出國報告（出國類別：出席國際會議）

出席 港灣環境與營運技術研討會 --NACE Northern Area Eastern Conference 2015 出國報告

服務機關：交通部運輸研究所
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出國期間：104 年 10 月 17 日~104 年 10 月 23 日
報告日期：105 年 1 月 11 日

出席 港灣環境與營運技術研討會--NACE Northern Area Eastern Conferenc 2015 出國報告

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關鍵詞：美國腐蝕工程師國際協會(National Assocation College and Empolyers Internal，簡稱 NACE Internal)、防蝕工程(Corrision Engineering)、材料選擇(Materials Selection)、塗裝(Coating) 、陰極防蝕(Corrosion Prevention)、電化學保護(Electrochemical Protection) 、訓練和認證課程(Training and certification programs)

內容摘要：

本報告為參加美國腐蝕工程師國際協會(NACE Internal)於加拿大渥太華主辦之NACE Northern Area Eastern Conferenc 2015研討會的彙整報告，報告內容主要包含研討會議程、論文研討與資料蒐集等。

本研討會議題以探討現代腐蝕預防與控制策略，包括材料選擇、電化學保護、表面性能變更、塗層與襯裡、腐蝕抑制劑、鋼筋混凝土腐蝕、防蝕工程設計…等牽涉之港灣環境營運技術與工程問題為主，會中將邀請專家及相關產業公司針對防蝕研究與開發進行紹及研討。藉由參加論文研討、專家論壇和參觀展示防蝕最新研發技術與成果，可深入瞭解加拿大當地腐蝕問題和防蝕對策，並期能作為我國日後新建與既有之港灣碼頭防波堤與橋梁等金屬或鋼筋混凝土結構物之防蝕設計與維護管理之參考依據。

本文電子檔已上傳至公務出國報告資訊網

摘　要

本(104)年度奉派參加港灣環境與營運技術相關之研討會，為期能提供我國日後新建與既有之港灣碼頭防波堤、橋梁等金屬或鋼筋混凝土結構物之防蝕設計與維護管理的參考依據，選擇出席NACE Northern Area Eastern Conference 2015研討會。

由美國腐蝕工程師國際協會(National Assocation College and Empolyers Internal，簡稱NACE Internal)加拿大首都支會主辦之北美地區北區東部研討會(NACE Northern Area Eastern Conference 2015)，於104年10月18日至10月21日在加拿大渥太華舉行，本研討會以探討現代腐蝕預防與控制策略，包括材料選擇、電化學保護、表面性能變更、塗層與襯裡、腐蝕抑制劑、鋼筋混凝土腐蝕、防蝕工程設計…等牽涉之港灣環境營運技術與工程問題為主，會中邀請學者及相關產業專家，針對防蝕研究與開發進行介紹及研討，共發表56 篇論文及22家相關業者與會展示其防蝕設備與技術研發成果。NACE Internal 係於1943年成立，以提升腐蝕防治相關工程技術與學術交流為其成立宗旨，對外發行學術期刊與辦理訓練認證課程，為國際防蝕工程知名協會，所擬訂腐蝕檢測及防治規範，更為世界各國引用之參據，多年來促進學術與工程技術交流，提供先進科技，對工程界貢獻良多。本報告主要就參與論文研討和參觀展示防蝕設備與技術研發成果心得分享。

本報告內容計分四章，第一、二章分別為參加本次研討會之目的與過程；第三章則是研討會心得包含與業務有關之論文研討與參與感想概述；第四章提出本次參加研討會的結論建議。

出席港灣環境與營運技術研討會--NACE Northern Area Eastern Conferenc 2015 出國報告

目次

一、目的

2015年 NACE 北美地區北區東部研討會(NACE Northern Area Eastern Conference 2015) 是由美國腐蝕工程師國際協會 (National Assocation College and Empolyers Internal，簡稱NACE Internal)北美地區加拿大首都支會所主辦之年度性研討會議，主要探討現代腐蝕預防與控制策略，包括材料選擇、電化學保護、表面性能變更、塗層與襯裡、腐蝕抑制劑、鋼筋混凝土腐蝕、防蝕工程設計、研究與開發…等牽涉之港灣環境營運技術與工程問題，藉由論文發表和展示防蝕最新設備與技術之研發成果，可讓與會人員深入瞭解加拿大當地腐蝕問題和防蝕對策，達成提升工程技術與學術交流之目的。

美國腐蝕工程師國際協會創始於1943年，是由11位公認的權威腐蝕工程師所成立，其總部設於美國設在德州休士頓，在加州聖地牙哥、馬來西亞吉隆坡、中國上海、巴西聖保羅和沙烏地阿拉伯Al-Khobar設有辦事處。北美地區(美國及加拿大)並設有北部、中部、東部與西部4個支部，其他在歐洲、亞太等地區亦各設有4個支部。NACE International擁有超過70年的發展經驗，其成員致力參與材料腐蝕防治的發展及研究，並訂立眾多防蝕規範及訓練認證制度。目前設有300多個技術委員會，有2600多家NACE成員參與技術委員會的活動，為現今全球最具規模的工程師協會。其參加會員資格開放給對於在防蝕工程及材料工程等有興趣的人員，目前主要是以防蝕工程及材料工程相關領域之學者專家所組成。最初會員來自美國、加拿大、英國等幾個國家成員，目前則已經有超過130個以上國家，經常性參與其會務和活動。該協會每年由總會舉行年會一次，是目前世界上最大型防蝕工程技術上之國際研討會，主要在美國各主要城市輪流舉行，各支會或支部在世界各國許多主要城市亦每年均辦理多場研討會。此外，NACE 國際訂有一個完整的訓練和認證方案，自2003年以來已舉辦超過 90 堂訓練認證課程。訓練認證課程包含：陰極防蝕技術、防蝕塗裝包覆及襯裡、腐蝕抑制劑、核能級防蝕塗料....等。訓練課程教師皆為專業的防蝕專家，

課程所提供的設備、書籍和學習工具十分詳盡，皆能幫助學員取得所需的認證。現今國際不論大小之防蝕工程設計與施工皆需具備NACE國際認證之工程人員參與，以確保施工品質及系統安全。

其主辦國際研討會議的主要目的計有下列三項：

1.促進防蝕及材料相關科學研究及技術的開發,並促成國際合作和共同參與。

2.即時提供防蝕及材料領域相關科學新知和資訊交流。

3.透過協會提供從事相關防蝕工程，施工與維護技術之支援。

統計2015 年，NACE國際單在美國、加拿大、英國和中國等地辦理研討會議，達22個以上之場次，會議主題、舉辦國籍及城市如下表1-1 所示。

本次藉由會議期間參與論文研討，獲得與其他國家學者專家直接交流機會，除可瞭解我國在防蝕領域之研究方向是否可與國際接軌外，並可獲知與擷取各國於防蝕及材料研究之最新發展現況，以作為未來相關研究推展之借鏡與參考。職幸獲蒙林所長信得先生核准前往參加研討會，特此深感致謝。

表1-1 2015年NACE在美國、加拿大等地辦理研討會議

日期	會議名稱	地點
2015/1/13-14	Nuclear Power Plant Coatings Symposium	Orlando, FL, U.S.
2015/1/20	Annual Vendor's Day Event	Harrah's Casino & Hotel 151 N Joliet St. Joliet, IL, U.S.
2015/1/20-22	NACE MR0175/ISO 15156 One-Day Seminar	Houston Marriott Westchase Houston, TX, U.S.
2015/2/17-18	SPE/NACE Deepwater Field Life Corrosion Prevention, Detection, Control, and Remediation	AT&T Executive Education and Conference Center Austin, TX, U.S.
2015/3/15-19	CORROSION 2015	Dallas Convention Center Dallas, TX, U.S.
2015/4/21-22	Annual Legislative Fly-In	Washington, DC, U.S.
2015/4/29-5/1	Bring on the Heat 2015	Houston, TX, U.S.
2015/5/14	NACE MR0175/ISO 15156 Seminar	St. Regis Abu Dhabi Abu Dhabi, United Arab Emirates
2015/5/12-14	NACE UAE Corrosion Conference	Abu Dhabi, United Arab Emirates
2015/6/29-30	NACE MR0175/ISO 15156 One-Day Seminar	Elcometer Training Building Room E Houston, TX, U.S.
2015/6/29-7/1	Concrete Service Life Extension Conference	Philadelphia, PA, U.S.
2015/7/27-29	Top of the Line Corrosion Conference	Jakarta, Indonesia
2015/7/29-31	NACE PIMS Latin America	Swissotel Quito’ Quito, Ecuador
2015/8/31-9/2	NACE Central Area Conference 2015	St. Louis Union Station – A DoubleTree by Hilton Hotel St. Louis, MO, U.S.
2015/9/7-8	Bring On The Heat China 2015	Qingdao, China
2015/9/20-24	Corrosion Technology Week 2015	JW Marriott Austin Austin, TX, U.S.
2015/10/18-21	NACE Northern Area Eastern 2015	Courtyard by Marriott Ottawa Ottawa, Canada
2015/10/28-30	NACE Western Area Conference 2015	DoubleTree Resort by Hilton Hotel Paradise Valley Scottsdale Scottsdale, AZ, U.S.
2015/11/15-19	2015 Department of Defense - Allied Nations Technical Corrosion Conference	Wyndham Grand Pittsburgh Downtown Pittsburgh, PA, U.S.
2015/11/19-21	East Asia and Pacific Area Conference	Chennai, India
2015/11.30-12/1	NACE MR0175/ISO 15156 One-Day Seminar	Exova Corrosion Center Great Britain, U.K.
2015/12/3-4	NACE MR0175/ISO 15156 One-Day Seminar	Exova Aberdeen Aberdeen, Scotland (UK)

二、過程

2.1 研討會議簡介

本年度2015年 NACE 北美地區北區東部研討會(NACE Northern Area Eastern Conference 2015)於加拿大舉辦。會議地點位於加拿大首都渥太華，會議場址在渥太華市區的Courtyard by Marriott 旅館之會議廳，會議地點及會場外貌如圖2.1、圖2.2所示，於10月17日臺灣搭乘長榮航空班機先抵加拿大多倫多機場再轉飛渥太華機場，囿於經費限制，住宿旅店選在會場附近之 ByWard Blue Inn 旅館。會議舉行時間為10月18日至10月21日，研討會議程概要如表2.1所示。

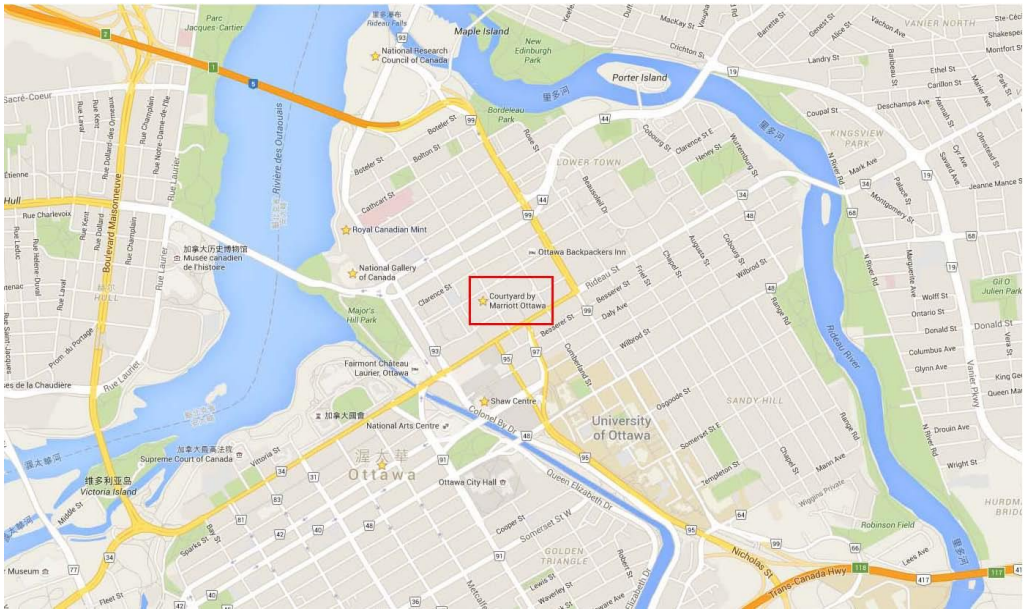

圖2.1 會議地點

圖2.1 會議地點外觀

表2-1 會議議程概述表

日期	議程概述表
10 月 18 日	報到
10 月 19 日	開幕典禮 論文研討 設備與技術研發成果展示 歡迎晚會
10 月 20 日	論文研討 設備與技術研發現場展示
10 月 21 日	論文研討 設備與技術研發現場展示 學生海報及 NACE 會員圓桌論壇

本次研討會投稿極為踴躍，論文經委員嚴格審查後，共蒐錄來自加拿大、美國、南非及中國等國家之56篇論文，會議研討共計4天，每日有4個時段，共8個場次，並設一展示會場提供22家業者展示最新防蝕設備與技術研發成果，小型會議室主要分布在會場地下1樓，每個會

議室可容納數十人同時與會，會場簡約隆重，議事安排順暢，支援人力及設備充足，會議之進行十分順利。開幕典禮於地下1樓大廳舉辦，大廳約可容納近175人，現場報到地點設在會場1樓，圖2.3為在報到台前留影。

圖2.3 現場報到台前留影

2.2 會議主題概述

本次研討會之論文，共有56篇論文參與發表，論文涵蓋如：塗裝和襯裡、混凝土構造物腐蝕與防蝕研究、防蝕理論和監測技術、防蝕工法與材料選擇、腐蝕防治案例研究、國防工業腐蝕防治研究、防蝕材料研究與技術開發、陰極防蝕工法、石油與天然氣工業防蝕技術、核能發電防蝕技術等10大單元之理論分析與技術研發相關領域成果發表，同時展示13篇學生專題研究海報。研討會後，另邀請與會NACE會員針對加拿大現行之防蝕策略，舉辦圓桌論壇討論之。

本次大會未提供論文集或光碟給報名人員，相關論文摘要可至http://www.nace.org/uploadedFiles/Events/Area_International/Area_Conference/NAE-2015-finalprogram.pdf 網址內瀏覽。

2.3 論文研討

本所104年出國參加港灣環境與營運技術相關之研討會計畫，原訂參加104年6月21-26日之「ISOPE-2015第25屆海洋工程國際研討會」，然因接辦金門縣港務處委託本所代辦「金門港埠碼頭防波堤檢測及修復建議技術服務」1案，上述會議舉辦期間適逢需至金門料羅、水頭與九宮三港區碼頭防波堤執行現地調查與浮動碼頭基樁、浮箱之安全評估分析等工作，又經查本所103年已派員參加韓國釜山「ISOPE-2014第24屆海洋工程國際研討會」，完成蒐集港灣工程、大地工程、海嘯安全及能源環境方面資訊在案，故依研究業務實際需求，更改為參加本研討會，期能獲得與其他國家防蝕工程界專家學者直接交流機會，除擴增研究交流層面外，另可瞭解我國在防蝕領域之研究方向是否可能與國際接軌，獲知並蒐集其他國家於防蝕及材料研究之最新發展現況，作為本所未來相關研究推展之借鏡與參考，將更有益於本所研究業務之推展與精進。

本所港灣技術研究中心近年研究發現，材料腐蝕所造成之經濟損失極大，依美國與歐盟推估每年腐蝕損失約占GDP之3.0% ~ 3.5%，據此我國材料腐蝕年損失約為新臺幣4,300億元至5,100億元 ； 對照臺灣地區四面環海，屬高溫、高溼與高鹽份的環境，加上空氣污染的結果，腐蝕環境極為嚴重。以往港灣碼頭防波堤與道路橋梁等公共工程建設，常引用國外防蝕規範或大氣腐蝕調查數據，進行腐蝕速率評估與防蝕設計，結果常有未達設計年限就已銹蝕損壞的情形；有鑑於此，港灣技術研究中心近年來已針對港灣構造物耐久性與腐蝕防治策略、陰極防蝕準則研擬、本土化大氣腐蝕因子調查，臺灣大氣腐蝕環境分類與建立資料庫等項目進行研究，期能作為日後新建與既有之港灣碼頭防波堤與橋梁等金屬或鋼筋混凝土結構物之防蝕設計與維護管理的依據。故本次論文研討主要參與「混凝土構造物腐蝕與防蝕研究」、「防蝕理論和監測技術」、「防蝕工法與材料選擇、「腐蝕防治案例研究」、「防蝕材料研究與技術開發」、「陰極防蝕工法」等專題，除參與論文研討外，會議休息時間亦與多位與會之國外研究人員於展

示會場繼續進行會談，就現有防蝕監控儀器、防蝕材料、陰極防蝕外加電流與犧牲陽極等議題，進一步交換研究經驗與意見，相關業者亦將其其研究成果供參，並對我國港灣工程之防蝕發展現況表達濃厚興趣，期能後續可再進行交流。會議進行及展示會場照片如圖2.4-圖2.6。

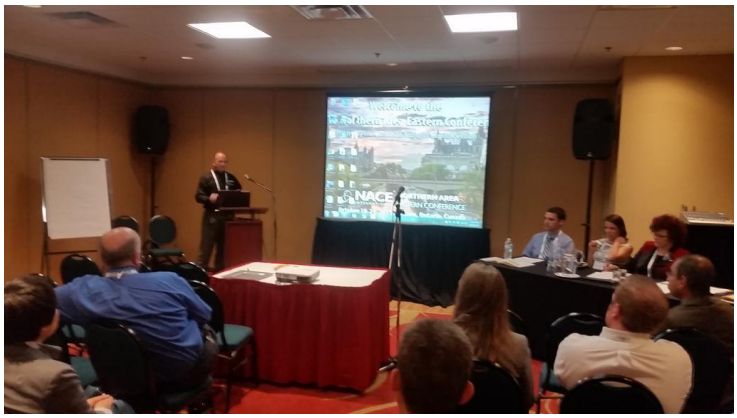

圖2.4 論文發表現場照片1

圖2.5 論文發表現場照片2

圖2.6 展示廳現場討論情形

2.4 參訪渥太華地標重要建築

本次會議主席在致歡迎辭時，特別推薦與會外賓研討會後至該市參訪國會山莊等地標重要建築。渥太華(Ottawa) 位於安大略省東南部與魁北克省交界處，是加拿大首都和政治文化中心，加拿大第四大城市。市內軍事歷史、科學技術、自然與航空等各種博物展覽館眾多，公園和美術館遍布。身在渥太華能欣賞不同時期的風格建築，感知到英法文化和諧的交融。其主要景點概述如下：

拜城博物館(Bytown Museum)位於勞瑞爾城堡大飯店後面的威靈頓街，地處運河入渥太華河口附近，是古老的泥瓦建築。由當年為存放軍需補給、錢糧的貯藏庫和辦公室改建而來，展品共約 3500 件，有拜城及渥太華的歷史文化實物及藝術品，以及有關當時建築裡多運河的資料和陸軍中校工程師約翰拜的個人事蹟等。此外，館內還不時舉行特別展覽。

拜沃市場(Byward Market)位於裡多區北端的里多運河與渥太華河交會處附近、靠近聯合車站的露天市場，是加拿大最古老和最大規模的公共市場之一。這裡除開始販售各種新鮮蔬果的地方，還有各式各樣的咖啡店、手工藝品店和夜總會，是渥太華最受歡迎的夜生活區。

國會山莊(Parliament Hill)位於加拿大首都渥太華的國會山，加拿大政府及參議院的所在地，是渥太華乃至整個加拿大的象徵。遊客可以參觀位於中央區的參、眾兩院，這裡可以看到英國女王的雕像和早期歷屆總理的雕像。國會大廈中央 90 米高的和平塔，是國會山莊一大亮點，是國會大廈中最高的建築，被譽為世界上最精緻的哥特式建築。

加拿大自然博物館(Canadian Museum of Nature)位於加拿大首都渥太華，是加拿大重要的科學和自然史博物館。館內收藏了 1000 多萬動植物標本，包括恐龍化石，哺乳動物，鳥類，植物和礦物質。種類繁多的化石生動的再現了生物的進化過程，在這裡可以更好的了解自然。此外還可以與恐龍標本近距離接觸。

加拿大當代攝影博物館(Canadian Museum of Contemporary)位於洛麗耶城堡與里多運河之間，成立於 1985 年，隸屬於加拿大國家美術館，是一間小而精美的展示廊。博物館展出加拿大的當代攝影作品，每 4 個月更換新的展覽主題。是攝影團體的集會及研究場所。另外博物館還附設了一個以播放加拿大的本土影片為主的迷你劇場。

冷戰博物館(Cold War Museum)位於加拿大渥太華卡普市，距離渥太華約 35 公里，佔地 9000 多平方。原是加拿大政府為在應對核子戰爭而建立的秘密防護處，內部有空調，核子過濾器、 廚房、電台、醫院等。現因沒有使用價值而改為冷戰博物館供遊客參觀。

加拿大銀行及貨幣博物館(Currency Museum/Bank Of Canada)位於斯帕克路上的加拿大巴爾德銀行內部。共有七個展廳，分別展出加拿大貨幣發展過程中的實物、圖解及照片，同時還用地圖及實物介紹早期中國各朝代、古希臘文化、羅馬及拜占庭王朝、中世紀各地和文藝復興時代各地的金融情形，以及北美在當時的金融狀況，值得一看。

勞瑞爾之家(Laurier House)外觀宏偉，是加拿大 1950 年前兩位總理勞瑞爾（Sir Wilfrid Laurier）和麥肯齊金（William Lyon Mackenzie King）的官邸，現在內部展示這兩位總理與歷史有關的資料及兩人私人的文物。

國立藝術中心(National Arts Centre)位於多運河西畔、議會山下的聯邦廣場上，是一座全封閉式、呈六角形的十分現代化的綜合性建築。藝術中心主要由歌劇院、小劇場、音樂廳 3 個部分組成。在這裡不僅可以欣賞大型歌劇和芭蕾舞，現代話劇，還能在音樂廳播放或錄製音樂和電視節目。

國家美術館(National Gallery of Canada)位於渥太華市中心，公元 1988 年成立，亮眼的玻璃帷幕建築別具一格。館內藏品豐富，除了有加拿大著名的“Group of Seven”等七位藝術家的作品，還收藏了其它歐洲名家林布蘭、塞尚（Cezanne）、高更（Gogh）、和畢卡索（Picasso）等人的作品。此外，館內還有鋼琴演奏、管弦樂器的表演、

聲樂家的歌唱等動態表演。

加拿大滑雪博物館(Canadian Ski Museum)位於史科特街一九六〇號，但收藏了歐洲滑雪五千年來及引進加拿大一百多年的滑雪歷史資料及發展經過， 在這裡可看到最古老的滑雪用具及現代精緻講究的滑雪工具，從而了解加拿大滑雪的歷史和文化。

麗都運河(Rideau Canal)建於 1832 年，長 12 公里，連接渥太華河與安大略湖，東達大西洋，西通北美五大湖區，河道沿風光秀麗成是遊人觀光的重點，此外運河上還不定期的開展冰雕展、雪橇活動、破冰船之旅、冰上曲棍球賽、雪鞋競走以及冰上駕馬比賽等精彩活動。

國立科技博物館(National Museum of Science and Technology)位於渥太華勞倫特大道的南端。是加拿大規模最大的科技博物館，博物館通過展覽收藏，參觀體驗，專題討論和講座等手段幫助公眾了解科學與技術的關係，以及技術變革對加拿大的影響。

皇家鑄幣廠(Royal Canadian Mint)位於渥太華市中心，建於 1908 年，隸屬於加拿大聯邦政府，主要製作各種手工的收藏品、紀念硬幣、飾金硬幣、獎牌和紀念章。參觀者可以通過遊覽了解鑄造錢幣過程中精細的手工和精湛的工藝。

聖母院(Cathedral Basilica of Notre-Dame)是渥太華歷史最為悠久，規模最大的教堂。內部裝修華麗輝煌，值得一觀。

本次出國因時間關係，僅於研討會後參觀國會山莊(如圖2.7-圖2.9)，參觀期間東西區兩棟建築正進行維護工程，其施工慎重嚴謹，顯示加拿大隊古蹟極為重視。鄰近之司法大廈(如圖2.10)、國家美術館、國立藝術中心、麗都運河、皇家鑄幣廠、聖母院則僅於建物外部拍照留影，回國前則至拜沃市場選購工藝品與加拿大楓葉糖漿(如圖2.11-圖2.12)。

圖2.7 國會山莊中央區建物與和平塔

圖2.8 國會山莊西區建物及維護施工情形

圖2.9 國會山莊東區建物及維護施工情形

圖2.10 司法大廈外觀

圖2.10 拜沃市場之情景

圖2.10 拜沃市場內王哥麵點(有台灣小吃、珍珠奶茶等)

三、心得

有關本次會議內容包含防蝕領域各式主題，由於會議場次限制，無法逐一參與研討，僅就參與部分會議，與本所港研中心業務有關的構造物防蝕塗裝與襯裡、大氣腐蝕環境調查及鋼筋混凝土構造物相關研究議題，並參觀防蝕設備與技術研發成果展示與資料蒐集等心得作一分享。

3.1 構造物防蝕塗裝與襯裡相關研究

本次研討會共分塗裝和襯裡、混凝土構造物腐蝕與防蝕研究、防蝕理論和監測技術、防蝕材料選擇、腐蝕防治案例研究、國防工業腐蝕防治研究、研究與技術開發、陰極防蝕工法、石油與天然氣工業防蝕技術、核能發電防蝕技術等10大主題，其中塗裝和襯裡共有10篇論文發表，占比最重。由於港灣工程之鋼筋混凝土構造物內部鋼筋，因處腐蝕嚴酷之海洋環境，鋼筋材質選用與外部塗裝或增加保護層厚度極其重要，以往多以選用耐蝕鋼材，或將鋼筋施作鍍鋅或環氧樹酯等加以塗裝。本次研討會中，亨佩爾美洲公司(Hempel Americas, Inc)Terence Aben針對富鋅環氧樹脂性能創新深入研究(富鋅環氧樹脂性能創新之研究 Activated Zinc – An Innovation that Redefines the Performance of Zinc Rich Epoxies)，富鋅塗層的防蝕機制主要為鋅粉塗料中的鋅可提供陰極保護。當塗料系統之富鋅底漆暴露於腐蝕性環境時，表面出現鏽蝕和發生氣泡為其最重要的失效機制。在眾多之腐蝕加速試驗過程中，隨著暴露時間增加，其缺陷在被塗物表面可由目視檢測清楚觀察到。經由密集研究和努力，本文研發一種在富鋅環氧樹脂增加鋅的活化之創新技術，結果顯示此技術可達成防蝕保護機制，大幅度提高其防腐性能，與傳統鋅環氧樹脂材料相比較豐富，沒有任何負面的影響，並可額外改進力學性能和可提高薄膜厚度。目前正持續依ISO 12944、ISO 9227等規範進行鹽霧試驗與開裂測試中。

此外，中國哈爾濱鑫科奈米科技有限公司王煥然博士、發表鈦奈

米聚合物及其防蝕應用(Titanium-nano Polymer and its Anti-corrosion Applications)，針對不同的腐蝕問題和環境的挑戰，研發制定出新型防蝕塗料--鈦奈米聚合物(Titanium-nano Polymer ,TNP)。利用一種創新技術，將鈦金屬轉化成奈米級超細化粉末，大幅提高鈦金屬表面活性。與此同時，雙鍵的有機化合物與奈米級鈦金屬粉末組合成為鈦奈米聚合物。TNP具有非常獨特的屬性，如抗強滲透性、高耐腐蝕性、良好的防垢除垢性能、熱導率、耐高溫，耐磨，耐水等性能。TNP 可以作為一種防腐塗料，在石油和化工行業、海洋結構物、食品工業等領域廣泛應用。

TNP 塗料在熱交換器的應用：煉油廠熱交換器在不同腐蝕環境，採用了不同的保護方法。經過長期努力，目前已取得部份成果和經濟效益。但石油和天然氣所用之腐蝕熱交換器，迄今仍未取得適當之防蝕材料，解決其在使用一段時間腐蝕生鏽和附著污垢等問題(如圖3.1)。

圖3.1 熱交換器表面腐蝕生鏽和附著污垢情形

經由一系列的腐蝕實驗，找到一種石油和天然氣熱交換器適用之防蝕塗層。將改質呋喃塗料(Modified furan coating)、聚烯烴(polyolefin)、聚脲酯(polyurea)、TNP等材料塗於熱交換器上實際測試180天。結果顯示，相對於其他材料、TNP材料性質未受劣化並保持穩定。因此採用TNP塗料塗覆於多套熱交換設備上。經過3年和 8 年再次觀察，熱交換器管內外壁塗覆TNP塗層者表面仍較其他塗料保持完整。並且有沒有污垢和鐵銹存在(如圖3.2-圖3.4)。

圖3.2 熱交換器表面使用環氧樹酯塗料3年後之情形

圖3.3 熱交換器表面使用TNP塗料3年後之情形

圖3.4 熱交換器表面使用TNP塗料8年後之情形

試驗結果，熱交換器塗上TNP之導熱係數較無塗裝和環氧樹酯塗料可分別增加 66.54%、49.97%以上。熱交換器塗上TNP比一般熱交換器使用年限可增加2–3倍。煉油廠酸性儲槽設施易發生嚴重腐蝕現象，如採用環氧樹脂塗料作為其防腐塗料，不到 3 個月即出現起泡，軟化或開裂情形，最後於其底部和槽壁焊縫處發生穿孔破洞現象，在使用2年報廢後裔對環境產生污染影響，選用5種不同塗料 (塗料、聚乙烯塗料、改質環氧樹酯、聚氨基甲酸乙酯塗料的改性糠醛)對酸性儲槽進行34至127天的測試。顯示 TNP具有最佳的性能。因此，TNP 安裝為酸性儲槽內壁之防蝕塗料。經過6年後，TNP塗料塗層表面仍保光澤，且無脫皮、起泡、開裂、剝落等劣化跡象，其可為煉油廠和石化業之酸性儲槽提供防蝕保護效益。

3.2 腐蝕環境分類相關研究

本次研討會中有關腐蝕環境分類的論文被歸類於塗裝和襯裡內，共有 RDC公司 (Research & Development Corporation) Matthew Kettle發表「惡劣的海洋環境評價塗層完整性及腐蝕性」(Harsh Marine Environment Assessment of Coating Integrity and Corrosivity)1篇論文

本文介紹了評估 RDC公司在北美地區針對沿海區域大氣腐蝕的嚴重性進行初步暴露試驗。此專案同時分析該沿海區域經過1年暴露試驗後之腐蝕環境分類等級和研發大氣腐蝕速率之預測模型。主要依據氣象條件包括：溫度，濕度、降雨量、日照時數、風速；大氣腐蝕條件：氯鹽(Cl^-)和二氧化硫(SO_2) 沉積速率，採用三種富鋅塗料系統塗覆於試樣表面，進行現地測試，同時將此地點之腐蝕機理關鍵因子輸入模型。利用流體動力學計算在4英畝試驗區上各點之預測風速和氣象與腐蝕因子等條件。最後，將此模型計算結果驗證現場測試成果。圖3.5氯鹽沉積速率設備如圖3.5。

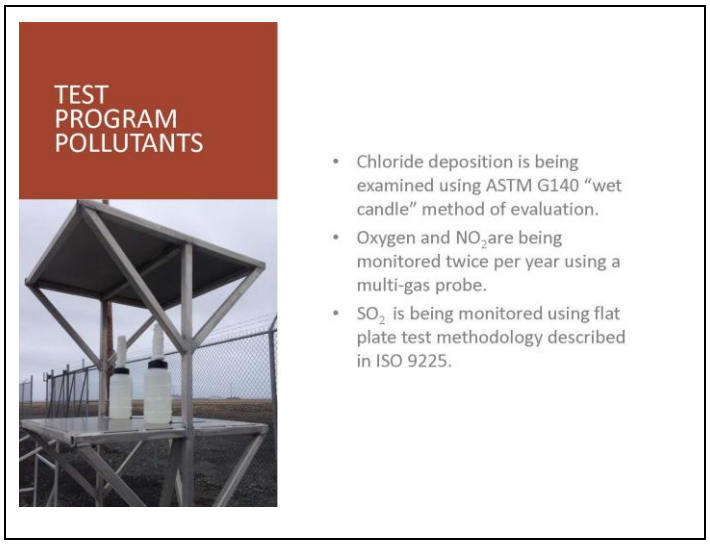

圖3.5 氯鹽沉積速率設備

現場測試地點沿海曝光位於紐芬蘭和拉布拉多的阿瓦隆半島南部暴露岬，如圖3.6；測試現場配置平面如圖3.7。此位置是在北美最嚴厲和最具有腐蝕性的環境之一。每年起霧時間約 200 天，全年平均相對濕度 75%，每年平均風速18 mile/hr (29 km/hr)，平均每月最大風速 mile/hr (101 km/hr)年均溫度43˚F (6˚C)，腐蝕環境分類最高等級 C5M (依據 ISO 9223分類，如圖3.8)，屬腐蝕嚴重區域。

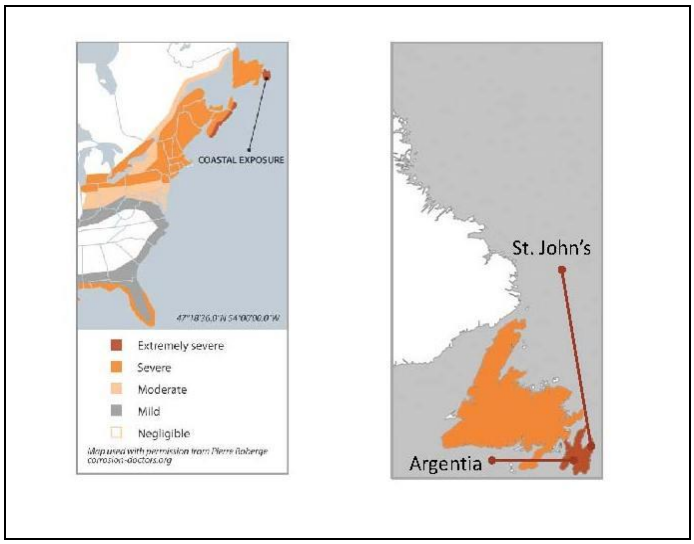

圖3.6 腐蝕試驗測試地點(紐芬蘭和拉布拉多的阿瓦隆半島南部)

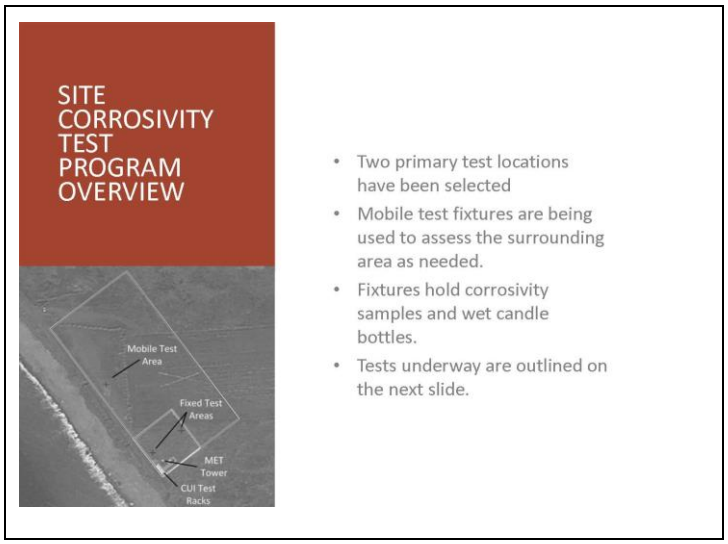

圖3.7 腐蝕試驗測試現場配置平面圖

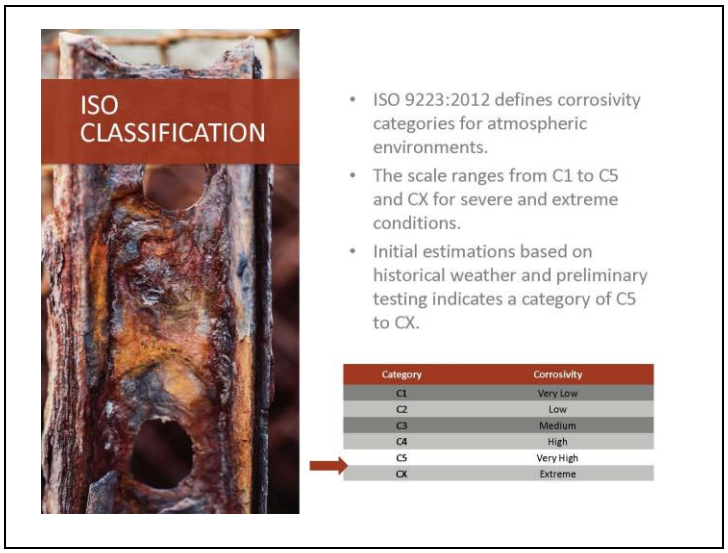

圖3.8 ISO 9223腐蝕環境分類

測試採用ASTM和ISO規範，包含：

ASTM G50:Standard Practice for Conducting Atmospheric Corrosion Tests on Metals (金屬大氣腐蝕試驗標準操作程序)

ASTM D1654: Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments (油漆或塗層試樣腐蝕環境評價標準試驗方法)

ASTM D714: Standard Test Method for Evaluating Degree of Blistering of Paints (塗料起泡程度評估標準試驗方法)

ASTM D610: Standard Practice for Evaluating Degree of Rusting on Painted Steel Surfaces鋼材表面塗漆銹蝕程度評估標準程序)

ASTM D4541: Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers (塗料使用可攜式附著力測試拉伸強度標準試驗方法)

ISO 1518: Determination of scratch resistance (耐刻痕性能測定)

ISO 1514: Standard panels for testing (試片測試標準)

ISO 2808: Standard panels for testing (膜厚度測試標準)

ISO 2810: Natural weathering of coatings — Exposure and assessment (塗層自然風化—暴露和評估)

ISO 4624: Pull-off test for adhesion (附著力拉伸試驗)

ISO 4628: Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance (塗層等級評估—外觀缺陷尺寸和密度變化)

3.3 混凝土構造物腐蝕與防蝕研究相關研究

本研討會混凝土構造物腐蝕與防蝕研究之主題，共有3篇論文發表，包括：①The Study of Chloride Diffusion of Waterproofed Bridge Decks in Ontario and the Associated Control Strategy.(安大略省防水橋甲板氯離子擴散及其腐蝕控制策略之研究)；②Field Performance of Low-shrinkage High performance Concrete Deck at Seaway International Bridge in Cornwall, Ontario.(安大略省康沃爾Seaway International Bridge高性能混凝土橋版現場性能)；③Duplex 2304 Stainless Steel Reinforcing Bar: Properties and Applications.(Duplex 2304不銹鋼鋼筋之性質和應用)，第一篇介紹Vector Corrosion 科技公司開發移除混凝土中氯離子之技

術，本技術 加拿大在90年代初首次應用，本文以建造完成約40年之Chantal Fequiere鋼筋混凝土橋為移除混凝土中氯離子之對象。利用減少鋼筋周圍電解質離子濃度，移除混凝土中鄰近鋼筋之氯離子至混凝土表面。移除過程部會影響結構正常使用。

第二篇介紹一種低收縮、低滲透並具優異力學性能之高性能混凝土應用於嚴重腐蝕環境之混凝土橋面版之現場性能測試結果。應用多孔性輕質粒料和添加減縮劑(shrinkage-reducing admixture)製成具低收縮性高性能混凝土，有效防止收縮裂縫和減少鋼筋混凝土橋構造物因氯離子導致之鋼筋銹蝕。由試驗結果推估氯離子侵入高性能混凝土橋面至內部鋼筋所需時間超過 100 年。應用生命週期成本分析，估計高性能混凝土橋面較典型普通混凝土橋面，可節省長期維修費用 65%。性能實測工作選於安大略康沃爾之新運河大橋上進行，於 2012 年 7 月在其橋面嵌入振弦式應變感應器監測溫度和應變，經過幾年監測結果顯示，混凝土橋面版之體積變化只有因溫度變化產生，其自體和乾燥收縮均甚小至可忽略不計。

第三篇Duplex 2304不銹鋼鋼筋之性質和應用，介紹該鋼筋在過去6年應用於加拿大幾座公路橋梁之監測結果。

3.4 其他防蝕相關研究

本研討會其他主題廣泛涉及國防及核能發電等工業，其與本所港灣技術研究業務關聯性較低，因無法同時參與研討，故略而不加敘述，本次大會未提供論文集或光碟給報名人員，相關論文摘要可至http://www.nace.org/uploadedFiles/Events/Area_International/Area_Conference/NAE-2015-finalprogram.pdf 網址內瀏覽。本次會議各主題及論文名稱臚列如下：

主題 A：塗裝與襯裡

1.What the Stink? On the Scent of Something Big with Acid Gases and Linings.

2.Close Encounters on the Third “Crude–Oil” Kind.

3.Polyaspartic Urethane Coatings: Reducing Painting Costs and Increasing Productivity.

4.Activated Zinc – An Innovation that Redefines the Performance of Zinc Rich Epoxies.

5.Titanium–nano Polymer and its Anti–corrosion Applications.

6.Harsh Marine Environment Assessment of Coating Integrity and Corrosivity.

7.Glass Flake Usage in Protective Coatings Formulations: Is North America Behind?

8.Corrosion Control – PDCA Concept Application.

9.Development and Implementation of a Novel Method to Remove Inorganic Zinc Coating from Low Alloy Steel.

10. Oscillating Chemistry During Electrochemical Studies of Coated Aluminum Beverage.

Can Corrosion in Neutral pH NaCl Solutions.

主題 B：混凝土構造物腐蝕

1.The Study of Chloride Diffusion of Waterproofed Bridge Decks in Ontario and the Associated Corrosion Control Strategy.

2.Field Performance of Low–shrinkage High–performance Concrete Deck at Seaway International Bridge in Cornwall, Ontario

3.Duplex 2304 Stainless Steel Reinforcing Bar: Properties and Applications.

主題C：理論研究與量測技術

1.Condition Assessment Guidelines for Concrete Structures Reinforced with Galvanized steel by Using Half–cell Potential Technique.

2.Strain Concentrations in Corroded Bridge Columns Repaired with

FRP Wraps.

3.Experimental and Theoretical Studies on Newly Synthesized Photo-cross-linkable Chalcones for Inhibitions of Mild Steel.

主題D：防蝕材料選擇

1.Between The Discovery and The Doing – FRP Pipe Commercialization.

2.Investigation into the Reaction of Co-Cr-W Alloy in Amine Doped Water.

3.Advances in the Rotating Cage Method for Materials Selection in Oil and Gas Production.

主題E：防蝕案例研究

1.Study of Corrosion Failures in Copper Plumbing Systems.

2. Is this Really a Failure? Case Histories in Failure Analysis.

3.The Arvida Aluminum Bridge: A Follow-Up Visit 29 Years after Repair Work.

4.Corrosion Mitigation of X-60 type Carbon Steel in Petroleum Formation Water Under Pressure of CO_2.

主題F：國防

1.New Technologies and Future Challenges for the Prevention of Corrosion in US DoD Assets.

2. The Future Direction of Military Coatings.

3. Powder Coatings in the Defense Industry.

主題G：研究與發展

1.Investigation of the Role of Iron Content on the Crevice Corrosion of Grade-2 Titanium using Atomic Probe Tomography.

2.On the Role of Grain Boundary Mechanical Property in the Intergranular Stress Corrosion Cracking Susceptibility of 310S Exposed in Supercritical Water.

3.Integrating Corrosion Science, Engineering, and Management: Opportunities and Challenges.

4.Corrosion Impact and Corrosion Awareness in Canadian National Capital Region.

5.Corrosion Behaviour of Polypyrrole–Coated WE43 Mg Alloy in a Modified Simulated Body Fluid Solution.

6. Hydrogen in Metals Studied by Thermal Desorption Spectroscopy (TDS).

7.Pitfalls with Electrochemical Impedance Spectroscopy and Equivalent Circuit Models.

8.Magnesium Alloys as Promising Degradable Implant Materials in Orthopaedic Research..

主題H：陰極防蝕

1.Electromagnetic Interference in Pipelines: the Influence of Conductivity of the Pipeline Contents.

2. DC Voltage Gradient Surveys for Pipeline Risk Management.

3.Solid Oxide Fuel Cells for Remote Impressed Current Cathodic Protection Application.

主題I：石油與天然氣

1.Corrosion Growth Rate Management Plan Considering Measurement Error 2. Validating Metal Loss In-line Inspection Using API 1163 and CEPA Guidance Document.

3.ASME PCC-2, 4.1 Compliant Composite Repairs .

主題J：核能發電

1.Monitoring Cathodic Protection Systems in Nuclear and Other Congested Plant .

2.The Corrosion Behaviour of Copper-coated Carbon Steel.

3.The Radiolytic Corrosion of Copper Nuclear Waste Containers.

主題K：學生專題研究海報

1.Sulfide Induced Corrosion of Carbon Steel in Carbonate Buffered Aqueous Solutions Maxwell Goldman, The University of Western Ontario.

2.Corrosion of Carbon Steel under Deep Geologic Disposal Conditions for Spent Nuclear Fuel Waste.

3.Effect of Friction Stir Welding on the Corrosion Fatigue Performance of Magnesium Alloy AZ31B-H24.

4.Characterization of Sulphide Films Formed on Copper in Aqueous Sulphide/ Chloride Solutions.

5.On the Role of Grain Boundary Mechanical Property in the Intergranular Stress Corrosion Cracking Susceptibility of 310S Exposed in Supercritical Water.

6.Effect of Casting Techniques on the Corrosion Performance of AA7050.

7.The Corrosion of Simulated Nuclear Fuel in Hydrogen Peroxide Solutions- Effects of Fission Products.

8.Galvanic Coupling of Copper and Carbon Steel: An Investigation for Used Nuclear Fuel Containers.

9.Oxide Scale Stability of High-Cr Containing Alloy 33: Static Autoclave vs. Flow Loop Test.

10. Radiolytic Corrosion of Copper Nuclear Waste Containers

11.The Influence of Cooling Rate on the Corrosion Behaviour of a Wedge Cast Mg ZEK100 Alloy.

12.Pitting Behavior of High Strength Pipeline Steel in Aerated NaCl Solutions.

13.Effect of pH and Gamma Radiation on Corrosion and Oxide Film Formation on Alloy 800.

Session L：圓桌論壇-防蝕政策

1.Objectives of this round table and introduction of panelists

2.Interactions with Policy Makers in Washington D.C.

3.Usage and impact of NACE standards in govern ent regulations and industry best practices.

4.Usage and impact of ASTM standards on corrosion in government regulations and industry best practices.

5.Usage and impact of CSA standards on corrosion in government regulations and industry best practices.

6.Experience from and advantages of "Corrosion Policy and Oversight", –George Keller,Department of Defense, USA.

7.Experience from developing and using "Corrosion Policy in the Industry".

8. Opportunities for corrosion technology development in Canada.

9. Opportunities for corrosion research in Canada .

10.Opportunities for corrosion education in Canada –University/ College/High school – Craig Stevenson Discussion and wrap up.

3.5 資料蒐集- NACE International 簡介及其訓練與認證制度

NACE International 成員創始於 1943年，係由當時11位從事防蝕相關行業之優秀工程師先成立「全國腐蝕工程師協會」，成立主要宗旨為：保護人、資產和環境免受腐蝕影響或破壞，並提供防蝕相關工程等之指導原則和戰略優先事項。成立初期雖僅屬於區域組織，但已

積極推廣介紹防蝕工法與從事陰極防蝕等研究，至今已成為全球領先研發腐蝕預防和控制標準、推廣認證和訓練教育之組織。

NACE International 總部設於美國設在德州休士頓，在加州聖地牙哥、馬來西亞吉隆坡、中國上海、巴西聖保羅和沙烏地阿拉伯Al-Khobar設有辦事處。北美地區(美國及加拿大)並設有北部、中部、東部與西部4個支部，其他在歐洲、亞太等地區亦各設有4個支部，目前全球共有108個辦公室和33個學生支會，贊助各地辦理相關工作，促進防蝕資訊交流和推廣技術教育等。NACE International 擁有超過70年的發展經驗，其成員致力參與材料腐蝕防治的發展及研究，並訂立眾多防蝕規範及認證制度。目前設有300多個技術委員會，有2600多家NACE成員參與技術委員會的活動，為現今全球最具規模的工程師協會。其參加會員資格開放給對於在防蝕工程及材料工程等有興趣的人員，目前主要是以防蝕工程及材料工程相關領域之學者專家所組成。最初會員來自美國、加拿大、英國等幾個國家成員，目前則已經有超過130個國家以上是經常性參與其會務和活動。該協會每年由總會舉行年會一次，是目前世界上最大型防蝕工程技術上之國際研討會，主要在美國各主要城市輪流舉行，各支會或支部在世界各國許多主要城市亦每年均辦理多場研討會。此外，NACE 國際訂有一個完整的訓練和認證方案，自2003年以來已舉辦超過 90 堂認證課程。其認證的課程包含了陰極防蝕技術、防蝕塗裝包覆及襯裡、腐蝕抑制劑、核能級防蝕塗料等。訓練課程教師皆為專業的防蝕專家，課程所提供的設備、書籍和學習工具十分詳盡，皆能幫助學員取得所需的的認證。現今舉凡國際不論大小之防蝕工程設計與施工皆需具備NACE International認證之工程人員參與以確保施工品質及系統安全。

本次參與會議，主辦單位特別準備NACE International 相關資料，包括期刊(MP- Material Perform；Corrosion；CoatingPro；Corrdefence；LatinCorr；InspectThis等，如圖3.9-圖3.12)、認證分級與訓練教育課程(如圖3.13-圖3.23，摘錄自TRAININGS&CERTIFICATION GUIDE,2014)、2015年出版品簡介(如圖3.24)、2015年修訂技術標準，2016防蝕年報名與參加展示資訊...等供與會人員參考。本所港灣技術研究中心近年來極

力從事港灣結構物防蝕準則、港灣構造物維護管理制度建立與大氣腐蝕環境分類等研究，期藉由相關研究成果作為後續推動港灣構造物維護管理士和本土防蝕技術人員認證等工作，本次所蒐集NACE International 資料可提供參考應用。

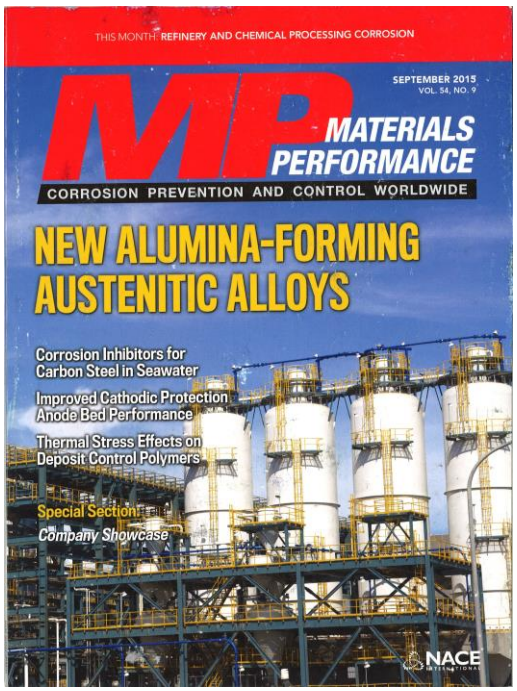

圖3.9 MP- Material Perform

圖3.10 Corrosion

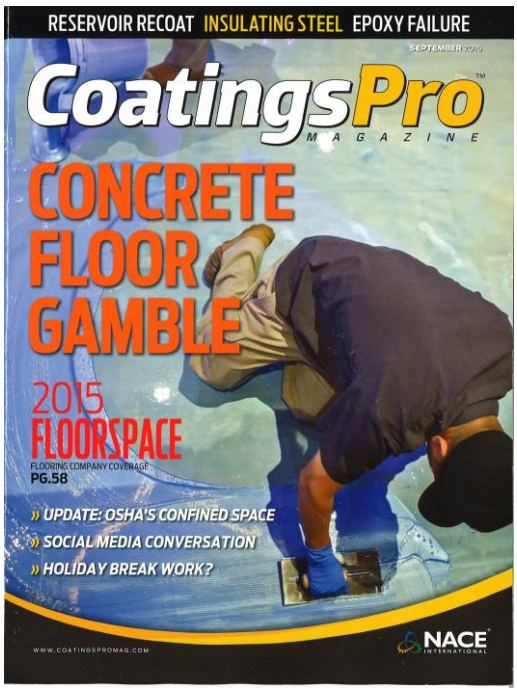

圖3.11 CoatingPro

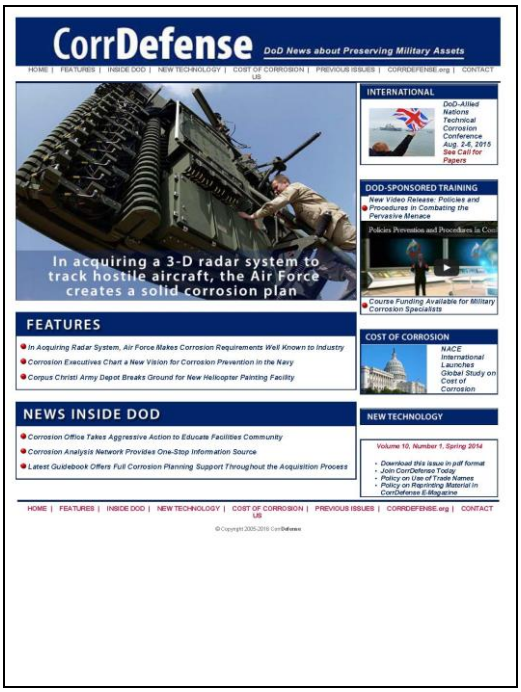

圖3.12 Corrdefence

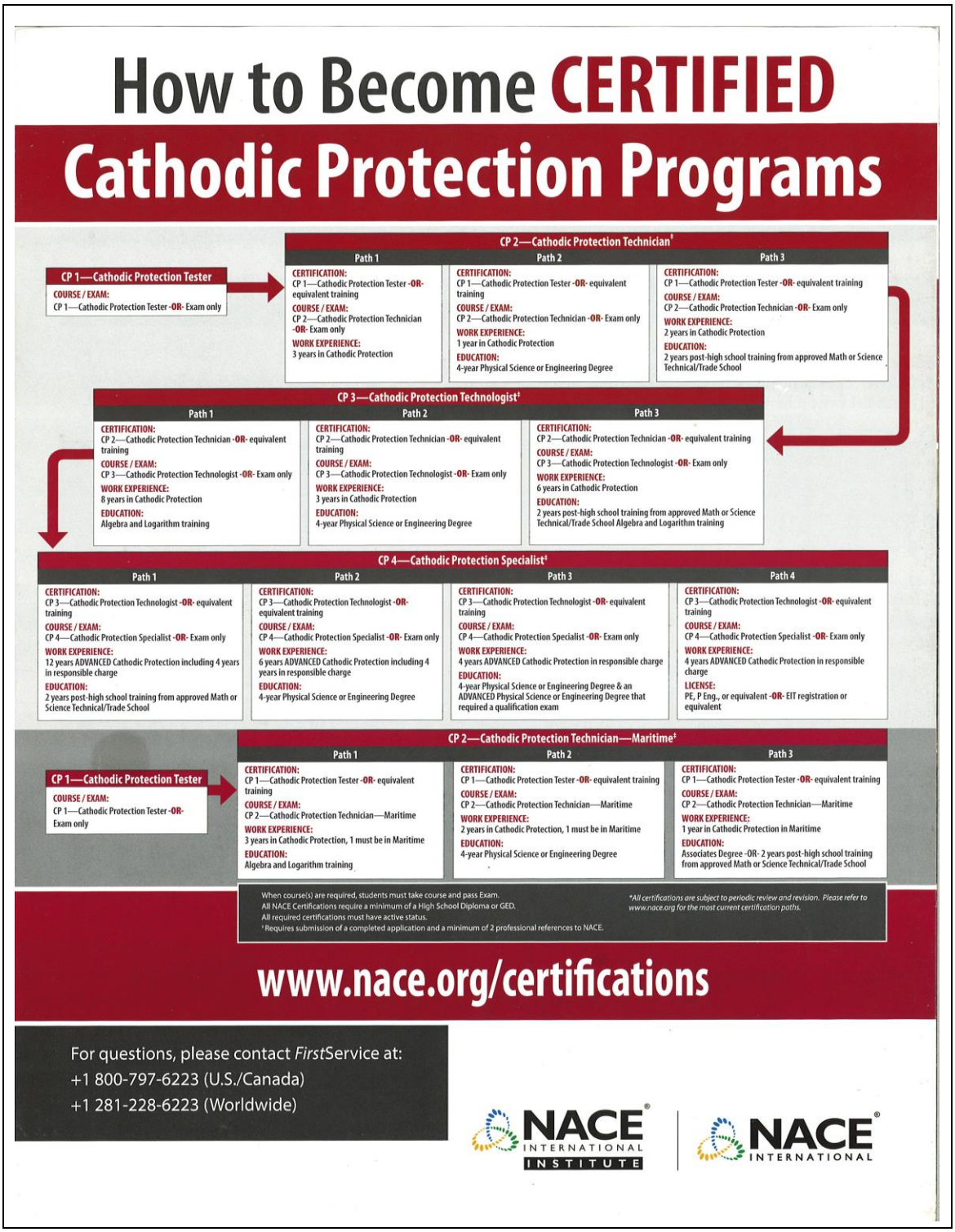

圖3.13 NACE International 陰極防蝕認證分級示意圖

GENERAL CORROSION PROGRAM

Offshore Corrosion Assessment Training (O-CAT)

This course addressess the elements of in-service inspection and maintenance planning for fixed offshore structures. Also covered in this course are the Bureau for Safety and Environmental Enforcement (BSEE) A-B-C facility evaluation grading system requirements for Level 1 Inspection Reporting. A written and practical exam is given at the end of the course.

5-Day Classroom Course
Days 1–5: 8 a.m. to 5 p.m., *unless otherwise noted*

3.8 CEUs

For current pricing information or to register for this course, please visit nace.org/education

Who Should Attend

Anyone involved in corrosion control and integrity management of fixed offshore structures. The curriculum benefits varied levels of personnel, from those with management and planning responsibilities to the field inspectors conducting in-service inspections of the facility. The program is also valuable for offshore platform operations personnel to better understand corrosion prevention systems utilized on offshore structures and their successful implementation.

Prerequisites

Previous training in corrosion control is not required to take this course. However, a basic understanding of science and chemistry is recommended to gain the most value from this course.

Learning Objectives—The goal is to prepare students to:

- Define corrosion and recognize the importance of corrosion control
- Consistently assess the condition of the corrosion protective systems in the offshore environment
- Recognize the various types of oil platforms/rigs and equipment
- Ensure the offshore structure is protected from corrosion and in accordance with regulations
- Provide safe and dependable structures and facilities through usage of corrosion prevention maintenance programs
- Identify and define the primary corrosion protection systems used in offshore
  - Protective Coatings
  - Splash Zone Systems
  - Cathodic Protection
- Recognize the various condition grading systems
- Break down a wellhead platform into a manageable system for condition assessment and data collection
- Perform a visual assessment and physical inspection of the corrosion prevention systems of a four-pile wellhead platform
- Be in accordance with assessment standards
- Deliver and maintain safety
- Understand the Bureau of Safty & Environmental Enforcement (BSEE) A-B-C facility evaluation grading system requirements for Level I inspection reporting

Reference Materials Included	Certification* Options
OCAT Offshore Platform Photo Assessment Guide	O-CAT Technician *A photo ID is required at the time of the certification exam.*

* *All certifications are administered by the **NACE International Institute**, the independent certification affiliate of **NACE International**. Certifications are subject to periodic reviews and revisions, please refer to **www.naceinstitute.org** for the most current certification information.*

For certification information, visit **naceinstitute.org**

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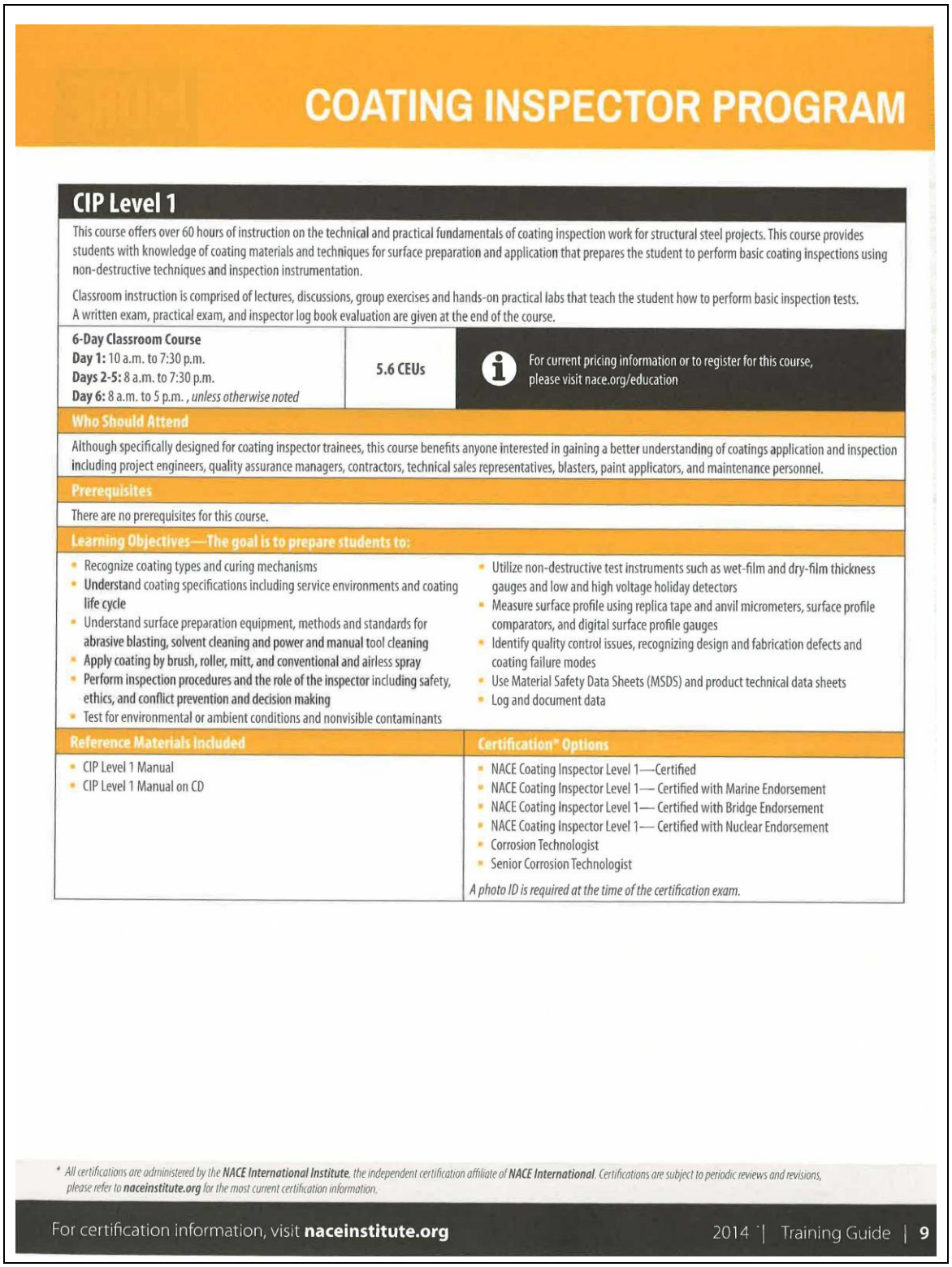
圖3.14 NACE International 海岸腐蝕訓練(0-cat)課程



COATING INSPECTOR PROGRAM

CIP Level 1

This course offers over 60 hours of instruction on the technical and practical fundamentals of coating inspection work for structural steel projects. This course provides students with knowledge of coating materials and techniques for surface preparation and application that prepares the student to perform basic coating inspections using non-destructive techniques and inspection instrumentation.

Classroom instruction is comprised of lectures, discussions, group exercises and hands-on practical labs that teach the student how to perform basic inspection tests. A written exam, practical exam, and inspector log book evaluation are given at the end of the course.

6-Day Classroom Course
Day 1: 10 a.m. to 7:30 p.m.
Days 2-5: 8 a.m. to 7:30 p.m.
Day 6: 8 a.m. to 5 p.m. , *unless otherwise noted*

5.6 CEUs

For current pricing information or to register for this course, please visit nace.org/education

Who Should Attend

Although specifically designed for coating inspector trainees, this course benefits anyone interested in gaining a better understanding of coatings application and inspection including project engineers, quality assurance managers, contractors, technical sales representatives, blasters, paint applicators, and maintenance personnel.

Prerequisites

There are no prerequisites for this course.

Learning Objectives—The goal is to prepare students to:

- Recognize coating types and curing mechanisms
- Understand coating specifications including service environments and coating life cycle
- Understand surface preparation equipment, methods and standards for abrasive blasting, solvent cleaning and power and manual tool cleaning
- Apply coating by brush, roller, mitt, and conventional and airless spray
- Perform inspection procedures and the role of the inspector including safety, ethics, and conflict prevention and decision making
- Test for environmental or ambient conditions and nonvisible contaminants
- Utilize non-destructive test instruments such as wet-film and dry-film thickness gauges and low and high voltage holiday detectors
- Measure surface profile using replica tape and anvil micrometers, surface profile comparators, and digital surface profile gauges
- Identify quality control issues, recognizing design and fabrication defects and coating failure modes
- Use Material Safety Data Sheets (MSDS) and product technical data sheets
- Log and document data

Reference Materials Included

- CIP Level 1 Manual
- CIP Level 1 Manual on CD

Certification* Options

- NACE Coating Inspector Level 1—Certified
- NACE Coating Inspector Level 1— Certified with Marine Endorsement
- NACE Coating Inspector Level 1— Certified with Bridge Endorsement
- NACE Coating Inspector Level 1— Certified with Nuclear Endorsement
- Corrosion Technologist
- Senior Corrosion Technologist

A photo ID is required at the time of the certification exam.

* *All certifications are administered by the* ***NACE International Institute****, the independent certification affiliate of* ***NACE International****. Certifications are subject to periodic reviews and revisions, please refer to* ***naceinstitute.org*** *for the most current certification information.*

For certification information, visit **naceinstitute.org**

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圖3.15 NACE International 塗裝目視檢察CIP Level 1訓練課程

COATING INSPECTOR PROGRAM

MORE with NACE

CIP Level 2

This course focuses on advanced inspection techniques and specialized application methods for both steel and non-steel substrates, including concrete using both nondestructive and destructive techniques. Surface preparation, coating types, inspection criteria, lab testing, and failure modes for various coatings, including specialized coatings and linings are also covered.

Classroom instruction is comprised of lectures, discussions, group exercises, and hands-on labs using destructive and nondestructive instruments and test methods. Students will also participate in case studies based on real-life situations and practices of a coatings inspector. The course concludes with both written and practical exams.

6-Day Classroom Course
Day 1: 10 a.m. to 7:30 p.m.
Days 2-5: 8 a.m. to 7:30 p.m.
Day 6: 8 a.m. to 5 p.m., *unless otherwise noted*

5.6 CEUs

For current pricing information or to register for this course, please visit nace.org/education

Who Should Attend

Anyone interested in becoming NACE Coating Inspector Level 2—Certified or increasing his or her coating inspection knowledge should attend this course.

Prerequisites

Successful completion of CIP Level 1 classroom training or CIP Exam Course 1 with a current CIP Level 1 certification is required to register.

Learning Objectives—The goal is to prepare students to:

- Understand the advanced corrosion theory
- Understand environmental controls and advanced environmental testing
- Identify centrifugal blast cleaning and water jetting equipment, standards, methods of use, and inspection concerns
- Recognize the importance of surface preparation, application and inspection of liquid-applied and thick barrier linings
- Use specialized application equipment including plural-component, electrostatic and centrifugal, and hot spray systems
- Understand concrete coatings
- Identify specialized coating techniques and application of non-liquid coatings
- Distinguish coating survey techniques and procedures and common coating failure modes

Reference Materials Included

- CIP Level 2 Manual
- CIP Level 2 Manual on CD
- *Corrosion Prevention by Protective Coatings, Second Edition* by C.G. Munger, revision Author L.D. Vincent
- *User's Guide to Hot Dip Galvanizing for Corrosion Protection in Atmospheric Service, TPC 9*

Certification* Options

- NACE Coating Inspector Level 2—Certified
- NACE Coating Inspector Level 2— Certified with Marine Endorsement
- NACE Coating Inspector Level 2— Certified with Bridge Endorsement
- NACE Coating Inspector Level 2— Certified with Nuclear Endorsement
- Corrosion Technologist
- Senior Corrosion Technologist

A photo ID is required at the time of the certification exam.

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圖3.16 NACE International 塗裝目視檢察CIP Level 2訓練課程

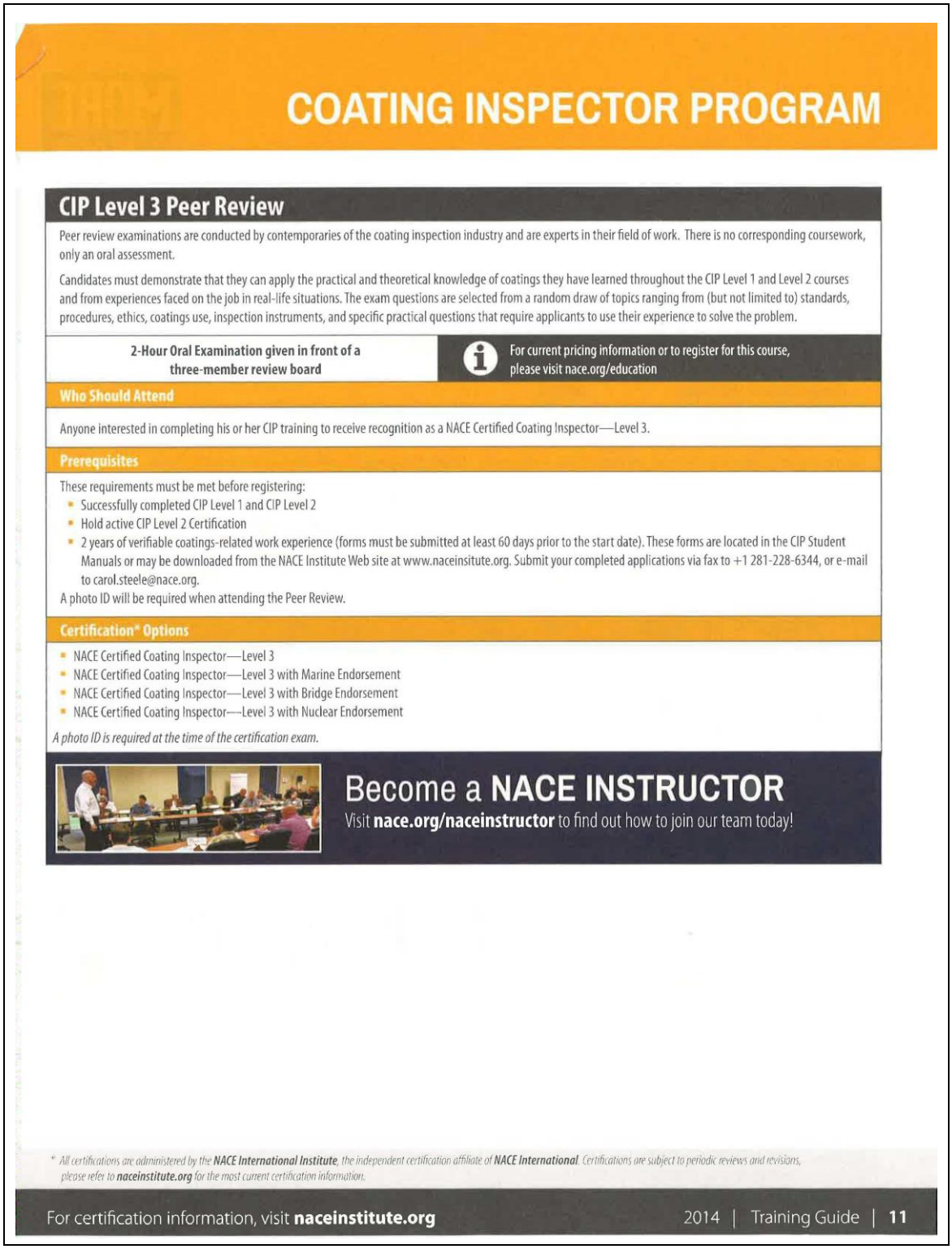

圖3.17 NACE International 塗裝目視檢察CIP Level 3訓練課程

COATING INSPECTOR PROGRAM

Marine Coating Technology

This course covers the fundamental issues that are specific to coatings in the marine industry. After a description of the most common types of ships, the course describes the corrosion types affecting the ships' areas, the types of coatings and linings that are effective in the marine environment, the shipbuilding process, the surface preparation, application and inspection techniques, the IMO PSPC for Ballast Tanks, Cargo Tanks and Voids, as well as in-service survey and inspection, inspection records and procedures. This course was prepared by a team of experts with more than 20 years of experience in marine coating industry developed with both shipowners and shipyards.

Classroom instruction is comprised of lectures and discussions but does not include inspection tools or equipment. A written examination is given at the end of the course.

4-Day Classroom Course **Days 1-4:** 8 a.m. to 5 p.m., *unless otherwise noted*	**3.1 CEUs**	For current pricing information or to register for this course, please visit nace.org/education

Who Should Attend

Although specifically designed for coating inspector trainees, this course benefits anyone interested in gaining a better understanding of coatings application and inspection including project engineers, quality assurance managers, contractors, technical sales representatives, blasters, paint applicators, and maintenance personnel.

Prerequisites

Content written and delivered with the assumption that students have completed CIP level 1. CIP Level 2 is highly recommended.

Learning Objectives—The goal is to prepare students to:

- Possess thorough knowledge of surface preparation and associated quality control
- Have intermediate knowledge of protective coatings, their uses on vessels, their application, and associated quality control
- Recognize salient safety issues associated with performing inspection in marine industry
- Identify and use instruments mainly used in marine coating inspection
- Understand various IMO Resolutions related to protective coatings (PSPC for ballast tanks, cargo tanks and voids, antifouling, etc.)

Reference Materials Included	Certification* Options
• Marine Coating Technology Manual • Marine Coating Technology Manual on CD	• NACE Coating Inspector Level 1—Certified with Marine Endorsement • NACE Coating Inspector Level 2—Certified with Marine Endorsement • NACE Certified Coating Inspector—Level 3 with Marine Endorsement A certificate of completion is administered after successful completion of this course to students who are not CIP-certified. *A photo ID is required at the time of the certification exam.*

ON-SITE TRAINING

Interested in hosting this course at your own facility?

Visit **nace.org/hostacourse** to see details on how NACE can come to you!

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圖3.18 NACE International 海洋塗裝技術訓練教育課程

GENERAL COATINGS PROGRAM

MORE with NACE

Shipboard Corrosion Assessment Training (S-CAT)

The Shipboard Corrosion Assessment Training course provides a foundation of coatings, corrosion, and corrosion control knowledge for assessing the condition of tanks and other military ship structures, while determining the required actions necessary to effectively maintain fully operational status. The course equips the naval assessor with practical guidelines for surveying and evaluating the condition of the protective coating system on specific areas of U.S. Navy vessels. The course concludes with a written and practical exam.

5-Day Classroom Course **Days 1-5:** 8 a.m. to 5 p.m., *unless otherwise noted*	3.8 CEUs	For current pricing information or to register for this course, please visit nace.org/education

Who Should Attend

- Coating Inspectors
- Shipyard Planners
- Design Engineers
- Type Commander Representatives
- Port Engineers

Prerequisites

It is is highly recommended that students possess a High School Diploma or GED and have a minimum of three months work experience in the evaluation of corrosion or coatings breakdown on marine vessels.

Learning Objectives—The goal is to prepare students to:

- Perform visual assessments for all ship areas
- Determine corrosion control methods:
  - Design
  - Inhibitors
  - Protective Coatings
  - Cathodic Protection
  - Corrosion Resistant Materials
  - Alteration of Environment
- Utilize evaluation tools and equipment such as a tooke gauge and precision groove grinder
- Accurately evaluate a corrosion protection system
- Plan maintenance and manage inspection results in a Corrosion Control Information Management System (CCIMS)
- Properly conduct a tank inspection using the Corrosion Control Assessment Maintenance Manual (CCAM)
- Perform total tank scoring
- Perform adhesion testing

Reference Materials Included	Certification* Options
▪ S-CAT Manual	▪ S-CAT Technician *A photo ID is required at the time of the certification exam.*

* *All certifications are administered by the **NACE International Institute**, the independent certification affiliate of **NACE International**. Certifications are subject to periodic reviews and revisions, please refer to **naceinstitute.org** for the most current certification information.*

圖3.19 NACE International 船舶甲板腐蝕訓練(s-cat)課程

CATHODIC PROTECTION PROGRAM

MORE with NACE

CP 1—Cathodic Protection Tester

This course provides theoretical knowledge and practical fundamentals for testing on both galvanic and impressed current CP systems. Classroom instruction is comprised of lectures and hands-on training at an outdoor facility, using equipment and instruments for CP testing. An open book written exam and a closed book practical exam is given at the end of the course.

6-Day Classroom Course
Day 1: 1 p.m. to 6:30 p.m.
Days 2-5: 8 a.m. to 6:30 p.m.
Day 6: 8 a.m. to 3 p.m., *unless otherwise noted*

4.8 CEUs

For current pricing information or to register for this course, please visit nace.org/education

Who Should Attend

This program benefits anyone responsible for supervising CP systems, measuring the effectiveness of CP systems, and/or recording this data, including CP field personnel and technicians.

Prerequisites

The following prerequisites are highly recommended, but not required:

- High School Diploma or GED
- Six months of CP work experience
- Ability to perform basic math calculations *(simple algebra, fractions, and conversions)*

If you are not sure if you possess the basic knowledge to pass CP 1, you may walk through the short primer on Ohm's Law and Math Assessment online at **nace.org/cp.**

Learning Objectives—The goal is to prepare students to:

- Understand the basics of electricity, electrical laws, electrochemistry, corrosion, and CP theory
- Understand how polarity is related to current flow and metal corrosion activity
- Conduct tests to identify shorts and continuity tests in CP systems
- Use test instruments to perform a variety of field tests such as structure-to-soil potentials, voltage and current measurements, soil resistivity, pipe/cable locating, and rectifier readings
- Understand CP components including impressed current systems, galvanic anodes and test stations
- Read shunts and understand their use in rectifiers, bonds, and anodes
- Perform periodic surveys to confirm the effectiveness of a CP system
- Gain knowledge of reference cells, their maintenance, use, and precautions
- Learn basic location mapping, report preparation, and recordkeeping
- Review safety issues specific to CP
- Understand code requirements related to CP

Reference Materials Included

- CP 1—CP Tester Manual
- CP 1—CP Tester Manual on CD plus First 2 Chapters
- *Peabody's Control of Pipeline Corrosion, Second Edition* by A.W. Peabody

Certification* Options

- CP 1—Cathodic Protection Tester

A photo ID is required at the time of the certification exam.

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圖3.20 NACE International 陰極防蝕測試人員(CP1)訓練課程

CATHODIC PROTECTION PROGRAM

CP 2—Cathodic Protection Technician

This course provides both theoretical knowledge and practical techniques for testing and evaluating data to determine the effectiveness of both galvanic and impressed current CP systems and to gather design data.

Classroom instruction is comprised of lectures and hands-on training at an outdoor facility, using equipment and instruments for CP testing. An open book written exam and a closed book practical exam is given at the end of the course.

6-Day Classroom Course
Day 1: 1 p.m. to 6:30 p.m.
Days 2-5: 8 a.m. to 6:30 p.m.
Day 6: 8 a.m. to 3 p.m., *unless otherwise noted*

4.8 CEUs

For current pricing information or to register for this course, please visit nace.org/education

Who Should Attend

This program benefits anyone responsible for supervising CP systems, measuring the effectiveness of CP systems, and/or recording this data, including CP field personnel and technicians.

Prerequisites

The following prerequisites are recommended.

- In-depth high school chemistry and mathematics course
- The NACE Basic Corrosion course
- CP 1-Cathodic Protection Tester or equivalent

Learning Objectives—The goal is to prepare students to:

- Perform advanced field tests (including current requirement test, shorted casing test, IR drop test, soil resistivity, and interference tests) and evaluate the results
- Perform tests to verify the presence of stray current interference and recommend method(s) to mitigate the interference
- Conduct and understand the importance of periodic surveys, including IR-Free readings, polarization decay tests, and current measurements
- Maintain documentation and records, including data plotting and analysis
- Understand AC voltage and its mitigation
- Test and troubleshoot rectifier component parts
- Understand corrosion coupon test stations
- Understand code requirements related to CP

Reference Materials Included

- CP 2—CP Technician Manual
- CP 2—CP Technician Manual on CD plus First 2 Chapters
- *Cathodic Protection Survey Procedures*, by W. Brian Holtsbaum

Certification* Options

- CP 2—Cathodic Protection Technician
- Corrosion Technologist
- Senior Corrosion Technologist

A photo ID is required at the time of the certification exam.

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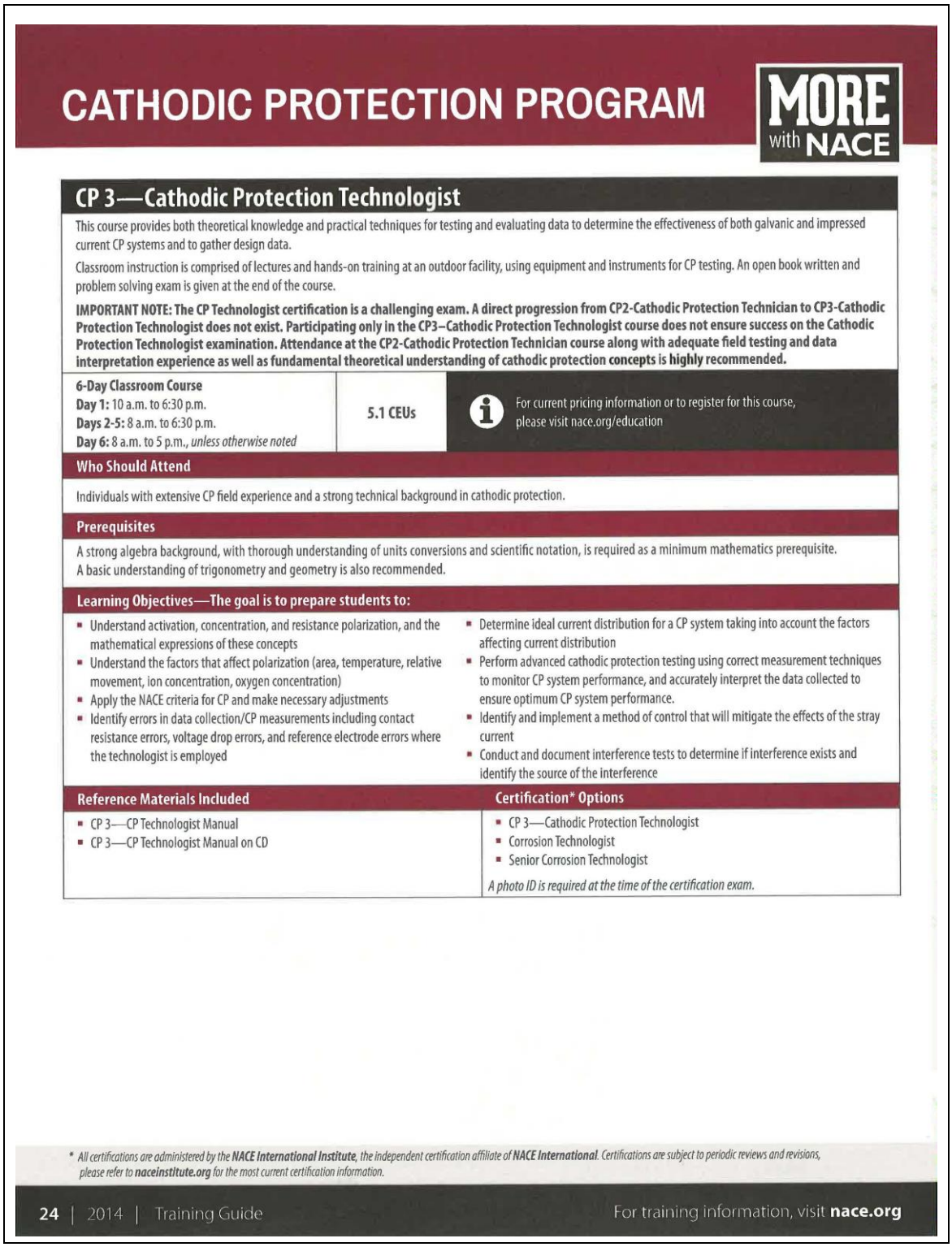
圖3.21 NACE International 陰極防蝕技術士(CP2)訓練課程



CATHODIC PROTECTION PROGRAM

MORE with NACE

CP 3—Cathodic Protection Technologist

This course provides both theoretical knowledge and practical techniques for testing and evaluating data to determine the effectiveness of both galvanic and impressed current CP systems and to gather design data.

Classroom instruction is comprised of lectures and hands-on training at an outdoor facility, using equipment and instruments for CP testing. An open book written and problem solving exam is given at the end of the course.

IMPORTANT NOTE: The CP Technologist certification is a challenging exam. A direct progression from CP2-Cathodic Protection Technician to CP3-Cathodic Protection Technologist does not exist. Participating only in the CP3–Cathodic Protection Technologist course does not ensure success on the Cathodic Protection Technologist examination. Attendance at the CP2-Cathodic Protection Technician course along with adequate field testing and data interpretation experience as well as fundamental theoretical understanding of cathodic protection concepts is highly recommended.

6-Day Classroom Course	5.1 CEUs	For current pricing information or to register for this course, please visit nace.org/education
Day 1: 10 a.m. to 6:30 p.m. **Days 2-5:** 8 a.m. to 6:30 p.m. **Day 6:** 8 a.m. to 5 p.m., *unless otherwise noted*		

Who Should Attend

Individuals with extensive CP field experience and a strong technical background in cathodic protection.

Prerequisites

A strong algebra background, with thorough understanding of units conversions and scientific notation, is required as a minimum mathematics prerequisite. A basic understanding of trigonometry and geometry is also recommended.

Learning Objectives—The goal is to prepare students to:

- Understand activation, concentration, and resistance polarization, and the mathematical expressions of these concepts
- Understand the factors that affect polarization (area, temperature, relative movement, ion concentration, oxygen concentration)
- Apply the NACE criteria for CP and make necessary adjustments
- Identify errors in data collection/CP measurements including contact resistance errors, voltage drop errors, and reference electrode errors where the technologist is employed
- Determine ideal current distribution for a CP system taking into account the factors affecting current distribution
- Perform advanced cathodic protection testing using correct measurement techniques to monitor CP system performance, and accurately interpret the data collected to ensure optimum CP system performance.
- Identify and implement a method of control that will mitigate the effects of the stray current
- Conduct and document interference tests to determine if interference exists and identify the source of the interference

Reference Materials Included

- CP 3—CP Technologist Manual
- CP 3—CP Technologist Manual on CD

Certification* Options

- CP 3—Cathodic Protection Technologist
- Corrosion Technologist
- Senior Corrosion Technologist

A photo ID is required at the time of the certification exam.

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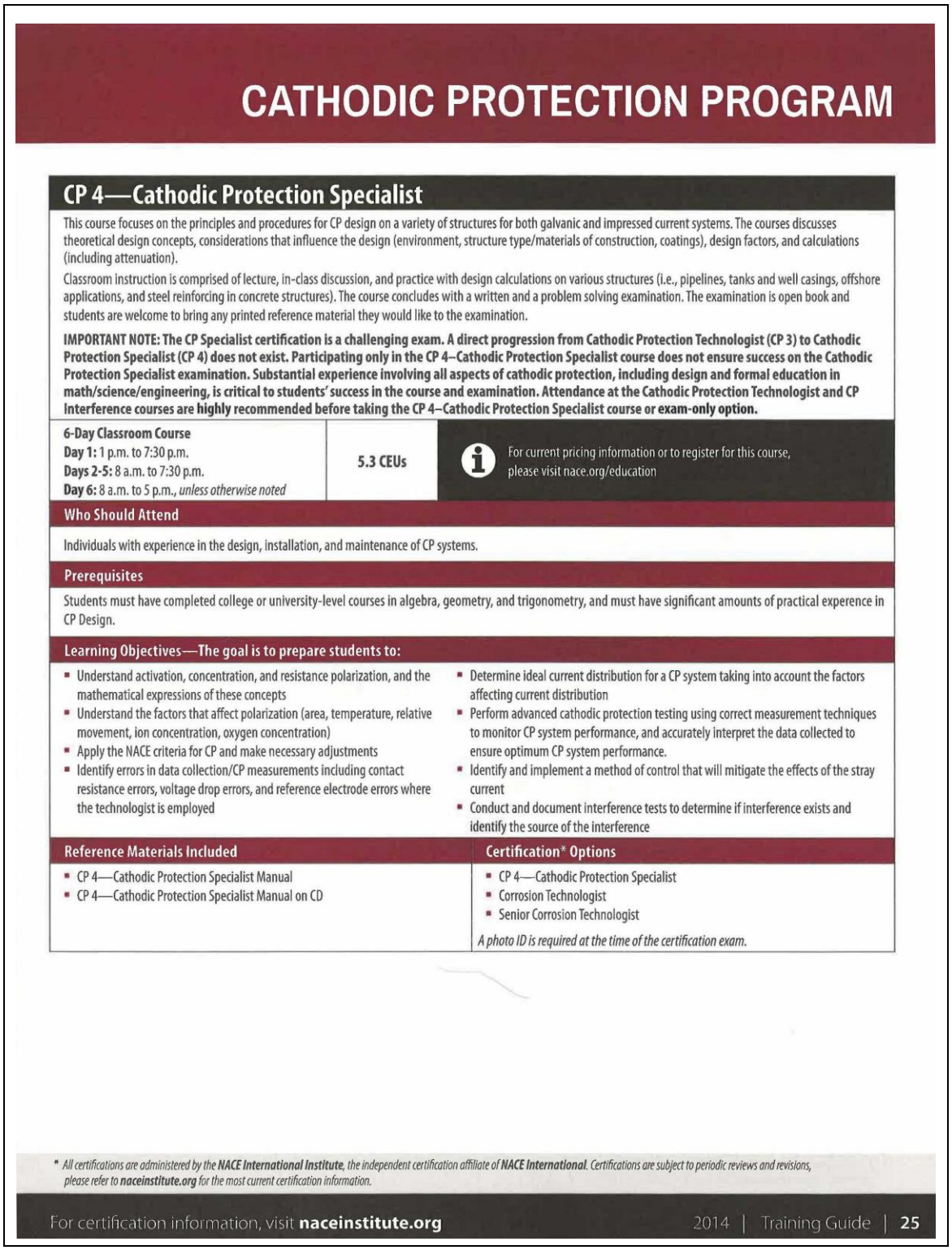
圖3.22 NACE International 陰極防蝕技師(CP3)訓練課程



CATHODIC PROTECTION PROGRAM

CP 4—Cathodic Protection Specialist

This course focuses on the principles and procedures for CP design on a variety of structures for both galvanic and impressed current systems. The courses discusses theoretical design concepts, considerations that influence the design (environment, structure type/materials of construction, coatings), design factors, and calculations (including attenuation).

Classroom instruction is comprised of lecture, in-class discussion, and practice with design calculations on various structures (i.e., pipelines, tanks and well casings, offshore applications, and steel reinforcing in concrete structures). The course concludes with a written and a problem solving examination. The examination is open book and students are welcome to bring any printed reference material they would like to the examination.

IMPORTANT NOTE: The CP Specialist certification is a challenging exam. A direct progression from Cathodic Protection Technologist (CP 3) to Cathodic Protection Specialist (CP 4) does not exist. Participating only in the CP 4–Cathodic Protection Specialist course does not ensure success on the Cathodic Protection Specialist examination. Substantial experience involving all aspects of cathodic protection, including design and formal education in math/science/engineering, is critical to students' success in the course and examination. Attendance at the Cathodic Protection Technologist and CP Interference courses are highly recommended before taking the CP 4–Cathodic Protection Specialist course or exam-only option.

6-Day Classroom Course	5.3 CEUs	For current pricing information or to register for this course, please visit nace.org/education
Day 1: 1 p.m. to 7:30 p.m. **Days 2-5:** 8 a.m. to 7:30 p.m. **Day 6:** 8 a.m. to 5 p.m., *unless otherwise noted*		

Who Should Attend

Individuals with experience in the design, installation, and maintenance of CP systems.

Prerequisites

Students must have completed college or university-level courses in algebra, geometry, and trigonometry, and must have significant amounts of practical experence in CP Design.

Learning Objectives—The goal is to prepare students to:

- Understand activation, concentration, and resistance polarization, and the mathematical expressions of these concepts
- Understand the factors that affect polarization (area, temperature, relative movement, ion concentration, oxygen concentration)
- Apply the NACE criteria for CP and make necessary adjustments
- Identify errors in data collection/CP measurements including contact resistance errors, voltage drop errors, and reference electrode errors where the technologist is employed
- Determine ideal current distribution for a CP system taking into account the factors affecting current distribution
- Perform advanced cathodic protection testing using correct measurement techniques to monitor CP system performance, and accurately interpret the data collected to ensure optimum CP system performance.
- Identify and implement a method of control that will mitigate the effects of the stray current
- Conduct and document interference tests to determine if interference exists and identify the source of the interference

Reference Materials Included

- CP 4—Cathodic Protection Specialist Manual
- CP 4—Cathodic Protection Specialist Manual on CD

Certification* Options

- CP 4—Cathodic Protection Specialist
- Corrosion Technologist
- Senior Corrosion Technologist

A photo ID is required at the time of the certification exam.

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For certification information, visit **naceinstitute.org** 2014 | Training Guide | 25

圖3.23 NACE International 陰極防蝕專家(CP4)訓練課程

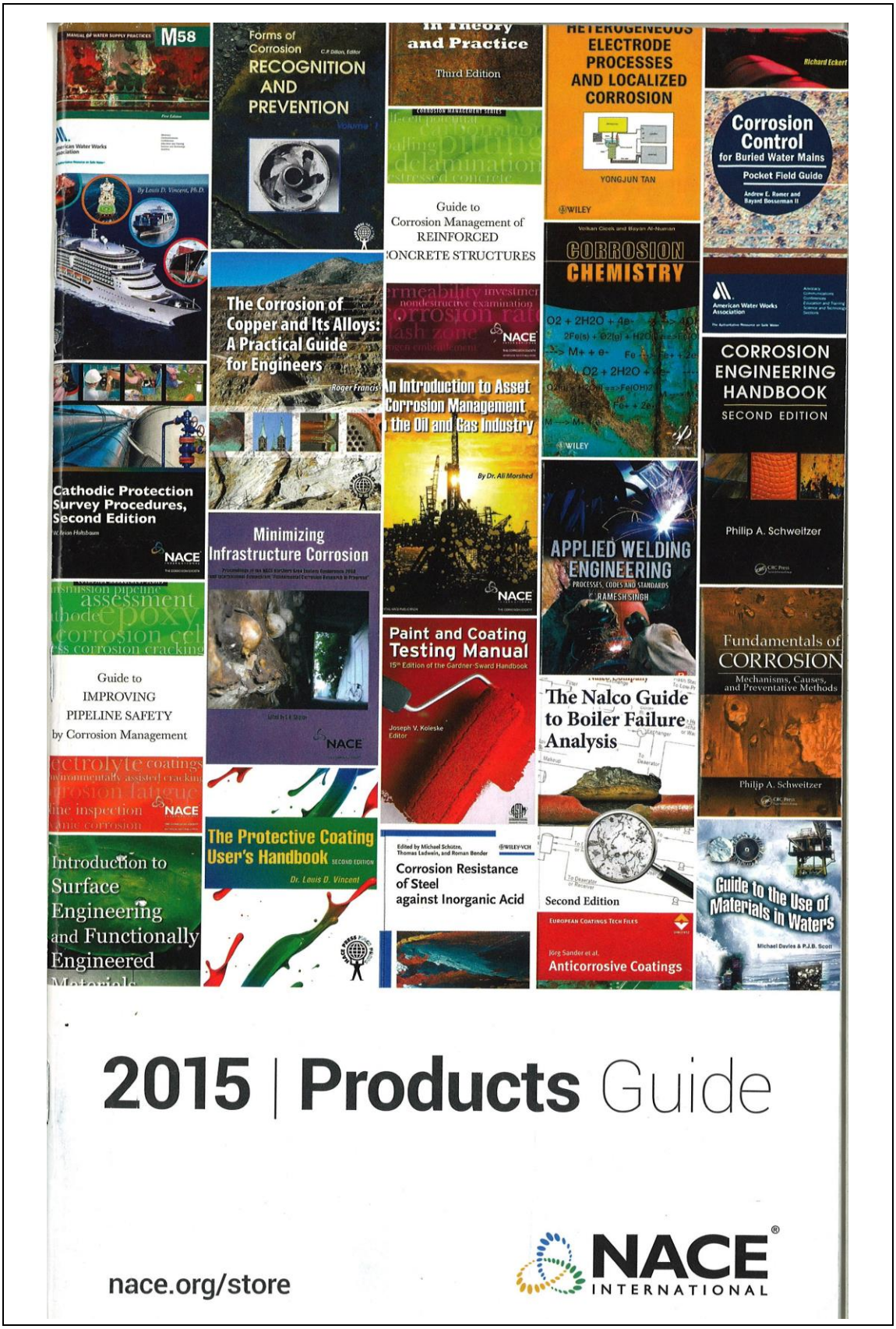

圖3.24 NACE International 2015年出版品簡介

四、結論與建議

本次2015年 NACE 北美地區北區東部研討會，共有加拿大、美國、南非及中國等國家的專家學者參與發表56篇論文，每篇均能深入探討其相關議題，與會研討人員發言相當踴躍，且能就有興趣之議題與論文內容交換意見，配合展示之設備與技術研發成果，所獲心得豐碩。議程4天共8場次，議場安排在加拿大首都渥太華市Courtyard by Marriott Ottawa旅館會議廳，該會議廳內部設置2個會議室，和1展示大廳，每個小型會議室可容納數十人同時與會，議事安排順暢，支援人力及設備充足，會議之進行十分順利。

與國內相關防蝕工程研討會比較，本研討會共分10個主題，涵蓋面廣泛，參與展示廠商家數亦更踴躍，相關研究議題均為該領域先進課題，經由本次參與研討，就大致可瞭解國外近來與本身職務有關研究方向與發展。因此，參加本次研討會對職個人業務、視野或資訊取得有極正面的幫助與提升。綜合以上心得說明，茲有以下數點結論與建議：

1. 本次參加研討會，在奈米聚合物應用於防蝕技術，有一初步的體認與收穫，此塗裝材料具備之防蝕與防污功能顯著，如能應用在港灣工程重要構件，將可達到延長使用壽命與確保營運安全之目的，惟其研發技術尚有精進空間，使用經費較高，經濟效益不彰。

2. RDC公司在北美地區沿海區域進行大氣腐蝕暴露試驗，其試驗方法與成果，可與本所港灣技術研究中心之腐蝕環境分類及港灣構造物腐蝕劣化調查研究成果相互交流，此專案同時分析該沿海區域經過1年暴露試驗後之腐蝕環境分類等級和研發大氣腐蝕速率之預測模型，可供本所研究參考。

3. 混凝土構造物腐蝕與防蝕之研究主題，介紹移除混凝土中氯離子之技術與橋梁使用高性能混凝土為建造材料性能探討，與本所RC橋梁材料耐久性評估與殘餘壽命預測之研究業務密切相關，可供本所與

國內相關橋梁管理單位參考。

4. 本所港灣技術研究中心歷年進行之碼頭鋼(管)板樁調查結果發現，飛沫帶與潮間帶腐蝕嚴重，防蝕措施亦較不易施作，以金門水頭及九宮港區浮動碼頭為例，基樁表面受浮箱滾輪摩擦碰撞導致塗層脫落現象，本次研討會介紹多種塗料與防蝕技術，可供做參考。

5. NACE International 所提供該組織之防蝕訓練與認證機制，可供我國公共工程規範辦理防蝕工程設計或監造施工單位必備能力參考，本所港灣技術研究中心研擬推動建立港灣構造物維護管理技術士，其訓練課程與認證制度，亦可引用參考。

6. 參加國際大型研討會，可更瞭解國際上新近之研究發展，吸取廣泛資訊及相關新知，提升對業務的幫助，建議鼓勵同仁參加。

附錄　研討會議程、論文題目及作者

NACE INTERNATIONAL NORTHERN AREA EASTERN CONFERENCE

Schedule at a Glance

Sunday, October 18, 2015		
8:00 a.m. - 5:00 p.m.	**BOARD OF TRUSTEES —** McDonald	
2:00 - 5:00 p.m.	**REGISTRATION OPENS —** Foyer	
2:00 - 5:00 p.m.	**EXHIBITOR SET UP —** Laurier	
5:30 - 7:30 p.m.	**MEET & GREET —** The Bistro	
Monday, October 19, 2015		
7:30 a.m. - 5:00 p.m.	**REGISTRATION —** Foyer	
8:00 a.m. - 5:00 p.m.	**EXHIBITOR HALL OPEN —** Laurier	
	McDonald	**Cartier**
8:00 - 9:30 a.m.	**OPENING CEREMONY & PLENTARY LECTURE** **Artifacts from the Franklin Expedition's Erebus** Flora Davidson, Parks Canada	
9:30 - 10:00 a.m.	**MORNING BREAK —** Exhibit Hall	
10:00 - Noon	**Session A** **Coatings and Linings** Chair: Glenn McRae	**Session B** **Corrosion in Concrete Structures** Chair: Frank Smith
10:00 - 10:30 a.m.	**1.What the Stink? On the Scent of Something Big with Acid Gases and Linings** Mike O'Donoghue and Vijay Datta, International Paint LLC	**1.The Study of Chloride Diffusion of Waterproofed Bridge Decks in Ontario and the Associated Corrosion Protection Strategy** David Lai & Chris Parsons Ministry of Transportation Ontario
10:30 - 11:00 a.m.	**2.Close Encounters of the Third "Crude-Oil" Kind** Mike O'Donoghue and Vijay Datta, International Paint LLC	**2.Chloride Extraction for Reinforced Concrete Structures** Chantal Fequiere Vector Corrosion Technologies
11:00 - 11:30 a.m	**3. Polyaspartic Urethane Coatings: Reducing Painting Costs and Increasing Productivity** Ahren Olson, Covestro LLC	**3. Field Performance of Low-shrinkage High-performance Concrete Deck at Seaway International Bridge in Cornwall, Ontario** Daniel Cusson, NRC Canada - Construction
11:30 - Noon	**4. Activated Zinc - An Innovation that Redefines the Performance of Zinc Rich Epoxies** Terence Aben, Hempel Americas, Inc.	**4. Duplex 2304 Stainless Steel Reinforcing Bar: Properties and Applications** Frank Smith, Consultant
Noon - 1:30 p.m.	**LUNCH BREAK —** Exhibit Hall	

Schedule at a Glance

1:30 - 3:00 p.m.	**Session A** **Coatings and Linings (continues)** Chair: Glenn McRae	**Session C** **Theory and Measurements** Chair: Jieying Zhang
1:30 - 2:00 p.m.	**5. Titanium-nano Polymer and its Anti-corrosion Applications** Huanran Wang Harbin Xinke Nano Scientific & Technical Development Co.,Ltd. China	**1. Condition Assessment Guidelines for Concrete Infrastructures Reinforced with Galvanized Steel by Using Half-Cell Potential Technique** Jieying Zhang National Research Council Canada
2:00 -2:30 p.m.	**6. Harsh Marine Environment Assessment of Coating Integrity and Corrosivity** Matthew Kettle Research & Development Corporation	**2. The Influence of Sigma and Random Grain Boundaries on the Corrosion of Ni – Cr – Mo Alloy C22** Nafiseh Ebrahimi, University of Western Ontario
2:30 - 3:00 p.m.	**7. Glass Flake Usage in Protective Coatings Formulations: Is North America Behind?** Edward Malison, NGF Canada Ltd	**3. Effect of pH and temperature on corrosion and oxide film formation on Alloy 800** Mojtaba Momeni, University of Western Ontario
3:00 - 3:30 p.m.	**AFTERNOON BREAK** — Exhibit Hall	
3:30 - 5:00 p.m.	**Session A** **Coatings and Linings** (Continues) Chair: Matt Kettle	**Session D** **Materials Selection** Chair: Sandy Williamson
3:30 - 4:00 p.m.	**8. Corrosion Control – PDCA Concept Application** Alain Beaulieu Versaille	**1. Between The Discovery and The Doing - FRP Pipe Commercialization** Michael Boire Fibreglass Solutions Inc.
4:00 -4:30 p.m.	**9. Development and Implementation of a Novel Method to Remove Inorganic Zinc Coating from Low Alloy Steel** Yasir Idlibi[1], Barry Messer[2], and Sergio Vitomir[3] ADANAC Global Testing & Inspection, Calgary, AB[1] Fluor Canada Ltd., Calgary, AB[2] Protocol Environmental Solutions Inc., Coquitlam, BC[3]	**2. Investigation into the Reaction of Co-Cr-W Alloy in Amine Doped Water** Rachel Collier Deloro Stellite Co Inc
4:30 - 5:00 p.m.	**10. Oscillating Chemistry During Electrochemical Studies of Coated Aluminum Beverage Can Corrosion in Neutral pH NaCl Solutions** G.A. McRae and D.R. McCracken, Carlton University	**3. Advances in the Rotating Cage Method for Materials Selection in Oil and Gas Production** Allan Runstedtler CanmetENERGY
5:00 - 7:00 p.m.	**WELCOME RECEPTION** — Exhibit Hall	

Schedule at a Glance

Tuesday, October 20, 2015		
7:30 a.m. - 5:00 p.m.	**REGISTRATION** — Foyer	
8:00 a.m. - 5:00 p.m.	**EXHIBITOR HALL OPEN** — Laurier	
	McDonald	**Cartier**
8:00 - 10:00 a.m.	**Session E** **Case Studies** Chair: Frank Smith	**Session F** **Defence** Chair: George Keller
8:00 - 8:30 a.m.	**1. Study of Corrosion Failures in Copper Plumbing Systems** Alan Humphreys , Simpson Gumpertz and Heger	**1. New Technologies and Future Challenges for the Prevention of Corrosion in US DoD Assets** George Keller, U.S. Department of Defense Corrosion Policy and Oversight Office (Part 1)
8:30 - 9:00 a.m.	**2. Is this Really a Failure? Case Histories in Failure Analysis** David Twigg, Glencor Engineering Ltd.	**2. New Technologies and Future Challenges for the Prevention of Corrosion in US DoD Assets** George Keller, U.S. Department of Defense Corrosion Policy and Oversight Office (Part 2)
9:00 - 9:30 a.m	**3. The Arvida Aluminum Bridge: A Follow-up Visit 29 Years After Repair Work** Frank Smith , Consultant	**3. The Future Direction of Military Coatings** Beth Ann Pearson, Sherwin-Williams Co.
9:30 - 10:00 a.m.	**4. Unusual Aspects of Failure Investigations** Scott MacIntyre, AMC Atlantic Metallurgical Consulting Limited	**4. Powder Coatings in the Defense Industry** Beth Ann Pearson, Sherwin-Williams Co.
10:00 - 10:30 a.m.	**MORNING BREAK** — Exhibit Hall	
10:30 - Noon	**Session G** **Research & Development** Chair: Mike Graham	**Session H** **Cathodic Protection** Chair: Craig Stevenson
10:30 - 11:00 a.m.	**1. Investigation of the Role of Iron Content on the Crevice Corrosion of Grade-2 Titanium using Atomic Probe Tomography.** Dmitrij Zagidulin University of Western Ontario	**1. Electromagnetic Interference in Pipelines: the Influence of Conductivity of the Pipeline Contents** David Boteler Natural Resources Canada
11:00 - 11:30 a.m.	**2. On the Role of Grain Boundary Mechanical Property in the Intergranular Stress Corrosion Cracking Susceptibility of 310S Exposed in Supercritical Water** Yinan Jiao, McMaster	**2. DC Voltage Gradient Surveys for Pipeline Risk Management** Daniel Fingas, Corrosion Service Co., Ltd.

Schedule at a Glance

11:30 - Noon	**3. Integrating Corrosion Science, Engineering, and Management: Opportunities and Challenges** Sankara Papavinasam CorrMagnet Consulting Inc.	**3. Solid Oxide Fuel Cells for Remote Impressed Current Cathodic Protection Application** Mike Brennan Acumentrics
Noon - 1:30 p.m.	**LUNCH BREAK —** Exhibit Hall	
1:30 - 3:00 p.m.	**Session G** **Research & Development (continues)** Chair: Mike Graham	**Session I** **Oil & Gas** Chair: Winston Revie
1:30 - 2:00 p.m.	**4. Corrosion Impact and Corrosion Awareness in Canadian National Capital Region** Sankara Papavinasam CorrMagnet Consulting Inc.	**1. Corrosion Growth Rate Management Plan Considering Measurement Error** Mona Abdolrazaghi Enbridge Pipelines Inc.
2:00 - 2:30 p.m.	**5. Corrosion Behaviour of Polypyrrole-coated WE43 Mg Alloy in a Modified Simulated Body Fluid Solution** Sasha Omanovic, McGill University	**2. Validating Metal Loss In-line Inspection using API 1163 and CEPA Guidance Document** Yan Ping Li, Enbridge Pipelines Inc.
2:30 - 3:00 p.m.	**6. Hydrogen in metals studied by Thermal Desorption Spectroscopy (TDS)** Michael Graham, NRC Canada	**3. ASME PCC-2, 4.1 Compliant Composite Repairs** Tammy Bomia, NRI
3:00 - 3:30 p.m.	**AFTERNOON BREAK —** Exhibit Hall	
3:30 - 5:00p.m.	**Session G** **Research & Development (continues)** Chair: Mike Graham	**Session J** **Nuclear Power** Session Chair: Sridhar Ramamurthy
3:30 - 4:00 p.m.	**7. Corrosion -- An Accidental Choice -- When Metals Meet Living Tissue** R Winston Revie	**1. Monitoring Cathodic Protection Systems in Nuclear and Other Congested Plant** Craig Stevenson , Apex Corrosion
4:00 - 4:30 p.m.	**8. Pitfalls with Electrochemical Impedance Spectroscopy and Equivalent Circuit Models** G.A. McRae & D.R. McCraken Carlton University	**2. The Corrosion Behaviour of Copper-coated Carbon Steel** Sridhar Ramamurthy The University of Western Ontario
4:30 - 5:00 p.m.	**9. Magnesium Alloys as Promising Degradable Implant Materials in Orthopaedic Research** Sasikumar Yesudass, North-West University, South Africa	**3. The Radiolytic Corrosion of Copper Nuclear Waste Containers** Mehran Behazin, The University of Western Ontario
5:00 - 7:00 p.m.	**EXHIBITOR APPRECIATION RECEPTION —** Exhibit Hall	

Schedule at a Glance

Wednesday, October 21, 2015		
7:30 a.m. - 5:00 p.m.	**REGISTRATION** — Foyer	
8:00 a.m. - noon	**EXHIBITOR HALL OPEN** — Laurier	
Noon - 2:00 p.m.	**EXHIBITOR TEAR DOWN**	
	McDonald	**Cartier**
8:00 - 9:30 a.m.	**Session K** **Student Poster Presentations** Chair: Nafis Ebrahimi	**Session L** **Round Table - Corrosion Policy** Chair: Sankara Papavinasam
8:00 - 9:30 a.m.	**Of students, for students, and by students** (Attendance for others by student invitation only)	**Round Table Discussion on Policies on Corrosion** 1. Objectives of this round table and introduction of panelists – Sankara Papavinasam 2. Interactions with Policy Makers in Washington D.C – Jim Feather, NACE International 3. Usage and impact of NACE standards in government regulations and industry best practices – Sandy Williamson, NACE International 4. Usage and impact of ASTM standards on corrosion in government regulations and industry best practices – Krista M. Robbins, ASTM International 5. Usage and impact of CSA standards on corrosion in government regulations and industry best practices – Pablo Fernandez Marchi, CSA Group
9:30 - 10:00 a.m.	**MORNING BREAK** — Exhibit Hall	

10:00 - Noon	**Session K (Continues)** **Student Poster Presentations** Chair: Nafis Ebrahimi	**Session L (Continues)** **Round Table - Corrosion Policy** Chair: Sankara Papayinasam
10:00 - 11:30 a.m.	**Of students, for students, and by students** (Attendance for others by student invitation only)	**Round Table Discussion on Policies on Corrosion** 6. Experience from and advantages of "Corrosion Policy and Oversight", –George Keller, Department of Defense, USA 7. Experience from developing and using "Corrosion Policy in the Industry" – Monica Hernandez, Lloyd's Register Energy Canada Limited. 8. Opportunities for corrosion technology development in Canada – Nancy Winchester, Research Development Corporation 9. Opportunities for corrosion research in Canada – Joseph Kish (TBC) 10. Opportunities for corrosion education in Canada – University/College/High school – Craig Stevenson Discussion and wrap up
11:30 - Noon	**STUDENT POSTER AWARD AND CLOSING CEREMONY** — Exhibit Hall	
Noon - 2:00 p.m.	**LUNCH BREAK** — On your own	
2:00 - 5:00 p.m.	**Lab Tour**	**Corrosion Policy Discussion & Canadian National Capital Section (CNCS) members meeting**