

SEMI S5-93

SAFETY GUIDELINE FOR FLOW LIMITING DEVICES

This Safety Guideline was technically approved by the Environmental Health & Safety Global Technical Committee. Available at www.semi.org in 1993.

1 Purpose

1.1 This Safety Guideline is intended to suggest a method to limit the rate of release of hazardous gases from the gas cylinder valve during transportation, storage, and use.

2 Scope

2.1 This Safety Guideline covers flow limiting devices for valves on cylinders containing hazardous gases. It covers uncontrolled releases of gases at or downstream of the valve outlet. It does not cover gas releases caused by failure of the cylinder, the valve connection to the cylinder, actuation of the cylinder pressure relief device, or failure of the valve.

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 Safety Warnings

3.1 *Installation* — Only the cylinder owner should install, remove, or otherwise service the flow limiting device. Special equipment and procedures may be required to perform any installation or service operation safely. No other person should install, remove, replace, clean, adjust, or otherwise alter the flow limiting device unless authorized by the cylinder owner.

3.2 *Purging* — The addition of a flow limiting device in the cylinder valve may restrict gas flow during purging. The purchaser must assure that adequate purging methods are used to prevent plugging the flow limiting device.

NOTE 1: The user should purge the valve after use with the same procedure used in the initial purge of the cylinder. This is important to prevent contamination of the valve and reduce the probability of creating a hazard at the cylinder supplier's plant.

4 Referenced Standards and Documents

4.1 NFPA Documents¹

NFPA 49 — Hazardous Chemicals Data

NFPA 704 — Standard System for the Identification of Fire Hazards of Materials

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

5 Terminology

5.1 *Design Flow Rate* — The maximum flow rate exiting a gas cylinder valve when the valve is in a fully open position. All flow rates are given in standard liters per minute (slpm).

5.2 *Hazardous Gases* — Gases supplied in cylinders which are listed in NFPA 49 with a degree of hazard rating 3 or 4 in Health, Flammability, or Reactivity, or which would be so rated by experienced, technically competent persons when evaluated in accordance with the criteria set forth in NFPA 704.

5.3 *Flow Limiting Device* — A device installed in a valve that is designed to reduce the maximum flow from the valve under full flow conditions.

¹ National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02269, USA; Telephone: +1.617.770.3000, Fax: +1.617.770.0700, <http://www.nfpa.org>

6 Flow Limiting Device Requirements

6.1 The valves used for gas cylinders containing the hazardous gases listed in Table 3 should be supplied with flow limiting devices. Table 3 lists those hazardous gases for which flow limiting devices can now be applied by reason of testing and experience. Annually, SEMI will consider modifying Table 3 as new information becomes available. SEMI will encourage testing by its members of hazardous gases not listed in Table 3.

6.2 The flow limiting device should be installed by the gas supplier or cylinder owner.

6.3 The flow limiting device will not allow equivalent air flows out of the valve outlet to exceed the design flow rates listed in Table 1, but will allow flow within the range indicated. The choice of design flow rate A, B, or C will be made by the purchaser.

The design flow rates in Table 1 are specified at 700 kiloPascals (kPa) (100 pounds per square inch gauge (psig)) of air. A purchaser should calculate, using the method specified in §§ 6.3.1 and 6.3.2, the flow rate of the gas being purchased at various pressure to determine the proper flow limiting device for her application. The choice of the flow limiting device should be the smallest rate which satisfies the process requirements. Table 4 gives minimum flow rates for the gases listed in Table 3 at 700 kPa discharging to atmospheric pressure.

6.3.1 Effect of Pressure

$$Q = \frac{(P_{init} + P_{atm}) \times Q_D}{(P_D + P_{atm})} \quad (1)$$

P_{init} = initial gauge pressure in the gas cylinder for which the flow rate is being calculated.

Q = maximum flow rate of the gas in slpm.

P_{atm} = standard atmospheric pressure (101 kPa or 14.7 psig) at sea level.

P_D = design final cylinder pressure for the cylinder (700 kPa or 100 psig).

Q_D = design flow rate.

EXAMPLE: What is the maximum flow rate of air through a 4.5 slpm flow limiting device at 7000 kPa (1015 psig)?

$$Q = \frac{7000 \text{ kPa} + 101 \text{ kPa}}{700 \text{ kPa} + 101 \text{ kPa}} \times 4.5 \text{ slpm} \\ = 40 \text{ slpm air}$$

NOTE 2: This formula is valid only for values of P_{init} and P_D greater than 101 kPa. Table 1 gives flow rates at 700 kPa. This formula corrects for pressure P .

6.3.2 Effect of Gas Specific Gravity

$$Q = \frac{Q_D}{\sqrt{\text{specific gravity}}} \quad (2)$$

Specific gravity of the gas is relative to air. In case of mixtures, the specific gravity of the gas mixture should be used.

EXAMPLE: What is the flow range for Silane at 700 kPa (100 psig) through a 'C' flow limiting device?

$$Q = \frac{Q_D}{\sqrt{1.114}} = \\ = \frac{6.0 \text{ slpm}}{1.055} \text{ to } \frac{8.0 \text{ slpm}}{1.055}$$

Therefore, Silane flow is 5.7 slpm to 7.6 slpm.

6.4 *Identification* — The preferred method of identifying the flow limiting devices or the valves, in the case of built-in devices, is by the letters A, B, or C as shown in Table 1. Other means of identification, requiring identification by