出國報告（出國類別：國際會議、其他-參訪）

參加 11th Global Congress on Process Safety 研討會及赴 Mary Kay O'Connor 製程安全中心參訪

服務機關：國立雲林科技大學
姓名職稱：廖光裕專案助理
派赴國家：美國
出國期間：104 年 4 月 23 日~5 月 5 日
報告日期：104 年 8 月 4 日

摘要

本次旅程赴德州奧斯丁參與第11屆全球製程安全會議，除了解全球製程安全領域最新研究成果及資訊，並發表論文，並將於會議中所吸收之新知，陸續整理成相關資訊，待日後提供我國相關主管機關及業者參考。隨後赴美國德州大學Mary Kay O'Connor製程安全研究中心，了解美國於製程安全之科學研究，並就我國實際產業情況，與該中心研究人員進行學術交流，其中包括如異常情況之管理、工廠設施選址之重要性、定量風險評估及安全氛圍等研究項目。

目次

一、目的

本次出國考察之目的：

1. 參觀於製程安全領域聞名國際的德州農工大學 Mary Kay O'Connor 製程安全中心，瞭解其研究主題，並針對我國現況有所助益之研究，如異常情況之管理、工廠設施選址之重要性、定量風險評估及反應性化學品等項目，與該中心研究人員進行交流探討，藉此體認歐美先進國家於製程安全上之發展趨勢與管理方式，並將相關概念作為國內相關產業強化製程安全及管理之基礎。

2. 全球製程安全會議 GCPS (The Global Congress on Process Safety)，為國際化學製程安全領域規模最大的會議，每年舉辦一次，今年為第 11 屆，舉辦會議地點位於德州奧斯丁，本次與會除了汲取全球製程安全領域最新研究成果及資訊，於會議上由國立雲林科技大學環境事故應變中心洪肇嘉主任口頭報告發表"A Case-Study of a Fire Incident of Trichlorosilane Process and Response Measures"研究成果，並與中台科技大學曾若鳴副教授合作發表海報論文"Exothermal test for green plastics materials by DSC"。

貳、過程

本次赴赴德州奧斯丁參與第 11 屆全球製程安全會議，104 年 4 月 26 日起，美國化學工程師協會（AIChE）2014 年會暨第十屆全球過程安全大會(2014 AIChE Spring Meeting and 10th Global Congress on Process Safety)在美國舉行，來自全球 30 餘個國家和地區的 1200 多位元專家學者參加會議研討會，本次研討會包含 Process Safety Culture、Risk Analysis/Risk Based Decision 等 13 項主題共計 114 篇文章，本人分別與洪肇嘉教授及中台科技大學增若鳴教授共同發表” ”A Case-Study of a Fire Incident of Trichlorosilane Process and Response Measures”及”Exothermal test for green plastics materials by DSC”。

CCPS 為世界化工製程安全會議之頂尖會議。本次會議邀請在全球領先的安全專家出席並報告他們的工作，經由世界級專家的報告及討論，會使與會者能夠提高自己於化工製程安全之知識，拓展自己的網絡及人脈，並將會議上得到之知識，應用於化工安全上，以防止製程中安全事故之發生。

4 月 29 日起參訪美國德州農工大學，分別參訪德州農工大學 Mary Kay O'Connor Process Safety Center 及德州農工大學技術推廣服務機構（TEEX,Texas A&M Engineering Extension Service）。

玫琳凱奧康納過程安全中心(Mary Kay O'Connor Process Safety Center)成立於 1995 年，主要為紀念玫琳凱奧康納的運營總監在菲利普斯石油公司因爆炸死於 1989 年 10 月 23 日，玫琳凱奧康納畢業於密蘇里 - 哥倫比亞大學，主修化學工程，並從休斯敦清湖大學獲得工商管理碩士學位。

1997 年，山姆·甘露博士，因他在製程安全領域上的聲譽被任命為中心主任。該中心的使命是以促進世界各地製成安全的成長為目標，以防止未來的事故。此外，該中心開發更安全的工業技術，設備，程序和管理策略以盡量減少工業中的損失。然而，該中心意識到有必要推進製程中的安全技術，以保持該行業的競爭力。

TEEX 德州農工大學技術推廣服務機構（TEEX,Texas A&M Engineering Extension Service）位於美國德克薩斯州的 College Station 市，超過 140 個訓練項目，包括石化工廠火災模擬訓練、槽車、飛機、及其他建物消防人員急救訓練等等，為全球最大緊急應變訓練場，該訓練場以逼真模擬實體作為訓練場所，符合訓練應變人員實際操作訓練之需求。

本次出國其行程如表 1 及會議議程表表 2 所示。

表 1　行程一覽表

日期	行　　程	附　　註
04/23(週四)	搭機前往美國 ● 台灣桃園國際機場至美國休士頓布希國際機場	美國
04/24(週五)	抵達美國德州休士頓布希國際機場	美國
04/25(週六)	前往會議辦理地點德州奧斯汀	美國
04/26(週日)	參加 CCPS 製程安全會議	美國
04/27(週一)	參加 CCPS 製程安全會議	美國
04/28(週二)	參加 CCPS 製程安全會議	美國
04/29(週三)	參訪德州農工大學 Mary Kay O'Connor Process Safety Center	美國
04/30(週四)	參訪德州農工大學 Mary Kay O'Connor Process Safety Center	美國
05/01(週五)	搭機回台	美國
05/02(週六	搭機回台，轉機(未支差旅費)	-
05/03(週日)	休假(未支差旅費)	-
05/04(週一)	休假(未支差旅費)	-
05/05(週二)	抵達台灣(未支差旅費)	臺灣

表二 GCPS 製程安全會議議程表(範例，詳細議程如附件一)

SUNDAY, April 26	
8:00 AM – 5:00 PM	GCPS Short Courses
6:30 PM – 8:00 PM	2015 AIChE Spring Meeting and 11th GCPS Opening Reception Location: Conv. Ctr. Exhibit Hall 5
MONDAY, April 27	
7:00 AM	Complimentary Breakfast Location: Conv. Ctr. Ballroom D
8:00 AM	2015 AIChE Spring Meeting and 11th GCPS Opening Plenary Session: **Cheryl Teich ,** AIChE President and **June C. Wispelwey**, AIChE Executive Director Location: Conv. Ctr. Exhibit Hall 5
8:30 AM	**Keynote Address: Chemical Engineering – Is this the "Golden Age"?** Presented by**Marvin O. Schlanger**, Chairman of the Supervisory Board of LyondellBasell (Ret.) Location: Conv. Ctr. Ballroom D
9:15 AM	**Coffee Break** Location: Conv. Ctr. Exhibit Hall 5
9:40 AM	**11th GCPS Welcoming Plenary Session** Location: Conv. Ctr. Ballroom D 11th GCPS Introduction and Welcome: **Shakeel Kadri** (Executive Director, CCPS) and **Rainer Hoff** (GCPS Chair) Symposia Introductions: **Samantha Scruggs** (CCPS Chair), **Charles A. Soczek** (LPS Chair), **Karen Study** (PPSS Chair), **Lisa Long** (PSM2 Chair), **Jatin Shah** (Spotlight Track Chair), **Laura Turci** (RPPS), and **J. Wayne Chastain** (DIERS) Presentation of William H. Doyle Award for LPS Best Paper Award and PPSS Best Paper Award

三、心得

（一） 德州農工大學 Mary Kay O'Connor Process Safety Center 製程安全技術研究成果考察：

為了紀念不幸於 1989 年 Phillips 化學公司聚乙烯工廠爆炸身亡的 Mary Kay O'Connor 女士，美國德州農工大學於 1995 年所成立的相關製程安全研究機構便命名為 Mary Kay O'Connor 製程安全中心，是國際該領域上之重要研究機構，研究之面向皆是與製程安全方面相關，其研究項目非常多元化，另該中心除了戮力於製程安全技術研究上，在人才培訓及養成方面，也不餘遺力，每年會不定時規劃舉辦相關研習課程，並邀請該領域知名的學者及實務專家進行授課及經驗分享。因其研究項目非常多元化，故本次參訪著重於對我國現況有所助益之研究，其相關研究內容簡述如下：

(1) 異常情況之管理：

在歷年重大化災事故案例中，可發現準確的製程相關元件故障檢測與診斷有其必要性，故通過建立自動化之分析系統，有效地從製程正常運作環境中記錄其模式，並藉此進行監控檢測，判斷製程中是否有錯誤發生，以利人員掌控，進而確保製程之安全性為該研究之目的。

(2) 工廠設施選址之重要性：

石化工業廠區擁有眾多之設備元件，如管道、儲槽、反應器水霧防護裝置及脫硫塔等設施，且所涉及化學品多為具易燃性、毒性及反應性之物質，所以挑選適當地點及妥善安排其設施建置，能有效降低廠區周遭社區與民眾之風險等級、減輕毒性影響、抑制火場範圍之擴大及降低爆炸帶來之損失，此外，能更安全的執行設備維護工作。

(3) 定量風險評估：

化工製程是一個動態複雜的過程，於不同階段皆會有不同的影響因子，如季節的變化、設備老舊、物理過程，隨機過程以及操作人員於化工製程系統中的反應時間等因素，但傳統風險評估無法有效估算其動量特性，因此一個能模擬製程中隨機事件的離散估算之定量風險評估的方法有其必要性。

(4) 工程之持續發展：

工程之持續發展（Engineering for Sustainable Development,ESD）為一種集成性之系統方法，旨在當前利益相關者之發展與不損害後代子孫利益兩者間之獲取平衡，並滿足經濟，生態環境，社會標準以及安全和健康之要求，然而當工程之持續發展所需標準不明確時，缺乏相關資訊及決策過程所需之具體數據，便無法做出正確之決策，所以該研

究目標即是開發出方法以利解決這些困難。

(5) 可燃性及燃燒研究：

許多化工製程皆有使用燃性化學品，因此瞭解易燃性化學品之閃點和可燃性相關資訊是非常重要的，該訊息能有助於提高製程運作時之安全性，目前多數可獲知的可燃性相關資訊，主要是針對純化合物，但仍有許多混合物相關可燃性數據仍是未知，尤其是非理想混合物，所以該研究之目的便是通過實驗之方式，得知混合物於含氧環境及各種溫度壓力下的可燃性相關數據。

(6) 液化天然氣(**Liquefied Natural Gas, LNG**)之安全研究：

液化天然氣是全球依賴甚深的主要能源之一，但當其不慎外洩時，易形成可燃性蒸氣雲，並導致爆炸，造成人命及財產莫大之損失，所以如何對液化天然氣蒸氣進行有效的檢測、抑制及控制，進而達到減災之目的；該研究之主要內容是探討如何運用流體動力學運算軟體預測液化天然氣蒸氣之擴散範圍，並據此作為水霧設備建置工程之基礎。

(7) 安全氛圍：

安全氛圍意指員工對工作機構的安全健康事宜之整體看法，如管理層是否重視職業安全、上司或同事對職業安全的關注、自身對工作安全行為的評價、作業環境是否安全等，而其指標即以安全氛圍指數示之，其指數高低可判斷此工作機構是否為一個安全之工作環境，根據研究報告指出，當安全氛圍指數越高時，可以有效促進員工的安全行為，減少事故之發生。

石油化學工業為我國重要發展產業之一，其工業主要危害是製程設備元件眾多，設備運轉環境多為高壓高溫，所涉及化學品多為高危害性物質，故潛在風險程度與其他產業相比自然高出許多，且如不慎發生事故，除了容易造成人命及財物嚴重之損失外，其後續更容易衍生出環境污染之問題，因此，落實製程安全、良好的設備維護、建立安全的作業環境及防護設施妥善之建置等製程安全相關事項，為我國未來發展亟需加強之重點，另加上台灣人口密度甚為集中，所以廠場設置地點也需經過完善之評估，將對周遭環境及民眾所帶來之衝擊降至最低；此次憑藉參訪 Mary Kay O'Connor 製程安全中心之良機，將所獲取之資訊及觀念提供給我國政府相關單位及業界參考，以期能達到事半功倍之成效。

（二） GCPS 製程安全會議相關議題研討及成果發表

全球製程安全會議(Global process safety Conference)由美國化學工程協會(American Institute of Chemical Engineers,AIChE)主辦，化學製程安全中心(Center for Chemical Process Safety ,CCPS)承辦，廣邀全球製程安全領域相關專家學者，於美國一年舉辦一次

的大型會議，旨在交流世界各國最新製程安全相關議題及研究成果，並分享災害預防及妥善管理的觀念，進而增進與會人對於製程安全領域之重視，為目前國際該領域最重要、且最具規模的之會議，本屆會議為第 11 屆，舉辦地點位於德州奧斯丁，共近 2000 名相關領域人員參加，其會議主題可概分為 10 主題及 216 個分會議題，因議題眾多，無法參與所有議程，所以僅能選擇參與與我國工業或環境相關之議題，下列為參與議程之摘要範例：

(1) 層流燃燒速度於製程安全中之應用(On the Use of Laminar Burning Velocities in Process Safety)：

摘要：層流燃燒速度通常用確定火災和爆炸之潛在嚴重性，並據此選擇適當之安全措施，減輕其危害，故本研究目的於建立層流燃燒速度之數據，以評估化學製程設施中可燃氣體和蒸氣的爆炸危險性。

(2) 石化工業儲槽區之安全管理(Safety Management of Petrochemical Tank Farms)：

摘要：分析石化工業系統於儲槽安全管理上之缺失，根據所得之結論與魚骨圖，可得到由 12 個一級指標，37 個二級指標所構成之儲槽安全管理評價系統。

(3) 危險品運輸的感知風險與風險管理(Hazardous Material Transportation Perceived Risks & Risk Management)：

摘要：分別就運輸供應鏈、事故率及運輸系統之擴張等主要參數，建立針對危險品運輸的風險評估模型，該風險評估模型可作為業者在制定風險管理計畫之依據。

(4) 碳納米纖維的燃燒及爆炸之相關特性(Combustion and Explosion Related Properties of Carbon Nanofibers)：

摘要：為了確認納米材料燃燒及爆炸之相關參數，選用碳納米作為實驗物質，對其進行燃燒及爆炸之相關測試，以求得其相關參數，如最大壓力、爆燃指數、最小點燃能量、最低爆炸濃度等數據。

(5) 瞭解填充比對熱動力學數據之影響(Understanding the Effect of Fill-Ratio on Thermo-Kinetic Data)：

摘要：其研究目的在於探討填充率對於熱動力學數據所造成之影響，測試合成芳香族單體在不同填充比例時，其溫度及壓力之變化率。

本次與會除了汲取全球製程安全領域最新研究成果及資訊，並於 28 日由國立雲林科技大學環境事故應變中心洪肇嘉主任口頭報告發表之論文『三氯矽甲烷製程火災事故及應變措施(A Case-Study of a Fire Incident of Trichlorosilane Process and Response Measures)』，且中臺科技大學曾若鳴副教授也以海報方式發表綠色塑材使用示差掃描量

熱儀所進行之放熱實驗 (Exothermal test for green plastics materials by DSC) 研究報告(相關摘要如附件 2 及附件 3 所示)。

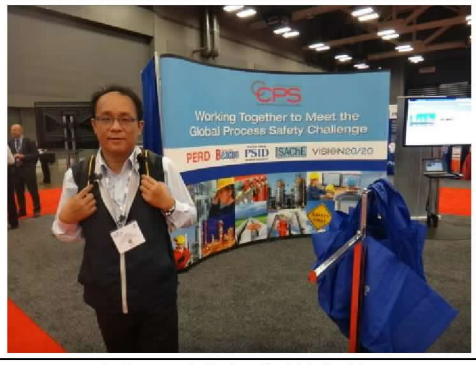
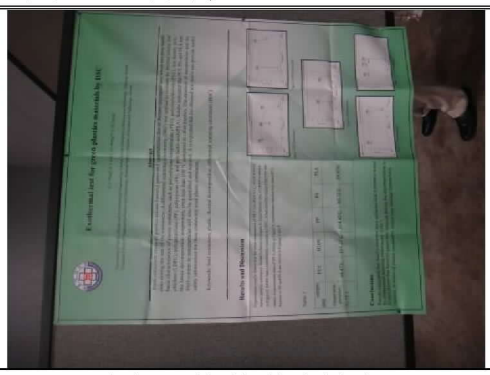
四、建議事項

（一）從高雄氣爆事故後，工業安全議題逐漸受到社會大眾之重視，特別是在石化工業相關製程方面，尤其我國石化工業大多數都集中在同一區域，如林園工業區、大社工業區及麥寮石化專區等，且因受制國土面積之故，有些石化廠場甚至臨近人口密集處，如中油桃園廠及高雄廠，加上我國屬於海島型氣候，設備易因潮濕多鹽環境之故，而有腐蝕及材質劣化等狀況發生，故其潛在風險不容小覷，因此，強化我國在製程安全方面之能量，實為刻不容緩，建議除由政府相關單位持續派遣人員前往歐美先進國家，汲取製程安全發展經驗及相關資訊外，業者及學術單位也應盡量參與，以期能於最短時間內有效地提升我國製程安全之水準，避免再有工安憾事發生。

（二）參與全球製程安全會議此類型之國際會議，除了可深入瞭解國際間於製程安全技術上的發展及相關資訊外，也經由講師分享事故案例，獲取經驗教訓，並藉由發表研究成果之契機，以提升我校於國際間之知名度，另考量到不是每個相關領域人員皆可以出國參加此類型研討會議，所以也建議政府相關單位可每年定期辦理規模較大的研討會，廣邀我國相關領域學者專家擔任講師，並鼓勵各相關領域從業人員參加，如此一來，方能有效營造安全的工作環境，減低製程事故發生之概率 。

五、附錄

附件一、與會照片

<table>
<tr><td colspan="2">104 年 4 月 26-28 日(CCPS 製程安全會議)</td></tr>
<tr><td> 
</td><td>  </td></tr>
<tr><td>圖 1：於主會場留影</td><td>圖 2：海報發表論文</td></tr>
<tr><td>  </td><td> 
</td></tr>
<tr><td>圖 3：於小組議題教室外留影</td><td>圖 4：與洪肇嘉教授、曾若鳴副教授合影</td></tr>
<tr><td colspan="2">104 年 4 月 29.30 日(德州農工大學 Mary Kay O'Connor Process Safety Center)</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>圖 5：MKOPSC 發表之研究報告</td><td>圖 6：與所長 Dr.Sam Mannan 合影</td></tr>
<tr><td>  </td><td> 
</td></tr>
<tr><td>圖 7：製程安全相關心得經驗交流</td><td>圖 8：與研究人員合影</td></tr>
</table>

附件二、會議議程表

SUNDAY, April 26	
8:00 AM – 5:00 PM	GCPS Short Courses
6:30 PM – 8:00 PM	2015 AIChE Spring Meeting and 11th GCPS Opening Reception Location: Conv. Ctr. Exhibit Hall 5
MONDAY, April 27	
7:00 AM	Complimentary Breakfast Location: Conv. Ctr. Ballroom D
8:00 AM	2015 AIChE Spring Meeting and 11th GCPS Opening Plenary Session: **Cheryl Teich** , AIChE President and **June C. Wispelwey**, AIChE Executive Director Location: Conv. Ctr. Exhibit Hall 5
8:30 AM	**Keynote Address: Chemical Engineering – Is this the "Golden Age"?** Presented by **Marvin O. Schlanger**, Chairman of the Supervisory Board of LyondellBasell (Ret.) Location: Conv. Ctr. Ballroom D
9:15 AM	**Coffee Break** Location: Conv. Ctr. Exhibit Hall 5
9:40 AM	**11th GCPS Welcoming Plenary Session** Location: Conv. Ctr. Ballroom D 11th GCPS Introduction and Welcome: **Shakeel Kadri** (Executive Director, CCPS) and **Rainer Hoff** (GCPS Chair) Symposia Introductions: **Samantha Scruggs** (CCPS Chair), **Charles A. Soczek** (LPS Chair), **Karen Study** (PPSS Chair), **Lisa Long** (PSM^2 Chair), **Jatin Shah** (Spotlight Track Chair), **Laura Turci** (RPPS), and **J. Wayne Chastain** (DIERS) Presentation of William H. Doyle Award for LPS Best Paper Award and PPSS Best Paper Award

MONDAY, April 27							
	Process Safety Spotlights	4th Process Safety Management Mentoring (PSM^2)	30th Center for Chemical Process Safety International Conference (CCPS)	17th Process Plant Safety Symposium (PPSS)	49th Annual Loss Prevention Symposium (LPS)	Perspectives on Process Safety from Around the World	Design Institute for Emergency Relief Systems (DIERS)
	Executive Panel: Opportunity Crudes in a Changing Market and Process Safety Considerations	***Guidelines for Effective Implementation of PSM I***	***Committed Culture I***	***Technological Advances and Their Impact on Process Safety***	***Fires and Explosions I***	***Challenges of Japan's Process Safety***	***Effective Scenario Identification for Pressure Relief and Effluent Handling Systems***
	Location: Conv. Ctr. Ballroom E	Location: Conv. Ctr. Ballroom G	Location: Conv. Ctr. Room 18B&C	Location: Conv. Ctr. Room 17A&B	Location: Conv. Ctr. Room 19A&B	Location: Conv. Ctr. Room 18D	Location: Conv. Ctr. Ballroom F
	Co-Chairs: **Tim Olsen** **Jatin Shah**	**Co-Chairs:** **Ravi Ramasamy** **Bruce K. Vaughen**	**Co-Chairs:** **Jim Klein** **Stacey Moore**	**Co-Chairs:** **Sanjeev Saraf** **Vic Edwards**	**Co-Chairs:** **Jerome Taveau** **Derek Miller**	**Co-Chairs:** **Masaki Nakagawa** **Neil Concibido**	**Co-Chairs:** **Peter Howell,** **Wayne Chastain**
10:30 AM	Panelists Include: **Steve Arendt,** ABSG Consulting, Inc. **Carl Weaver,** Baker Hughes **Michael E. Webber,** Webber Energy Group **Terry Higgins,** HART Energy	Development and Implementation of Process Safety and Integrity Management (PSIM) *Frik Febby*	OK so our culture sucks! What Do We Do Now? *Mike Broadnbb,*	Eli Lilly PSM Implementation Case Study *Robert Stankovich*	Suppression of Overpressure during a Vapor Cloud Explosion *Chris Buchwald*	Development and Research Activities of Advanced System Safety Laboratory for Safety Education/Culture *Atsuko Fumoto*	Overpressure Protection of a Pressure Vessel By System Design through the Application of ASME VIII Ug-140 in Lieu of a Relief Device By an Appropriate Choice of Mawp and/or By Safety Instrumented System *Dilip K. Das*
11:00 AM		PSM Implementation at Binh Son Refining & Petrochemical Ltd. - Challenges and Strategies *Vo Hoang Vu*	Leading Indicators – The Corner Stone of a Committed Process Safety Culture *Anne O'Neal*	Autonomous Remote Gas Detection Using Optical Imaging Technology *Jonathan Morris*	Deflagration Load Generator: Repeatability and Application to Test Article Blast Loading *Brad Horn*	Development of Quantitative Hazard Analysis Method for Inherently Safer Chemical Processes *Yuto Mizuta*	Understanding Gas Blowby Scenario Calculations *Nancy Faulk*
11:30 AM		Capital Projects: Process Safety from Conception through Retirement *Robert Wasileski*	Essential Practices for Developing, Strengthening, and Implementing Process Safety Culture *David Moore*	An Optimal Cost-Effective Approach to Sensor Siting for Industrial Facilities *Azar Shahraz*	Safety Critical Items Siting Based on CFD Deterministic Fire Simulations *Rafael Storch*	Development of Best Practices of Process Safety in Japan *Masatoshi Kumamoto*	Can I Use My Cooling Water Header As a Relief Device? *Rahul Raman*
12:00 PM	**Luncheon with Speaker: Wesley E. Lohec – "Challenges in sustaining effective process safety"** Location: Hilton, Sixth Floor, Salon F, G and H						

MONDAY, April 27							
	Process Safety Spotlights	4th Process Safety Management Mentoring (PSM^2)	30th Center for Chemical Process Safety International Conference (CCPS)	17th Process Plant Safety Symposium (PPSS)	49th Annual Loss Prevention Symposium (LPS)	Perspectives on Process Safety from Around the World	Design Institute for Emergency Relief Systems (DIERS)
	Process Safety in LNG and LPG I	*Guidelines for Effective Implementation of PSM II*	*Committed Culture II*	*What You Need to Know about Process Safety for Capital Projects*	*Fires and Explosions II*	*Indicadores De Seguridad De Procesos*	*Relief Considerations for Low Pressure Storage Tanks*
	Location: Conv. Ctr. Ballroom E	Location: Conv. Ctr. Ballroom G	Location: Conv. Ctr. Room 18B&C	Location: Conv. Ctr. Room 17A&B	Location: Conv. Ctr. Room 19A&B	Location: Conv. Ctr. Room 18D	Location: Conv. Ctr. Ballroom F
	Co-Chairs: Trey Morrison, Kathy Pearson, Victor Edwards	Co-Chairs: Ravi Ramasamy, Bruce Vaughen	Co-Chairs: Jim Klein, Stacey Moore	Co-Chairs: Bob Wasileski, Katherine Prem	Co-Chairs: Jerome Taveau, Derek Miller	Co-Chairs: Marcela Recaman	Co-Chairs: Casey Houston Georges Melhem
1:30 PM	CFD Modeling of Large Scale LNG Pool Fires *Fillipo Gavelli*	Implementing PSM: Perspective from a Process Engineer Turned PSM Attorney *D.A. Duggar*	Creating a Culture of Chronic Unease *Laurence Pearlman*	Real World Challenges in Meeting Risk Criteria for Brownfield Projects *Anne Branson*	Hydrogen Jet Vapor Cloud Explosion: Test Data and Comparison with Predictions *J. Kelly Thomas*	Indicadores De Seguridad De Procesos y Observaciones Planificadas De Seguridad *Ricardo Ceskiavikus*	Influence of Overpressure in Pressure Vacuum Safety Valves on Emission Reduction and Explosion Risk Minimization of Atmospheric Storage Tanks *Davide Moncalvo*
2:00 PM	CFD Modeling of LNG Spreading and Atmospheric Dispersion *Anh Bui*	Improving Risk-Based Decision Making By Connecting PSM Systems to Day-to-Day Plant Operations *Mike Neill*	Guidelines for Creating a Process Safety Culture Assessment Tool *Farheen Khan*	Pre-Developing an Asset Integrity Program during the Capital Project *F. Russ Davis*	Prediction of the Mass Flow of Heavy Gas Released from Standard Gas Bottles *Christian Rauchegger*	Choosing Inspections Using Composite Indicators – a New Safety's Regulator Approach in the Brazilian Continental Shelf *Alex Almeida Sr.*	A Comprehensive Guide to Accurately Size Pressure and Vacuum Relief Devices for Atmospheric and Low Pressure Storage Tanks *Steve Streblow*
2:30 PM	Mitigation Effect of High Expansion Foam on LNG Vapor Hazard *Bin Zhang*	Implementation of Process Safety at SABIC-Sinopec Tianjin, China *Homoud Al-Maynouni*	Cracking the Code of Process Safety Culture with Organizational Network Analysis *Elliot Wolf*	Prevention or Mitigation of Major Accident Hazards through Early Identification of Safety Critical Elements *Raminaidu Girada*	Engineered Floating Beads: New Method for Vapor Suppression and Fire Prevention for Flammable Liquids *Joe Riordan*	El Uso De Metricas De PSM y Su Impacto En La Cultura De Seguridad *Alberto E. Vignale*	Overfilling Protection for Weak Tanks *Rahul Raman*
3:00 PM	**Coffee and Networking Break** Location: Conv. Ctr. Exhibit Hall 5						

	Process Safety in LNG and LPG II	*Careers in PSM – Invited Panel*	*Vibrant Management Systems*	*LOPA and the Process Safety Lifecycle*	*Fires and Explosions III*	*Historia De Casos y Lecciones Aprendidas*	*Effectively Deal with Evolving Codes, Standards, and RAGAGEP for Pressure Relief Systems*
	Location: Conv. Ctr. Ballroom E	Location: Conv. Ctr. Ballroom G	Location: Conv. Ctr. Room 18B&C	Location: Conv. Ctr. Room 17A&B	Location: Conv. Ctr. Room 19A&B	Location: Conv. Ctr. Room 18D	Location: Conv. Ctr. Ballroom F
	Co-Chairs: Trey Morrison Kathy Pearson Victor Edwards	Co-Chairs: Jeff Fox Dow Corning	Co-Chairs: Russ Ogle Bernard Groce	Co-Chairs: Christy Blanchard Kimberly Mullins	Co-Chairs: Jerome Taveau Derek Miller	Co-Chairs: Nestor Sposito Luisa Lopez	Co-Chairs: Warren Greenfield Wayne Chastain
3:30 PM	The Human Factors behind Inherently Safer Design of LNG Liquefaction Terminals *David Weimer*	Invited Panel	Recent Process Safety Developments at BASF Ludwigshafen, the World's Biggest Chemical Site *Hans Volkmar Schwarz*	Impacts of Process Safety Time on Layer of Protection Analysis *Geoffrey Barnard*	Risk Ranking Criteria for Catastrophic Vessel Failures Due to Fire Exposure. Vessel Wall Dynamics & Consequence Analysis *Jordi Dunjó*	Un Caso Real En Ocotlan, México: Aplicación De análisis De Causa Raíz y Acciones En Base a Pareto *Hugo Hernadez*	Changes Between API STD 521 6th Ed and 5th Ed Cataloged *Dustin J. Smith*
4:00 PM	The Hazard We Know: Comparing Transportation Risk of LPG and LNG *Ryan J. Hart*		Next Generation Root Cause Investigation and Analysis - Elimination of Repetitive Incidents through Strengthening Management Systems *Kenan Stevick*	Demonstrating Separation and Independence of Automated Systems *Angela. E. Summers*	Observations and Modeling of Off-Site Damage from Large Vapor Cloud Explosion (VCE) Events *Raymond H. Bennett*	Alineación De Causalidad De Accidentalidad Con El Modelo De Gestión ASP *Clara Ines Arbelaez*	Changes Between API STD 520 Part II 6th Ed and 5th Ed Cataloged *John Burgess*
4:30 PM	Experimental Study on Propane Jet Fire Hazards: Thermal Radiation *Bin Zhang*		Internal Auditing of Process Safety - a False Sense of Security? *Lee Allford*	LOPA - More Observations from the Originators *William Bridges & Art Dowell*	Risk Assessment for a Gas and Liquid Hydrogen Fueling Station *Jo Nakayama*	Incidentes Ocurridos En La Industria Del Gnl *Juan G. Haitzaguerre*	Evolution of Relief Sizing at an Operating Company *Michael J. Maness*
5:00 PM	**GCPS Electronic and Paper Poster Session and Cocktail Reception,** Co-Chairs: Peter Lodal, Jennifer Mize, Revonda Tew, Jack Chosnek Location: Conv. Ctr. Exhibit Hall 5						

TUESDAY, APRIL 28							
	Process Safety Spotlights	4th Process Safety Management Mentoring (PSM^2)	30th Center for Chemical Process Safety International Conference (CCPS)	17th Process Plant Safety Symposium (PPSS)	49th Annual Loss Prevention Symposium (LPS)	Perspectives on Process Safety from Around the World	Design Institute for Emergency Relief Systems (DIERS)
	Human Factors I	*The Day PSM Hit Home I*	*Responsible Collaboration*	*Process Safety Management Audits*	*Combustible Dusts Hazards*	**Latest Developments in Process Safety in China I**	*Initial Design and Managing Ongoing Operation of Pressure Relief Systems*
	Location: Conv. Ctr. Ballroom E	Location: Conv. Ctr. Ballroom G	Location: Conv. Ctr. Room 18B&C	Location: Conv. Ctr. Room 17A&B	Location: Conv. Ctr. Room 19A&B	Location: Conv. Ctr. Room 18D	Location: Conv. Ctr. Ballroom F
	Co-Chairs: **Tim Murphy** **Amanda Chapman**	**Co-Chairs:** **Michael Morris** **Scott Haney**	**Co-Chairs:** **Jerry Forest** **John Wincek**	**Co-Chairs:** **Jim Thompson** **Donnie Carter**	**Co-Chairs:** **Michael Moosemiller** **Henry L. Febo**	**Co-Chairs:** **Dongfeng Zhao** **Yi Liu** **Meng Yi-fei**	**Co-Chairs:** **Daniel Nguyen** **Wayne Chastain**
8:00 AM	The Psychology of Decision Making in Process Hazard Analysis *Paul Baybutt*	We Learn and Share but We Don't Get Better! Time for Huaa *Mike Bearrow*	The Evolution of Process Safety Standards and Legislation Following Landmark Events - What Have We Learnt? *Trish Kerin*	API Process Safety Site Assessment Program - Promoting a Culture of Process Safety *Andrew Broadbent*	A Theoretical-Based and Generalized Method for Dust and Gaseous Deflagration Vent Sizing *Hans K. Fauske*	Safety Management of Petrochemical Tank Farms *Dongfeng Zhao*	Overlooked Factors in Pressure Relief Systems Design *Steve Streblow*
8:30 AM	Advanced Procedure Research Study - Applying Human Factor Principles to Procedure Presentation and Design *Elliott Lander*	Young, Inexperienced, and Learning: How Process Safety Hit Home While Attending a Conference *Ashley M. Weckwerth*	Industrial Partnerships and PSM Standards in Canada *Adrian Pierorazio*	Process Safety Auditing: Thinking Beyond Compliance *Stephen Gill*	Combustion and Explosion Related Properties of Carbon Nanofibers *Jiaqi Zhang*	Study on Separation Distance Determination of LNG Filling Station on Water *Gujun Wan*	Will It Really Make That Much of a Difference? Broad Effects of Operational Changes on Relief System Design *Marie Baker &Teddy Bucher*
9:00 AM	Examination of Events That Occur during an Alarm Flood - Their Impact on Safety and Proper Corrective Action *Darwin Logerot*	The Road Between Reality and Philosophy (aka HSE Success within an Engineering Organization) *Rao Akula*	AIChE/CCPS White Paper: Recommendations for Establishing Process Safety Investigation Boards *Scott Berger*	Ignorance Is No Defense…Audit Management Best Practices *Mike Bearrow*	Unconfined Deflagration Testing for the Assessment of Combustible Dust Flash Fire Hazards *Michael C. Stern*	A Case-Study of a Fire Incident of Trichlorosilane Process and Response Measures *Jao-Jia Horng*	Auditing Relief Systems Design Basis - Best Practices *Neil Prophet*
9:30 AM	**Coffee and Networking Break** Location: Conv. Ctr. Exhibit Hall 5						

	Human Factors II	*The Day PSM Hit Home II*	*Disciplined Adherence to and Harmonization of Standards*	*Best Practices in Process Safety and Risk Management I*	*Facility Siting Consequence Analysis I*	*Latest Developments in Process Safety in China II*	*Development of Engineering Analysis Methods and Tools for Pressure Relief Valve Stability and Relief Pipe Reaction Forces*
	Location: Conv. Ctr. Ballroom E	Location: Conv. Ctr. Ballroom G	Location: Conv. Ctr. Room 18B&C	Location: Conv. Ctr. Room 17A&B	Location: Conv. Ctr. Room 19A&B	Location: Conv. Ctr. Room 18D	Location: Conv. Ctr. Ballroom F
	Co-Chairs: **Tim Murphy** **Amanda Chapman**	**Co-Chairs:** **Alan C. Brackey** **Brenton L. Cox**	**Co-Chairs:** **Marty Timm** **John Herber**	**Co-Chairs:** **Sandipan Laskar** **Mervyn Carneiro**	**Co-Chairs:** **Ronald J. Willey** **Jean-Paul Lacoursiere**	**Co-Chairs:** **Dongfeng Zhao** **Yi Liu** **Meng Yi Fei**	**Co-Chairs:** **Marc Levin,** **Georges Melhem**
10:15 AM	Procedural Safeguard Reliability *Sean J. Dee*	2007 Valero McKee Refinery Fire *Shannon Gillespie*	How Does "Deviation" Become "Normal"? *Jennifer Mize*	Using PHA As a Framework for Effectively Addressing Evolving PSM/RMP Guidelines, Such As Damage Mechanism Hazard Reviews *Steven T. Maher*	Modelling Liquid Fuel Cascades with Open Foam *Jennifer X. Wen*	Case Analysis of Oil and gas Pipeline Deflagration Accidents *Shi Li*	Dynamics of Direct Spring Operated Prv's with Inlet Piping in Gas Service *Kenneth Paul & Alan Champneys & Csaba Hos*
10:45 AM	Changing Demographics: Preserving Safety and Increasing Performance *Denise Brooks*	1987 Celanese Pampa Butane Vapor Cloud Explosion *Jack Mc Cavit*	The Changing Tide of US Process Safety/Risk Management Regulations - How CCPS Risk Based Process Safety and Vision 20/20 Concepts Can Harmonize Future Requirements *Steve Hawkins*	A Case Study to Show How Bow-Tie Analysis Can be Used As an Effective Communication Tool in Risk Assessments *Varsha Pedhireddy*	Consequence Modeling of Dynamic Source Terms *Michael D. James*	Research of Process Safety Management Platform Architecture Based on Internet of Things *Guoliang Yang*	Effect of Body Bowl Choking on Pressure Relief Valve Stability *Hisao Izuchi*
11:15 AM	Human and Organizational Factors Assessment and Their Use As Potential Safety Barriers *Mehmood Ahmad*	"Let Me Tell You……." The impact of Eastman's Aniline Plant Explosion on Process Safety Awareness *Pete Lodal*	PSM/RMP Modernization Programs in California - Current Initiatives and What's on the Horizon *Steven Maher*	The Lifecycle of a Process Safety Recommendation *Benjamin Poblete*	Toxicity-Hazard Index and the "Infinite Point" *Richard Prugh*	Application and Optimization of Quantitative RBI on Equipment of Station Yard *Shuang Liang*	Modeling and Computation of Reaction Forces on Relief Piping during Depressurization *Jens Conzen & Gabe Wood*
11:45 AM	**Luncheon with Speaker: Shakeel Kadri – Process Safety Culture – an organizational view** Location: Hilton, Sixth Floor, Salon F, G and H						

Tuesday, April 28							
	Process Safety Spotlights	4th Process Safety Management Mentoring (PSM^2)	30th Center for Chemical Process Safety International Conference (CCPS)	17th Process Plant Safety Symposium (PPSS)	49th Annual Loss Prevention Symposium (LPS)	Perspectives on Process Safety from Around the World	Design Institute for Emergency Relief Systems (DIERS)
	Process Safety in Upstream Operations I	*PSM Mastery I - Specific examples of the four pillars of risk based process safety*	*Enhanced Application of Lessons Learned*	*Best Practices in Process Safety and Risk Management II*	*Facility Siting Consequence Analysis II*	**A Importância Da Segurança De Processos Para o Crescimento e Perpetuidade Da Industria Quimica No Brasil**	*How to Measure the Right Data for Reaction Systems*
	Location: Conv. Ctr. Ballroom E	Location: Conv. Ctr. Ballroom G	Location: Conv. Ctr. Room 18B&C	Location: Conv. Ctr. Room 17A&B	Location: Conv. Ctr. Room 19A&B	Location: Conv. Ctr. Room 18D	Location: Conv. Ctr. Ballroom F
	Co-Chairs: Cheryl Grounds Robert Benedetti	**Co-Chairs: Brian Dickson Ruifeng "Ray" Qi**	**Co-Chairs: Andrew Goddard Swati Umbrajkar**	**Co-Chairs: Sandipan Laskar Mervyn Carneiro**	**Co-Chairs: Ronald J. Willey Jean-Paul Lacoursiere**	**Co-Chairs: Americo Diniz Carvalho Neto,**	**Co-Chairs: Peter Ralbovsky Wayne Chastain**
1:30 PM	Safety Case VS SEMS: Are They Really All That Different? an Operator's Perspective *Brent Dunagan*	Sherlock Holmes, Why Trees, Bow Ties, and Investigating Process Incidents, *James Klein*	Dow Learnings & Actions from the Deepwater Horizon Accident *John Champion*	Problems with HAZOPs and How to Correct Them *Howard Duhon*	Discharge and Dispersion for Large-Diameter CO2 Releases: Experimental Data and Data Review *Jock Brown*	Panel Session "Disciplina Operacional: Indicador De Cumprimento Das Rotinas" *Maria C. Saraiva,*	Phi Correction for Exothermic Gas Generation Rate *Guibing Zhao*
2:00 PM	A Modern Well HAZOP Approach *Yaneira Saud*	Ten Commandments of Risk Based Process Safety *Robert Rosen*	Three Decades after Bhopal: What We Have Learned about Effectively Managing Process Safety Risks *Bruce Vaughen*	Improving Process Safety Performance *James Klein*	Quantitative Collision Risk Analysis for Offshore Installations . *Susan Y. Guo*		Calorimetric Study of the Exothermic Decomposition of Dimethyl Sulfoxide *B. Todd Brandes*
2:30 PM	To Safely Go Where No Man Has Gone before: Exploring and Producing with Process Safety *Mike Broadribb*	Developing Credible Scenarios for a PHA, *Nestor Paraliticci*	HUAA…When Local Learning and Casual Sharing Is Not Enough *Mike Bearrow*	Good till the Last Drop – How Much Is Too Much Valve Leakage? *Timothy J. Wagner*	Calculating Facility Siting Study Leak Sizes - Applications of the Maximum Design Leak (MDL) Approach *Gary A. Fitzgerald*		Relief System Sizing for Runaway Chemical Reactions - a Simple Comprehensive Approach *Charles Kozlowski*
3:00 PM	**Coffee and Networking Break** Location: Conv. Ctr. Exhibit Hall 5						

Tuesday, April 28						
	Process Safety Spotlights	4th Process Safety Management Mentoring (PSM²)	30th Center for Chemical Process Safety International Conference (CCPS)	17th Process Plant Safety Symposium (PPSS)	49th Annual Loss Prevention Symposium (LPS)	Design Institute for Emergency Relief Systems (DIERS)
	Process Safety in Crude Oil Transportation	***PSM Mastery II - Specific examples of the four pillars of risk based process safety***	***Intentional Competency Development***	***Getting the Most from Your Process Safety Near Misses I***	***Facility Siting and Consequence Analysis III***	***Practical Methods for Two Phase Flow Estimates***
	Location: Conv. Ctr. Ballroom E	Location: Conv. Ctr. Ballroom G	Location: Conv. Ctr. Room 18B&C	Location: Conv. Ctr. Room 17A&B	Location: Conv. Ctr. Room 19A&B	Location: Conv. Ctr. Ballroom F
	Co-Chairs: **Dan Miller** **Bernard Groce**	**Co-Chairs:** **Nicholas N. Cristea, Faraz Khan, Siemens**	**Co-Chairs:** **Lizbeth Cisneros** **Don Connolley**	**Co-Chairs:** **John Champion** **Colin (Chip) Howat III**	**Co-Chairs:** **Ronald J. Willey** **Jean-Paul Lacoursiere**	**Co-Chairs:** **Davide Moncalvo** **Georges Melhem**
3:30 PM	Human Factors Considerations: Midstream Process Safety Integration *Denise Brooks*	The Three Main Causes of Major Process Safety Accidents *William Bridges*	Know Your Target Audience - Building Leader Competency in Process Safety *Joan Bruney*	Are We Really Learning from Incidents? a Discussion of Best Practices and Common Mistakes *Laurence Pearlman*	Development of Quantitative Financial Risk Tolerance Criteria *Elliot Wolf*	Choked and Near-Choked Real Gas and Two-Phase Flow Analysis of Discharge Piping *Leonid Korelshteyn*
4:00 PM	Overcoming the Process Safety Challenges in Midstream Pipeline Operations *Juan E. Contreras*	Efficiency and Quality Improvements for Better PHAs *John Alderman*	Bridging Hazard Recognition Knowledge and Competency for Process and Occupational Safety *Michael Fleming*	Praxair's Process Safety Metric Program and Use if Large Data *Dan Rathgeber*	Blast Resistant Design and Retrofit of Buildings at Petrochemical Facilities *Paul Summers*	Models for Multi-Phase & Single-Phase Flow in Pressure Relieving System Using Bernoulli Integration *Freeman Self*
4:30 PM	Invited papers	Surviving an OSHA PSM National Emphasis Program Audit *James Johnstone*	Making Sense of Reason: A Review of the Message James Reason Put Forward for a Re-Think of Safety Management Principles *Brian Dickson*	Systematic Approach to the Root Cause of Process Safety Events at Equion Energia Ltd *Ignacio Alonso*	Thermal Radiation Analysis from Large Pool Fires in an Existing Atmospheric Storage TANK Farm to Estimate the Maximum FIRE Water Demand *Marco-Antonio Medrano*	How to Size a Rupture Disk Vent Line for Two-Phase Gas/Liquid Flow Based on Current Engineering Practices *Juergen Schmidt*

Wednesday, April 29					
	Process Safety Spotlights	30th Center for Chemical Process Safety International Conference (CCPS)	17th Process Plant Safety Symposium (PPSS)	49th Annual Loss Prevention Symposium (LPS)	Design Institute for Emergency Relief Systems (DIERS)
	Big Data Analytics Panel I	*Enhanced Stakeholder Knowledge*	*Application of Risk Analysis I*	*Process Safety in Upstream Operations II*	*New Developments in Fire Exposure and Depressuring Systems Design and Evaluation*
	Location: Conv. Ctr. Ballroom E	Location: Conv. Ctr. Room 18B&C	Location: Conv. Ctr. Room 17A&B	Location: Conv. Ctr. Room 19A&B	Location: Conv. Ctr. Ballroom F
	Co-Chairs: Jatin Shah Eric Peterson Leo Chiang	Co-Chairs: Brad Newman Ryan Hart	Co-Chairs: Phil M. Myers Mike Broadribb	Co-Chairs: Cheryl Grounds Robert Benedetti	Co-Chairs: Michael Maness, Georges Melhem
8:00 AM	Panelists Include: **Ted Wasserman**, Tableau Software **Lyold F. Colegrove**, The Dow Chemical Company **Deborah Grubbe**, Operations and Safety Solutions, LLC **Michael Firstenberg**, Waterfall Security Solutions	Enhanced Stakeholder Knowledge through the Mary Kay O'Connor Process Safety Center *Sam Mannan*	Dependent, Independent and Pseudo-Independent Protection Layers in Risk Analysis *Hui Jin*	CFD Analysis and Field Tests of Gaseous Leaks with 80% CO2 on Offshore Facilities *Jianxin Lu*	Modification of the Diers Fire Exposure Test Methodology *Peter J. Ralbovsky IV*
8:30 AM		Advancing the Imperative for Process Safety Education in Engineering Curricula *Gord Winkel*	The Societal Risk of Process Industry Based on Integrated Assessment of Quantitative Risk Analysis (QRA) and Risk-Based Inspection (RBI) Methodologies *Vinicius Esteves*	Case Study: Laser-Based Gas Detection Technology and Dispersion Modeling Used to Eliminate False Alarms and Improve Safety Performance on Terra Nova FPSO *Rajat Barua*	Guidance for Sizing Relief Devices That Are Installed below Liquid Level in an External Fire *Rahul Raman*
9:00 AM		Dow Laboratory Safety Academy Promotes Safety Mindset in Future Chemical Workforce *Marabeth Holsinger*	Addressing Issues in the Design and Use of Risk Matrices in Process Safety *Paul Baybutt*	Escape Routes Selection for Offshore Units Based on Quantitative Risk Assessment Results *Mariana B. Bardy*	Mechanical Integrity Considerations in LNG Depressurization *Daniel Nguyen*
9:30 AM	**Coffee and Networking Break** Location: Conv. Ctr. Exhibit Hall 5				

	Process Safety Spotlights	17th Process Plant Safety Symposium (PPSS) *Track II*	30th Center for Chemical Process Safety International Conference (CCPS)	17th Process Plant Safety Symposium (PPSS)	49th Annual Loss Prevention Symposium (LPS)	Design Institute for Emergency Relief Systems (DIERS)
	Big Data Analytics Panel II	***Getting the Most from Your Process Safety Near Misses II***	***CCPS Featured Projects – Vision 20/20***	***Application of Risk Analysis II***	***Reactive Chemicals***	***Unique Aspects of Pressure Relief Systems Design and Evaluation for Reaction and Flare Systems***
	Location: Conv. Ctr. Ballroom E	Location: Conv. Ctr. Ballroom G	Location: Conv. Ctr. Room 18B&C	Location: Conv. Ctr. Room 17A&B	Location: Conv. Ctr. Room 19A&B	Location: Conv. Ctr. Ballroom F
	Co-Chairs: Jatin Shah Eric Peterson Leo Chiang	Co-Chairs: J ohn Champion Colin (Chip) Howat III	Co-Chairs: Jeff Fox Eric Freiburger	Co-Chairs: Phil M. Myers Mike Broadribb	Co-Chairs: Kathleen A. Kas John F. Murphy	Co-Chairs: Ken Kurko Wayne Chastain
10:15 AM	Panelists Include: **Ted Wasserman**, Tableau Software **Lyold F. Colegrove**, The Dow Chemical Company **Deborah Grubbe**, Operations and Safety Solutions, LLC **Michael Firstenberg**, Waterfall Security Solutions	Process Safety Opportunities for the Refining and Petrochemical Industries *Jerry J. Forest*	Vision 20/20 Panel Facilitators: Jack McCavit & Cheryl A. Ground	New Building Siting Using Risk-Based Approach *John N. Dyer*	Chemical Incompatibility Matrices *Michelle Murphy*	Statistical Review of Runaway Reaction Kinetics *Enio Kumpinsky*
10:45 AM		A Miss, Amiss, a Near Miss *John Wincek*		Holistic Approach to Barrier Integrity *San Burnett*	Understanding the Effect of Fill-Ratio on Thermo-Kinetic Data *Swati Umbrajkar*	Emergency Relief System Design for Reactive System Using Direct Scale-up Method *Surendra Singh*
11:15 AM		Lesson Learnt and Process Safety of Ammonia Urea Plant *Muhammad Haider*		Identifying and Quantifying Major Hazard of Construction Lifting Activities *Akhmad Harmantoro*	Lending Industrial Experience through Reactive Hazard Examples in University Safety Instruction *Henry T. Kohlbrand*	Engineering Safe Pressure Relief for Existing Flare Systems *Jay Riha & Steve Streblow*
11:45 AM	**Spring and GCPS Joint Luncheon with Speaker: Al Sacco – You think you have safety concerns!! The flight of STS-73** Location: Hilton, Sixth Floor, Salon F, G, H, J and K					

	Case Histories and Lessons Learned – GCPS Joint Session Location: Conv. Ctr. Ballroom D Co-Chairs: Fred Henselwood, Kathy Shell and Kendall Werts
1:30 PM	Fire from the Cascading Failure of an Oxygen Supply System *Delmar Morrison & Vijay Kumar*
2:00 PM	Lessons Learned from an Incident at a Cryogenic Gas Processing Facility *Adrian Pierorazio*
2:30 PM	The Normalization of Deviation Leads to a Significant Process Safety Incident *Steven Barre*
3:00 PM	**Break**
3:15 PM	U.S. Chemical Safety Board's Final Investigation Report on the Chevron Richmond Refinery Rupture and Fire *Lauren Grim & Mark Wingard*
4:00 PM	Bhopal 30 Years Later *Ronald J. Willey & Dan Crowl*
4:45 PM	**GCPS Concluding Remarks**

A Case-Study of a Fire Incident of Trichlorosilane Process and Response Measures

Horng Jaojia[1] , Liao Kuangyu[2], Liou kehun[1], Yuan Paochiang[3]

1. Department of Safety, Health, and Environmental Engineering, National Yunlin University of Science and Technology, Taiwan.
2. Graduate School of Engineering Science and Technology, National Yunlin University of Science and Technology, Taiwan.
3. College of Science, Engineering and Technology, Jackson State University, Mississippi, US.

Prepared for Presentation at
American Institute of Chemical Engineers
2015 Spring Meeting
11th Global Congress on Process Safety
Austin, Texas
April 27-29, 2015
UNPUBLISHED

A Case-Study of a Fire Incident of Trichlorosilane Process and Response Measures

Horng Jaojia[1] , Liao Kuangyu[2], Lioukehun[1], Yuan Paochiang[3]

1. Department of Safety, Health, and Environmental Engineering, National Yunlin University of Science and Technology, Taiwan.
2. Graduate School of Engineering Science and Technology, National Yunlin University of Science and Technology, Taiwan.
3. College of Science, Engineering and Technology, Jackson State University, Mississippi, US.

Keywords: Tricholorsilance, fire distinguisher, liquid nitrogen

Abstract

There was a fire occurring of a overheating Trichlorosilane (TCS) reactor in a solar panel manufacture plant in 2011. Although no injury happened, the leak-out TCS caught fire and produced acid plume creating great concerns for responding governmental agencies, nearby general public and news media. Since TCS is an important raw material for petrochemical, semi-conductor, and solar panel manufactures, its hazardous properties of low flash point, easy combustible, water-reactive, and acid-producing have created many difficulties in response as its leaking out.

All incidents of chlorosilanes (CS) materials would produce large acid plume as large amount of leaking lead to burning. The fires could not be controlled by water due to their water-reactive properties. When other distinguishers such as foams were applied, the uses of water jetty were essential to cover the burning surface and to reduce the acid plume. The best practice was to continuously put foams on top until it burn out. However, this action would prolong the response and could not control the damages well. Therefore, the prevention of acid plume and the correct use of foams were essential for fire response to CS and TCS.

Upon our field tests, we found that no fire distinguishing was observed for powder, carbon dioxide, water and halon on small-scale fire (3 kg) of TCS. All continuously produced acid plume and some even reacted to form harmful byproducts. The fires would be distinguished as the application of foams and liquid nitrogen. The effective practices were that 6% mixed middle-expansion foams with 15 cm of covering height and liquid nitrogen with volume (ml) of 177+0.287*(TCS volume). However, two methods adopted totally different principles for fire extinguishing.

Our study indicated that when using liquid nitrogen to effectively distinguish the TCS fire was due to it adsorbed reaction heat of burning and stop the reaction. We further prove that no property change of TCS after our application. This application was safe and was different from applying foams that water actually reacted with TCS and producing dangerous hydrogen gas. This finding might be used in future development for cooling agency for CS fire application.

附件四、海報發表論文(文章摘要)

Exothermal test for green plastics materials by DSC

C. J. Wang[a], K.Y. Liao[b], J.J. Horng[b]*, J. M. Tseng[a]

[a]Department of Safety, Health and Environmental Engineering, Central Taiwan University of Science and Technology, Taichung, Taiwan
[b]Graduate School of Engineering Science and Technology, National Yunlin University of Science and Technology, Taiwan

Abstract

Food containers made of plastics release harmful gases and nanoparticles due to thermal decomposition, which can pose health risks during use of the containers. Differential scanning calorimetry (DSC) was applied to evaluate the thermal kinetic and basic characteristics of plastic containers, such as polyethylene terephthalate (PET), low density polyethylene (LDPE), polypropylene (PP), polystyrene (PS), and poly lactic acid (PLA). Results indicated that PET, PS, and PLA had the lower decomposition temperature, even less than 100 ℃ compared to other plastics. It is expected that the obtained test results can provide useful safety information for these commonly used plastic containers.

Keywords: containers, plastic, differential scanning calorimetry (DSC), thermal kinetic, safety information

*Corresponding author: *E-mail*: horngjj@yuntech.edu.tw (J. J. Horng)