

SEMI S18-1102

ENVIRONMENTAL, HEALTH, AND SAFETY GUIDELINE FOR SILANE FAMILY GASES HANDLING

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NOTICE: Paragraphs entitled “NOTE” are not an official part of this document and are not intended to modify or supersede the official guideline. The task force has supplied them to clarify and to enhance usage of the guideline by equipment designers.

1 Purpose

1.1 This guideline is intended as a minimum set of safety and health criteria for silane family gases handling related to equipment and facilities used in semiconductor or Flat Panel Display (FPD) manufacturing.

2 Scope

2.1 Silane family gases which are described in this guideline are: monosilane (SiH_4), disilane (Si_2H_6), trisilane (Si_3H_8), dichlorosilane (SiH_2Cl_2) and trichlorosilane (SiHCl_3).

2.2 This guideline includes the following sections:

- Purpose
- Scope
- Limitations
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- Terminology
- General Principles
- Education and Training
- Leak Detection and Alarm Systems
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- Materials, Components, and Construction for Silane Family Gas Handling Equipment and Facilities
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- Equipment Using Silane Family Gases
- Exhaust Systems and Plumbing
- Exhaust Treatment Systems
- Related Documents

NOTICE: This safety guideline does not purport to address all of the safety issues associated with its use. It is the responsibility of the users of this safety guideline to establish appropriate safety and health practices and determine the applicability of regulatory or other limitations prior to use.

3 Limitations

3.1 This document is not intended to impart requirements on any party.

3.2 This document is not intended to apply to gas manufacturers or distribution companies.

4 Referenced Standards and Documents

4.1 SEMI Standards

SEMI F1 — Specification for Leak Integrity of High Purity Gas Piping Systems and Components

SEMI F3 — Guide for Welding Stainless Steel Tubing for Semiconductor Manufacturing Applications

SEMI F4 — Specification for Pneumatically Actuated Cylinder Valves

SEMI F5 — Guide for Gaseous Effluent Handling

SEMI F6 — Guide for Secondary Containment of Hazardous Gas Piping Systems

SEMI F13 — Guide for Gas Source Control Equipment

SEMI F14 — Guide for the Design of Gas Source Equipment Enclosures

SEMI F15 — Test Method for Enclosures Using Sulfur Hexafluoride Tracer Gas and Gas Chromatography

SEMI S1 — Safety Guideline for Equipment Safety Labels

SEMI S2 — Environmental, Health, and Safety Guideline for Semiconductor Manufacturing Equipment

SEMI S4 — Safety Guideline for the Segregation/Separation of Gas Cylinders Contained in Cabinets

SEMI S5 — Safety Guideline for Flow Limiting Devices

SEMI S6 — Safety Guideline for Ventilation

SEMI S10 — Safety Guideline for Risk Assessment

SEMI S13 — Safety Guideline for Operation and Maintenance Manuals Used with Semiconductor Manufacturing Equipment

SEMI S14 — Safety Guidelines for Fire Risk Assessment and Mitigation for Semiconductor Manufacturing Equipment

4.2 NFPA Standards¹

NFPA 13 — Installation of Sprinkler Systems

NFPA 70 — National Electrical Code

NFPA 318 — Standard for the Protection of Cleanrooms

4.3 Compressed Gas Association²

CGA P-20 — Standard for the Classification of Toxic Gas Mixtures

CGA P-23 — Standard for Categorizing Gas Mixtures Containing Flammable and Nonflammable Components

4.4 Other Documents

High Pressure Gas Safety Law³

The High Pressure Gas Safety Institute of Japan (KHK), Application Guide for the High Pressure Gas Safety Law⁴

Santa Clara County Toxic Gas Ordinance No. NS-517.44⁵

SSA Journal,⁶ — Volume 11 No. 4, Winter 1997

1 National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02269, USA. Telephone: 617.770.3000; Fax: 617.770.0700; <http://www.nfpa.org>

2 Compressed Gas Association, 1725 Jefferson Davis Highway, Suite 1004, Arlington, VA 22202-4102, USA

3 KHK, Sumitomo-Tranomon Bldg., 4-3-9 Toranomon, Minatoku, Tokyo 105-8447, Japan

4 KHK, Sumitomo-Tranomon Bldg., 4-3-9 Toranomon, Minatoku, Tokyo 105-8447, Japan

5 Santa Clara County TGO

4.5 US Code of Federal Regulations

Uniform Fire Code (UFC)⁷ — Sections 51, 79 and 80 — Semiconductor Facility-Specific Sections

29CFR 1910.1200,⁸ — “Hazard Communication” (OSHA)

NIOSH Pocket Guide — available online at <http://www.cdc.gov/niosh/topreq.html>

4.6 EU Directive

The Safety Sheets Directive 93/112 EEC

5 Terminology

5.1 Terminology defined in SEMI S2 should be referred to except if otherwise specified below.

5.2 Abbreviations and Acronyms

5.2.1 *ACGIH*[®] — American Conference of Governmental Industrial Hygienists. (ACGIH is a registered trademark of the American Conference of Governmental Industrial Hygienists.)

5.2.2 *ESOV* — Emergency Shut Off Valve

5.2.3 *IDLH* — Immediately Dangerous to Life and Health, concentration of airborne contaminants, normally expressed in parts per million or milligrams per cubic meter, which represents the maximum level from which one could escape within thirty minutes without any escape-impairing symptoms or irreversible health effects. This level is established by the National Institute of Occupational Safety and Health (NIOSH). [SEMI F6]

5.2.4 *MSDS* — Material Safety Data Sheet, a document that provides information on the properties of a chemical material in a format specified by a regulation such as OSHA 29 CFR 1910.1200, “Hazard Communication.”

5.2.5 *PTFE* — Poly Tetra Fluoro Ethylene

5.2.6 *SSCS* — silane safety control system. SSCSs are integrated systems of detection devices that, when monitored as a group, provide for an overall status of the safety of the hazardous gas handling system (e.g., pressure transducers linked to valve status monitors and valve cycle counting programs or excess-flow monitoring interlocked to shutdown the source).

5.2.7 *TLVs*[®] — Threshold Limit Values for chemical substances in the work environment adopted by ACGIH[®] (*TLV*[®] is a registered trademark of the American Conference of Governmental Industrial Hygienists.). [SEMI F6]

5.2.8 *TWA* — Time Weighted Average — As defined by the American Conference of Governmental Industrial Hygienists (ACGIH[®]). [SEMI F6]

5.2.9 *VMB* — Valve Manifold Box

5.3 Definitions

5.3.1 *abatement system* — a system used to modify the effluent from a process in order to make it safe to emit from the facility or to reduce emissions of hazardous materials to safe levels.

5.3.2 *authorized personnel* — those persons trained and capable of performing activities involving the risks associated with the defined tasks.

5.3.3 *carriage* — a hand cart for carrying one or two gas cylinders.

5.3.4 *chlorosilane* — dichlorosilane or trichlorosilane.

5.3.5 *controlled condition* — when related to silane family gases, a condition in which the gas is controlled within the confines of an approved piping system with controls that can determine if the safe parameters of the piping system have failed.

6 SSA Journal, SSA Journal Headquarters 1313 Dolly Madison Blvd. Suite402, McLean, VA 22101, USA

7 Uniform Fire Code, 5360 South Workman Mill Road, Whittier, CA 90601, USA

8 Occupational Safety and Health Administration U.S. Department of Labor; <http://www.osha.gov>

5.3.6 *exhaust treatment system* — a system similar to an abatement system, except it handles only the airborne emissions from a process in order to make them safe to emit or to reduce the levels of hazardous materials to safe emission levels.

5.3.7 *fail-safe* — designed so that a failure does not result in an increased risk. [SEMI S2]

5.3.8 *flammable gas* — any gas that forms an ignitable mixture in air at 20°C (68°F) and 101.3 kPa (14.7 psia). [SEMI S2]

5.3.9 *Flow Limiting Device* — a device installed in a valve that is designed to reduce the maximum flow from the valve under full flow conditions. [SEMI F5] [One such device is a Restricted Flow Orifice (RFO).]

5.3.10 *foolproof* — designed so that any single human error or misuse does not result in unacceptable risk.

5.3.11 *occupational exposure limits (OELs)* — Various terms are used to refer to OELs, such as permissible exposure levels, Threshold Limit Values[®], maximum acceptable concentrations, maximum exposure limits, and occupational exposure standards. When OELs are used to specify work-area criteria in this document, OELs are generally established on the basis of an eight hour workday. When OELs are used to specify criteria in this document for alarm or warning in non-occupational area, OELs established on shorter exposure basis may be used. However, the criteria used in determining OELs can differ among the various countries that have established values. Refer to the national bodies responsible for the establishment of OELs. (Threshold Limit Value is a registered trademark of the American Conference of Governmental Industrial Hygienists.)

5.3.12 *oxidizer gas* — a gas which will support combustion or increase the burning rate of a combustible material with which it may come in contact. [SEMI S4]

5.3.13 *pyrophoric gas* — a gas which upon contact with air will ignite spontaneously at or below a temperature of 54°C (130°F) at a pressure of 101.3kPa (14.7psia). [SEMI S4]

5.3.14 *safe shutdown condition* — a condition in which all hazardous energy sources are removed or suitably contained and hazardous production materials are removed or contained, unless this results in additional hazardous conditions.

5.3.15 *safe state* — a condition in which the equipment does not present any uncontrolled hazards to itself or to personnel. It does not allow hazardous production chemicals to flow. An acceptable safe state is determined by the designer of the equipment and is based on the hazards in the design.

5.3.16 *silane* — any of monosilane, disilane, or trisilane.

5.3.17 *unacceptable risks* — risks of a degree or type which are not acceptable to the person who approves a design or procedure.

5.3.18 *unsafe gas condition* — a condition in which the gas is not safely contained within the designed parameters of the equipment process, or which could lead to a gas emission or gas hazard.

6 General Principles

6.1 Since silane family gases have several hazardous properties, personnel should wear appropriate protective equipment when working with silane family gas sources.

6.1.1 Monosilane (SiH_4), disilane (Si_2H_6) and trisilane (Si_3H_8) are pyrophoric. If these gases are mixed with stronger oxidizing gases than air, combustion and explosion energies can radically increase.

6.1.2 Dichlorosilane (SiH_2Cl_2) is pyrophoric and trichlorosilane (SiHCl_3) is flammable. Dichlorosilane (SiH_2Cl_2) and trichlorosilane (SiHCl_3) are also corrosive gases. If these gases are mixed with moisture, corrosivity can radically increase and pyrophoric byproduct gases might also be produced.

NOTE 1: The most recent and best research on DCS puts the AIT (Auto Ignition Temperature) at $44^\circ\text{C} \pm 3^\circ\text{C}$, or about 111°F . It should be noted however, that unlike silane, DCS is not expected to autoignite in almost all ambient conditions where we would find it in use. For fire protection purposes it can be treated as a highly flammable gas.

6.2 *Risk Management Strategies* — Fundamental concepts of safety and accident prevention are:

6.2.1 An understanding of facilities, piping and equipment, from storage to gas abatement, is essential for safe handling of silane family gases in semiconductor or FPD manufacturing facilities.

6.2.2 The safety of facilities can be enhanced by implementation of designs for sources, piping and equipment that use devices with fail-safe, foolproof, self-diagnostic and predictive functions.

6.2.3 Safety systems should detect current safety status and generate notices that indicate conditions of elevated risk, through computer self-diagnosis and dedicated SSCS devices. If the SSCSs cannot confirm normal operation of assigned silane family gas handling system or unit, the silane family gas supply should automatically be shut off.

6.2.3.1 SSCSs can determine if a safe status has been achieved before proceeding to the next step in a silane family gas handling process.

6.2.3.2 SSCSs should be provided in distribution facilities, cylinder cabinets, process equipment, gas treatment systems, and the like.

6.2.4 Safe design depends on equipment designers' and facilities designers' understanding of silane family gas properties and hazards. Design methods for controlling these hazards require full integration of measures from all portions of the delivery and use systems.

NOTE 2: Information on silane family gases' hazards is available from various sources, including: regulations, MSDSs, Factory Mutual Loss Prevention Data Sheets, NFPA Standards, consensus Building Codes, and various research papers.

6.2.4.1 The supplier should complete, prior to use, a hazard identification and risk assessment [such as Process Hazard Analysis (PHA), Hazard and Operability Analysis (Haz-Op), Failure Mode Effects Analysis (FMEA)], for all silane family gas systems.

6.2.4.2 The results of the analysis should be reported using the SEMI S10 risk matrix.

6.2.5 *Minimization of Quantity* — The quantity of any silane family gas online and in use should be limited to the smallest amount necessary for effective production.

NOTE 3: Separation and setback considerations for silane family gas storage and dispensing areas must be in accordance with jurisdictional requirements.

6.2.6 Periodic accident prevention assessments should be performed to assist in minimizing incident frequency.

6.3 *Isolation (Lockout/Tagout)* — Isolation ("lock out/tag out") capability should be provided for all silane sources at all levels necessary to perform service or maintenance safely on silane family gas systems.

6.3.1 Energy isolation of all other energy sources (e.g., electrical, mechanical) should be performed, as appropriate, to provide safety for personnel working on energy systems associated with silane family gases.

NOTE 4: Maintenance on energized non-hazardous electrical systems may not be safe when a silane family gas is present in the system.

6.4 *Access Control*

6.4.1 Multiple level access control, to each point where any hazard may exist in a normal or failure state, should be provided for all silane family gas systems.

6.5 All personnel concerned in silane family gas handling should be trained for the jobs they are to perform and hazards to which they will be exposed. All such training should be formally documented and if regulations apply then the documentation should be in accordance with the regulations.

6.5.1 Audits of system status and equipment condition should be performed and documented on a periodic basis.

6.5.2 The operator or technician should be capable of checking the current status and any abnormal condition before beginning work on any system or sub-system.

6.5.3 *Evacuation and Purging*

6.5.3.1 When connecting silane family gas piping to equipment, the air in the piping should be purged out with inert gas such as nitrogen into a safe location to prevent reaction with silane family gases.

6.5.3.2 To enable purging without venting into unsafe locations, a purge port should be installed at locations where sealed systems require purging. Purge ports should have a stop valve and, if not connected to the purge gas, should be sealed with a cap or plug.

6.5.3.3 The user should introduce silane family gases only after purging oxidizing gases and other incompatible gases, materials or substances from the system.

6.5.3.4 Silane family gas systems should have procedures based on calculated minimum purge cycles, minimum purge-gas pressures, and necessary vacuum levels to insure the system has been adequately purged before being opened to atmosphere. Calculations are needed to define minimum number of cycles. Process purges typically far exceed this number of cycles, therefore testing is usually not necessary.

6.5.3.5 An adequate means should be provided to avoid a cross contamination of purge gases and the process gases by accidental backflow.

6.5.3.6 Separation of purge gas and silane family gases should not solely depend on check valves. A control valve, such as a pneumatic valve placed before or after the check valve, is preferred for isolating silane family gases from other gases during procedures that might allow reverse flow.

6.5.4 The purge gas for silane family gases should be supplied from dedicated source containers.

NOTE 5: Some regional codes (e.g., Japan's High Pressure Gas Safety Law) require a purge gas source which is totally separated from the purge gas source for oxidizer gas lines.

6.5.4.1 Purge lines from dedicated bulk supplies (where allowed at all by the jurisdiction) should have multi-level back-flow and pressure differential protection to prevent potential back-flow of pyrophoric gases into bulk systems.

NOTE 6: Back-flow into these bulk purge systems has been known to generate ignitable mixtures when the inert gas is exposed to atmosphere far from the source of contamination.

7 Education and Training

NOTE 7: It is important for managers as well as employees to deepen their understanding of the characteristics of gases that they handle, so as to ensure safe work practices. If employees do not handle gases, this section is not applied.

7.1 Everyone who handles silane family gases should be specially educated about the hazardous properties and safe handling methods of these gases.

NOTE 8: Some jurisdictions (such as Japan) require that users of "specialty high-pressure gases" provide special safety education to their employees.

7.1.1 In regard to safety education and training, each organization should create the curricula or obtain approved curricula for education and training, assign a person responsible for education and training, and implement a periodic training plan.

7.1.2 Instructors should be persons who have sufficient knowledge and experience about the hazards, use and safe control of silane family gases.

NOTE 9: It may be necessary to request the assistance of outside experts, depending on an organization's capabilities.

7.1.3 Training should include safe use, handling, hazardous properties and by-products and emergency procedures of process gases as well as case studies of past accidents.

7.1.4 Training should be performed periodically and the training results documented.

7.2 Equipment and facilities suppliers, maintenance service providers and users should establish education curricula for job specific Environmental, Safety, and Health (ES&H) education programs, train their personnel, and keep records or issue certificates.

7.3 Maintenance personnel should be fully trained in their own areas of responsibility.

7.3.1 Maintenance personnel should understand the overall design of facilities and equipment for silane family gases.

7.3.2 Energy isolation ("lock out/tag out") training should be provided to all employees who are expected to perform service or maintenance on silane family gas systems.

7.4 Training curricula, should be requested from the responsible party (constructor, facility manager, or equipment manufacturer) as part of the purchase specifications.

7.4.1 Each party should have qualified persons to train personnel working in their facility.

NOTE 10: It may be necessary to request the assistance of outside experts to perform training, depending on an organization's capabilities.

NOTE 11: Responsible persons for each party must be trained as required by regulation.

7.5 Training of persons performing periodic inspections should be provided to ensure the inspections are performed and documented properly.

NOTE 12: Ideally, information on safe design practices and accident investigation summaries should be freely shared across the industry, so the information can be provided, as part of education and training, to all personnel who could potentially be exposed.

8 Leak Detection and Alarm Systems

8.1 General

8.1.1 Audible and visual alarms should be provided at a location where they can be seen and heard by workers.

8.1.2 Remote audible and visual alarms should be provided at a constantly attended location so that appropriate actions can be taken.

8.2 Silane Family Gas Leak Detection Practice

8.2.1 Leak can be detected directly with leak sensors (gas detectors) or indirectly with heat or fire detectors.

NOTE 13: Sensor types include electrochemical, chemically treated tape, chemiluminescence, ionization detection, and UV/IR.

8.2.1.1 Gas detection should be capable of detecting the silane family gas down to a level at least one-half of the TLV[®] level.

8.2.1.2 Ultraviolet/Infrared (UV/IR) detectors may be allowed in some jurisdictions.

8.2.1.3 If UV/IR detection is used, it should be designed to focus its detection beam across all areas within the silane family gas exhausted enclosure where leaks may occur.

8.2.1.3.1 UV/IR detection may be able to detect the heat signature at levels lower than detectable limits for gas detectors in some situations.

8.3 Leak Detection Installation

8.3.1 The location of detection points should be determined by considering airflow patterns, specific gravity of the gas, surrounding conditions or barriers, and equipment height.

8.3.2 A leak detection system should be installed with detection points at intervals appropriate to the detection technology, or as required by regulation, for exhaust ducts or cylinder storage.

8.3.3 Leak detectors should also be placed:

- in gas cabinets at locations that will detect leaks from the piping system or the cylinder,
- in gas manifold boxes for silane family gas distribution systems, and
- to detect leaks within equipment gas boxes for equipment using silane family gases.

8.3.4 Leak detectors should be provided or specified for locations where potential exposure is anticipated during maintenance or service, when the normal detection points might not detect a release.

8.3.5 The number and location of detection points should be determined from detector capabilities, and the area (or volume) to be monitored by each detector.

NOTE 14: A detection point is a collection opening for a suction type gas leak detection system or a detector for a diffusion-type gas-leak detection system.

8.3.5.1 The coverage should be tested after installation to verify performance.

8.4 *Leak Detection Systems Characteristics*

8.4.1 Leak detection systems should be fail safe.

8.4.2 Effective detection that can generate warnings and alarms when a given concentration of gas is detected.

8.4.3 Warnings, which may not activate the audible and visual alarms, should be generated at a concentration level equal to or below OEL or as specified in an applicable regulation of the country of use. Alarms, which do activate notifications and audible and visual alarms, should be activated at OEL concentration level. If the OEL value is not available for a silane family gas, or if the value is impractical for the system, the lowest detectable concentration technically practical or the concentration set by an applicable regulation should be used.

8.4.4 The system should be capable of detecting the target gas beginning at a level at least $\frac{1}{2}$ of the OEL, and continuing to at least $\frac{1}{2}$ IDLH (Immediately Dangerous to Life and Health) levels.

8.4.5 A 10% voltage variation should not produce more than a 30% change in the indicated concentration.

8.4.6 Detection should be capable of detecting a release, within one minute of exposure of the detection point, to a leak, which has a concentration above the concentration of the warning or alarm level.

8.4.7 The alarm should continue, even if the concentration varies after detection, until it is manually reset.

8.4.8 Activation of the leak detection system in a gas cabinet should close the automatic cylinder shut off valve referenced in Section 14.3.5.

8.5 *Maintenance*

8.5.1 Gas leak detection and alarm systems should be periodically inspected and maintained following the procedures provided by the gas detection system manufacturer.

8.5.1.1 Inspection and maintenance should be recorded.

8.5.2 The system should be calibrated at intervals specified by the detection system manufacturer.

8.5.3 Calibration should be performed frequently enough to meet the accuracy criteria.

8.6 The gas leak detection system should have back up power (e.g., UPS, emergency power, etc.) to maintain its function during short-term power interruption or be fail-safe. The back up power should be periodically tested or inspected and the test or inspection documented.

NOTE 15: The testing, the inspection, and the documentation must be in accordance with any applicable regulations.

8.7 There may be a need for gas detection in some exhaust treatment systems to detect breakthrough. See the Exhaust Treatment System section for details.

NOTE 16: Gas detector monitoring in ducts may be required by regulation or permits.

9 **Fire Detection, Suppression, and Alarm Systems**

9.1 Alarms should connect to the facility under the guidelines of SEMI S2.

9.2 Fire Detection and suppression system(s) where used should be operational at all times, including when equipment or facilities are shut down or in maintenance modes. See SEMI S14 for guidelines for determining whether such systems are appropriate and for designing them.

EXCEPTION 1: Maintenance of the fire detection system.

EXCEPTION 2: Activation of the fire detection system should not remove power from fire detection system and safety systems.

9.3 *Fire Detection and Suppression for Bulk Silane Systems*

9.3.1 An automatic fixed water spray system should be provided for any bulk silane system for purposes of cooling the system only.

9.3.1.1 The regulator station and control panel areas should also be protected by a water spray system for purposes of cooling the system only.

NOTE 17: Design density, area and duration should be calculated appropriate to the surface area of the container using a method such as the one provided in NFPA 318.

9.3.2 Activation of the optical flame detectors, manual activation, or heat-link activators should initiate the water spray system and should close emergency shutoff valves (ESOVs). ESOVs should be located directly on the source or on the piping, as close to the container as possible.

9.4 Fire Detection and Suppression

9.4.1 Fires within valve manifold boxes (VMBs) may impinge on other lines within the VMBs. If this is assessed as an unacceptable risk, there may be a need for fire protection.

9.4.2 When fire protection is installed, it should remain active during all conditions such as maintenance and service.

EXCEPTION: Maintenance of the fire protection system.

10 Emergency Response

10.1 Exhaust and abatement systems should be left running during any emergency event, including fire in the facility.

10.2 Evacuation of Personnel

10.2.1 Procedures for evacuation, as a result of a gas leak, should be developed based on a hazard analysis and should be appropriate to the level of hazard.

10.2.2 After an evacuation, no one should re-enter the area until the exposure risk has been reduced to an acceptable level.

10.2.3 All personnel in the facility should be trained regarding proper evacuation procedures.

10.3 Leak Identification and Isolation

10.3.1 If the appropriate method of achieving a safe situation is for a response team to enter, only authorized and trained response personnel may enter to locate and fix the leak.

10.3.2 If the leak location can be accurately determined, the specific source supplying silane family gases to the leak location should be automatically shut down.

10.3.3 If the leak location cannot be accurately determined, all of the systems supplying the area where the leak was detected should be shut down.

10.3.4 Do not enclose a silane installation where adequate exhaust flow can not remain during a leak. This could lead to an explosion.

10.4 Recovery from Leaks

10.4.1 Trained personnel should investigate the incident until the original or root cause is determined. Systems should not be restarted until the safety of the entire system is confirmed.

10.4.2 Sufficiently purge all affected systems with an inert gas.

10.4.3 Perform appropriate leak tests to confirm that the affected system is safe before allowing silane family gas back into the system.

10.4.4 Check the reliability of installed detectors. Change the detectors if necessary.

10.4.5 Confirm that the system (from the silane family gas, source systems to the gas abatement systems) is not damaged. Perform corrective actions if necessary.

10.5 Fire and Explosion

10.5.1 The only safe way to extinguish a gas fire is to shut off the source.

NOTE 18: Do not attempt to extinguish any gas fire except by shutting off the source. Many countries require fire extinguishers at gas storage areas, but these should be used for extinguishing things other than the gas, or for escape.