

Air Pollution Control and Emissions Standards for the Semiconductor Industry

Ten articles promulgated by Environmental Protection Administration Order (87) Huan-Shu-Kung-Tzu No. 0087593 on January 6, 1999.

Revisions to Articles 1 and 8 promulgated by Environmental Protection Administration Order (88) Huan-Shu-Kung-Tzu No. 0019418 on April 7, 1999.

Revisions to Article 1 promulgated in Environmental Protection Administration Order Huan-Shu-Kung-Tzu No. 0910069403J on October 16, 2002.

Article 1

These Standards are determined pursuant to Article 20, Paragraph 2, Article 22, Paragraph 2, and Article 23, Paragraph 2 of the Air Pollution Control Act.

Article 2

Terms and symbols used in these Standards are defined as follows:

- I. "Semiconductor manufacturing industry" means operators engaging in the integrated circuit wafer manufacture, wafer packaging, wafer packaging, epitaxy, mask manufacturing, and wire guide manufacturing.
- II. "Integrated circuit wafer fabrication" means the operations to produce wafers of various specifications intended for various uses, and includes physical vapor deposition, chemical vapor deposition, photoresist, photolithography, etching, diffusion, ion implantation, oxidation, and heat treatment processes.
- III. "Integrated circuit wafer packaging" means the operations to produce various semiconductor products from completed wafers intended for various uses, and includes cutting into dice, followed by welding, electroplating, organic solvent washing, and acid washing processes.
- IV. "Photoresist" means the acid-resistant photosensitizer required during the selective etching process in the manufacture of integrated circuit wafers.
- V. "Photoresist process" means the process in which wafers undergo photoresist application, exposure, and developing in order to produce various types of circuits.
- VI. "Volatile Organic Compounds (VOCs)" means the general designation for air pollutants containing organic compounds. However, this shall not include such compounds as methane, carbon monoxide, carbon dioxide, carbonic acid, carbides, carbonates, or ammonium carbonate.
- VII. "Closed vent system" means a system in which air pollutants produced by process equipment are effectively trapped and sent to pollution control equipment, so that the conveyed gases are in indirect contact with the atmosphere. Such a system shall include piping and connecting devices.
- VIII. "Pollution control equipment" means equipment used to treat exhaust gas, and includes sealed incineration facilities such as thermal incinerators, catalytic incinerators, boilers, and thermal furnaces, condensers, adsorption devices, absorption towers, exhaust gas combustion towers, biological treatment facilities, and other equipment approved by the central competent authority.
- IX. "Total plant emission quantity" refers to the sum of all individual air pollutants discharged from all discharge pipes within the peripheral boundaries of the same plant; measured in units of kg/hr.
- X. The following formulas are used to calculate the reduction quantities and emission reduction rates of pollution control equipment:

Pollution control equipment reduction quantity = $E - E_o$; measured in units of kg/hr.

Emission reduction rate = $((E - E_o) / E) \times 100\%$; measured in units of kg/hr.

I. E : flow rate of gaseous pollutants entering the front of the pollution control equipment via the closed vent system, in units of kg/hr.

II. E_o (emission quantity): flow rate of gaseous air pollutants discharged directly into the atmosphere from the back of pollution control equipment, in units of kg/hr.

XI. “Wetting factor” means the washing cycle water quantity / (specific surface area of the packing × horizontal cross section of the packing) in units of m^2/hr .

XII. “Washing cycle water volume” means the volume flow of washing water passing through the packing within wet washing equipment; measured in units of m^3/hr .

XIII. “Specific surface area of the packing” means the gas-liquid contact area provided per unit volume of the packing in wet washing equipment; measured in units of m^2/m^3 .

XIV. “Horizontal cross section of the washing tower packing section” means the horizontal cross-section area of the packing filling wet washing equipment; measured in units of m^2 .

XV. “Flow meter” means any equipment that can directly or indirectly measure the emission volume flow of exhaust gas.

XVI. “Effective quarterly monitoring rate” means (operating hours of pollution sources during quarter – number of hours continuous automatic monitoring) / (total hours in quarter).

Article 3

These Standards shall apply to the semiconductor manufacturing industry. However, the substance in question shall not be subject to these Standards when annual consumption of raw materials is less than the amount listed in the following table:

Raw material	Annual consumption
VOCs	1,700 kg/year
Trichloroethylene	60 kg/year
Nitric acid	1,700 kg/year
Sulfuric acid	300 kg/year
Hydrochloric acid	1,700 kg/year
Phosphoric acid	1,700 kg/year
Hydrofluoric acid	1,200 kg/year

Article 4

Air pollutants emitted by a semiconductor manufacturing firm shall be conveyed to pollution control equipment via a closed vent system, and shall be treated before discharge to the extent that they comply with the regulations in the following table.

Air pollutant	Emissions Standards
VOCs	The discharge reduction rate shall exceed 90% or the total plant emission quantity shall be less than 0.6 kg/hr (taking methane as a basis for calculation).

Air pollutant	Emissions Standards
Trichloroethylene	The discharge reduction rate shall exceed 90% or the total plant emission quantity shall be less than 0.02 kg/hr.
Nitric acid, hydrochloric acid, phosphoric acid, and hydrofluoric acid	The pollution emissions reduction rate for each pollutant shall exceed 95% or total plant emission quantity of each pollutant shall be less than 0.6 kg/hr.
Sulfuric acid	The discharge reduction rate shall exceed 90% or the total plant emission quantity shall be less than 0.1 kg/hr.

If exhaust gases including nitric acid, hydrochloric acid, phosphoric acid, hydrofluoric acid, and sulfuric acid are treated using wet washing equipment, control conditions shall comply with the following regulations when it cannot be proved that the standards in the foregoing paragraph are met:

- I. Equipment washing cycle tank pH shall exceed 7, the wetting factor shall exceed $0.1 \text{ m}^2/\text{hr}$, empty tower packing section residence time shall exceed 0.5 seconds, and the specific surface area of the packing shall exceed $90 \text{ m}^2/\text{m}^3$.
- II. An application may be made to the central competent authority for approval of control conditions that can be proved to yield an equivalent or better treatment effect.

Article 5

Flow meters and continuous automatic air pollutant concentration monitoring devices, in accordance with the foregoing article, shall be installed as prescribed below when exhaust gas is collected for treatment in pollution control equipment:

- I. Flow meters shall be installed at the exhaust gas inlets or outlets of pollution control equipment.
- II. Concentration monitoring device shall be installed at the exhaust gas outlets of VOC control equipment in plants where annual VOC consumption exceeds 50 tons.
- III. When the total plant emission quantity of VOCs is greater or equal to 0.6 kg/hr, concentration monitoring devices shall be installed at the exhaust gas inlets and outlets of VOC control equipment.
- IV. The effective quarterly monitoring rate of flow meters and concentration monitoring devices shall exceed 80%. Comparative testing of flow meters and concentration monitoring devices shall be performed using standard testing methods at least once each year; comparative testing shall last for at least two hours on each occasion. Results obtained from flow meters and concentration monitoring devices shall be corrected on the basis of the most recent comparative testing results.

When flow meters and pollutant concentration monitoring devices have not been installed as prescribed in the foregoing paragraph, the firm may submit an alternative monitoring program able to discharge pollutants verifiably complying with the regulations in the foregoing article to the central competent authority for approval.

Article 6

VOCs, trichloroethylene, nitric acid, sulfuric acid, hydrochloric acid, phosphoric acid, hydrofluoric acid records, their preservation, testing, and reporting regulations are as follows:

- I. Air pollutant input volume (volume added to processes as solvent or in other form), output volume (volume leaving processes with waste solvent, waste, wastewater, or in other form), and pollution control equipment reduction quantities shall be recorded on a monthly basis.
- II. When pollution control equipment constitutes an acid/alkali washing and absorption facility, service and maintenance matters shall be recorded to ensure that the wetting factor and empty tower packing section residence time comply with facility standards; washing cycle water volume

and pH value in each washing tank shall be recorded on a daily basis.

- III. When pollution control equipment constitutes a water washing and absorption facility, service and maintenance matters shall be recorded to ensure that the wetting factor and empty tower packing section residence time comply with facility standards; washing cycle water volume in each washing tank and wastewater discharge flow shall be recorded on a daily basis.
- IV. When pollution control equipment constitutes a condenser, condensate volume shall be recorded on a monthly basis and condenser outlet temperature shall be recorded on a daily basis.
- V. When pollution control equipment constitutes a biological treatment facility, service and maintenance matters shall be recorded to ensure that the state of the facility is suitable for biological growth and metabolism; volume of gas treated, inlet temperature, and outlet relative humidity shall be recorded on a daily basis.
- VI. When pollution control equipment constitutes a thermal incinerator, combustion temperature shall be recorded on a daily basis.
- VII. When pollution control equipment constitutes a catalytic incinerator, the type of catalyst and catalytic bed replacement date shall be recorded; the catalytic bed inlet and outlet gas temperatures shall be recorded on a daily basis.
- VIII. When exhaust gas is treated using other pollution control equipment, service and maintenance matters shall be recorded, and chief operating parameters recorded on a daily basis.
- IX. When VOC pollution control equipment lacks a concentration monitoring device, the removal rate or emission quantity shall be calculated on the basis of the average daily value of automatic monitoring results, corrected in accordance with the recent comparative testing results, and recorded on a daily basis.
- X. When VOC pollution control equipment lacks a concentration monitoring device, pre- and post-treatment concentrations and emission quantities shall be tested at least once each year. Process and treatment equipment operating conditions shall be recorded at the time of testing. Each test shall last at least eight hours. Test reports shall state measured concentrations, hourly average values and total average values; control equipment treatment efficiency and emissions quantities shall be calculated on the basis of the overall average value of measured concentration.
- XI. With regard to trichloroethylene pollution control equipment, pre- and post-treatment concentrations and emission quantities shall be tested at least once each year. Process and treatment equipment operating conditions shall be recorded at the time of testing. Each test shall last at least eight hours, and at least three samples shall be tested for each hour. Test reports shall state measured concentrations, hourly average values and total average values; control equipment treatment efficiency and emissions quantities shall be calculated on the basis of the overall average value of measured concentration.
- XII. The usage, operating, and testing records in subparagraphs 1-11 shall be preserved at least two years. Records for the previous quarter shall be submitted to the local competent authority in the format prescribed by the central competent authority by the end of each January, April, July, and October. The competent authority may adjust report content and frequency at appropriate times.

Article 7

Air pollutant testing methods shall be based on the standard testing methods announced by the central competent authority.

Article 8

Semiconductor manufacturing firms established prior to January 6, 1999 shall submit pollution control plans to the central and local competent authorities in the format prescribed by the central competent authority by April 7, 1999, and shall comply with the regulations of Articles 4, 5, and 6 of these Standards starting from July 1, 2000.

Article 9

For matters not provided in these Standards, other relevant regulations shall apply.

Article 10

These Standards shall take effect from the date of promulgation.