub> 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 CO<sub>2</sub> equivalent (MMT CO<sub>2</sub>e ) 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

GWP<sub>100</sub> = the GWP of the fluorinated gas

10<sup>9</sup> = the number of kilograms per million metric ton

For an operation emitting more than 0.0008 MMT CO<sub>2</sub>e per calendar year, total fluorinated gas emissions in MMT CO<sub>2</sub>e are converted to kilograms of

CO<sub>2</sub> equivalents per square centimeter (Kg CO<sub>2</sub>e/cm<sup>2</sup>) 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:

10<sup>9</sup> = the number of kilograms per million metric ton

π = 3.1416

r<sub>n</sub> = one half the diameter in millimeters of a given size wafer

n = diameter of a wafer in millimeters

Wf<sub>n</sub> = the number of wafers of a given size processed in the calendar year

100 = the number of square millimeters per square centimeter

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

<b>CVD Chamber Cleaning and Etching Processes</b>	
<b>Wafer Surface Area Processed</b> (Million Square Centimeters Per Calendar Year)	<b>Maximum Emissions Limit Per Square Centimeter for a Calendar Year</b> (Kg CO <sub>2</sub> e/cm <sup>2</sup> )
Tier 1: >37.7	0.2
Tier 2: >3.7 and ≤ 37.7	0.3
Tier 3: ≤3.7	0.5

- (b) The emission standards in Table 1 shall not apply to a semiconductor operation that emits 0.0008 million metric tons or less of CO<sub>2</sub>e per 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.
- (d) The owner or operator of a semiconductor operation that is installing equipment to meet the emission standards in Table 1 by January 1, 2014 pursuant to section 95323(a), must submit a permit application to the permitting agency no later than March 1, 2013.

Note: Authority cited: Sections 38501, 38510, 38560, 38560.5, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38501, 38505, 38510, 38550, 38551, 38560, 38560.5, 39600, and 39601, Health and Safety Code.

**§ 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 1<sup>st</sup> of each calendar year that quantifies CO<sub>2</sub>e 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:
  - (A) hexafluoroethane (C<sub>2</sub>F<sub>6</sub>),
  - (B) octafluoropropane (C<sub>3</sub>F<sub>8</sub>),
  - (C) octafluorocyclopentene (C<sub>5</sub>F<sub>8</sub>),
  - (D) tetrafluoromethane (CF<sub>4</sub>),
  - (E) trifluoromethane (CHF<sub>3</sub>),
  - (F) difluoromethane (CH<sub>2</sub>F<sub>2</sub>),
  - (G) octafluorocyclobutane (c-C<sub>4</sub>F<sub>8</sub>),
  - (H) octafluorotetrahydrofuran (C<sub>4</sub>F<sub>8</sub>O),
  - (I) hexafluoro-1,3-butadiene (C<sub>4</sub>F<sub>6</sub>),
  - (J) carbon fluoride oxide (COF<sub>2</sub>),
  - (K) nitrogen trifluoride (NF<sub>3</sub>), and
  - (L) sulfur hexafluoride (SF<sub>6</sub>).
- (3) the monthly and annual square centimeters of wafers processed;
- (4) the use of process optimization, alternative chemistries, or equipment to reduce fluorinated gas emissions and estimated emissions reductions in CO<sub>2</sub>e per square centimeter of wafer processed;
- (5) monthly and annual CO<sub>2</sub>e emissions determined in accordance with section 95323 (a)(1);

- (6) the volume of fluorinated heat transfer fluids used in the processing 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 0.0008 MMT or less of CO<sub>2</sub>e per calendar year is not subject to the reporting requirements in section 95324(b)(3) and (b)(4) and may provide annual data in lieu of monthly data in the emission reports.

Note: Authority cited: Sections 38501, 38510, 38560, 38560.5, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38501, 38505, 38510, 38550, 38551, 38560, 38560.5, 39600, and 39601, Health and Safety Code.

**§ 95325. Recordkeeping Requirements.**

(a) Purchase or delivery records

The owner or operator of a semiconductor operation must maintain monthly records that clearly document all purchased quantities 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. The owner or operator of a semiconductor operation that emits 0.0008 MMT or less of CO<sub>2</sub>e per calendar year may keep annual in lieu of monthly records.

(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.

Note: Authority cited: Sections 38501, 38510, 38560, 38560.5, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38501, 38505, 38510, 38550, 38551, 38560, 38560.5, 39600, and 39601, Health and Safety Code.

**§ 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.

Note: Authority cited: Sections 38501, 38510, 38560, 38560.5, 38580, 39600, and 39601, Health and Safety Code. Reference: Sections 38501, 38505, 38510, 38550, 38551, 38560, 38560.5, 39600, and 39601, Health and Safety Code.