

出國報告(出國類別：其他-國際會議)

參加第四屆 CCPS 中國製程安全會議

服務機關：國立雲林科技大學環境事故應變諮詢中心

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摘要

本次出國行程為赴中國大陸青島參加第 4 屆美國化工製程安全中心(CCPS)中國製程安全會議，本年度舉辦時間由 105 年 6 月 1 日至 105 年 6 月 3 日，有來自中國、台灣、美國、韓國、挪威及新加坡等多個國家，近 300 位專家學者與會，本次會議共分為 14 個主題報告，28 個分會報告，此次與會之目的為汲取美中台相關領域之專家學者於製程安全最新研究成果及實務經驗等成果，此外，並發表論文” An Evaluation of Emergency Response Database for Hazardous Material Incidents ”，另國立雲林科技大學毒災中心組長易逸波副教授也發表針對高雄氣爆事故進行災情調查統計，並以 FLACS 軟體對該事故進行初步探討之研究論文” A Preliminary Study of Explosion Simulation for Underground Pipeline Release”而待回國後，將陸續把與會所得陸續整理成相關資訊，提供我國相關領域之政府單位及業者酌參。藉由與中國石化產業之安全專家相關研究發表及實務交流，可瞭解目前中國石化產業之安全領域發展情況，並瞭解其市場之規模與需求。

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一、目的

本次出國考察參與研討會之目的：

第 4 屆美國化工製程安全中心(CCPS)中國製程安全會議於中國青島康大豪生大酒店舉辦，該會議主題為「製程安全在中國」，本次與會除了汲取美中台相關領域之專家學者於製程安全最新研究成果及實務經驗等成果外，並於研討會上投稿發表” An Evaluation of Emergency Response Database for Hazardous Material Incidents ”研究成果，並由國立雲林科技大學環境事故應變中心洪肇嘉主任進行口頭報告，另國立雲林科技大學毒災中心組長易逸波副教授也發表針對高雄氣爆事故進行災情調查統計，並以 FLACS 軟體對該事故進行初步探討之研究論文” A Preliminary Study of Explosion Simulation for Underground Pipeline Release”。

二、 過程

本人於 6 月 1 日至 6 月 3 日前往中國青島參與 4th CCPS 研討會，本次研討會於青島康大豪生大酒店舉辦，該會議由中國化學品安全協會、中國石油大學（華東）、美國化學工程師協會化工過程安全中心主辦，美國化學工程師協會化工過程安全中心中國分部承辦，是「以製程安全在中國」為其主題，近 300 位與會專家學者分別來自中國、臺灣、美國、韓國、挪威、新加坡、巴基斯坦等多個國家，會議就製程安全管理(Process Safety Management,PSM)在中國的發展、全球製程安全展望、國內外 PSM 要素實施經驗及技術、製程安全法律法規及標準、製程安全技術、後果分析及風險評估方法、緊急應變及規劃、事故調查及經驗分享、化學工業環境風險評估、保護層分析法(Layer protection analysis,LOPA)和安全完整性等級 (Safety Integrity Level,SIL)等 10 個面向，進行廣泛及深入之學術探討，研討會期間，共舉行 14 場主題報告、28 場分會報告。

開幕式後 CCPS 中國分部主任趙東風教授首先就「關於城市型煉化企業可持續發展的思考」為研究之報告進行演講，內容主要探討城市周邊或內部存在化工產業之優劣評估策略，對當前應對城市型煉化之不同策略進行了研究分析，得到了當前各種策略的主要優點及不足，趙東風教授最後提出應基於風險/成本的綜合評估結果進行決策，並對適用於之風險綜合分析關鍵技術進行了討論，而該研究報告也恰巧反應我國因國土面積要素，所以工業區多鄰近城市之現況，更是值得吾人深入探討，以台灣國內為例：台灣化學股份有限公司彰化廠被要求停工遷廠之案例，究竟是『化工圍城』或者是『城圍化工』，實在需另我們深思。

藉由會議中專家所發表之研究報告及後續的交流討論，有效增進於製程安全領域之學識，並瞭解與會各國於製程安全上之發展，也可以作為反思我國不足處之參照。因研討會議題眾多，所以本人參加與我國石化產業、事故緊急應變及重大事故案例分析等相關研究議題，如液態天然氣儲槽池火之多米諾效應風險評估(Risk Analysis of Domino Effect from LNG Tank Pool Fire)、基於脆弱性的液化天然氣加油站之風險評估(Risk Assessments of LNG Filling Stations Based on Vulnerability)、基於 ANP-Fuzzy 之危險化學品港區應變管理之脆弱性評估(Vulnerability Assessment for Emergency Management in port of hazardous Chemicals Based on ANP-Fuzzy)、基於 safeti 的點火源對城市型煉廠的風險影響研究(Research On The Risk Of Urban-refinery Influenced By Ignition Source

Based On Safeti)及硝酸胍之熱危險性的差示掃描量熱法研究(A Study of Thermal Hazards of Guanidine Nitrate by Differential Scanning Calorimeter)等討論議題，本人另與洪肇嘉教授共同發表” An Evaluation of Emergency Response Database for Hazardous Material Incidents”，並由洪肇嘉特聘教授以此議題進行專題演講。

三、心得：

一、 4th CCPS 中國製程安全會議研討會相關議題研討及成果發表

本年度中國製程安全會議 (Global process safety Conference) 為第 4 屆，會議地點位於中國青島的康大豪生大酒店，其主辦單位是中國化學品安全協會、中國石油大學(華東)、美國化學工程師協會化工過程安全中心，承辦單位為美國化學工程師協會化工過程安全中心中國分部，該會議由 2013 年辦理至今，已是中國製程安全領域一年一度重要之研討會，今年約 300 位與會人士分別來自中國、臺灣、美國、韓國、挪威、新加坡、巴基斯坦等國家，皆為各國製程安全領域相關人員，該研討會主要就製程安全管理 (Process Safety Management, PSM) 在中國的發展、全球製程安全展望、國內外 PSM 要素實施經驗及技術、製程安全法律法規及標準、製程安全技術、後果分析及風險評估方法、緊急應變及規劃、事故調查及經驗分享、化學工業環境風險評估、保護層分析法 (Layer protection analysis, LOPA) 和安全完整性等級 (Safety Integrity Level, SIL) 等 10 個面向技術發展及危害管理等新知，讓與會人士都能進行廣泛及深入之學術探討，研討會期間，共舉行 14 場主題報告、28 場分會報告，另因研討會議題眾多，僅列出部分參與議程之摘要範例：

(1) 液態天然氣儲槽池火之多米諾效應風險評估 (Risk Analysis of Domino Effect from LNG Tank Pool Fire)：

概述：液化天然氣作為一種沸騰液體儲存形式，於儲存、運輸和利用的過程中一旦發生洩漏，容易形成液池，引發池火，大面積的池火不僅給滅火帶來較大困難，而且長時間熱輻射會給周圍設施帶來損壞，從而發生連鎖事故，即為多米諾效應。

本研究採用 CFD 軟體 FLACS，計算液化天然氣儲槽區在不同場景下，發生液池洩漏後，火災之熱輻射影響，並進一步利用 probit 模型計算不同場景下火災熱輻射的多米諾效應，得知附近液化天然氣儲槽的失效概率，據此制定安全防護措施，以有效抑制多米諾效應的發生，減少事故發生後之災損。

(2) 基於脆弱性的液化天然氣加氣站之風險評估 (Risk Assessments of LNG Filling Stations Based on Vulnerability)：

概述：該研究主要是從承災體的角度對區域脆弱性進行研究，結合液化天然氣加氣站之特點、承災體系構成以及主要事故類型的能量釋放形式，基於脆弱性分析模型從人員、設施、環境暴露性和易損性的角度，對液化天然氣加氣站進行綜合脆弱性

評估。

該脆弱性分析研究，討論了因承載體人員、設施和環境的固有脆弱性屬性致災因數對承載體造成的傷害和損失，並進而於對影響因素充分剖析之基礎上，採用層次分析法對指標權重進行了參數確認，同時採用多指標權重之模糊綜合評估得到加氣站的脆弱性等級分佈，最終可根據致災因素使得對液化天然氣加氣站的風險評估更為客觀和準確，為風險的控制和預防提供了參考方向。

(3) 基於 ANP-Fuzzy 之危險化學品港區應變管理之脆弱性評估(Vulnerability Assessment for Emergency Management in port of hazardous Chemicals Based on ANP-Fuzzy)：

概述：本研究在分析化學工業園區當前現狀和事故特色之基礎上，綜合考慮影響園區事故應變能力之各類因素，構建相對全面的化學工業園區事故應變能力評估指標體系，並運用網路層次分析法(Analytic Network Process, ANPA)確定各指標權重，進而採用模糊綜合評價的方法建立園區應變能力評估模型。

網路層次分析法(ANP)考慮了各指標之間的影响和回饋關係，因此而能夠提高對化學工業園區應變能力評價的可靠性和準確性，從而對化學工業園區改進事故應變能力建設提供一定之參考。

(4) 基於 safeti 的點火源對城市型煉廠的風險影響研究(Research On The Risk Of Urban-refinery Influenced By Ignition Source Based On Safeti)：

概述：城市型煉廠指的是已經存在之石化工業在建廠之初位於相對偏僻的環境中，但由於城市發展，導致煉廠周邊存在越來越多的公共居住區，如學校、醫院、賓館等人員集中之敏感區域，有的煉廠甚至與上述敏感區域的衛生防護距離已經無法滿足相關法規和標準之要求。

而該研究對比中國及各國點火源概率之研究方法，結合實際情況，提出適合城市型煉廠點火概率的計算方法，然後採用數值模擬的方法來研究城市型煉廠點火源分佈對城市型煉廠的風險影響，一般而言，點火源類型可分為以下三類：產生能量的方式：如電器火花(電能轉變為熱能)、撞擊與摩擦(機械能變為熱能)、絕熱壓縮(機械能變為熱能)及化學反應放熱(化學能變為熱能)等。火源性質：如機械火源、熱火源、電火源及化學火源等所處位置分類：如廠內點火源(一般可預測和控制)及廠外點火源(一般難以預測和控制)。

最後該研究以中國某城市型煉廠為例，在保持其他影響因素不變的情況下，改變點火源的分佈位置，使用 DNV 的 Safeti 軟體對其風險進行類比計算，總結出點火源分

佈對城市型煉廠風險影響的規律。

(5) 硝酸胍之熱危險性的差示掃描量熱法研究(A Study of Thermal Hazards of Guanidine Nitrate by Differential Scanning Calorimeter)：

概述：硝酸胍為白色結晶粉末或顆粒狀，是一種有機強鹼，氧化性強之化學品，為醫藥、農藥、染料及顏料產業不可或缺之重要中間體，但硝酸胍是典型的硝酸鹽類反應性物質，熱敏感度高，且性質也極不穩定，故其特性同時也提高了於製造、儲存和運輸時之風險。本研究即是探討硝酸胍利用差示掃描量熱法(Differential Scanning Calorimeter,DSC)測定在不同升溫速率下之熱分解過程，評估其熱危害性，建立相關數據，作為硝酸胍在製造、儲存和運輸等過程中之參考依據。

本次與會除了汲取全球製程安全領域最新研究成果及收集相關資訊外，並於 12 日由國立雲林科技大學環安系洪肇嘉教授進行專題演講合作撰寫之論文『危險化學品事故應變之應用及使用分析 (An Evaluation of Emergency Response Database for Hazardous Material Incidents)』，該研究報告主要是在考量 HAZMATs 時，因有化學品危害特性瞭解之需求，透過應變資料庫可以有效的在事故初期進行危害辨識及後續之應變，本研究綜合分析中國國內及國外資料庫之應用內容，皆各有所長，端視應變需求與應用決定如何使用這些應急資料庫，協助事故現場應急人員及單位依資訊選擇資料庫進行應急作業規劃及處置，其實可透過這些資料互相參考，進而互補長短，擬定妥善應急方針，稗能使救災工作更為順遂，使損害降至最低。一般因各資料庫之應用目的不同，在應變時建議參考三種以上不同資料庫，除能有效確保資料之正確性，亦可全面考慮應變時之不同需求及目的，綜合規劃及考慮應急行動及處置。本文結語整理如下：

- (1) ERG(緊急應變指南)所提供的訊息較為概略性，適合運用於危害物運輸遭遇到火災、爆炸或洩漏時該如何進行應急，包括最初步的隔離距離與救護作為，建議陸上運輸發生化學災害時，優先使用 ERG 指南進行參考。若為海運或船倉等發生化學災害事故時，則因特殊考慮應優先使用 IMDG Code 進行參考，其他之文獻則建議使用常用危險品應急速查手冊。
- (2) 若為危險品包裝及儲運部分，一般為船運、陸運包裝及儲運也可參考 IMDG Code，其它文獻則建議參考石油化工危險化學品實用手冊。然在 HAZMATs 應急時，規劃及處置參考如前述。

- (3) 有關環境污染資訊查詢及圍堵控制策略，建議參考環境應急與典型案例、環境應急回應實用手冊、ERG 應急指南、WISER 資料庫等，以利進行化學品污染物的緊急圍堵及移除工作。
- (4) 於人體健康的暴露危害評估或毒理學資料之收集，則以 NIOSH CDC、WISER 資料庫、環境應急回應實用手冊的資料較完全面，於穿戴防護具或評估化學品危險性時可參考使用。

二、會議參與心得

本次會議由中國石油大學（華東）、中國化學品安全協會、美國化學工程師協會化工製程安全中心（AICHE CCPS）主辦，“過程安全在中國”為主題的第四屆美國化工過程安全中心（CCPS）中國過程安全研討會在青島舉行。來自中國、美國、韓國、澳大利亞、挪威、新加坡、巴基斯坦等多個國家的近 300 位專家學者就 PSM（過程安全管理）在中國的發展、全球過程安全展望、國內外 PSM 要素實施經驗及技術、過程安全法律法規及標準、過程安全技術、後果及風險評估方法、應急回應及規劃、事故調查及經驗分享、化學工業環境風險評估、LOPA&SIL（保護層分析和安全儀錶等級）等 10 個方向，展開廣泛的學術研討。研討會期間，共舉行 14 場主題報告、28 場分會報告 8 個主題展開學術研討。本次研討會 Keynote Speaker CCCPS 中國分部主任趙東風教授的“關於城市型煉化企業可持續發展的思考”報告，從近年來頻繁出現的“化工圍城”及“城圍化工”等熱詞出發，指出混亂無序、缺乏長遠眼光的規劃是導致惡性傷亡事故、引起輿論譁然的根源原因。對當前人們應對城市型煉化的不同策略進行了分析，提出應基於風險、成本的綜合評估結果進行決策，並對適用於城市型煉廠的風險綜合分析關鍵技術進行了討論，相較之下，國內早期開發的石化工業園區，也當即將面臨此項問題，如中油的五輕廠，高雄之大社及林園等石化工業區，及台化公司的彰化廠區的，均面臨民眾圍廠或地方政府要求搬遷的命運，各石化廠區如何永續發展，與民共存的未來將是重要的發展重點，台灣似可在這部分多加努力。

此外，青島 OSIS 公司臧洪龍分以主題為“HAZOP 在多點式地面火炬危險辨識中的應用”和“城市型煉廠外部保護區的討論”的報告，其發表之報告以烯烴高壓火炬為例，展示了 HAZOP 分析在多點式地面火炬的風險分析的應用。通過對火炬氣總管壓力低/高、火炬頭未點燃/燃燒異常、火炬系統緊急泄壓系統和氮氣吹掃系統異常

等具體偏差的分析，針對地面火炬在設計可能存在的問題，提出了相應的建議措施，此部分研究領域為較新知研究領域，無論在消防設備配置上的使用或者工廠配置的設計，都將可使用本部分研究作為基礎，國內研究也將可考量針對此項研究進行評估。

CCPS 中國過程安全會議由中國石油大學（華東）發起並已成功舉辦三屆，會議為大陸地區及海外學者於製程安全領域的專業人士、政府人員、大專校院、研究院所及企業人員提供一個學術交流和工業實踐共用的平臺，促進了製程安全管理的整體水準。筆者有幸參加了三次 **CCPS** 中國過程安全會議，深感其論文或發表的文章越來越具專業性，質量也突飛猛進，建議國內學者也可參考參加會議以獲得中國於化工製程領域之領先技術，他山之石，可以攻錯，可以讓我們在學術領域上獲得啟發。

四、 建議事項

(1) 我國因國土面積及城市發展因素，導致許多化學工廠鄰近如住宅區、學校、醫院及其他人口聚集之敏感區域，而化學品事故往往伴隨著高毒性、高爆炸性、高易燃性等特色，因這些特色常常造成工業區鄰近民眾存著在恐懼心理，而隨著時間更常常易造成情緒化舉動，進而妨礙產業的永續發展及社會和諧，而中國大陸近年來也因「城市型鏈化企業」此一現象的出現，陷入與我國一樣的困境，甚或有過之而無不及，但此次與會由 CCPS 中國分部主任趙東風教授的「關於城市型煉化企業可持續發展的思考」演講報告中，可得知中國官產業界已針對此點進行許多研究，也提出許多可行之解決方案。而台灣目前較無整體提出有效之政策來解決本相問題，除了造成民眾持續不滿外，造成我國產業無法有效發展，甚或出走之憾事；建議我國相關主管機關應從政策法規層面著手，與業者合作，支援無法搬遷之業者，就地進行廠場設備及製程之監督改善，降低民眾之恐慌心理，而後續也持續加強城市發展及產業的適當規劃，創造產業發展之有利條件，增進我國於國際上之競爭力。

(2) 本次與會許多研究議題是利用 CFD 軟體 FLACS 及 Safeti 等模擬程式對於石化設備，進行風險評估及危害分析，該類模擬程式隨著科技發展，也從早期結果誤差較大進步到越來越能符合現況，除了能有效反應廠場可能存在風險外，也能作為危害預防準備階段(如就地安全避難及疏散等)及政府發放相關證照之參考依據，建議未來我國無論是政府、學術界及業界可以著重於此方面之投資，培養專業人才。

五、附錄

1、出國行程一覽表

日期	行程	附註
05/31 (週二)	搭機前往中國青島 台灣桃園國際機場至中國青島流亭國際機場	
06/01 (週三)	參加 4th CCPS China Conference on Process Safety	-
06/02(週三)	參加 4th CCPS China Conference on Process Safety	-
06/03(週四)	參加 4th CCPS China Conference on Process Safety	-
06/04、05 (週五、六)	休假	不支日支費
06/06(周日)	回程 中國青島流亭國際機場至台灣桃園國際機場	--

2、4th CCPS 中國製程安全會議研討會

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3、各項研討會照片



4thCCPS 研討會議程情況



洪肇嘉特聘教授 Keynote Speaking 情形



於 4thCCPS 研討會留影



易逸波老師及中國石油大學韓磊老師合影



危險化學品事故應急數據庫之應用及使用分析
An Evaluation of Emergency Response Database for Hazardous Material Incidents

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危险化学品事故应急数据库之应用及使用分析

An Evaluation of Emergency Response Database for Hazardous Material Incidents

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关键词: 危害化学品事故、应急响应、化学品数据库

Keywrd: Hazardous Material Incidents (HAZMATs), Emergency Response, Chemical Database or Depository

摘要

当危险品灾害伴随着化学品泄漏、扩散、火灾与爆炸、对人类及生态的可能毒性等，正确的应急行动需要降低事故危害及减低对于民众、环境及财产的影响。由于这些事故灾害常涉及多种化学品、反应及危害，初步行动应为辨识化学品种类，评估其危害特性及规划适当现场应急行动。因此，这些数据库要能对第一现场应急人员，技术员，专家及事故指挥官能方便使用及广泛地提供化学品及应急行动相关讯息。

为评估这些国际上常用之应急数据库或信息系统，国际间常用 ERG(Emergency Response Guidebook)、Wiser(Wireless Information System for Emergency Responders)、NIOSH Pocket Guide to Chemical Hazards、IMDG Code (International Maritime Dangerous Goods Code)、安全数据表及国内环境应急与典型案例、石油化工危险化学品实用手册、常用危险化学品应急速查手册、化学品事故应急救援、环境应急响应实用手册等以涵盖各陆路运输，生产厂商、船运及其它危险品应急。并分析及评估其应用于几种应急事故，以讨论不同阶段之应用，包括最初安全措施、隔离区域、危害评估、围堵或控制之应急行动方案、及防护装备之选择与保护行动。当许多经济部门生产更常用化学品时，预防及应急的教育训练更需强化以保护公司企业及社会大众。

Abstract

Since many hazardous material incidents (HAZMATs) usually accompany with chemical leakage, proliferation, fire and explosion, and possibly toxic to human or ecology, the proper response actions not only need to mitigate the incidents but also to reduce the influences to peoples, environment, and property. As HAZMATs might involve many chemicals, possible interactions and many types of hazards, the initial actions should be involved the identification of the chemical species, the evaluation of possible hazardous properties, and the planning of proper response actions. Therefore, those databases and repositories on chemical properties and mitigation information should be handy and versatile for the first responders, technicians, specialists as well as incident commanders.

The information systems were selected internationally including the Emergency Response Guidebook (ERG), Wireless Information System for Emergency Responders (WISER), NIOSH' s Pocket Guide to Chemical Hazards, International Maritime Dangerous Goods Code(IMDG Code), Safety Data Sheet (SDS) and others for the possible HAZMATs during road transportation, manufacture plant, boat shipping, and other possible chemicals emergencies. Their applications were analyzed and evaluated against several typical HAZMATs for their usefulness in different stages in responding to HAZMATs, such as initial safety measure, isolation zone determination, hazards size-up, action planning for containment and control as well as the selection of protective equipment and protection action, etc. As chemicals were used more and more in many economic sectors, the use of those databases in training and education of HAZMATs prevention and mitigation should be strengthened to protect the companies and general public.