

SEMI S4-92

SAFETY GUIDELINE FOR THE SEGREGATION/SEPARATION OF GAS CYLINDERS CONTAINED IN CABINETS

This Safety Guideline was technically approved by the Environmental Health & Safety Global Technical Committee. Available at www.semi.org in 1992.

NOTE 1: The configuration generally considered to be the best is one cylinder of process gas per gas cabinet. An inert gas may be in the same cabinet with a process gas.

1 Purpose

1.1 This Safety Guideline provides the method for determining which types of gas (in cylinders) should be maintained in separate gas cabinets and which types may be combined with other types. The guideline is designed to be used by those working or doing research in semiconductor-related technology, but the application is not limited to this field. The guideline also recommends a classification scheme which is consistent with that given by Federal OSHA in 29 CFR 1910.1200.

2 Scope

2.1 This Safety Guideline refers to gases; however, it also includes those materials stored in cylinders as liquids and used in gaseous form because of their vapor pressure, or because they may be transported as a vapor by a carrier gas. It also includes all sizes and types of cylinders. It does not include those special cases where cylinder gases are incorporated within a specific piece of process equipment as a part of the equipment, such as lecture bottles. The primary intent of the guideline is directed to a cylinder gas in use in, or being dispensed in, the manufacturing process. Mixtures of two or more gases should be considered to have the hazardous properties of their individual components. If the dilution of the hazardous component removes the hazard, the mixture may then be classified according to its actual characteristics.

NOTICE: SEMI Standards and Safety Guidelines do not purport to address all safety issues associated with their use. It is the responsibility of the users of the Documents to establish appropriate safety and health practices, and determine the applicability of regulatory or other limitations prior to use.

3 Referenced Documents

- 3.1 29 CFR 1910.1200 — Published by The Office of the Federal Register, Washington, D.C. 20037.
- 3.2 49 CFR 172.101 — Published by The Office of the Federal Register, Washington, D.C. 20037.
- 3.3 49 CFR 173 — Published by The Office of the Federal Register, Washington, D.C. 20037.
- 3.4 16 CFR 1500 — Published by The Office of the Federal Register, Washington, D.C. 20037.
- 3.5 Uniform Fire Code — Published by International Conference of Building Officials and Western Fire Chiefs Association.
- 3.6 Identification of Fire Hazards of Materials — NFPA 704, National Fire Protection Association.
- 3.7 Hazardous Chemicals Data — NFPA 49, National Fire Protection Association.
- 3.8 BOCA National Fire Prevention Code — Published by Building Officials and Code Administration.
- 3.9 SBCCI Standard Fire Prevention Code — Published by Southern Building Code Conference International, Inc.
- 3.10 Matheson Gas Data Book — 6th Edition, 1988.
- 3.11 Gases for the Electronics Industry — 1988 Edition, Distributed by Union Carbide Corporation.

NOTICE: Unless otherwise indicated, all documents cited shall be the latest published versions.

4 Terminology

4.1 *cylinder* — pressure vessel designed for containing chemicals at a pressure higher than 276 kPa (40 psia) and having a circular cross section. It does not include a portable tank, multiunit tank car tank, cargo tank, or tank car.

4.2 *acid* — a corrosive material whose chemical reaction characteristic is that of an electron acceptor.

4.3 *base* — a corrosive material whose chemical reaction characteristic is that of an electron donor.

4.4 *corrosive* — a chemical that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the site of contact. A chemical is considered to be corrosive if, when tested on the intact skin of albino rabbits by the method described in the U. S. Department of Transportation in Appendix A to 49 CFR 173, it destroys or changes irreversibly the structure of the tissue at the site of contact following an exposure period of four hours. This term shall not refer to action on inanimate surfaces.

4.5 *flammable gas* — a gas which is flammable in a mixture of 13% or less (by volume) with air, or the flammable range with air is wider than 12% regardless of the lower limits.

NOTE 2: Certain gases which meet the above criteria may be labeled as nonflammable by the Department of Transportation in 49 CFR 172.101. Ammonia, for example, is not flammable at less than 13%; however, the *Matheson Gas Data Book*, 6th Edition and the Union Carbide catalog, *Gases for the Electronics Industry*, 1988 Edition lists its flammable range as 15% to 28%, giving it a 13% range (wider than 12%).

4.6 *gas cabinet* — a metal enclosure which is intended to provide local exhaust ventilation, protection for the gas cylinder from fire from without the cabinet, and protection for the surroundings from fire from within.

4.7 *gas* — materials [which] are shipped in compressed gas cylinders, or act as a gas upon release at normal temperatures and pressure, or are used or handled as a gas, whether or not in strict accordance with the definition of a compressed gas as set forth in Article 9 of the Uniform Fire Code.

4.8 *hazardous production materials (HPM)* — a solid, liquid, or gas that has a degree of hazard rating in health, flammability, or reactivity of Class 3 or 4 as ranked by NFPA 704 and which is used directly in research, laboratory, or production processes which have as their end product materials which are not hazardous. (Uniform Fire Code, Section 51.102)

4.9 *inert gas* — a gas which at ambient conditions does not react chemically with other materials.

4.10 *oxidizer gas* — a gas which will support combustion or increase the burning rate of a combustible material with which it may come in contact.

4.11 *pyrophoric gas* — a gas which upon contact with air will ignite spontaneously at or below a temperature of 54°C (130°F).

4.12 *separation of gases* — the National Fire Codes use the terms, ‘separated,’ ‘segregated,’ and ‘isolated’ when referring to storage of hazardous materials. Separation as defined by NFPA 49 is “storage within the same fire area, but separated by as much space as practical, or by intervening storage from incompatible materials.” Segregated storage is generally defined by NFPA Standards as “storage in the same room, but physically separated by space or barrier from incompatible materials.” Isolation is defined by NFPA 49 as “storage away from incompatible materials in a different storage room or in a separate and detached building located at a safe distance.”

NOTE 3: For the purposes of this Document, the terms ‘separation’ and ‘segregation’ will both be understood to have the meaning “being kept in different gas cabinets.”

4.13 *toxic gas* — a chemical that has a median lethal concentration (LC_{50}) in air of more than 200 parts per million but not more than 2,000 parts per million by volume of gas or vapor, or more than 20 milligrams per liter of mist, fume, or dust, when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.

4.14 *highly toxic gas* — a chemical that has a median lethal concentration (LC_{50}) in air of 200 parts per million by volume or less of gas or vapor, or 2 milligrams per liter or less of mist, fume, or dust, when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.

4.15 *irritant* — a chemical, which is not corrosive, but which causes a reversible inflammatory effect on living tissue by chemical action at the site of the contact. A chemical skin irritant if, when tested on the intact skin of albino rabbits by the method of 16 CFR 1500.41 for four hours exposure or by other appropriate techniques, it results in an empirical score of five or more. A chemical is an eye irritant, if so determined under the procedure listed in 16 CFR 1500.42 or other appropriate techniques.

4.16 *water reactive* — a chemical that reacts with water to release a gas that is either flammable or presents a health hazard.

4.17 *unstable (reactive)* — a chemical which in the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shocks, pressure, or temperature.

4.18 *other health hazard* — (Those items in this section that are not listed elsewhere are included here.) A chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term ‘health hazard’ includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic system, and agents which damage the lungs, skin, eyes, or mucous membranes.

4.19 *carcinogen* — a chemical is considered to be a carcinogen if:

1. it has been evaluated by the International Agency for Research on Cancer (IARC), and found to be a carcinogen or potential carcinogen; or
2. it is listed as a carcinogen or potential carcinogen in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition); or
3. it is regulated by OSHA as a carcinogen.

5 Requirements

5.1 The requirements for the segregation/separation of gases are found in the Uniform Fire Code, BOCA National Fire Prevention Code, and SBCCI Standard Fire Prevention Code. The thrust of these requirements is summed up in the following excerpts from the Uniform Fire Code:

“Separate cabinets shall be provided for each class of hazardous materials. Flammables, acids, bases, oxidizers, toxics, and other incompatible materials shall not be stored within the same cabinet. Inert materials may be intermingled with other materials.”

“Separation requirements within storage rooms. Flammables, corrosives, oxidizers, water-reactive solids, and liquids within a storage room shall be separated from each other in accordance with Table No. 51-110-A of the Uniform Fire Code. Table No. 51-110-A provides the requirements if distance is to be the method of segregation/separation.”

The code further states “HPM gas shall be separated from HPM liquids and solids by at least a one-hour fire-resistive occupancy separation.”

5.1.1 It should be noted that the code recognizes gas cabinets as the first method of segregation/separation.

5.2 Gases should be classified according to the following categories and assigned a symbol as shown:

<i>Classification</i>	<i>Symbol</i>
Flammable	F
Pyrophoric	P
Corrosive Acid	CA
Corrosive Base	CB
Toxic or Highly Toxic	T or HT
Oxidizer	O
Inert	I
Irritant	IRR
Water Reactive	WR
Unstable (Reactive)	UR
Other Health Hazard (Target Organic Toxics)	OHH
Carcinogen	CAR