2019產業安全衛生技術輔導成果發表會

製程安全事故之經驗學習 108/11/29

中華民國工業安全衛生協會
安全與環保技術服務處高雄辦公室
李圻陽工程師

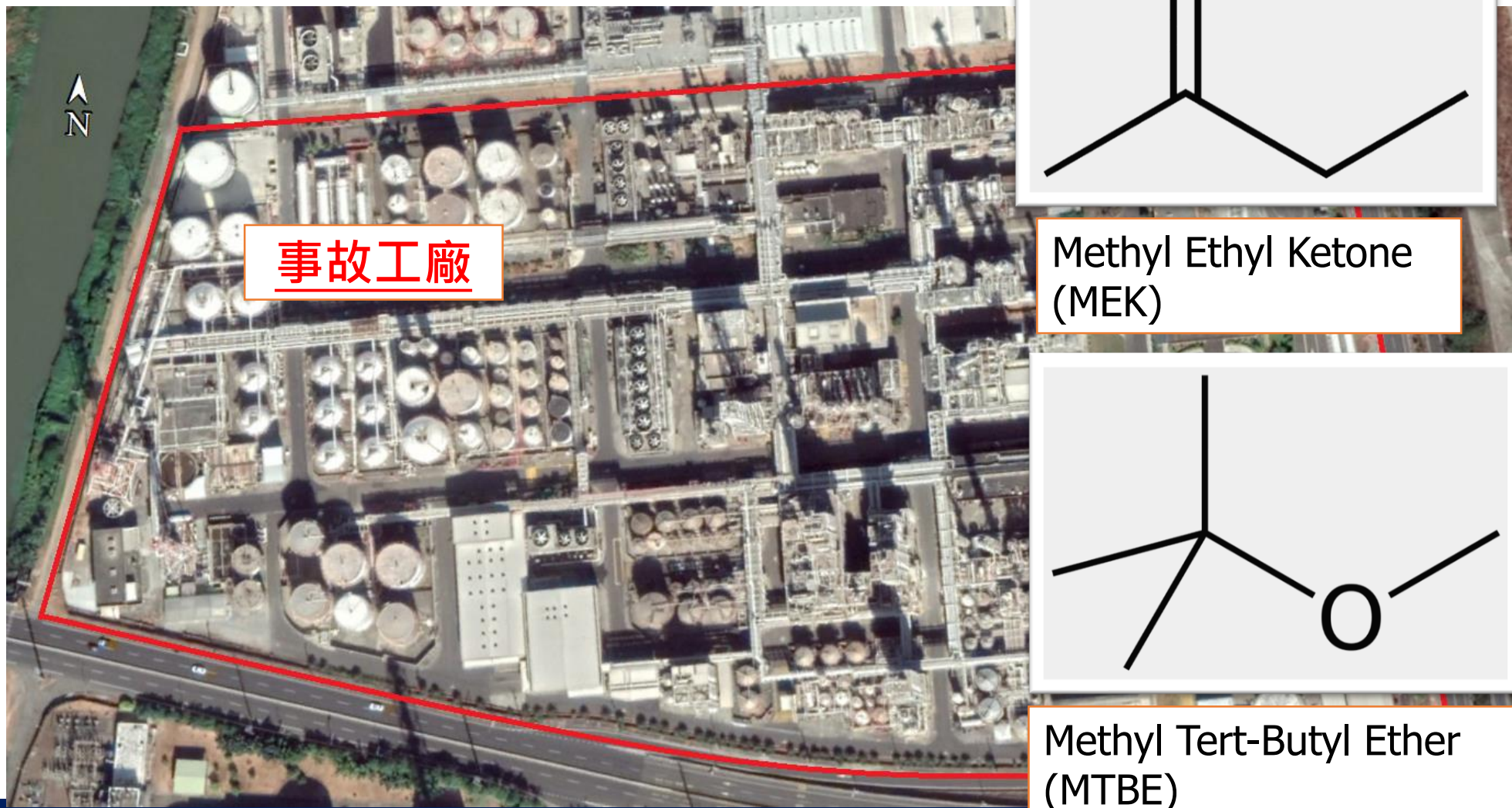
說明大綱

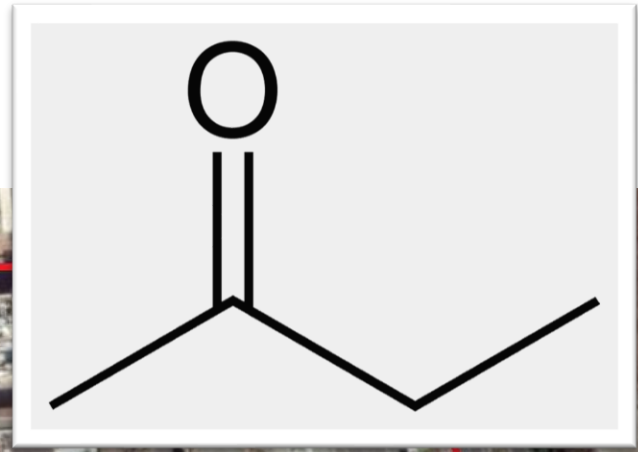
- 前言
- 製程/事故描述
- 事故經驗學習
- 結論

PART 1 | 前言


蘋果日報

工業局督導

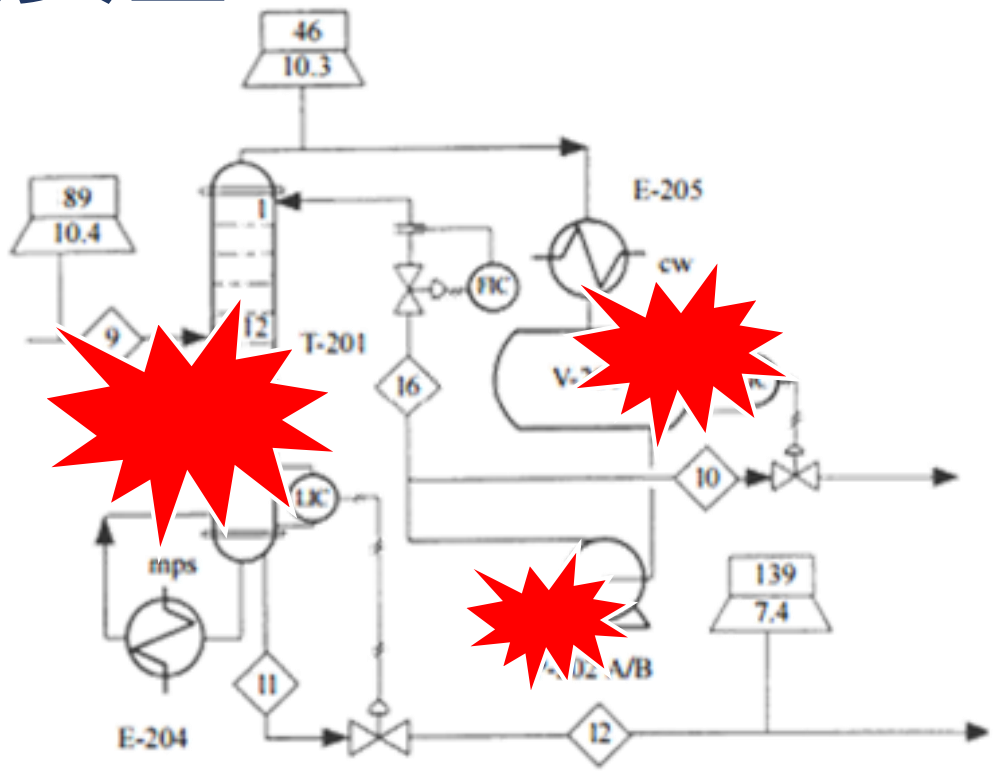




Methyl Ethyl Ketone (MEK)

Methyl Tert-Butyl Ether (MTBE)

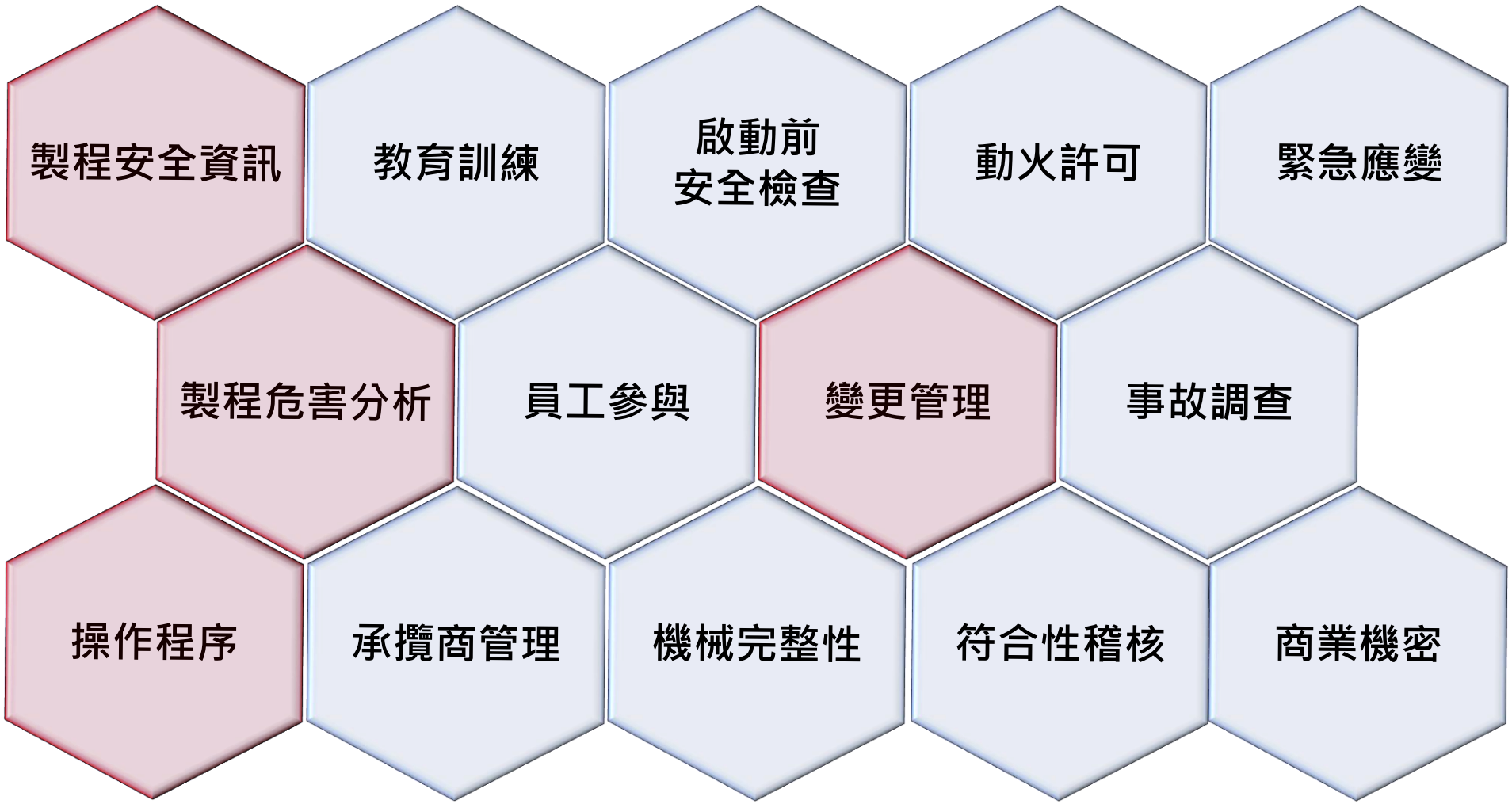
製程安全與職業安全



人員安全(職業安全)

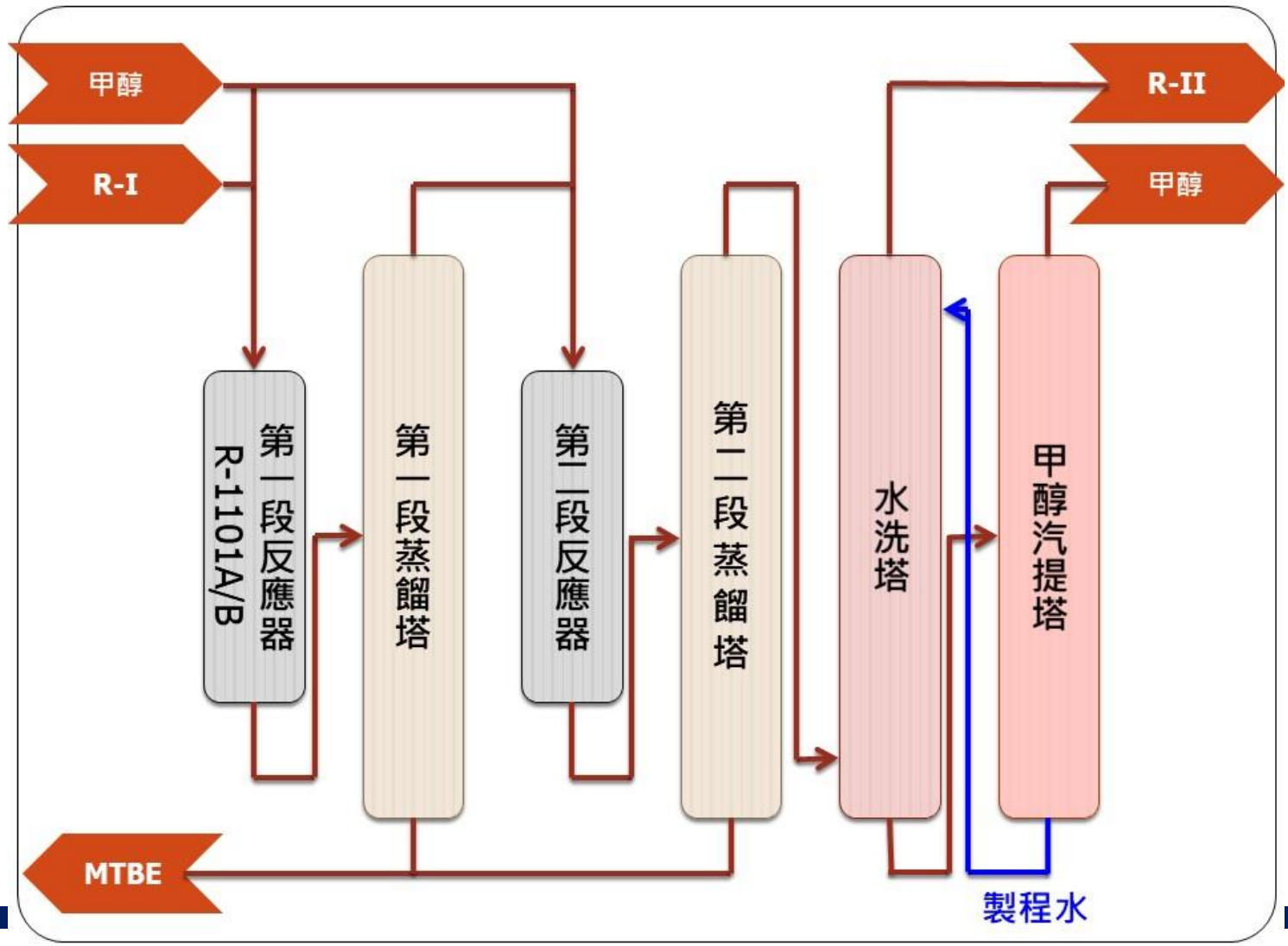
製程安全

製程安全管理


製程安全資訊
教育訓練
啟動前
安全檢查
動火許可
緊急應變
製程危害分析
員工參與
變更管理
事故調查
操作程序
承攬商管理
機械完整性
符合性稽核
商業機密

PART 2 | 製程/事故描述

製程描述


甲醇
R-I
第一段反應器
R-1101A/B
第一段蒸餾塔
第二段反應器
第二段蒸餾塔
水洗塔
甲醇汽提塔
R-II
甲醇
MTBE
製程水

開槽作業程序

步驟	描述
1	R-1101A排定時程開始進行設備停操隔離
2	反應器冷卻程序完成
3	將管路安排為R-II置換反應器內容物
4	置換期間取樣分析內容物甲基第三丁醚濃度
5	目標須達甲基第三丁醚<0.5%
6	以氮氣壓空反應器作業
7	將端板底部內容物以高壓軟管接至廢棄回收系統排空
8	將反應器進出管路盲封
9	批次補純水入R-1101A內浸洗，重覆水洗共三次
10	打開槽底阻閥卸觸媒
11	將觸媒送至觸媒再生場，準備再生或再進一步作最終處理
12	用純水清洗反應器內部
13	反應器開槽工檢

事故描述

因應 3 月 6 日 MTBE#1 反應器 R-1101A 與冷卻器 E-1102A 需要內部工檢，2 月 28 日早班開始將 R-1101A/B 兩個串聯反應器隔離，並做工檢前的出清工作。

順序	步驟	時間	描述
1	1	0800	R-1101A排定時程開始進行設備停操隔離
2	2		反應器冷卻程序完成
3	6	1200	以氮氣將反應器內容物壓排至TK-1904A(不合格儲槽)
4	3	1330	將管路安排為**R-II**置換反應器內容物
5	7	1435	將反應器底部以高壓軟管連接至泵浦入口，並打開兩側阻閥
6	4	-	置換期間取樣分析內容物甲基第三丁基醚濃度

事故描述

順序	時間	描述
7	1540	許進行早中班交接班後，續作R-II置換工作並巡視現場。
8	1630	盤控人員發現**D-2905**液位低警報，為穩定下游製程進料，限縮進與出**R-1101A**之控制閥開度，**R-1101A**壓力由**7.8Kg/cm²**升至**9Kg/cm²**。
9	1730	盤控員發現**D-2905**液位未上升，續限縮**R-1101A**出口控制閥**(FV-1108)**開度，**R-1101A**壓力升到約為**11Kg/cm²**。
10	1740	控制室氣體偵測器警報作動，由控制室窗戶發現**R-1101A**底部出現洩漏，立即由控制室內吳工程師至現場將泵浦**(P-1072)**出口阻閥關閉並回到控制室告知已關閉，再由工程師帶領操作員趕赴**R-1101A**底部現場止漏。
11	1748	爆炸發生，控制室門窗/天花板震破，**DCS**系統當機，控制室人員自行撤離。

PART 3 | 事故經驗學習

1.製程安全資訊

Process safety information. In accordance with the schedule set forth in paragraph (e)(1) of this section, the employer shall complete a compilation of written process safety information before conducting any process hazard analysis required by the standard. The compilation of written process safety information is **to enable the employer and the employees involved in operating the process to identify and understand the hazards posed by those processes** involving highly hazardous chemicals. This process safety information shall include **information pertaining to the hazards of the highly hazardous chemicals used or produced by the process**, **information pertaining to the technology of the process**, and **information pertaining to the equipment in the process**.

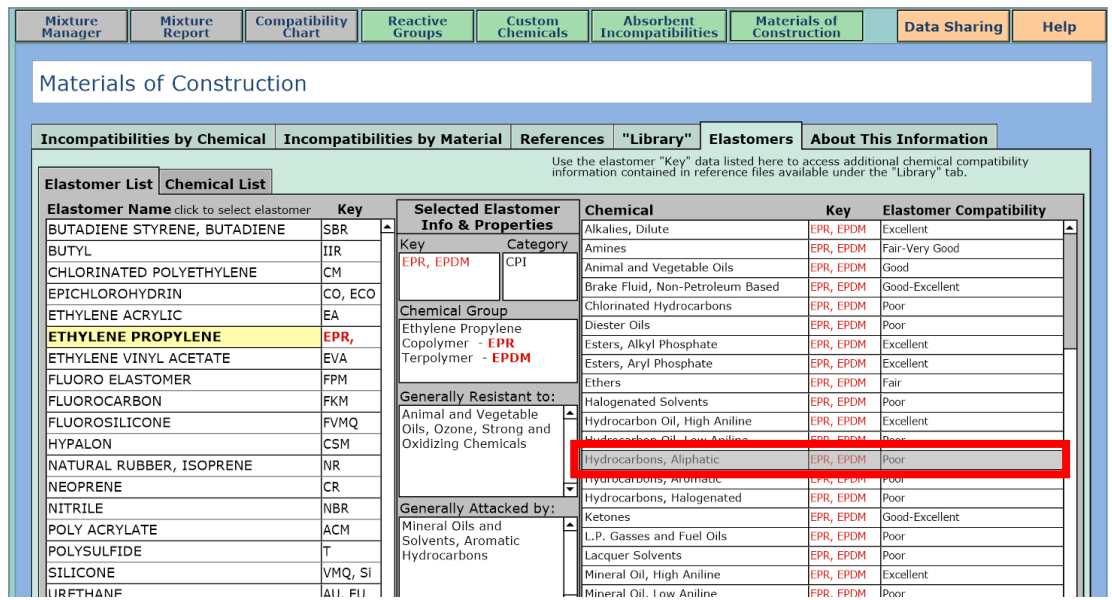
Information pertaining to the hazards of the highly hazardous chemicals used or produced by the process, **information pertaining to the technology of the process :**
Toxicity information; Permissible exposure limits; Physical data; Reactivity data; Corrosivity data; Thermal and chemical stability data; and **Hazardous effects of inadvertent mixing of different materials that could foreseeably occur**.

Information pertaining to the equipment in the process :
Materials of construction; Piping and instrument diagrams (P&ID's); **Electrical classification**; Relief system design and design basis; Ventilation system design; Design codes and standards employed; Material and energy balances for processes; and Safety systems (e.g. interlocks, detection or suppression systems)

1.製程安全資訊

Information pertaining to the hazards of the highly hazardous chemicals used or produced by the process, **information pertaining to the technology of the process :**
Toxicity information; Permissible exposure limits; Physical data; Reactivity data; Corrosivity data; Thermal and chemical stability data; and **Hazardous effects of inadvertent mixing of different materials that could foreseeably occur**.

Chemical Reactivity Worksheet



2.製程危害分析

The process hazard analysis shall be appropriate to the complexity of the process and **shall identify, evaluate, and control the hazards involved in the process**. Employers shall determine and document the priority order for conducting process hazard analyses based on a rationale which includes such considerations as extent of the process hazards, number of potentially affected employees, age of the process, and operating history of the process.

The process hazard analysis shall address:

1.The hazards of the process;

2.The identification of any previous incident which had a likely potential for catastrophic consequences in the workplace;

3.Engineering and administrative controls applicable to the hazards and their interrelationships such as appropriate application of detection methodologies to provide early warning of releases. (Acceptable detection methods might include process monitoring and control instrumentation with alarms, and detection hardware such as hydrocarbon sensors.);

4.Consequences of failure of engineering and administrative controls;

5.Facility siting;

6.Human factors; and

7.A qualitative evaluation of a range of the possible safety and health effects of failure of controls on employees in the workplace.

3.操作程序&變更管理

OPERATING PROCEDURE

The employer shall develop and implement written operating procedures that **provide clear instructions for safely conducting activities** involved in each covered process consistent with the process safety information and shall address at least the following elements.

MNAGEMENT OF CHANGE

The employer shall establish and implement written procedures to **manage changes** (except for "replacements in kind") to process chemicals, technology, equipment, and procedures; and, changes to facilities that affect a covered process.

4.其他-氣體偵測器之有效性

2019/2/28
高雄市林園工業區

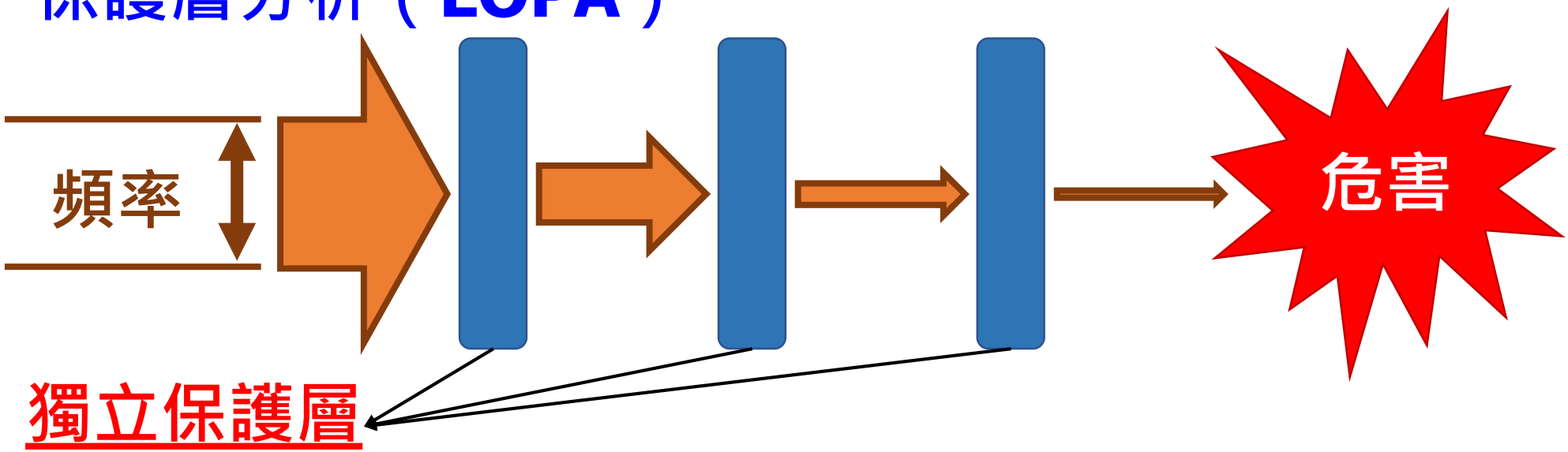
警報作動 → 8 mins → 蒸氣雲爆炸

2019/4/7
雲林縣麥寮工業區

警報作動 → 12 mins → 蒸氣雲爆炸

4.其他-氣體偵測器之有效性

保護層分析（LOPA）



- **Effective** in preventing the consequence when it functions as designed
- **Independent** of the initiating event and the components of any other IPL already claimed for the same scenario
- **Auditable** the assumed effectiveness in terms of consequence prevention and PFD must be capable of validation in some manner

PART 4 | 結論

- **「製程安全管理得以有效減少重大事故風險並提高化學工業績效」**已於國際間被廣泛地認可。
- 目前國際上主要的製程安全管理法規皆為**性能式法規(Performance-Based codes)**，故從事各項製程安全管理相關工作之**人員的能力訓練**與**安全文化的培養**是相當重要的課題。
- **製程安全事故相較於職業安全事故，是相對罕見且後果也相對較為嚴重。**因此，**從具有相似性質工廠已發生的事故進行經驗學習，為最實際且成本最低的方法。**針對此事件，所有與會同仁可以思考，目前所屬工廠內是否具有相關事故發生的原因。

感謝聆聽
謝謝指教

THANK YOU