行政院及所屬各機關出國報告

（出國類別：考察）

（裝訂線）

考察加拿大環保業務經營情形

服務機關：台灣電力公司

出國人 職　　稱：副處長

姓　　名：蔡顯修

出國地區：加拿大

出國日期：自九十一年三月十二日

至九十一年三月廿一日

報告日期：九十一年四月卅日

行政院及所屬各機關出國報告提要

出國報告名稱：考察加拿大環保業務經營情形

頁數 29 **含附件：□是■否**

出國計畫主辦機關/聯絡人/電話　台灣電力公司人事處/陳德隆/(02)2366-7685

出國人員姓名/服務機關/單位/職稱/電話

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出國類別：■1 考察□2 進修□3 研究□4 實習□5 其他

出國期間：九十一年三月十二日至九十一年三月廿一日　出國地區：加拿大

報告日期：九十一年四月卅日

分類號/目

關鍵詞：環境保護(Environmental Protection**)、風力能源(**Wind Power**)。**

內容摘要：(二百至三百字)

鑑於國內近年來環保法規日趨嚴格，對電力設施各種污染之排放標準逐年提昇，為使本公司未來於開發電力設施時，能擬定最佳之環保技術及最適之環境影響減輕對策，實有需要派員赴先進國家考察其各項環保技術及相關之環保措施之必要。加拿大環球 2002 **年環保展於九十一年三月十三日至十五日於溫哥華盛大舉行，會中針對最新的環保法令規章、氣候變化而衍生的環保問題、產業界之環保策略、污染防治技術及未來趨勢等環保相關議題提供最新的訊息。另安大略省環保部於多倫多主辦有關環保檢測技術、廢水處理等不同領域之營運情形展示。**

經由本計畫之執行可增進本公司對電力事業有關環保措施規劃經驗及環保技術之瞭解，可供本公司新興計畫及既有電力設施改善時規劃參考，進而提昇本公司環保業務品質。

本文電子檔已傳至出國報告資訊網（http：//report.gsn.gov.tw）

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壹、報告人：蔡顯修

貳、出國任務：考察加拿大環保業務經營情形

參、出國期間：九十一年三月十二日至九十一年三月廿一日，共計十天。

肆、國外公務之內容與過程：

一、三月十二日至三月十二日：路程，台北→加拿大卑詩省溫哥華。

二、三月十三日至三月十六日：參加卑詩省於溫哥華舉行之加拿大環球 2002 年環球展，特別至 Vestas–**加拿大風力科技公司及加拿大風力能源協會二個攤位瞭解風力發電對環保之衝擊相關問題。赴** Dynamotive **能源公司由董事長助理** Bar-chya Lee **簡報** Bio-oil **生產技術、流程及赴現場生產線參觀。另赴** Axys **分析公司拜訪總經理** Harry weiler**, 聽其簡報及參觀有關** POPs、Dioxin **及** PCBs **有機污染物分析流程。**

三、三月十七日至三月十九日：路程，卑詩省溫哥華→安大略省多倫多。參加安大略省環保部於多倫多舉行環球 2002 年後之相關合作議題之環保展。拜訪 Maxxam **分析公司，由該公司安大略省環保作業部門總經理** Taras Obal **博士簡報及參觀其分析設備及流程。**AGAT **分析公司參訪，由該公司之技術服務代表** Phil Morneau **及顧客服務部經理** Marcus Maguire **簡報及說明其實驗室分析設備及流程。**

四、三月二十日至三月廿一日：路程，加拿大多倫多→溫哥華→台北。

伍、國外公務之心得與感想：

一、前言

加拿大一向致力於保護他們的環境空氣與水的品質，保育大自然與野生動物。加拿大人體認環保技術的發展除帶來工作機會與經濟成長外，還能經由保護及預防措施而強化生態系統，而減少有害健康與環境的污染物，也能改善生活品質。這樣的態度，使加拿大的環保產業勇於接受生態挑戰，進而以創新的科技，備受舉世推崇。

加拿大目前有將近 6000 家從事環境產業的公司，總營業額超過 200 億加幣(4000 億新台幣)，其中大部分來自於產品的銷售，例如污水處理滲透膜、熱交換器、通風系統、回收設備、替代燃料車輛零細件及汽渦輪機等。在環保服務業方面，如顧問業、環境與能源工程及多元化的科技服務業等，也都有穩定的成長，尤其在油污洩漏預防與清理、地理資訊、遙測、廢棄物管理、實驗測試與研究等方面，更是快速成長。加拿大出口約 16 億(320 億新台幣)的環保相關設備與服務。其中大約百分之五十銷往美國，其次為歐洲、亞洲及南美洲。因此冀望藉本次出國考察之機會，收他山之石可以攻錯之成效，本公司正值民營化推動之際，理應將環保業務經營

的更好，作為與居民溝通的良好橋樑及更進一步作好環保工作之借鏡與參考。

鑑於國內近年來環保法規日趨嚴格，對電力設施各種污染之排放標準逐年提昇，為使本公司未來於開發電力設施時，能擬定最佳之環保技術及最適之環境影響減輕對策，實有需要派員赴加拿大考察其相關環保技術之必要。

加拿大環球 2002 年環保展於九十一年三月十三日至十五日於溫哥華盛大舉行，會中針對最新的氣候變化而衍生的環保問題、產業界之環保策略、污染防治技術及未來趨勢等環保相關議題提供最新的訊息。

其中特別至知名的 Vestas 加拿大風力科技公司及加大風力能源協會二個攤位瞭解風力發電對環境噪音、鳥類生態的影響如何，俾供本公司瞭解未來十年發展風力發電計畫時需注意因應之環保問題，以減少開發之阻力，並安排赴 Dynamotive 能源公司參觀世界上開發快速熱解技術的領導先趨，可轉化有機的農林業廢棄物為液態的生化燃油及焦炭。另亦拜會 Axys 分析公司，其為世界知名的分析公司，百分之八十的業務係來自世界各國，尤其對殘留性之有機污染物之微量分析技術及品保品管值得學習，因本公司前試驗所及部分電廠化驗室亦取得行政

院環保署代檢認證，可藉此參訪吸收其特殊之處。

另安大略省環保部於多倫多主辦有關環保檢測技術、廢棄物處理等不同領域之展示及講解，事後又安排赴 Maxxam 及 AGAT 二家分析公司參訪其實驗室分析設備及流程等。

經本次的考察可增進本公司對風力發電與環境生態相關議題的瞭解，且可進一步瞭解到廢棄物資源再利用等環保新技術的開發情形。另亦藉參觀訪問三家有機分析公司於微量分析技術的發展，可供未來本公司環保檢測分析工作改善之參考，進而提昇本公司環保業務品質。

二、考察期間相關見聞

(一)溫哥華環球 2002 年環保展

本次係加拿大駐台北貿易辦事處邀請相關業者參加第七屆加拿大環球環保展(Globe 2002)，本國計有環保署、工業局、綠色生產力基金會、工研院、台灣區環保設備工業同業公會、台灣省環保工程工業同業公會及中華民國環境檢驗測定商業同業公會等單位業界與代表參加。Globe 環保展為加拿大最大、最重要的環保產業展。計有來自七十多個國家、超過二千名的

國際環保專業人士齊聚溫哥華，共同分享全球環保產業經濟型態與經營策略。反映市場潮流，介紹領先科技, 協助業者在競爭激烈的國際市場中定位其產品。

Globe 環保展的主題係著重於環境與能源、環保企業的營運及國際商機。主辦單位邀請近百位的專家學者在約四十多場座談會中, 針對最新的環保法令和規章、氣候變化而衍生的環保問題、產業界之環保策略、污染防治技術、市場商機及未來趨勢等環保相關議題, 提供最新的訊息。另外於會場佈置來自不同省份之展示館，主要為加拿大各省環保產業, 僅少部分來自國外的美國、德國及台灣(工研院)。

由於本公司現正積極開發風力發電，自 92 年起未來十年於台灣西岸擬裝置 205 台, 第一期五年擬裝置 66 台計 9.72 萬瓩，惟開發是否造成當地環境生態如鳥類、噪音及景觀等之影響資訊較缺乏，因此特至風力發電有關之展示攤位洽談, 現場計有全世界生產風力發電設備前五大之 Vestas 風力科技公司及加拿大推動風力發電不虞餘力之加拿大風力能源協會二攤位展示說明，其中有關「噪音」部分，其認為主要涵蓋變速箱、發電機的機械噪音及風力葉片轉動產生的

空氣動力噪音二種。機械噪音問題，由於現今設計已避免其共振之工程設計及軟性大齒輪之使用，使得機械噪音問題事實已不存在。另外由於轉動葉片之葉片尖端及後緣引起之空氣動力噪音, 經過去十多年改善設計已大大地削減葉片轉動帶來之颼颼聲。至於「景觀」部分，由於風力發電機為歐洲人文景觀特色已超過八佰年歷史，其像其他許多之人造構造一樣，只要有好的風力發電機及風力廠設計將會產生有趣的景色及提供具新建築上的價值之景觀. 就像風力發電機的塔架有人認為方格形狀較管狀鋼鐵較佳, 因其較不顯著可視，然而並無一定的標準，完全依賴該地區傳統建物的配合及景觀. 因此風力發電機製造商及風力電廠開發業者於荒地. 山脈或海邊等敏感地區蓋風力電廠時，皆會根據實質經驗降低建造所造成的生態衝擊。最後大家最關心的「野生生物」影響探討發現地面上的鹿及牛經常於風力發電機下吃草，且羊也會於附近自己尋著遮蔽物不受影響；至於空中飛的鳥比較會受電線、柱子或建築物等人為構造之碰撞影響，反而較少受到風力發電機之影響。依據最近丹麥的研究指出風力電廠電力輸出的高空電線對鳥類的影響遠比風力電廠本身還大；另外也發現獵鷹築

巢及繁殖於二個風力發電機上。從荷蘭、丹麥及美國的許多研究顯示風力電廠對鳥類的總影響比起道路交通造成的影響是可忽略的。

(二)參觀 Dynamotive 能源公司

在董事長 Richard Lin 陪同下由董事長助理 Bar-chya Lee 主持簡報，並至現場參觀每天生產二噸生物油(Bio-oil)之原型工廠。由現場簡報及參觀瞭解生物質能是低成本且全球供應豐富的資源，存在於地表，較其他資源容易取得，且可再生無溫室效應問題。但因其體積大不易運輸且能源效率低。故 Dynamotive 能源公司發展快速熱解技術將上述生物質轉化為液態生化燃油(Bio-oil)，以增加能源密度可有效儲存及運輸，並可增加能源效率, 可使用於氣渦輪機及柴油引擎，相容於現有的燃料技術，進一步可藉生化燃油再精製為高價燃料及化學原料以提高其開發價值。

至於什麼是快速熱解技術呢？就是在高溫厭氧下快速熱解有機生物質。生物質被分解成三個主要部分，分別為生化燃油 55~75%(重量比)、焦炭 15~25%及不可凝聚的氣體(主要為 H_20)15-20%。其生物質原材料包括農林業廢料如

樹皮、木屑、甘蔗渣、稻桿、稻殼等。目前規模已達每天十噸之商業化試驗工場, 朝每天一百噸第一個商業化工廠進行，未來若能將規模發展為每天四佰噸之生化燃油工廠則市場即具有競爭力。惟以目前有限的化石能源考量，這一再生能源技術已受到英國、美國及加拿大等政府的注目並提供資金合作，未來之發展潛力是無限的。

(三)參觀 Axys 分析公司

Axys 分析公司於超微量有機分析技術獨步全球，其不但提供分析結果，還提供解決的方法，Axys 分析公司藉著其長期人員的經驗、訓練及投注而享譽, 其也定期有國內及國際性會議報告提出，並於科學雜誌出版。故安排至其實驗室參觀瞭解其特色, 俾供本公司環化或相關實驗室參考改進, 由參觀過程發覺其係加拿大第一個商業化之實驗室，裝置有高解析度的質譜儀供超微量分析用。並陸續填加多部微量自動質譜分析儀及高解析氣相分析質譜儀設備以配合其高超的技能用於例行分析及先進分析方法的研發。其實驗室計有四十名工作人員，其已獲得美國、加拿大政府認證，並獲國際組織承認為這一分析領域的領導者，可見其品保品管之確實。其百分之八十的業務係來自國際市場，可見其工作規模經

驗已達全球經濟需求。由於其分析樣品數多，故樣品之萃取所需時間佔據一關鍵地位, 即需多條萃取設施以縮短等候的時間，因殘存性之有機污染物 戴奧辛及多氯聯苯等化學物會蓄積於脂肪組織內，並經食物鏈的生物濃縮效應而產生對身體健康及環境不良影響，所以需於最短時間內分析出來供談判依據分析之用。可見國內未來經行政院環保署認證核可之代檢業(包括台電公司)於市場之競爭性必須考量實驗室規模及樣品化驗成本問題，以迎合市場需求才能生存。至於實驗室設施、流程中較特殊的是因其係從事超微量有機分析，故進入樣品萃取室之出入口需經兩道門控制，不允許外界可能含有污染物之氣流進入萃取室而造成污染干擾影響，且萃取室內部通氣由下往上送，空氣中沒有有機萃取溶劑之味道，這方面的管控是值得我們學習的。

(四)多倫多環球 2002 年後環保展

三月十三日起於溫哥華舉行之環球 2002 年環保展係由卑詩省主辦，加拿大全國各省主要環保產業皆參加，規模較大。而三月十八日假多倫多舉辦之 2002 年環保展係延續溫哥華環保展由安大略省環保部主辦，其規範較小且參與之環保產業也較少。展示主題內容大部與溫哥華重覆，

主要強調為個別產業需求對談與現場參觀，因為參展之環保產業於多倫多有現場之實績可供說明，比起溫哥華展示場僅是提供簡介及相關環保資料供參觀者取用較無法深入瞭解。

由於職現為中華民國環境檢驗測定商業同業公會常務理事，且本公司部分電廠化驗室亦取得環保署認證合格，故特別安排二家位於安大略省之環境分析公司參觀。

(五)參觀 Maxxam 及 AGAT 分析公司

Maxxam 分析公司係一世界級的分析公司，經由其革新的完美技術及經驗解決所有問題及提供實驗室的服務。其提供之服務項目計有微量有機＆無機分析、環境空氣品質分析、污染源排放取樣分析、毒性試驗、及可移動式的實驗室服務等。Maxxam 分析公司於加拿大境內計有十三個實驗室設備提供上述的服務，成立於 1972 年，在過去三十年裡該公司已建立了快速、準確、高品質的分析結果之美譽。其亦在墨西哥、斯洛伐克及泰國等國家設有國際性實驗室提供分析服務。

參觀位於加拿大安大略省 WATER-LOO 地方之實驗室係 1999 年成立其為具有高解析度質譜

(HRMS)分析儀之優質環境分析中心，提供 Dioxin、furans、PCBs、NDMA 及其他化合物等微量分析之用，計有二十名職員服務於此，其實驗室工作安全衛生、分析結果品質係經 QA/QC 及遵守標準作業程序值得學習觀摩(詳參附錄)，其標準作業程序亦經加拿大安大略省環境部及美國環保署確認。

由現場參觀實驗室之佈置情形與國內環境檢驗分析公司比較最大的不同是他們可能土地較大之故，每一步驟如收樣、處理樣品、器皿清洗、萃取、分析都在不同的房間，如此可避免干擾污染事宜發生，尤其進行超微量分析更是應該注意，另外實驗室聞不到臭味、有機溶劑等味道且很乾淨係值得學習之處。不過分析過後器皿洗滌廢水及抽風污濁空氣(或萃取室有機揮發性溶劑)並沒有看到前處理設施，係分別排到都市污水處理系統及大自然空氣中(可能係加拿大地廣人稀之故)，由自然界的稀釋現象淨化上述產生之污染物排放。

另又前往 AGAT 實驗室參觀，其係一加拿大國內級之實驗室，境內共計有 19 個主要實驗室 250 名員工，提供有環境、空氣品質監測、油及

氣體化學、岩石性質、貯水池工程及農業等服務。經由污染地的測定、詳細的土壤分析及飲用水標準分析等詳細分析結果報告可提供顧客有關污染整治指引。由參觀位於 Mississauga 地區之實驗室，發覺其係新設之實驗室，提供有機分析及包含金屬無機物之分析，計有 12 名員工，不夠從現場實驗室佈置來看，除了較特殊貴重的分析儀器於另一實驗室隔間外，其他包括取樣、萃取及分析等設施皆放置於同一大的空間裡，似乎不是很妥當，可能對分析品質會有影響才是，該實驗室技術服務部門代表 Mr.Morneau 說明由於市場競爭，為了減少成本，故將大部分設施放置於一較大的空間中，以便分析人員可同時兼顧多樣工作，譬如執行一樣品萃取、濃縮之外，也可兼顧儀器注射分析之用，這種現象與國內之許多民間環境檢驗測定分析公司相似，另外其使用過之器皿清洗污水係直接引至都市污水系統，實驗室抽風空氣亦直接排至大氣並無進一步處理。

三、參考文獻

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Environmental News Network Inc, http://www.

enn.com/

American Wind Energy Association , http://www.awea.org/faq/noise/faq.htm

Soren Krohn, http://www.windpower.org/tour/env/birdsoff.htm

Canadian Renewable Energy Corporation , http://www.crec.ca/wind .htm

Canadian Wind Energy Association, http://www.canwea.ca/link.htm

四、心得與感想

(一)此次加拿大溫哥華環球 2002 年環保展較特殊的有室內生活空間佈置上將綠化生態方法納入建築物室內設計中，以達環境淨化綠化之效果。另外資源再利用上的推展，如生活垃圾處理、煤灰石膏等利用及樹皮木屑蔗渣生化油之開發亦是一大重點。

(二)本次計赴 Axys 分析公司、Maxxam 分析公司及 AGAT 實驗室三個環境分析公司現場參觀，其員工規模分別為 40 員、24 員及 12 員。由於面臨市場競爭，分別朝向較專業化、特殊領域發展(尤其超微量有機污染物分析)及降低人力成本努力，以取得較佳之市場位置，

值得像我國資源有限國家省思參考。

(三)參觀三家加拿大環境分析公司現場後發覺實驗室的空間規劃佈置及動線等較有條理，可能係加拿大地大人稀土地較便宜有關。另外實驗室內工作環境中之空氣聞不到揮發性有機萃取溶劑，對工作人員身體健康較有保障。

(四)溫哥華環球 2002 年環保展會場內計有加拿大風力能源協會及 Vestas－加拿大風力科技公司參展有關風力發電的介紹，經瞭解現今風力發電技術進展很快，無論設備或成本皆大大提昇競爭力，尤其大家關心的環境衝擊如鳥類生態、噪音及景觀的影響皆很小幾乎可忽略，對目前本公司推動風力發電有很大幫助。

陸、出國期間所遭遇之困難與特殊事項：無

柒、對本公司之具體建議：

1.以資訊公開的角度及避免環保抗爭的現今來看，台電公司推動風力發電及其有關環保措施內涵應上網頁，使大眾能多瞭解本公司的作為，並樹立及提升公司之環保形象。

2.目前本公司正大力推動十年風力發電計畫，有關國外長期以來對風力發電之探討及研究資訊已相當多，應可經網路加以蒐集整理供為規劃參考，俾減少未來開發時不

利之質疑及衝擊。

3.由於我國位於北迴歸線經過的地區，一年四季陽光充足，應積極推展、充分利用太陽能於室內建築有關綠化生態系統、採光照明及發電使用之設計中，如此可減少地狹人稠的我國於非再生能源之開發，且可大大提昇我國在環境保護工作落實推動之形象。

4.本公司於 94 年底民營化前可充分利用綜合研究所既有分析能力及分析設備發展超微量有機分析之水準，並取得國內外國家環保機關認證，俾民營化後可取得市場服務之先機。

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SECTION 3

QUALITY ASSURANCE PROGRAM

Section 3

Quality Assurance Program

Maxxam Analytics Inc. maintains a quality assurance (QA) policy designed to ensure the integrity of data generated. This policy is embodied in Maxxam's Comprehensive Quality Assurance Plan (QAP). Our Quality Manual complies with:

ISO/IEC Guide 17025: "General Requirements for the Competence of Testing and Calibration Laboratories"; and

CAN/CSA Z753: "Requirements for Competence of Environmental Analytical Laboratories"

The QA program pervades the entire Maxxam organization and its work products.

Maxxam's Comprehensive Quality Assurance Plan establishes practices and procedures that yield an effective program to:

- Receive, label and store all samples properly.
- Maintain custody records of samples from sample collection through sample preparation, analysis, reporting, and disposal.
- Perform all analytical tests with trained analysts within required holding times using approved methods and properly calibrated and maintained instruments.
- Prepare and analyze samples with the appropriate control elements to ensure that the quality of the sample preparation and analysis process is known, that there are no external sources of contamination, and that non-random errors are controlled.
- Record and maintain quality control (QC) results for all analyses on a continuing basis, and use these results to generate QC limits for all tests where applicable.
- Reduce and review all data and present final results in the approved format for delivery to the client.
- Dispose of hazardous wastes according to federal, provincial, and local regulations.
- Document all of the laboratory activities in such a manner that they can be reconstructed and validated independently.
- Protect all samples and all associated raw data and results from loss, damage, theft, and tampering.

The objectives of Maxxam's Quality Assurance (QA) and Quality Control (QC) programs are to provide legally and scientifically valid laboratory services. The QC program controls, assesses and documents data quality through two distinct, interrelated functions: i) providing quality control data that can be used to determine precision and accuracy; and ii) controlling data quality within acceptable limits. The QA program directs organizational adherence to a system of mandatory operating

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practices and procedures which ensure that all generated laboratory data are scientifically correct, legally defensible and fulfilling of all applicable regulatory requirements. These component QA/QC operating procedures involve both technical and evidentiary aspects of all Maxxam analytical services.

Quality Organization

It is the responsibility of each member of the laboratory team to adhere to the quality principles and practices of Maxxam Analytics Inc. To administer the program, each Maxxam facility has a QA Officer. The QA Officer assists in the production of accurate, valid, and reliable data by monitoring the many aspects of the program. The QA Officer is responsible for executing QC procedures and techniques to ensure that the laboratory achieves established standards of quality, and for evaluating data quality and maintaining records to ensure adherence to QA programs.

The QA Officer will administer interlaboratory QA efforts, review performance evaluation results, take corrective actions, and prepare QA reports to management. The QA Officer is not responsible for pricing, sample scheduling, costs, or other production or personnel issues, other than those related directly to the QA staff. Within the laboratory organization, the QA Officer works with the Strategic Business Unit (SBU) Manager, but has direct accountability to the Corporate QA Manager, and has the authority to stop work in any analytical area if QC problems arise which affect the quality of the data produced.

Quality Assurance Reviews

Maxxam Analytics Inc. conducts regular internal systems audits supervised by the QA Officer. During these audits, selected laboratory staff and the QA Officer select a laboratory test or operation and review how well it conforms to written standard operating procedures (SOPs), the QAP, and good laboratory procedures. The internal audits may also take the form of documentation review, such as personnel training records, SOPs, and laboratory documentation. Internal performance audits may be conducted at the discretion of the QA Officer at random or regular intervals using commercially prepared blind samples. The results of these audits will be documented and reported to the Laboratory Operations Manager and the SBU Manager so that any necessary adjustments can be made.

Quality Control Samples and Procedures

Performance Monitoring

Quality control samples allow us to monitor the performance of the test method. Routine monitoring activities include: measuring extraction efficiency by using surrogates, spiked blanks or spiked samples; measuring possible contamination using extraction blanks; measuring reproducibility using replicates or duplicates (when available).

Quality Control Elements

Differing analytical methods require various levels of quality control during the batch extraction process. Maxxam follows all required quality control procedures as per the clients' requested method.

The following QC elements are routinely employed by Maxxam to ensure confidence in the analytical data generated for specific projects or regulations:

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QC Element	Frequency
Calibrations	Per method
Continuing Calibration Standard	Per run
Laboratory Control Samples	1 per 20
Method Blanks	1 per 20
MS/MSDs	Upon request
Laboratory Duplicates	1 per 20
Sample Specific MDLs	Upon request
Matrix Specific MDLs	Yearly
Method Validations	Method start-up/Accreditation
Resolution Checks	Every run

Corrective Actions

QC elements are used to monitor and assess the validity of sampling and analysis activities. Before analytical results are released, all data are routinely reviewed by senior chemists and Section Coordinators. This technical review includes verification that all appropriate QC samples were analyzed according to the appropriate method and the QA Program. Formal corrective actions will be initiated if data are determined to be of questionable validity or if QC elements are not within required limits. Often, the analysts correct the problem and document such activity in the analytical run log or worksheet. Any laboratory employee that becomes aware of a problem related to one or more samples is responsible for initiating a corrective action report with the QA Officer.

Formal corrective action reports (CARs) are used to document deficiencies and exceptions that may impact data quality, production efficiency, or client relations. The CAR describes the problem, identifies the samples and parameters affected, and identifies recommended actions to resolve the problem both now and in the future. Recommended actions are approved by the affected department manager in consultation with the QA Officer. The approved action is implemented and the result documented in the CAR. Each CAR must include review by client services staff. This requirement ensures that client notification occurs whenever necessary and that customers are consulted regarding the corrective action. In some cases, customers may identify a problem that requires corrective action. The laboratory Project Manager or Client Services Manager initiates a CAR in this case.

Upon completion of a corrective action, the relevant CAR is routed to the QA Officer for approval and closure. If additional corrective actions are needed, the QA Officer can stop formal closure of the CAR until these additional actions are implemented.

A detailed discussion of corrective actions, listing specific occurrences that always require corrective action is provided in the QAP.

Other Quality Control Measures

For all analytical methods, Maxxam monitors control charts to ensure methods are within acceptable statistical control. Control charts are available to our clients upon request.

Internal audits are performed regularly as per Maxxam's Quality Assurance Plan. These audits include: sample audits, method audits, operating procedure audits, and quality control check samples.

Performance Evaluation Programs

As part of our commitment to ensuring that our clients receive the highest quality data, Maxxam participates in a number of check sample programs and round robin studies. The following is a list of some of the programs in which we have actively participated.

- Ontario Ministry of Environment and Energy (MOEE) International Interlab Study – Dioxins/Furans and dioxin-like PCB's
- EPA Dioxin/Furan Water Supply Certification Program proficiency testing (Method EPA 1613), administered through AccuStandard Inc.
- California State proficiency testing for dioxin/furan in soil (Method EPA 8290), administered through Resource Technology Corporation
- Umea University (Sweden), Department of Chemistry proficiency testing for dioxin and furan in soil/sediment
- New York State Department of Health Certification Program – Environmental Laboratory Check Sample Program
- Environment Canada Interlaboratory Quality Study on Environmental Pollutants – Quality Assurance Section, NWRI
- International Joint Committee Interlaboratory Study on Analysis of Toxic Contaminants
- Agriculture Canada – Interdepartmental Committee on Pesticides (FICP) check sample program
- Upper Great Lakes Connecting Channel Quality Control Study on PCB's, Chlorobenzenes, Organocholorines, PAH's, and Metals
- Alberta Environment Environmental Protection Services Check Samples on Environmental Pollutants
- Canada Department of National Defense – Semi-annual Analysis of External Check Samples for Trace Contaminants in Gases – DND Quality Engineering Test Establishment (QETE)
- Lesser Slave Lake Interlaboratory blood analysis for PCB's
- NIST/ETL Interlaboratory comparison study 1997 – 1999

SECTION 4

LABORATORY PROTOCOL AND ANALYTICAL METHODS

Section 4

Laboratory Protocol and Analytical Methods

This section describes our strategy for effectively and expeditiously executing all components of an analysis program. The analytical methods used by Maxxam Analytics' HRMS Strategic Business Unit are detailed herein. Our experience includes numerous organic compounds of concern at ultratrace levels in water, wastewater, soil, solid waste, hazardous materials, soil gases, and biota.

Maxxam has proven experience in providing comprehensive analytical support to a wide range of environmental projects requiring HRMS analyses.

Laboratory Certification and Accreditation

Maxxam Analytics Inc. complies with all guidelines and requirements of the Standards Council of Canada (SCC) and the Canadian Association of Environmental Analytical Laboratories (CAEAL). A copy of our Laboratory certificate is included in Appendix B of this document. The complete Scope of Accreditation is also provided.

Maxxam's HRMS facility is also accredited by the States of California (ELAP), Washington and Florida (NELAP), the Commonwealth of Kentucky and United States Army Corp of Engineers (Nebraska) for Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzo Furans (PCDD/F) (See Appendix D). Continued certification requires absolute compliance with specified QA/QC, as well as regular and periodic on-site auditing of the laboratory by the state or their designate. Maxxam Analytics Inc.'s certifications have resulted in project awards from the USEPA, the US Navy, the US Army, ABB and CH2M Hill Inc. in support of high profile site remediation projects in the United States.

We have submitted our final response to a SCC audit administered by CFIA on December 11-12, 2001 for accreditation for tissues. We expect to be granted final accreditation within 90 days.

Maxxam Analytics Inc. are currently active members, in good standing with the Canadian Council of Independent Laboratories (CCIL).

Standard Operating Procedures

Maxxam Analytics Inc. uses standard operating procedures (SOPs) as an essential part of our laboratory QA program. SOPs serve the following functions:

- They document the specific activities that comprise routine operations and the sequence of those activities, thereby providing a uniform approach to routine tasks.

- They are useful tools in training new personnel on how to properly perform an activity, thereby providing a consistent basis for training.
- They provide criteria that allow persons independent of a specific activity to verify that the activity is being performed correctly, thereby providing a consistent basis for auditing.
- They can provide a basis for the development of other SOPs for similar or related activities.

Laboratory SOPs describe in detail all aspects related to laboratory operations. All laboratory SOPs are consistent with the QA Program. All SOPs describe how the analytical procedures and other laboratory practices and procedures are accomplished. Each SOP requires documentation to ensure compliance with the procedures, which become a part of the SOP.

SOPs used in the lab are controlled documents, meaning that their distribution to laboratory staff is documented. This allows the distribution of SOP updates to persons who have previous versions of the document. SOP distribution is the responsibility of the QA Officer or designee. SOPs are reviewed on a yearly basis to ensure their continued accuracy and applicability.

Analytical Methodologies

The analytical procedures and references used by Maxxam Analytics Inc. are carefully selected based on client input in order to insure that project and regulatory requirements are met. The following is a partial list of method references used by Maxxam for the analysis of trace organic, inorganic, and physical parameters in a variety of matrices including water, soil, and biota. Maxxam routinely performs analyses from all of the method references cited below.

- ✓ *Test Methods for Evaluating Solid Wastes* (SW-846). Office of Solid Waste and Emergency Response, EPA.
- ✓ US EPA method 1613/B
- ✓ Environment Canada Report EPS 1/RM/19 and 1/RM/23
- ✓ US EPA method 1668/A
- ✓ *Standard Methods for the Examination of Water and Wastewater*, American Public Health Association, American Water Works Association, Water Environment Federation, Washington, D.C.
- ✓ *Annual Book of ASTM Standards*, American Society for Testing and Materials (ASTM), Philadelphia, Pennsylvania.
- ✓ *Official Methods of Analysis*, Association of Official Analytical Chemists, Arlington, Virginia.

Dioxins & Furans

Maxxam's approach for the analysis of PCDDs and PCDFs is documented in our Standard Operating Procedure (SOP #TO.1031.04). This SOP is based on the extraction, clean-up, and analysis principles detailed in Environment Canada methods EPS 1/RM/19 and EPS 1/RM/23, EPA method 1613B and EPA method 8290B, with specific references to equipment and instrumentation that is used in Maxxam's High Resolution Mass Spectroscopy Laboratory.

Method highlights include:

- Acid Digestion / Liquid-Liquid extraction with dichloromethane/hexane
- Acid wash
- Four stage chromatographic clean-up
- High Resolution Gas Chromatographic/High Resolution Mass Spectrometric Analysis (HRGC/HRMS)
- Built-in Quality Assurance/Quality Control (QA/QC)

After the necessary sample work-up, the extracts are analyzed by high resolution mass spectrometry using one of Maxxam's three HRMS systems using 60 metre DB-5 chromatography columns. These systems are described in detail in Section 2.

Polychlorinated Biphenyl Congeners

The analysis of dioxin-like PCBs is documented in Maxxam's Standard Operating Procedure (SOP #TO.1059.01; see Appendix F). This SOP is based on EPA method 1668A. The extraction and clean-up method is similar to that employed for PCDDs & PCDFs. As with the dioxins/furans, the extracts are analyzed using one of Maxxam's three HRMS systems using 60 metre DB-5 chromatography columns. These systems are described in detail in Section 2.

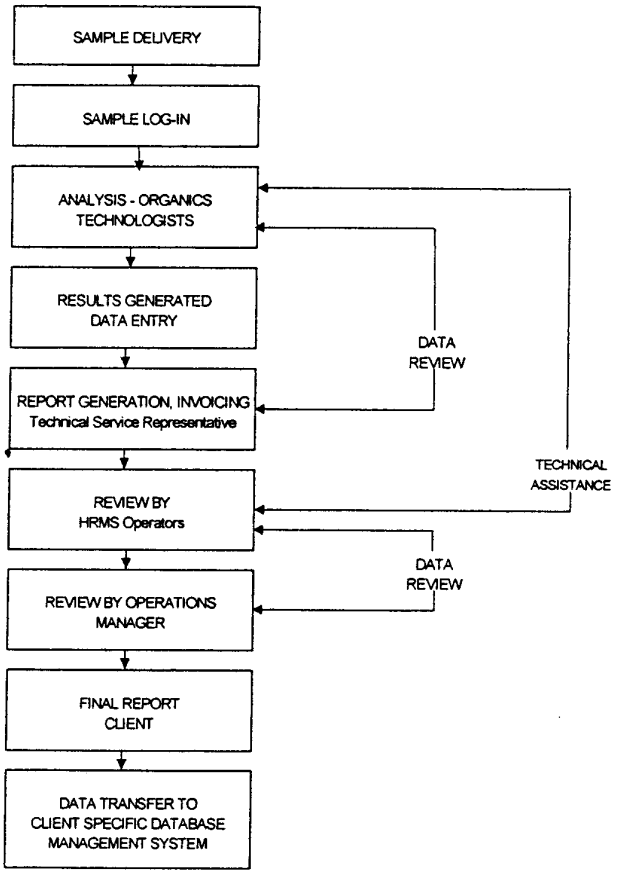
N-Nitrosodimethylamine (NDMA) and Other Nitrosamines

In response to a significant NDMA contamination issue in southern Ontario, the HRMS Strategic Business Unit was instrumental in working with Ontario Ministry of the Environment to develop a highly sensitive method for determining N-nitrosodimethylamine (NDMA) and other nitrosamines in drinking water. The techniques we employ are based on USEPA Method 607, incorporating HRMS analysis and the addition of a pre-extraction spike of deuterated d_6-NDMA, which enables the quantitation to be conducted by isotope dilution. Isotope dilution is a highly accurate method of quantitation since it effectively corrects for the recovery of the analyte. This procedure is particularly well suited for compounds with low extraction efficiencies such as NDMA. Maxxam's methodology has since been successfully used to identify NDMA in various sample matrices.

Analytical Workflow

The flow of analytical work through Maxxam's HRMS facility is illustrated in Figure 4-1.

Figure 4-1: Workflow through the Laboratory



Chain of Custody

Maxxam's chain of custody form is included as Appendix C. This form has been designed to provide all relevant information with regards to the analytical requirements. Maxxam also accepts client-specific chain of custody forms. The chain of custody form is typically included with all sample container orders, and are filled out by the sampling personnel. One copy is retained by the client for document and sample control, the other two copies are sent to Maxxam where the receipt is "signed off" by our sample custodian. One copy will remain with the evidentiary files and records at Maxxam, the last copy will be returned with the report to complete the custody cycle.

Sample Receipt and Log-in Procedures

Upon arrival at the laboratory, samples are delivered to the sample log-in area. The samples are checked against the Chain of Custody form for shipment completeness, breakage and cross-referencing of sample names, and integrity. Should there be a breach of sample integrity, or improper documentation, the project manager is notified at once in order to establish further procession. The samples are logged in for required tests.

At this point a sample receipt acknowledgement is generated and faxed to the client (optional). The samples, along with the appropriate paperwork, are forwarded to the laboratory and copies of the

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submission forwarded to the project manager All samples are stored at less than 4°C in secure facility. Tissue samples are typically maintained at -20°C. All sample storage facilities are equipped with an audible alarm should the temperature fall outside the acceptable range. As part of our ongoing quality control activities, the freezer temperatures are monitored on a daily basis.

An entry sheet detailing the particulars of each job is generated and an active file, including the entry sheet and all other relevant documents, is created. Forms are filled out for aberrations and deviations. Confirmation sheets are generated, and forwarded to the client to confirm the reception of the samples and to allow for any revisions to be made. The files are kept in a central filing cabinet and a report manager, whose responsibility entails the follow up of the respective job, is designated for each file.

Sample Analysis

The analyst retrieves samples from their storage location and verifies that the identification numbers on the sample containers corresponds to the numbers appearing on the worksheet. Should any discrepancies be found, the analyst immediately informs the sample custodian so that corrective actions may be taken.

The extraction/analysis worksheet is initialled and dated by the analyst and consigns the sample extract to the instrument analyst. A photocopy of the completed worksheet is placed in a binder for general reference. The instrument analyst attaches the chromatograms (or data) to the respective job worksheet and initials and dates the worksheet. The calculation of the data is then performed by the analyst, who initials all chromatograms and data sheets. The results are validated by the principal analyst, supervisor, or manager, and faxed to the client.

SECTION 7

HEALTH AND SAFETY POLICY

Section 7

Health and Safety Policy

The management of Maxxam Analytics Inc. is committed to providing a safe and healthy working environment to all of our employees. Health and Safety is the only activity given a higher priority than our commitment to Quality. Protection of employees from injury, hazards or occupational disease is a primary objective of this firm. Maxxam employees have the right to know about the hazards associated with their work. Maxxam Analytics Inc.'s Health and Safety Manual includes material on policies, procedures and responsibilities designed to develop an awareness of potentially hazardous chemicals and situations in the laboratory and to train employees in appropriate, safe working procedures.

The management of Maxxam Analytics Inc. is committed to providing a safe and healthy working environment for all of our employees.

Occupational Health and Safety

Maxxam Analytics Inc., as the employer, is ultimately responsible for employee health and safety. In fulfilling this commitment, we will provide and maintain a safe and healthy work environment as indicated by acceptable industry practices and compliance with legislation requirements. We will strive to eliminate any foreseeable hazards, which may result in fires, security losses, damage to property and personal injury/illness. Accidental loss can be controlled through good management practices in combination with active involvement of our employees. Loss prevention is the direct responsibility of all staff.

It is important that all employees assume responsibility for laboratory safety. Supervisors are accountable for the health and safety of employees under their supervision. They have a responsibility to ensure that equipment is safe and that employees comply with established safe work practices and procedures. All employees must perform their jobs properly, safely and in accordance with established procedures and operating philosophy. Employees must report all unsafe or unhealthy working conditions to an employee representative on the Joint Health and Safety Committee.

The regular review of safety matters occurs as a result of scheduled Joint Health and Safety Committee Meetings, periodic site assessments, management meetings and individual employee contact. This input, in combination with on-going health and safety training, enable us to achieve excellence in our safety record.

WHMIS Compliance

All environmental laboratory, administrative and support staff at Maxxam receive comprehensive Workplace Hazardous Materials Information System (WHMIS) training session immediately upon

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joining the company, and once every two years thereafter. Documentation relating to WHMIS training is maintained in each staff members' employee training file.

First Aid Training

First Aid training is offered to all full-time employees at Maxxam's HRMS facility.