無人操控氣體工廠:
設計與操作

UNMANNED AIR GAS PLANT:
DESIGN & OPERATION

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

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UNMANNED AIR GAS PLANT: DESIGN & OPERATION

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Table of Contents

1 Introduction 前言

This document has been written to address issues relating to the increasing number of air gas production facilities that are run unmanned.

There are many similarities in the operation of manned & unmanned plants, however there are some differences. These differences are not only in how the plant is operated and maintained, but also how the plant is designed. In particular, designing new unmanned plants or converting existing plants from manned to unmanned operation requires special precautions to maintain an adequate level of safety.

有鑑於無人操控的氣體製造廠有日漸增多的趨勢，特撰本文討論相關議題。
有人操控與無人操控的工廠操作有許多類似之處，然而兩者之間還是有若干差別。不同之處，除操作與維護外，兩者在設計上也不同。尤其是設計全新的無人操控工廠，或將現有廠房變更爲無人操作時，需特別留意才能維持一定的安全等級。

2 Scope and purpose 範疇與目的

Unmanned plant functionality can range from a plant with full remote functionality i.e. satellite plant controlled by a Remote Operating Centre (ROC) to a simple plant with a local monitoring system and a dial-out function to alert a local technician.

The installations that are included in this document are:

- Air separation plants (with backup systems and site storage as appropriate)
- Nitrogen generators
- Non cryogenic plants (Pressure swing absorption, Vacuum pressure swing absorption, Membrane, etc) for oxygen and nitrogen
- Pipeline compression stations (including compressed dry air facilities), that are partially or totally operated from a remote location and that have unmanned operations.

Specifically excluded are product supply tanks installed at a customer’ s premises, home care units (e.g. concentrators) and non-cryo generators with a capacity of 5 000 kg per day or less. For non-cryo generators from 5 000 – 20 000 kg per day, a proper risk assessment should be made as to which provisions apply. Consideration shall be given to process complexity, location etc when making this assessment.

The purpose of this document is to provide guidelines for the design, operation, and maintenance of a plant that will have unmanned operations.

本文所涵蓋的設施包括：

- 空氣分離廠(具有替代系統與適當的現場儲存)
- 氮氣產生器
- 氧氣與氮氣的非低溫廠(壓力切換式的吸收作用、真空壓力切換式的吸收作用、薄膜等)
- 部份或全部在遠端無人操控的管線壓縮站(包括壓縮乾燥空氣設施)。

設在客戶端的氣體供應槽、家庭照護單位與日產量少於5000公斤的非低溫氣體產生器均不在本文討論範圍內。而日產量介於5千至2萬公斤的非低溫氣體產生器須採取適當的風險評估並採取預防措施。進行評估時須考慮評估步驟的複雜度與評估地點等。

此文件提出之宗旨係作爲無人操作工廠於本身設計,操作及維護上之指南。

3 Definitions 定義

3.1 Verbal Forms 助動詞格式

"Shall" indicates a very strong concern or instruction.「須」表示強烈關切或指示
"Should" indicates a recommendation.「應該」表示強烈建議
*"May "*and *"need not"* are used when the application is optional.「可」及「不需要」表示可自行選擇做與不做
"Will" is used to indicate the future only, not a degree of requirement.
「可」及「不需要」表示可自行選擇做與不做
*"May "*and *"need not"* are used when the application is optional.「將」表示未來，不表示需求

3.2 Unmanned Plant 無人操控的工廠

The unmanned plant includes the Air Separation Units (ASU) or gas generator, storage, filling and back-up systems.
無人操控的工廠包括空氣分離單元或氣體產生器，儲存，裝填與備用系統。

3.3 Unmanned Operation 無人操控

The condition where a plant operates without the physical presence of a site operator.
意指工廠沒有操作員在現場作業的狀況

3.4 Remote Operation 遠端操控

The condition where operational control of a plant is at a location other than the plant site.
Such a condition may exist whether or not there are personnel (e.g. performing filling or maintenance tasks) at the plant site.
Remote Operation does not necessarily imply continuous communication with the plant.

意指工廠的操控作業是在工廠以外的地方進行，
不論現場有無人員參與裝填或維護工作。
遠端操控與工廠之間不一定需要持續聯絡。

3.5 Remote Control/Remote Monitoring 遠端控制/遠端監控

Remote Control of a plant implies two way communication from the plant to/from the ROC (e.g. receiving plant alarm/trip signals & the ability to remotely start/stop machinery etc).

Remote Monitoring implies one way communication from the plant to the ROC (e.g. receive only plant alarm/trip signals, plant data etc).

遠端控制包含從工廠到操控中心與操控中心到工廠兩種對向控制(例如接收工廠警報/停機訊號以及遠端啓動機器與停機的能力等)。

遠端監控指的是從工廠到操控中心的單向控制(例如單向接收工廠警訊/跳停訊號以及工廠運轉資料等)。

3.6 Remote Operating Centre (ROC) 遠端操控中心 (ROC)

This is a Centre that remotely monitors and operates a plant or multiple plants. It could be a dedicated centre, be located at a plant site or any other remote location.

The ROC may also provide specialist operations support (maintenance, engineering, control systems etc).

指的是從遠端監控及操作一家或多家工廠。遠端操控中心可能是設在廠房內或任何遠端的精密中心。

遠端操控中心也能提供專家作業支援(維修、監督、控制系統等)。

3.7 Personnel Roles 人員職掌

3.7.1 Plant Owner / Person Responsible for the Plant 工廠所有人/ 廠方負責人

Single point of contact who is responsible for plant operation, maintenance, etc.

負責工廠作業、維修等的單一窗口

3.7.2 Remote Operator 遠端操控員

Person remotely located that has control of the plant. The remote operator does not need to be located at the ROC.

在遠端控管工廠的人員。遠端操作員不一定在遠端操控中心內執行工作

3.7.3 Local Operator 現場操控員

Person who is on site and has control of the plant.
Personnel who are working at the plant but are not in control of the plant are not considered to be Local Operators.

在現場控管工廠的人員。
在現場工作但不負責控管工廠的人員，並不視爲現場操控員。

3.7.4 First Responder 第一應變人員

The First Responder is the person that is first to arrive at the physical site of an emergency. This could be the Operator, Customer, Fire Dept., etc.

指的是當緊急事故發生時，第一個到達事發現場的人員。那可能是操控員、客戶、消防隊員等。

4 Safety Aspects of Plant Design 工廠設計的安全考量

4.1 General Considerations 一般考量

This section briefly introduces the complex subject of safety in plant design and the reader is referred to various documents in section 9.4 for more detailed information.

The starting point for evaluation of safety systems is always a review that is focused on safety. This can typically be a “HazOp” for new plant designs or a “What If” analysis for retrofits. Either type of analysis will lead to Hazard Identification and Risk Assessment. The objective of these assessments is to identify the safety features necessary to reduce the risk to the “As Low As Reasonably Practicable” (ALARP) threshold – the necessary safety target set by each country/company.

Safety related features may prevent, contain or mitigate the hazard and comprise the following categories:

- *Passive Engineering Systems* e.g. selection of pipeline materials to eliminate the hazard, tank bunds to contain the leak etc.

- *Active Engineering Systems* – a device e.g. safety valve, non return valve or instrumentation (alarms & trips)
- *Procedural Controls / Human Actions* e.g. Operating Instructions, Emergency Response – plant shutdown, isolation etc.

Ideally plants should have been designed to incorporate controls in the first category (which eliminate or reduce the risk) as these are inherently more reliable than those in the other two categories.

Certain safety related features that rely on instrumentation are called Safety Instrumented Systems (SIS) and the following design standards give a systematic approach that is internationally recognised as best practice:

- IEC 61508: Functional Safety of electrical/electronic/programmable electronic safety related systems. This standard is focused towards manufacturers and suppliers of devices.

- IEC 61511: Functional Safety – Safety instrumented systems for the process industry sector. This standard is focused towards system designers, integrators and users.

Both standards give guidance on how to achieve suitable reliability for these Safety Instrumented Systems (Risk Graph, Layer of Protection etc). This reliability is called the Safety Integrity Level (SIL numbered 1 to 4) and such systems are usually considered to be “safety critical”.

A high SIL rating means a more demanding safety function requiring more sophistication in the equipment (e.g. SIL 4 is usually only used in the nuclear industry) and would require duplication/redundancy/diversity in the instrumentation so that no single component could cause the overall system to fail.

Typically air separation plants have only a few Safety Instrumented Systems. Most are passive systems (material selection, location, etc) or physical engineering system (Safety valves, etc) The instrumentation elements of the SIS may be specified with Safety Integrity Levels (SIL). Where applied, these are usually specified to SIL 1 or SIL 2 (i.e. 1 dangerous failure every 100,000 to 1 million hours for SIL 1 and 1 dangerous failure every 1 million to 10 million hours for SIL 2).

See section 5.8.4 high priority items for typical examples.

Having established the required design reliability there is then guidance on how to establish suitable hardware reliability. The key message here is an overall life cycle requirement for Safety Instrumented Systems so that the control function operates with the correct reliability over the whole life of the plant.

本章先就工廠設計的安全考量簡述如下，讀者可參考9.4節中所述及各文件詳細資料。

評估安全系統的起點自然把焦點放在安全本身。評估的類型大致可分爲新廠的「製程操作危害(HazOP)」或舊廠更新的「如果…該怎麼辦 (What If)」的分析。 無論何者均牽涉危險的認定標準與風險評估。 這些評估的目的在於認定那些安全特性能降低危機至 ALARP 的臨界點即每個國家/公司所設 的必 要安全標的。 安全特性可預防，抑制或減低危險性，它包括：

被動監督工程系統(*PassiveEngineeringSystems)*如減低危險的管路材質的選定，抑漏槽體之防液堤設置等。

主動監督工程系統(*Active Engineering Systems)* 一種裝置如安全閥、單向閥或配備(警報及停機裝置)

. 程序控制/人員啓動，如作業指導，緊急應變處理—工廠停機、隔離等。

理想上工廠應該被設計擁有第一類的監督系統(即排除或降低風險)，因爲前者比後兩類安全可靠。

某些必須仰賴儀器操作的安全特性稱爲安全儀錶系統(SIS)，以下兩種設計標準是國際公認最好的：

IEC 61508: 電機/電子/程式電子安全系統。本設計標準主要針對設備的製造廠與供應商。

IEC 61511:工業製程專用、配備儀器的安全系統。本設計標準主要針對系統設計師、整合師及使用者。

以上標準對配備儀器的安全系統如何達到一定的可靠度(風險示意圖、防護層等)有詳盡說明。此儀錶可靠度標示爲安全整合級數(SIL,可分爲1至4級)，所以此類安全系統通常被認爲是不可或缺的。

安全整合級數高代表設備安全要求的精密度愈高(例如：等級SIL4通常只適用於核子工業)，而且儀器內部要有複製/備組/多樣等特性，以避免單一元件失效導致整個系統停機。

一般來說空氣分離廠僅有少數配備儀器的安全系統，且大部份爲被動系統(材質篩選，地點過濾等)或物理監督系統(安全閥等)。配備儀器的安全系統可以鑑別爲安全整合級數SIL1或級數SIL2(例如：每10萬到100萬小時之間發生一次失效爲級數SIL1，每100萬到1000萬小時之間發生一次失誤爲級數SIL2)。

一般案例的高優先權項目，請見第 5.8.4章。

一旦建立所需的設計可信度，接著便有建立硬體可信度的指南。這裡談的重點是符合安全儀錶系統的整個使用生命週期需求，如此一來控制功能的操作可信度才足以安全運作整座工廠。

4.2 Recommendations for Unmanned air gas plants 無人操控氣體工廠的建議

A Risk Assessment paying particular attention to the consequences of unmanned & remote operation shall be made for all unmanned plants. For new projects the authorities normally require a Risk Assessment as part of the operating licence.

If the general risk assessment has not been done before, it shall be done prior to implementing unmanned operation.

For retrofits, the existing Risk Assessment shall be reviewed in detail and updated where necessary.

The Risk Assessment for an operating plant shall be reviewed whenever a significant change is made to the process – see section 4.4. The objective of the review should be to ensure that changes in operating conditions, connected supplier & customer processes and surrounding communities have not created an unacceptable risk or altered safety features that were originally built into the design.

Whenever a process is acquired from a third party, the Risk Assessment documentation for that process shall be reviewed and revalidated. If there is no existing Risk Assessment documentation, a new formal Risk Assessment shall be conducted.

所有的無人操控工廠都應進行風險評估，因爲它對無人操控或遠端操控的結果有絕對性的影響。對於某些新案例，主管機關通常把風險評估視爲工廠執照取得的一部份。

倘若事先沒有做風險評估，在其工廠正式運作前應該完成之。

舊廠更新時應就現有的風險評估重新逐一檢視並視需要更新之。

運行中的工廠只要製程中有重大改變，更應重新檢視風險評估—
請見4.4章。檢視的目標在於確認，當操作條件、連接供應商與客戶的程序以及週遭環境的改變不會產生令人無法接受的風險，或改變原始內建的安全特性。

當製程係來自第三者時，該製程的風險評估文獻應檢查並重新確效。若該製程並無現有的風險評估文獻，應正式進行新的風險評估作業。

4.3 Plant location risk 工廠的風險

For unmanned plants, detection and mitigation of off-site risks becomes more important since human intervention can not be assumed.

Typical questions that shall be considered are:

- How could the installation and the total stored volume of products affect the neighbourhood?
- How could the neighbourhood affect the safety of the plant?
- Can planned future developments in the neighbourhood or within the plant area have a negative influence on safety?
- Can the local fire-fighting organisation handle a major release of products from the plant?

See EIGA document 75/01 (Determination of Safety Distances) and Chapter 6 of EIGA document 127/04 (Bulk oxygen, nitrogen and argon storage systems at production plants)

因事先無法預期是否會有人員的介入，對無人操控的工廠來說，偵測並降低風險便顯得十分重要。

一般來說應注意的問題如下：

- 產品的放置與存量對鄰近地區可能的影響？
- 鄰近地區對工廠安全可能會有那些影響？
- 鄰近地區或廠區的未來發展對安全會有那些負面影響？
- 當地的消防機構可以處理工廠產品的大量釋放嗎？

請見EIGA 文獻75/01 (安全距離的認定)以及EIGA文獻第六章127/04 (製造廠的大量儲存系統)。

4.4 Management of Change (MOC) Review 變更管理檢視 (MOC)

Modifications to an existing process shall be managed by following Management of Change (MOC) procedures (see AIGA 010/04). The safety of small changes may be confirmed through a properly documented process design review. More complex changes require a formal Process Hazard Analysis (PHA) or formal Design Review based on the criteria stated above. Key operating documents (e.g. P&ID, PFD, electrical drawings etc) shall be updated to reflect the changes made.

現有製程的變更應由下列的變更管理程序管理之(請見AIGA010/04))。小變更經由正確的製程設計文案檢視可確保其安全無虞。較複雜的變更便需要審慎的製程危害分析或較正式的如同上述標準要求的設計檢查。主要操作文件(如製程儀錶圖P&ID, 製程流程圖PFD，電機圖等)應該就隨著變更即時更新。

5 Plant design and retrofit considerations 工廠設計與舊廠更新的考量

5.1 Compliance with permits and regulations 遵守相關規定與許可

All applicable regulations shall be followed and appropriate permits acquired.
Delegation of responsibility for compliance with permits and regulations shall be defined in the company management system for each unmanned plant.
大家應遵守所有的使用規定，並取得適當的許可。
每一家無人操控的工廠的管理單位應明確界定遵循各項規定與許可的責任代表。

5.2 Shutdown systems 停機系統

5.2.1 Emergency Shutdown System 緊急停機系統

All unmanned plants shall be provided with an emergency shutdown system that, when activated, will put the plant into a safe condition. Typical items that might activate the shutdown system include:

- Manually operated hardwired stop buttons strategically located around the plant. At least one of the stop buttons shall be accessible by the first responder – see section 8.1
- Trip signals from the plant control system or external trip signals (e.g. from customer's control room) may also activate the emergency shutdown system as long as the appropriate Safety Integrity Level is maintained throughout.

It is recommended that only two types of emergency button be specified -one for the production unit and one for the storage & truck filling area.

The Storage & Truck Filling emergency shutdown system shall isolate all storage tank liquid valves and cease filling operations. If the main storage tank is used to directly feed the back-up vaporisation system to a pipeline customer, a risk evaluation shall be made covering the case for isolating the liquid outlet valve.

Remote reset of the emergency shutdown system shall not be possible.

每一家無人操控的工廠均應配備緊急停機系統，該系統一旦啓動，整座工廠便處於安全狀態。可啓動緊急停機系統的項目大體上包括：

手動停機按鈕策略性地遍佈工廠。至少第一應變人員應能啓動任一個停機按鈕—請見8.1節。

從工廠控制系統發出的停機訊號，或外部發出的停機訊問(如來自客戶的控制室)亦能啓動緊急停機系統，只要能維持在適當的安全整合級數。

我們只建議指定2個緊急按鈕，其一是生產單位，其二是儲存與卡車灌裝區。儲存與卡車裝填的緊急停機系統作動時，可隔離儲存槽液體閥門及停止裝填作業。倘若主要儲存槽被直接用來供給管線客戶的備用汽化系統，此時應評估隔離液體排氣閥的風險。

不可自遠端重置緊急停機系統。

5.2.2 Plant Tripping System 工廠停機裝置

The plant tripping system will normally be activated by various trip signals e.g.

- Critical safety devices identified during the risk assessment phase e.g. liquid leak detectors, hydrocarbon detectors etc.
- Process safety devices e.g. pressure switch
- Quality control devices e.g. analyzers
- Machine protection devices e.g. vibration, low oil pressure
- Local or remote manual inputs

Remote reset of the plant tripping system could be possible in accordance with documented procedures.

工廠的停機系統通常可由幾組不同的停機訊號啓動，例如：

- 在風險評估項目中，由必備的安全設施認定，如液體外漏偵測儀、碳氫化合物偵測儀等
- 製程安全設施，如壓力開關

- 品管設施，如分析儀
- 機械保護設施，如振動、低油壓力
- 現場或遠端手動輸入

在依照文獻記錄的程序，工廠跳停系統應可自遠端重新設定。

5.2.3 Remote Tripping System 遠端工廠舊換新系統

The ability to trip the plant from a remote location (e.g. ROC) is desirable but does not form part of the emergency shutdown system or the plant tripping system (the communication link usually does not have the appropriate reliability level).

工廠自遠端操控中心執行停機作業，基本上是可行的，但不能納入緊急停機系統或
工廠停機的標準程序(因兩者之間的聯絡網路通常不足以信賴)。

5.3 Fire & Gas Alarm System 火警與氣體外洩警報系統

Subject to a risk assessment, unmanned plants may be provided with an automatic fire detection system. Examples of areas that may require protection are the control room and electrical switchgear room.

It is recommended that the fire detection system be monitored and form part of the emergency response plan.

Gas (e.g. hydrocarbons, ammonia, hydrogen, oxygen deficiency etc) detectors and alarm systems shall be located according to the risk assessment evaluation.

根據風險評估，無人操控的工廠可配備自動火警偵測系統。需要受到保護的區域包括控制室與電機交換室。

火警偵測系統應受到監視，並納入緊急應變計畫的一部份。

氣體(如偵測碳氫化合物、氨、氮、氧氣等之不足)偵測儀與警報系統應依照風險評估的建議設置。

5.4 Remote Detection of Liquid Spillage 液體外溢遠端偵測

The spillage of cryogenic liquid due to leakage or malfunctioning valves is a risk to be controlled closely. Process related drain valves should be connected to the liquid disposal system.

A specific risk assessment shall be made to identify any additional protective measures that may be required e.g. ground temperature measurement, video camera surveillance etc.

Typically risk areas include:

- Liquid disposal systems
- Large liquid storage capacity
- Truck filling stations

因外漏或閥門故障而引起的低溫液體外溢的風險應嚴加控管。製程相關排液出口閥應連接到液體處理系統。
設置藉由特定的風險評估認定而鑑別出所需之任何額外的偵測儀，如地面溫度儀、錄影帶監視系統等。
典型的風險區域包括：

- 液體處理系統
- 大型液體儲存裝置
- 卡車裝填站

5.5 Process Equipment Guidelines 製程配備指南

See Appendix A for detailed list of considerations.
詳細考量的事項請參考附件A

5.6 Truck Filling Systems 卡車裝填系統

All merchant liquid plants include a filling & analysis system for transferring liquid to trucks. Larger production plants are likely to have a fully automated weighbridge filling and analysis system and this is the preferred solution. However it is recognised that smaller plants may involve varying degrees of manual operation.

For filling systems at unmanned plants, the following items shall be considered:

- Only authorised & properly trained drivers will have access to the site.
- All personnel operating the loading system shall be positively identified as being authorised to access the site & equipment e.g. password access, ID card, key entry etc.
- Analysis certification can be provided by a properly documented manual system or by an automatic system.
- Leak detection devices shall be considered for areas around cryogenic liquid pumps and storage tanks.
- Both manual and automatic systems should ensure that trailers do not leave the site overloaded in accordance with local regulations.
- A “man down” or “driver push-button timer alarm” system shall be considered.
- Anti tow-away devices shall be considered – refer to IGC Doc 63/99.
- If the storage tank is to be filled from a road tanker, it shall be confirmed that the venting capacity of the tank is adequately sized – refer to IGC Doc 59/98.

所有的商用液體廠均包含一套運送液體到卡車上的裝填暨分析系統。大型的製造廠還可能有全自動過磅裝填暨分析系統，這是較理想的方法。然而，小廠間仍可能牽涉到不同程度的手動操作作業。

設在無人操控工廠的裝填系統，應考慮以下事項：

- 唯有經授權並接受完整訓練的駕駛才可進入裝填現場
- 所有操作裝填系統的人員應以正確的授權方式進入現場或操作設備，如密碼、識別卡，鑰匙等。
- 分析證明可由管理完善的手動或自動文件管理系統提供。
- 低溫液體幫浦與儲存槽附近均可考慮加裝外漏偵測儀。
- 手動及自動灌充系統應該確保拖車司機依照現場規定，不超載作業，不擅自離開超載現場。
- 或 “駕駛計時警報” 系統應列入考慮。
- 防止拖曳設備應列入考慮 – 參考 IGC文獻 63/99. .
- 如果儲存槽是由路上的液罐車裝填，須確保儲存槽的排壓洩量合宜 – 參考IGC文獻 59/98.

5.7 Distribution Pipeline & Vaporiser Systems 分裝管路與汽化系統

5.7.1 Distribution Pipeline Systems 分裝管路系統

Consideration should be given to maximum pipeline flow regulation, shutdown on low pipeline pressure and customer emergency shutdown. Refer to AIGA 021/05 Oxygen Pipeline Systems.

最大的管線流量規定、低管線壓力停機及客戶緊急停機均應列入考量。請參考AIGA文獻 021/05 氧氣管路系統。

5.7.2 Back-up Vaporiser Systems 備用蒸發器系統

Back-up vaporiser systems should share the following features:

- In order to protect the system against low process temperatures and to ensure reliability of a critical supply, the control system should rely on secure sources of power and instrument gas. This may require the use of a UPS to supply an electronic control system or a completely pneumatic control system (including pneumatic low temperature trip).
- Sizing of storage tanks & vaporisers should be reviewed for unmanned operation and response time for service and product delivery. Remote monitoring of tank levels may be considered. Special consideration should be given to the sizing of ambient air vaporisers in regard to severe ambient conditions.
- Back-up systems should be tested on a regular basis to ensure that they will operate properly when required.

Refer to AIGA 027/06 Cryogenic vaporisation systems: Prevention of brittle fracture in equipment and piping.

備用蒸發器系統應包含以下特點：

- 爲保護系統免於低溫，並確保氣體供應無虞，該系統所仰賴之電力與儀錶氣體來源應該可靠。故建議使用不斷電系統去執行電子控制系統或完全氣動控制系統(包括氣動低溫停機)
- 儲存槽與蒸發器的大小應考慮在無人操控情況下，服務與產品運送的反應時間。可考慮自遠端監看槽體的庫存液位。強烈建議應視週圍情況決定空氣蒸發器的大小。
- 備用系統應定期檢測，以確保必要時操作正常。

請參考AIGA文獻 027/06 預防設備及管線脆化破壞。

5.7.3 Liquid Disposal Systems 液體廢棄物處理系統

Liquid disposal systems are needed to safely dispose of plant liquids. Ambient air, water-bath, steam heated or other vaporisers may be used.

The disposal system should be designed to prevent uncontrolled liquid from being discharged. This may include low ground temperature detection, loss of utility, adequate sizing for all eventualities etc.

When converting from manned to unmanned operation, careful consideration should be given to safe disposal of liquid from automated drains that may freeze in the open position.

液體廢棄物處理系統是專爲安全處理工廠的廢棄液體所設計的。系統可能會使用到周遭空氣、水浴，蒸氣加熱或其他蒸發器。該系統應做到避免液體未經控制自行流出。這包括地面溫度過低偵測、公用設施故障，各種可能衍生事故之設施適當設計考量等。

當工廠從有人操控轉換成無人操控時，應留意自動排液口流出的液體在開放空間結凍。

5.7.4 Fogging Hazards 霧氣產生的危險性

The operation of some vaporisers may cause fogging within the plant area and adjacent roadways and care should be taken in locating these equipment items.

Consideration should be given to installing equipment to disperse fog away from the affected area e.g. ground mounted fans.

Plant signage covering fog hazards shall be installed as appropriate.

某些蒸發器操作期間，可能會在廠區或鄰近道路產生霧氣，故裝設蒸發器時應特別留意。
或考慮裝設散發霧氣的設備，如嵌入式電扇。

霧氣偵測應納入工廠的信號系統內。

5.8 Control System Guidelines 控制系統指南

Different levels of automation and alarm monitoring are possible. In any case, automation systems contain both a monitoring - control function and a safety function.

自動化警報監看功能可區分爲不同等級。無論如何，自動化系統必須具備監看—控管制與安全功能。

5.8.1 Monitoring-Control Function 監看—控管功能

The monitoring - control system automatically controls the unit to set values. This may include:

- Start-up of the unit in standard operating mode
- Controlling process variables close to set-point
- Ensuring product quality and/or adapting to customer requirements
- Transmission of alarms
- Process and machinery trip & interlock signals
- Management functions e.g. reports, alarm logs, etc.
- Enabling access to information locally or remotely
- Normal controlled shut down

監看—控管功能系統可使單元操控於設定值上，範圍包括：

- 標準作業模式下機體的啓動
- 控制流程參數趨近設定點
- 確保品質且/或依客戶需求作調整
- 警報傳輸
- 製程及機組之停機與連鎖訊號
- 管理作業如報告、警報日誌等
- 可在現場或遠端取得必要資訊
- 一般性停機

5.8.2 Safety function 安全功能

The control system processes safety functions based on control system internal functions or external detectors:

The safety system’ s process alarms and alert detectors perform several functions:

- Shut down the unit in a safe mode, should a process value reach a critical limit
- Rotating machinery imminent start warning – e.g. horn/flashing light.
- Send any abnormal values to the alarm management station
- Send safety critical information to the ROC and/or customer’ s monitoring-control system when necessary. These safety critical alarms may include fire detection, hazardous atmosphere, “man down”, site intrusion etc

When the plant is installed on the customer’ s site, these requirements will generally be co-ordinated with the customer, in accordance with local regulations, and will be specified in the customer's Safety and Emergency Response Plan.

控制系統的安全功能執行，是根據系統本身的內部功能與外部偵測儀而來的。

包含警報與警告偵測儀的安全系統其執行的功能如下：

- 當製程操作達到一限值，將於安全模式下停機，
- 轉動機械的緊急啓動警告—如響聲或閃燈。
- 將任何異常訊號送至警報管理站。
- 必要時，將重要的安全資料送至遠端操控中心及/或客戶的監看—控制系統。這些重要的安全警報包括火警偵測、有毒環境氣體、 “man down”, 侵入現場等。

當工廠設在客戶端時，上述這些功能應與客戶取得協同管理，配合當地規定，並註明在客戶的安全暨緊急應變計畫中。

5.8.3 Plant Network & Communication System Integrity & Security 工廠網路與溝通系統的整合與保全

The Emergency Shutdown system shall always be independent of any external communication system.

The Plant Control System operates the plant safely and will, when needed, shut down the plant without any remote action.

Communication systems associated with unmanned plants should be designed in a reliable way. Consideration may be given to the installation of a redundant network or modem back-up.

Remote access to the plant system shall be made by secure methods e.g. password protection, firewalls, defined IP addresses etc. Depending on the complexity of the plant, different access security levels may be identified for different classes of user (e.g. operator access, controls engineer access etc).

An Emergency Plan should be prepared to cover the failure of the ROC. The plan may involve deploying ROC operators to the plant sites, moving the network connections to another location etc.

緊急應變系統必須獨立於任何外部溝通系統之外。

工廠控制系統負責工廠的安全，並在必要時，在不受任何外力的干預下停止工廠運作。

無人操控工廠的溝通系統應以可靠的方式設計。可考慮安裝額外網路或備用數據機。

遠端切入工廠系統應採用保全方式，如密碼保護、防火牆、認定的IP地址等。依照工廠的複雜程度，應給予不同等級的使用者不同的安全切入等級(如操作員切入、控管工程師切入等)。

緊急應變計畫應涵蓋遠端操控中心故障時的應變方式，如將遠端操控中心操作員部署到工廠現場，將網路連接設在他處等。

5.8.4 Alarm Prioritisation 警報的優先處理順序

Each alarm shall be reviewed against potential consequences should corrective action not be promptly initiated. The following shall be considered:

Safety	Reacting to the alarm could prevent/mitigate a plant incident with potential injury or loss of life
Environment	Reacting to the alarm could prevent/mitigate potential breach of environmental permit limits or contamination
Equipment /Production	Reacting to the alarm could limit financial consequences e.g. by preventing damage to equipment, lost production, loss in efficiency, output loss during plant outage

Alarms shall be categorised.

Detailed information on alarm prioritisation is available from several publications e.g. EEMUA- 191.

A typical categorisation could be:

High Priority: Any abnormal condition which plant supervision shall immediately address so emergency response procedures or customer outages can be initiated. For reliability requirements refer to section 4.

Special consideration shall be given to the design of high priority alarm systems with respect to loss of the primary communication system.

Typical examples of high priority alarms/trips include:

- "Man down" alarm
- Fire alarm (building alarms, oxygen compressor fire etc)
- Main condenser high/low level
- High hydrocarbon concentration in reboiler/condensers
- High storage tank level
- Cryogenic liquid spillage detection
- Critical safety alarms defined with the customer (e.g. low pipeline pressure, backup system failure, loss of safety N2 purity etc)

Medium Priority: Any abnormal condition which plant supervision must address to maintain or restore facility production.

Typical examples of medium priority alarms include:

- Loss of product purity.
- Machine trip.
- Loss of remote control capability (e.g. switched to local control or communication failure)
- Process alarms which indicate an imminent failure (e.g. cycle timer failure on the molecular sieve adsorbers).

- Machine alarm which indicates a possible problem (high oil temperature, vibration alarm etc)
- Supervisory control system failure (e.g. watchdog timer alarm, PLC failure etc)

Low Priority: Is any abnormal condition not classified as High or Medium that plant supervision wishes to be advised of. Attempt should be made to minimise the number of low priority alarms.

萬一正確的處理方式未立即啓動，每一個警報都應評估其所可能造成的結果。以下事項須被列入考量：

安全	回應警報可預防/減少工廠引發人員受傷或死亡的意外事故
環境	回應警報可預防/減少環境潛在破壞或污染
設備/生產	回應警報可降低財務的損失，如防止設備破壞、生產損失、效能損失、工廠停機期間輸出耗損

警報須區分爲不同程度的優先權。

有關警報優先順序的詳細資料可在幾個出版品中查詢得到，如 EEMUA- 191.
典型的分類可區分如下：

高度優先權: 工廠高層須立即下達執行緊急應變程序，或客戶停機時的異常狀況。更詳盡的要求請參考第四節。
高度優先警報系統的設計應多加考量原有的溝通系統失誤時的後果。

典型的高度優先警報/停機包括：

- 手動的 "Man down" 警報
- 火警(建築物火警，氧氣壓縮機火警等)
- 主要冷凝器過高或過低
- 再沸器/冷凝器的碳氫化合物濃度過高
- 儲存槽存量過高
- 低溫液體溢出偵測
- 客戶端相關的重要安全警報 (如管線壓力過低、備用系統故障、N2純度不足等)

中度優先權: 工廠高層須下達執行維修設備生產的異常狀況。

典型的中度優先警報包括：

- 產品純度有問題
- 機組停機
- 遠端控制功能失靈 (如切換壓現場控管或溝通失靈)
- 顯示立即異常的製程警報(如分子篩眼吸附器上的循環計時器故障)
- 顯示機組潛在問題的警報(油溫過高、振動警報等)
- 監督控管系統故障(如監督計時器警報、PLC故障等)

低度優先權:
不在高度或中低度優先權列管範圍內，而工廠高層想被知會的異常狀況。低度優先權的警報最好愈少愈好。

5.8.5 Management of Plant Alarms 工廠警報管理

A system should be designed so that high priority safety alarms are processed without delay. The local plant alarm system should transmit at least all high priority alarms to the remote operator, to the ROC, or to any other designated point of contact. These can be transmitted as grouped common alarms if the system functionality is limited.

應建立良好的管理系統，才能確保高優先安全警報會立即獲得處理。現場的工廠警報系統應至少將所有的高優先警報傳送給遠端操作員，遠端操控中心或任何預設的聯絡點。若系統功能有限，這些警報可以群體共有的方式傳送。

5.9 Design Aspects of Plant Maintenance 工廠維護的設計考量

In order to minimise safety issues associated with lone working, attempts should be made to “design out” as many routine high maintenance tasks as possible at the design phase.

Examples of this include;
- Work performed at elevated heights that is routine in nature should be modified for ground or platform access.
- Routine maintenance tasks involving heavy lifting by one person should be automated (e.g. by providing lifting beams etc).

爲減少安全議題造成工作隔離，工廠在設計階段應盡可能考慮多一點一般性的高維護工作。

舉例來說：

- 需在一定高度上執行的工作可修改爲地面或採用工作平台設施
- 牽涉到單人升抬重物的一般性維護工作應改成自動化操作(例如由起重機代勞等)。

6 Plant Operation 工廠運作

6.1 Plant safety requirement 工廠安全需求

Operating procedures for unmanned plants shall be clear and detailed.

They may typically include:
- Emergency response planning and routines
- Access procedures
- Specific customer safety rules e.g. sign-in procedures, personal protective equipment
- Use of work permit systems
- Detailed work instructions
- Maintenance of machinery, process control equipment and calibration of instruments and safety devices
- Regular testing of high priority loops (alarms/trips) and critical safety systems
- Training of new personnel, contractors and other persons visiting the plant
- Safety procedures agreed with the customer

無人操控工廠的運作程序應該清楚且詳盡。

大體上可包括：

- 緊急應變計畫與一般例行公事
- 獲准進入工廠的程序
- t特定客戶安全守則，如簽入程序、個人防護配備
- 使用工作許可系統
- 詳盡的工作指示
- 機械維護、製程控制設備以及儀器與安全設施的校正
- 高優先迴路(警報/停機)與重要安全系統的例行性測試
- 新進人員、合約商與其他拜訪工廠人員的訓練
- 與客戶商議的安全程序

6.2 Plant Responsibility 廠方責任

For each unmanned plant one person (the Plant Owner) shall be designated to assume operational management responsibility. This includes safety, regular training of local personnel, maintenance, adapting of operating procedures etc. Such a person could also be responsible for more than one plant.

Local regulations and operating permits must be respected for assignment and delegation of responsibility.

每一家無人操控工廠須指派一人負責操作管理。包括安全，現場人員的例行性訓練，維護、操作程序的調整等。這個人可以同時負責多家工廠的管理工作。

6.3 Training and skills 訓練與技能

6.3.1 Plant Operator Training 工廠操作員訓練

All plant operators (local & remote) shall be trained in safety, emergency procedures and plant operation. They shall also be trained in the operation of the type of plants they are controlling. Periodic re-training is recommended to ensure the operator's skill level remains current. Satisfactory completion of training/retraining shall be documented.

所有的工廠操作員(現場及遠端)應受訓以熟稔安全、緊急程序與工廠運作。對他們所控管同型工廠的文件化運作，他們也應該接受此方面的訓練。爲確保每位操作員的技能更新，定期再訓是有必要的。令人滿意的訓練/再訓須加以記錄。

6.3.2 Cooperation between Local & Remote Operators 現場與遠端操作員的合作

Local and Remote operators need to work in close co-operation. Clear responsibility and communication procedures need to be established.
Communication regarding plant activities shall be documented in the logbook (may be electronic or logbooks at both sites).

現場與遠端操作員需密切合作。並建立明確的責任歸屬與溝通步驟。有關工廠活動的溝通須記錄在廠誌中(可以電子或書面的方式在兩方記錄)。

6.4 Documentation 文件管理

Typical examples of documentation that should be available to the remote operator are:

Up to date copies of relevant plant drawings & documentation (same as used by local operator) e.g.

- Emergency Plan (including contact names & phone numbers)
- Process & Instrumentation Diagrams & Electrical One Line diagrams
- Operating Manual
- Log book
- Management of Change (MOC) documents when applicable

Use of standardised documents for standard plants instead of site specific documents may also be considered.

Internal ROC procedures e.g.:

- Operating Procedures
- "Issue Escalation" process

遠端操作員可適用的文獻管理方式有：
工廠圖樣與文獻的最新副本(和現場操作員使用的相同)，如：

- 緊急計畫(包括緊急聯絡人與電話號碼)
- 製程與儀器的線路圖與電機單線線路圖
- 操作手冊
- 工廠日誌
- 適用情況下的變更管理文獻

標準工廠採用標準化的文獻，考量避免各個工廠使用其個別文獻。

內部的遠端操控中心程序如：

- 操作程序
- "事件擴大 issue escalation" 製程

6.5 Transfer of plant control 工廠控制的移轉

Clear written procedures shall be established to transfer operational control from:

- Remote operation to Local operation
- Local operation to Remote operation
- Remote operation to another Remote operation (e.g. ROC to control system engineering).

These procedures shall comply with all applicable rules & local permits.

The transfer shall be properly recorded in a traceable way (e.g. log book entries, work permits, historical record in the control system etc).

It is technically possible for multiple locations to operate the plant at the same time. However it is recommended that only one Operator have overall operating responsibility.

Note: *These procedures do not replace the need for on-site technicians to protect themselves from accidental equipment starts caused by the control system or through possible remote operation of a plant. Always use Lock Out/Tag Out and other safety measures (Circle of Safety, Work Permit, etc.) when working on equipment.*
The non-observance of these procedures may endanger personnel working on site and affect the plant operation.

以下各點的傳送操作控制步驟應以書面明確書寫。

- 遠端操作到現場操作
- 現場操作到遠端操作
- 遠端操作到他地的遠端操作(如遠端操控中心到控管系統工程)

以上步驟須配合適用的規定與現場許可。

傳送須以可追蹤的方式記錄下來(如工廠日誌、工作許可、控管系統的歷史記錄等)

同時間在多地操作一家工廠，在技術上是可行的。然而，僅建議由一人擔負整體的操作責任。

注意:
以上步驟並不代表現場技術人員不需要保護自己免於因控管系統或工廠遠端操控引起的設備意外啓動。當設備維護工作時，務必使用”鎖住/簽出”及其他安全措施(安全循環、工作許可等)。
未遵守以上步驟可能陷現場工作人員於危險之中，並影響工廠之正常運作。

6.6 Alarm Handling Procedures 警報處理程序

Procedures for calling out on duty personnel shall be available.
In case of automated call out systems (local installations), escalation steps have to be foreseen in case the called out support does not respond.

In case of a major incident a large number of alarms of the same priority may occur simultaneously. In such cases it is very important to support the operator with a plant prioritisation and an alarm prioritisation system which helps to determine the most important plant/alarm and deal with it first.

It is preferred that a “first-out” system (which allows the operator to identify the initial alarm) be implemented.

In all cases, the person called out should be informed about current conditions so that he is aware of any expected hazards on arrival.

打電話給執勤人員的步驟也應涵蓋在內。

在自動警報系統作動輒現場作動)狀況下，接獲警報通知無法及時回應時，可能造成事件擴大。

當遭逢重大事故，並有一連串同等級的警報同時響起時，操作員應獲得適當支援以判定何種警報為最重要且須優先處理。
最好能有一套”第一優先first-out”的執行系統，(以讓操作員能自我判定最初的警報。)

無論在何種情況下，接到緊急電話的人員應被通知的是現場最新狀況，以便在抵達現場時已預知危險性。

6.7 Remote Restart Considerations 遠端重新啓動的注意事項

Procedures for remote restart shall be documented. See section 5.8.2 for safety requirements for remote restart of machinery.

There are certain circumstances where remote restart is not recommended unless a detailed analysis has been carried out. Typical examples include:

- Oxygen compressor safety related trip
- Any machinery vibration trip
- Any high priority alarm that caused a plant trip
- Any instance where the 3 previous shutdowns had the same “first out” indication

遠端重新啟動的程序應被列入記錄。請參考第5.8.2節有關機械遠端重新啟動的安全須知。
在某些情況下，是不建議遠端重新啟動程序的，除非事前有詳細的分析。典型的案例有：

- 與氧氣壓縮機安全有關的停機
- 任何機械振動的停機
- 任何造成停機的高優先警報
- 任何以上三種停機狀況伴隨同樣的”第一優先”指示

6.8 Activity communication follow-up 活動溝通後續追蹤

Activities on an unmanned plant shall be recorded in a logbook (electronic or paper at both the ROC and the unmanned plant).
Procedures need to be established in order to inform people entering the unmanned plant about the current operating situation.
Activities on the unmanned plant should not be started without permission from the operator in control of the plant.
Notification of technical changes shall be available at both locations.

無人操控工廠的任何活動應記錄在工廠日誌內(以電子或書面的方式在遠端操控中心與工廠內記錄)。

需建立程序以告知將進入無人操控工廠的人員目前最新操作狀況。

未獲得操控工廠的操作員的許可下，無人操控工廠不得進行任何活動。

任何技術上的變更須在兩方留下記錄

6.9 Work Permits 工作許可

Work permit systems shall be established. (See AIGA 011/04)

The work permit system does not apply to routine activities with written procedures. Even when someone is alone on the site, a work permit in accordance with the work permit system needs to be prepared. Lock out procedures also need to be applied in all cases.

應建立工作許可系統。 (請參考 AIGA 011/04)

工作許可系統並不適用於有書面程序的例行活動。即使當某人獨自在現場，與工作許可規定有關的許可仍需準備。簽出程序需在任何情況下適用

6.10 Driver – truck filling activities 駕駛—卡車灌充活動

Drivers performing truck filling activities should either follow the sign-in procedure or have authorised means to access the truck filling area.
Security systems & procedures should be in place to limit free access to plant controls other than those strictly related to the truck filling operation.

Truck drivers are often the most frequent personnel at the site. Measures should be taken so that they are aware of situations that may endanger their health and safety. Systems should be in place such that they can escalate problems that they encounter at the site.
They shall be trained in emergency procedures.
The training shall be refreshed periodically and after technical changes on the filling station.
The training & authorisation shall be documented.

執行卡車灌充任務的駕駛人應遵守簽入程序或經由授權方式進入卡車裝填區。
與卡車裝填作業非相關人員，保全系統與程序應限制其自由進入工廠控管區。
卡車駕駛是最常在現場出入的人員。他們應接受檢測，以便他們對可能危及自身健康及安全的狀況有所知悉。萬一他們在現場遭遇任何問題時，應有適當系統讓他們反應問題。

駕駛們須接受緊急應變處理的訓練。

訓練應定期更新或在裝填站技術有所變更後更新之。

訓練與授權均須加以記錄文件化。

6.11 Atmospheric monitoring / Man down systems 大氣監測/手動查核 (Man down)系統

All accessible areas of the plant shall be reviewed for potential oxygen deficiency or enrichment. Atmospheric monitoring systems (fixed or portable) shall be used for these areas and appropriate labelling & marking installed.

A man-down procedure shall be considered to minimise the risk for workers under "working alone" conditions. Factors affecting the design & complexity of the man-down system include the frequency & duration of the visit, the process risk, the tasks to be performed and any environmental factors.

工廠所有可進入的區域須檢查氧氣含量是否充足。這些區域須使用空氣監看系統(固定式或手提式)，系統須作適當標示及記號。

爲降低"獨自工作"人員的風險，須建立手動查核(man-down) 程序。影響手動查核 (man-down) 系統設計與複雜度的因素包括拜訪的頻率與時間長短，流程的風險、待執行的勤務以及其他環境因素。

6.12 Plant / site security 工廠/現場保全

Plant security is needed to protect an intruder from hurting himself as well as to protect the installation from damage caused by an intruder. All unmanned plants shall be provided with adequate security systems to prevent intrusion by unauthorised persons.

The level of security installed at the site depends on the process risk and on the local environment. Unmanned plants located inside a customer' s property may not need additional security systems.

Typical security systems used inside the plant may include:

- Signage/labelling
- Locked valves (e.g. manual valves with risk of cryogenic exposure)
- Self locking doors
- Burglar Alarms

設立工廠保全系統是爲保護闖入工廠者免於受傷，同時也爲保護工廠設備免遭闖入者的破壞。所有無人操控工作均須設立適當的保全系統，以避免未經授權者闖入。

:設在現場的保全等級視流程的風險與現場環境而定。設在客戶端的無人操控工作可能不需要額外的保全系統。工廠內部使用典型的保全系統可包括：

- 訊號/標誌
- 鎖定閥 (如有低溫暴露風險的手動閥)
- 自我鎖定門
- 防盜警鈴

6.12.1 Entry / Exit Procedures 進場/出場程序

On both arrival to and departure from an unmanned plant that is Remotely Controlled, persons working in the plant area shall register with the operator who has current plant control (usually the ROC) e.g. by phone, electronic device etc. This is necessary in order to maintain good communications & co-ordination between the ROC & local persons. Drivers performing routine duties and personnel located close to the plant egg sales office etc are excluded from this requirement - see section 6.10

This requirement may not apply to plants that are only Remotely Monitored.

進入暨離開無人操控工廠時，皆需受遠距操控系統管控。在廠區工作的人員須向負責控管工廠的操作員(通常是遠端操控中心)登記，例如用電話、用電子設備等。爲讓遠端操控中心及協管者與現場人員維持良好溝通與協調，登記程序是有必要的。執行例行勤務的駕駛與鄰近工廠的人員如業務部等不在此限中—請參考6.10節。

僅有遠端監看的工廠也不適用此規定。

7 Routine Maintenance and Conservation 一般性的維修與保存

In order to ensure safe operation of unmanned plants, maintenance activities should always be performed in a consistent manner. The additional operational issues presented by unmanned operation require a more detailed approach to planning, record keeping, failure analysis etc.

爲確保無人操控工廠的操作安全，維修活動應持續進行。額外的操作議題需要進一步涉及計畫、記錄保存、故障分析等。

7.1 Planned Maintenance and Record Keeping 有計劃性的維修與記錄保存

Maintenance of unmanned plant is typically performed by different groups of contractors and/or technicians. This carries the danger that personnel are unaware of each other’ s actions. Therefore it is essential that the record keeping and communication systems be rigorously followed.

A detailed description of the work to be carried out shall be documented in work instructions.
Written procedures shall be available for each major item of equipment and the site should be inspected regularly to ensure it is maintained in a proper and safe condition.

無人操控工廠的維修通常是由不同組別的包商及/或技師所負責。他們對對方進行的維修工作毫不知悉，這就形成一種潛在危險。因此，記錄保存與溝通系統必須嚴格執行。
待執行工作的細節須詳述在工作指示內。設備的每一重要部位應有書面描述，現場應定期檢查，才能確保工廠設備正確及安全的執行維護工作。

7.2 Lone Worker Tasks 獨自工作者的任務

Tasks prohibited for lone workers shall be defined in detail in local work instructions and may include any task that involves e.g.

- Confined space entry
- High & medium voltage electrical work
- Elevated work etc

Other major maintenance activities should be reviewed to ensure that a single person can safely perform the task.

Procedures to assure appropriate surveillance during lone worker operations shall be considered based on the specificity and duration of the activity. Systems used to assist with surveillance of lone workers may include entry/exit procedures, routine telephone calls, dead man timer, “man down” monitor etc.

凡禁止獨自工作者執行的工作應明文規定在工作指南內，這些工作可包括：

- 限定進出區域
- 高度暨中度電壓工作
- 高空作業等
- 其他主要維修工作應檢視，是否能確保獨自一人安全執行勤務。

爲確保獨自工作者作業期間受到適當監督，應根據維修工作的性質與時間長短建立正確程序。用來幫助該監督工作的系統可包括進場/出場程序、例行電話、稻草人(dead man)計時器，手動(man down)監看等。

7.3 Training and Skills 訓練與技能

All personnel performing maintenance tasks shall be trained in safety, emergency procedures and tasks for the specific unmanned plant. Periodic re-training is recommended to ensure the technician’s skill level remains current. Satisfactory completion of training/retraining shall be documented.
This also applies to personnel performing maintenance tasks from a remote location (e.g. control engineers) and contractors.

所有執行維修工作的人員須受訓予處理安全、緊急應變程序，以執行在特定的無人操控工廠的相關任務。爲確保每位操作員的技能更新，定期再訓是有必要的。令人滿意的訓練/再訓若符合要求須加以記錄。此規定同時適用於在遠端(如控管工程師)及合約商執行維修工作的人員。

7.4 Interface between Operations & Maintenance 操作與維修的介面

The interface between Operations and Maintenance is especially important in remotely operated plants. As a minimum, there should be a written procedure which co-ordinates the following areas:

- Control of personnel presence at site

- Control of maintenance jobs at site (e.g. Lock-out Tag-out procedure)
- Continuity of supply to the customer (e.g. Schedule the maintenance task when adequate product inventories are available)

操作與維修之間的介面在無人操控工廠顯得特別重要。故至少應有明文規定讓下列各區取得協調：

- 現場在場人員的控管
- 現場維修工作的控管(如上鎖 掛卡程序)
- 不間斷供應給客戶(如產品有適當庫存量，安排維修計劃)

7.5 Lock-out Tag-out 上鎖 掛卡

Most automated equipment in ASU plants is designed to remotely start or stop. In this case the equipment may appear shutdown when it actually is not. In such installations, it is possible for the system to be in stand-by (idle but ready to restart remotely). It is especially important that these systems be Locked Out prior to the commencement of maintenance. This will prevent any unintentional restart during maintenance. Signs that warn of the potential of automatic restart of the unit should be clearly posted around the equipment.

Before working on machinery or electrical systems, attempt to start the equipment locally to ensure proper lockout. Make sure all permissives are satisfied before attempting.

工廠的大部份設備被設計成可以從遠端開機或停機。在這種情況下，顯示爲停機狀態的設備，可能事實上仍在運轉中。其實這些設備是可以設成待機狀態的(備用期間但隨時可從遠端重新啓動)。所以這些系統在維修前做上鎖動作是很重要的，並可防止維修中之異常人爲啓動。該設備四周應貼上警語標籤。
在操作機械或電機設備之前，在現場試著開機前需確認設備正式簽出。試機之前需先確認所有許可步驟皆已完成。

8 Emergency plans and External Notification 緊急計畫與外部注意事項

Procedures shall be developed to cover the response to emergency conditions that the plant operator may have to contend with.

Typical examples of emergency conditions that shall be considered include:

- Fire
- Major product release, pipeline rupture or energy release
- Civil disturbance e.g. threat, riot or other civil disobedience.
- Severe weather conditions
- Adjacent industry incidents such as explosions, toxic chemical or gas releases etc.
- Personal injury (e.g. man down alarm)
- Site intrusion/security breach
- Major perlite release

Maximum anticipated response times for emergency services should be considered as part of the Emergency Planning process. If the plant is located inside a customer facility (e.g. Chemical plant or refinery), close liaison with the customers emergency services organisation will be necessary. The emergency plan shall include procedures for warning and evacuation of on-site personnel or contractors (e.g. assembly point, audible warning etc).

Emergency procedures and related fail-safe shutdown systems are an integral part of the plant design. Therefore technician response time in case of a plant emergency should not be critical.

Emergency Services shall be updated with the latest site Emergency Plan.

Also refer to EIGA document 60/98 – Prevention of Major Accidents. Guidance on compliance with Seveso II Directive.

須建立緊急事故的應變程序，以便讓操作員預知可能對抗的事故狀況：

須列入考量的典型意外事故包括：

- 火警
- 主要產品外洩、管線破裂或能量釋放
- 人民動亂如威脅、暴動或其他違反法律的行爲
- 惡劣的天候狀況
- 鄰近的工安意外，諸如爆炸、有毒化學品或氣體外洩
- 人員受傷(如手動查核 (man down)警報)
- 闖入現場/保全系統遭破壞
- 主要珍珠岩棉 (perlite) 外洩

緊急事故的最大應變時間應被列入緊急應變計畫的一部份。若工廠位於客戶廠房內(如化工廠或煉油廠)，便有必要與客戶的緊急應變機構保持緊密聯繫。緊急應變計畫須包括對現場人員或包商的警告與疏散(如集合訊號，廣播警告等)。

緊急應變程序與相關的安全停機系統是整廠設計整合的一部份。因此面對工廠緊狀況時，工程師的反應應該是刻不容緩的。緊急處理程序應隨著最新的現場緊急應變計畫更新。

請參考EIGA 文獻60/98 – 重要事故的防範。 配合 Seveso II Directive入門

8.1 First Responder functions 第一應變人員的功能

The functions of the First Responder, as defined in the Emergency Plan, are to secure the site and to organise the response.

緊急應變計畫中第一應變人員的功能是爲保護現場，並統籌各項應變活動。

8.2 Remote Operator functions during an emergency 緊急事件時遠端操作員的功能

The emergency plan shall give clear instructions about how a Remote Operator may interact with Emergency Services during a major incident. The remote operator may be the initiator of the Emergency Plan. He may also participate in the plan (e.g. as mobilisation co-ordinator).

緊急應變計畫須有明確指示，包括在重大事故時，遠端操作員如何執行緊急應變措施。遠端操作員可能是緊急應變計畫的發起人。他也可參與計畫中(如作爲一名行動的協同者)。

8.3 External Emergency Services 外部的緊急應變服務

Emergency Services are often the first responder to an incident at an unmanned plant. In some instances, they require additional training so they can take appropriate action without company personnel being present.

External Emergency Services can be provided by the Customer, Fire brigade, Police or Security Service – as defined in the Emergency Plan.

Emergency Services shall be updated with the latest site emergency plan as soon as possible.

緊急應變處理通常是第一個抵達事故現場的人員執行之。在某些情況下，他們需接受額外訓練，才能在無公司人員在場的情況下採取正確行動。

外部的緊急應變服務可由客戶、消防單位、警察局或保全公司提供—如緊急應變書中之明定說明。

緊急應變服務須盡可能隨著最新的現場緊急應變計畫更新。

8.4 Emergency drills 緊急應變操練

Emergency drills and training requirements shall be defined in the Emergency Plan and shall be based on the complexity of the installation.

Wherever possible, all the services that are named in the emergency plan should participate in the drills (fire brigade, ambulance, police, security service, customer, ROC, authorised personal, etc).

緊急應變計畫須根據工廠設備的複雜度，明文定義各項應變訓練。

如果可能的話，緊急應變計畫內所提到的各項服務都應加入標準程序(消防隊、救護車、警察局，保全服務、客戶、遠端操控中心、授權人員等)。

9 References 參考資料

9.1 AIGA Documents 文獻

008/04 Hazards of inert gases 惰性氣體的危險性
009/04 Safety training for employees員工的安全訓練
010/04 Management of change 變更管理
013/05 Incident/accident investigation and analysis偶發事件/事故的調查與分析
014/05 Safety audit guidelines安全稽查指南
021/05 Oxygen pipelines systems氧氣管線系統
027/06 Cryogenic vaporisation systems—prevention of brittle fracture in equipment & piping 低溫汽化系統—設備及管線預防脆化破壞

9.2 EIGA/IGC Documents 文獻

Doc 10/81. Reciprocating compressors for oxygen service. Code of practice.
往復式氧氣壓縮機。施行法規。
Doc 11/82. Code of practice for the design and operation of centrifugal oxygen pumps
離心式氧幫浦的設計與操作的施行法規
Doc 27/01 Centrifugal compressor for oxygen services. Code of practice.
氧氣供給的離心壓縮機。施行法規。
Doc 60/04 Prevention of major accidents. Guidance on compliance with the Seveso II Directive
重大事故的防範。 配合Seveso II Directive入門
Doc 59/98 Prevention of excessive pressure in cryogenic tanks during filling
低溫儲存槽裝填時如何避免過壓
Doc 63/99 Prevention of tow-away accidents 拖曳事故的防範

Doc 65/99 Safe operations of reboilers/condensers in air separation units
空氣分離設備之在沸器/冷凝器的安全操作
Doc 75/01 Determination of safe distances. 安全距離的判定
Doc 127/04 Bulk storage systems at production plants 製造廠的大量儲存系統

9.3 CGA Documents 文獻

P-8 Safe practices guide for air separation plants空氣分離廠的安全操作指南
P-8.1 Safe installation and operation of PSA and membrane oxygen and nitrogen generators PSA 的安裝與操作，薄膜氧與氮氣產生器
P-31 Tanker loading system guide儲存槽裝載系統指南
G 5.5 Hydrogen Vent Systems氫氣通風系統
P 12 Safe Handling of Cryogenic Liquids低溫液體的安全處理
P 16 Recommended Procedures for Nitrogen Purging of Tank Cars槽車的氮氣吹驅的建議步驟
P 17 Procedures for Pneumatic Retesting of Cargo and Portable Tanks貨物與移動式儲存槽的氣動再試程序
SB 15 Avoiding Hazards in Confined Work Spaces During Maintenance, Construction and Similar Activities 維修、建造與類似活動期間，避免侷限空間工作危害
G 4.8 Safe Use of Aluminium-Structured Packing for Oxygen Distillation氧氣蒸餾鋁材分餾板的安全使用方法
P 8.2 Air Separation Unit and Trailer Filling Validation Guideline for Oxygen USP and Nitrogen NF氧氣USP 與氮氣NF的空氣分離設備與拖車裝填確效指南
P 8.3 Perlite Management Perlite 管理
P 8.4 Safe Operation of Reboilers/Condensers in Air Separation Units (EIGA DOC 65/99/E)
空氣分離設備之在沸器/冷凝器的安全操作(EIGA DOC 65/99/E)
P 25 Guide for Flat-Bottomed LOX/LIN/LAR Storage Tank Systems 平底LOX/LIN/LAR 儲存槽系統手冊

9.4 Other Documents 其他文獻

IEC 61.511-1 Functional safety. Safety instrumented systems for the process industry sector Framework, definitions, system, hardware and software requirements
IEC 61.511-1 功能性安全。製造工業專用之配備儀器的安全系統
工作架構、定義、系統、硬體與軟體需求
IEC 61.511-2 Functional safety. Safety instrumented systems for the process industry sector Guidelines for the application of IEC 61511-1
IEC 61.511-2 功能性安全。製造工業專用之配備儀器的安全系統 IEC 61511-1 操作手冊

IEC 61.511-3 Functional safety. Safety instrumented systems for the process industry sector Guidance for the determination of the required safety integrity levels
IEC 61.511-3 功能性安全。製造工業專用之配備儀器的安全系統
安全整合標準所需的判定指南

EEMUA 178 a Design Guide for the Electrical Safety of Instruments, Instrument / Control Panels and Control Systems.
EEMUA 178 a 儀器的電機安全設計手冊，儀器/控制面板與控制系統

EEMUA 191 Alarm Systems - A Guide to Design, Management and Procurement
EEMUA 191 警報系統—設計、管理與採購手冊

Note: 專有名詞：
IEC - The International Electro technical Commission
IEC – 國際電子技術委員會

EEMUA - The Engineering Equipment and Material Users Association
EEMUA – 工程設備與材料使用者協會

Appendix A: Process Equipment Guidelines 附件A: 製程設備設施指南

Purpose of the Check List 檢查表的目的

The purpose of the check list is to assist in determining the automation level required for operating an unmanned plant. The list is not complete and should only be used as support for a detail risk assessment.

The normal questions to be answered on each point are:

What manual interaction should be automated:
- During normal operation
- Following a trip
- At start-up and shutdown
- During a process upset

The automation level needed should be adapted to each plant depending on local circumstances.

本檢查表的目的是爲幫助判定無人操控工廠的自動化程度。由於本表之完整性不足，僅供風險評估的輔助之用。

每一點應被回答的一般性問題是：

那些手動的互動模式應改成自動化：

- 正常運作期間
- 緊接停機後
- 啓動與停機時
- 製程混亂期間
- 依據各別狀況，採行各廠可接受的自動化程序

CHECK LIST

No 項次	*Item*項目	*Considerations Comments* 考量事項	建議事項
1	Ambient 週圍環境	1. Air temp 空氣溫度 2. Humidity 濕度 3. Wind direction and speed 風向與風速 4. Vents or emissions from nearby sources 1. 從附近來源排出或洩放	1.Alert ROC on extreme weather conditions 警告遠端操控中心有關極端的天候狀況 2. Where risk of fog is an issue 在霧氣可能存在風險的地方 3. For fan ejector running when certain direction is restricted 當風向被限制時，啓動風扇 4. Perimeter or feed air hydrocarbon detection 周界空氣碳氫化合物偵測
2	Air Filter 空氣過濾器	1. dP filter monitoring (alarm) dP過濾器監視(警報) 2. Heaters 加熱器 3. Roll filter 捲筒式過濾器 4. Filter room 過濾室	1. 在集塵區考慮自我洗淨功能設計 2. 在冰雪容易堵塞過濾器入口的國家 3. 事先限定捲筒式 4. 限制進入過濾室一侷限空間
3	離心壓縮機與渦	1. Add Surge information to the control system	1.Improved visibility at the ROC

	輪機 (空氣、氮氣、氧氣)	增加電湧資料至控制系統 2. Local trips/start-up interlock and alarms to be connected to the control system 現場停機/啓動連鎖裝置與警報連接至控制系統 3. Vibration signals connected to the control system 振動訊號連接至控制系統 4. Remote start/stop 遠端啓動/停機 5. “first out” alarm “第一優先”警報 6. Implement Auto load/ Auto start 執行自動加載/自動啓動 7. Imminent start warning (Local flashing light or horn) 緊急啓動警告(現場閃光燈或警報聲) 8. Major oil spill 主要油品溢出 9. Oil demister running indication 油品流動指示 10. Automated cooler drain valves 自動冷卻器排出閥 11. TV camera surveillance 電視攝影監視 12. Mixing of cooling water and oil 冷卻水與油的混合 13. Mixing of water and gas (for oxygen and nitrogen) 水與氣體的混合(氧與氮)	提高遠端操控中心的監視度 2.Improved visibility at the ROC 提高遠端操控中心的監視度 3.Improved visibility at the ROC 提高遠端操控中心的監視度 4.Consider the aspects when not being able to remote stop 當無法遠端停機時，考慮當時的狀況 5. Easier troubleshooting 較容易解決問題的方法 6. Easier handling 較容易處理 7. Personal safety see section 7.2 , 6.11 人員安全請參考7.2與6.11節 8.Environmental – oil level switch, oil trap switch, locked wells etc. 環境的— 油位開關、滑油卻水器油開關、油井閉鎖等 9.Environmental – oil leakage in the machine hall 環境的—機械漏油 10. Reduced energy consumption 減少能源耗費 11. Improved visibility at the ROC 提高遠端操控中心的監視度 12. - 13. -
4	Oxygen compressor Special considerations 氧氣壓縮機—特別考量	Minimum instrument level for Oxygen Compressors - see EIGA 10/81 for reciprocating and EIGA 27/01 for centrifugal 氧氣壓縮機的最低儀器等級—請參考EIGA 10/81 的往復式壓縮機與EIGA 27/01的離心式壓縮機	-
5	Pre-cooling (Direct Cooler, Vap Cooler, Chiller) 預冷(瞬冷器、汽冷器、冷卻器)	1.Level indication and alarm/trip on water separator pots and dp over the DCAC demister 水份分離壺的水量指示與警報/停機，及DC AC之上的 dp 2.Ability to open separator pot drains 開啓分離壺排水口的能力 3.Ability to remote start secondary pumps 遠端啓動二次幫浦的能力 4.Combining any chiller PLC control to the overall plant control system 結合任何冷卻器PLC控制至全廠控制系統	1.Improved reliability, visibility at the ROC 提高遠端操控中心的能見度與可信度 2. Improved, reliability controllability at the ROC 提高遠端操控中心的可信度與可控制度 3.Improved controllability at the ROC 提高遠端操控中心的可控制度 4.-
6	Pre Purification (Revex, PPU/MSA, adsorbers, regen System) 預先純化(Revex, PPU/MSA吸附器、再生系統)	1.Air inlet temperature to purification unit to control system 空氣入口溫度到純化設備到控制系統 2.Ability for remote step advance 遠端進階控管能力 3.Regeneration flow, temperature and humidity (steam heater) 再生流動、溫度與濕度(蒸氣加熱器) 4.Regeneration gas outlet temperature to the control system 再生氣體出口溫度到控制系統	1.To avoid excess moisture 避免濕度過高 2.Improved capability at the ROC 提高遠端操控中心的性能 3.Guarantee regeneration of the PPU’s. 保證PPU的再生 4.Guarantee regeneration of the PPU’s. 保證PPU的再生 5.To avoid contamination of the plant 避免工廠汙染

		5.Air temperature, moisture and CO2 to control system 空氣溫度、濕度與二氧化碳到控制系統 6.Automate mid point temp control on revex revex上的自動中溫控制	6.To avoid contamination of the plant & improve efficiency 避免工廠汙染並提高效率
7	Cold Box 冷卻箱	1.Leaks into cold box shell 外漏至冷卻箱外殼 2.Column dP indications 系統差壓(dp)指示 3.Automate any manual valves needed for liquid drainage 液體排出所需手動閥的自動化 4.Need for automating process liquid pumps (including seal gas system) 製程液體幫浦的自動化需要(含封閉氣體系統) 5.Areas with potential for LOX boiling to dryness LOX沸騰至乾燥的潛在區域	1. Consider pressure indicators and purge flow meters 考慮壓力指示器與淨化流量計 2. Used for start-up and major process upset 啓動及重大製程混亂時使用 3. At plant trip and major process upset when liquid levels are too high or product quality excursions 工廠停機及重大製程混亂時，當液體等級過高或產品品質偏離時 4. To avoid long production outages 避免長時間生產中斷 5. To avoid hydrocarbon buildup in reboiler, LOX vaporiser etc. Examples include hydrocarbon analysers, DP indicators etc. 避免在沸器及LOX蒸發器積存碳氫化合物等。包括碳氫化合物分析儀、差壓(DP)指示器等

8	Storage & Back up Vaporisers (liq pumps, HP buffer storage, pipelines) 儲存暨備用蒸發器(液體幫浦、HP緩衝液儲存,管路)	1.Double block and bleed systems for all liquid flows to storage 所有液體流動到儲存的二次閉鎖與抽取 2.Detection of liquid leaks. - Low temperature detection in the ground surrounding tanks and fill areas connected to control system - Low temperature detection on any liquid drain to atmosphere with alarm 液體外漏偵測 -- 地面儲存槽與連接到控制系統的裝填區的低溫偵測 --任何液體排水到空氣中的低溫偵測加上警報 3.Upgrade of Storage tank protection systems 儲存槽保護系統升級 4.Automation level required of the backup pump and vaporiser system 備用幫浦與蒸發器系統所需的自動化程度 5.Assess dependency on electricity, steam and instrument air with special reference to common modes of failure (e.g. same source of power for back-up system & plant) 從特別數據到一般故障模式評定電力、蒸汽與儀器空氣的獨立程度(如備用系統與工廠使用	1. To ensure product quality in the storage tanks 確保儲存槽內的產品品質 2. See section 5.4 Remote Detection of liquid spillage 請參考5.4節液體外溢的遠端偵測 3. See EIGA 124/04 Storage at Production Sites 請參考EIGA 124/04生產現場的儲存 4. Depending on the response time required by the customer 視客戶要求的應變時間而定 5. Depending on the required availability by customer 視客戶要求的適用性而定 6. See section 5.7.4 請參考5.7.4節 7. To avoid cold embrittlement 避免冷脆化 8. To guarantee the customer supply 保證客戶供應

		同樣的電力來源) 6. Risk of fog during atmospheric vaporisation. 空氣蒸發期間霧氣造成的風險 7.Adequacy of low temperature protection after vaporiser. 蒸發後適當的低溫保護 8. Adequacy of pipeline purity protection (double block & bleed) 適當的管路純度保護(二次閉鎖與抽取)	
9	Argon Purification (cryogenic & conventional) 氬純化(低溫的與慣性的)	1.Need of automating process liquid pumps (including seal gas system) 製程液體幫浦的自動化需要(含密封氣體系統) 2.Double block & bleed for H2 to the warm argon system 氫氣到溫熱氬氣系統的二次閉鎖與抽取 3.Ammonia and hydrogen leak detection 氨氣與氫氣的外漏偵測 4.Automation level of the argon compressor(s) 氬氣壓縮機的自動化程度	1.To avoid long production outages 避免長時間生產中斷 2.The block and bleed is for shut-down situations 閉鎖與抽取是指停機狀態 3.See section 5.3 Fire and gas alarm system 請參考第5.3節火警與氣體警報系統 4.To avoid long production outages or process upsets 避免長時間生產中斷與製程混亂
10	Electrical System (HV, MV, LV & motors) 電機系統(HV, MV,LV與馬達)	1.How voltage disturbances or other power supply issues can be eliminated or minimised for auxiliary equipment or minimised for auxiliary equipment 如何排除電壓干擾或其他電力供應問題或如何減少輔助設備當機的機率 2.Switch gear alarms needed to the control system 控制系統所需的啓動開關盤(Switchgear)警報 3.Fire alarm system 火警警報系統 4.Redundant power supply for critical equipment e.g. back-up system, control system ups, oil pumps, lights etc 重要設備的備用電力供應，如備用系統，控制系統不斷電系統、油幫浦，燈具等	1.To avoid long production outages and the need for local reset 避免長時間生產中斷及現場重新設定的需要 2.Improved visibility at the ROC 提高遠端操控中心的監視度 3.See section 5.3 Fire and gas alarm system 請參考第5.3節火警與氣體警報系統 4.Improved reliability 提高遠端操控中心的可信度

11	Auxiliary equipment (boilers, diesel generators) 輔助設備(鍋爐、柴油產生器)	1. Automation level required 所需的自動化程度	1. -
12	Cooling System (inc water treatment) 冷卻系統(inc水處理)	1. CW temp and flow to control system CW溫度與流動到控制系統 2. Automation level required e.g. 所需的自動化程度，如 - fan control 風扇控制 - cooling water pump(s) auto start - 冷卻水幫浦自動啓動 - water treatment including blow-down and chemicals - 水處理包括排液到化學品 - tower bypass valve	1. Improved visibility at the ROC 提高遠端操控中心的監視度 2. Improved reliability, visibility at the ROC 提高遠端操控中心的監視度與可信度 3. Improved reliability, visibility at the ROC 提高遠端操控中心的監視度與可信度

		冷卻塔的分支閥 - side stream filter(s) 分流過濾器 3.TV camera surveillance to monitor ice build up on tower 1. 電視攝影監視到監看冷卻塔結冰過程	
13	Control system (incl. (incl. analysers) 控制系統(包括儀器/分析儀)	1. Back-up redundancy plan for loss of communications (dial in over telephone, local operators, backup network, etc) 失聯時的備用計畫(電話撥入、當地接線生、備用網路等) 2.Alarm Prioritisation 警報優先權 3. Need of full or limited remote control functionality at the ROC 遠端操控中心全數與有限度的遠端操控需求 4.functionality at the ROC System 控制系統的遠端再開機需求 5.Integration of local control into control system. 現場控制到控制系統的整合 6.A “first out” feature for the plant tripping system 工廠停機系統的”第一優先”特性 7. Need of UPS capacity 不斷電系統的需求 8. Back-up instrument air/gas. Ensure that any additional hazards are covered when using instrument N2. 備用儀器空氣/氣體。使用氮氣時，確保任何可能額外的危險均被考慮在內 9.Analysis system e.g. replacement of manual analysis, auto-calibration, calibration switch status, auto-range, range feedback, procedures for when range feedback, procedures for when 1. 分析系統，如手動分析的置換、自動校正、校正切換狀態、自動範圍、返回範圍、何時校正與校正頻率的程序	1. See section 5.8.3 請參考第5.8.3節 2. See section 5.8.4 請參考第5.8.4節 3. Improved reliability, visibility at the ROC 提高遠端操控中心的監視度與可信度 4. Improved reliability at the ROC 提高遠端操控中心的可信度 5. Improved controllability at the ROC 提高遠端操控中心的可控制度 6. Improved troubleshooting 提高遠端操控中心解決問題能力 7. Improved reliability at the ROC. Ensure event logging after power failure. 提高遠端操控中心的可信度。停電後確保會記錄在工廠日誌 8.Improved plant reliability 提高工廠的可信度 9.Improved reliability, visibility at the ROC. Also see section 6.11 提高遠端操控中心的監視度與可信度。請參考第6.11節
14	Liquid Disposal System 液體處理系統	1. Automation level of the waste disposal system 廢棄物處理系統的自動化程度 2. Detection of liquid leaks 液體外漏偵測 3. TV camera surveillance to monitor operation 電視攝影監督到監看作業 4. Risk of fog 霧氣產生的風險	1.See section 5.7.3 請參考第5.7.3節 2. See section 5.4 請參考第5.4節 3. Improved visibility at the ROC 提高遠端操控中心的監視度 4. See section 5.7.4 請參考第5.7.4節
15	Truck Filling System 卡車裝填系統	1. Automation level on fill system 過濾系統的自動化程度 2.Detection of liquid leaks 液體外漏偵測 3.Risk of storage tank filling by road tanker 由路上的液罐車裝填儲存槽的風險	1. See section 5.6 請參考第5.6節 2. See section 5.4 請參考第5.4節 3. See section 5.6 請參考第5.6節
16	Site Security, Fire Protection, Signage	1. Ensure fire monitoring systems are integrated to control system and third party monitoring company 確保火警監測系統整合到控制系統與第三方監視公司	1. See section 5.3 請參考第5.3節 2. See section 5.3 請參考第5.3節

	現場保全、火警保護、信號系統	2. Buildings have adequate room analysis for oxygen enrichment / depletion 建築物有足夠空間分析氧氣含量 3. TV camera surveillance to monitor site perimeter 電視攝影監督到監看現場週圍 4. Control of entrance gates 入口控制 5.Lone Worker system in place (mandown alarm and procedures) 獨自工作者管理就定位(手動(man down)警報與程序) 6. Signs indicating machinery can be started remotely 指示機械可遠端啓動的訊號 7. Greater restriction on access to the site 進入現場的大規模限制 8. Intrusion alarm system/service 闖入警報系統/處理 9.Define and segregate unmanned plant area from other activities e.g. - Parking and maintenance of vehicles - Cylinder filling station by e.g. locked door, fencing etc 無人操控工廠與其他活動的界定與分離，如 -停車與車輛維修 -在上鎖的門邊，圍籬邊等的鋼瓶裝填站	3. Improved visibility at the ROC 提高遠端操控中心的監視度 4. Improved controllability at the ROC 提高遠端操控中心的可控制度 5. See section 7.2 請參考第7.2節 6. Personal safety see section 6.7 人員安全請參考第6.7節 7. See section 6.12 請參考第6.12節 8. See section 6.12 請參考第6.12節 9. See section 6.10 請參考第6.10節