儲存與處置矽甲烷及矽甲烷混合氣

STORAGE AND HANDLING OF SILANE AND SILANE MIXTURES

(正體中文翻譯)
Traditional Chinese text version
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全球調和一致性文獻
GLOBALLY HARMONISED DOCUMENT

(Based on CGA G-13—2006)

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NOTE—Appendices A and B (Informative) are for information only.

NOTE—Appendices C and D (Normative) are requirements.

備註 — 附錄 A 及 B (資訊性質)為僅供參考。

備註 — 附錄 C 及 D (規範性質)為要求。

Contents **Page**

Tables

表格

Figures

圖表

Appendices

附錄

1 Introduction 前言

The use of the pyrophoric gas silane as a source of silicon has grown with its consumption by semiconductor manufacturers, producers of solar cells, and allied technologies. Systems once imagined to be rare are now commonplace and are in use worldwide. The hazards of this material are noteworthy due to the ability of the material to self-ignite with visible flame upon release, or in other cases to be released with either no ignition or delayed ignition. The material has been the subject of technical study by users and suppliers [1].[1] Studies conducted by the Compressed Gas Association (CGA) of the release of both large and small-scale quantities of silane have produced new technical data [2]. The data have been used to establish minimum separation distances for delivery system installations as well as for the storage of this material. Distance limitations are used to minimize risk to property and personnel in the event of an inadvertent release. The distances determined recognize the probability for immediate ignition as well as the probability of latent ignition with its potential explosive effects. Although the uncontrolled release of compressed gas is a cause for concern, it is the application of engineering and administrative controls to prevent the release of material that allows the users to handle this material at a reduced level of risk. Suppliers and users have contributed to the development of the controls presented in this standard as a means to provide reasonable safeguards for handling this unique material that is characterized by its chemical and physical nature.

CGA G-13 supersedes and replaces CGA P-32. The revision has taken into account the comments received from the American National Standards Institute (ANSI) canvass of CGA P-32. Comments received from users, producers, and regulatory officials were evaluated by CGA's technical committee and modifications were made to address technical issues and concerns raised in the evaluation process. There were a number of changes made to this edition to eliminate permissive language so the document can be used as a regulatory tool. Provisions that were in need of clarification have been edited to clarify the intent of the technical committee. There were several questions common to a number of those that reviewed the first edition during the ANSI review phase. A question was raised as to whether or not the standard applied to manufacturers as well as users. The scope section has been clarified to show that the standard applies universally to silane and silane systems regardless of the location in which they are found. A second concern was whether the standard applies to cylinder systems in lieu of "large scale" uses. It is intended that the standard applies to silane storage and use regardless of the size of the container with the exception of small containers of 0.5 standard cubic feet (scf) or less that are commonly found in laboratory operations.

使用自燃性氣體矽甲烷當作矽的來源因半導體製造、太陽能電池的生產及關聯技術的消耗而蓬勃發展，此系統一度被預測是少數的製程，現在則是相當普遍而且全世界都在使用。因為此物質釋放時自燃成可見的火焰或在某些情況下其釋放不是未點燃就是延遲點燃而使其危害更加值得注意，此物質已經被許多的使用者及供應商當成技術研究的主題[1][1]。經由壓縮氣體協會 (Compressed Gas Association, CGA) 所贊助的大、 小規模矽甲烷數量的釋放研究已經獲得許多新的技術數據[2]。此技術數據已用以建立此物質輸送系統安裝及儲存的最小分離距離，距離的限制用以在不小心洩漏事件中將財產的損失與人員的傷害降到最低的風險。距離之決定乃依據其立即點燃及延遲點燃潛在爆炸效應的或然率，雖然壓縮氣體的失控洩漏起因於疏忽，但其可應用於工程上與管理上的管制以避免此物質釋放，從而使使用者在操作此一物質時將風險降低到一定的程度。供應商與使用者自此獨特物質的物理特性與化學特性本質提供操作時之安全保護，已貢獻其管制的發展於此標準中。

CGA G-13 接替與取代 CGA P-32，此版本已經將美國國家標準局 (American National Standards Institute, ANSI) 對CGA P-32 審查所提出之意見納入其中。 來自使用者、 製造商及法令官員的意見已經在壓縮氣體 協會的技術委員會評估中，在評估過程中將適度的進行修改以將此些技術問題及提出的利害考量納入文件中。本版本做了許多的變更，將一些寬容的字眼消除，使其更能夠成為管理的工具。需要澄清的相關條款已經編輯完成並提出，以確認技術委員會的意圖。在美國國家標準組織審查本文件時，有許多的問題提出，其中一個問題是本標準是否應用於製造商與使用者，在範圍章節已經清楚敘述本標準廣泛的應用於矽甲烷與矽甲烷系統，不論他們所在的位置。另一個受關注的問題是本標準可否"大規模"的替代應用於鋼瓶系統，本標準的意圖就是不論其量多寡的應用於矽甲烷儲存及使用，但不大於0.5立方呎或常常在實驗室使用小於此大小的容器的系統則排除在外。

2 Scope and purpose 範圍與目的

2.1 Scope 範圍

This standard governs the installation of systems and sources that are used to store, transfer, or contain silane or silane mixtures. The scope of this standard includes guidance for siting, design of equipment, piping and controls, and the

[1] References are shown by bracketed numbers and are listed in order of appearance in the reference section.

fabrication and installation of silane gas storage and closed-use systems. Additional guidance on operational steps associated with the use of silane and silane mixtures as well as fire protection, gas monitoring, ventilation, and related safeguards are provided.

本標準規範使用於儲存、傳輸或包裝矽甲烷或矽甲烷混合氣系統之設置。本標準的範圍包含設備、管路及控制的設置、設計，以及矽甲烷氣體儲存與封閉使用系統的製造與安裝指導。其他相關矽甲烷與矽甲烷混合氣使用的操作步驟及火災防範，氣體監控，通風及相關的安全保護亦規範於文中。

2.1.1 Application

The requirements of the standard apply to pure silane and silane mixtures with a silane content greater than 1.37% [3]. A concentration of 1.37% has been chosen as it represents the lower flammable limit (LFL) for the material in air under conditions of normal temperature and pressure. Silane containers include tube trailers, ISO modules, cylinder packs with manifolded cylinders, and individual cylinders.

應用

本標準所規範的需求應用於純的矽甲烷及矽甲烷體積比濃度高於1.37%的矽甲烷混合氣[3]。選擇濃度1.37%乃因其爲此物質於常溫與常壓下於空氣中之燃燒下限 (LFL)。

矽甲烷容器包含管束拖車， ISO模組，具有鋼瓶銜接管路的鋼瓶集束及個別的鋼瓶。

2.1.2 Limitations

This standard is not intended to provide requirements beyond the first point of control within a user's facility where connections are made to piping systems associated with internal transmission and/or use of this material.

The following subjects are outside the scope of the standard:

- Equipment downstream of a gas cabinet with the exception of valve manifold boxes (VMBs) when VMBs are used;
- Off-site transportation of compressed gases regulated by the national government; and
- Requirements within the jurisdiction of national regulatory authorities with laws or regulations that preempt the provisions of this standard. When such is the case, it is recommended that the authority having jurisdiction be guided by this standard in determining requirements.

A full risk management program is comprised of a hazard assessment, a management system, a prevention program, and an emergency response program. Such programs and assessments must be developed on a case-by-case basis in response to the requirements of the relevant risk management programme at the respective country and the circumstances found at each individual company where silane is stored or used.

限制

本標準並不提供超過使用這物質於工廠內部傳輸系統管路，或使用的第一個控制點的要求。

下列主題不包含於本標準的範圍中：

[1] 於括弧中顯示的數值為參考文獻的編號，其順序為該文獻在本文中出現的順序。

- 氣瓶櫃 (Gas Cabinet) 及若使用額外的氣體供應分歧箱 (VMBs) 的設備下游；
- 由美國運輸部 (US Department of Transportation, DOT) 所規範的壓縮氣體廠外運輸規定；及
- 若本標準的規定條款與當地、州、省/地區、聯邦法規管理局法令或法規的要求有差異，建議有關當局以此標準為指引以決定最後之要求。

本標準並不意圖取代或滿足乾淨空氣準則 (CleanAir Act, CAA) 第112(r) 節風險管理方案 (Risk Management Program, RMP)
的強制要求項目。完整的風險管理方案包含危害評估、管理系統、防範措施及緊急應變計畫。此一計畫與評估必須針對每一件矽甲烷儲存或使用個案，依照風險管理方案的要求與各公司所發現的情況進行。

2.2 Purpose目的

The purpose of this standard is to prescribe the controls for the installation of silane systems and the recommended methods for storage or transfer of silane or its mixtures from a source of supply to a point of use to provide protection against injury, loss of life, and property damage.

本標準的目的在於指定矽甲烷系統安裝的控管及矽甲烷或其混合氣自氣源到使用點的儲存或傳輸的方法建議，以提供保護、避免人員受傷、死亡或財產損失。

2.3 Equivalency 等同

Nothing in this standard is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this standard. Systems, methods, or devices to be used as equivalents shall be supported by technical documentation that demonstrates equivalency. The use of equivalencies shall be subject to approval by the authority having jurisdiction.

本標準的規範並不企圖限制系統使用其他方法或等同的裝置或較高等級產品、強度、防火、有效性與耐久性的設備。使用等同的系統、方法或裝置必須有相當的技術文件說明其與規範的設置同一等級。使用等同的設置必須經由相關授權的單位核准。

3 Definitions 定義

For the purpose of this standard, the following definitions apply.

下列定義應用於本標準：

3.1 Barricade construction

Room, building, or enclosed structure of such type, size, and construction as to limit in a prescribed manner the effect of an explosion on nearby buildings or within the building in which an explosion occurs.

防護建設 (Barricade construction)

任何形式、大小所建造的工作空間、建築、或封閉結構，當爆炸發生用以限制鄰近建物或建物本身對爆炸的影響的建設。

3.2 Barrier, shield

Partition constructed of materials in such a manner so as to isolate the hazard from contact with personnel (see Appendix A for information on personnel protection).

NOTE—Barriers are designed with structural strength and arranged in such a way to resist physical forces.

屏障，擋板 (Barrier, shield)

用以區隔人員接觸危害的隔間建築材料 (見附錄A，人員保護資訊)

備註—屏障的設計結構強度及安排是以抵抗物理性力量爲基礎。

3.3 Burning velocity

Intrinsic property of burning gases or vapors expressed as the motion of the flame relative to the motion of the unburned gas.

燃燒速率 (Burning velocity)

燃燒氣體或蒸氣的本質特性，以火焰移動的速率與未燃燒氣體移動速率的比值表示。

3.4 Container

3.4.1 Cylinder

Pressure vessel designed for pressures higher than 40 psia (276 kPa) and having a circular cross section with an internal water volume not exceeding 16 ft^3 (450 L) or a water capacity of 1000 lb (454 kg).[2] It does not include a portable tank, multiunit tank car tank, cargo tank, highway tank, or tank car.

[2] kPa shall indicate gauge pressure unless otherwise noted as (kPa, abs) for absolute pressure or (kPa, differential) for differential pressure. All kPa values are rounded off per CGA P-11, *Metric Practice Guide for the Compressed Gas Industry* [4].

容器

鋼瓶 (Cylinder)

壓力容器具有圓柱形外觀、設計壓力高於40 psia (276 kPa)，其內部水容積不超過16 立方呎 (450 公升)
或裝水量1000 磅 (454 公斤).[2]
其不包括移動式儲槽、多單元之車載儲槽、航空或海運儲槽、公路運送儲槽或儲槽車。

[2] 除非有特別指定爲 (kPa, abs) 爲絕對壓力或(kPa, 差壓)爲不同壓力，kPa指的是錶壓力。所有 kPa 數值均依照 CGA P-11 *壓縮氣體工業公制數值實務指導 (Metric Practice Guide for the Compressed Gas Industrial)* 做捨去小數點以下位數[4]。

3.4.2 Cylinder pack

Arrangement of cylinders into a cluster where the cylinders are confined into a grouping or arrangement with a strapping or frame system and connections are made to a common manifold. The frame system is allowed to be on skids or wheels to permit movement.

NOTE—Six-packs and twelve-packs are terms used to further define cylinder packs with a specific number of cylinders involved. The characteristic internal water volume of individual cylinders in a cylinder pack ranges from 1.52 ft^3 to 1.76 ft^3 (43 L to 50 L) or a water capacity of 95 lb to 110 lb (43 kg to 50 kg).

鋼瓶集束 (Cylinder pack)

鋼瓶集合成一叢集固定於具外框之結構組架內，所有鋼瓶連接到一共同的歧管。此一結構可置於移動組架或安裝輪子供移動。

備註一六支組 (Six-packs) 及十二支組 (twelve-packs) 是用以進一步定義特定數量的鋼瓶組裝。
鋼瓶集束內的個別鋼瓶特定內部水容積爲1.52立方呎到1.76立方呎 (43公升到50公升) 或裝水量95磅到110磅 (43 公斤到 50 公斤)。

3.4.3 ISO module

Assembly of tubular cylinders permanently mounted in a frame conforming to International Organization for Standardization (ISO) requirements. The characteristic internal water volume of individual tubular cylinders is 43 ft^3 (1218 L) or a water capacity of 2686 lb (1218 kg). The frame of an ISO module and its corner castings are specially designed and dimensioned for use in multimodal transportation service on container ships, special highway chassis, and container-on-flatcar railroad equipment.

ISO模組 (ISO module)

依照國際標準組織 (International Organization for Standardization, ISO) 之規範將一定數量的管束永久 組裝於
固定框架中。 個別的管束內部水容積爲43立方呎 (1,218公升) 或裝水量1,688磅(1,218公斤)。
ISO模組的框架及其腳座特別規格設計，使其可用於多種集裝箱運輸設備，特別是公路的聯結拖板車及鐵路運輸之平板拖板台設備。

3.4.4 Mobile supply unit

Any silane supply source equipped with wheels so it is able to be moved. Examples include ISO modules, tube trailers, and cylinder packs.

移動式供應單元 (Mobile supply unit)

任何可安裝輪子供移動的矽甲烷供應氣源，包含ISO模組、管束拖車及鋼瓶集束。

3.4.5 Tube trailer

Truck or semi trailer on which a number of tubular cylinders have been mounted and manifolded into a common piping system. The characteristic internal water volume of individual tubular cylinders ranges from 43 ft^3 to 93 ft^3 (1218 L to 2633 L) or a water capacity of 2686 lb to 5803 lb (1218 kg to 2632 kg).

管束拖車 (Tube trailer)

一定數量的管束固定於卡車或半拖車並經由歧管連接到一共通的管路系統，其管束個別的內部水容積自43立方呎到93立方呎 (1,218 公升到 2,633 公升) 或裝水量2,686磅到5,803磅 (1,218 公斤到2,632公斤)。

3.5 Deflagration

Exothermic reaction, such as extremely rapid oxidation of a flammable dust or vapor in air, in which the reaction progresses through the unburned material at a rate less than the velocity of sound. A deflagration will have an explosive effect.

爆燃 (Deflagration)

放熱反應，如可燃性粉塵或蒸氣於空氣中極快速的氧化作用，其中未燃燒的物質反應進展速率低於音速，爆燃具有爆炸的效應。

3.6 Detonation

Exothermic reaction characterized by the pressure of a shock wave in material that establishes and maintains the reaction. The reaction zone progresses through the material at a rate greater than the velocity of sound. The principal heating mechanism is one of shock compression. A detonation will have an explosive effect.

爆震 (Detonation)

放熱反應，物質的震波壓力所導致和持續的反應。物質在該反應區的進展速率高於音速，主要的放熱反應機構為震波壓縮，爆震具爆炸的效應。

3.7 Exhausted enclosure

Appliance or piece of equipment that consists of a top, a back, and not more than two sides providing a means of local exhaust for capturing gases and vapors.

密閉排氣空間 (Exhausted enclosure)

裝置或設備的部分具有頂蓋，背牆及不超過兩側的氣體或蒸氣抽氣收集裝置。

3.8 Explosion control

Means to either prevent or mitigate the effects of an explosion. Deflagration venting, containment barricades, analogous construction, or other means including fuel reduction and oxidant reduction are used to protect buildings against the effects of an explosion.

爆炸控制 (Explosion control)

意指預防或移除爆炸的影響。如爆燃排放，圍堵圍籬，類似建築，或其他等同裝置或方法，包含使用降低燃料，及降低氧化性物質的材料以保護建物免於遭受爆炸影響。

3.9 Face seal fitting

Threaded joints in which the tightness of the joint is provided by a sealing surface other than the threads such as a union comprised of male and female ends joined with a threaded union nut or other construction.

NOTE—The sealing surface is typically a metal gasket when used in high purity applications.

面密合接頭 (Face seal fitting)

以螺牙銜接提供一緊度使兩接頭透過面接合而非如一直接頭單以螺牙密合，其包含母頭螺帽或其他組成與另一公頭互相銜接。

備註--當應用於高純度，典型使用金屬墊片當作密合介面。

3.10 Fire barrier

Fire-resistance rated vertical or horizontal assembly of materials designed to restrict the spread of fire in which openings are protected.

防火屏障 (Fire barrier)

防火材料以垂直或水平組合，設計於限制開放區域之火焰發散。

3.11 Fire partition

Vertical assembly of materials designed to restrict the spread of fire in which openings are protected.

防火隔間 (Fire partition)

垂直組裝的防火材料，設計於限制開放區域之火焰發散。

3.12 Flame speed

Extrinsic property of burning gases or vapors that describes the motion of the flame relative to a stationary reference.

火焰速度 (Flame speed)

燃燒氣體或蒸氣的限制特性，以火焰移動與固定物的比值表示。

3.13 Flammable limits

Minimum and maximum concentrations of flammable gas in a homogeneous mixture with air (or other oxidizing gas or gas mixture) that will propagate a flame when ignited.

燃燒界限 (Flammable limits)

易燃性氣體與空氣 (或其他氧化性氣體或氣體混合氣) 以均勻相混合，點火產生燃燒的最低及最高濃度。

3.14 Gas cabinet

Fully enclosed, noncombustible enclosure used to provide an isolated environment for compressed gas cylinders in storage or use. Doors and access ports for exchanging cylinders and accessing pressure-regulating controls are allowed to be included.

氣瓶櫃 (Gas cabinet)

完全密閉，非可燃包覆，用以提供壓縮氣體鋼瓶於儲存或使用的隔離環境，可包括更換鋼瓶使用的門及調整調壓閥使用的小窗。

3.15 Gas filling room

Separately ventilated, fully enclosed room used for cylinder filling operations in which only compressed gases and associated equipment and supplies are stored or used.

氣體充填室 (Gas filling room)

獨立排風，用以鋼瓶充填操作完全密閉的房間，其中僅有儲存或使用的壓縮氣體鋼瓶，相關的設備及操作人員。

3.16 House gas

Source of gas either originating at a bulk source or generated on site where the gas is used to supply multiple systems for uses across the site.

公用氣體 (House gas)

來自大宗供應或廠內直接生產的氣源，其用以供應整廠許多不同的系統。

3.17 Incompatible materials

Materials that when mixed have the potential to react in a manner that generates heat, fumes, gases, or byproducts that are hazardous to life or property.

不相容物質 (Incompatible materials)

不同的物質經混合後潛在反應產生熱，煙，氣體或副產品，此些產出物可危害人體健康或財產安全。

3.18 Instrument nomenclature

See Figure 1.

儀錶術語 (Instrument nomenclature)

見圖1。

3.19 Laminar burning velocity

Velocity at which a flame reaction front moves into the unburned medium as it chemically reacts to transform a fuel and oxidant mixture into combustion products. Burning velocity is only a fraction of the flame speed. The fundamental burning velocity is the burning velocity for laminar flame under stated conditions of composition, temperature, and pressure of the unburned gas. The combustion wave in a laminar stream of uniform velocity is said to occur under laminar conditions when every portion of the wave in the plane of combustion remains uniform.

線性燃燒速率 (Laminar burning velocity)

火焰前端移入未燃的媒介，經燃料與氧化性混合物化學性反應轉化為可燃產品的速率。燃燒速率僅是火焰速度的一個分率，基礎燃燒速率是線性火焰在特定的組成、溫度及未燃氣體之壓力的燃燒速率。線性流中的燃燒波具有相同的速率，亦即在線性條件下，燃燒波平面每一小段都具有相同的速率。

3.20 Location

位置 (Location)

3.20.1 Outdoor

Location that is either:

- outside the confines of a building; or
- one that is sheltered from the elements by overhead cover and is protected from weather exposure by not more than one exterior wall that obstructs not more than one side with the other sides unobstructed and open to the atmosphere.

室外 (Outdoor)

位置符合下列任一敘述

- 局限建築之外；或
- 一區域具有上方全遮蔽物，並具有不超過一側避免天候暴露的阻礙外牆，其他側為未阻礙並開放對大氣。

3.20.2 Indoor

Locations that do not meet the definition of outdoor shall be defined as being indoor locations.

室內 (Indoor)

位置不符合室外的定義者均歸類為室內。

3.21 Nitrogen, facility or house

Supply of nitrogen that is used for utilities and general purposes. It is usually industrial grade (99.998% pure) and supplied from an on-site air separation plant, liquid nitrogen tank, or other sources. It is piped to use points throughout the facility.

公用氮氣 (Nitrogen, facility or house)

用於公用或一般用途的氮氣供應，一般是工業等級 (99.998%純度)， 供應自現場空氣分離廠， 液態氮氣儲槽或其他氣源，其經全廠管路系統輸送至使用點。

Figure 1—Instrument nomenclature
圖 1 – 儀錶術語

3.22 Operations

操作

3.22.1 Operations, attended
Operations where an operator is physically present and responsible for the control of the operation or transfer process throughout the period of time where the operation occurs.

操作，生產 (Operations, attended)

當操作發生時，操作人員真實存在，在一定時間內負責操作控制或充填製程。

3.22.2 Operations, transfer
Operations where silane is transferred from one container to another for the purpose of filling, processing, evacuating, or otherwise preparing containers that are used to contain silane that will be delivered to an end user.

操作，轉充 (Operations, transfer)

將矽甲烷經轉充、製程、排空或其他容器整備，由一容器到另一目標容器的操作，此容器會被再運送到終端使用者
。

3.22.3 Operations, unattended
Operations where silane is connected for use, other than those conducted by the silane supplier or manufacturer, where the use is not constantly attended by operators involved in the process of transfer or use.

操作，消費 (Operations, unattended)
銜接使用矽甲烷，不同於矽甲烷供應商或製造商的操作作業，其過程不需操作人員一直在旁邊作業以轉充或使用。

3.23 Panel

盤面 (Panel)

3.23.1 Panel, control
A panel-mounted arrangement of electrical components including power supplies, programmable logic controllers, and other instrumentation necessary to determine process parameters associated with the delivery of silane to the piping system.

盤面，控制 (Panel, control)

固定的盤面，上有電源供應，可程式邏輯控制器，及其他決定製程所需的儀錶參數銜接於矽甲烷輸送的管路系統。

3.23.2 Panel, process
A panel-mounted arrangement of manually or automatically operated pressure-regulating or control equipment, control valves, check valves, pneumatic controls, and interconnecting piping that is used to control the delivery of silane gas.

盤面，製程 (Panel, process)

固定的盤面，上有手動或自動操作的壓力調整裝置或控制設備、控制閥、逆止閥、氣動控制及用以控制矽甲烷氣體
輸送的內部銜接管路。

3.23.3 Panel, purge
A panel-mounted arrangement of manually or automatically operated pressure-regulating or control equipment and interconnecting piping designed to deliver a purge gas to the process gas panel for purging atmospheric gases and/or silane from the process gas panel.

盤面，沖吹 (Panel, purge)
固定的盤面，上有手動或自動操作的壓力調整裝置或控制設備及內部銜接管路設計用以輸送沖吹氣體到製程盤面、沖吹製程氣盤面的大氣及/或矽甲烷。

3.24 Part per million (ppm)
A term used to express the concentration of a gas in parts per million as opposed to expressing the concentration in terms of volume or mol percent. One molar ppm or one ppm by volume is equal to 0.0001%.

百萬分比 (Part per million, ppm)

一詞用以表示氣體在分成一百萬份後之比例濃度，以進一步將體積或莫耳百分比的詞細分，百萬分之一莫耳或體積比百萬分之一等於0.0001%。

3.25 Physical hazard

A chemical for which there is evidence that it is a combustible liquid, compressed gas, flammable or oxidizing cryogenic fluid, explosive, flammable gas, flammable liquid, flammable solid, organic peroxide, oxidizer, pyrophoric, unstable-reactive, or water-reactive material.

物理危害 (Physical hazard)

化合物可證明其為可燃性液體、壓縮氣體、易燃性或氧化性低溫流體、爆炸性、易燃氣體、易燃液體、易燃固體、有機過氧化物、氧化物、自燃性、不穩定反應性或禁水性物質。

3.26 Pigtail

A relatively short and semi flexible section of connecting piping or tubing that is used to connect a compressed gas source to the control system. A pigtail contains a fitting to mate with the outlet of the control valve at the source at one end with the opposite end being connected into a manifold or control panel. The purpose of the pigtail is to accommodate slight variations in height or position presented by the use of moveable containers.

銜接管 (Pigtail)

銜接管路相對軟性及半彎曲的部位，其用以銜接壓縮氣體氣源到控制系統。銜接管包含接頭，一端接合氣源端控制閥的出口，另一端則接合控制盤面。銜接管的目的在於方便銜接可移動容器，其高度與位置有些許不同。

3.27 Piloted ignition

The ignition by application of a pilot flame. By comparison, ignition without a pilot energy source is referred to as autoignition, self-ignition, or spontaneous ignition.

引導點燃 (Piloted ignition)

經由引導火焰點燃；相對的，不需引導能量點燃的方式一般稱作自動點火，半自動點火或自發點火。

3.28 Pressure relief device

A pressure- and/or temperature-activated device used to prevent the pressure from rising above a predetermined maximum, and thereby preventing rupture of a normally charged cylinder when subjected to a standard fire test as required by 49 CFR 173.301(f). The term “pressure relief device” is synonymous with “safety relief device”.

壓力釋放裝置 (Pressure relief device)

用以避免壓力上升至最大預定值的壓力及/或溫度觸發的裝置，進而避免一般鋼瓶依49CFR173.301(f)在火場測試中產生爆破。”壓力釋放裝置”一詞與用於美國運輸部 (DOT) 規定的”安全釋放裝置”同義[5]。

3.29 Purging

The replacement of the atmosphere in a piping system or enclosure used to house mechanical or electrical connections by the introduction of a controlled atmosphere consisting of an unreactive gas or fresh air.

沖吹 (Purging)

管路系統中將大氣置換或密閉空間使用公用機械或電氣銜接導入未反應氣體或新鮮空氣以置換空間內的氣體。

3.30 Rack system

An unenclosed silane process gas panel and purge gas panel mounted to a support structure used with silane cylinders. It is designed for unconfined open ventilation, as opposed to the confinement provided in ventilated gas cabinets.

氣瓶架系統 (Rack system)

非密閉之矽甲烷氣體盤面及沖吹氣體盤面固定於一支撐結構與矽甲烷鋼瓶共同使用，其設計成非局限開放的通風方式，以別於使用通風於局限空間的氣瓶櫃。

3.31 Remotely located, manually activated shutdown control

A control system that is designed to initiate shutdown of the flow of gas and is activated from a point located some distance from the delivery system.

手動遠端關閉控制 (Remotely located, manually activated shutdown control)

設計以停止氣流的控制系統，其驅動的位置位於輸送系統的一定距離外。

3.32 Shall

Indicates a mandatory requirement.

必須 (Shall)

表示為強制要求項目。

3.33 Silane systems and sources

3.33.1 Silane

Silane and silane in combination or mixed with other gases where the concentration of silane exceeds 1.37% by volume.

矽甲烷系統與氣源 (Silane systems and sources)

矽甲烷 (Silane)

矽甲烷及濃度高於體積比1.37%的矽甲烷與其他氣體的混合氣。

3.33.2 Silane delivery system

A system used to transfer silane from a source of supply to a point where connections are made to piping systems associated with internal transmission and/or use of this material. The piping and components that make up the silane gas delivery system include:

- container connections;
- process control panel and integral components;
- purge gas panel and integral components;
- piping between the process gas panel and the purge gas panel; and
- output piping from the process control panel terminating at the point where the gas either enters the building piping system or the outlet from a valve manifold box (VMB) when VMBs are used as a means to supply individual points of use.

The delivery system does not include:

- silane containers (cylinders, tubes, etc.);
- gas cabinets;
- gas disposal equipment; or
- auxiliary equipment related to a silane installation.

矽甲烷輸送系統 (Silane delivery system)

自供應的氣源傳輸矽甲烷到另一定點的系統，其使用管路銜接內部傳送器及/或使用此物質；矽甲烷氣體輸送系統的管路與元件包括：

- 容器銜接；
- 製程控制盤面及整合元件；
- 沖吹氣體盤面及整合元件；
- 製程氣體盤面與沖吹氣體盤面之間的管路；及

– 製程氣體盤面的出口點，此氣體可能流向建築物管路系統或如果使用氣體供應分歧箱/模組(VMB)供個別點使用的氣體供應分歧箱。

輸送系統不包括；

- 矽甲烷容器 (鋼瓶、管束等)；
- 氣瓶櫃；
- 氣體廢棄處理設備；或
- 矽甲烷裝置的輔助設備。

3.33.3 Silane, bulk source

A container or interconnected group of containers with a water volume exceeding 8.8 ft^3 (250 L).

矽甲烷，大宗氣源 (Silane, bulk source)

內部水容積超過8.8立方呎 (250公升)之容器或互相銜接的容器組。

3.33.4 Silane, nonbulk source

A container or interconnected group of containers with a water volume not exceeding 8.8 ft^3 (250 L).

矽甲烷，非大宗氣源 (Silane, nonbulk source)

內部水容積不超過8.8立方呎 (250公升)之容器或內部互相銜接的容器組。

3.34 Site

A location on a premise from which distances to exposures are measured.

工作場所 (Site)

地基上的一個位置，其到暴露點的距離均受控管。

3.35 Storage

The keeping or retention of material in bulk sources connected to a piping system or in nonbulk source systems or bulk sources that are not connected to a piping system other than piping systems integral to the source.

儲存 (Storage)

將物質存放或保留在大宗氣源銜接到管路系統的管路中、非大宗氣源系統或與銜接到氣源必要管路系統不同的未銜接的大宗氣源。

3.36 Ultra high integrity service (UHIS)

An acronym used for outlet connections designed for ultra high integrity service.

NOTE—In 1989, CGA approved a new group of cylinder valve outlet connections commonly referred to as the CGA 630/710 series. This series was conceived to provide “higher purity and leak integrity” than previous connections. The connection is distinctive in appearance and uses a sealing mechanism that is common to high purity applications. See CGA V-1, *Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections* [6].

超高純完整性用途 (Ultra high integrity service, UHIS)

超高純完整性用途出口接頭設計的縮寫。

備註 – 在1989年 , 壓縮氣體協會認可一批新的鋼瓶閥出口接頭, 一般稱爲CGA 630/710 系列。
此系列被認爲可提供比先前的出口接頭具有”較高純度與洩漏完整性” 。他們使用外觀做區分,
並使用一般通用於高純度應用的密封機制, 請參考CGA V-1 壓縮氣體鋼瓶閥出口及入口接頭標準。[6]

3.37 Use

The placement of material into service by connecting to a piping or pressure control system or by using the product in process operations.

使用 (Use)
物質利用銜接管路或壓力控制系統傳輸或於製程操作中使用該產品。

3.38 Valve

3.38.1 Valve, automatic
A valve designed to be operated by pneumatic pressure or other power source other than manual means.

閥 (Valve)

閥，自動 (Valve, automatic)

閥門的設計使用氣壓或其他除手動方法的動力源操作。

3.38.2 Valve, check
A valve designed to provide for flow in one direction. The internal components of the valve are designed to prevent flow in the reverse direction. Check valves are not viewed as safety devices.

閥，逆止 (Valve, check)

閥門設計使氣流僅可單向流動,閥的內部組件設計以防止氣流反方向流動, 逆止閥不可視爲安全裝置。

3.38.3 Valve, pressure relief
A valve designed to open if a predetermined pressure is exceeded. Pressure relief valves are commonly referred to as pressure safety valves with the recognition that relief is provided to prevent a dangerous condition due to overpressurizing a system or container.

閥，壓力釋放 (Valve, pressure relief)

閥門設計用於超過設定壓力可開啟,壓力釋放閥通常被當作壓力安全閥,以避免因為系統或容器超壓的危險狀況可立即釋壓。

3.38.4 Valve manifold box (VMB)
A fully enclosed, ventilated enclosure of limited size used to house valves, fittings, pressure regulating, monitoring, and flow control systems suitable for the distribution of gases in closed piping systems to one or more tools or workstations.

氣體供應分歧箱/模組 (Valve manifold box, VMB)

一個完全包覆,大小受限的通風箱,用於包覆在密閉管路系統氣體配送至一部以上的機台或工作站的閥,接頭,壓力調壓閥, 監控及流量控制系統。

3.39 Vapor cloud explosion
An explosion occurring outdoors that results in damaging overpressure . It is initiated by the unplanned release of a large quantity of flammable vaporizing liquid or high pressure gas from containers including but not limited to a storage container, delivery system, process vessel, or piping system.

蒸氣雲爆炸 (Vapor cloud explosion)
發生於室外的爆炸導致破壞性超壓,其起於意外的大量可燃性汽化的液體或從容器包含不止於儲存容器,配送系統,製程容器或管路系統的高壓氣體釋放。

4 Physical and chemical properties 物理與化學性質

4.1 Description 描述

Silane is a colorless, pyrophoric gas that is able to burn at concentrations from 1.37% to 96% volume in air [3]. At concentrations between 1.37% and about 4.5%, mixtures can react if an ignition source is provided. When the silane concentration in air is greater than about 4.5%, the mixture is metastable and will undergo bulk autoignition after a certain delay with shorter ignition delays at higher concentrations [1]. Due to the nature of the reaction, it does not always ignite when vented to the atmosphere. It has been reported to have a repulsive odor that is able to be physiologically detected well below the Threshold Limit Value–Time-Weighted Average (TLV®–TWA) concentration of 5 parts per million by volume (ppmv); however, odor is not to be relied upon as a means to indicate the absence of a hazardous material [7]. Notwithstanding reports regarding odor, the reported odor for silane is believed to be a characteristic of burning silane rather than of the material itself.

矽甲烷爲無色、自燃性氣體，可在空氣中濃度範圍介於1.37%至96%（容積比）時燃燒[3]。在濃度1.37%與約4.5%之間時，若提供點火源，矽甲烷混合物即可進行反應。當空氣中的矽甲烷濃度大於約4.5%時，混合物爲介穩狀態，在特定延遲後會進行大量的自燃，在較高濃度下，其點火延遲時間較短[1]。基於此反應本質，當其排放到大氣中時，並不一定會被點燃。有研究指出，矽甲烷具有令人作嘔的氣味，在其恕限值-時量平均容許濃度(TLV-TWA) 5 ppm以下即能輕易的讓人聞到；然而, 氣味並不是用於確認此危險物質存在的方法[7]。儘管有關於氣味的報導，矽甲烷的氣味仍被視爲是矽甲烷燃燒的特性，而非物質本身的氣味。

4.2 Properties 性質

Fundamental physical and chemical properties of silane are noted in Table 1.

甲烷的物理及化學基本性質註明於表1。

4.3 Pyrophoric nature of silane 矽甲烷的自燃本質

Silane is pyrophoric; however, it does not always ignite when vented to the atmosphere. Lack of instantaneous ignition can lead to delayed ignition resulting in fireballs or vapor cloud explosions, which can range in character from deflagration to detonation. It is important to understand the pyrophoric nature of silane and conditions surrounding ignition.

矽甲烷具自燃性，但被排放至大氣中時，並不一定會著火。若缺乏瞬間點火源，可能導致延遲自燃而造成火球或蒸氣雲爆炸，其特徵介於爆燃（deflagration）到爆震（detonation）的範圍。重要的是，務必要了解矽甲烷的自燃本質及其自燃周邊的狀況。

Table 1—Physical and chemical properties of silane

Parameter	Value
Chemical name	Silane
Synonyms	Silicon tetrahydride, silicane, monosilane, silicon hydride
Chemical formula	SiH_4
Chemical Abstracts Service (CAS) registration number	7803-62-5
Appearance	Colorless gas
Boiling point	–169 °F (–112 °C)
Melting point	–300.5 °F (–184.7 °C)
Gas density at 1 atm and 68 °F (20 °C)	0.084 lb/ft^3 (1.35 kg/m^3)
Specific gravity (liquid) at 301 °F (–185 °C)	0.711
Specific gravity (gas) at 1 atm and 70 °F (21.1 °C)	1.12 (Air = 1)
Specific volume at 1 atm and 70 °F (21.1 °C)	12.0 ft^3/lb (0.75 m^3/kg)
Vapor pressure at 68 °F (20 °C)	Gas
Molecular weight	32.12
Solubility in water	Negligible. Slowly decomposes
Critical temperature	25.8 °F (–3.4 °C)
Critical pressure	702.5 psia (4 844 kPa, abs)
Critical density	15.4 lb/ft^3 (0.247 g/cm^3)
Compressibility	See Appendix B
Heat of combustion	19 076 Btu/lb (44 370 kJ/kg)
Flammable limits in air	1.37% to 96%
Autoignition temperature	–58 °F (–50 °C)
ACGIH TLV–TWA	5 ppm
Acute toxicity	Inhalation rat LC_{50} – 9600 ppm/4 hr [8]

表1 – 矽甲烷的物理及化學性質

參數	數值
化學名稱	矽甲烷
同義字	四氫化矽、矽烷、單矽烷、氫化矽
化學式	SiH_4
美國化學文摘社（CAS）登錄號碼	7803-62-5
外觀	無色氣體
沸點	-169℉（-112℃）
熔點	-300.5℉（-184.7℃）
在一大氣壓 68℉（20℃）下之氣體密度	0.084 lb/ft^3（1.35 kg/m^3）
在301℉（-185℃）下之比重（液體）	0.711
在**一大氣壓** 70℉（21.1℃）下之比重（氣體）	1.2（空氣=1）
在**一大氣壓** 70℉（21.1℃）下之比容積	12.0 ft^3/lb（0.75 m^3/kg）
在68℉（20℃）下之蒸氣壓	氣體
分子量	32.12
水溶性	可忽略，緩慢分解
臨界溫度	25.8℉（-3.4℃）
臨界壓力	702.5 psia（4 844 kPa，絕對）
臨界密度	15.4 lb/ft^3（0.247 g/cm^3）
可壓縮性	請參閱附錄B
燃燒熱	19 076 Btu/lb（44 370 kJ/kg）
空氣中之燃燒界限	1.37% - 96%
自燃溫度	-58℉（-50℃）
美國工業衛生師協會制定之**時量平均容許濃度**限值 (ACGIH TLV – TWA)	5 ppm
急毒性	LC_{50} – 9600 ppm / 4hr, 大鼠吸入[8]

4.3.1 Ignition and combustion

The ignition and combustion characteristics of 100% silane release have been the subject of major studies [1, 2, 3]. Based on these studies, the LFL of silane in air has been established as 1.37%. Concentrations from 1.37% to 4.5% in air are able to be ignited by an external source (piloted ignition) resulting in deflagration with laminar burning velocity reaching 5 m/sec (985 linear ft/min). When the silane concentration is greater than 4.5% in air, the mixture is metastable and is capable of autoignition after a certain delay, with shorter ignition delays at higher concentrations. Test results also have shown that silane air mixtures do not always autoignite, even at higher concentrations. A delayed ignition is capable of resulting in a deflagration or a detonation [1].

點火及燃燒

純的矽甲烷釋放的點火及燃燒已成為主要的研究課題[1,2,3]。根據這些研究，建立了矽甲烷在空氣中的燃燒下限(LFL)為1.37%。空氣中矽甲烷濃度達1.37%至4.5%時，可經由外部火源（前導點火）點燃而造成爆燃，其線性燃燒速率可達5m/sec（985線性ft/min）。當空氣中矽甲烷的濃度超過4.5%時，混合物會成為介穩狀態，在特定延遲後會進行大量的自燃，在較高濃度下，其點火延遲時間較短。測試結果亦顯示，矽甲烷與空氣混合物即使在較高的濃度下也不一定會自燃。延遲點火可能會造成爆燃或爆震[1]。

4.3.2 Combustion reaction

The stoichiometric combustion reaction of silane in air is expressed as follows:

$SiH_4 + 2\ O_2 + 7.52\ N_2 \rightarrow SiO_2\ (s) + 2\ H_2O + 7.52\ N_2$

The stoichiometric mixture contains 9.51 volume percent silane [3]. Large quantities of amorphous silica are formed during the combustion of silane. For each 1.0 lb (0.45 kg) of silane completely burned, approximately 1.87 lb (0.85 kg) of amorphous silica is formed.

燃燒反應

空氣中矽甲烷的化學燃燒反應可由下式表示：

$SiH_4 + 2\ O_2 + 7.52\ N_2 \rightarrow SiO_{2(s)} + 2\ H_2O + 7.52\ N_2$

化學計算的混合物包含9.51容積百分比的矽甲烷。矽甲烷的燃燒過程中可產生大量的非晶矽。每1磅(0.45公斤)的矽甲烷完全燃燒後約可產生1.87磅（0.85公斤）的非晶矽。

4.4 Health hazards 健康危害

The primary health hazards associated with silane are burns due to silane flame exposure or thermal radiation. The LC_{50} (inhalation-rat) for silane is 9600 ppm at 4 hour of exposure [8]. Little information exists on the toxicity of silane because of its pyrophoric nature; however, the American Conference of Governmental Industrial Hygienists (ACGIH) has established a TLV-TWA concentration of 5 ppm to protect workers from the risk of eye, skin, and upper respiratory tract irritation with exposure to this substance [9]. In addition, the inhalation of oxidized silane presents a potential health hazard. The combustion of silane forms oxides of silicon that is able to cause irritation to the respiratory tract.

矽甲烷的主要危害爲矽甲烷燃燒的火焰或熱輻射之燒傷。矽甲烷之LC_{50}（吸入-大鼠）爲9600 ppm, 4小時暴露[8]。因其自燃的本質，矽甲烷毒性的資訊相當少；然而, 美國工業衛生師協會（ACGIH）已制定5 ppm濃度作爲恕限值-時量平均容許濃度，以保護工作人員免於暴露在此物質時造成眼部、 皮膚及上呼吸道刺激的風險[9]。此外，吸入矽甲烷氧化物也潛在對健康造成危害。矽甲烷燃燒時產生的矽氧化物可導致呼吸道的刺激。

4.5 Gaseous/liquid phase of silane 矽甲烷的氣相與液相

The critical temperature of silane is 25.8 °F (–3.4 °C) and the critical pressure is 702.5 psia (4840 kPa, abs). Silane is able to exist in liquid form depending upon temperature and pressure conditions. Engineering analysis and controls are required in systems where liquefaction is to be avoided, for example, equipment operability under liquid fill conditions.

矽甲烷的臨界溫度爲25.8℉（-3.4℃）而臨界壓力爲702.5 psia（4840kPa，絕對）。矽甲烷可依溫度及壓力狀況而以液態形式存在。爲避免矽甲烷產生液化情形, 系統中應具備工程分析與控制, 例如在液體充填情況下的設備的可操作性。

5 Packaging information 包裝資訊

5.1 General 一般

Containers used to contain silane offered for transportation shall the relevant governing regulations. As an example, in the US, transport regulations for silane are governed by the US DOT Regulations [5].Information from the US DOT is shown in the following Table 2.

用於運輸用途的矽甲烷包裝容器必須符合美國運輸部的相關法規[5]，請見表2 美國運輸部包裝資訊。

Table 2—DOT packaging information

DOT hazard class	2.1
DOT label	Flammable gas
DOT/United Nations (UN) number	UN 2203
Valve outlet connection	CGA 350 or CGA 632 (UHIS)
Packaging	49 CFR Parts 100-180 [5]
CGA publications	V-1, *Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections* [6] V-7, *Standard Method of Determining Cylinder Valve Outlet Connections for Industrial Gas Mixtures* [10] S-1.1, *Pressure Relief Device Standards–Part 1–Cylinders for Compressed Gases* [11] S-1.2, *Pressure Relief Device Standards–Part 2–Cargo and Portable Tanks for Compressed Gases* [12] S-7, *Method for Selecting Pressure Relief Devices for Compressed Gas Mixtures in Cylinders* [13]

表2 – 美國運輸部包裝資訊

DOT危害等級	2.1
DOT標籤	可燃性氣體
DOT/聯合國物質編號	UN 2203
閥門出口接頭	CGA 350 或 CGA 632 (UHIS)
包裝	49 CFR Parts 100-180[5]
壓縮氣體協會出版品	V-1, *Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections* [6] V-7, *Standard Method of Determining Cylinder Valve Outlet Connections for Industrial Gas Mixtures* [10] S-1.1, *Pressure Relief Device Standards-Part 1-Cylinders for Compressed Gases* [11] S-1.2, *Pressure Relief Device Standards-Part 2-Cargo and Portable Tanks for Compressed Gases* [12] S-7, *Method for Selecting Pressure Relief Devices for Compressed Gas Mixtures in Cylinders* [13]

6 Outdoor storage and use 室外儲存與使用

6.1 Applicability 適用性

In addition to the requirements of Section 6, outdoor storage and use of silane shall be in accordance with the requirements of Sections 8 through 17 as applicable.

除了第6章要求之外，矽甲烷的室外儲存和使用必須與第8到17章用的部分一致。

6.2 General 一般

The release of silane represents a hazard due to the potential for fire or explosion. If released into a confined space, the effects of either immediate or latent ignition or autoignition of silane have the potential to be severe as the atmosphere immediately surrounding the burning material is heated and expands. The expansion of the atmosphere and the poten-

tial shock wave propagating through the ignited material can cause injuries to personnel and damage buildings and equipment in proximity to the source. Outdoor areas are used as a means to minimize or eliminate these effects.

矽甲烷釋放顯現的危害是由於它具有潛在的可燃性或者爆炸。如果矽甲烷釋放到局限的空間，矽甲烷立即或延遲或自動點燃的效應如同當大氣立即包圍燃燒物質時潛在嚴重的放熱與膨脹。大氣的膨脹與潛在震波經由點燃物質的傳播可導致鄰近氣源之人員傷害與建物及設備的受損。室外區域使用是減少或消除這些效應的方法。

6.2.1 Location

Silane sources and systems shall be located outdoors. An exception to this is nonbulk systems installed in accordance with the requirements of Section 7. Although indoor locations are allowed, it is preferred that areas for the storage and use of silane be located outdoors to minimize risk to users and facilities in the event of a fire or explosion. By locating silane installations in an unconfined space, the surrounding environment is able to absorb unlimited amounts of heat, and the surrounding environment is free to infinitely expand allowing overpressures to quickly attenuate.

位置

除了依據第7章之要求設置的非大宗(nonbulk)系統以外，矽甲烷氣源和系統必須設置在室外。雖然室內設置是可允許的，但是貯存和使用矽甲烷最好仍在室外，使得在火災或爆炸的事件中使用者及設施的風險降到最低。藉由將矽甲烷裝置在非局限空間，周遭環境能吸收無限的熱量，並且周遭環境可無限地擴大，可使過大的超壓迅速減弱。

6.2.1.1 Openness

A system shall be sited so it is open to the surrounding environment (see the definition of outdoor in 3.20.1). A system is open to the environment when objects that encroach on the silane sources are located at a distance from the source not less than twice the height of the encroaching object).

開放性

系統必須安裝在開放的環境中，(參考室外定義3.20.1)，當物件置入矽甲烷使用區域，其與矽甲烷氣源距離不可小於此物件高度的兩倍 (22.5度角)。

6.2.1.1.1 Mitigation

Silane sources and systems that are not in conformance with the requirements of 6.2.1.1 shall be provided with mitigation measures to address encroachment. When mitigation measures are applied, the maximum encroachment is allowed to be reduced to a distance not less than the height of the encroaching object. This limitation results in the angle between the height of the encroaching object and the base of the silane containers being not greater than 45 degrees. Overpressures and thermal effects shall also be included when locations are specified. See Appendices C and D.

For example, assume that an equipment item 10 ft (3.0 m) high is located off to one side of silane cylinders that are located under a roofed structure. Applying the rule, the equipment shall be located at a distance not less than 20 ft (6.1 m) from the roofed structure. If a distance of 20 ft (6.1 m) is not able to be achieved, mitigation shall be applied before further encroachment is allowed. Forced air circulation is allowed to be used as a means of mitigation. Mitigation is accomplished by moving air over cylinder valves and valve connections at a rate not less than 150 ft/min (0.8 m/s). See 13.1.1.

減輕

不符合6.2.1.1過程中要求的矽甲烷氣源和系統處理將需要配有其他減輕措施。當使用減輕措施時，可允許縮短隔離距離，但隔離距離不得小於置入物件的高度。這限制導致在置入的物件高度與矽甲烷容器之間的角度不大於45度角。當位置指定時，過壓和熱效應也應被包括其中。參考附錄C和D。

例如，假設一項設備高10呎(3.0公尺)設置在一個屋頂架構下方位於矽甲烷容器的一側。依據此原則，設備設置距離建築物應不得少於20呎(6.1公尺)。如果無法使其距離在20呎(6.1公尺)**以上**，在設備置入之前，必須使用減輕的措施。強制通風可以是減輕的一種方法，其使空氣流經鋼瓶閥與瓶閥接頭,其速率不得小於150呎/分(0.8**公尺/秒**)。參見13.1.1。

6.2.1.1.2 Weather protection

Where controls or unconnected cylinders in storage require protection against the elements, an overhead roof or canopy shall be provided. An exception to this is that roofs shall not be provided to shelter silane bulk sources.

天候防護

除了大宗矽甲烷氣源上方不可有遮蔽物以外，對於控管或儲存區未連結的鋼瓶必須提供屋頂或遮棚加以防護。

6.2.1.2 Height of overhead construction

When a roof is provided, the lowest point of the roof shall be not less than 12 ft (3.7 m) high as measured from the surrounding floor. For lighter than air gas mixtures, a slanted roof with a vent at the apex is allowed to be used for venting of fugitive gases.

高架建築物高度

當有提供屋頂時，從地板開始測量，距屋頂的最低點必須不少於12呎(3.7公尺)。對於較輕於空氣的混合氣，可用傾斜屋頂之排放口排放逸出的氣體。

6.2.2 Egress

Outdoor storage and use areas shall have no less than two exits. An exception to this is that one exit is allowed for outdoor storage and use areas less than 200 ft^2 (19 m^2) when a dedicated means of egress between cylinders or silane equipment is maintained. The maximum distance to an exit shall not be greater than 75 ft (23 m).

出入口

室外儲存和使用區域必須不少於二個出口。例外情況爲面積小於200平方呎（19平方公尺）的室外儲存及使用區域，鋼瓶或矽甲烷設備區之間有專用出入口，則一個出口是可被允許的。區域內任何一點到出口的最大距離必須不大於75呎(23公尺)。

6.2.2.1 Hardware

Means of egress gates or doors in fenced areas shall not be provided with a latch or lock unless it is panic hardware.

硬體

除非是安全門所用的推壓式門鎖，否則圍籬區域的出口大門或門不可使用門閂或加鎖。

6.2.3 Security

Storage or use areas shall be secured against unauthorized entry. Barriers against entry shall allow for the free circulation of air throughout the area of storage or use.

保全

儲存或使用區必須設置保全措施，以限制未授權人員進入。限制人員的隔籬設施必須使空氣可以在儲存或使用區域自由流通。

6.2.4 Vehicular traffic

Storage or use systems shall be located so there is access to transport vehicles to allow for loading and exchange operations to be conducted. Storage and use areas shall be protected from damage by vehicular traffic.

車輛交通

儲存或使用區域必須設置於運輸工具可接近位置以方便裝載及更換操作的處理。儲存及使用區域必須加以保護,以避免車輛碰撞損壞。

6.2.5 Fire apparatus access roads

Fire apparatus access roads shall be provided in accordance with local regulations.

消防通道

消防通道應根據當地法規設置。

6.2.6 Separation from incompatible materials

Silane in storage or use shall be separated from incompatible materials by the use of distance or fire-resistive partitions.

與不相容物質的隔離

矽甲烷在儲存或使用時，應利用距離或防火牆與不相容物質隔離。

6.2.6.1 Separation by distance or barrier protection

Silane storage or use shall be separated from incompatible materials by a minimum separation distance of 20 ft (6.1 m) or by a 2 hour fire barrier wall extending 18 in (46 cm) above and beyond the footprint of the containers.

用距離或防火牆當做隔離

矽甲烷儲存或使用必須與不相容的物質間隔至少20呎(6.1公尺)，或用2小時防火牆隔離，防火牆應高於容器及距離容器各18吋 (46公分)以上。

6.2.6.2 Arrangement of fire barrier walls

When used to separate incompatible materials, fire barrier walls shall be arranged so as not to preclude the flow of air through areas where silane sources are in use.

Walls used to separate unconnected containers in storage shall not be considered encroachment as described in 6.2.1.1.

防火牆的配置

使用防火牆隔離不相容物質時，防火牆的配置不可阻礙空氣於整個矽甲烷氣源使用區域流通。

在儲存區用以隔離未銜接容器的牆不應視為6.2.1.1所描述之置入物品。

6.2.6.3 Proximity to physical hazard fluids

Silane storage and use areas shall be located so spills or leaks from outdoor, aboveground fluid storage vessels or systems used to contain fluids with physical hazards will not present an exposure hazard to the storage or use area. Dikes, diversion curbs, grading, or alternate means may be used to divert liquids and runoff away from the silane area of storage or use.

鄰近危害流體

矽甲烷儲存及使用區域必須設置於不被鄰近危害流體噴濺或洩漏影響的位置，危害流體容器應該使用防液堤，導流渠道，斜坡或其他方法使洩漏的危害流體不會流向矽甲烷儲存或使用的區域 。

6.2.7 Securing of containers

Cylinders and mobile supply units shall be secured to resist movement.

容器固定

鋼瓶和移動式的供應單元必須固定避免移動。

6.2.8 Other requirements

In addition to the previously stated provisions, outdoor delivery systems shall be in accordance with the following. Refer to the applicable section for details:

- system configuration (cylinder sources) See Section 8
- system configuration (bulk sources) See Section 9
- piping and components See Section 10
- gas monitoring See Section 11.1
- flame or heat detection See Section 11.2
- fire protection See Section 12
- ventilation See Section 13
- venting and treatment See Section 14
- purge gas systems See Section 15
- electrical See Section 16
- supervisory control systems See Section 17

其他要求

除前面說明的條款之外，室外輸送系統必須符合下列要求。參考以下適用部分的細部說明：

- 系統配置(鋼瓶氣源) 參閱第8 章
- 系統配置(大宗氣源) 參閱第9章
- 管路與元件 參閱第10章
- 氣體偵測 參閱11.1
- 火焰或熱源偵測 參閱11.2
- 消防系統 參閱第12章
- 通風系統 參閱第13章
- 排放與處理 參閱第14章
- 沖吹氣體系統 參閱第15章
- 電器要求 參閱第16章
- 基本監督控制要求 參閱第17章

6.3 Distances to exposures 暴露距離

6.3.1 Distances between cylinder sources and exposures

Silane source cylinders in storage or use shall be separated from exposure hazards by distances not less than those indicated in Table 3. Separation distances are variable since distances providing protection from radiant heat are dependent upon storage volume. The distances are based on permissible exposure to thermal radiation. Fire, not explosion, is the plausible event for cylinders in storage. See Appendix C for guidelines to other exposures with silane cylinders in storage. An exception to this is individual containers with a silane content not to exceed 0.50 ft^3 (14 L).

鋼瓶氣源和暴露物的距離

矽甲烷氣源的鋼瓶在儲存或使用區域必須以距離隔離暴露危險，其距離不得少於表3的規定。因輻射熱的距離會依儲存容積而改變，因此隔離距離是可變動的。距離係根據可容許之熱輻射，非爆炸的火災在鋼瓶儲存區域是可能發生的事件。關於儲存之矽甲烷鋼瓶的其他暴露準則，請參閱附錄C。例外的情況為單一矽甲烷容器之內容量不超過0.50立方呎（14公升）。

6.3.2 Protective walls

防護牆

6.3.2.1 Encroachment

The distances in Table 3 are allowed to be reduced to 5 ft (1.5 m) when fire-resistive partitions or fire barrier walls having a minimum fire resistance rating of 2 hour as defined by national or regional building and/or fire codes interrupt the line-of-sight between the container and the exposure. When provided, the partitions or walls shall be at least 5 ft (1.5 m) from the exposure.

置入

當使用防火牆或防火屏障時，而且防火牆或防火屏障具有國家或地區所定義的可耐火2小時等級或地區大樓或消防法規規範能中斷容器與暴露氣體之間的蔓延，則在表格3的安全距離允許降低到5呎(1.5公尺)。防火屏障或防火牆本身距離暴露位置至少要5呎(1.5公尺)以上。

6.3.2.2 Penetrations and openings

Penetrations and openings in fire-resistive partitions or walls shall be protected in accordance with the requirements of national or regional building and/or fire codes. The fire-resistive rating of opening protectives provided shall be not less than the required fire-resistance rating of the fire-resistive partition or wall being penetrated.

穿透與開口

在防火屏障或防火牆的穿透與開口位置必須根據國家及/或當地建築或消防法規的保護要求設置。防火牆之穿透與開口的防火等級必須不小於防火間隔或防火牆的防火等級

6.3.2.3 Obstructions

The configuration of the fire partitions or barrier walls shall allow natural ventilation to prevent the accumulation of vapors. An exception to this is outdoor storage consisting of unconnected cylinders with closed valves.

障礙物

防火屏障或防火牆的配置必須允許自然通風以避免氣體的累積。貯存於室外，未連接且瓶閥關閉的鋼瓶則例外。

6.3.3 Distances between ISO modules or trailers and exposures

The minimum distances from exposures for ISO modules or trailers containing silane in storage or use shall be not less than those listed in Table 4. Table 4 shall not apply to piping systems downstream of the restrictive flow orifice (RFO).

Additional exposures are as follows:

- In installations where electrical power lines are present or in areas where exposure to electricity is conceivable, silane delivery vehicles used for loading and unloading shall be at least 25 ft (8 m) horizontal distance from overhead electrical wires; and
- The area above silane bulk sources shall be unobstructed.

The distances are based on the potential for overpressure due to latent ignition of released silane from individual containers of the size noted. Overpressures are determined in part by potential release from the pressure relief device used for containers of the size noted. The container volumes shown are based on the maximum water content of individual containers whether manifolded or not.

ISO 模組(ISO modules)或管束拖車與暴露之間的距離

裝有矽甲烷的ISO 模組或管束拖車在儲存或使用時的最小暴露距離必須不小於表4所列。

表4將不適用於限流孔(限流器)下游的管路系統。

其他暴露如下：

- 在存有電源線或暴露於電氣的區域，矽甲烷之裝卸運送車輛應與上方的電線至少保持25呎（8公尺）水平的距離。
- 大宗矽甲烷氣源上方區域不應被阻礙。

距離係根據因個別標註的容器尺寸，其釋放矽甲烷的潛在點火造成過壓的可能性而定。過壓取決於個別標註的容器尺寸之壓力釋放裝置的部分潛在釋放。所示之容器容積依個別容器之最大水容量而定，與是否有岐管連接無關。

Table 3—Minimum distance from cylinder sources in storage or use to outdoor exposures

Type of exposure	Minimum distance to exposures for different storage volumes or nests [1) 2) 3)]							
	Cylinders [4)] ≤ 600 ft³ (17 m³)		Cylinders [5)] 601 ft³ to 2500 ft³ (71 m³)		Cylinders [5)] 2501 ft³ to 10 000 ft³ (283 m³)		450 L cylinders [6)] ≤ 10 000 ft³ (283 m³)	
	ft	(m)	ft	(m)	ft	(m)	ft	(m)
Places of public assembly, property line that is able to be built upon.	20	(6)	30	(9)	50	(15)	60	(18)
Public street and sidewalk	20	(6)	30	(9)	50	(15)	60	(18)
Buildings of nonrated construction [7)]	15	(5)	25	(8)	25	(8)	40	(12)
Buildings of nonrated construction [8)]	20	(6)	25	(8)	25	(8)	40	(12)
Buildings with 2 hr fire rating and no openings within 25 ft (8 m)	5	(1.5)	5	(1.5)	5	(1.5)	5	(1.5)
Buildings with 4 hr fire rating and no openings within 25 ft (8 m)	0	(0)	0	(0)	0	(0)	0	(0)
Compatible compressed gas cylinder storage or other silane nests [7)]	9	(3)	9	(3)	12	(4)	30	(9)
Compatible compressed gas cylinder storage or other silane nests [8)]	20	(6)	20	(6)	20	(6)	40	(12)
Incompatible compressed gas cylinders and materials	20	(6)	20	(6)	20	(6)	40	(12)
Flammable and/or combustible liquid storage above ground [7)]								
(a) 0 gal to 1000 gal (3785 L)	10	(3)	10	(3)	25	(8)	25	(8)
(b) In excess of 1000 gal (3785 L)	25	(8)	25	(8)	50	(15)	50	(15)
Flammable and/or combustible liquid storage above ground [8)]								
(a) 0 gal to 1000 gal (3785 L)	20	(6)	20	(6)	25	(8)	25	(8)
(b) In excess of 1000 gal (3785 L)	25	(8)	25	(8)	50	(15)	50	(15)

1) The distances are based on permissible exposure to thermal radiation. See Appendix C for thermal radiation data.

2) The distances specified are allowed to be reduced to 5 ft (1.5 m) when protective walls are provided in accordance with 6.3.2 or reduced to zero feet (metre) when in accordance with 6.2.6.2.

3) Volume shown in liters refers to the water volume of the cylinder.

4) For cylinders with an internal volume of 1.8 ft³ (50 L) or less in storage or for those in use when separated to prevent flame impingement as required by 6.4.4.

5) For cylinders with an internal volume of 1.8 ft³ (50 L) or less in storage only.

6) For cylinders with an internal volume greater than 1.8 ft³ (50 L) and not exceeding 16 ft³ (450 L) in storage or use.

7) Silane packaged in steel cylinders or fiber overwrapped aluminum cylinders or silane stored in proximity to compatible gases packaged in steel or aluminum fiber overwrapped cylinders.

8) Silane packaged in aluminum cylinders or silane stored in proximity to compatible gases packaged in aluminum cylinders.

表3----鋼瓶氣源之儲存或使用至室外暴露間之最小距離

暴露的類型	不同的儲存容積或儲位的暴露之最小距離 (1)(2)(3)							
	鋼瓶 (4) ≤ 600 立方呎 (17 立方公尺)		鋼瓶 (5) 601立方呎至2500立方呎 (71立方公尺)		鋼瓶 (5) 2501立方呎至10000立方呎(283立方公尺)		450 公升 鋼瓶 (6) ≤ 10 000 立方呎 (283 立方公尺)	
	呎	(公尺)	呎	(公尺)	呎	(公尺)	呎	(公尺)
公眾聚集場所、能建造之產權界限	20	(6)	30	(9)	50	(15)	60	(18)
公共街道及人行道	20	(6)	30	(9)	50	(15)	60	(18)
非耐火結構建築物(7)	15	(5)	25	(8)	25	(8)	40	(12)
非耐火結構建築物(8)	20	(6)	25	(8)	25	(8)	40	(12)
具2小時耐火等級之建築物及25呎 (8公尺) 內無開口	5	(1.5)	5	(1.5)	5	(1.5)	5	(1.5)
具4小時耐火等級之建築物及25呎 (8公尺) 內無開口	0	(0)	0	(0)	0	(0)	0	(0)
可相容高壓氣體鋼瓶儲存或其他矽甲烷鋼瓶儲位(7)	9	(3)	9	(3)	12	(4)	30	(9)
可相容高壓氣體鋼瓶儲存或其他矽甲烷鋼瓶儲位(8)	20	(6)	20	(6)	20	(6)	40	(12)
不相容高壓氣體鋼瓶及物質	20	(6)	20	(6)	20	(6)	40	(12)
可燃及／或易燃液體地上儲槽(7) (a)0加侖 – 1000加侖(3785公升) (b)超過1000加侖(3785公升)	 10 25	 (3) (8)	 10 25	 (3) (8)	 25 50	 (8) (15)	 25 50	 (8) (15)
可燃及／或易燃液體地上儲槽(8) (a) 0加侖 – 1000加侖(3785公升) (b) 超過1000加侖(3785公升)	 20 25	 (6) (8)	 20 25	 (6) (8)	 25 50	 (8) (15)	 25 50	 (8) (15)

(1) 距離是根據對熱幅射的容許暴露。熱幅射數據參閱附錄C。

(2) 依據6.3.2設置防護牆時，指定的距離可縮減至5呎 (1.5公尺)，依據6.2.6.2時則可縮減到0呎。

(3) 容積用公升表示，參考鋼瓶的水容積。

(4) 儲存或使用中，內容積等於或小於1.8 立方呎 (50 公升) 的鋼瓶，需依據6.4.4要求隔開以防止火焰衝擊。

(5) 僅儲存內容積等於或小於1.8立方呎(50 公升) 的鋼瓶。

(6) 儲存或使用中，內容積大於1.8立方呎(50 公升) 但不超過16立方呎(450 公升) 的鋼瓶。

(7) 矽甲烷儲存於鋼瓶內或纖維包覆鋁瓶，或矽甲烷儲存於接近裝有與矽甲烷相容的鋼材或纖維包覆鋁瓶內。

(8) 矽甲烷裝在鋁瓶，或矽甲烷儲存於接近裝有與矽甲烷相容之纖維包覆鋁瓶內。

Table 4—Distance to exposures for outdoor silane trailers, ISO modules, and containers >450L in storage or use

Type of exposure	Minimum distance to exposure [1) 2) 3) 4) 5) 6)]					
	>450 L[5)] cylinder to include tube trailer or ISO module[1)]					
	<600 psig (4140 kPa)		>600 psig to 1000 psig (6900 kPa)		>1000 psig to 1600 psig (11 030 kPa)	
	ft	(m)	ft	(m)	ft	(m)
Places of public assembly	175	(53)	275	(84)	450	(137)
Property lines	110	(34)	180	(55)	300	(91)
Buildings on site [7)]	110	(34)	180	(55)	300	(91)

1) Maximum silane pressure in the container.

2) The distances are based on the potential for overpressure due to latent ignition of released silane from individual containers of the size noted. Overpressures are determined in part by potential releases from the pressure relief device used for containers of the size noted. The container volumes shown are based on the maximum water content of individual containers whether manifolded or not.

3) Distances to buildings are allowed to be reduced depending on the ability of the building to resist overpressure. See Appendix D.

4) Distances for pressures or volumes outside of those shown in the table shall be determined by engineering analysis subject to the approval by the authority having jurisdiction.

5) Volumes expressed in liters refer to the water content of containers specified.

6) Tube trailers or ISO modules equipped with PRDs with a venting orifice of ≤ 1.0 in (25 mm) in diameter.

7) Where greater encroachment is required for buildings on site refer to Appendix D for guidance.

表4 :儲存或使用中之室外矽甲烷管束拖車，ISO模組與大於450公升容器的暴露距離

暴露的類型	暴露的最小距離[(1)(2)(3)(4)(5)(6)]					
	>450 公升 [(5)] 鋼瓶包括管束拖車或ISO模組[(1)]					
	<600 psig (4140 kPa)		>600 psig 至 1000 psig (6900 kPa)		>1000 psig 至1600psig (11030 kPa)	
公眾聚集場所	呎	(公尺)	呎	(公尺)	呎	(公尺)
產權界限	175	(53)	275	(84)	450	(137)
現場建築[(7)]	110	(34)	180	(55)	300	(91)
暴露的類型	110	(34)	180	(55)	300	(91)

(1) 容器內之最大矽甲烷壓力。

(2) 距離係根據因個別標註的容器尺寸，其釋放矽甲烷的潛在點火造成過壓的可能性而定。過壓取決於個別標註的容器尺寸之壓力釋放裝置的部分潛在釋放。所示之容器容積依個別容器之最大水容量而定，與是否有岐管連接無關。

(3) 建築物的距離可視建築物耐壓能力而縮減。參閱附錄D。

(4) 超出表中所示以外的壓力或容積，其距離應經過工程分析後，再由主管機關核准。

(5) 容積用公升表示，參考容器的水容積。

(6) 管束拖車或ISO模組設有PRD其排氣限流孔徑≦1.0吋（25公釐）。

(7) 現場建築物若需有較大的置入物時，參閱附錄D之指引。

6.3.4 Silane delivery systems 矽甲烷輸送系統

6.3.5 General

Outdoor locations are advised for silane delivery systems to prevent the potential accumulation of silane in the event of a release. Although outdoor locations are advised, the use of outdoor systems is not always achievable due to site or environmental considerations such as when the other constituents of silane mixtures are toxic.

一般

矽甲烷輸送系統建議於置於室外，以預防當矽甲烷釋放造成潛在的蓄積。雖然建議在室外使用，但室外系統的使用無法完全依循，因爲現場或環境考量，例如矽甲烷混合物的其他成分具有毒性。

6.3.6 System operation

A means of detecting a potential fire at the source connection or process gas panel shall be provided in accordance with the requirements of 11.2.1. The means provided shall be designed to minimize personnel exposure when silane flow is initiated after a change of source containers occurs.

系統操作

矽甲烷氣源銜接與製程氣體盤面潛在著火的偵測方法，必須根據11.2.1的要求。當矽甲烷氣源容器更換後，矽甲烷開始流動時，應提供降低人員暴露之設計。

6.3.7 Shutdown and source isolation

A means for shutting down the silane delivery system shall be provided in accordance with the requirements of 6.4.3.

關斷及氣源隔離

矽甲烷輸送系統關斷的方法，應依據6.4.3的要求。

6.3.7.1 Remotely located, manually activated shutdown

At least one remotely located, manually activated shutdown control shall be provided. The shutdown control shall be located not less than 15 ft (4.6 m) from the source of supply and the process gas panel control system. Activation of the shutdown control shall immediately stop the flow of gas at the source and isolate the source from the delivery system. Additional remotely located, manually activated shutdown controls shall be located at each exit from the secured area.

遠端手動關閉

至少應提供一個遠端手動關斷控制裝置。關斷控制裝置距離矽甲烷氣源和製程控制盤面控制系統，不得少於15呎(4.6公尺)。關斷控制應可立即啓動關閉氣源停止氣體的流動，並且隔離來自供氣系統的氣源。在每一個出入口應再增設遠端手動控制以防護整個區域。

6.3.7.2 Automatic shutdown

An automatic shutdown system shall be provided to automatically shut off the gas flow when fire is detected in accordance with the requirements in 11.2.

自動關斷系統

當偵測到著火時，根據11.2 的要求，自動關斷系統應能自動關閉氣流。

6.3.8 Arrangement of cylinder systems

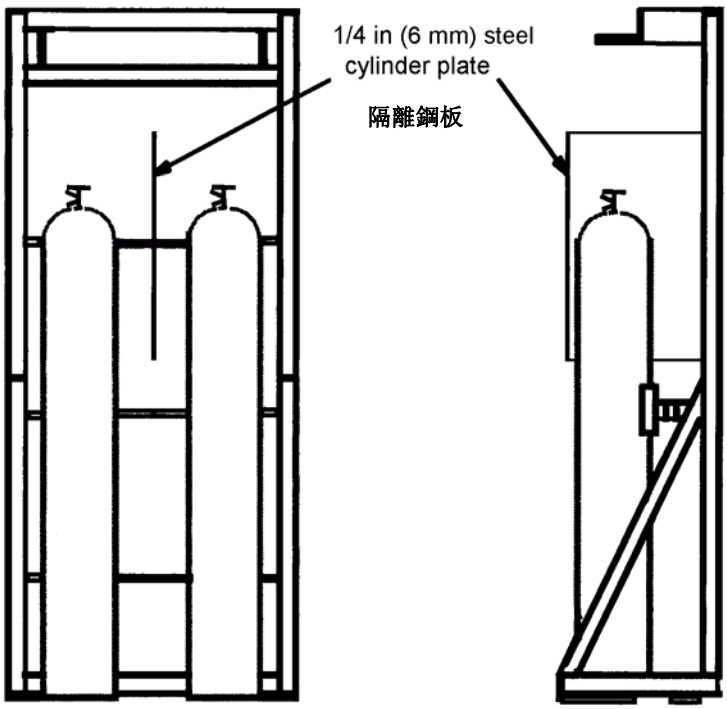
Individual cylinders containing silane shall be secured in open steel racks and separated from other silane cylinders to prevent flame impingement from a silane release to an adjacent cylinder or valve area. Separation shall be by 1/4 in (6 mm) thick steel plates with the plate extended a minimum of 18 in (460 mm) below the centerline of a cylinder valve and a minimum of 6 in (150 mm) above the centerline of the cylinder valve or other means providing equivalent protection. An exception to this is individual cylinders in attended transfer operations that are in the process of being filled shall not be required to be separated by barriers to prevent flame impingement.

Figure 2 shows an example of an open steel rack with steel plate separators designed to prevent flame impingement on adjacent cylinders if failure at a cylinder valve occurs. Figure 3 shows a typical outdoor area used for unattended operations.

鋼瓶系統的配置

每一矽甲烷鋼瓶，應置於開放式鋼架上，並與其他矽甲烷鋼瓶分離，以避免其他臨近的鋼瓶或閥區，因為矽甲烷漏氣造成的火焰影響。隔離方法是透過1/4吋(6公釐)厚的鋼板延伸到距瓶閥中線下方至少18吋(460公釐)之處，往上則到高於瓶閥中線至少6吋(150公釐)之處，或提供同等的保護方法。例外情況為，鋼瓶處於充填過程且在監控之下，可不需使用屏障隔離來防止火焰侵入。

圖2所示爲開放式鋼架使用鋼板作爲鋼瓶隔離的範例。隔離鋼板的設計在於防止瓶閥失效時，火焰侵入鄰近的鋼瓶。圖3所示爲一個典型的室外操作使用。

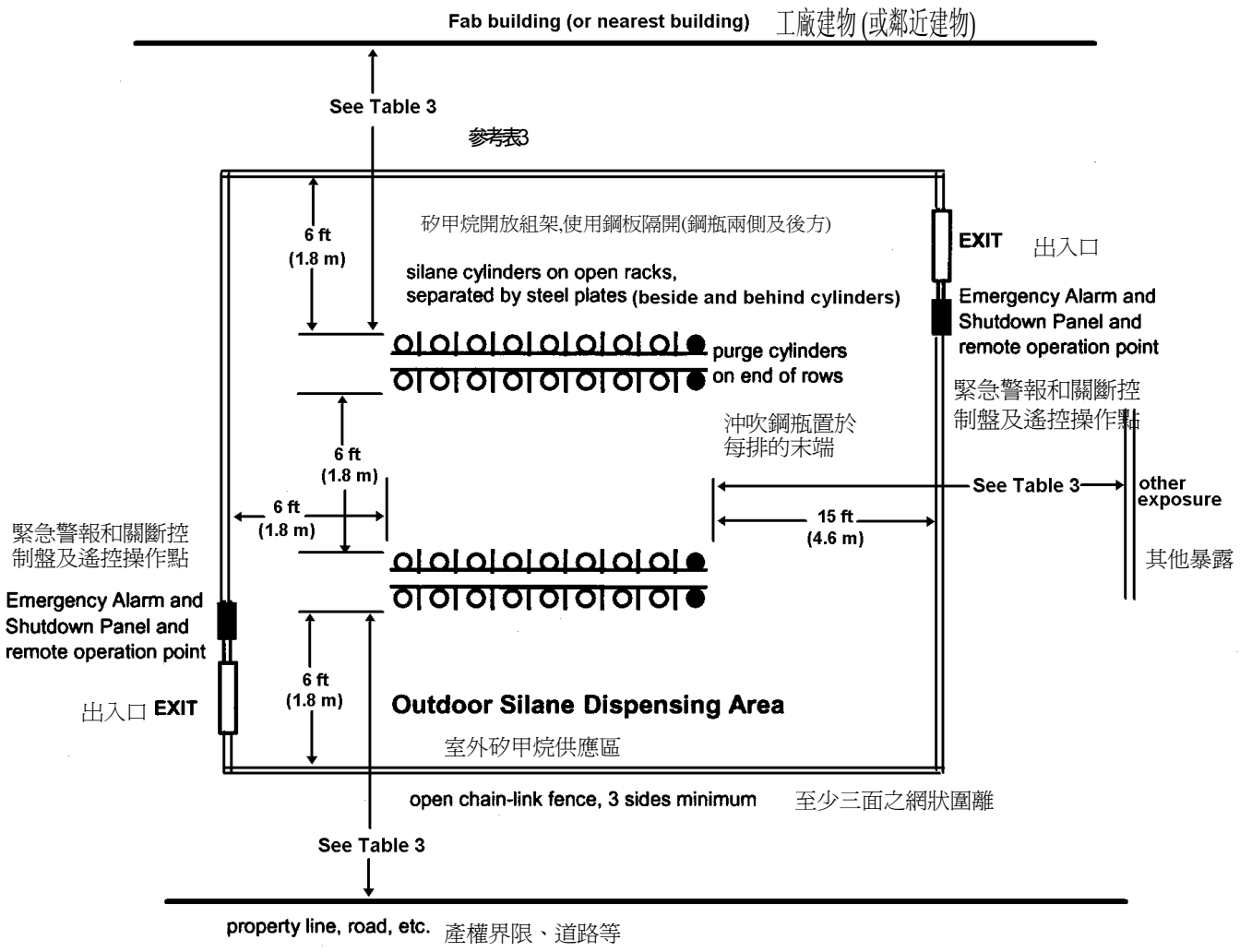


NOTE—The plate is designed to prevent flame impingement from the valve source to the adjacent cylinder. The plate shall be extended below the centerline of the valve a minimum of 18 in (460 mm). Figure 2 has been provided to illustrate the concepts described in the text of the standard. The figure is schematic in nature. It is neither to be interpreted as a design document nor is it intended to restrict alternate designs.

註：隔離鋼板的設計在於防止從瓶閥的火焰衝擊到鄰近的鋼瓶。隔離鋼板應從閥的中心線向下延伸至少18吋（460公釐）。圖2表示本標準內文所說明的概念。圖示本身僅為示意，不必以此作為設計文件的解釋或用於限制其他替代設計。

Figure 2—Support structure protection against flame impingement

圖 2 – 防止火焰影響的支撐保護結構



NOTE—Figure 3 has been provided to illustrate the concepts described in the text of the standard. The figure is schematic in nature. It is neither to be interpreted as a design document nor is it intended to restrict alternate designs. For instrument nomenclature, see Figure 1. Figure 3 applies only to steel cylinder or aluminum cylinder protected with aluminum overwrap. For unprotected aluminum cylinders, see Table 3.

註：圖3顯示本標準內文所說明的概念。圖示本身僅為示意，不必以此作為設計文件的解釋或用於限制其他替代設計。關於儀器術語，請參閱圖1。圖3僅適用於鋼瓶或有瓶帽保護的鋁瓶，而未保護的鋁瓶則參見表3。

Figure 3—Typical end user outdoor cylinder layout
圖3 – 典型末端消費使用者室外容器配置

6.3.9 Arrangement of bulk source systems

A silane bulk source system includes a bulk container of silane discharging through a pressure control and piping system. Bulk source delivery systems shall be in accordance with the requirements of 6.4.5 and Section 9.

大宗氣源系統之配置

大宗矽甲烷氣源系統包括經由壓力控制流出矽甲烷的大型容器及管路系統。大宗氣源供氣系統將根據6.4.5及第9章之要求。

6.3.9.1 Operator controls

The silane bulk gas supply control system shall consist of one or more control panels and one or more process gas panels.

操作者控制

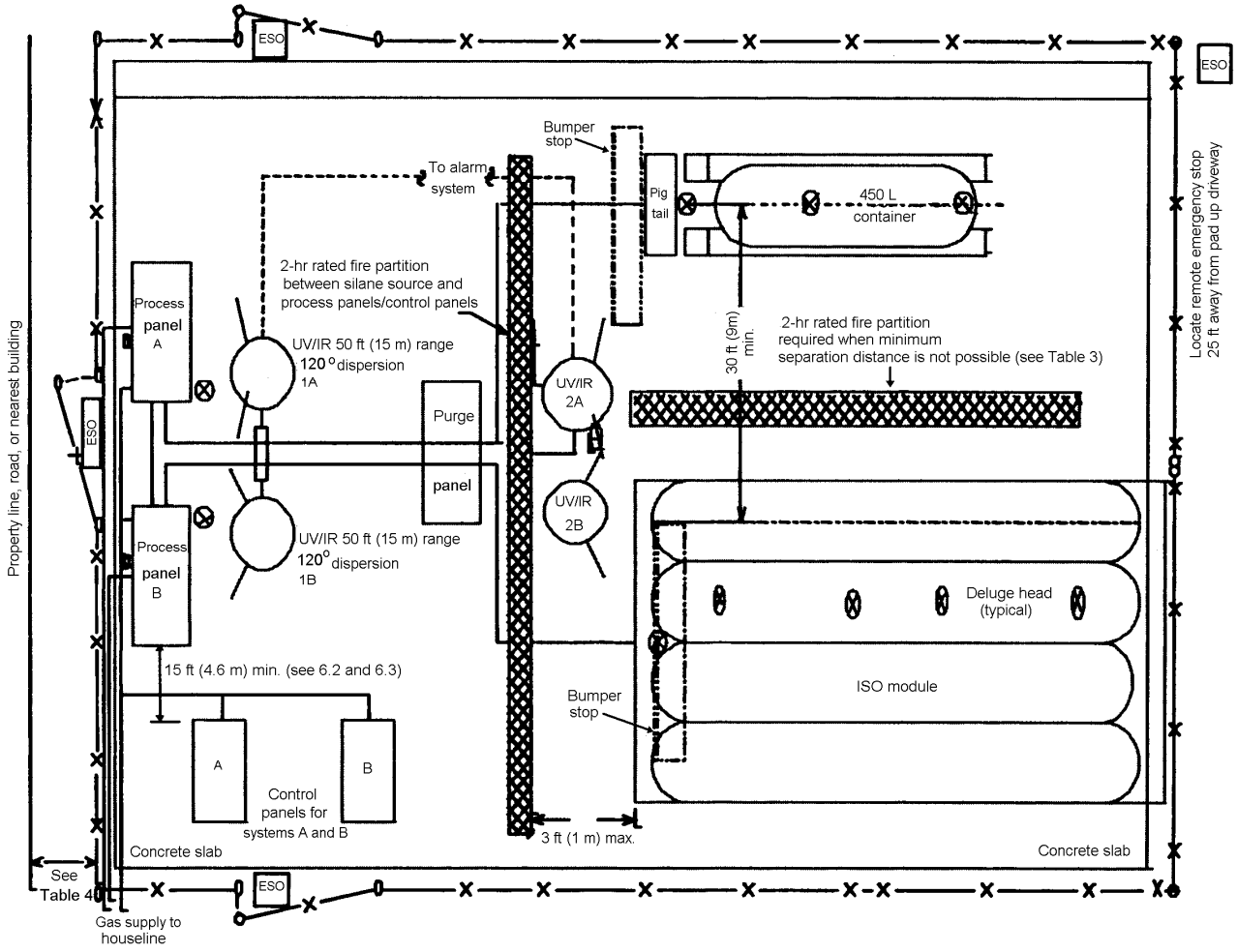
大宗矽甲烷氣源供應控制系統應由一個或多個控制盤面及一個或多個製程氣體盤面所組成。

6.3.9.2 Panel location

A typical bulk source container layout is shown in Figure 4.

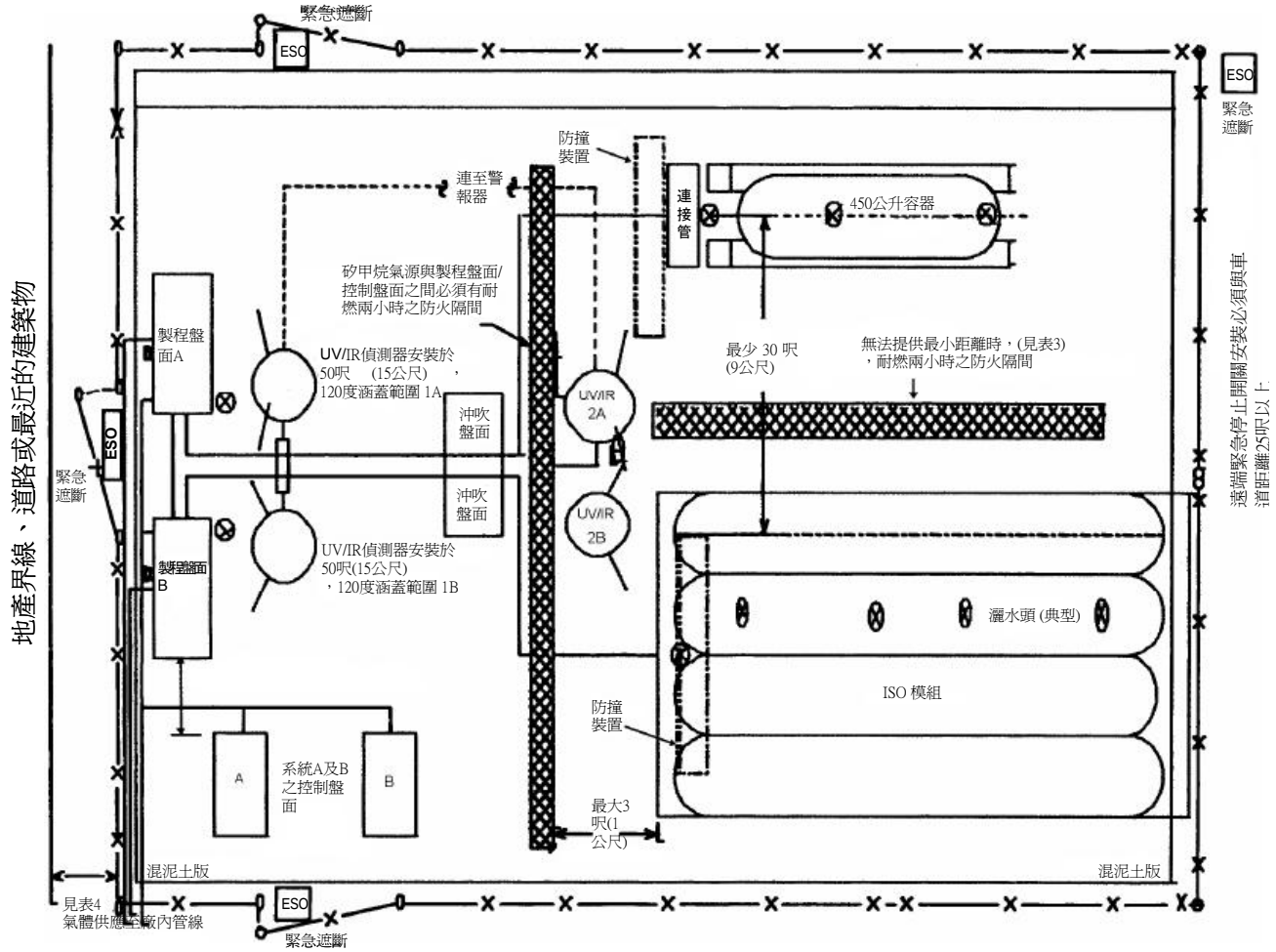
盤面位置

典型的大宗矽甲烷氣源配置圖如圖4所示。



NOTE—Figure 4 has been provided to illustrate the concepts described in the text of the standard. The figure is schematic in nature. It is neither to be interpreted as a design document nor is it intended to restrict alternate designs. For instrument nomenclature, see Figure 1.

Figure 4—Typical bulk source container layout (unattended operations)



註：圖4 顯示本標準內文所說明的概念。圖示本身僅為示意，不得解釋為設計文件或用於限制其他替代設計。關於儀錶術語，請參閱圖1。

圖4 – 典型的大宗氣源容器配置（消費操作）

6.3.9.2.1 Separation between control panels and bulk sources

There shall be a 2 hour fire partition provided between the silane bulk source containers and the control panels or process gas panels. Alternatively, a 30 ft (9 m) separation shall be provided between the supply containers and the control or process gas panels.

控制盤面和大宗氣源之間的分隔

大宗矽甲烷氣源容器與控制盤面或製程氣體盤面之間應有耐燃2小時之防火隔間。否則，必須間隔30呎(9公尺) 以上。

6.3.9.2.2 Separation between control panels and process gas panels

Control panels shall be located not less than 15 ft (4.6 m) from process gas panels.

控制盤面和製程氣體盤面之間的分隔

製程氣體盤面與控制盤面的分隔不應小於15呎 (4.6公尺)。

6.3.9.2.3 Field of view between control panels and process gas panels

Control panels shall be mounted in a location that allows an unobstructed view of the process gas panels (potential leak points).

控制盤面和製程氣體盤面之間的視野

控制盤面的安裝與製程氣體盤面 (潛在洩漏點) 之間不可有任何視線阻擋。

7 Indoor storage and use 室內儲存與使用

7.1 Applicability 適用性

In addition to the requirements of Section 7, indoor storage and use of silane shall be in accordance with the requirements of Sections 8 through 17 as applicable. An exception to this is individual containers with a silane content not greater than 0.50 scf (14 L).

除第7章的要求之外，矽甲烷的室內儲存和使用尚需符合第8到17章適用部分的要求。如果單一矽甲烷容器容量不大於0.50 立方呎 (14公升) 可爲例外。

7.2 Indoor storage 室內儲存

Indoor storage of silane shall be in accordance with the requirements of 7.2 and 7.4 through 7.10 as applicable. Buildings, rooms, or areas used for silane storage shall be constructed in accordance with the requirements of national codes and regulations.

矽甲烷於室內儲存應符合7.2和7.4到7.10的適用要求。用於矽甲烷儲存的建物，房間或地區應符合國家或當地法規的要求建造。

7.2.1 Bulk sources

Silane bulk sources shall not be located indoors.

大宗氣源

矽甲烷大宗氣源不可設置於室內。

7.2.2 Location

Silane shall not be stored in locations below ground level.

位置

矽甲烷不可儲存在低於地面的位置。

7.3 Indoor use 室內使用

Indoor use of silane shall be in accordance with the requirements of 7.3 and 7.4 through 7.10 as applicable.

室內使用矽甲烷應符合7.3 和7.4到7.10的適用要求。

7.3.1 Bulk sources and systems

Silane bulk sources shall not be located indoors.

大宗氣源和系統

矽甲烷大宗氣源不可設置於室內。

7.3.2 Nonbulk sources and systems

Nonbulk silane sources and delivery systems are allowed indoors. Buildings, rooms, or areas used for the installation of silane delivery systems shall be constructed in accordance with 7.3.2.2 and the requirements of national codes and regulations. The guidelines for indoor cylinder systems are analogous to those for outdoor cylinder systems. The difference is that indoor installations have additional requirements for forced fresh air ventilation across mechanical connections to prevent accumulation of silane in the event of a release and controls to limit potential damage in the event of fire or explosion.

非大宗氣源和系統

非大宗矽甲烷氣源和供氣系統可以設置在室內。用於設置矽甲烷供氣系統的建物、房間或地區必須符合7.3.2.2及國家或當地法規的要求建造。室內鋼瓶系統的指導綱要與室外鋼瓶系統類似，差別在於室內設置必須加裝額外強制通風系統使其通過機械式接點，以避免矽甲烷洩漏時造成累積並控制以限制潛在火災或爆炸的傷害。

7.3.2.1 Location

Silane delivery systems shall not be installed below ground level.

位置

矽甲烷供氣系統不可設置在低於地面的位置。

7.3.2.2 Barricade construction

7.3.2.2.1 Unattended operations

Rooms or areas used to contain silane sources used in unattended operations shall be constructed to meet the requirements for barricade construction designed to address the potential for a detonation of released material. Ordinary construction methods and the use of explosion venting or relief systems are not allowed as a means to offset the effects of a detonation.

防禦建設

消費操作

消費操作使用時，設置矽甲烷氣源的房間或地區，應符合防禦建設設計的要求以防物質釋放引發爆震的潛在風險。使用普通建造方式及洩爆口或釋放系統設計不可當作抵銷爆震效應的方法。

7.3.2.2.2 Attended operations

Rooms or areas used for attended transfer operations shall not be required to meet the requirements for barricade construction when such areas are in conformance with the requirements of 7.3.2.2.3 or 7.3.2.2.4 as applicable.

生產操作

用以轉充操作的房間或地區，如果已經符合7.3.2.2.3或7.3.2.2.4的適用規範，則不須再符合防禦建設的要求。

7.3.2.2.3 Filling in exhausted enclosures

Cylinders shall be filled in exhausted enclosures in accordance with the requirements of 7.3.2.2.3 or shall be filled in a gas filling room in accordance with the requirements of 7.3.2.2.4. Filling operations conducted in exhausted enclosures shall comply with all of the following:

- Explosion control shall be provided in accordance with 7.5;
- Cylinders being filled shall be located within an exhausted enclosure that is ventilated in accordance with the requirements of 13.2; and
- Gas monitoring shall be provided in accordance with 11.1.2. The gas monitoring system shall initiate a local alarm to alert operators at concentrations of 5 ppm (TLV-TWA) or less [7]. Activation of the monitoring system shall automatically isolate the source of gas supply from the filling manifold.

在密閉排氣空間灌充

鋼瓶必須於符合7.3.2.2.3要求的密閉排氣空間灌充，或於符合7.3.2.2.4要求的氣體灌充室灌充。於密閉排氣空間進行灌充操作必須符合下列事項：

- 爆炸控制必須符合7.5的要求；
- 鋼瓶灌充時必須置於符合13.2要求的密閉排氣空間內；並且
- 氣體監控應依據11.1.2要求設置。氣體監控系統須設定在小於或等於5 ppm (恕限值-時量平均容許濃度，TLV-TWA)時[7]，啓動地區警報警告操作人員。啓動中的監控系統必須自動於灌充盤面切斷氣體供應來源。

7.3.2.2.4 Filling in gas filling rooms outside of exhausted enclosures

Cylinders shall be filled in gas filling rooms in accordance with the requirements of 7.3.2.2.4 or shall be filled in an exhausted enclosure in accordance with the requirements of 7.3.2.2.3. Filling operations in gas filling rooms shall comply with all of the following:

- Explosion control shall be provided in accordance with 7.5;
- Cylinders being filled shall be considered to be in unenclosed indoor installations. Ventilation shall be provided in accordance with the requirements of 13.2; and
- Gas monitoring shall be provided in accordance with 11.1.2. The gas monitoring system shall initiate a local alarm to alert operators at concentrations of 5 ppm (TLV-TWA) or less [7]. Activation of the monitoring system shall automatically isolate the source of gas supply from the filling manifold.

在密閉排氣空間以外的氣體灌充室灌充

鋼瓶必須於符合7.3.2.2.4要求的氣體灌充室灌充，或於符合7.3.2.2.3要求的密閉排氣空間灌充。於氣體灌充室進行灌充操作必須符合下列事項：

- 爆炸控制必須符合7.5的要求；
- 鋼瓶灌充應視爲在非密閉之室內裝置進行。通風必須符合13.2的要求；而且
- 氣體監控應依據11.1.2要求設置。氣體監控系統須設定在小於或等於5 ppm (恕限值-時量平均容許濃度，TLV-TWA)時[7]，啓動地區警報警告操作人員。啓動中的監控系統必須自動於灌充盤面切斷氣體供應來源。

7.4 Egress 出入口

There shall be a minimum of two exits from storage and use areas. An exception to this is one exit is allowed when areas are less than 200 ft^2 (19 m^2). unless national regulations indicate otherwise and the equipment is arranged so the exit access is clear.

儲存和使用地區不能少於二個出入口。可例外的是使用區域小於200平方呎(19平方公尺)，且設備安裝妥當未擋住出入口，只有一個出口是被允許的。

7.4.1 Travel distance to exits

The maximum travel distance to an exit shall not exceed 75 ft (23 m).

出入口的行經距離

到出入口的最大行經距離不能超過75呎(23公尺)。

7.5 Explosion control 爆炸控制

A means of explosion control shall be provided when the quantity of silane in individual containers exceeds 0.50 scf (14 L). Explosion control shall be designed and constructed in accordance with the requirements of national building and/or fire codes.

當單一容器內矽甲烷的容量超過0.50
立方呎(14公升)時，應設置爆炸控制裝置，爆炸控制裝置之設計與裝設應符合國家及當地建造法規的要求。

7.6 Electrical requirements 電氣要求

For requirements see 16.3.

電氣的要求請參考16.3。

7.7 Ventilation 通風

For requirements see 13.2.

通風的要求請參考13.2。

7.8 Quantity limits 總量限制

7.8.1 Buildings containing mixed uses

The maximum quantity of silane and other pyrophoric gases stored or used inside buildings containing other occupancies or uses (mixed uses) as defined by national building codes shall not exceed detached building threshold limits as established by national codes. Quantities of silane and other pyrophoric gases exceeding this amount shall either be located in a detached building or outdoors.

混合使用建築物的規範

依照國家及/或當地建築法規規範包含其他使用目的建築物內，矽甲烷及自燃性氣體儲存或使用的最大量，不得超過國家及/或當地建築法規規範須使用獨棟建築物的數量基準值。矽甲烷及其他自燃性氣體數量超過此基準值時，應將其設置於獨棟建築物內或室外。

7.8.2 Detached buildings

The maximum quantity of silane in detached buildings shall not be limited when the use of the building is confined solely to the storage or use of hazardous materials and the building, storage or use conditions comply with applicable national codes.

獨棟建築物

當獨棟建築物僅限於儲存或使用危害物質，且建築物、儲存或使用狀況符合國家及/或當地法規時，矽甲烷不應有最大量的限制。

7.9 Separation from incompatible materials 不相容物之隔離

Regardless of whether a detached building or mixed-use building is used, silane shall be separated from incompatible materials in storage and use as required by national or regional codes and regulations. Separation shall be provided by distance, gas cabinets or similar appliances, or noncombustible partitions.

不管是獨棟建築物或混合使用的建築物，矽甲烷的儲存與使用必須依照當地法規的要求與不相容物隔離；隔離的方式可以是一定距離、氣瓶櫃、類似裝置或不可燃的隔間。

7.10 Gas cabinets 氣瓶櫃

Gas cabinets or equivalent ventilated enclosures shall be provided for silane sources or systems in use where the pressure of the gas supply exceeds 30 psig (207 kPa) or where silane is mixed with a toxic or highly toxic component. When gas cabinets are used, refer to 8.2.2.

An exception to this is cylinders in rooms meeting the requirements of 7.3.2 and the requirements of 13.2 for unenclosed indoor installations.

矽甲烷氣源或系統的使用，當氣體的壓力超過30 psig (207 kPa) 或矽甲烷與毒性或者高毒性成份混合時，
應使用氣瓶櫃或等同的密閉通風裝置。當使用氣瓶櫃時，請參考8.2.2。

可以例外的是當矽甲烷鋼瓶使用的房間符合7.3.2的要求和13.2的非密閉室內裝置的要求。

7.11 Other requirements 其他要求

The additional control measures required by 7.11 shall be provided when silane storage or delivery systems are located indoors.

當矽甲烷儲存或供氣系統設置在室內時，應符合7.11的額外控制措施要求。

7.11.1 Engineering controls

Detailed information on the required controls is provided in the referenced sections:

- system configuration — See Section 8
- piping and components — See Section 10
- gas monitoring — See Section 11.1
- flame or heat detection — See Section 11.2
- fire protection — See Section 12
- ventilation — See Section 13
- venting and treatment — See Section 14
- inert purge gas systems — See Section 15
- electrical — See Section 16
- supervisory control systems — See Section 17

工程控制

必須控制的細部資訊，規範在下列章節中：

- 系統配置 — 參閱第8章
- 管路與元件 — 參閱第10章
- 氣體偵測 — 參閱第11.1章
- 火焰或熱偵測 — 參閱第11.2章
- 消防系統 — 參閱第12章
- 通風系統 — 參閱第13章
- 排放與處理 — 參閱第14章
- 惰性沖吹氣體系統 — 參閱第15章
- 電氣要求 — 參閱第16章
- 監督控制要求 — 參閱第17章

7.11.2 Shutdown and source isolation

A means for shutting down the silane delivery system shall be provided.

At least one remotely located, manually activated emergency shutdown system is required. The shutdown system shall be capable of being activated from a point immediately outside of and adjacent to each exit door from the room or area in which silane delivery systems are located. Activation of the shutdown system shall immediately stop the flow of gas at the source and isolate the source from the delivery system. Activation of the shutdown control shall sound a local alarm.

關閉與氣源隔離

必須建立矽甲烷輸送系統關閉的程序。

至少必須設置一套遠端、手動啟動之緊急關閉系統。緊急關閉系統必須可以在緊鄰矽甲烷供氣系統的房間或區域之各出口外啟動。緊急關閉系統啟動後，必須可立即停止氣體流並隔離供應系統的氣源。緊急關閉系統啟動的同時，現場必須伴隨發出聲響警報。

8 System configuration—cylinder sources系統配置—鋼瓶氣源

8.1 Outdoor installations 室外裝置

8.1.1 Use equipment

Equipment used for outdoor cylinder installations consists of individual source and purge gas supply cylinders, a process gas panel, a purge gas panel, and a support structure. For information on locating cylinders, support structures, and typical layout, see 6.1 and 6.3 and Figures 2 and 3.

使用設備

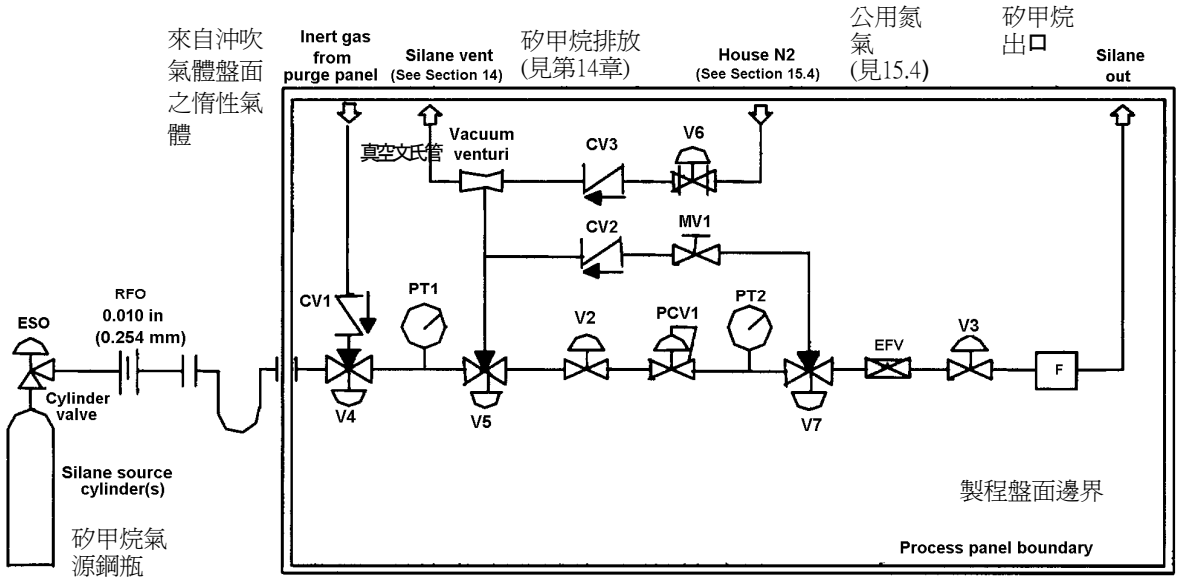
室外鋼瓶設置是由個別的氣源、沖吹氣體供應鋼瓶、製程氣體盤面、沖吹氣體盤面和支撐結構所組成。鋼瓶位置、支撐結構和典型配置圖資訊，請參考6.1，6.3及圖2和圖3。

8.1.2 Process gas panel

Process gas panels shall be used to regulate the downstream pressure of gas from the silane source cylinder(s) to a VMB or point of use. General requirements for process gas panel piping systems, RFO, emergency shutoff system (ESO) valves, and components are specified in Section 10. See Figure 5.

製程氣體盤面

必須使用製程氣體盤面以調節矽甲烷氣源鋼瓶到下游氣體供應分歧箱/模組 (VMB) 或使用點的氣體壓力；製程氣體盤面的管路系統、限流器(RFO)、緊急遮斷系統(ESO) 閥門及組成元件規範於第10 章。請參閱圖



NOTE—The ESO valve is allowed to be located on the cylinder or on the pigtail close coupled to the cylinder. Figure 5 has been provided to illustrate the concepts described in the text of the standard. The figure is schematic in nature. It is neither to be interpreted as a design document nor is it intended to restrict alternate designs. For instrument nomenclature, see Figure 1.

註：緊急遮斷（ESO）閥可安裝在鋼瓶上或在緊鄰鋼瓶的連接管上。圖5展示本標準內文所說明的概念。圖示本身僅為示意，不得以此作為設計文件的解釋或用於限制其他替代設計。關於儀器術語，請參閱圖1。

Figure 5—Typical silane process gas panel
圖 5 – 典型的矽甲烷製程氣體盤面

8.1.2.1 Materials of construction

Process gas panel components shall be constructed of materials compatible with silane and assembled with components and fittings designed to minimize leakage.

構建材料

製程氣體盤面必須使用與矽甲烷相容的材料構建與以最小洩漏的設計組合相關元件與接頭。

8.1.2.2 Excess flow control

Process gas panels shall be provided with excess flow control in accordance with the requirements of 10.2.5.

超過流量控制

製程氣體盤面應符合10.2.5的要求設置超過流量控制。

8.1.3 Purge gas panel

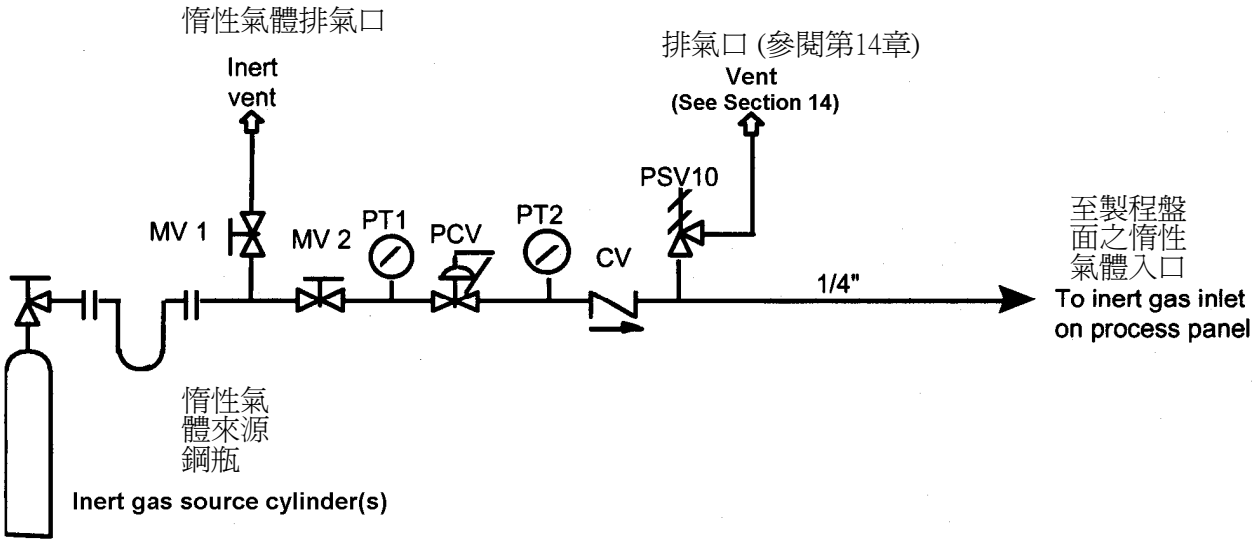
Purge gas panels shall be provided as a means to control the supply of inert purge gas to process gas panels serving each silane delivery system. Purge gas panels shall be designed to prevent the backflow of process gas and potential cross-contamination of the purge gas source. Individual purge gas panels serving process gas panels used to control silane gas shall be solely for use on silane delivery systems.

Silane systems shall be purged with an inert gas by means that ensures complete purging of silane from the piping and control system before the source system is either opened to the process or to the atmosphere at times when silane sources are changed or for purposes of maintenance. See Figure 6.

沖吹氣體盤面

必須設置沖吹氣體盤面以供應惰性沖吹氣體至每一組製程氣體盤面給氣體供應系統使用。沖吹氣體盤面必須設計可防止製程氣體逆流，潛在交錯汙染沖吹氣體氣源的風險。個別的沖吹氣體盤面必須單獨用於矽甲烷供氣系統的製程氣體盤面。

當維修或更換氣源時，在氣源系統可通至製程或開放大氣之前，應用惰性氣體沖吹矽甲烷系統，以確保矽甲烷管路及控制系統沖吹完全。請參閱圖6。



NOTE—Figure 6 has been provided to illustrate the concepts described in the text of the standard. The figure is schematic in nature. It is neither to be interpreted as a design document nor is it intended to restrict alternate designs. For instrument nomenclature, see Figure 1.

註：圖6展示本標準內文所說明的概念。圖示本身僅爲示意，不得以此作爲設計文件的解釋或用於限制其他替代設計。關於儀器術語，請參閱圖1。

Figure 6—Typical silane purge gas panel
圖 6 – 典型的矽甲烷沖吹氣體盤面

8.2 Indoor installations 室內裝置

8.2.1 Use equipment

Equipment used for unattended operations conducted with indoor cylinder installations consists of individual source and purge gas supply cylinders, a process gas panel, a purge gas panel, and gas cabinet or rack system. VMBs are customarily used in indoor installations where distribution to multiple use points is required. See 8.2.4.

使用設備

消費操作的室內鋼瓶設置設備是由個別的氣源、沖吹氣體供應鋼瓶、製程氣體盤面、沖吹氣體盤面及氣瓶櫃或支撐結構所組成。氣體供應分歧箱/模組(VMBs) 通常爲室內裝置，用於分配氣體至所需的多個使用點。

參考 8.2.4。

8.2.2 Gas cabinet systems

A gas cabinet system is comprised of the cabinet or enclosure, the controller (when automated controls are provided), and process gas panel(s). A gas cabinet is a protective device used to house compressed gas cylinder(s) and to ensure that a potential gas release is confined to the area where released and directed away from operators and plant personnel. Gas cabinets are connected to an exhaust system that is used to capture and remove leaked gas and transport it to a point of discharge away from personnel, air intakes, or building openings.

Gas cabinets are fully enclosed appliances designed to house the cylinder(s) they contain. They are uniformly exhausted to maximize operator protection during use and to ensure operator protection while making and breaking connections during cylinder changes. Once a gas cylinder has been secured into an enclosure, limited access is used (usually a large lockable window) to allow operators to view and operate the process gas panels contained inside the cabinet. The purge gas panel(s) is typically housed within the cabinet as well. The control panels used to operate the process gas panel(s), when such panels are automated, are typically installed outside the cabinet. The controller is commonly used to enable automated purge procedures to ensure efficiency and consistency in purge operations. The

process gas panel is typically designed to eliminate dead ends in the piping system, to minimize gas stream contamination, and to ensure the optimum purge efficiency.

氣瓶櫃系統

氣瓶櫃系統包括氣瓶櫃或密封箱、控制器
(當提供自動控制時)，和製程氣體盤面。氣瓶櫃是一個用於室內使用的壓縮氣體鋼瓶的保護裝置，可以確保可能的潛在氣體洩漏於限制的區域並且遠離操作人員及工廠的員工。氣瓶櫃連接一個排氣系統，用來捕捉及排除洩漏的氣體並將它傳送至遠離人員、通氣口或者建築物通道等的排放地點。

氣瓶櫃是一種完全阻隔的設備用於容納鋼瓶。氣瓶櫃均勻一致的排氣提供操作人員在進行鋼瓶更換與中斷鋼瓶連接時最大的保護。一旦鋼瓶被固定入氣瓶櫃內，其進入使用即受限(通常是一扇大的可上鎖的視窗)，只允許操作人員觀看及操作氣瓶櫃內的製程氣體盤面；沖吹氣體盤面通常也被設置在氣瓶櫃內；控制面板用於操作製程氣體盤面，當盤面設計成自動化時，控制面板通常被安裝在氣瓶櫃外。控制器通常用於執行自動化的沖吹程式程序以確保在沖吹過程中效率一致。典型的製程氣體盤面設計將氣體管路的死角消除，使氣體污染減到最小，並且確保最佳的沖吹效率。

8.2.2.1 Limitations

Where gas cabinets are used, only single-cylinder cabinets are recommended to minimize the exposure potential in the event of fire. Where there is more than one source cylinder in a gas cabinet, each cylinder shall be separated by a 1/4 in (6 mm) steel plate as described in 6.4.4.

限制

若使用氣瓶櫃，建議使用單支鋼瓶的氣瓶櫃，發生火災時可將暴露減到最小。若氣瓶櫃內有不止一支鋼瓶氣源，應依6.4.4的敘述，使用1/4吋 (6公釐)鋼板將每支鋼瓶隔開。

8.2.2.2 Labeling

Gas cabinets shall be labeled with the name of the process tool or equipment they serve, as well as with the name of the gases contained such as SILANE or SILANE MIXTURE and the type of purge gas used. Additional labeling indicating HAZARDOUS—KEEP FIRE AWAY shall be placed on the cabinet as a warning to prevent potential fire exposure and as a means to alert emergency response personnel to the presence of compressed gas cylinders.

標示

氣瓶櫃必須貼上所供應的製程設備的名稱及氣體名稱的標示，如**矽甲烷**或**矽甲烷混合物**及沖吹氣體的名稱。在氣瓶櫃上貼上附加的標示以表明具有**危害性--遠離火源**作爲警告以預防潛在火源暴露，並藉以提醒緊急事故處理人員注意到壓縮鋼瓶的存在。

8.2.3 Process gas and purge gas panel

Process gas panels and purge gas panels for indoor use shall be in accordance with the requirements of 8.1.

製程氣體和沖吹氣體盤面

於室內使用的製程氣體盤面和沖吹氣體盤面應符合8.1的要求。

8.2.4 Valve manifold box

8.2.4.1 Description

Gases in closed piping systems shall be allowed to be distributed through a VMB to one or more points of use. Distribution to multiple use points serves to reduce the quantity of source cylinders on site as well as the number of individual gas pipelines containing silane located throughout the user facility. VMBs are allowed to be controlled automatically using pneumatically operated valves. Operations such as emergency gas shutoff at the point of use and purging at the point of use are allowed to be accomplished with automated VMB systems without venting the primary delivery line from the gas source thereby minimizing the potential for contamination as well as the consumption of silane.

氣體供應分歧箱/模組(VMB)

描述

氣體在密閉的管路系統必須經由氣體供應分歧箱/模組(VMB) 分配到一個或多個使用點。 透過對多個使用點的分配可降低現場鋼瓶氣源的數量，及降低遍佈整個工廠包含矽甲烷氣體管路的數量。氣體供應分歧箱/模組

(VMBs) 可以使用氣動閥作自動控制， 諸如緊急關閉使用點氣源及使 用點沖吹就 可透過自動化的
氣體供應分歧箱/模組達成，而不需排放管路內已存在的氣體，進而使矽甲烷潛在的污染及消耗降到最低。

8.2.4.2 VMB manifold branch purging

VMB manifold branches shall be purged with an inert gas by means that ensure complete purging of the piping and control system before the system is used to deliver silane to the process or before the system is allowed to be opened to atmosphere for maintenance purposes. See Figure 7 for recommended locations of VMB manifold branch purging points.

氣體供應分歧箱/模組(VMB)沖吹

氣體供應分歧箱/模組(VMB)在供應矽甲烷到製程之前與因維修目的而拆除管路對大氣之前，必須使用惰性氣體沖吹，
以確保管路及控制閥件沖吹完全。氣體供應分歧箱/模組(VMB) 建議的沖吹點位置請參閱圖7。

8.2.4.3 Gas monitoring

Gas monitoring shall be provided at the VMB in accordance with the requirements of 11.1.2. Activation of the gas monitoring system shall shut down the source of gas at the VMB being monitored in accordance with the requirements of 11.1.5.

氣體監控

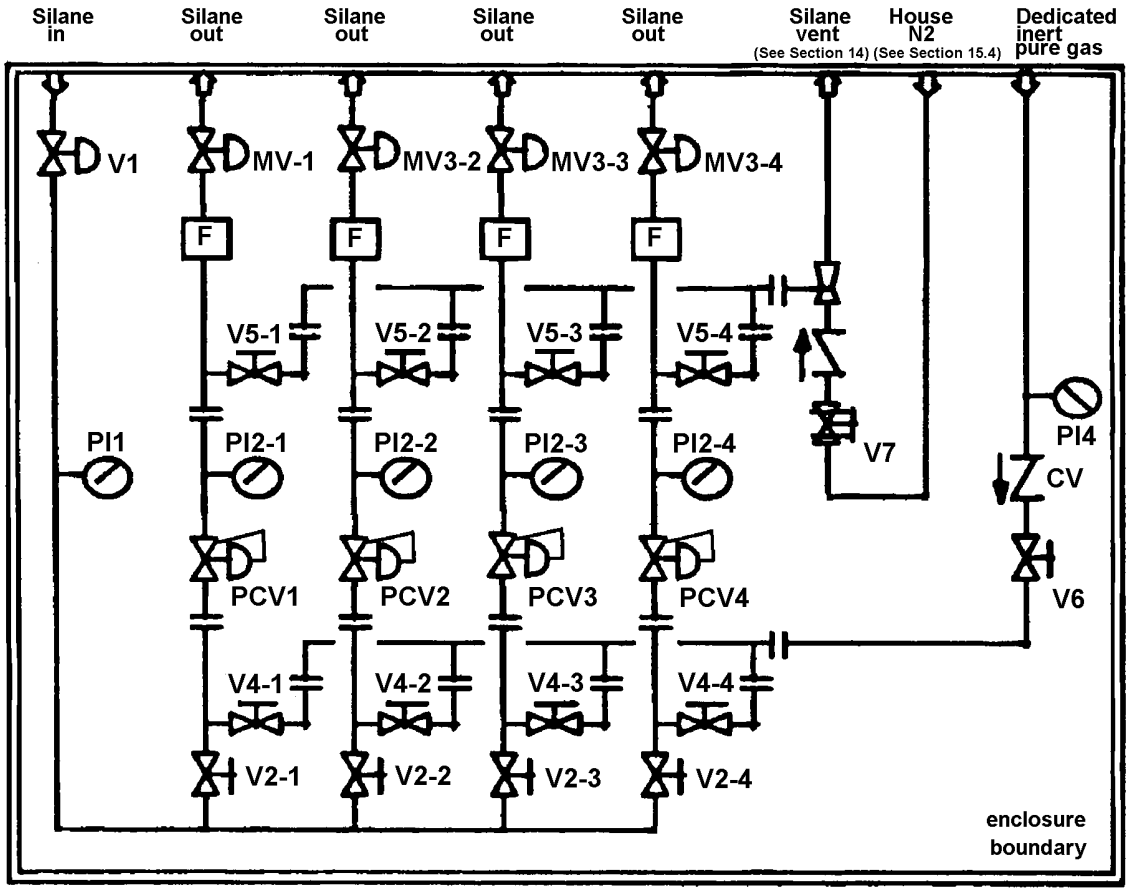
氣體供應分歧箱/模組(VMB)內應設置符合11.1.2要求的氣體監控系統。氣體監控系統啓動時必須符合11.1.5的要求，
關閉氣體供應分歧箱/模組(VMB)的供應氣源。

8.2.4.4 Flame detection

Flame detection shall be provided at the VMB in accordance with the requirements of 11.2.2.3. Activation of the flame detection system shall shut down the source of the gas supply at the VMB being monitored in accordance with the requirements of 11.2.3.

火焰偵測

氣體供應分歧箱/模組(VMB)必須符合11.2.2.3的要求設置火焰偵測器。火焰偵測系統啓動時必須符合11.2.2.3的要求，關閉氣體供應分歧箱/模組(VMB)的供應氣源。



NOTE—Figure 7 has been provided to illustrate the concepts described in the text of the standard. The figure is schematic in nature. It is neither to be interpreted as a design document nor is it intended to restrict alternate designs. For instrument nomenclature, see Figure 1.

註：圖7展示本標準內文所說明的概念。圖示本身僅為示意，不得以此作為設計文件的解釋或用於限制其他替代設計。關於儀器術語，請參閱圖1。

Figure 7—VMB flow schematic
圖 7 – 氣體供應分歧箱/模組(VMB)流向示意圖

9 System configuration—bulk sources系統配置—大宗氣源

9.1 Use equipment 使用設備

Equipment used for silane bulk source installations consists of a silane bulk source and its attendant control systems. A silane bulk source consists of an ISO module, tube trailer, cylinder packs, or individual containers having an aggregate water volume greater than 8.8 ft^3 (250 L). The attendant control systems include a process gas panel, purge gas panel, and control panel. Bulk silane source systems distribute silane to use points located indoors. Distribution within the building where the material is used is customarily performed using of VMBs. A typical process flow diagram is shown in Figure 8. Equipment used for bulk source systems shall be in accordance with the requirements of 6.4.5.

用於大宗矽甲烷氣源安裝之使用設備，包含大宗矽甲烷氣源及其相關之附屬控制設備。大宗矽甲烷氣源包含ISO標準模組之管束拖車、鋼瓶集束組、或是水容積總計達8.8立方英尺(250公升)之單一容器。
附屬控制設備包含製程系統氣體控制盤面、沖吹氣體之控制盤面和儀電控制面盤。大宗氣源供應系統，將矽甲烷分配傳送至室內之各使用點。建物內之分配傳送方式與設備，通常透過氣體供應分歧箱/模組(VMB)來執行。典型的製程流程圖面如圖-8 。大宗氣源供應系統的使用設備必須與6.4.5 的要求一致。

9.2 Outdoor installations 室外裝置

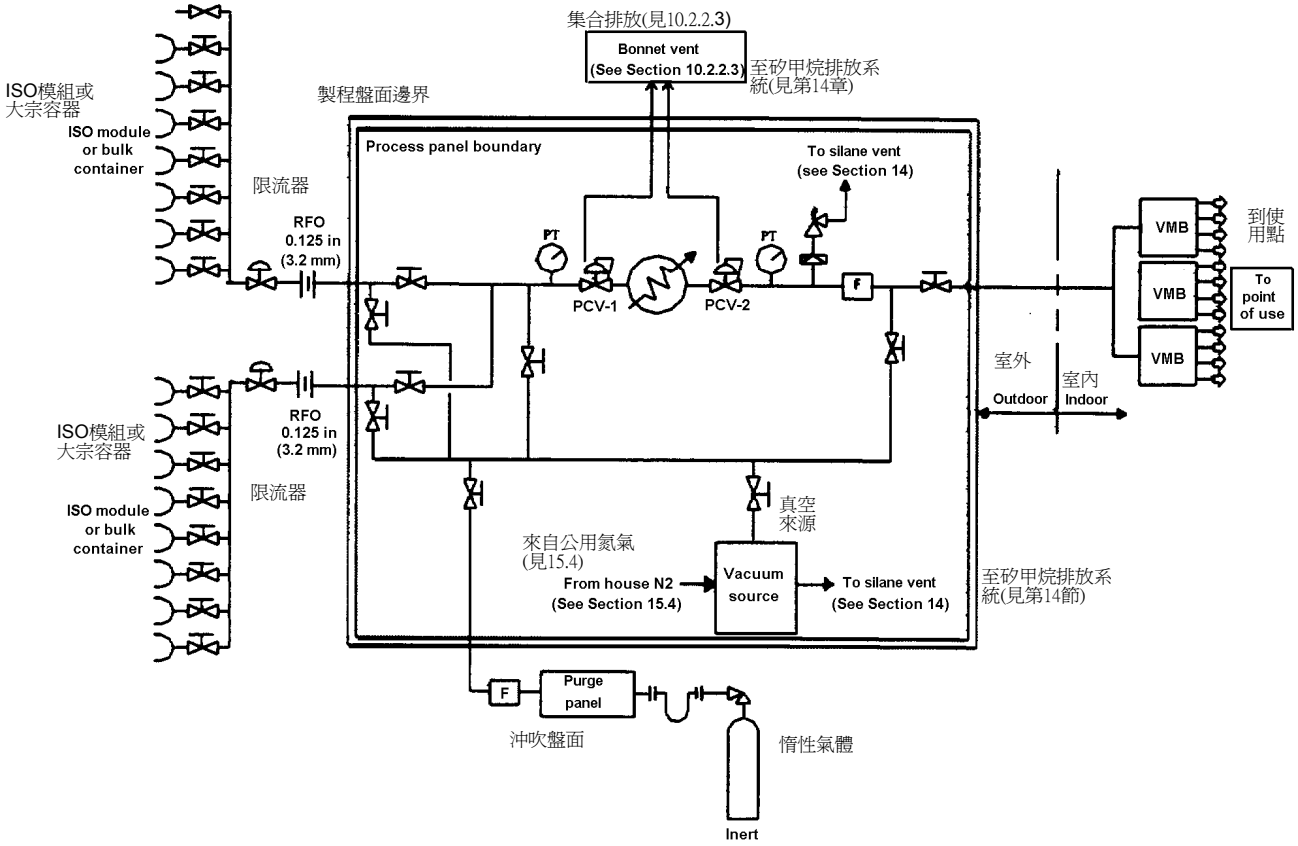
The location of outdoor delivery systems shall be in accordance with the requirements of Section 6.

室外輸送系統的位置必須與第6章的要求一致。

9.3 Bulk containers 室外裝置

Silane bulk source containers shall comply with 9.2 and relevant national regulations.

室外輸送系統的位置必須與第6章的要求一致。



NOTE—The vacuum source is either a vacuum pump system or a vacuum venturi system. Figure 8 has been provided to illustrate the concepts described in the text of the standard. The figure is schematic in nature. It is neither to be interpreted as a design document nor is it intended to restrict alternate designs. For instrument nomenclature, see Figure 1.

註：真空系統來源是真空泵系統或文氏管真空系統。圖8展示本標準內文所說明的概念。圖示本身僅為示意，不得以此作為設計文件的解釋或用於限制其他替代設計。關於儀器術語，請參閱圖1。

Figure 8—Typical bulk system process flow diagram
圖 8 – 典型大宗系統製程流程圖

9.3.1 Tube trailers and ISO modules

An ISO module consists of a number of cylindrical tubes that have been mounted onto a frame suitable for over-the-road and ocean transport. The typical tube is 2 ft (0.6 m) in diameter and ranges from 20 ft to 40 ft (6.1 m to 12.2 m) in length. The delivery end of the module is typically equipped with a piping manifold that interconnects each of the tubes in the system. Each tube contained within tube trailers or ISO modules shall have an isolation valve capable of isolating the silane supply from the piping manifold.

管束拖車及ISO模組

一部管束拖車包含許多圓筒型管束固定於框架中，適合陸地運輸及海上船運。典型的管束直徑是2呎（0.6公尺），長度介於20呎至40呎(6.1公尺至12.2 公尺)之間。 在模組的輸送端是以閥件歧管將各個管束互相連結。管束拖車模組中，每支管束本身必須安裝隔離閥，使管路盤面具備隔離矽甲烷供應的能力。

9.3.2 450-liter cylinders

A 450-liter cylinder is an individual cylinder with an internal water volume of approximately 16 ft^3 (450 L). The cylinder shall be mounted horizontally and fastened to a skid so a forklift truck or suitable power mover is able to move it. The typical 450-liter cylinder has a valve on one end.

450 公升鋼瓶

450公升鋼瓶是指內部水容積大約16立方呎（450公升）的單一鋼瓶。鋼瓶必須以水平方式固定及束緊於鋼瓶座上，使堆高機或適當之動力移動裝置可以搬運。典型的450公升鋼瓶於一端裝有瓶閥。

9.3.3 Cylinder packs

Cylinder packs have multiple silane cylinders assembled on a cart or skid. Some carts are equipped with wheels and a frame so they are able to be moved manually or with a forklift truck. The larger carts do not have wheels and depend on a forklift for movement. The typical internal water volume of the individual cylinders ranges from 1.52 ft^3 to 1.76 ft^3 (43 L to 50 L).

鋼瓶集束

鋼瓶集束是將多支矽甲烷鋼瓶組裝於小拖車或框架中。許多小拖車備有輪子及框架使其可以人力移動或堆高機搬運。而較大的小拖車組，則沒有輪子，須仰賴堆高機搬運。一般集束內單支鋼瓶內部的水容積是1.52立方呎至 1.76立方呎（43公升至50 公升）。

9.3.3.1 Securing of cylinders

Individual cylinders shall be firmly supported within the cart and frame assembly.

鋼瓶之固定

各支鋼瓶必須穩固固定於小拖車及框架中。

9.3.3.2 Isolation valves

Each cylinder shall be equipped with an isolation valve capable of isolating the cylinder from the piping manifold. The isolation valves shall be connected to a piping manifold that interconnects each cylinder to a common outlet valve and connection.

隔離閥

集束內各支鋼瓶必須裝有隔離之鋼瓶閥，使能隔離鋼瓶與連接歧管。隔離閥連接至歧管組，並與其它鋼瓶相互連 結，有共通的出口閥銜接。

9.3.3.3 Protection from flame impingement

Cylinders shall be separated from each other by 1/4 in (6 mm) thick steel plates or other means designed to prevent flame impingement from a silane release to an adjacent cylinder or valve.

火焰衝擊防護

框架內鋼瓶必須以1/4吋（6毫米）厚鋼板區隔或其它等同的設計方式，以避免因矽甲烷洩漏造成火焰衝擊相鄰的鋼瓶或瓶閥。

9.4 Pressure relief devices 壓力釋放裝置

Individual tubes or cylinders shall be equipped with pressure relief devices per relevant national regulations and industry standard. When multiple cylinders or tubes are grouped into a framework or other fixed system, the discharge from pressure relief devices shall be directed away from adjacent containers within the group.

各支管束或鋼瓶必須裝有依49 CFR Part 173.301(f) 及 CGA S-1.1 [5,11]規範之壓力釋放裝置。
當數個鋼瓶或管束組裝於同一框架，或其它固定設備時，壓力釋放裝置的出口必須導引離開同組內相鄰的鋼瓶容器。

9.4.1 Bulk source process gas panel

The silane bulk source process gas panel is used to regulate the pressure from silane bulk source storage systems downstream to the VMB(s) that is (are) customarily installed inside the building where the material is used. The process gas panel is typically an independent module mounted on a skid or independent frame. It consists of an arrangement of isolation valves, pressure regulation controls, filtration equipment, excess flow control, and other shutoff controls. A process heater is allowed to be used to prevent two phase flow where there are high flow demands and a Joule-Thompson cooling effect is probable. See Figure 8.

大宗氣源製程氣體盤面

大宗矽甲烷製程氣體盤面，是用以調整控制從大宗矽甲烷氣源儲存系統到下游客戶安裝於室內使用此物質的氣體供應分歧箱/模組(VMB)之壓力。典型的製程氣體盤面以獨立的模組化架設於托架或單一的框架上，它包含適當安排的隔離閥、壓力調整控制、過濾設備、過流量控制及其它中斷控制裝置。允許使用製程加熱器以避免因高流量使用，造成焦耳-湯普森（Joule-Thompson）冷卻效應的兩相流動。請見圖8。

9.4.2 Location

The silane bulk source process gas panel shall be located outdoors.

位置

大宗矽甲烷氣源之製程氣體盤面必須安裝於室外。

9.5 Valve manifold box 氣體供應分歧箱/模組(VMB)

VMBs are used in bulk distribution applications where there are multiple use points to be served by a single source. The typical VMBs used for bulk sources are of the same design as those described for use with indoor installations. See 8.2.4.

氣體供應分歧箱/模組(VMB)用於大宗氣體之分配輸送，使單一氣源能供應多個使用點。典型用於大宗氣源的氣體供應分歧箱/模組(VMB)的設計與安裝於室內的裝置是相同的。請見8.2.4。

9.5.1 Location

VMBs used in conjunction with bulk source systems are allowed to be located indoors.

位置

用於銜接大宗氣源供應系統的氣體供應分歧箱/模組(VMB)，是允許安裝於室內。

10 Piping and components 管路與元件

10.1 Piping system design 管路系統設計

Piping systems shall be designed, constructed, examined, inspected, and tested in accordance with established and recognized standards like ASME B31.3, *Process Piping* [14].

管路系統必須依照美國機械工程師學會ASME B31.3, *製程管路* [14] 之規範設計、建造、檢驗、檢查及測試。

10.1.1 Construction

Piping systems used for silane service shall be of metal construction.

建造

用於矽甲烷之管路系統應爲金屬材質。

10.1.2 Piping connections

Connections in the piping system shall be in accordance with established and recognized standards like ASME B31.3 [14]. Welded connections are the required method of assembly where connections in the piping system are needed. Exceptions are as follows:

- Face-seal fittings are allowed where connections are used for maintenance. Gaskets used with face-seal fittings shall be constructed of metal. The number of unwelded mechanical fittings shall be kept to a minimum and shall be secured in such a manner as to prevent leaks resulting from rotational or vibratory forces especially between the cylinder valve and the connecting pigtail; and
- Threaded connections used on cylinder valves inserted into source cylinders.

管路銜接

管路系統的銜接必須依照美國機械工程師學會ASME B31.3 [14]之規範。
管路系統之銜接，必須以焊接方式組裝，但下列除外：

- 用於維修作業之銜接，允許使用面密封接頭，用於面密封接頭之墊片，必須爲金屬材質。非焊接之機械管件，應保持於最低數量，並且必須確保防止因旋轉或震動產生洩漏，特別在瓶閥銜接鋼瓶銜接管之間；及
- 鋼瓶閥必須使用螺牙銜接旋入氣源鋼瓶。

10.1.3 Secondary containment

Secondary containment of piping systems shall not be required for piping used to convey silane or silane mixtures that are neither toxic nor highly toxic. When secondary containment or coaxial piping or tubing is provided, the secondary containment shall be of metal construction that is rated to contain the maximum pressure expected based on system design under failure of the primary piping or tubing system.

When secondary containment is provided, the use of air as a means to purge the annular space between the primary and secondary containment piping or tubing shall not be allowed due to the potential for an air/silane reaction and the resultant fire, explosion, and/or the subsequent plugging of the annular space.

二次圍堵

非毒性，亦非高毒性之矽甲烷或矽甲烷混合氣之管路並不要求其管路系統具備二次圍堵。如配備二次圍堵或雙套管路，其二次圍堵必須使用金屬材質，並能承受系統主要管路失效可能達到的最高壓力。

如使用二次圍堵時，不可使用空氣作爲沖吹主要與次要管路間夾層之空間，因爲其潛在空氣/矽甲烷反應及火災，爆炸及/或造成夾層空間的阻塞。

10.1.4 Manifolding with gases other than silane

矽甲烷以外的氣體盤面

10.1.4.1 Manifolding at the source of supply

Silane shall not be piped into manifolds used to convey other process gases upstream of the point of use.

供應氣源之盤面

矽甲烷不可連接至使用點上游之其他製程氣體盤面。

10.1.4.2 Manifolding at the point of use

Controls downstream of the first point of control within users' facilities are outside of the scope of this standard. See 2.1.2. Safeguards internal to the process equipment are used to prevent the material from coming into contact with re-

active gases until the right conditions are achieved. The use of a manifold to handle multiple gases at point-of-use process equipment shall be the responsibility of the equipment manufacturer and/or the owner.

使用點之盤面

使用者工廠的第一控制點之下游控制屬於本標準範圍之外，參見2.1.2。在達到正確條件之前，製程設備本質預防措施必須防止此物質與其他反應氣體接觸。在製程設備使用點，利用歧管操作多種氣體之責任，應爲設備製造商及/或其所有人。

10.1.4.3 Manifolding of vent gases

Silane and vent gases containing silane and an inert gas, e.g., nitrogen, from silane delivery systems or VMBs shall not be piped into manifolds used to convey other process gases.

氣體排放盤面

矽甲烷及排放氣體含矽甲烷及惰性氣體，例如來自矽甲烷輸送系統或氣體供應分歧箱/模組(VMB)的氮氣，不可銜接至其他製程氣體排放盤面。

10.1.5 Leak testing

Before initial operation and after the applicable examinations required by established and recognized standards like ASME B31.3, piping systems shall be leak tested to ensure tightness [14]. Piping systems that have been modified and/or repaired shall be tested as required for new installations.

洩漏測試

首次操作之前及依照美國機械工程師學會ASME B31.3 要求實施適當檢驗後，管路系統必須進行洩漏測試以確保其氣密性[14]。 管路系統經修改及/或維修後，應視同新設裝置實施測試。

10.1.5.1 Test pressure

Test pressures shall be determined to enable the system to be assessed for leaks under the conditions of use expected but not less than that specified by established and recognized standards like ASME B31.3 [14].

測試壓力

測試壓力應取決於系統在預期使用條件下，經評估所能容許之洩漏，但不得低於美國機械工程師學會ASME B31.3 [14]之規定。

10.1.5.2 Portions of the system subject to testing

Pressure testing of newly constructed systems shall include the entire piping system beginning from the source valves at the point of supply. Portions of the system are allowed to be tested independently; however, the entire system is subject to pressure tests as required by established and recognized standards like the ASME code. Testing of the source connection is required after each cylinder or container change.

系統分段測試

新設系統之壓力測試，必須包含從供應點的起始氣源閥開始之所有路系統。容許系統分段獨立測試；然而，整體系統必須依照美國機械工程師學會ASME標準實施壓力測試。每次鋼瓶或容器更換時，應實施氣源連接之測試。

10.1.5.3 Test fluid

The test gas used for pneumatic testing, if not air, shall be nonflammable and nontoxic. Inert gases are customarily used in conducting pneumatic pressure tests. Regardless of the test gas that is used to supply pneumatic pressure, residual air or other oxidizing gases shall be removed from the piping system after the test is complete and before charging the system with silane.

測試流體

用於氣壓測試之氣體，若非空氣時，必須為非可燃性及非毒性。惰性氣體常做為氣壓測試之用。不論何種用於供應氣壓壓力之測試氣體，測試完畢之後，導入矽甲烷之前必須將管路系統內殘留的空氣及其他氧化性氣體移除。

10.1.6 Identification

Piping systems shall be marked, labeled, and identified in accordance with established and recognized standards like ASME A13.1, *Scheme for the Identification of Piping Systems* as follows [15]:

- Markings used for piping systems shall consist of the content's name and include a direction of flow arrow;
- Markings or labels shall be provided:
  - at each valve
  - at wall, floor, or ceiling penetrations
  - at each change of direction; and
- At a minimum of every 20 ft (6.1 m) or fraction thereof throughout the piping run.

識別

管路系統必須加註記號、貼標籤及依照美國機械工程師學會ASME A13.1*管路系統之識別方案*加以識別如下[15]：

- 用於管路系統之記號，應包含內容物名稱及流向箭頭；
- 記號或標籤必須標示於：
- 各個閥
- 穿越牆、樓板或天花板
- 各個流向改變之處；及
- 至少每20 呎 (6.1公尺) 或遍及管路各段。

10.2 Components 元件

10.2.1 Valves

Packed valves shall not be used since silane has a potential to autoignite when exposed to the atmosphere. Bellows sealed valves and diaphragm sealed valves are allowed to be used in lieu of packless design. The selection of valves or components with bonnet seals shall be of the type where the seal nuts or fittings are not able to be loosened or removed from the component without tools. Valves shall be designed so that rotation of the manual valve handle against its stop does not loosen the seal nut. Automatic actuated valves shall be of fail-safe or fail-closed design to protect against the accidental flow of gas in the event of energy loss to the valve actuator.

閥

矽甲烷暴露於空氣中有自燃之虞，不可以使用襯墊閥(Packed)。可使用囊式密封閥(Bellows)及膜片式密封閥(Diaphragm)，以代替無襯墊設計。選用閥蓋密封式之閥或元件，必須是密封螺帽或管件之型式，不得在沒有工具的情況下可被鬆開或從元件移除。手動閥應被設計為手動旋轉操作時，不會旋鬆密封螺帽。自動開關閥，應為故障安全防護或失效關閉之設計，以防發生閥促動器能量流失時，意外的氣流。

10.2.2 Backflow prevention

A means of protection shall be provided to prevent backflow and back diffusion of silane into portions of the piping system that are designed to convey gases other than silane.

逆流防止

系統必須提供保護方法以防止矽甲烷逆流或逆向擴散，進入管路系統其他設計於非矽甲烷氣體的管路部。

10.2.2.1 Check valves

Check valves shall not be used as the sole means of control to prevent backflow. When used, check valves shall be used to provide a means of redundant protection. Check valves shall be spring-opposed, positive shutoff type.

逆止閥

逆止閥不可用做控制逆流的唯一方法。當使用逆止閥時，應採用多重保護方式。逆止閥必須為彈簧壓制，全關閉型。

10.2.2.2 Regulators

Regulators shall be equipped with a metal diaphragm.

調壓閥

調壓閥必須使用金屬膜片。

10.2.2.3 Bonnet relief vents

Regulator bonnets shall be equipped with bonnet relief vents provided with an attached vent line or positioned to allow silane to escape to a protected location in the event of a diaphragm leak or rupture. A means to detect a ruptured regulator diaphragm shall also be provided. When bonnet relief vent lines are provided, they shall be sized not to restrict the flow from the bonnet relief vent. See Section 14.

釋壓帽蓋

調壓閥必須具有釋壓帽蓋，當膜片洩漏或破裂時，可銜接排放管或容許矽甲烷排放至適當安全地點。並須具備檢測調壓閥膜片破裂之方法。當設有釋壓管路排放管時，其管路尺寸必須使從釋壓帽蓋排放之氣流不受限制。見第**14章**。

10.2.3 ESO system

Silane delivery systems shall be provided with ESO systems that are able to be activated at each point of use and at the source. ESO valves shall be located to be clearly visible and accessible. See Sections 6.4.3 and 7.11.2.

緊急遮斷系統

矽甲烷輸送系統，應設有緊急遮斷系統，以能於各操作使用點及氣源啓動遮斷。緊急遮斷閥必須設於能夠清楚辨識及進入之處所。參見 6.4.3 及7.11.2。

10.2.3.1 Shutoff at source

A manual or automatic fail-safe ESO valve shall be installed on supply piping at the cylinder or bulk source.

氣源端遮斷

鋼瓶或大宗氣源之供應管路上，必須裝設手動或失效安全防護之自動緊急遮斷閥。

10.2.3.2 Shutoff at point of use

Shutoff systems provided to shut off the flow of gas at a designated VMB are allowed to be used as a means of ESO for systems where distribution to multiple use points is involved.

使用點遮斷

在用以分配至多使用點的特定氣體供應分歧箱/模組(VMB)設置關閉氣流之遮斷閥，可視爲系統緊急遮斷的方法之一。

10.2.3.3 Marking

ESO valves and shutoff controls shall be identified by means of a sign.

標示

緊急遮斷閥及遮斷控制，必須標示方式作識別。

10.2.4 Restrictive flow orifice

10.2.4.1 Nonbulk sources

Silane source cylinder outlet valves shall be equipped with an RFO. The inside diameter of the RFO used on individual cylinders shall not exceed 0.010 in (0.254 mm). Exceptions follow:

- source cylinders in the process of being filled or serviced to remove residual product; and
- cylinders in storage at the filling or distributor location equipped with a solid plug that forms a metal-to- metal gas-tight seal at the valve outlet.

限流器

非大宗氣源

矽甲烷鋼瓶出口閥，必須裝設限流器。用於個別鋼瓶之限流器內孔直徑，不可超過0.010 吋 (0.254 毫米)，
下列除外：

- 在充填製程中或排放殘餘氣體之容器；及
- 存放於充填廠或配銷站之鋼瓶，已在閥出口裝有金屬對金屬之氣密型式固定閥塞。

10.2.4.2 Bulk sources

An RFO shall be placed in each outlet valve or in the outlet valve of the delivery manifold serving bulk source systems. The inside diameter of the RFO used on outlet valves for individual cylinders of unmanifolded bulk sources shall not exceed 0.125 in (3.175 mm) in diameter. For bulk source systems connected to a manifold, the outlet valve from the manifold shall be limited-by-design with an effective orifice not exceeding 0.125 in (3.175 mm) in diameter. An exception is bulk sources equipped to service attended transfer operations.

大宗氣源

限流器必須裝設於各個出口閥或大宗系統輸送盤面的出口閥中。用於非集合盤面的個別容器出口閥的限流器之內孔直徑，不可超過0.125 吋 (3.175 毫米)。

大宗氣源系統集合連接到盤面，其出口閥設計限制氣流必須裝設有效的限流器，其內孔直徑不可超過0.125 吋 (3.175 毫米)。大宗氣源用於生產灌充操作者，不在此限。

10.2.5 Excess flow control

Means shall be provided to shut off the flow of silane due to a rupture of the piping system. Excess flow valves, control devices, or the use of pressure and/or flow control systems are allowed. The use of a flow switch that activates an automatic shutoff valve or an automatic positive shutoff device is allowed.

過流量控制

因應管路系統破裂，必須設有關斷矽甲烷氣流之措施，其可允許採用過流量閥、控制裝置或使用壓力及/或流量控制系統，亦可使用流量開關觸動式自動關斷閥或自動正向關斷裝置。

10.2.5.1 Location of shutoff device

The shutoff device shall be located as close to the silane source as practicable.

遮斷裝置之位置

遮斷裝置應盡可能裝設於靠近矽甲烷氣源。

10.2.5.2 Venting of gas

Systems that incorporate the venting of gas in the system design shall be designed to vent the gas in a controlled manner. See Section 14.

氣體排放

系統中設有氣體排放，必須設計可控制之方式排放氣體。參見第14章。

10.2.5.3 System controls

The excess flow control device or system shall be capable of being manually reset once corrective action to the excess flow condition has been taken.

系統控制

過流量保護裝置或系統，必須具備在完成矯正措施後可手動復歸功能。

10.2.6 Overpressure protection

An overpressure relief device shall be used to protect silane delivery systems where the design pressure of the delivery system is less than the supply source pressure and where, due to the gas capacity of the source, the system design pressure is able to be exceeded. Sources of pressure to be considered shall include but not be limited to ambient influences, pressure oscillations and surges, improper operation of equipment, and failure of control devices.

過壓保護

當輸送系統的設計壓力小於供應氣源壓力，矽甲烷輸送系統必須設置過壓釋放裝置，以保護由於氣體來源容量，超過系統設計壓力。壓力來源應被考慮，但不僅限於周圍環境影響，壓力波動及瞬壓，設備不當操作及控制裝置失效等。

10.2.7 Static seals

In addition to chemical compatibility, gaskets, O-rings, and seals used in pressure-retaining components shall be suitable for the operating pressure and temperature of the system. When selecting polymeric materials, consideration shall be given to the rate at which these materials mechanically extrude or thermally behave over time. Since these properties directly affect the ability of a seal to repeatedly perform positive containment during pressure or thermal cycling, the selection of thin seals (1/32 in [<0.795 mm] or less) in these services is required. There shall be no thickness restriction for metallic gaskets, seals, or metallic O-rings provided that the component is suitable for the operating pressure and temperature of the system, and that it is constructed from metals having comparable thermal expansion characteristics compared to the housing, flange, or valve body that it seals.

固定密封墊

除化學相容性之外，墊片、O型環及用於壓力維持有關元件的密封墊，必須合乎系統之操作壓力及溫度。當選擇聚合物材料時, 應考慮這些材料隨時間受機械擠壓或熱作用的能力等級。 因為這些特性直接影響密封性能，在壓力或熱循環期間，反覆做確實的密封，用於這方面的服務時，必須選用薄密封墊(1/32 吋 [<0.795 毫米] 以下)。 金屬墊片、密封墊或金屬O型環等元件，若合乎系統之操作壓力及溫度， 應無厚度限制，並且墊片可與外罩、法蘭或閥體等金屬材料相比較其熱膨脹性質。

10.3 Support of piping systems管路系統支撐

10.3.1 Method of piping support

Piping used to convey silane shall be supported in accordance with the requirements of national codes by supports designed in accordance with established and recognized standards like ASME B31.3 [14]. Typical means for piping system support includes the use of a supporting structure such as a cable tray, pipe trestle, or rack system.

管路支撐的方式

用於輸送矽甲烷之管路支撐，應依照當地政府法規及/或美國機械工程師學會ASME B31.3 [14]之規範。
管路系統支撐一般採用之支撐結構方式，如電纜托盤、管架或支架系統。

10.3.1.1 Minimum installation height

When piping is to be located in overhead support systems in a space that is occupied by operating personnel, it shall be located at a height not less than 7 ft (2.1 m). Where vehicle access is required, the height shall permit clearance of vehicular traffic.

最小安裝高度

當管路需以高架支撐系統設置，有佔用操作人員之空間時，其高度不應低於7 呎 (2.1 公尺)。 車輛需行經之處，其高度應能容納車輛交通之空間。

10.3.1.2 Piping containing other materials

Other process gas and/or chemical piping is allowed to be installed in the same trestle or racking system used to support the silane piping system.

其他物質管路

其他製程氣體或化學品管路，允許安裝於同樣支撐矽甲烷管路的管架或支架系統。

10.3.2 Alternate method of piping support

Silane piping installed through trenches or tunnels that are closed or sealed shall be contained within coaxial piping or tubing systems in accordance with the requirements of 10.1.3. Protection from impact hazards shall be provided through use of structural guards or bollards where the tubing enters or exits the tunnel or trench.

管路支撐的替代方式

矽甲烷管路安裝穿過封閉或密封之溝渠或涵洞，應依照10.1.3之規定使用雙套配管。在管路進、出溝渠或涵洞之處，應設置防護結構或防撞柱，以防止碰撞危害。

11 Gas and flame detection 氣體與火焰偵測

11.1 Gas monitoring 氣體偵測

11.1.1 Outdoor locations

Gas monitoring is not required for outdoor storage or use installations.

室外場所

室外儲存或使用不需安裝氣體偵測器。

11.1.2 Indoor locations

Indoor silane delivery systems shall be monitored for gas leaks using a gas monitoring system.

室內場所

室內矽甲烷供應系統必須安裝氣體偵測系統監控氣體外洩。

11.1.3 Location of monitors

11.1.3.1 Exhaust ducts serving enclosures and cabinets

When gas monitoring is provided, sampling points shall be placed in the exhaust ventilation ducts serving enclosures used to protect mechanical connections. Sampling points placed inside of exhaust ducts serving enclosures or cabinets shall be located at a point not less than five duct diameters downstream of the point where the exhaust duct is connected to the enclosure or cabinet.

偵測器位置

氣瓶櫃或封閉系統排氣管路

使用氣體偵測器於封閉系統之排氣管路時，取樣點必須設置於封閉系統之通風排氣管內部，以保護相關機械式銜接點。
當取樣點安裝於直接銜接至氣瓶櫃或封閉系統之排氣管內部時，其安裝位置必須在氣瓶櫃或封閉系統排氣管路銜接點下游不小於五倍排氣管直徑的位置。

11.1.3.2 Areas without enclosures

When area gas monitoring systems are used, sampling points shall be within the room or area where silane delivery systems or sources are located.

非封閉區域

於非封閉區域使用氣體偵測系統，其取樣點必須安裝在矽甲烷輸送系統或氣源的位置。

11.1.4 Sensing requirements

11.1.4.1 Monitoring within exhausted zones

When gas monitoring is provided within exhausted zones, the gas monitoring system shall initiate a warning at concentrations of 0.34% (25% of the LFL) or less.

偵測要求

排氣區域內的偵測

使用氣體偵測器於排氣區域內時，氣體偵測系統之警報設定點必須等於或小於濃度0.34%(25% 的燃燒 下限)。

11.1.4.2 Monitoring outside of exhausted zones

When gas monitoring is provided outside of exhausted zones, the gas monitoring systems shall initiate a warning at concentrations of 5 ppm (TLV-TWA) or less [7].

排氣區域外的偵測

使用氣體偵測器於排氣區域外時，氣體偵測系統之警報設定點必須等於或小於濃度5 ppm (TLV-TWA) 或以下[7]。

11.1.5 Shutdown requirements

停機要求

11.1.5.1 Monitors in ducts serving enclosures

Activation of the gas monitoring system shall shut off the flow of gas at the source or within the enclosure being monitored when a concentration of greater than 0.34% (or 25% of the LFL) is detected.

封閉系統排氣管內的偵測器

當氣體偵測系統偵測到濃度大於0.34% (或25%的燃燒下限) 時，必須切斷來自氣源或封閉系統的氣流。

11.1.5.2 Monitors used for area monitoring

Activation of area monitors shall not require automatic shutdown of the system.

偵測器用作區域偵測

用於區域偵測的偵測器不要求設置自動切斷系統。

11.1.6 Alarms

Activation of the gas monitoring system shall initiate a local alarm and transmit a signal to a constantly attended location so responsible parties will act on the alarm condition.

警報

氣體偵測系統作動時，必須啟動該區域警報，並將訊號傳送至經常監控處所，如此應變人員才可對警報進行相關處理。

11.2 Flame detection火焰偵測

11.2.1 Outdoor systems

When silane delivery systems are located outdoors, an optical flame detection system approved for silane service shall be located to detect fire in potential silane leak zones, e.g., cylinder support rack, cylinder packs, ISO modules, and process and purge gas panels. Detectors used outdoors shall be approved for outdoor service and tested for immunity to sunlight, arc welding, artificial area lighting, or stray sources of ultraviolet or infrared light that are able to inadvertently trip a detector.

室外系統

矽甲烷供應系統安裝於室外時，必須安裝核准於矽甲烷使用之光學式火焰偵測系統，以偵測矽甲烷可能洩漏區域的火焰，例如鋼瓶支撐架、鋼瓶集束、ISO模組、和製程及沖吹氣體盤面；使用於室外之偵測器必須為核准於室外使用且經測試不受日光、電焊、人為區域照明設備干擾，或環境周遭的紫外線輻射或紅外線導致偵測器不慎作動之類型。

11.2.2 Indoor systems

An optical flame detection system shall be provided in rooms or areas where silane delivery systems are used. The flame detection system shall be approved for silane service. The flame detection system shall be located in accordance with 11.2.2.1 through 11.2.2.3 as appropriate. Optical flame detectors used indoors shall be tested for immunity to arc welding, artificial area lighting, or stray sources that are able to inadvertently trip a detector. Alternatively, a temperature switch placed directly above individual gas cylinders is allowed to be used in lieu of the optical flame detection system.

室內系統

矽甲烷供應系統使用於室內或區域內，必須安裝光學式火焰偵測器，火焰偵測系統必須爲核准使用於矽甲烷之類型，火焰偵測系統安裝必須符合於11.2.2.1 至 11.2.2.3內適用的要求； 使用於室內之光學式火焰偵測器必須經測試不受電焊、人爲區域照明設備干擾、或環境週遭可能導致偵測器不慎作動之類型。於個別氣體鋼瓶上安裝溫度開關可用以取代光學式火焰偵測系統，兩者擇其一。

11.2.2.1 Outside of gas cabinets

Optical flame detection systems shall be provided to detect a fire at potential leak points on the delivery system. Coverage shall be provided to address container connections, process gas and purge gas panels, and other potential leak points where unwelded fittings or connections are used.

氣瓶櫃外部

矽甲烷輸送系統上的潛在洩漏點必須安裝光學式火焰偵測系統，所涵蓋範圍必須可偵測到容器銜接點、製程氣體及沖吹氣體盤面，及潛在洩漏之非焊接管件或接點。

11.2.2.2 Inside gas cabinets

An optical flame detection system shall be provided inside of gas cabinets to detect a fire within the cabinet.

氣瓶櫃內部

氣瓶櫃內部必須安裝光學式火焰偵測系統以偵測氣瓶櫃內火焰。

11.2.2.3 Inside VMBs

An optical flame detection system shall be provided inside of VMBs to detect a fire within the VMB.

氣體供應分歧箱/模組(VMB)內部

氣體供應分歧箱/模組(VMB)內部必須安裝光學式火焰偵測系統，以偵測氣體供應分歧箱/模組(VMB)內火焰。

11.2.3 Shutdown requirements

Automatic shutdown of the silane delivery system is required whenever flame detection occurs. Whenever a shutdown action occurs as the result of optical flame detection, an alarm shall be transmitted to a constantly attended location on the premises so responsible parties will act on the alarm condition.

停機要求

不論何時偵測到火焰，矽甲烷供應系統都必須自動切斷；當光學式火焰偵測器自動切斷作動時，其警報訊號必須傳送至經常監控處所，如此應變人員才可對警報進行相關處理。

12 Fire protection system 消防系統

12.1 General 一般

Do not attempt to extinguish a silane flame. Shutting off the source of the gas is the preferred method of control. If shutdown is not practicable, let the fire burn until the container is either determined to be empty or the flame decreases to a point where shutoff is able to be achieved without endangering personnel. The container and associated equipment involved in a silane fire shall be cooled and the silane source isolated. Halogenated hydrocarbon fire extinguishers such as Halon™ or similar systems shall not be used on silane fires. Silane will react with Halon chemicals. The reaction has the potential to be violent. Fire extinguishing agents designed to deplete oxygen such as carbon dioxide shall not be used.

不要試圖撲滅矽甲烷火焰，關閉氣源是優先的抑制方法，若無法關閉氣源，則讓它持續燃燒至該鋼瓶成爲空瓶或於火焰較小時，在無人員安全顧慮下關掉氣源。涉及矽甲烷火災之容器及相關設備必須進行冷卻並與矽甲烷氣源隔離。海龍®(Halon™)滅火器或系統不可使用於矽甲烷火災，矽甲烷會與海龍®化合物反應，

反應可能非常劇烈；也不可以使用以特定物質消減氧氣的滅火方法，如二氧化碳進行滅火。

12.2 Outdoor systems 室外系統

12.2.1 Deluge system

A manually activated deluge water spray fire protection system shall be provided to protect bulk silane delivery systems. In the event of fire, silane bulk sources shall be cooled if the source cannot be shut off since the continued leaking of silane is able to result in an explosion if the container ruptures.

灑水系統

大宗矽甲烷供應系統必須裝設手動啟動之消防灑水系統予以保護，在火災時，如果無法關閉氣源，則必須冷卻矽甲烷大宗氣源，因為如果容器破裂，矽甲烷持續洩漏可能導致爆炸。

12.2.1.1 Manual activation

Automatic deluge systems are allowed as an option to manual activation; however, automatic systems shall not be required.

手動啟動

自動灑水系統可以是手動啟動的一種選擇；但是，自動灑水系統是非強制的。

12.2.1.2 System installation—seismic considerations

Systems shall be designed and installed in accordance with national codes. The system shall be designed to resist seismic forces.

系統裝置 – 地震考量

系統設計及設置必須符合當地法規的要求，系統設計必須可承受地震強度。

12.2.1.3 Design density

The deluge system shall provide a minimum density of 0.30 gallons per minute per square foot (gpm/ft^2) (12 liters per minute per square meter [lpm/m^2]) for a minimum of a 2-hour duration over the external container surface areas including the silane cylinders, bulk containers, and process gas panels. The water spray shall be directed toward the walls of the containers for cooling as well as the valves and piping connections that represent a potential location for a leak to propagate.

設計密度

灑水系統的設計必須可供應最小密度每平方呎每分鐘0.3加崙(gpm/ft^2)(每平方公尺每分鐘12公升(lpm/m^2))
且最少持續達2小時在容器外部表面上方區域，包括矽甲烷鋼瓶、大宗容器、及製程氣體盤面的水量。水霧必須直接噴灑於容器壁及其衍生潛在洩漏的閥件及管路銜接點上。

12.2.1.4 Materials of construction

Sprinkler system piping shall be of metal construction. Joints used in the piping system shall be threaded or welded fittings. Clamped fittings with elastomeric seals shall not be used in portions of the system that are installed within 50 ft (15 m) of the silane bulk source.

建造材料

灑水系統管路必須為金屬材質，管路系統的銜接必須是鎖牙或焊接裝配。於大宗矽甲烷氣源50英尺內 (15公尺), **不可使用以合成彈膠密封之**鉗緊銜接方式。

12.2.1.5 Automatic shutdown

Activation of the water deluge system shall shut off the flow of gas at the bulk source.

自動切斷

灑水系統作動時必須同時切斷大宗氣源。

12.2.2 Protection of structures

When the outdoor installation is located beneath a roof or canopy constructed as weather protection under the requirements of 6.2.1.1.2, an automatic fire extinguishing system shall be provided. The system design shall be not less than Extra Hazard Group 2 with a minimum design area of 2500 ft^2 (232 m^2). For more information, see NFPA 13, *Installation of Sprinkler Systems* [16] or equivalent national fire codes.

結構保護

當室外裝設如6.2.1.1.2中所規定的屋頂或遮雨篷之天候防護建構時，必須裝設自動消防系統，系統的設計必須不小於Extra Hazard Group 2所規範的2500 平方呎 (232 平方公尺)之最小設計區域。請見NFPA 13, *消防灑水系統裝置* [16]。

12.2.3 Fire hydrants

A fire hydrant shall be located not greater than 150 ft (46 m) from a silane supply container.

消防栓

消防栓必須設置在離矽甲烷供應容器不超過150呎(46公尺)**的位置**。

12.3 Indoor systems 室內系統

12.3.1 Gas cabinet sprinkler systems

Gas cabinets shall be provided with an automatic sprinkler equipped with a quick response sprinkler head positioned to keep the source cylinder cool but not to extinguish a fire in the cabinet. Water extinguishing systems shall be provided. Alternate fire extinguishing systems shall not be used.

氣瓶櫃灑水系統

氣瓶櫃必須設置自動灑水裝置，使用快速反應灑水頭來保持鋼瓶冷卻但不能撲滅氣瓶櫃內部的火焰。必須使用水消防系統，不可以使用其他類型消防系統替代。

12.3.2 Area sprinkler systems

Indoor rooms or areas where silane is stored or used shall be protected by an automatic sprinkler system. The design of the sprinkler system in storage rooms shall not be less than Extra Hazard Group 1 with a minimum design area of 2500 ft^2 (232 m^2). See NFPA 13 [16 or equivalent national fire codes].

區域灑水系統

矽甲烷儲存或使用之室內廠所必須裝設自動灑水系統。系統的設計必須不小於Extra Hazard Group 1 所規範的2500平方呎 (232 平方公尺)之最小設計區域。請見NFPA 13[16]。

13 Ventilation systems 通風系統

13.1 Outdoor systems 室外系統

13.1.1 Air flow requirements

Natural ventilation is allowed for outdoor storage and use installations providing the space is unconfined. See 3.20.1. An exception to this is when confined as described by 6.2.1.1.1, mechanical ventilation shall be provided in accordance with the requirements of 13.2.2.

空氣流量要求

室外儲存和使用設備，只要空間未受局限(參照3.20.1)，可以使用自然通風。6.2.1.1.1所敘述的受局限空間為例外的情況，在這種情況下必須依據13.2.2的要求設置機械通風。

13.1.2 Spacing between equipment

System design shall allow for the unrestricted natural flow of air between equipment to prevent accumulation of gas in the event of a silane release. See 6.2.1.1.

設備之間的空間

系統設計必須保有設備之間的空間使自然通風不受限制，以防止矽甲烷洩漏的氣體累積，參照6.2.1.1。

13.2 Indoor systems 室內系統

A continuous mechanical exhaust ventilation system shall be provided in locations where cylinders are stored or connected for use.

當鋼瓶於室內儲存或銜接使用，必須設置連續性機械式抽風通風系統。

13.2.1 Ventilation rate

Where silane is stored or used in a room without being placed in a gas cabinet or an exhausted enclosure, the room itself shall be exhausted at not less than 1 cubic foot per minute per square foot (300 lpm/m^2) of floor area or six changes per hour, whichever is greater.

A supply of outside air shall be used to replace the air removed by the mechanical exhaust system. The pressure in the room shall be maintained negative to the surrounding space.

通風率

當矽甲烷在室內，未裝設於氣瓶櫃或封閉式排氣裝置內儲存或使用，其通風率必須是地板面積的每平方呎每分鐘至少1立方呎（300 lpm/m^2）或每小時置換六次的設計排氣通風，選較大者。

必須設置室外空氣補充入口，以置換經由機械式通風系統移除的空氣，室內的壓力應對周遭的空間維持負壓。

13.2.2 System air flow requirement for unenclosed indoor installations

Containers connected for use located outside of gas cabinets or exhausted enclosures shall be provided with a mechanical ventilation system designed to dilute potential leakage from mechanical connections. The ventilation system shall direct a source of air across unwelded mechanical connections at a velocity of not less than 150 ft/min (0.8 meter/s). Recirculated air shall not be used as the source of forced, induced, or captured air to be directed across mechanical connections. System design shall promote ventilated airflow so the allotted spacing between equipment will not cause a restriction in the airflow in the event of a silane release.

非封閉式室內安裝的系統空氣流量要求

容器未使用氣瓶櫃或封閉式排氣裝置的銜接使用，必須設置機械式通風系統，以稀釋潛在機械式銜接點的洩漏。機械通風系統必須引導不少於150 呎/分（0.8 公尺/秒）。
速度的空氣氣流通過非焊接銜接的機械式銜接點。再循環的空氣不可以用來當作強制流通、引導或取用通過機械式銜接點的空氣來源。系統設計必須能促進空氣流通，如此設備之間的分配空間才不會在矽甲烷洩漏時，導致空氣流通遭到限制。

13.2.3 System air flow requirement for ventilated enclosures, exhausted enclosures, and gas cabinets

Exhaust ventilation shall be used to prevent accumulation of silane resulting from a leak and to limit silane leak concentrations not more than 25% of the LFL(LEL). The LFL for silane under atmospheric conditions has been established as 1.37% by volume. The use of 25% of LFL results in a maximum concentration of 0.34% thereby providing a safety factor of four to one (4:1).

通風式封閉裝置、排氣式封閉裝置及氣瓶櫃的系統空氣流量要求

系統必須使用排氣通風以防止洩漏造成的矽甲烷累積，並限制矽甲烷洩漏濃度不超過燃燒下限(LFL)的25％。矽甲烷在大氣條件下的燃燒下限(LFL)已被確立為體積百分比1.37％。使用燃燒下限(LFL)的25％，其最大濃度為0.34％，因此可提供4比1（4：1）的安全係數。

13.2.3.1 Determining minimum volumetric air flow

The minimum volumetric flow rate of ventilation air shall be in accordance with 13.2.3.1.

決定最小的體積空氣流速

最小的通風空氣體積流速必須符合13.2.3.1的要求。

13.2.3.1.1 Standard silane volumetric flow rate, unattended operations

The standard silane volumetric flow rate for unattended operations shall be determined by the maximum flow rate of silane that can be discharged from the piping system into the enclosure. The flow rate is determined by the size of the

RFO in the discharge line or cylinder valve at the maximum silane source pressure. For concentrations of silane less than a nominal 100%, the standard silane volumetric flow shall be determined based on the mole or volume fraction of silane present in the supply source. The minimum volumetric flow rate of air ventilation across unwelded fittings and connections at the silane source cylinder or the piping system shall not be less than the maximum silane volumetric flow rate multiplied by 300. For gas cabinets, the maximum silane volumetric flow rate is determined by the maximum flow through an RFO with a maximum source pressure on the inlet and 1 atmosphere on the outlet. This assumes a rupture of the connecting tubing or piping between the cylinder valve and the first point of pressure control within the delivery system. For a VMB or other enclosure, the maximum silane flow into the enclosure must be determined. The use of an RFO in the piping feeding the enclosure can be used to restrict the maximum flow into the enclosure.

Where mixtures of silane and other pyrophoric gases are present, the standard silane volumetric flow rate shall be determined by assuming that the combination of silane and other pyrophoric components is all silane. For typical flows see Table 5.

標準矽甲烷體積流速，消費操作

消費操作之標準矽甲烷體積流速必須以管路系統到封閉式裝置所能使用的最大量決定，其流速由使用管路在最大矽甲烷氣源壓力的限流器或鋼瓶閥規格所決定，在濃度不及標稱100%的矽甲烷，其標準矽甲烷體積流速必須以矽甲烷供應氣源的莫耳或體積分率決定。通過矽甲烷氣源鋼瓶或管路系統的非焊接閥件及銜接點的最小空氣通風的體積流速不可小於矽甲烷體積流速乘以300的量。對於氣瓶櫃，最大的矽甲烷體積流速是以在最大氣源壓力，流經限流器，變成一大氣壓的最大流量所決定；其以輸送系統自鋼瓶閥到第一個壓力控制使用點的管路破裂為假設基礎。
對於氣體供應分歧箱/模組(VMB)或其他封閉式裝置，必須決定流入封閉裝置的最大矽甲烷流速。在輸入管路上使用限流器可限制流入封閉式裝置的最大流速。

在矽甲烷混合氣或其他自燃性氣體存在之處，決定標準矽甲烷體積流速時，應假設矽甲烷及其他自燃性成分均為矽甲烷，而結合計算。關於典型流速，參照表5。

13.2.3.1.2 Minimum volumetric air flow rate for cabinets and enclosures, unattended operations

Table 5 illustrates the minimum volumetric flow rate of air as a function of RFO size and source pressure for four specific orifices typical of those used in conjunction with gas cabinets and VMBs. Regardless of the orifice used, the minimum volumetric flow rate of dilution air shall not be less than the standard silane volumetric flow rate multiplied by 300.

氣瓶櫃和封閉式裝置的最小體積空氣流速，消費操作

表5針對氣瓶櫃和氣體供應分歧箱/模組(VMB)連接中經常使用的四種特定限流器，說明了空氣的最小體積流速是限流器尺寸和氣源壓力的函數。不論是否使用限流器，稀釋空氣的最小體積流速不得小於標準矽甲烷體積流速的300倍。

13.2.3.1.3 Standard silane volumetric flow rate, attended transfer operations

The standard silane volumetric flow rate used for attended transfer operations shall be determined by assuming discharge from a valve or fitting under the maximum silane source pressure through an opening with an RFO equivalent diameter of 0.006 in (0.15 mm). The RFO equivalent diameter shall be used to determine a theoretical leak recognizing that cylinders in the process of being filled or processed are not equipped with an RFO. For typical flows see Table 6.

標準矽甲烷體積流速，生產轉充操作

用於決定生產轉充操作的標準矽甲烷體積流速，應假設在最大矽甲烷氣源壓力下來自閥門或裝配的排放是經由一個有0.006 in（0.15 mm）。
相等直徑的限流器之開口。在轉充或製程中的鋼瓶並未配備限流器的條件下，有相等直徑的限流器應被用來決定理論洩漏。
關於典型流速，參照表6。

Table 5—Minimum ventilation volumetric flow rate for gas cabinets and VMBs, unattended operations

Source pressure (psig)	Typical gas cabinet RFO 0.006 in diameter (0.15 mm diameter)		Typical gas cabinet RFO 0.010 in diameter (0.25 mm diameter)		Typical VMB RFO 0.014 in diameter (0.36 mm diameter)		Typical VMB RFO 0.020 in diameter (0.51 mm diameter)	
	Silane flow (scfm)	Ventilation flow (scfm)	Silane flow (scfm)	Ventilation flow (scfm)	Silane flow (scfm)	Ventilation flow (scfm)	Silane flow (scfm)	Ventilation flow (scfm)
50	0.025	8	0.069	21	0.136	41	0.288	86
100	0.045	14	0.124	37	0.243	73	0.497	149
200	0.085	26	0.237	71	0.465	140	0.949	285
400	0.173	52	0.480	144				
600	0.275	83	0.755	227				
800	0.395	119	1.08	324				
1000	0.555	167	1.51	453				
1200	0.724	217	1.97	591				
1500	0.913	274	2.50	750				
1650	0.987	296	2.70	810				

NOTES

1 Silane source temperature is 75 °F (24 °C).

2 RFO downstream pressure is 0 psig.

3 RFO discharge coefficient is 0.8.

4 To convert standard cubic feet per minute (scfm) to standard liters per minute (slpm), multiply by 28.32.

5 To convert psig to kPa, multiply by 6.895.

備註表5 氣瓶櫃及氣體供應分歧箱/模組(VMB)的最小通風體積流速，消費操作

氣源壓力（psig）	典型的氣瓶櫃限流器 直徑0.006 吋（直徑0.15 公厘）		典型的氣瓶櫃限流器 直徑0.010 吋（直徑0.25公厘）		典型的VMB 限流器 直徑0.014 吋（直徑0.36公厘）		典型的VMB 限流器 直徑0.020 吋（直徑0.51公厘）	
	矽甲烷流速（scfm）	通風流速（scfm）	矽甲烷流速（scfm）	通風流速（scfm）	矽甲烷流速（scfm）	通風流速（scfm）	矽甲烷流速（scfm）	通風流速（scfm）
50	0.025	8	0.069	21	0.136	41	0.288	86
100	0.045	14	0.124	37	0.243	73	0.497	149
200	0.085	26	0.237	71	0.465	140	0.949	285
400	0.173	52	0.480	144				
600	0.275	83	0.755	227				
800	0.395	119	1.08	324				
1000	0.555	167	1.51	453				
1200	0.724	217	1.97	591				
1500	0.913	274	2.50	750				
1650	0.987	296	2.70	810				

1 矽甲烷氣源溫度為75^{0}F（24℃）。

2 限流器下游壓力為0 psig。

3 限流器排放係數為0.8。

4 欲將每分鐘標準立方英尺（scfm）轉換成每分鐘標準公升（slpm），應乘以28.32。

5 欲將psig轉換成kPa，應乘以6.895。

Table 6—Minimum ventilation volumetric flow rate for exhausted enclosures, attended operations

Source pressure (psig)	RFO equivalent 0.006 in diameter (0.15 mm diameter)	
	Silane flow (scfm)	Ventilation flow (scfm)
50	0.025	8
100	0.045	14
200	0.085	26
400	0.173	52
600	0.275	83
800	0.406	122
1000	0.568	170
1200	0.711	213
1500	0.852	256
1650	0.917	275

表6 封閉式排氣裝置的最小通風體積流速，生產操作

氣源壓力（psig）	相當於直徑0.006 吋（直徑0.15 公厘）的限流器	
	矽甲烷流速（scfm）	通風流速（scfm）
50	0.025	8
100	0.045	14
200	0.085	26
400	0.173	52
600	0.275	83
800	0.406	122
1000	0.568	170
1200	0.711	213
1500	0.852	256
1650	0.917	275

13.2.3.1.4 Minimum volumetric flow rate for exhausted enclosures, attended transfer operations

Table 6 illustrates the minimum volumetric flow rate of air as a function of an RFO equivalent diameter and source pressure. The minimum volumetric flow rate of dilution air shall not be less than the standard silane volumetric flow rate multiplied by 300.

封閉式排氣裝置的最小體積流速，生產轉充操作

表6說明了空氣最小體積流速是限流器等同直徑與氣源壓力的函數，用以稀釋的空氣之最小體積流速不得小於標準矽甲烷體積流速的300倍。

13.2.3.2 Ventilation system design (pocketing)

Ventilation within enclosures shall be designed to eliminate dead zones and pocketing at potential leak sites.

通風系統設計（氣體蓄積）

封閉式系統內的通風設計必須能去除潛在洩漏點的死角和氣體蓄積。

13.2.4 Ventilation monitoring

Exhaust from gas cabinets, VMBs, exhausted enclosures, or room ventilation exhaust ducts shall be monitored to detect a failure in the ventilation system.

通風監控

氣瓶櫃、氣體供應分歧箱/模組(VMB)、封閉式排氣裝置或房間通風排氣管的排氣應受到監控，以偵測通風系統是否故障。

13.2.4.1 Loss of ventilation alarm

A failure in the ventilation system shall activate an alarm. Activation of the alarm shall initiate a local alarm and transmit a signal to a remotely located constantly attended location.

通風失效的警報

通風系統失效必須能啟動警報，警報必須在當地作動，並將訊號傳送到持續有人值勤的遠距地點。

13.2.4.2 Isolation of gas supply

Loss of the ventilation system in gas filling rooms shall automatically cause the source of silane supply to be isolated from filling manifolds.

氣體供應隔離

在氣體充填室的通風系統失效，必須自動隔離矽甲烷供應氣源與充填盤面。

14 Venting and treatment 排放與處理

14.1 General 一般

Requirements for venting and treatment of silane shall be limited to silane that is vented from process gas panels, VMBs, piping or equipment within the scope of this standard. See 2.1.2.

矽甲烷的排放及處理要求必須僅限於從製程氣體盤面、氣體供應分歧箱/模組(VMB)、管路或本標準範圍內的設備所排放的矽甲烷。參照2.1.2。

14.2 Disposal options 處置選擇

The majority of hazards associated with the use of a pyrophoric gas are fires or explosions. These hazards shall be analyzed when selecting a method of treatment for silane that will be released into the atmosphere during emergencies or when systems are purged. A number of methods of treatment are able to be used to reduce the risk of fire or explosion and still meet environmental protection requirements. Dilution with an inert gas followed by open-air disposal is one of the simplest methods when silane is not mixed with a toxic gas. This method is allowed to be used to dispose of small quantities of silane required at times when systems are purged of residual material. For example, the material left in a connecting pigtail that is purged before changing a cylinder can be vented without endangering personnel when well diluted. When dilution is not used, thermal oxidation or radio frequency (RF) plasma treatment, wet scrubbing with caustic soda, or other reactive media are allowable options.

自燃性氣體使用的相關主要危害是火災或爆炸，在緊急狀況要將矽甲烷排放到大氣中或系統進行沖吹時，選擇矽甲烷的處理方法，必須分析這些危害，有許多方法可用以降低火災或爆炸的風險並仍可符合環境保護的要求。當矽甲烷未與毒性氣體混合時，使用惰性氣體稀釋再排放到開放的大氣中的處理是最簡單的方法之一，這個方法被允許用以在沖吹殘留的小量矽甲烷處置的時候。例如，更換鋼瓶前的沖吹，殘留在銜接管接點的物質經過適當稀釋即可排放而不會對人產生危險。如果未進行稀釋，可以使用加熱氧化或射頻電漿處理，溼式氫氧化鈉洗滌塔或其他反應性介質，都是選項之一。

14.3 Treatment system requirements 處理系統要求

Treatment systems shall be designed for the use intended. They shall be designed to react with any silane or dilute it to allowable levels so it can be discharged without endangering facilities or personnel. The treatment system shall have the capacity to treat the flow of silane and any components of its mixtures expected under both operational and upset conditions. The potential presence of incompatible gases mixing in the treatment system shall be analyzed to ensure that the design will prevent an unanticipated chemical reaction that will result in an uncontrolled fire, explosion, or the release of a toxic gas. Inert gases shall be allowed to be used as a means to shield the silane from atmospheric oxygen.

處理系統必須為預期用途而設計。這些系統必須能使任何矽甲烷產生反應，或將矽甲烷稀釋到可排放且不會危及設備或人員的程度。處理系統的容量必須能處理操作和異常狀況下預期的矽甲烷及其混合物任何成份的流量。可能在系統中出現的不相容氣體混合物必須進行先行分析以確保系統的設計可以避免不預期的化學反應所導致的無法控制火災、爆炸或毒性氣體的釋放，惰性氣體可允許用以隔離大氣中的氧氣與矽甲烷。

14.4 Direct venting into exhaust ducts 引導氣體排放到排氣管路

Silane shall not be introduced into exhaust ventilation systems in concentrations that produce a fire or explosion within the exhaust system. A fire or explosion can occur due to autoignition of the silane itself, from the ignition of other flammables, or from a chemical reaction with incompatible materials within the exhaust system. When the ignition effects of silane in air is the only concern, the maximum permissible concentration allowed to be released into the duct system shall not be greater than 25% of the LFL or 0.34%. When exhaust systems have the potential to contain other gases or vapors, treatment systems to remove the other gases or vapors shall be provided so the discharge from the exhaust system meets the requirements of national regulations. See 4.3.1.

引導到排氣通風系統的矽甲烷濃度必須不會導致排氣系統內產生火災或爆炸，在排氣系統中火災或爆炸的發生可能來自矽甲烷本身的自燃、燃性物質的點燃或與其他不相容物質產生的化學反應。

如僅考慮矽甲烷在空氣中點燃的影響，可釋放到排氣管路系統的最大允許濃度不應超過其燃燒下限的25％，亦即0.34％。當排氣系統可能包含其他氣體或蒸汽時，處理系統必須可以處理其他氣體或蒸汽，使排氣系統的排放能符合當地法規的要求。參照4.3.1。

14.5 Dedicated process vent 專用的製程排放

Vent lines used for silane to be discharged from process gas panels shall be dedicated to lines that are used exclusively for silane service. Purging of silane vent lines is required to eliminate atmospheric oxygen from migrating into the silane vent system.

製程氣體盤面用以排放矽甲烷的排放管路應專用於矽甲烷作業，為消除進入矽甲烷排放系統的大氣中的氧氣，應進行矽甲烷排放管路的沖吹。

14.5.1 Continuous purge

Vent lines shall be purged continuously with an inert gas to prevent atmospheric oxygen from entering in the vent line with the vent line discharge directed to a treatment system. See 14.2. The minimum velocity of purge gas in the vent line system shall be 1 ft/s (0.3 m/s).

持續沖吹

排放管路應持續使用惰性氣體沖吹，以防止排放管路排放的氣體被導入處理系統中時大氣氧氣進入排放管路。參照14.2。排放管路中的沖吹氣體最小流速必須為1 呎/秒（0.3公尺/秒）。

14.5.2 Restrictions in vent lines

Vent lines shall be designed for minimum pressure drop by minimizing the use of restrictions including elbows and similar fittings or reductions in the size of vent. When multiport vent line manifolds, silencers, or scrubbers are used, their contribution to vent line backpressure shall be analyzed. Isolation valves shall not be installed downstream of the purge line connection in the vent line.

排氣管路中的阻礙

排放管路的設計必須將阻礙降到最低以使壓降降到最小，包括彎管和類似接頭或管徑縮小等。當使用多通路排放管路面盤、消音器或洗滌塔，必須分析其可能產生的背壓，沖吹管路下游到排放管路的銜接點不可安裝隔離閥。

14.5.3 Vent gas supply

The use of an inert gas such as nitrogen from nondedicated house gas supply systems is allowed providing the vent line system is continuously vented to atmosphere or otherwise arranged to preclude either the backflow of air or the development of backpressure at the point where the vent line is discharged. A purge gas flow with a minimum velocity of 1 ft/s (0.3 m/s) is required.

排放氣體供應

使用來自非專用的室內氣體供應系統的惰性氣體如氮氣於排放管路持續排放到大氣中，或以其他方式安排，使排放管路的排放點不會產生空氣的逆流或背壓是可被允許的。沖吹氣體的最小流速必須是1呎/秒（0.3 公尺/秒）。

15 Purge gas system 沖吹氣體系統

15.1 Purging of the delivery system 輸送系統的沖吹

Portions of the silane delivery system that will contain silane shall be purged with an inert or other gas to displace entrained air or other gases that will react under the conditions of use anticipated before the introduction of silane. The use of vacuum as the sole means to remove residual gases that may be entrained within the delivery system shall not be allowed. Vacuum systems shall be used in conjunction with a purge gas to rid the system of undesired atmospheres. Purging of the system shall be by manual or automatic means.

在導入矽甲烷之前，矽甲烷輸送系統輸送矽甲烷的部分應使用惰性氣體或其他氣體沖吹，以置換管路中的空氣或其他預期在使用狀況下會與其反應的氣體，使用真空當作唯一的方法以去除輸送系統中可能殘留的氣體是不被允許的。真空系統必須配合沖吹氣體以去除輸送系統中不預期的大氣，系統的沖吹必須為手動或自動的方法。

15.2 Dedicated purge source 專用沖吹氣源

Purge gas used for the purging of silane delivery system piping and components shall be supplied from a dedicated inert gas supply source. A purge gas manifold shall be provided when one inert purge gas cylinder or supply is used as the common purge gas source for multiple silane systems.

用於沖吹矽甲烷輸送系統管路及元件的沖吹氣體，應從專用的沖吹氣體來源供應。當多個矽甲烷系統共同使用單一惰性沖吹氣體鋼瓶或供應氣源時，應配置沖吹氣體盤面。

15.2.1 Limitations on source of purge gas

House gas supplies shall not be used for purging silane delivery systems due to the risk of back flow into the house gas supply. An exception is made for vent lines from process gas panels when in accordance with the requirements of 14.5.

沖吹氣源的限制

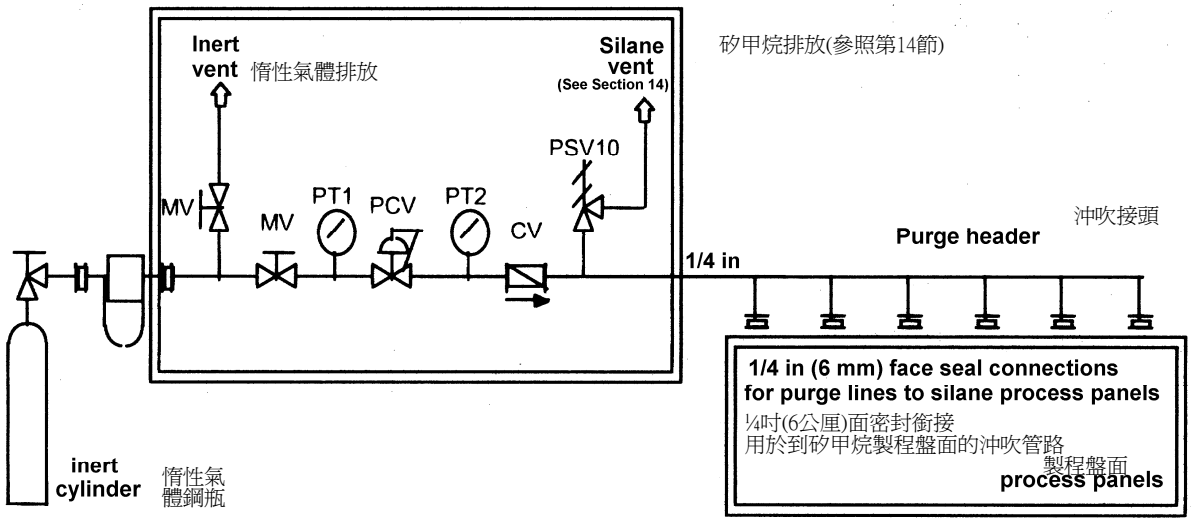
不可使用公用氣體供應進行矽甲烷輸送系統的沖吹，因為有逆流到公用氣體供應的風險。但不包含符合14.5要求的用以沖吹製程氣體盤面的排放管路。

15.2.2 Protection of the purge gas source

The purge gas source shall be provided with controls to prevent silane from entering the purge gas supply. See Figure 9.

沖吹氣源的保護

沖吹氣體氣源必須配備控制裝置，以防止矽甲烷進入沖吹氣源供應。參照圖9。



NOTE—The purge gas panel is allowed to be connected to one or more process gas panels with the purge header. Figure 9 has been provided to illustrate the concepts described in the text of the standard. The figure is schematic in nature. It is neither to be interpreted as a design document nor is it intended to restrict alternate designs. For instrument nomenclature, see Figure 1.

註：沖吹氣體盤面可以銜接到一至多個製程氣體盤面。圖9展示本標準內文所說明的概念。圖示本身僅為示意，不得以此作為設計文件的解釋或用於限制其他替代設計。關於儀器術語，請參閱圖1。

Figure 9—Inert purge gas flow schematic

圖 9 – 惰性沖吹氣體流程圖

15.3 Controls 控制

The inert gas purge system shall be equipped with a dedicated inert gas supply or source, a pressure regulator, an overpressure relief device, a check valve, and a low purge gas pressure alarm system.

惰性氣體沖吹系統應配備專用的惰性氣體供應或氣源、調壓閥、過壓釋放裝置、逆止閥，以及沖吹氣體低壓警報系統。

15.3.1 Backflow prevention

Backflow prevention shall be provided on purge gas supply lines to ensure that a potential backflow of silane does not contaminate the dedicated purge gas source. The check valve (CV) and pressure relief valve (PSV10) shown in Figure 9 are used as safeguards to prevent a silane backflow if that silane is fed back into the purge gas system. The PSV10 serves as a redundant feature to protect the CV from overpressure. Electronic interlocks and engineering controls are allowed to be used to prevent backflow. One example is to automatically isolate the purge process if the purge gas pressure is at or below the silane source pressure.

逆流防止

為確保矽甲烷的可能逆流不會污染專用的沖吹氣體氣源，必須在沖吹氣體供應管路上設置逆流防止裝置。圖9顯示的逆止閥（CV）和釋壓閥（PSV10）被用來當作防護措施，以便防止矽甲烷逆流回沖吹氣體系統。PSV10當作第二重保護裝置，用以防止逆止閥過壓回流。電子連鎖及工程控制方法可允許用於防止逆流，一個例子是在沖吹氣體壓力處於或低於矽甲烷氣源壓力時自動隔離沖吹過程。

15.3.2 Low pressure alarm

A low pressure alarm system shall be provided to indicate low pressure on the purge gas source of supply. Indication of a low pressure condition shall activate an audio and/or visual local alarm. Low pressure shall be determined by the system designer and is dependent in part with performance of the system. The primary purpose of purge gas source is to purge atmospheric gases from the system and low pressure is determined to be a pressure less than that required for operation of the system. When purge gas is used for purposes of leak checking the system, the minimum purge gas pressure shall not be less than the highest pressure that the component being leak checked will be exposed to under operating conditions.

低壓警報

爲指出沖吹氣體供應氣源上的低壓，應設置低壓警報系統。在指出低壓狀況時，應能啓動聽覺及/或視覺的現場警報器。低壓應由系統設計者來決定，且部分取決於系統的性能。沖吹氣體氣源的主要目的是沖吹在系統的大氣氣體，而低壓係指低於操作系統所需要的壓力。當沖吹氣體用於系統洩漏檢查目的時，最小沖吹氣體壓力不應低於被檢查的元件在操作狀況下將身處其中的最高壓力。

15.3.3 Pneumatic line source

An inert gas or supply of clean compressed air is required for the operation of pneumatic valves used to operate the purge gas system. Although interruption of the inert gas or compressed air supply ordinarily poses no threat to contamination of the silane system, overpressurization of valve operators is of concern. The pneumatic supply pressure shall be pressure regulated and overpressure protection shall be provided to protect the system component with the lowest working pressure in the system served.

氣動管路來源

用來操作沖吹氣體系統的氣動閥，需要惰性氣體或乾淨壓縮空氣的供應才能操作。雖然惰性氣體或壓縮空氣供應的中斷，通常不會對矽甲烷系統污染造成威脅，但閥門操作的過壓是應顧慮的問題。氣動閥供應壓力應受到調節，且應設置過壓防護，以便用服務系統內的最低工作壓力來保護系統元件。

15.4 Vacuum generator purge gas source 真空產生器沖吹氣體氣源

When vacuum generators or vacuum venturis are used to produce the vacuum needed for evacuation/purge cycles in silane systems, nitrogen or other inert gas shall be used to provide the motive force necessary to generate the vacuum.

Vacuum venturis require high volumetric flow rates (~100 lpm) supplied at modest pressures (~100 psig [690 kPa]) to generate the vacuum needed for clearing systems of silane. See Figure 5.

在使用真空產生器或文氏真空管（vacuum venturis）
來產生矽甲烷系統淨空/沖吹循環所需要的真空時，應使用氮氣或其他惰性氣體來提供產生真空所需要的動力。文氏真空管需要在適壓下（～100 psig〔690 kPa〕）有高體積流速（～100 lpm），才能產生沖吹矽甲烷系統所需要的真空。參照圖5。

15.4.1 Source of purge gas used for vacuum venturi systems

The use of facility or house nitrogen shall be allowed as a means to operate vacuum venturi systems connected to the silane venting system. See 14.5.

用於文式真空管系統的沖吹氣體氣源

工廠或室內氮氣，可做爲連接到矽甲烷排放系統的文氏真空管系統的氣源。參照 14.5。

15.4.2 Backflow prevention at venturi supply

When inert house gas supplies are used to operate vacuum venturi systems, the house gas supply system shall be protected against backflow with a check valve and a pressure relief device located at the connection where the inert gas source is introduced to the vacuum venturi. See Figure 5.

文氏真空管的逆流防止

當惰性公用氣體供應被用來操作文氏真空管系統時，應在惰性氣體來源被引入文氏真空管連接處設置逆止閥及釋壓裝置，以防止公用氣體供應系統發生逆流。參照圖5。

16 Electrical requirements 電氣要求

16.1 General 一般

Electrical systems and components shall comply with the equivalent national standard that meets the requirements of the United States *National Electrical Code*® (NEC) [17]. In case of use of the NEC code, regardless of the provisions in NEC Section 500-2 that allow the use of unclassified electrical equipment where pyrophoric materials are used, electrical equipment shall be classified in accordance with the requirements of Tables 7 and 8.

電氣系統及元件應符合國家電氣法（National Electrical Code®，NEC）[17]。不論NEC第500-2 節的規定（允許在使用自燃性材料之處使用未分類的電氣設備），電氣設備均應根據表7及表8的要求來分類。

Table 7—Indoor electrical requirements for silane systems containing silane in concentrations exceeding 1.37% by volume

Indoor installations	Classification	Conduit seals	Purging of control enclosure	Uninterruptible power supply (UPS)
Where electrical enclosure interfaces with a gas cabinet.	Unclassified	Per NEC 501-5(b). Conduits used to join a control box to a gas cabinet shall be sealed.	Purging of the electrical control panel cabinet is required. Purging is allowed to be by means of an inert gas or fresh air supply.	A UPS system shall be provided for required controls that are electrically powered, i.e., gas monitoring system, fire detection system, etc. Mechanical systems shall be provided with an emergency power system in lieu of UPS.
Within gas cabinets.	Class I, Division 2	Per NEC 501-5(b). Conduits used to join a control box to a gas cabinet shall be sealed.		
Where electrical enclosures are located within 5 ft (1.5 m) of unwelded silane pipe fittings.	Class I, Division 2 within 5 ft (1.5 m) of enclosure	Conduit seals are required on the electrical enclosure side of the conduit.	Air intakes for the fresh air supply shall be located to prevent migration of unreacted silane into the controller.	The required controls shall remain powered through a power failure or a controller shutdown.
Where other hazardous gases are in the vicinity.	As required for other gases in accordance with NEC Section 500-2.	Conduit seals are required on the electrical enclosure side of the conduit. If gases in the area require classification then conduit seals shall be per requirement of NEC classification.	Additional purging if required per electrical classification.	

表7 矽甲烷濃度超過體積比1.37%的矽甲烷系統之室內電氣要求

室內安裝	分類	導線管密封	控制密封箱的沖吹	不斷電系統（UPS）
氣瓶櫃的電氣密封箱介面	未分類	根據NEC 501-5(b) 用以連接控至箱與氣瓶櫃的導線管應密封	電氣控制面盤箱必須沖吹。 沖吹可利用惰性氣體或新鮮空氣供應來進行。	電源控制應裝設不斷電系統，包括氣體監控系統、火災偵測系統等。對於機械系統，應提供緊急電力系統來取代UPS。 即使電力故障或控制器關閉，必要的控制仍必須維持電力。
氣瓶櫃內	第1類，第2級	根據NEC 501-5(b) 用以連接控至箱與氣瓶櫃的導線管應密封		
電氣密封箱位於非焊接的矽甲烷管路接頭週邊5 呎（1.5 公尺）內	在密封箱5 呎（1.5 公尺）內為第1類，第2級	在電氣密封箱側的導線管應密封	新鮮空氣的供應入口應設置在防止未反應的矽甲烷進入控制器的位置	
在附近有其他危害氣體之處	根據NEC 500-2 對其他氣體的要求	在電氣密封箱側的導線管應密封 如區域中的氣體需要分類，導線管密封應根據NEC分類的要求。	根據電氣分類，如需要應進行額外沖吹。	

Table 8—Outdoor electrical requirements–silane systems containing silane in concentrations exceeding 1.37% by volume

Outdoor installations	Classification	Conduit seals	Purging of control enclosure	Uninterruptible power supply (UPS)
General	Classified Class I, Division 2 within 5 ft (1.5 m) of points of connection, otherwise unclassified.	Conduit seals are allowed to be used; however, they do not always function as intended since silane is capable of dispersing into the surrounding area.	Purging of the electrical control panel cabinet is required when panels are located within 5 ft (1.5m) of points of connection to the gas distribution system. Purged enclosures shall be in accordance with the requirements of NFPA 496, *Standard for Purged and Pressurized Enclosures for Electrical Equipment* [18].	A UPS system shall be provided for required controls that are electrically powered, i.e., fire detection systems, etc. These devices shall remain powered through a power failure or a controller shutdown. Mechanical systems shall be provided with an emergency power system in lieu of UPS.
Where other hazardous gases are in the vicinity.	Other gases in the area are able to require classification per NEC Section 500-2. If other gases in the area require classification then the area shall be classified.	If gases in the area require electrical classification then conduit seals shall be as required by the NEC.		

表8 矽甲烷濃度超過體積比1.37%的矽甲烷系統之室外電氣要求

室外安裝	分類	導線管密封	控制密封箱的沖吹	不斷電系統（UPS）
一般	在銜接點5 呎（1.5公尺）內為第1類，第2級，其餘未分類	導線管密封可以使用，但未必能發揮預期的功能，因為矽甲烷能擴散到週遭區域。	當電氣控制面盤箱位在氣體分配系統銜接點5呎（1.5公尺）內時，電氣控制面盤箱需要沖吹。沖吹密封箱必須符合NFPA 496「電氣設備沖次和正壓密封箱標準」的要求〔18〕。	電源控制應裝設不斷電系統，如火災偵測系統等。 即使電力故障或控制器關閉，必要的控制仍必須維持電力。 對於機械系統，應提供緊急電力系統來取代UPS。
在附近有其他危害氣體之處	區域中的其他氣體應根據NEC 500-2需求分類。 如區域中的其他氣體需要分類，區域亦應分類。	如區域中的氣體需要電氣分類，導線管密封應依照NEC的規定。		

16.2 Indoor electrical systems 室內電氣系統

Electrical equipment in indoor areas where silane systems are located shall be in accordance with the requirements of Table 7.

矽甲烷系統所在的室內區域中的電氣設備應符合表7的要求。

16.3 Outdoor electrical systems 室外電氣系統

Electrical equipment in outdoor areas where silane systems are located shall be in accordance with the requirements of Table 8. Bulk sources shall be grounded to earth before and during connection to the silane delivery system.

矽甲烷系統所在的室外區域中的電氣設備應符合表8的要求。大宗氣源連接到矽甲烷輸送系統之前及之間必須接地。

17 Fundamental supervisory control requirements 基本監督控制要求

17.1 Indoor requirements 室內要求

Supervisory control systems for silane delivery systems used indoors shall be in accordance with Table 9.

用於室內的矽甲烷輸送系統監督控制系統應符合表9的要求。

17.2 Outdoor requirements 室外要求

Supervisory control systems for silane delivery systems used outdoors shall be in accordance with Table 10.

用於室外的矽甲烷輸送系統監督控制系統應符合表10的要求。

Table 9—Indoor requirements for supervisory control
Silane systems containing silane in concentrations exceeding 1.37% by volume

Indoor installations	Exhaust monitoring	Gas monitoring (See 11.1)	Flame detection (See 11.2)	Emergency shutoff (See 10.2.3)
Gas cabinet	Alarm on loss of exhaust. Source shutdown on loss of exhaust NOT required.	Gas monitor required inside gas cabinet. Source shutdown on activation of gas monitor.	An optical flame detection system or temperature switch required in gas cabinet. Source shutdown on fire detection.	Emergency shutdown controls shall be provided outside each exit.
Silane piping systems with unwelded connections in other than coaxial piping systems		Area monitors required in room.	An optical flame detection system is required. Temperature switch not recommended. Source shutdown on fire detection.	
VMB		Gas monitor required inside VMB. Manifold branch shutdown on activation of gas monitor.	An optical flame detection system or temperature switch required in VMB. Manifold branch shutdown on fire detection.	

表9 室內監督控制要求
矽甲烷濃度超過體積比1.37%的矽甲烷系統

室內安裝	排氣監測	氣體監測（參照11.1）	火焰偵測（參照11.2）	緊急關閉（參照10.2.3）
氣瓶櫃	排氣喪失時發出警報 排氣喪失時不需要關閉氣源	氣瓶櫃中需要裝設氣體監測器 在氣體監測器作動時關閉氣源	氣瓶櫃中需裝設光學火焰偵測系統或溫度開關 偵測到火焰時關閉氣源	每個出口外應設置緊急關閉控制裝置
在非同軸管路系統中，有非焊接連接的矽甲烷管路系統		室內需裝設區域監測器	需裝設光學火焰偵測系統，但不建議使用溫度開關 偵測到火焰時關閉氣源	
氣體供應分歧箱/模組(VMB)		氣體供應分歧箱/模組(VMB)中需要裝設氣體監測器 在氣體監測器作動時關閉歧管分支	氣體供應分歧箱/模組(VMB)中需裝設光學火焰偵測系統或溫度開關 偵測到火焰時關閉歧管分支	

Table 10—Outdoor requirements for supervisory control
Silane systems containing silane in concentrations exceeding 1.37% by volume

Outdoor installations	Exhaust monitoring	Gas monitoring (See 11.1)	Flame detection (See 11.2)	Emergency shutoff (See 10.2.3)
General	Forced ventilation is NOT required.	Gas monitoring is NOT required.	Fire detection is required. Source shutdown on fire detection.	ESO controls shall be provided at each exit. Shutoff controls shall be located not less than 15 ft (4.6 m) from the supply system.

表10 室外監督控制要求
矽甲烷濃度超過體積比1.37%的矽甲烷系統

室外安裝	排氣監測	氣體監測（參照11.1）	火焰偵測（參照11.2）	緊急關閉（參照10.2.3）
一般	不需裝設強制通風	不需裝設氣體偵測	需裝設火焰偵測 在偵測到火焰時關閉氣源	每個出口應設置緊急關閉控制裝置 關閉控制裝置與供應系統的距離至少為15呎（4.6公尺）

18 References 參考文獻

Unless otherwise specified, the latest edition shall apply. 除非特別指定，應使用最新版本

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Appendix A—Personnel protection
(Informative)

A1 Personal protective equipment

Whenever an operator is separated from a silane system by less than two barriers, personal protective equipment (PPE) is required. Examples of two barriers are the container vessel and piping as a primary barrier, and a gas cabinet, fenced off area, or separation distance as a secondary barrier. If silane is in a mixture with a toxic gas, guidelines for the toxic gas shall be followed and additional PPE will be required.

A1.1 PPE for routine system operation

Minimum PPE requirements for operations that involve opening and closing of valves or any work within a 15 ft (4.6 m) vicinity of a silane storage or use system include the following:

- hard hat;
- safety glasses;
- leather gloves;
- fire resistant clothing/coveralls; and
- safety shoes.

A1.2 PPE for opening of process lines

Minimum PPE requirements for operations that involve opening of process lines and equipment in a silane system (e.g., cylinder change out, breaking fittings on a process line for maintenance, etc.) include the same equipment as in A.1.1 plus the following:

- fire resistant hood;
- face shield;
- hearing protection (e.g., ear plugs or ear muffs); and
- provision of a nitrogen shield across the outside of the fitting or a helium purge through the fitting (purge ports) to shield the fitting from exposure to atmosphere.

A1.3 PPE for emergency operations

PPE for emergency response includes:

- NFPA-approved firefighter turnout gear;
- firefighting gloves;
- fire helmet with face shield;
- fire resistant hood; and
- self-contained breathing apparatus (SCBA).

Minimum of two people, shall respond to emergency situations that include firefighting, silane source isolation, or personnel rescue. Any persons responding to an emergency shall be trained in emergency response, proper use of emergency response PPE, and other emergency response equipment.

A2 Training

Persons responsible for the operation of the silane system or storage shall be knowledgeable of the physical and chemical nature of silane and the mitigating actions necessary in the event of fire, explosion, or leakage before being qualified to operate the system. They shall be trained in the operation of the system and associated controls, alarms, and indications. Responsible persons shall be designated and trained to be liaison personnel for the fire department. These persons shall aid the fire department in preplanning emergency responses and identification of the locations where silane is located. They shall have access to the material safety data sheet (MSDS) and knowledge in the site

emergency response procedures. Operator competence shall be retested annually or when job assignments are changed.

A3 Emergency procedures

Whenever a leak is discovered downstream of the silane source, the best emergency procedure is to shut off the supply of silane at the source or to isolate the leak as close to the source as practicable. When source isolation is the desired emergency procedure but direct access to the source primary control valve is not possible, shutoff shall be accomplished with a remotely operated valve. When a leak is discovered at the connection of the cylinder valve to the silane source or anywhere on the source valve itself, the source cylinder or container shall be cooled until the release has subsided after which a containment vessel or exhausted enclosure shall be provided. The cylinder or container will be placed inside the enclosure using trained personnel and approved procedures. Once sealed and secured, the enclosure is able to be removed from site. Leaking or defective cylinders or containers shall be returned to the supplier for proper disposal or repair.

A4 Operations and maintenance

Trained personnel who have demonstrated understanding and competence in the operations they will perform shall perform all operations and maintenance of silane systems. Training shall be specific for the systems involved and include the use of written procedures that describe the operations to be conducted. Competence in system operation shall be demonstrated by the use of written tests as well as associated hands-on work.

A4.1 Operational instructions

There shall be printed operating instructions maintained at the operating location. Operating procedures shall be written and approved by knowledgeable personnel or persons knowledgeable of the hazards of silane, the function and use of equipment, and controls as well as with the facility in which the system is installed.

A4.2 Maintenance

Silane supply systems shall be inspected regularly for signs of leakage. A maintenance program shall be set up for the inspection, calibration, or replacement of wearing components such as valves, regulator, pressure transducers/gauges/switches, and flow switches. Defective components shall be replaced immediately. Maintenance procedures shall be written and approved by persons knowledgeable concerning the hazards of silane, the function and use of equipment and controls, and the facility in which the system is installed. Detection and alarm systems shall be maintained in operating condition. Weeds and long dry grass shall be cut and maintained within 15 ft (4.6 m) of outdoor supply systems.

A5 MSDS

Persons working with or around silane shall be knowledgeable with and understand the contents of the supplier’s MSDS.

附錄A — 個人保護
(資訊性質)

A1 個人防護裝備

當操作人員位於少於兩道屏障的矽甲烷系統中，需著個人防護裝備。兩道屏障的例子如容器與管路當作第一道屏障，及氣瓶櫃，圍籬隔離區域，或以隔離距離作為第二道屏障。如果矽甲烷與毒性氣體混合，必須另行遵照毒性氣體所需的額外個人防護裝備。

A1.1 日常系統操作個人防護裝備

操作包含開/關矽甲烷閥門或任何在矽甲烷儲存區鄰近15呎(4.6公尺)內之作業或使用系統的個人防護裝備最低需求包括：

- 安全帽；
- 安全眼鏡；
- 皮手套；
- 防火衣/外套；及
- 安全鞋。

A1.2 開啟製程管路個人防護裝備

操作作業包含開啟矽甲烷系統製程管路及設備 (如更換鋼瓶，維修時拆開製程管路等)以及項次A1.1的設備其個人防護裝備最低需求應再加上：

- 防火頭套；
- 面罩；
- 聽力保護 (如耳塞或耳罩)；及
- 接頭外部氮氣保護或氦氣沖吹接頭 (沖吹氣門)，以保護接頭不暴露於空氣中。

A1.3 緊急操作個人防護裝備

緊急應變使用的個人防護裝備必須包括：

- 美國國家消防署 (NFPA) 認可之消防用防護衣服；
- 消防用手套；
- 包含面罩的消防頭盔；
- 防火頭套；及
- 自負式呼吸設備 (SCBA)

包含消防，矽甲烷氣源隔離或人員救助之緊急應變最少需兩人作業。任何進行緊急應變之人員均須接受過緊急應變的相關訓練，以適當的使用緊急應變個人防護裝備與其他緊急應變器材。

A2 訓練

矽甲烷系統或儲存操作合格人員必須具備矽甲烷本質的化學與物理性質的知識，且可於火災，爆炸或洩漏的情況下進行隔離所必須的作業。這些人員必須接受系統操作相關的控制，警報及指示訓練，應變人員必須是特定人員並接受聯絡消防部門的訓練，其需協助消防人員作緊急應變的前置計畫並識別矽甲烷的相關位置。他們必須可取得物質安全資料表 (MSDS)
並熟稔區內緊急應變步驟。操作人員的能力必須每年或於更換工作時重新測試。

A3 緊急應變步驟

不論何時發現矽甲烷氣源下游發生洩漏，最佳的緊急應變步驟就是在可行的情況下自矽甲烷氣源處關閉矽甲烷供應以阻隔洩漏。如果隔離氣源是主要的緊急應變步驟，而氣源的主要控制閥又無法直接接近，則必須以遠端控制的方式關閉操作閥。當洩漏發生在鋼瓶氣源接頭處或主要氣源控制閥本身，則必須保持氣源鋼瓶或容器降溫直到洩漏消失，在此過程中美國運輸部 (DOT)
認可的密封容器或密封排氣裝置可能是有必要的。此鋼瓶或容器會經由合格人員使用正確步驟放到美國運

輸部認可的密封容器中，一旦密封並保全了鋼瓶或容器，美國運輸部認可的密封容器即可移離該區。洩漏或故障的鋼瓶或容器必須送還原供應商做進一步的廢棄處理或維修。

A4 操作與維護

訓練過的操作人員在作業上表現出相關的了解與能力可進行所有操作與維護矽甲烷系統的作業。訓練必須包含指定的系統及書面的操作作業的使用，系統操作能力之審核必須使用書面的測驗與實際操作作業。

A4.1 操作說明書

操作現場必須保有書面的操作說明書，操作步驟的書寫與審查人員必須是具備足夠相關知識或熟稔安裝現場矽甲烷危害相關知識，設備的使用與功能及控制的人員。

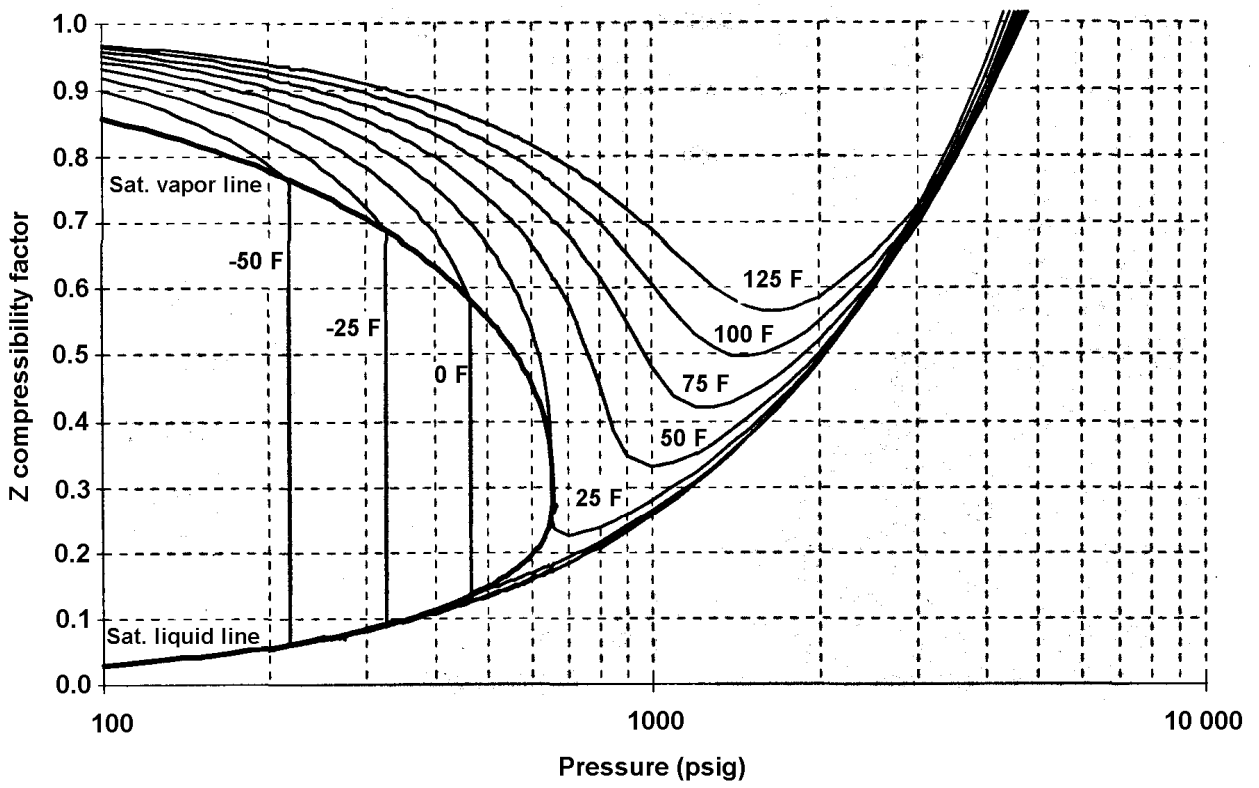
A4.2 維護

矽甲烷系統必須定期針對洩漏跡象進行檢查，必須建立相關的系統維護計畫，包含檢查、校正、或更換如閥門、調壓閥，壓力傳送器/壓力錶/開關及流量開關的耗材。有缺陷的零附件必須立即更換，維護步驟的書寫與審查人員必須是具備足夠相關知識或熟稔安裝現場矽甲烷危害相關知識，設備的使用與功能及控制的人員。偵測與警報系統必須維持其可用狀態，室外供應系統週邊15呎 (4.6 公尺) 內的乾燥雜草必須割除。

A5 物質安全資料表

矽甲烷操作人員或週遭的人員必須熟稔與了解供應商所提供的物質安全資料表。

Appendix B—Silane compressibility 矽甲烷壓縮係數
(Informative)
(資訊性質)



Appendix C—Thermal radiation
(Normative)

Thermal radiation kW/m^2	Exposure	Minimum distance to exposure ft (m)							
		Cylinders [1] ≤ 600 ft^3 (17 m^3)		Cylinders 601 to 2500 ft^3 (71 m^3)		Cylinders 2501 to 10 000 ft^3 (283 m^3)		450 L cylinder [2] ≤ 10 000 ft^3 (283 m^3)	
		ft	(m)	ft	(m)	ft	(m)	ft	(m)
1.6	Location where personnel with protective clothing are allowed to be continuously exposed [19].	16	(5)	30	(9)	50	(15)	60	(18)
4.7	Heat intensity where emergency actions lasting up to three minutes is required [19].	12	(4)	20	(6)	30	(9)	50	(15)
6.3	Heat intensity in areas where emergency actions lasting up to 1 minute is required [19].	10	(3)	16	(5)	25	(8)	45	(14)
9.5	Heat intensity at any location where people have access – exposure limited to up to ten seconds, used for escape only [19].	8	(2.4)	15	(5)	23	(7)	40	(12)
15.8	Heat intensity on structures and in areas where operators are performing duties. Shelter from radiant heat is provided [19].	8	(2.4)	12	(4)	20	(6)	40	(12)
37.5	Damage to process equipment [20].	8	(2.4)	10	(3)	12	(4)	40	(12)

NOTE—The data in this thermal radiation table is based on a model with the following assumptions:

–Three nested volumes 600 ft^3 (17 m^3), 2500 ft^3 (71 m^3), and 10 000 ft^3 (283 m^3) for 44 L-size cylinders and one nest size of 10 000 ft^3 for 450 L-size cylinders were evaluated.

–Silane released through the rupture disk and exits through two 1-in (25 mm) holes in the cylinder cap. The jets exiting the cylinder cap were assumed to be horizontal.

–The average release rate of a cylinder at 165° F (74 °C) was used in the radiation calculations since the relieving cylinders are expected to be at different stages of venting. Approximate release time for one cylinder is 2 min. The accuracy of the silane radiation calculations was verified by comparison with experimental radiation data [21].

–A low wind speed was selected to provide the maximum radiation.

–Calculations were made for cylinders at 1000 psig (6900 kPa), 1500 psig (10 340 kPa), and 1650 psig (11 380 kPa), and the worst case was listed in the table.

–50% of the cylinders in the nested volume were assumed to be relieving at one time. The relieving cylinders were those closest to the receptor. The radiation was corrected for the location of cylinders, which were tightly packed.

[1] The definition for “cylinders” as it applies to this table is compressed gas cylinders with an internal volume of 1.8 ft^3 (50 L) or less.

[2] The definition for “450 L cylinder” as it applies to this table is compressed gas cylinders with an internal volume of 16 ft^3 (450 L) or less.

附錄C — 熱輻射
(規範性質)

熱輻射 kW/m²	**暴露**	**暴露的最小距離 呎 (公尺)**			
		鋼瓶容積[1] ≤ 600 立方呎 (17 立方公尺)	**鋼瓶容積 601 到 2500 立方呎 (71立方公尺)**	**鋼瓶容積 2501 到 10,000 立方呎 (283立方公尺)**	**450公升鋼瓶容積[2] ≤ 10,000 立方呎 (283 立方公尺)**
		呎 (公尺)	呎 (公尺)	呎 (公尺)	呎 (公尺)
1.6	人員著保護服裝允許持續暴露的位置[19]	16 (5)	30 (9)	50 (15)	60 (18)
4.7	緊急應變行動可持續到三分鐘的熱力強度[19]	12 (4)	20 (6)	30 (9)	50 (15)
6.3	緊急應變行動必須達到一分鐘的熱力強度[19]	10 (3)	16 (5)	25 (8)	45 (14)
9.5	任何位置的人員進入的熱力強度-暴露限制到10秒鐘，用於人員逃生[19]	8 (2.4)	15 (5)	23 (7)	40 (12)
15.8	結構及該區域值班人員的熱力強度，有熱輻射防護圍籬者[19]	8 (2.4)	12 (4)	20 (6)	40 (12)
37.5	製程設備損壞[20]	8 (2.4)	10 (3)	12 (4)	40 (12)

備註—熱輻射表格內的所有數據乃基於下列假設之推衍

- 使用3種 44公升規格鋼瓶的巢狀擺放體積600立方呎(17立方公尺)，2500立方呎(71立方公尺)及10000立方呎(283立方公尺)及一種450公升規格鋼瓶的巢狀擺放體積10000立方呎。
- 矽甲烷自破裂片處釋放經兩個1吋(25公厘)的瓶蓋孔排出，其自瓶蓋噴射出的角度假設為水平。
- 在熱輻射計算使用鋼瓶在165^0F(74^0C)的平均釋放速率，因為在釋放的階段其速率不盡相同，一支鋼瓶的釋放時間大約是2分鐘，矽甲烷輻射熱計算已經與實驗的輻射熱資料驗證正確[21]。
- 風速選擇最低以得到最大輻射熱結果。
- 計算使用的鋼瓶壓力為1000 psig (6900 kPa)，1500 psig (10340 kPa)，1650 psig (11380 kPa)及最壞情況如上表所列。
- 在巢狀擺放體積中假設一半的鋼瓶同時釋放，釋放鋼瓶為最接近接收器者，鋼瓶為緊密綑綁，已經修正鋼瓶位置對輻射熱值的影響。

[1] 本表所使用的"鋼瓶"為內容積1.8立方呎(50公升)或更小的壓縮氣體鋼瓶。

[2] 本表所使用的"450公升鋼瓶"為內容積16立方呎(450公升)或更小的壓縮氣體鋼瓶。

Appendix D—Overpressure
(Normative)

Over-pressure Psi (kPa)	Minimum distance to exposure ft (m)											
	PRD with ≤ 0.375 in (10mm) orifice				PRD with > 0.375 in (10mm) to ≤ 0.5 in (13 mm) orifice				PRD with > 0.5 in (13mm) to ≤ 1 in (25 mm) orifice			
	1000 psig (6900 kPa)		1600 psig (11 030 kPa)		1000 psig (6900 kPa)		1600 psig (11 030 kPa)		600 psig (4140 kPa)		1000 psig (6900 kPa)		1600 psig (11 030 kPa)	
	ft	(m)	ft	(m)	ft	(m)	ft	(m)	ft	(m)	ft	(m)	ft	(m)
0.5 (3)	105	(32)	175	(53)	140	(43)	225	(69)	175	(53)	275	(84)	450	(137)
1 (7)	65	(20)	110	(34)	80	(24)	145	(44)	110	(34)	180	(55)	300	(91)
2 (14)	40	(12)	65	(20)	50	(15)	90	(27)	65	(20)	100	(30)	165	(50)
3 (21)	30	(9)	50	(15)	40	(12)	70	(21)	50	(15)	80	(24)	140	(43)
4 (28)	25	(8)	45	(14)	35	(11)	55	(17)	45	(14)	65	(20)	115	(35)
5 (34)	23	(7)	35	(11)	30	(9)	50	(15)	35	(11)	60	(18)	100	(30)
6 (41)	20	(6)	30	(9)	25	(8)	40	(12)	30	(9)	50	(15)	80	(24)

NOTES

1 The data in this overpressure table is based on a model and validated by large scale testing as described in *Large Scale Silane Release Tests* [2]. This table can be used as a guideline for design and layout of equipment, structures, and exposures. There are a number of references that are able to be used to evaluate the effect of overpressure caused by a vapor cloud explosion. See Section 18. The following assumptions were made:

- Silane release is through the PRD on the container with the pressure in the container as indicated in the table;
- The PRD shall be in compliance with CGA S-1.1 and CGA S-1.3 [11, 22]
- The silane release produces a vapor cloud explosion (does not spontaneously ignite upon release).
- The model that generated the data in this table used a yield factor of 1 for the purposes of calculating overpressure. A yield of 1 is conservative relative to the actual test data.

2 The most common orifice size found in PRDs in current use on tube trailers and ISO modules is 0.87 in (22 mm) diameter. The size of the orifice shall be determined in accordance with the requirements of pressure relief device standards [11].

3 This table shall not apply to high pressure piping. Engineering evaluation shall be provided to predict releases from piping systems and the resultant potential overpressure or thermal radiation. The rate of release shall be determined by intrinsic factors including but not limited to system pressure, valve orifice size friction loss, and tubing volume.

附錄D — 超壓
(規範性質)

超壓 Psi (kPa)	最小暴露距離 呎(公尺)						
	PRD 內含 ≤ 0.375 吋 (10公厘) 的限流孔		PRD內含 > 0.375 吋 (10 公厘) 到 ≤ 0.5 吋 (13 公厘) 的限流孔		PRD內含 > 0.5 吋 (13 公厘) 到 ≤ 1吋 (25 公厘) 的限流孔		
	1000 psig (6900 kPa)	1600 psig (11030 kPa)	1000 psig (6900 kPa)	1600 psig (11030 kPa)	600 psig (4140 kPa)	1000 psig (6900 kPa)	1600 psig (11030 kPa)
	呎 (公尺)	呎 (公尺)	呎 (公尺)	呎 (公尺)	呎 (公尺)	呎 (公尺)	呎 (公尺)
0.5 (3)	105 (32)	175 (53)	140 (43)	225 (69)	175 (53)	275 (84)	450 (137)
1 (7)	65 (20)	110 (34)	80 (24)	145 (44)	110 (34)	180 (55)	300 (91)
2 (14)	40 (12)	65 (20)	50 (15)	90 (27)	65 (20)	100 (30)	165 (50)
3 (21)	30 (9)	50 (15)	40 (12)	70 (21)	50 (15)	80 (24)	140 (43)
4 (28)	25 (8)	45 (14)	35 (11)	55 (17)	45 (14)	65 (20)	115 (35)
5 (34)	23 (7)	35 (11)	30 (9)	50 (15)	35 (11)	60 (18)	100 (30)
6 (41)	20 (6)	30 (9)	25 (8)	40 (12)	30 (9)	50 (15)	80 (24)

備註

1. 本超壓表內所有的資料來自模型的評估，其已使用大規模矽甲烷釋放測試(Large Scale Release Tests[2])
   的結果做過確認，本表可用以作爲設計，設備擺設，結構，與暴露之指導。有許多的參考文獻可用以評估蒸氣雲爆炸導致的超壓效應，見第18章。下列爲相關的假設：
   - 矽甲烷以表中的壓力經壓力釋放裝置釋出；
   - 壓力釋放裝置必須依照CGA S-1.1及CGA S-1.3[11,12]安裝
   - 矽甲烷釋放產生蒸氣雲爆炸 (釋放後並未立即點燃)
   - 本模型爲使用降伏參數1計算超壓產出的資料，降伏參數1來自實際測試資料的轉換。

2. 目前最常使用於管束拖車及ISO模組之壓力釋放裝置的限流孔規格是0.87吋(22公厘)直徑，限流孔規格必須依照壓力釋放裝置標準[11]的要求決定。

3. 本表不可應用在高壓管路，其必須使用工程評估預測管路系統的洩漏可能造成的超壓與輻射熱，釋放速率必須依照包含不止系統壓力，閥門限流規格之摩擦損耗及管路體積的本質參數決定。

The following graphs have been created from the data presented in Appendix D. 下圖為依照附錄D的資料所建立