出國報告（出國類別：其他）

參加巴塞爾公約

第九次締約國大會COP9

服務機關：行政院環境保護署

姓名職稱：黃拯中簡任技正

派赴國家：印尼

出國期間：97 年 6 月 22 日至 6 月 28 日

報告日期：97 年 7 月 25 日

摘 要

今（2008）年6月23日至6月27日於印尼巴里島舉行之巴塞爾公約第九次締約國大會(Conference of the Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, Ninth meeting, 以下簡稱COP9)，此會議係由聯合國環境署之巴塞爾公約秘書處主辦，歷時五天。以廢棄物越境轉移為核心議題，包括巴塞爾公約之廢棄物技術、法律及執行相關事宜，希望透過本會議確認各項決議以及接下來三年之執行規劃，主要內容如下：

一、巴塞爾公約區域中心(全球共計14個區域中心)；

二、巴塞爾公約公私部門合作夥伴計畫；

三、技術議題如含汞廢棄物、廢輪胎、焚化、掩埋及家庭廢棄物、持續性有機污染物、斯德哥爾摩公約有關最適技術之草案、廢棄物分類及有害特性、及檢視或調整巴塞爾公約附件八及附件九清單等；

四、法律議題如非法運輸：檢視執行人員手冊之架構、檢視有關信託基金之執行、議定書：保險、契約或其他財務保證及對巴塞爾公約第17條第5項之解釋；

五、財務議題及其他。

我國為地球村的一份子，雖非巴塞爾公約締約國，多年來主動遵守公約各項規定，在長期爭取參與空間的努力下，已受到公約秘書處及部分議題主導國家的重視與肯定，我國除可藉由議題深度討論讓其他國家了解我國廢棄物管理具體成效，進行經驗交流，同時有助於國內廢棄物/資源管理法規之國際接軌。

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壹、目的

自 1992 年巴塞爾公約生效以來，該公約已屬於國內長期參與的國際環保事務之一。我國雖非巴塞爾公約締約國，考量國內廢棄物通路之需求及符合國際規範，仍秉持其精神及規定，修定國內相關廢棄物輸出入法規。

在我國廢棄物與資源回收管理成效有長足的成長之際，對於國外資訊需求已由早期法規與執行架構的初步了解，轉變成對立法背景、制度設計構思及執行細節為重點，在這樣的狀況下，對於國外廢棄物專家學者直接的溝通聯繫，更顯得重要。是以近年來將巴塞爾公約定位成我國廢棄物相關議題之對外交流平台，依國內外需求，不定期與各國政府及產業界進行聯繫、溝通，是以國內每年都需要持續派員參與巴塞爾公約秘書處主辦之會議。

本次與會我國代表團特別關切的幾項議題包括：

1. 電腦夥伴計畫（Partnership for Action on Computing Equipment, PACE）籌備進度，及手機夥伴計畫（Mobile Phone Partnership Initiative, MPPI）成果展現。
2. 含汞廢棄物技術準則草案（Technical guidelines on the environmentally sound management of mercury wastes）
3. 巴塞爾公約、鹿特丹公約及斯德哥爾摩公約三個公約的整合進度（Cooperation and coordination between the Basel, Rotterdam and Stockholm Conventions）
4. 掌握其他議題之最新進度及後續規劃

貳、行程及團員分工

一、計畫類別：參加國際環保公約

二、前往國家：印尼

三、出國期間：97 年 6 月 22 日至 6 月 28 日

四、行程表

日期	地點	內容
06/22(日)	台北→印尼巴里島	啟程及報到
06/23(一)至 06/27(五)	印尼巴里島國際會議中心	參加會議
06/28(六)	印尼巴里島→台北	返程

本次我國出席第九次締約國大會（COP9）成員包括：環保署廢管處黃拯中簡任技正(本人)、專家小組成員呂喬松顧問及樊國恕教授，與財團法人環境資源研究發展基金會邱文琳博士等四位，團員名單與任務分工如下：

編號	姓名	服務單位	職稱	任務分工
1	黃拯中	環保署廢管處	簡任技正	團長及政策指示
2	呂喬松	綠色生產力基金會	顧問	法律議題諮詢
3	樊國恕	國立高雄第一科技大學	工學院院長	技術議題諮詢
4	邱文琳	環境資源研究發展基金會	副研究員	專題參與及行政協調

參、與會過程及內容

一、會議概況

巴塞爾公約第九次締約國大會(簡稱 COP9)於 2008 年 6 月 23 日至 6 月 27 日於印尼巴里島國際會議中心舉行。原則上，每日全體會議（plenary）分為二個時段召開，分別為 10:00 至 13:00 以及 15:00 至 18:00。另為促使全體會議順利進展，以整合各議題決議內容，會議期間或其他時間並同步召開各類協商（contact group）及周邊會議（side event）。另，本次在印尼政府的大力宣導公約所增加的記者會(每日二次)。每日的議程範例如表一所示。

表一　第九次締約國會議議程範例

<table>
<tr><td>時間</td><td colspan="4">2008.06.23【公約秘書處當日早上公布之暫定議程】</td></tr>
<tr><td>09:00-10:00</td><td>區域協調會議</td><td>記者會【1】
公約概況</td><td colspan="2">JUSSCANNZ 交流會議</td></tr>
<tr><td>10:00-13:00</td><td colspan="2">大會（plenary）【上午議程】
■ 三大公約整合
■ COP10 行政相關
■ 策略計畫</td><td colspan="2">磋商小組(Contact Groups)【1】
■ 區域中心
■ 技術議題
■ 拆船</td></tr>
<tr><td>13:00-14:00</td><td rowspan="2">周邊活動【1】
歐盟如何以實際行動減少非法運輸</td><td>—</td><td rowspan="2">JUSSCANNZ
交流會議</td><td rowspan="3">區域協調會議
■ 非洲
■ 亞洲
■ GRULAC
■ WEOG
■ CEE</td></tr>
<tr><td>13:15-</td><td>記者會【2】
執行秘書提供公約最新資訊</td></tr>
<tr><td>14:00-15:00</td><td>周邊活動【2】
(BAN)日本經濟協議是否在推動有毒物之跨國交易？</td><td>—</td><td>—</td></tr>
<tr><td>15:00-18:00</td><td colspan="2">大會【下午議程】
■ 法律議題及執行委員會</td><td colspan="2">磋商小組【2】
■ 區域中心及技術議題</td></tr>
<tr><td>18:00-20:00</td><td colspan="2" rowspan="2">磋商小組【3】
■ 區域中心
■ 技術議題</td><td colspan="2">周邊活動【3】
氣候變遷與公約的聯結
（5 個演講）</td></tr>
<tr><td>20:00 以後</td><td colspan="2">—</td></tr>
</table>

二、開幕

大會開始由主辦之地主國提供美麗的傳統舞蹈表演。

接下來分別由聯合國環境署署長及第九次締約國大會主席－印尼環境部長進行簡單之致詞。之後，由巴塞爾公約秘書處執行秘書 Dr. Katharina Kummer Peiry[1]（瑞士籍）在會議開幕式上致詞。首先，她感謝大家的與會及公約秘書處籌備會議的辛苦。其次，談及巴塞爾公約生效進入第 16 年頭，擁有 170 個會員，公約對於廢棄物越境轉移已有成熟的運作機制，讓已開發國家、開發中國家及轉型中國家均獲益。再者，關於會議議題的部分，執行秘書強調公約需要更多的財務資源以落實 2006 年底提出的奈若比部長宣言，來加強電子廢棄物的管理。她也相當肯定公私部門夥伴關係（public-private partnerships）的建制，包括手機夥伴計畫豐碩的成果以及電腦設備夥伴計畫的籌組（Partnership for Action on Computing Equipment, PACE）。再次強調對於公約經費不足，造成無法完成第八次締約國大會（COP8，肯亞奈若比舉行，2006.12）決議的所有工作項目，實為一憾事，未來除增加公約運作效率外，也大力呼籲各界的捐助。最後，她對印尼政府協助籌辦本次締約國大會表達感謝。

[1] 爲法律專業、多年參與歐洲環保事務，曾有巴塞爾公約及其他環保相關著作。

三、議程

（一） 會議開幕

（二） 選舉主席和其他主席團成員

（三） 通過議程

（四） 確認會議安排

（五） 第九次締約國大會主題：廢棄物管理促進人類健康和生計

（六） 遵約委員會

（七） 第八次締約國大會決議執行進度

1. 至 2010 年之巴塞爾公約策略計畫

2. 區域中心的工作和運作

   【執行進度及南亞區域中心籌備】

3. 夥伴關係

4. 技術議題

5. 各項技術準則：含汞廢棄物、廢輪胎、焚化/掩埋及家庭廢棄物、持續性有機污染物及斯德哥爾摩公約有關最適技術之草案

6. 廢棄物分類及有害特性

   (1) 依第 VIII/21 號決議，檢視 H10 及 H11 技術準則草案

   (2) 依第 VIII/20 號決議，檢視與世界海關組織及其所屬調和系統委員會之合作狀況

   (3) 增加持續性有機污染物項目

   (4) 檢視或調整巴塞爾公約附件八及附件九清單

   (5) 調和與合作

   (6) 附件九清單廢棄物輸入之國家分類及管制程序

7. 法律及執行事項

(1) 非法運輸：檢視執行人員手冊之架構

(2) 檢視有關信託基金之執行

(3) 議定書：保險、契約或其他財務保證

(4) 對巴塞爾公約第 17 條第 5 項之解釋

8. 船舶拆解

9. 對外合作：鹿特丹公約、斯德哥爾摩公約、國際海事組織及世界貿易組織

10. 資源運用和財務永續。

11. 巴塞爾公約 2009-2010 整體工作計畫

（八） 其他

（九） 通過決議和報告

（十） 會議閉幕

四、會議出席情況

本次會議計有 156 個單位參與，共計約 550 位代表與會[2]，包括：95 個締約國、4 個非締約國（如美國）、6 個巴塞爾公約區域中心（BCRCs）、9 個聯合國機構與組織（如 UNFCCC 及世界銀行）、2 個國際官方組織（如 OECD）、17 個非政府組織（NGO）、18 個其他（如日本環境廳智庫單位 NIES）及 25 個觀察單位（以印尼政府官員為主）。

[2] 資料來源：本次會議現場發放資料 Provisional list of participants

五、最新進度

巴塞爾公約秘書處執行秘書 Dr. Katharina Kummer 去年剛上任，舊任副執行秘書 Mr. Pierre Portas（法國籍）已於 2007 年初退休，在公約秘書處欠缺領導、整合的期間裡，許多議題進行並不順利。此外，近二年公約財務狀況不佳，許多第八次締約國大會決議規劃執行之議題，迄今尚未能找到主導國及參與者。是以整體而言，本次締約國大會期間可以呈現的具體成果相較於過去較為有限，不少議題僅能由公約秘書處商請各界限期提出修改意見、協助彙整，未能拍板定案。以下內容僅依會議文件及會議期間發放之各決議草稿[3]，將議題討論及其最新進度分二類作說明：

I. 重點議題：即備受公約重視或與我國密切相關者，分為背景、討論內容、後續追蹤及與我國關聯性等作比較詳細之說明；

II. 其他議題：摘要其重點彙整於本節最後【表四】供後續執行之參考。

I. 重點議題

（一） 奈若比宣言─電子廢棄物[4]

1. 全體會議討論時間：2008 年 6 月 25 日上午及 6 月 27 日上午。

2. 背景

(1)依巴塞爾公約第 VIII/2 號決議辦理。

(2)全球自第六次締約國大會後（2002.12）迄今，有關電子廢棄物活動如手機夥伴計畫（五項技術準則及試驗性計畫）、亞太電子廢棄物合作計畫、公約祕書處及各區域中心辦理相關活動、非洲及南美洲之電子廢棄物環境管理方案等（會議文件附件一）。

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3 資料來源：UNEP/CHW.9/1-38 及 INF/1-44 會議文件、本次會議現場發放資料之會議紀錄草稿 UNEP/CHW.9/CW/L.1、各項議題決議草稿 UNEP/CHW.9/CRP.1-CRP.23 及國際媒體組織 IISD 發放之會議摘要報告

4 資料來源：UNEP/CHW.9/9 會議文件、UNEP/CHW.9/INF/10 電腦設備夥伴計畫、UNEP/CHW.9/INF/11 全球性電子廢棄物的顧問機構、UNEP/CHW.9/INF/10 電腦設備夥伴計畫籌備小組進度報告，及本次會議現場發放資料之會議紀錄草稿 UNEP/CHW.9/CW/L.1

(3)亞太地區有關電子廢棄物活動（會議文件附件二)：摘要如表二。

表二 亞太地區電子廢棄物相關活動

國別/區域中心	項目名稱	範圍	現狀
中國	在北京巴塞爾公約區域中心建立電子廢棄物環境無害管理資訊中心的可行性分析	區域	已完成
	電子廢棄物進出口標準		將於 2009 年 6 月完成
南太平洋區域環境方案，薩摩亞	太平洋五島國電子廢棄物清單建立試驗專案	區域	將於 2008 年 12 月完成
巴塞爾公約東南亞區域中心，雅加達	制定關於電子廢棄物清單建立方法和電子廢棄物環境無害再使用、再利用、維修、翻新/處置之準則	區域	已完成。詳見 http://www.bcrc-sea.org/
巴塞爾公約東南亞區域中心，雅加達	關於電子廢棄物環境無害管理教育訓練	區域	2007 年已完成，詳見：http://www.bcrc-sea.org/
斯里蘭卡	制定國家電子廢棄物管理執行計畫	國家	已完成
印度（非政府組織）	促進印度的電子廢棄物環境無害管理夥伴關係（非政府組織專案)：第一階段	國家	已完成
印尼	電子廢棄物初步清單建立	國家	已完成
柬埔寨、馬來西亞、泰國、越南	電子廢棄物清單建立	國家	已完成
柬埔寨	編制電子廢棄物管理相關之教育訓練教材	國家	將於 2008 年 8 月完成

(4)側重開發中國家和經濟轉型中國家的活動（會議文件附件三至五)：內容重點在於電子廢棄物清單建立、回收/再使用（含翻修）/再利用及處理試驗計畫、區域中心建立資訊中心之可行性評估、及教育訓練相關。

3. 討論摘要：各國代表多肯定公約及各區域推動電子廢棄物管理之成效，部分代表並舉例說明之。多位代表同時表示相關計畫僅為初步階段，尚需要進一步的努力及資源投入。

4. 後續規劃：邀集各界積極參與電子廢棄物之環境無害管理議題，也歡

迎各國自願性捐助款項以利後續之推動。

5. 與我國關聯性

(1)本署目前正參酌歐盟 WEEE 指令，評估擴大國內應回收廢棄物項目，是以應持續關切全球及亞太地區對電子廢棄物之管理趨勢；此外，本署基管會已成立十年，四機一腦等項目已回收多年，可分享之成果眾多，是以應藉由電子廢棄物之深度參與，適度展現我國成果，以利爭取更多國際環保會議參與空間。

(2)二手產品之修復、再使用多列為各國資源管理之優先推動目標。然而二手品管制不易，長期以來優先再使用等文字多僅是宣示性條文。近年於先進國家推動再利用逐漸面臨瓶頸、開發中國家大量使用二手品，及持續發生假二手品之名非法輸出有害廢棄物至開發中國家情事等多重壓力下，各國均逐漸著力於前述問題的改善，其相關進度及內容或可供我國推動循環型社會之參考。

（二） 夥伴計畫—手機[5]【Mobile Phone Partnership Initiative，簡稱 MPPI】

1. 全體會議討論時間：2008 年 6 月 25 日上午及 6 月 27 日上下午。

2. 背景

(1)依公約第 VIII-6 號決議執行。

(2)手機工作小組自 2002 年底第六次締約國大會成立迄今已完成第一階段工作，第二階段工作亦將逐漸完成。

(3)第一階段工作：廢(舊)手機之再使用、回收、再利用、綠色設計及越境轉移共計五份技術準則草案已完成研擬，期間並依據英美二家再使用廠商試用半年的結果,針對舊手機再使用技術準則進行修訂。

(4)第二階段工作：以在開發中國家進行廢(舊)手機回收再利用(含再使用)為主，亞太地區目前以日本為主導國家推動中，我國亦參與相

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[5] 資料來源：會議文件 UNEP/CHW.9/11 暫行通過手機夥伴計畫之決議草案、UNEP/CHW.9/12 手機夥伴計畫、 UNEP/CHW.9/INF/13 整合對技術準則之意見及修改內容、UNEP/CHW.9/INF/16 手機夥伴計畫成果摘要、UNEP/CHW.9/CRP.14 及 CRP.15 巴西意見、及 UNEP/CHW.9/CW/L.1 等本次會議現場發放資料之會議紀錄草稿

關會議，以掌握鄰國電子廢棄物流向及管制現況。

3. 討論摘要

(1)手機夥伴計畫主席 Dr. Marco Buletti（瑞士籍）簡要報告整體成果：自 COP8 迄今，在各界積極投入下，本工作小組完成檢視五項技術準則草案，十分感謝六年來長期參與的各成員。另外請各界重視有關舊廢手機越境轉移討論過程中發現的問題（請參閱以「Chairman’s paper」為標題之附帶文件)，其內容甚或影響公約執行之公信力，建議各代表應審慎閱讀並提出意見。

(2)引發之爭議議題：由於舊廢手機及其他電子廢棄物（或二手電子產品）再使用之有害認定，目前各國認定不一，因將其視為有害或一般，會影響其進行越境轉移的管制方式，各有利弊，嚴格管制因成本提高而將減少舊品再使用的可能性，放鬆管制則需冒「假二手品之名越境運輸廢棄物」及衍生非法棄置的風險，故少部分與會國家代表發言表示不同意大會通過此一技術準則。

4. 後續規劃：

(1)原則上正式通過手機夥伴計畫完成的五項技術準則；

(2)廣邀各國參與暨成立臨時工作組，以針對二手電子產品越境轉移管理方式之後續討論；

(3)邀請各界捐款，以利推動在發展中國家舊(廢)手機回收再利用試驗計畫，其中包括在亞太地區推動的電子廢棄物合作計畫。

5. 與我國關聯性

(1)此一議題為我國在巴塞爾公約架構下，第一個完整參與之議題（包括近六年來，平時國際通訊會議及部分面對面協商會議)，我國代表自 2002 年底起以 NGO 名義，持續參與手機工作小組各子計畫。

(2)我國參與之附加效益包括

A.具體爭取到技術性議題之實質參與空間；

B.展現我國資源回收累積經驗及成效；

C.增加我國與各國、國際性產業界代表意見溝通之深度；

D.協助國內廠商因應國際環保議題，以增加我國產業之國際競爭力。

E.累積國內實質參與國際環保事務經驗。

（三） 夥伴計畫籌組—電腦設備[6]【Partnership for Action on Computing Equipment，簡稱 PACE】

1. 全體會議討論時間：2008 年 6 月 25 日上午及 6 月 27 日下午。

2. 背景

(1)依第 VI/32、VII/3、VIII/2 及 VIII/5 號決議執行。

(2)有鑒於手機夥伴計畫成效良好，成功地整合民間資源—尤其是企業界的參與。是以公約秘書處自 2004 年 3 月起，於公約網站第一次公布規劃成立電腦設備夥伴計畫。

(3)電腦工作小組第一次面對面籌組會議於 2007 年 9 月 3 日召開，由 Mr. Alvarez-Pérez（智利籍）及 Mr. Marco Buletti（瑞士籍）擔任該會議之主席。該次會議出席者近百人，遠遠超過預期，其中締約國代表超過 60 人，其他則為工業界及 NGO 代表。由此可知，各國對於成立此一小組已有共識。

(4)公約祕書處依第六次開放性工作組會議決定（2007.09），於 2007 年 10 月份成立電腦設備夥伴計畫籌備小組（PACE Interim Group，簡稱 PACE-IG），該小組已完成目標、運作原則、範疇界定及財務機制等內容之草擬。

(5)公約祕書處於今年五月份陸續向全球性之電腦設備廠商及相關公會，寄出參與 PACE 夥伴計畫之邀請函，迄今僅有 ITI[7]承諾參與，尚無單一廠商承諾參與。

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6 資料來源：會議文件 UNEP/CHW.9/13 電腦設備夥伴計畫籌組進度及決議草案、UNEP/CHW.9/INF/10 及/INF/10/Corr.1 與電腦設備相關計畫或活動、UNEP/CHW.9/INF/12 籌備小組進度報告及本次會議現場發放資料之決議草稿 UNEP/CHW.9/CRP.11。

7 ITI 為 Information Technology Industry Council 之簡寫，其成員包括 Apple、Canon、DELL、HP、Intel 等資訊產品相關之國際知名公司，其專屬網址為 http://www.itic.org/。

3. 討論摘要：在先前的會議中各代表對此一夥伴計畫之成立已有共識，是以於本次會議討論不多，僅有數位開發中國家代表明白表示對此一議題技術準則及試驗性計畫之期待，唯迄今運作資源仍不足，尚待已開發國家（所謂的 donor country）之協調。

4. 後續規劃：電腦設備夥伴計畫已於本次會議宣告正式成立，雖英國及智利已提出自願性捐款，唯其長期運作所需資源（尤其是幕僚作業的部份）尚待協調。

5. 與我國關聯性

(1)考量本署需持續掌握全球電子廢棄物管理現況與未來趨勢，且電腦設備為國內重要產業，是以我國代表[8]自去年（2007.10）起即參與電腦設備夥伴計畫（PACE）之籌組工作相關討論。

(2)目前國內已有二家廠商收到公約祕書處寄發之邀請函，本署將不定期提供國外廠商/公會之參與進度及相關諮詢。

（四） 巴塞爾公約與鹿特丹公約及斯德哥爾摩公約之整合[9]

1. 全體會議討論時間：2008 年 6 月 24 日上午及 6 月 27 日上午。

2. 背景

(1)依據第 VIII/8 號決議辦理。

(2)巴塞爾公約、鹿特丹公約【特定危險化學品及農藥】及斯德哥爾摩公約【關於持久性有機污染物】負責議題有重疊之處，是以近年來前述三個公約在部分議題（如持續性有機污染物的技術準則）合作密切，並且成立了促進公約間合作的臨時聯合工作組(Ad hoc Joint Working Group)，三個公約各任命 15 位成員參與（每區各有 3 位代表），由 Osvaldo Alvarez-P’erez 先生（智利籍）、岳瑞生先生（中國籍）及 Kerstin Stendhal 女士（芬蘭籍）三位共同主席負責協調溝通，以利

8 環境資源研究發展基金會邱文琳博士，邱博士也是我國手機夥伴計畫之長期參與者。

9 資料來源：會議文件 UNEP/CHW.9/14、UNEP/CHW.9//INF/19 共同主席摘要報告、UNEP/CHW.9//INF/20 相關費用、UNEP/CHW.9//INF/21 公約秘書處規劃之相關活動及 UNEP/CHW.9/CW/L.1 會議記錄草稿。

三個公約間具體合作計畫之訂定。

(3)前述之臨時聯合工作組已召開三次工作會議，分別是 2007 年 3 月在芬蘭赫爾辛基，12 月在奧地利維也納，及 2008 年 3 月在義大利羅馬。經過此三次會議的召開，達成多項建議，此建議業經鹿特丹及斯德哥爾摩公約的通過，其主要建議包括機構、技術、資訊管理及公眾意識、決策等五大項，摘要如下：

A.機構事項（organizational Issues Witnefield）

(1)協調工作係以國家為對象。

(2)邀請相關組織參與及協調各組織間的差異。

(3)以區域中心來協調及協助。

B.技術事項（Technical Issues）

(1)建立各國提供報告及資訊體系。

(2)建立執行及不須執行的機制。

(3)提供技術及科學事項的合作。

C.資訊管理及公眾意識事項（Information Manegent and Public Awareness Issues）

(1)共同推動公眾意識及辦理活動。

(2)建立有關健康及環境衛生的資訊交換及資料庫的機制。

(3)共同推動其他相關的識題。

D.行政事項（Administrative Issue）

(1)建立共同的管理功能。

(2)資源流通使用。

(3)財務管理及稽查的功能。

(4)共同服務。

E.決策的形成

(1) 協調會議的召集。

(2) 召集三個公約的特別會議。

這些建議在其他兩個公約業已確認，本次會議最後亦在絕大多數贊成下通過（巴西數度提出多項的細節問題）。

3. 討論摘要：略

4. 後續規劃

(1)促請各締約國促進國內有關三個公約負責單位間的聯繫,及共同議題如打擊非法運送、緊急應變等的協調、溝通。

(2)促請各國與區域之具體合作規劃。

(3)持續推動三個公約在各議題上的交流，包含資源統籌運用、預算同步審議等。

5. 與我國關聯性：持續觀察公約整合的趨勢，未來如有必要時再進行國內相關部會間之交流、合作。

（五） 修改廢輪胎技術準則[10]

1. 全體會議討論時間：2008 年 6 月 23 日下午及 6 月 25 日下午。

2. 背景：

(1)依據公約第 VIII/17 號決議辦理，由巴西主導本技術準則之修改。

(2)截至 2008 年 3 月 31 日，秘書處收到來自以下代表之修改建議：澳大利亞、加拿大、歐盟及其成員國、巴西波特蘭水泥協會、國際回收局、歐洲水泥協會及歐洲輪胎與橡膠製造商協會。其內容可於網站查閱（http://www.basel.int/techmatters/code/comments.php?guidId=57）。

(3)此外，巴西已根據前述意見分別於 2008 年 3 月 10 日和 3 月 31 日編寫兩份技術準則修正草案。

3. 討論摘要：許多代表提出對內容和架構上的修改意見，包括部分資料

[10] 資料來源：會議文件 UNEP/CHW.9/18 公約秘書處準備之進度摘要說明以及由巴西主導的廢輪

過於老舊必須更新等。因此主席宣布成立由 Mohammed Khashashneh 先生（約旦籍）擔任主席的大會期間臨時諮商小組（contact group）做進一步的討論。

4. 後續規劃：持續修改，並交由第十次締約國大會決議。

5. 與我國關聯性：廢輪胎屬於本署公告應回收廢棄物項目，屆時可參考公約技術準則修訂相關法規，如廢輪胎貯存清除處理方法及設施標準。

（六） 含汞廢棄物之管理技術準則[11]

1. 全體會議討論時間：2008 年 6 月 23 日下午及 6 月 27 日上午。

2. 背景：

(1)依公約第 VIII/33 號決議辦理。

(2)目前已有一份由日本提出的技術準則草案，另已提出降低汞風險和防止汞污染的能力建設和技術之援助方案。

(3)截至 2008 年 3 月 31 日為止，公約秘書處從加拿大、德國、全球環境基金（GEF）、聯合國開發計畫署（UNDP）、巴塞爾行動網（BAN）等單位收到一些評論意見。其中包括若干具體的修改建議，及對此一技術準則範疇釐清的要求。

3. 討論摘要：

(1)許多代表表示十分認同含汞廢棄物管理的重要性，並對於公約欠缺執行資源感到遺憾。

(2)對於處理設施的管理其主要精神如下：

A. 相關處理設施應該符合 EMS

B. 處理設施應採取足夠的措施來保障職業上及環境的健康及安全

C. 應該適當的監測

胎技術準則修改草案。

[11] 資料來源：會議文件 UNEP/CHW.9/19 決議草案、UNEP/CHW.9/INF24 技術準則草案，及各代表意見：加拿大（UNEP/CHW.9/INF25）、德國/GEF/UNDP（UNEP/CHW.9/INF/25/Add.1）及

D. 記錄及文件提送計畫

E. 應該對員工提供適當的訓練計畫

F. 緊急應變計畫

G. 封閉及日後的管理計畫

4. 後續規劃：廣邀各國代表來主導及參與含汞廢棄物技術準則之草擬，同時確認編列 2009-2010 經費，以推動降低汞風險和防止汞污染的能力建設和技術之援助方案。

5. 與我國關聯性：

(1)日本及 BAN 初步規劃在亞太區域，針對此議題進行進一步的討論，以了解、交流各國相關之管理現況。

(2)在目前技術準則草案條文中，我國應注意的事項包括：

A. 鼓勵各國訂出含汞產品（有替代者）的禁用規劃。

B. 建立含汞廢棄物的識別及儲存、進出口、產源…等資料。

C. 對處理廠的稽查及監測計畫。

D. 員工訓練及員工健康。

E. 處理設施污染行為的賠償及補償計畫，不執行相關措施的處罰計畫（此為經過三次修正後的草案，但加拿大將此刪除）。

F. 含汞產品的標示。

（七） 檢視焚化、特殊掩埋及家庭廢棄物回收技術準則[12]

1. 全體會議討論時間：自第六次開放式工作組會議迄今無進度，是以未討論。

2. 背景：

(1)本議題依公約第 VIII-17 號決議辦理。

BAN（UNEP/CHW.9/INF/25/Add.2）及 UNEP/CHW.9/CRP.2/Rev.1。

12 資料來源：會議文件 UNEP/CHW.9/21 公約秘書處準備之摘要說明及各界意見。

(2)第六次開放式工作小組應針對公約現有之焚化、特殊掩埋及家庭廢棄物回收技術準則進行檢視。不過，本次會議前僅有布吉納法索（Burkina Faso，法文）及英國針對此議題提出修改意見。

(3)英國意見為此一技術準則之內容應參酌世界各國相關規定及技術現況予以更新，以避免各國法規與公約規定不相符的狀況，也應針對有害廢棄物是否合適焚化或掩埋進行討論。

3. 後續規劃：再次懇請各界針對此一技術準則提出修改建議

4. 與我國關聯性：經去（2007）年本署巴塞爾公約專家小組第 2 次會議討論，有鑑我國焚化掩埋技術先進，在資源允許的前提下，應於技術準則工作小組(intersession group)成立後，列入國內後續長期參與之議題。

（八） 檢視公約附件八及附件九[13]

1. 全體會議討論時間：2008 年 6 月 24 日下午及 6 月 27 日上午。

2. 背景：

(1)依公約第 VII/21 號決議確認後續《巴塞爾公約》附件八和附件九法文版本的修訂。之後，於第八次締約國大會（第 VIII/10 號決議）通過了 2007—2008 年工作方案，其中包括針對附件八和附件九各種語文版本的措辭進行技術審查。此外，依據第 VIII/15 號決議應釐清公約附件修改之程序。是以邀請各界就《巴塞爾公約》附件八和附件九的各語言版本之用詞，特別是 B1030 內容提出修改意見。

(2)根據締約方會議在第 VII/2 號決定中通過的修訂和加拿大與法國之間的磋商，受託人（Depositary）根據 2008 年 2 月 26 日對締約國及簽署組織發出的更正紀錄對《公約》附件八和附件九的法文版本進行了一系列的更正，且持續進行中。(巴基斯坦及加拿大修改意見詳如本會議文件附件二)。

(3)公約秘書處向受託人轉交了對 B1030 的英文版本和法文版本擬議的

更正。受託人認為，擬議的更正似乎是一種修正，而不是一種更正，因此應該適用《公約》第 18 條規定的修正程式。(前述執行情況詳如本會議文件附件一)。

3. 討論摘要：略（以語言翻譯為主）

4. 後續規劃：請各界提出修改建議，並由公約秘書處彙整之。

5. 與我國關聯性：待公約決議後，附件八及附件九之修改內容將納入我國廢棄物越境轉移管制清單之重要參考資料。

（九） 巴塞爾公約 2009-2010 工作規劃[14]

1. 全體會議討論時間：2008 年 6 月 25 日下午及 6 月 27 日晚間。

2. 背景：

(1)公約配合締約國大會召開頻率，每二年修訂其具體工作項目及對應經費，其內容於開放式工作小組（OEWG）會議期間進行討論，以期於後續之締約國大會時通過。

(2)依公約第 VII/27 號決議辦理，迄今收到三個締約國之修改意見，其內容如表三。

表三 巴塞爾公約 2009-2010 工作規劃

標題	活動	優先次序
1.實施巴塞爾公約的戰略計畫(至 2010 年)		
A.策略計畫	1.向秘書處和巴塞爾公約區域中心提供關於援助各締約方實施戰略計畫著重領域各項工作的指導 2.向秘書處提供審查實施戰略計畫進展的指導	高
B.區域中心	1.向秘書處和各區域中心提供指導以加強其效力與能力 2.審查各區域中心的運作情況，以利協助之	高
C.夥伴關係	1.審查秘書處和巴塞爾公約區域中心為實施巴塞爾公約 2009–2010.年夥伴關係工作方案有關部分所開展的工作。	高

[13] 資料來源：會議文件 UNEP/CHW.9/24 公約秘書處準備之摘要說明及決議草案。

[14] 資料來源：會議文件 UNEP/CHW.9/37 公約秘書處準備之摘要說明及決議草案及 UNEP/CHW.9/INF/36 納入各界意見之修改版內容。

標題	活動	優先次序
	2. 提供關於締約方大會實施夥伴關係方案建議的指導。	
2. 技術性議題		
A. 技術準則	1. 完成制定及檢視電子廢棄物環境無害管理的技術準則	高
	2. 審查並增編持久性有機污染物的技術準則	高
	3. 完成制定及檢視含汞廢棄物與廢舊輪胎的技術準則	高
	4. 檢視關於陸上焚化（D10）、特別設計的土地填埋方式（D5）和住家廢棄物收集(Y46)的技術準則，並視必要予以修訂	中
	5. 檢視現有技術準則的實施情況（具體的困難和障礙）	中
B. 廢棄物認定及廢棄物的有害特性	1. 檢視附件八與附件九廢棄物清單調整的適用性(刪除或增加條目)並且透過秘書處向締約方大會彙報該事項 2. 檢視持久性有機污染物條目的修正方案 3. 對附件八和附件九的不同語言版本內容進行檢視、修改	高
	4. 檢視關於在世界海關組織商品名稱及編碼協調制度以及相關事務中確認廢棄物的問題	中
	5. 檢視有關國家廢棄物認定和管制流程	中
	6. 鑒於其涉及輻射科委會/全球統一制度的工作，審查有關統一與協調的問題	中
	7. 完成關於 H10 和 H11 危險特性訂定相關工作	低
3. 法律議題		
A. 公約的解釋問題	檢視經 COP9 修訂的公約解釋的問題並且擬定供 COP10 決議	高
B. 拆船	評估由國際海事組織通過的關於對船舶進行安全與環境無害回收的國際公約確立的控制標準，是否同等於巴塞爾公約所確立的標準，並且酌情澄清巴塞爾公約在有關船舶拆除方面的適用範圍	高
C. 公約與國際海事組織之間的合作	檢視巴塞爾公約及按照 1978 年議定書修訂的 1973 年國際防止船舶造成污染	高
D. 信託基金	檢視第 V/32 號決議實施情況並且向秘書處提供指導	中
E. 非法運輸	檢視涉及國家立法和促進實施的其他措施等等目的正在制定的指導檔草案	中
4. 資源調動和永續財務		
財務相關	監督 COP9 有關決議的落實情況並提供指導	高

3. 討論摘要

(1)考量公約執行需求及經濟因素，二次締約國大會期間至少需要召開一次開放式工作小組。

(2)此一議題之落實將視財務議題的決議以及主要捐助國（donor country）對議題的興趣而定。

4. 後續規劃：通過決議草案，請各界及秘書處持續協助執行。

5. 與我國關聯性：將視公約具體工作進度，適時調整我國對應之工作內容，以符合實際需求。

另，考量公約財務之艱難，規劃第七次開放式工作組會議【OEWG7】和第十次締約國大會【COP10】，分別於 2010 年 6 月及 2011 年召開。

表四、其他議題進度摘要及後續規劃

議題	主要進度摘要	後續規劃
策略計畫		
2007-2008 執行進度與成果[15]	◆ 依公約第 VIII-33 號決議，公約秘書處提出 2007-2008 執行進度及整體成果。 ◆ 部份決議事項如法律議題及其相關訓練會議，因為欠缺對應的資源，或是秘書處收取的費用少於原規劃所需金額，是以未執行或是僅部分執行。	—
技術議題		
持續性有機污染物(POPs)技術準則[16]	依公約第 VIII-14 號決議，本技術準則已納入歐盟、日本及挪威的修改意見。 ◆ 有代表再次提到有關處理 POPs 的電漿廢棄物轉換技術(plasma waste converter technology)雖未商業化，仍應納入技術準則。 ◆ 數位代表強調後續研擬有關決定 POPs 含量屬於高或低濃度範圍技術準則的必要性。	通過此一技術準則，並將內容轉交給斯德哥爾摩公約進行審議。
檢視有害特性 H10 及 H11 之指引文件[17]	依公約第 VIII-21 號決議辦理；澳洲和歐盟已提出修改意見，並由公約秘書處彙整之。	通過決議草案
各國廢棄物輸入(公約附件九	依第 VIII/22 號決議，請締約國限期提供有關公約附件九清單項目在分類及管制程序	通過決議，並持續相關工作。

[15] 資料來源：會議文件 UNEP/CHW.9/4 公約秘書處提供之各議題成果摘要及對應資源。

[16] 資料來源：會議文件 UNEP/CHW.9/20 公約秘書處提供之進度摘要及各界意見。

[17] 資料來源：會議文件 UNEP/CHW.9/22 公約秘書處提供之進度摘要及各界意見。

議題	主要進度摘要	後續規劃
清單)之分類及管制程序[18]	的困難或修改意見，不過截至今年 3 月 30 日為止並未收到任何意見。	
法律議題		
國家報告[19]	依公約第 VIII-14 號決議，(1)截至 2008 年 3 月 12 日止，僅有 101、94 和 52 個締約方分別彙報了其 2004、2005 和 2006 年度的資料，且部份資料不完整或有誤。(2)公約秘書處已初步彙整 2004-2005 國家報告，並納入資料庫。	公約秘書處 2008 年下半年完成彙編締約國之 2004-2006 三年報告。
檢視第 V-32 號決議執行狀況(信託基金之擴大運用)[20]	◆ 此基金為依據第 V/32 號決議，目的為協助締約國處理緊急事件之應變。 ◆ 針對「請求援助之標準表格」及過去累積經驗進行交流。	通過「請求援助之標準表格」，請各締約國捐助資金以擴大支援範圍。
非法運輸[21]	依公約第 VIII-24 號決議，請各界針對非法運送執行手冊草案限期提供修改意見，提供相關立法之資訊。	促請各國完成嚇阻非法運輸之相關立法。
責任議定書有關保險、契約或其他財務保證[22]	依公約第 VIII-25 號決議辦理。可是公約秘書處未能取得為討論此一議題召開會議所需之經費。	促請各國加速簽署巴塞爾公約責任議定書以使其生效。
有關公約第 17 條第 5 項之解釋[23]	◆ 公約第 17 條第 5 項是有關使公約修改內容生效，之前有締約國針對這個部份提出不同的解讀，是以必須予以釐清後，方可促進部分公約內容之調整。 ◆ 依公約第 VIII-30 號決議辦理。	—[24]
國家之有害廢棄物定義[25]	依公約第 VIII-27 號決議，公約祕書處均於最短時間內把各締約國依公約第三條的規定提交的「國家之有害廢棄物定義」，轉發給各締約國，並公布於網站上。不過受限於經費，僅能以原文提供，無法進行翻譯。	請公約秘書處持續辦理。

18 資料來源：會議文件 UNEP/CHW.9/26 公約秘書處提供之進度摘要及決議草案。

19 資料來源：會議文件 UNEP/CHW.9/17 公約秘書處提供之議題摘要。

20 資料來源：會議文件 UNEP/CHW.9/27 公約秘書處提供之進度摘要及決議草案。

21 資料來源：會議文件 UNEP/CHW.9/28 公約秘書處提供之進度摘要、決議草案及 COP8 決議之詳細內容。

22 資料來源：會議文件 UNEP/CHW.9/29 公約秘書處提供之進度摘要及決議草案。

23 資料來源：會議文件 UNEP/CHW.9/30 公約秘書處提供之決議草案。

24 尚待正式會議紀錄以釐清決議內容。

25 資料來源：會議文件 UNEP/CHW.9/31 公約秘書處提供之進度摘要、決議草案及各國回覆是否於公約清單外另訂定有害廢棄物之問卷彙整資料。

議題	主要進度摘要	後續規劃
執行議題		
檢視與世界海關組織(WCO)及其協調系統委員會之合作狀況[26]	依公約第 VIII-20 號決議，要求公約秘書處繼續針對海關商品編碼納入廢棄物之考量進行研析，並加強之。	請公約秘書處持續此項工作。
指定主管當局及聯絡人[27]	依公約第五條規定，各締約國須提交指定主管當局及聯絡人，讓公約秘書處將資料公布於網站上，以利各國間之聯繫、溝通。	請各締約國及公約秘書處持續辦理。

[26] 資料來源：會議文件 UNEP/CHW.9/23 公約秘書處提供之進度摘要及各界意見。

[27] 資料來源：會議文件 UNEP/CHW.9/33 公約秘書處提供之進度摘要。

肆、結論與建議

從巴塞爾公約近年的發展可明顯看出，公約資源主要投入在個別議題之工作小組或全球十四個區域中心的執行運作，故參與具體議題工作小組（如夥伴計畫）或區域中心相關會議日顯重要。綜合本次與會情形，以下針對我國未來參與巴塞爾公約相關活動與會議建議如下：

一、2009-2010 我國可能參與討論或提供意見之議題

（一）技術及法律議題：研訂含汞廢棄物技術準則（若成立建議優先參與）、修改廢輪胎技術準則。

（二）夥伴計畫：電腦設備夥伴計畫已正式成立，考量我國長期參與手機夥伴計畫之成果，規劃將比照手機工作小組模式持續參與。

二、亞太區域之參與

配合公約資源分配之調整，我國自 2005 年起成功地參與了在中國區域中心及日本各地舉行，以廢棄物整體或電子廢棄物為主題之亞太區域會議，近三年來我國學者專家持續被邀請擔任會議講師。藉由前述會議之參與，除了可以爭取更多參與空間，更可以掌握亞太地區鄰國廢棄物管理現況。

三、巴塞爾公約之國際永續參與

維繫現有聯繫管道並擴大至亞太區域國家，甚至與近年參加的 OECD 會議進行連結，都是必須持續進行的。

依照過去經驗可知，經由與固定會議參與人員的平時聯繫，方可取得各國人士對我國代表在專業上的尊重，進而願意長期往來，也因此我國得以與公約秘書處（如夥伴關係負責人）及歐美各國代表（如奧地利、比利時、加拿大、德國、瑞士、美國及英國等），建立起常態性之聯繫管道。

此外，配合台日雙邊的簽署以及我國廢棄物輸出亞太地區的持續進行，我國未來仍應持續建立並長期維繫與亞太地區鄰國在廢棄物議題上的交流。

整體而言，國際活動與會議之長期參與，必須結合國內需求及公約討論議題

之進度，選擇性做深入的參與，在提出我國有興趣了解問題（如越境轉移執行細節）的同時，也要有能力提供公約或議題參與者有興趣的內容（如電子廢棄物回收再利用管理機制），也就是說長期的參與必須以公約、各國與我國多贏的目標，我國與公約或各國的關係方可永續經營。

BC

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BASEL CONVENTION

Conference of the Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal
Ninth meeting
Bali, 23–27 June 2008
Item 7 (c) of the provisional agenda*

Implementation of the decisions adopted by the Conference of the Parties at its eighth meeting: Nairobi Declaration on the environmentally sound management of electrical and electronic waste and decision VIII/2

Nairobi Declaration on the environmentally sound management of electrical and electronic wastes and decision VIII/2

Note by the Secretariat

I. Introduction

1. Reference is made to the Nairobi Declaration on the Environmentally Sound Management of Electrical and Electronic Waste and decision VIII/2 adopted by the Conference of the Parties. By decision VIII/2 the Open-ended Working Group was mandated, beginning at its sixth meeting, to develop a workplan for consideration by the Conference of the Parties at its ninth meeting on the environmentally sound management of electrical and electronic waste (e-waste), focusing on the needs of developing countries and countries with economies in transition. By the same decision the Conference of the Parties encouraged Parties to develop further strategic partnerships targeting e-waste and agreed to review progress at its next meeting in order to guide future work on the environmentally sound management of e-waste. It requested the Secretariat to initiate work on relevant activities for consideration by the Open-ended Working Group at its sixth session and to report on progress to the Conference of the Parties at its ninth meeting.

2. By decision OEWG-VI/23 the Open-ended Working Group requested the Secretariat, in consultation with relevant groups under the Basel Convention Partnership Programme, to develop further the proposed workplan for consideration by the Conference of the Parties at its ninth meeting. It also invited Parties and others to submit proposals on additional elements of the workplan on e-waste to the Secretariat by 30 November 2007.

* UNEP/CHW.9/1.

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II. Implementation

3. As of 30 November 2007 only the European Union and its member States had submitted a proposal for additional elements of the workplan on e-waste.

4. The detailed report, intended to provide information to Parties on past, continuing and future e-waste activities under the Convention, is set out in annex I to the present note; an overview of project activities is set out in annex II. A proposed e-waste workplan for consideration by the Conference of the Parties, as requested by decision VIII/2, is set out in annex III to the present note. In considering this item, the Parties may also wish to take into account documents UNEP/CHW.9/4 (Report on the work programme) and UNEP/CHW.9/10 (Basel Convention Partnership Programme: progress on the implementation of the workplan for 2007–2008 and workplan for 2009–2010).

III. Proposed action

5. The Conference of the Parties may wish to adopt a decision along the following lines:

The Conference of the Parties,

Welcoming the progress made in the management of electrical and electronic waste (e-waste) through the development of global partnerships and regional programmes of activities,

Also welcoming the financial support provided to date by Parties to the Basel Convention for e-waste programmes,

1. *Adopts* the workplan of the Basel Convention for the environmentally sound management of e-waste set out in the annex to the present decision;

2. *Agrees* to establish a multi-stakeholder advisory body to coordinate and provide advice and consistency between all programmes established or operating under the Nairobi Declaration on the Environmentally Sound Management of Electrical and Electronic Waste and decision VIII/2 and to mandate that body to address the issues identified in the paper by the chair of the Mobile Phone Partnership Initiative on issues raised during the discussion of the guideline on transboundary movements of used and end-of-life mobile phones; [1]

3. *Encourages* Parties and signatories to the Convention to provide voluntary contributions to the Basel Convention programmes on e-waste and to become actively involved in partnerships and regional programmes of activities established under the programme;

4. *Invites* countries in a position to do so to contribute extrabudgetary financial or in-kind resources toward the preparation of technical guidelines for the environmentally sound management of e-waste;

5. *Requests* the Secretariat to continue work on the development of pilot projects on collection and take-back systems, including the environmentally sound re-use, refurbishment and recycling of e-waste, in particular in developing countries and countries with economies in transition;

6. *Also requests* the Secretariat to continue monitoring e-waste activities and to expand global activities on used and end-of-life computing equipment to include all e-wastes;

7. *Further requests* the Secretariat to report on progress to the Conference of the Parties at its tenth meeting.

1 UNEP/CHW/OEWG/6/19/Rev.1, annex II.

Annex I

Report on past, ongoing and future activities on e-waste under the Convention and a proposed e-waste workplan as requested by decision VIII/2

A. Activities implemented since the sixth meeting of the Conference of the Parties

1. Mobile Phone Partnership Initiative (MPPI)

1. The Mobile Phone Partnership Initiative was launched in 2002, during the sixth meeting of the Conference of the Parties to the Basel Convention. At the sixth meeting, the Initiative constituted the establishment a sustainable public-private partnership for the environmentally sound management of used and end-of-life mobile phones to the benefit of the partners and the environment. Since the start of the Initiative, the Mobile Phone Working Group has successfully finalized five guidelines that address the refurbishment of used mobile phones; the collection of used mobile phones; the material recovery and recycling of end-of-life mobile phones; raising awareness on design considerations; and on the transboundary movement of collected mobile phones. These guidelines serve as vital information to recovery and refurbishment operations, governments, manufacturers and telecom operators. In addition to the five guidelines, an overall guidance document on environmentally sound management of used and end-of-life mobile phones was finalized in 2006 and was adopted provisionally by the Conference of the Parties at its eighth meeting. In that regard, a Chairman's paper prepared by the Chair of MPPI Project Group 2.1 that highlights some issues to be considered by the Parties is reproduced in document UNEP/CHW/OEWG/6/19. Further information on MPPI and the Chairman's paper can be found in documents UNEP/CHW.9/12 and UNEP/CHW.9/INF/13.

2. Basel Convention partnership on the environmentally sound management of e-waste in the Asia-Pacific region

2. The Basel Convention Partnership on the Environmentally Sound Management of Electrical and Electronic Wastes for the Asia-Pacific Region was officially launched in Tokyo on 25 November 2005. The following Asian countries have supported and are participating in the project activities: Cambodia, China, India, Indonesia, Malaysia, the Philippines, Singapore, Sri Lanka, Thailand and Viet Nam. In addition, the South Pacific Regional Environment Programme has prepared a regional proposal for the Pacific island countries. Activities involving detailed inventories of e-waste in Cambodia, Malaysia, Thailand and Viet Nam are also being carried out. Two sets of technical guidelines were completed under the leadership of the Basel Convention Regional Centre for South East Asia on the methodology of e-waste inventory and environmentally sound management and "3R" (reduce, reuses, recycle) of end-of-life e-products. Annex II to the present note shows the status of implementation of the activities as of 31 March 2008.

3. On 1 November 2006 a memorandum of understanding for the implementation of the Pilot Project on Transboundary Movement of End-of-Life Mobile Phones in South East Asian Countries was signed between the Secretariat of the Basel Convention, the Basel Convention Regional Centre for South East Asia based in Jakarta and the Dowa Eco-System Co. Ltd., Japan. Under the Pilot Project, Dowa Eco-System Co. Ltd. contributed ¥10 million of seed money to cover the costs of activities for the first stage of the project during the 2006 financial year, which finished on 31 March 2007. The whole project duration was planned from 1 November 2006 until 31 March 2008.

3. South America

4. As the use of personal computers grows at around 15 per cent a year in the South America, e-waste is becoming a growing concern in the region. The project on the Inventory of Electronic Wastes in the South American Region was aimed at assisting the participating countries to prepare, draft and update a national inventory and to establish technical directives to deal with e-waste in order to achieve the international standards on environmental sound management. This project was completed in 2006 by the Basel Convention Regional Centre for Training and Technology Transfer for the South American Region (BCRC-Argentina) together with the existing regional focal points and competent authorities, and in cooperation with the Secretariat of the Basel Convention.

B. Proposed activities of the Secretariat and the Basel Convention regional centres on the environmentally sound management of e-waste

5. In relation to the mandate given by decision VIII/2 to the Open-ended Working Group beginning at its sixth session to develop a work plan for consideration by the Conference of the Parties at its ninth meeting, in 2008, the Secretariat is proposing the element of the work plan as set forth in annex III to the present document for the consideration of the Conference of the Parties. The proposals are described in detail below:

1. Mobile Phone Partnership Initiative (MPPI)

6. The second phase of the work under the Mobile Phone Partnership Initiative work programme is focussed on disseminating information on the technical guidelines to the countries that can use it and to test the guidelines by launching pilot projects with industry partners. The pilot projects will be very instrumental in raising awareness on environmentally sound management of used and end-of-life mobile phones (see document UNEP/CHW.9/12 for further details on activities).

2. Potential advisory body

7. Following the direction of paragraph 162 of the Report of the Open-ended Working Group of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal on the work of its sixth session (UNEP/CHW/OEWG/6/29) and additional discussions in the Contact Group on Technical Matters, the concept of an e-waste forum (or body) to be established to undertake proposed activities on e-waste was of general interest. Nonetheless, further information was requested on proposals and options for such a body were needed before this concept could be considered by the Conference of the Parties at its ninth meeting. Information on such a body can be found in document UNEP/CHW.9/INF/11.

3. Global partnership on computing equipment

8. The partnership will begin to take form in 2007. The mission of the partnership is to increase environmentally sound management of used and end-of-life computing equipment, taking into account social responsibility, the concept of sustainable development and promoting information sharing of life cycle thinking.

9. More detailed information on the Partnership for Action on Computing Equipment is provided in documents UNEP/CHW.9/13 and UNEP/CHW.9/INF/12.

4. Programme of activities for the environmentally sound management of e-waste in the Asia-Pacific Region

10. The next phase of this project is initiation of pilot schemes on the collection and segregation of e-wastes, including take-back schemes; initiation of pilot repair, refurbishment and recycling schemes; and training of customs and enforcement officers to control or verify export or import of electrical and electronic wastes so as to combat illegal trafficking in such wastes. Development of appropriate methods for evaluation, testing, characterization and classification of electrical and electronic wastes, including the development of environmental management systems, extended producer responsibility (EPR), standards and guidelines or principles for environmentally sound management or certification schemes will also be initiated. The establishment of mechanisms for information exchange at the national and regional level and monitoring of the impacts on human health and the environment of activities concerning or related to the management of electrical and electronic wastes will also be a priority. The proposed work plan for the next biennium is set forth in annex IV to the present note.

5. Programme of activities for the environmentally sound management of e-waste in Africa

11. The Secretariat is proposing a three-year programme of activities aimed at reviewing the range of issues currently facing African countries relating to the environmentally sound management of e-waste. The objectives are:

(a) To obtain a more precise description of the e-waste-related trade and management issues in West Africa, trade patterns, types, volumes, recycling sites and dumping spots, countries concerned, and relevant legal frameworks;

(b) To evaluate existing e-waste management practices in one pilot country and provide guidance for the development of environmentally sound recycling capacity for e-waste;

(c) To carry out pilot training and demonstration projects on the community basis for establishing environmentally sound management systems for collection, refurbishment or recycling of e-wastes to address the issue of poverty reduction and environmental sustainability. Proposal for projects in Lagos, Nigeria, with assistance by the Basel Convention regional and coordinating centre;

(d) To develop an enforcement training programme, in cooperation with the European Union Network for the Implementation and Enforcement of Environmental Law, including peer matching of developed countries, for approximately six African countries that a high influx of e-wastes.

6. Programme of activities for the environmentally sound management of e-waste in South America

12. Following the project implemented in 2006 by the Basel Convention Regional Centre for Training and Technology Transfer for the South American Region (BCRC-Argentina) together with the existing regional focal points and competent authorities, pilot projects on collection, storage, repair, repair and refurbishment of e-waste will be initiated in a few pilot countries in the region. The detailed workplan and budget is set forth in annex V to the present note.

C. Coordination and cooperation

13. The Basel Convention will continue to participate in and consult with other stakeholders regarding activities including programmes on e-waste such as StEP – Solving the E-waste Problem and GeSI – Global e-Sustainability Initiative.

Annex II

Projects activities undertaken under the Basel Convention partnership on the environmentally sound management of e-waste in the Asia-Pacific region

Country/ Basel Convention regional centre	Title of project	Scope	Status
China	Feasibility analysis to develop a centre of excellence of information on the environmentally sound management of e-waste in the Basel Convention regional and coordinating centre in Beijing	Regional	Completed
South Pacific Regional Environment Programme, Samoa	Pilot inventory of e-waste in five Pacific island countries	Regional	In progress, to be completed in December 2008
Basel Convention Regional Centre for South-East Asia, Jakarta	Development of guideline documents on methodology on inventory of e-waste and environmentally sound recycling, reuse, repair, refurbishment/disposal of e-waste	Regional	Completed. See http://www.bcrc-sea.org/
Basel Convention Regional Centre for South-East Asia, Jakarta	Training workshop on environmentally sound management of e-waste	Regional	Completed between 13–15 March 2007 in Cambodia, see http://www.bcrc-sea.org/
Sri Lanka	Development of national implementation plan for e-waste management	National	Completed
India (non-governmental organization)	Facilitating partnerships for environmentally sound management of e-waste in India (non-governmental organization project): Phase I	National	Completed
Indonesia	Preliminary inventory of e-waste	National	Completed
Cambodia, Malaysia, Thailand, Viet Nam	Inventory of e-waste	National	Completed
Basel Convention regional centre, China	Import and export criteria for e-waste	Regional	In progress, to be completed in June 2009
Cambodia	Developing e-waste training kits and conducting training courses	National	In progress, to be completed in August 2008

Annex III

Workplan on the environmentally sound management of e-waste focusing on the needs of developing countries and countries with economies in transition

Title	Mandate and supervision	Implementation	Proposed budget
Preparation of technical guidelines for the environmentally sound management of e-waste through the involvement of all stakeholders	Decision VIII/3.3(a) Open-ended Working Group	To consider incorporating within the work programme of the Open-ended Working Group for 2009–2010	$100 000
Monitoring of developments in the environmentally sound management of e-waste	Decision VIII/3.3(b) Open-ended Working Group	Delegate to the commissioning of a survey to the Secretariat	$30 000
The Mobile Phone Partnership Initiative	Decision VI/31 Open-ended Working Group		see document UNEP/CHW.9/12
Partnership for Action on Computing Equipment	Decision VIII/2 Nairobi Declaration Decision OEWG-VI/22		see document UNEP/CHW.9/13
E-waste multi-stakeholder advisory body	Decisions VIII/2 and VIII/5 Report of the Open-ended Working Group on the work of its sixth session, par. 162		To be determined
Programme of activities for the environmentally sound management of e-waste in the Asia-Pacific region	Nairobi Declaration	See annex III	$2 330 700
Programme of activities for the environmentally sound management of e-waste in Africa	Decision VIII/2 Nairobi Declaration	Basel Convention regional and coordinating centres, the Secretariat and countries in West Africa	Euros 1 500 000
Programme of activities for the environmentally sound management of e-waste in South America	Nairobi Declaration	See annex IV	$70 000

Annex IV

Proposed e-waste projects for the Asia-Pacific region (2009–2010)

Country/ Basel Convention regional centre	Title of project	Activity number. as per project proposal	Amount	Scope
Cambodia	Pilot schemes on collection, evaluation/testing and segregation of e-wastes • Review existing infrastructure to collect, repair, refurbish and recycle used or end-of-life electrical and electronic equipment to scope out the country-specific situation and identify collection points or centres • Identify successful collection schemes in other countries so that such schemes can be tested • Develop an activity outline and business plans for setting up pilot collection scheme • Procure all the necessary containers for each collection point or centre • Make arrangements to transport collected used and end-of life equipment to an accumulation centre and make arrangements for evaluation and testing • Make arrangements to deliver collected used and end-of-life equipment to a refurbishment or material recovery and recycling facility	Activity 3	$160 700	National

Country/ Basel Convention regional centre	Title of project	Activity number. as per project proposal	Amount	Scope
Indonesia	Detailed inventory of e-waste in Indonesia: • Review customs import data sheets and identify quantities (if any) imported and countries from which such imports originate. If possible identify any illegal transboundary movements based on information obtained from bills of lading • Establish a level of refurbishment, provide a brief description of such operations, and identify the type of standards and or guidelines being used for refurbishment • Prepare an inventory of selected four types of electrical and electronic equipment generated each year and over the last 10 years (if data exist), determine how much generated per country, region and city • Prepare projection of quantities of the four types of electrical and electronic equipment available for recovery in one year, two years and five years	Activity 1	$200 000	National
Indonesia	Public awareness-raising programme	Activity 2	$50 000	National
Malaysia	Pilot schemes on collection, evaluation/testing and segregation of e-wastes: • Conduct a review of existing infrastructure to collect, repair, refurbish and recycle used or end-of-life electrical and electronic equipment to scope out the country-specific situation and identify collection points or centres • Develop activity outline and business plans for setting up pilot collection scheme • Procure all the necessary containers for each collection point or centre • Make arrangements to transport collected used and end-of life equipment to an accumulation centre and make arrangements for evaluation and testing • Make arrangements to deliver collected used and end-of-life equipment to a refurbishment or material recovery and recycling facility, if available in Malaysia	Activity 3	$200 000	National

Country/ Basel Convention regional centre	Title of project	Activity number. as per project proposal	Amount	Scope
Malaysia	Public awareness-raising programme: • Workshops for target groups • Development and implementation an awareness-raising programme for consumers on environmentally sound management of used and end-of-life electrical and electronic equipment and products • Developing brochures, flyers; campaigns in various local newspapers and on radio or television	Activity 1	$50 000	National
Philippines	Detailed inventory of e-waste: • Prepare a detailed inventory of selected types of electrical and electronic equipment (personal computers, televisions, refrigerators, air conditioners, washing machines, mobile phones and waste batteries) generated • Review customs import data sheets and identify quantities (if any) imported, and identify countries from which such imports originate. If possible identify any illegal transboundary movements based on information obtained from bills of lading	Activity 1	$100 000	
Sri Lanka	Phase III • National Implementation Plan for e-waste management developed in line with the National Strategy for Solid Waste Management • Information system developed to disseminate information and awareness-creation at national, provincial and local authority level Phase IV • Mechanism to register informal e-waste repair shops developed and implemented • E-waste tracking system developed	Phases III and IV	$150 000	National

Country/ Basel Convention regional centre	Title of project	Activity number. as per project proposal	Amount	Scope
Viet Nam	Detailed inventory of e-waste: • Prepare a detailed inventory of selected types of electrical and electronic equipment (personal computers, televisions, refrigerators, air conditioners, washing machines, mobile phones and waste batteries) generated • Review customs import data sheets and identify quantities (if any) imported, and identify countries from which such imports originate. If possible identify any illegal transboundary movements based on information obtained from bills of lading	Activity 1	$60 000	National
Viet Nam	Pilot schemes on collection, evaluation/testing and segregation of e-wastes: • Conduct a review of existing infrastructure to collect, repair, refurbish and recycle used and end-of-life electrical and electronic equipment to scope out the country-specific situation and identify collection points or centres. • Develop activity outline and business plans for setting up pilot collection scheme. • Procure all the necessary containers for each collection point or centre. • Make arrangements to transport collected used and end-of-life equipment to an accumulation centre and make arrangements for evaluation and testing • Make arrangements to deliver collected used and end-of-life equipment to a refurbishment or material recovery and recycling facility, if available	Activity 3	$300 000	National
Thailand	Develop and implement a public awareness-raising campaign	Activity 2	$40 000	National
Thailand	Pilot collection scheme	Activity 3	$260 000	National
Basel Convention Regional Centre for South-East Asia, Jakarta	Technical assistance for pilot collection schemes in four countries: • Provide technical assistance in order to encourage and ensure successful implementation of pilot assessment scheme	Activity 2	$200 000	Regional

Country/ Basel Convention regional centre	Title of project	Activity number. as per project proposal	Amount	Scope
Basel Convention Regional Centre for South-East Asia, Jakarta	Technical assistance for pilot reuse/ refurbishment/recycling scheme in three countries: • Provide technical assistance in order to encourage and ensure the successful implementation of pilot reuse/refurbishment/ recycling scheme	Activity 3	$100 000	Regional
Basel Convention regional and coordinating centre Beijing	Establishment of centre of excellence of information on e-waste for Asia-Pacific	Activity 2	$80 000	Regional
Basel Convention regional and coordinating centre Beijing	Laboratory and pilot project on e-waste treatment	Activity 3	$160 000	National
Non-governmental organization (India)	Phases II and III of project on facilitating partnerships for environmentally sound management of e-waste in India	Phases II and III	$220 000	National
	TOTAL		**$2 330 700**	

Annex V

Projects on the environmentally sound management of e-waste in South America

A. Project timetable and workplan

Inventory on e-waste for South America

	First year												Second year											
Activities	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**
1. Selection of project coordinator	X	X	X																					
2. Review and collection of countries' data			X	X	X	X	X																	
3. Compilation of countries' information on e-waste					X	X	X	X																
4. Desk study								X	X	X	X	X	X	X										
5. Development of a proposal for the national framework													X	X	X	X	X							
6. Development of the national framework																		X	X	X				
7. Pilot study									X	X	X	X	X	X	X	X	X	X	X	X	X	X		
8. Final report and evaluation																							X	X

B. Budget

Estimated budget (two years)

Activity	Sub-activity actions	Cost (United States dollars)
1. Project personnel component		
	(Year 1)	6 000.00
	(Year 2)	6 000.00
Subtotal for activity 1		**12 000.00**
2. Subcontracting component		
	Compilation of information	3 000.00
	Desk study	5 000.00
	Technical report	8 000.00
	National Framework	4 000.00
	Pilot study	25 000.00
Subtotal for activity 2		**45 000.00**
3. Miscellaneous costs		
	Reporting costs	2 000.00
	Sundry (Year 1)	2 000.00
	Sundry (Year 2)	947.00
Subtotal for activity 3		**4 947.00**
4. Project support costs		
	UNEP PSC (13 per cent)	8 053.00
Subtotal for activity 4		**8 053.00**
Project grand total		***70 000.00***

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BASEL CONVENTION

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Item 7 (d) of the provisional agenda*

Implementation of the decisions adopted by the Conference of the Parties at its eight meeting: Partnership Programme

Progress report on the Mobile Phone Partnership Initiative

Note by the Secretariat

1. By decision, VIII/6, paragraph 9, the Secretariat is transmitting to the ninth meeting of the Conference of the Parties, a report on progress of the Mobile Phone Partnership Initiative (MPPI), as prepared by the Chair of the Mobile Phone Working Group (MPWG). The annex to this present note describes the accomplishments under the Initiative and describes lessons learned. The MPWG reviewed the Initiative as a whole, and decisions of the Conference of Parties (VI/32, VII/4, VIII/6) and the Declaration of Commitment as signed by the 12 Mobile Phone Manufacturer partners, in 2002.

2. The Mobile Phone Working Group, in reviewing its mandate and decisions of the Conference of the Parties, believes it has completed its' tasks as requested, and it has successfully met its objectives. The Mobile Phone Working Group would like to propose to the Parties of the ninth Conference of the Parties, that it would cease operation and cease to exist as a group. Any outstanding tasks to be completed could then be carried out by ad-hoc forum, as indicated in the elements of a decision in document UNEP/CHW.9/12. The ad-hoc forum could continue to include multi-stakeholder participation interested in the topic.

* UNEP/CHW.9/1.

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Annex

Progress report by the Chair of the Mobile Phone Working Group

I. Introduction

1. This is a report on progress made by the Mobile Phone Partnership Initiative (MPPI), as prepared by the Chairman of the Mobile Phone Working Group (MPWG), and as requested in the decision VIII/6. In addition to taking note of the present progress report, the Chairman wishes to request that the ninth meeting of the Conference of the Parties take note of comments that were submitted on the Chairman's Paper on issues that were raised during the deliberations of the Project 2.1 Group when preparing the guideline on the transboundary movement of collected mobile phones. Parties may wish to consider how to address issues raised in this Chairman's Paper.

II. Background

2. Since December 2002, the MPWG, established under the auspices of the Open-ended Working Group (OEWG), held a series of meetings aimed at implementing a number of activities, as set out in its work programme, which was approved by the OEWG during its first session in May of 2003. The first round of activities under the work programme was to develop a set of technical guidelines on the environmentally sound management of used and end-of-life mobile phones. Five guidelines have been completed and approved by the MPWG. They are currently found on the Basel Convention web site at: http://www.basel.int/industry/mppiwp/projects.html. In addition the MPWG developed an overall Guidance Document on environmentally sound management of used and end-of-life mobile phones. This overall Guidance Document, which provides summaries and recommendations contained in the five individual guidelines, was provisionally adopted during the eighth meeting of the Conference of Parties. Since then it was revised, and is being submitted for final adoption during the ninth meeting of the Conference of the Parties to the Basel Convention.

III. Work programme

3. The work programme for the MPWG comprised of two phases:

(a) **Phase A** consisted of the following four project areas:

(i) Project 1.1: *Refurbishment and Reuse of Used Mobile Phones*. This group completed the development of the guideline on refurbishment of used mobile phones. It is a fact that more mobile phones are being discarded after quite short periods of use when they are in fact designed and built to last several years. Recommendations in the guideline promote a high standard for the refurbishment for used mobile phones, which can extend the life of such product.

(ii) Project 2.1: *Collection and Transboundary Movement of Used Phones*. The project group 2.1 addressed the collection and transboundary movement of used and end-of-life mobile phones and prepared **two guidelines:** i) one on the collection of used and end-of-life mobile phones, and ii) the second one on the transboundary movement of collected mobile phones.

These guidelines are valuable in providing information on the establishment of collection schemes; procedures for evaluating and testing collected mobile phones and options for transboundary movement procedures.

(iii) Project 3.1: *Material Recovery and Recycling of End-of-Life Mobile Phones*. The task of this group was to identify existing and needed recycling technologies for the environmentally sound management of end-of-life mobile phones, and to assess demand and supply for such facilities.

(iv) Project 4.1: *Awareness Raising on Design Considerations*. This guideline focuses on the provision of information to consumers to assure them that the way the current mobile phones are designed do not pose negative life cycle impacts on human health and the environment, including end-of-life impacts and waste management. Second, it recommends design features for new mobile phones that would facilitate their extended use and improve their end-of-life recycling and material recovery, with economic efficiency and minimal environmental impact.

(b) **Phase B** consisted of the following activities:

(i) Testing of Technical Guidelines

The mobile industry partners have made a commitment to evaluate the five technical guidelines in a facility type environment, to see if any changes are required to recommendations that are contained in these guidelines. This work is complete, and all Guidelines are being revised to incorporate proposals from these evaluation studies. This work will have to be completed post COP 9.Two of the guidelines (Refurbishment of Used Mobile Phones and Awareness Raising-Design Considerations) that have been evaluated, revised, and approved by the MPWG.

(ii) Awareness Raising

The mobile industry partners recognise that there are particular challenges in building capacity and establishing appropriate facilities to process end-of-life electronic equipment in developing countries where a "grey market" already exists. They agreed to continue to promote awareness raising of the MPPI Guidelines in cooperation with planned activities by the Secretariat of the Basel Convention.

(iii) Pilot Projects on collection in developing countries and countries with economies in transition

Where a local or international commitment of resources is available from industry, governments, and competent authorities, the mobile phone industry partners agree to work with competent authorities and Basel Convention Regional Centres (BCRCs) in all UN regions that expressed interest in hosting projects on collection.

(iv) Revisions to provisionally adopted overall Guidance Document, as requested by the OEWG decision VI/21 paragraph 4 a), based on comments received from Parties. Changes are shown in the document UNEP/CHW.9/11.

4. In summary, Phase A activities are completed and Phase B tasks are almost complete with few tasks to revise some of the Guidelines, to be carried post COP 9.

IV. Transboundary movement

5. The transboundary movement issue for used mobile phones destined for repair, refurbishment or upgrading underwent numerous deliberations in an effort to find a compromise proposal. The compromise proposal lists two options for Parties to consider when dealing with transboundary movement of used mobile phones destined for reuse possibly after repair, refurbishment of upgrading in the importing country. The guideline on the transboundary movement of collected mobile phones and chapter 4 of the Guidance Document provides clear and concise information on the options that could be undertaken by Parties and Signatories and other stakeholders such as exporters or importers. Also, during discussions of transboundary movement of collected mobile phones a number of issues came up which are reflected in the Chairman's Paper, document (UNEP/CHW.8/INF/6, Appendix 1). This paper raises issues and ideas that were brought forward by the project group, but for which there was no consensus. It was circulated for comments, as requested in the decision OEWG VI/21 and the Secretariat has submitted these comments for consideration by Parties during this ninth meeting of the Conference of the Parties, document UNEP/CHW.9/INF/13.

6. This COP may wish to forward this paper and comments to the OEWG for its consideration and report back to the tenth meeting of the Conference of the Parties.

V. Review of the Mobile Phone Partnership Initiative and lessons learned

7. The MPWG reviewed the MPPI, Decisions VI/32, VII/4, VIII/6, and the Declaration signed by industry partners in 2002. The group feels it has completed all tasks assigned, and has met its objectives successfully. As such it is proposing that the MPWG ceases its operation and all the outstanding tasks be carried out by ad-hoc forums, known as the Partnership Updates on Mobile Phones with participation by those Parties, Signatories, industry and non governmental organizations that continue to be interested in the issue.

8. Valuable lessons were learned from the MPPI, which should be taken into account when setting up new public-private partnerships, to be undertaken by the Basel Convention. These include:

(a) Strong and continued leadership is crucial.

(b) All stakeholders need to be actively involved in the partnership from the beginning; transparency is of paramount importance.

(c) A self funding mechanism for the whole partnership must be agreed to at the beginning to ensure that resources are available for editing, translation and printing of guidelines; for organizing workshops in different regions, to disseminate information on environmentally sound management; and for pilot projects agreed to by the whole group.

(d) Balanced participation is required between developed and developing countries and between types of stakeholders and funds should be allocated for the participation of delegates and stakeholders from developing countries and countries with economies in transition. A better understanding of the Basel Convention as well as the perspectives and viewpoints of the various stakeholders should be sought at the beginning of the partnership to avoid misunderstandings and conflicts.

(e) Sound coordination of activities throughout the process is important.

(f) Successes of the initiative rests on finding committed officials (from key countries, the Secretariat and the private sector) to actively participate, and to lead projects.

(g) Mechanisms should be established for reaching consensus or resolving conflict among different interest groups at the beginning of the initiative.

(h) The work programme needs to be flexible and allow for adjustments along the way.

(i) There needs to be a mechanism for sending legal interpretive questions to the Parties for resolution, such as issues raised during the discussion of the transboundary movement of used and end-of-life mobile phones.

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Implementation of the decisions adopted by the Conference of the Parties at its eight meeting: Nairobi Declaration on the environmentally sound management of electrical and electronic waste and decision VIII/2: Partnership Programme

Report of the Interim Group on the Partnership for Action on Computing Equipment

Note by the Secretariat

1. The purpose of this note is to inform Parties on recent activities undertaken to structure the partnership on the environmentally sound management of used and end-of-life computing equipment, referred to as the Partnership for Action on Computing Equipment (PACE). It also contains the scope of the partnership, working principles and activities (Annex I), the proposed declaration of commitment by industry members and the proposed declaration of commitment by non-governmental members (Annex II), proposed working structure (Annex III), terms of reference for the PACE (Annex IV) and list of members of the Interim Group on PACE (Annex V).

2. Further information on the partnership is contained in document UNEP/CHW.9/13.

I. Introduction

3. Computing equipment, in particular personal computers, have been instrumental in improving public access to information and services, contributing to both future progress and the demand for such technology simultaneously. The manufacture of electronic equipment, in particular computing equipment, is one of the world's fastest growing industries today. It has become a demand driven market with consumers demanding faster and equipment with more functionalities.

* UNEP/CHW.9/1.

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4. Worldwide shipments of personal computers totaled 271.2 million units in 2007 (see table 1), according to results by Gartner, Inc., with these figures are still rising[1]. This high growth of computing equipment production also brings the social, health and environmental challenge of the proper management of used and end-of-life equipment. Due to the pace of technological development, large quantities of this computing equipment become obsolete. It is the management of end-of-life computing equipment that is a problematic waste issue in many countries, as significant quantities are not being managed in an efficient or environmentally sound manner.

Table 1

Preliminary Worldwide PC Vendor Unit Shipment Estimates for 2007 (Thousands of Units)

Company	2007 Shipments	2007 Market Share (%)	2006 Shipments	2006 Market Share (%)	2007-2006 Growth (%)
Hewlett-Packard	49,434	18.2	38,037	15.9	30.0
Dell Inc.	38,709	14.3	38,050	15.9	1.7
Acer	24,257	8.9	18,252	7.6	32.9
Lenovo	20,131	7.4	16,652	7.0	20.9
Toshiba	10,932	4.0	9,198	3.8	18.9
Others	127,717	47.1	119,022	49.8	7.3
Total	**271,180**	**100.0**	**239,211**	**100.0**	**13.4**

Note: Data includes desk-based PCs, mobile PCs and X86 servers.

Source: Gartner (January 2008)

5. The technology and skills do exist to secure proper management of such used and end-of-life computing equipment and, indeed, much of this computing equipment has a high economic value due to the valuable materials that can be recovered. Used computing equipment and its components can often be reused directly or after it has been refurbished or repaired. Those units that cannot be reused can go to environmentally sound material recovery/recycling facilities that can reclaim plastics and precious metals to manufacture new products. At the same time, end-of-life computing equipment does contain certain toxic substances and one should bear in mind the risks to human health and the environment if these are not recovered and managed in an environmentally sound manner.

II. Background

6. At the sixth meeting the Conference of the Parties in December of 2002, as a follow up to the high-level ministerial roundtable discussion, Parties acknowledged the importance of environmentally sound management of hazardous wastes, including end-of-life computing equipment. They emphasized the need for concrete actions to be taken by all stakeholders in order to ensure waste computing equipment is diverted from unsustainable waste management operations towards facilities that can recover/recycle valuable materials, and minimize any potential adverse environmental effects.

7. The Ministerial Statement on Partnerships for the seventh meeting of the Conference of the Parties in 2004[2] emphasizes the value of Partnerships for meeting the Global Waste Challenge. In particular the Statement affirms that:

- Parties in close cooperation with their existing and new partners need to work together to endeavour to reduce the generation of hazardous waste, including to reduce the quantity of hazardous and other wastes going to final disposal;
- The momentum gained in implementing the Basel Declaration on Environmentally Sound Management and the Strategic Plan for the Implementation of the Basel Convention must not be lost;
- More efforts, through working in cooperation between partners, should be devoted to building sustainable partnerships between Parties and all stakeholders, networking among Parties and Basel Convention regional centres for information exchange and information

[1] Gartner (January 2008), www.gartner.com, Gartner, Inc. (NYSE: IT).
[2] Pages 99-100 of document UNEP/CHW.7/33.

clearing house functions, and strengthening national capacities to segregate hazardous wastes;

- Building partnerships for meeting the global waste challenge will contribute to the implementation of Agenda 21 and the Johannesburg Plan of Implementation, and partnerships will bring benefits for all;
- A partnership approach should be adopted when dealing with priority waste streams, such as, *inter alia*, electrical and electronic wastes.

8. The Nairobi Declaration on the environmentally sound management of electrical and electronic waste[3], adopted at the eighth meeting of the Conference of the Parties in 2006, emphasised specific support for strategic public-private partnerships for e-waste and these partnerships are an important instrument for improving the environmentally sound management of e-waste worldwide. The economic and social opportunities that recycling and recovery of used and end-of-life computing equipment could bring were also recognised by Parties and stakeholders in this Declaration.

III. Partnership for Action on Computing Equipment (PACE)

9. By its decision VIII/5, the Conference of the Parties approved the 2007-2008 work plan for the Partnership Programme. The work plan contained a task of establishing of a global partnership on used and end-of-life computing equipment.

10. Following decision OEWG-VI/22, the Secretariat of the Basel Convention initiated a process to facilitate the establishment of an interim group on PACE, tasked with setting up the partnership among industry, governments, international organisations and civil society to address the environmentally sound management of used and end-of-life computing equipment. A list of members of the Interim Group is contained in Annex V of the present document.

11. The Interim Group was requested to seek a balanced and diverse partnership with special expertise and sustainable financial support, and looks for commitment by partners towards PACE, with aims to include:

- Developing technical guidelines for proper repair, refurbishing and recycling;
- Promoting the effectiveness of a certification scheme for environmentally sound repair, refurbishing and recycling facilities;
- Promoting the diversion of end-of-life personal computers from land disposal and open burning into environmentally sound commercial material recovery operations;
- Promoting sustainable development in developing countries through the continued use, repair and refurbishment of used personal computers;
- Providing a forum to share information and raise awareness of concerns.

12. PACE activities will include demonstration pilot projects in order to assist developing countries in assessing the current situation of used and end of life computing equipment in their countries, and to achieve the Convention’s objectives. PACE will provide a forum for governments, industry leaders, international organisations and non-governmental organisations to work together to improve the current management of used and end-of-life computing equipment through the development of global refurbishment and recycling guidelines on the environmentally sound management of computing equipment. It will also offer training, expert advice, guidance, networking and confidence building, and create sustainable commercial practices with economic and environmental benefits to all participants, in particular those in developing countries and countries with economies in transition.

A. Outcomes

13. Through a series of teleconferences and one physical meeting, the Interim Group has set out a work plan, terms of reference and an organizational structure for PACE for the Partnership. These are contained in Annex I, Annex III and Annex IV of this document. In developing the proposed work plan for PACE, the Interim Group further agreed upon the mission statement, scope of coverage, working principles, and four general activities for the partnership, which are contained in document UNEP/CHW.9/13.

[3] Annex IV (pages 108-109) of document UNEP/CHW.8/16.

14. The mission of PACE agreed upon by the Interim Group is:

To increase environmentally sound management of used and end-of-life computing equipment, taking into account social responsibility, the concept of sustainable development and promoting information sharing on life cycle thinking.

15. Through a sub-group of members, the Interim Group developed a model sustainable funding mechanism for the Partnership, encompassing prospective funding needs. Partnership funding needs were categorised into four areas: 1) operational costs; 2) participation by developing countries and non-governmental organisations; 3) projects agreed to by the partnership and 4) funding for additional projects initiated by partners. The proposal is to have a mixture of funding mechanisms – including modest membership fees, voluntary and in-kind contributions..

16. In anticipation of the establishment of the partnership through a decision on PACE by the ninth meeting of the Conference of the Parties, it is proposed that a working group on PACE would be established which will be responsible for reviewing the four general activities and developing a more specific work plan with detailed project descriptions and project schedules. The draft terms of reference for the PACE Working Group will also need to be finalised, taking into account that the Terms of Reference were agreed upon by the Interim Group. These Terms of Reference are contained in Annex IV to the present document. As part of its on-going consultations, the Secretariat will continue to promote PACE, encourage other stakeholders to join the partnership, and formalize the declarations of commitment. It is further anticipated that the PACE Working Group, through the Secretariat, will make its first progress report on what has been achieved to the seventh session of the Basel Convention's Open-ended Working Group in 2009.

Annex I

Partnership for Action on Computing Equipment (PACE)

Scope

The scope of the partnership will cover: Personal Computers (PCs) and associated displays, printers and peripherals [4]

Working Principles

In addition, the group reviewed the working principles presented in the document UNEP/SBC/PACE/2, and agreed to the following three working principles:

1. Promote dialogue amongst governments, industries, NGOs and academia on initiatives that could be carried out in different UN regions.
2. Seek innovative solutions, showing concrete and practical results consistent with the Basel Convention, and make recommendations.
3. Coordination and cooperation, as appropriate, with other bodies involved in e-waste activities.

Activities

A set of activities have been identified that would assist, in particular developing countries and countries with economies in transition, to manage used and end-of life computing equipment in an environmentally sound manner:

- Develop tools (inter alia guidelines) and activities on environmentally sound refurbishment/repair, including criteria for testing, certification, and labelling.
- Develop tools (inter alia guidelines) and activities on environmentally sound recycling and material recovery, including facility certification.
- Develop and promote pilot schemes for environmentally sound management of used and end-of-life computing equipment towards the achievement of the Millennium Development Goals found in the UN Millennium Declaration of 2000.
- Develop awareness raising and training programme activities.

[4] Personal desk top computers, including the central processing unit and all other parts contained in the computer. Personal notebook and laptop computers, including the docking station, central processing unit and all other parts contained in the computer. Computer monitors, including the following types of computer monitor:(a) cathode ray tube;(b) liquid crystal display;(c) plasma[4].Computer keyboards, mouse, and cables. Personal computer printers:(a) including the following types of computer printer:(i) dot matrix;(ii) ink jet; (iii) laser;(iv) thermal; and (b) including any computer printer with scanning or facsimile capabilities, or both.

Annex II

PARTNERSHIP FOR ACTION ON COMPUTING EQUIPMENT[1]

PROPOSED DECLARATION OF COMMITMENT BY INDUSTRY MEMBERS [1 bis]

On the occasion of the ninth meeting of the Conference of the Parties to the Basel Convention and having regard to the Basel Declaration on Environmentally Sound Management and the Nairobi Declaration on the environmentally sound management of electrical and electronic waste,

We, the industry members of the Partnership for Action on Computing Equipment,

Recognizing that we have a role to play, in partnership with the Secretariat of the Basel Convention, in increasing the environmentally sound management of used and end-of-life computing equipment, *taking into account social responsibility, the concept of sustainable development and promoting information sharing of life cycle thinking*; and

Having regard to the Guidelines on Cooperation between the United Nations and the Business Community, which encourage business partners to advance and adhere to the principles of the United Nations Secretary-General's Global Compact.

Declare our intention to:

Contribute towards meeting the goals and objectives of the Basel Convention, the Basel Declaration on Environmentally Sound Management and the Nairobi Declaration on the environmentally sound management of electrical and electronic waste;

Promote the Environmentally Sound Management of used and end-of-life computing equipment with the aim of protecting human health and the environment;

Promote dialogue amongst governments, industry organisations, international organisations, non-governmental organisations, academia and Basel Convention Regional and Coordinating Centres for Capacity Building and Technology Transfer on initiatives that could be carried out in different United Nations regions;

Seek innovative solutions, showing concrete and practical results consistent with the Basel Convention;

Coordinate and cooperate, as appropriate, with other bodies and organisations involved in e-waste activities;

Enter into a sustainable partnership with the Basel Convention in cooperation with other stakeholders[5] to develop and promote the environmentally sound management of used and end-of-life computing equipment;

Participate in the Working Group and Project Group(s) of the Partnership, including the aforementioned stakeholders as appropriate, whose purpose is to act as a forum for information sharing; initiate, propose or undertake activities or projects for a work programme and to undertake the following activities:

- Develop tools (inter alia guidelines) and activities on environmentally sound refurbishment/repair, including criteria for testing, certification, and labelling.
- Develop tools (inter alia guidelines) and activities on environmentally sound recycling and material recovery, including facility certification.

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[1] Partnership is to be understood in the context of the Basel Declaration. It is cooperation between different stakeholders (private and public) to work together towards a common goal; it has no legal implication.

[1 bis] This document is the subject of further consultations and may be modified prior to signature

[5] Such as a Party or Signatory to the Basel Convention, international organisation, industry organisation, non-governmental organisation, academic institution, Basel Convention Regional and Coordinating Centre for Capacity Building and Technology Transfer.

- Develop and promote pilot schemes for environmentally sound management of used and end-of-life computing equipment towards the achievement of the Millennium Development Goals found in the UN Millennium Declaration of 2000.
- Develop an awareness raising and training programme activities.

To this end we will play an active role in developing and implementing the 2008-2010 work plan of the Partnership for Action on Computing Equipment with other stakeholders and join in the effort to take appropriate actions to achieve environmentally sound management of end-of-life and used computing equipment.

PROPOSED DECLARATION OF COMMITMENT BY NON- GOVERNMENTAL MEMBERS[6]

On the occasion of the ninth meeting of the Conference of the Parties to the Basel Convention and having regard to the Basel Declaration on Environmentally Sound Management and the Nairobi Declaration on the environmentally sound management of electrical and electronic waste,

We, the non-governmental members of the Partnership for Action on Computing Equipment,

Recognizing that we have a role to play, in partnership with the Secretariat of the Basel Convention, in increasing the environmentally sound management of used and end-of-life computing equipment, *taking into account social responsibility, the concept of sustainable development and promoting information sharing of life cycle thinking.*

Declare our intention to:

Contribute towards meeting the goals and objectives of the Basel Convention, the Basel Declaration on Environmentally Sound Management and the Nairobi Declaration on the environmentally sound management of electrical and electronic waste;

Promote the Environmentally Sound Management of used and end-of-life computing equipment with the aim of protecting human health and the environment;

Promote dialogue amongst governments, industry organisations, international organisations, non-governmental organisations, academia and Basel Convention Regional and Coordinating Centres for Capacity Building and Technology Transfer on initiatives that could be carried out in different United Nations regions;

Seek innovative solutions, showing concrete and practical results consistent with the Basel Convention;

Coordinate and cooperate, as appropriate, with other bodies and organisations involved in e-waste activities;

Enter into a sustainable partnership with the Basel Convention in cooperation with other stakeholders[7] to develop and promote the environmentally sound management of used and end-of-life computing equipment;

Participate in the Working Group and Project Group(s) of the Partnership, including the aforementioned stakeholders as appropriate, whose purpose is to act as a forum for information sharing; initiate, propose or undertake activities or projects for a work programme and to undertake the following activities:

- Develop tools (inter alia guidelines) and activities on environmentally sound refurbishment/repair, including criteria for testing, certification, and labelling.
- Develop tools (inter alia guidelines) and activities on environmentally sound recycling and material recovery, including facility certification.
- Develop and promote pilot schemes for environmentally sound management of used and end-of-life computing equipment towards the achievement of the Millennium Development Goals found in the UN Millennium Declaration of 2000.
- Develop an awareness raising and training programme activities.

To this end we will play an active role in developing and implementing the 2008-2010 work plan of the Partnership for Action on Computing Equipment with other stakeholders and join in the effort to take appropriate actions to achieve environmentally sound management of end-of-life and used computing equipment.

Annex III

[6] **This document is the subject of further consultations and may be modified prior to signature**

[7] Such as a Party or Signatory to the Basel Convention, international organisation, industry organisation, non-governmental organisation, academic institution, Basel Convention Regional and Coordinating Centre for Capacity Building and Technology Transfer.

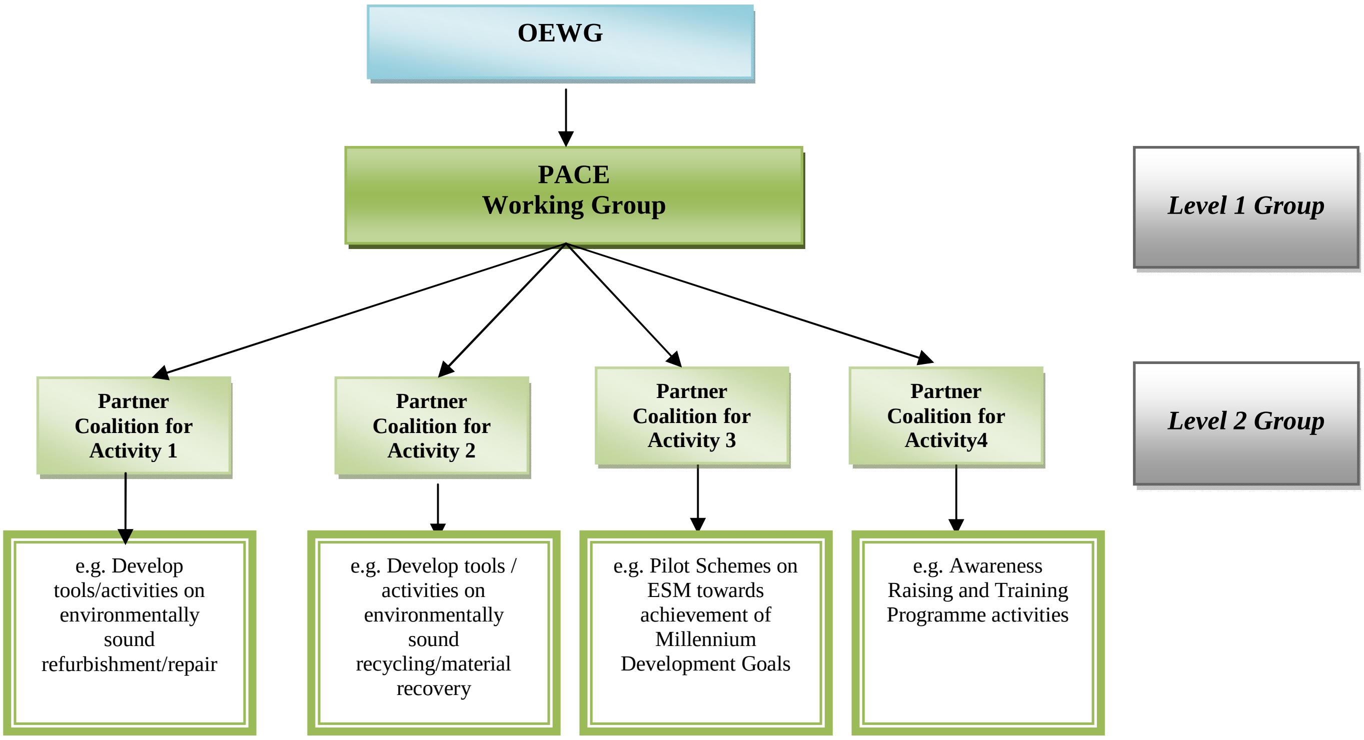
Proposed Working Structure

Level 1

- Membership Open to: Parties, Industry, International Organizations, NGOs and academia
- Headed by a Chair, a Vice Chair or two Co-chairs
- Bureau of Advisory Group of [x].
- It is a Forum for information sharing, it can initiate or propose activities or projects, seek funding and in-kind resources in the furtherance of PACE, provide oversight over awareness raising, outreach and coordination of level 2 activities.

Level 2

- Membership is open to members of Level 1 group and any new members interested in a specific activity only[8] that are substantively interested in the particular activity.
- Undertakes priority activities as proposed by Level 1 group.
- Selects its own chair to conduct meetings, teleconferences.
- Reports to Level 1 Group.



[8] New members at level 2 would have to provide a financial contribution

Annex IV

Terms of Reference for the Partnership for Action on Computing Equipment

Partners of the Partnership for Action on Computing Equipment (PACE)

Recalling decision VI/32 adopted by the sixth meeting of the Conference of the Parties to the Basel Convention inviting Parties, Signatories and other governments to promote partnership with industry and business sectors and non-governmental organisations,

Recalling decision VII/3 adopted by the seventh meeting of the Conference of the Parties to the Basel Convention which adopted the 2005-2006 work plan for the Basel Convention Partnership Programme and the General Principles for the Partnership Programme, as restated herein,

Further recalling decision VIII/2 adopted by the eighth meeting of the Conference of the Parties to the Basel Convention, which strongly encouraged Parties to develop further strategic partnerships targeting e-waste, [and decision [IX/xx] adopted by the ninth meeting of the Conference of the Parties to the Basel Convention which established the Partnership for Action on Computing Equipment on [xxxx] June 2008,]

Further recalling Resolution 56/76 adopted by the United Nation General Assembly which stressed that principles and approaches that govern global partnerships should be built on the firm foundation of United Nations purposes and principles, as set out in the Charter, and invites the United Nations system to continue to adhere to a common approach to partnerships which, without imposing undue rigidity in partnership agreements, includes the following principles: common purpose, transparency, bestowing no unfair advantages upon any partner of the United Nations, mutual benefit and mutual respect, accountability, respect for the modalities of the United Nations, striving for balanced representation of relevant partners from developed and developing countries and countries with economies in transition, and not compromising the independence and neutrality of the United Nations system in general and the agencies in particular,

Bearing in mind the Guidelines on Cooperation between the United Nations and the Business Community, issued by the Secretary-General of the United Nations on 17 July 2000, and the Ten Principles of the Global Compact, in particular Principles 7, 8 and 9 on the Environment,

Recognising that the Partnership for Action on Computing Equipment shall be a non-bureaucratic, open and voluntary initiative which shall serve as a complement to instruments of regulation at national, regional and international levels,

Adopts the terms of reference for the Partnership for Action on Computing Equipment (herein after referred to as 'the Partnership') as follows

Mandate

1. By its decision VIII/2 adopted at its eighth meeting, the Conference of the Parties to the Basel Convention mandated the Open-ended Working Group to develop a work plan on the environmentally sound management of e-waste. Decision VIII/2 strongly encouraged Parties to develop further strategic partnerships targeting e-waste. Decision VIII/5 of the Conference of the Parties further adopted the work plan of the Basel Convention Partnership Programme for 2007-2008, and confirmed the importance of electrical and electronic wastes as a Strategic Plan Focus area and the engagement of civil society is a priority of the Partnership Programme. This decision also initiated work towards this global partnership on used and end-of-life computing equipment.
2. The Partnership cannot create or abrogate rights or responsibilities of Parties under the Basel Convention. Partners in the Partnership acknowledge that the Basel Convention is the main global instrument for guiding the environmentally sound management of hazardous e-waste and its provisions need to be fully respected. Neither decisions nor actions of the Partnership can deviate from or abrogate the provisions of the Basel Convention.
3. The Partnership operates under the guidance of the Open-ended Working Group and the authority of the Conference of the Parties to the Basel Convention.

Mission Statement

4. To increase environmentally sound management of end-of-life computing equipment, taking into account social responsibility, the concept of sustainable development and promoting information sharing on life-cycle thinking.

Working Principles

5. Promote dialogue amongst governments, industries, non-governmental organizations and academia on initiatives that could be carried out in different UN regions.

6. Seek innovative solutions, showing concrete and practical results consistent with the Basel Convention, and make recommendations.

7. Coordinate and cooperate, as appropriate, with other bodies involved in e-waste activities.

Scope

8. By its decision IX/xx, the Conference of the Parties of the Basel Convention stated that the scope of the Partnership for Action on Computing Equipment (PACE) is to be defined as below:

"The scope of the partnership will cover: Personal Computers (PCs) and associated displays, printers and peripherals.[9]"

Duration

9. The Partnership shall be dissolved upon completion of its activities under the 2009-2010 Work Plan provided in Annex 1 to the present Terms of Reference or upon the Tenth Conference of the Parties, unless by a consensus vote, partners of the Partnership agree to extend the Partnership. The Partnership may be terminated at any time prior to completion of the 2009-2010 Work Plan by consensus vote of the partners of the Partnership or by a decision of the Conference of the Parties of the Basel Convention.

9. bis The Partnership commitment shall terminate upon completion of the 2009-2010 Work Plan provided in Annex 1 to or upon the Tenth Conference of the Parties. Some or all of the Parties may extend the Partnership. The Partnership may be terminated at any time prior to completion of the 2009-2010 Work Plan by consensus vote of the partners of the Partnership or by a decision of the Conference of the Parties of the Basel Convention.

Organisation

10. The Partnership shall be organized into two levels as follows:

Level One - Working Group

Level Two - Project Groups.

Working Group

11. The Working Group of the Partnership shall be a forum for information sharing.

12. The duties of the Working Group are outlined in Annex 2.

13. The Working Group shall operate under the guidance of the Open-ended Working Group of the Basel Convention.

14. The duties of the Working Group are enumerated in greater detail in Annex 2 to the present Terms of Reference.

A. Membership

[9] This shall include Personal desk top computers, including the central processing unit and all other parts contained in the computer. Personal notebook and laptop computers, including the docking station, central processing unit and all other parts contained in the computer. Computer monitors, including the following types of computer monitor:(a) cathode ray tube;(b) liquid crystal display;(c) plasma[9].Computer keyboards, mouse, and cables. Personal computer printers:(a) including the following types of computer printer:(i) dot matrix;(ii) ink jet; (iii) laser;(iv) thermal; and (b) including any computer printer with scanning or facsimile capabilities, or both.

15. Membership of the Working Group of the Partnership is open to any Party or Signatory to the Basel Convention, international organization, industry organization, non-governmental organization, academic institution, Basel Convention Regional and Coordinating Centre for Capacity Building and Technology Transfer which satisfies the following criteria:

    a. Demonstrated commitment to the principles, practice and promulgation of the concept of environmentally sound management;

    b. Demonstrated commitment to engage in meaningful and constructive dialogue and cooperation with other partners, the Parties and signatories to the Basel Convention, Basel Convention regional centres, and the Secretariat of the Basel Convention (herein after referred to as 'the Secretariat');

    c. Demonstrated expertise or standing in the subject of the particular project or initiative;

    d. Demonstrated disposition to be proactive, collaborative, and solution-oriented with respect to the Partnership mission;

    e. Demonstrated networking capacity[10] and commitment to follow the procedures and practices provided in the present Terms of Reference, including in particular those related to confidentiality.

15 bis Partners will seek to achieve a Working Group membership that includes a diversity and balance of stakeholders and geographic regions.

16. The participation of partners will at all times be voluntary.

17. Representatives of partners of the Partnership participate solely in their official capacity.

18. Admission and suspension of membership to the Partnership shall be subject to review by the Working Group. Any entity wishing to be admitted to the Partnership shall formally communicate this to the Secretariat, stating how the applicant has met the membership criteria under the present Terms of Reference, for onward transmittal to, and consideration by, the Working Group.

    Any objections by the partners to an application for membership shall be communicated to the Partnership for its decision.

19. All partners of the Partnership shall have equal status, rights and responsibilities within the Partnership.

20. Government partners of the Partnership shall be represented by an official from a Ministry or agency which is concerned with the subject matter of the Partnership.

B. <u>Officers</u>

21. The Working Group of the Partnership shall elect Co-Chairs and such other Officers as it deems necessary. Industry, developing countries and countries with economies in transition will be encouraged to assume leadership roles.

22. The Officers' responsibilities shall include:

    i. Conduct meetings of the Working Group;

    ii. Coordinate the Working Group's activities;

    iii. Liaise between the Working Group and the Project Groups, and, if required, the Secretariat;

    iv. Assist the Working Group in their responsibilities if required;

    v. [Assist in the recruitment of new partners].

23. If an Officer resigns or is otherwise unable to complete his or her term of office or to perform his or her functions, the Working Group of the Partnership shall consider the need to elect a replacement to serve for the remainder of the mandate.

C. <u>Meetings of the Working Group of the Partnership</u>

24. Partners will meet at least twice a calendar year. Meetings may be in person, by conference call or by any other means, including electronically.

25. Meetings of the Partnership shall be closed, unless the Partnership decides otherwise. Any partner may, however, invite non-partners to Partnership meetings for specific purposes, such as providing expert guidance, subject to the approval of the Co-Chairs in consultation with the Partners

[10] As per Decision VII/3 of the seventh meeting of the Conference of the Parties and its Annex

26. Admitted non-partners must agree to rules of procedure and confidentiality of the Partnership before being allowed to attend the meetings.

Project Groups

27. Project Groups of the Partnership, their structure and Terms of Membership shall be established by the Working Group of the Partnership as necessary and undertake activities as assigned.
28. Project Groups shall follow the decision-making procedures outlined in the section entitled "Decision-Making" of the present Terms of Reference.
29. Project Groups shall report regularly to the Working Group, through the Project Group Chair.
30. Once a Project Group has completed the objective assigned to it by and reported to the Working Group, the Project Group shall be dissolved, unless decided otherwise by decision of the Working Group.

Secretariat

31. The Secretariat of the Basel Convention shall be the Secretariat of the Partnership.
32. The functions of the Secretariat shall be to facilitate the Partnership's activities as necessary, in accordance with the relevant provisions of Article 16 of the Basel Convention on the Control of the Transboundary Movements of Hazardous Wastes and relevant decisions adopted by the Conference of the Parties.

Decision-making

33. Decisions on all matters shall be made by consensus.
34. Decisions taken by the Partnership shall only be effective as between the partners. Any decision taken under the Partnership cannot create or abrogate rights or responsibilities of Parties under the Basel Convention.
35. In the event of any disagreement or conflict between the partners, the conflicts procedure as set out in paragraph 50 below shall apply.

Confidentiality

36. The Chatham House Rule shall apply to all activities under the Partnership, including meetings and inter-sessional correspondence. The Chatham House Rule states that participants are free to use the information received, but neither the identity nor the affiliation of the speaker(s), nor that of any other participant may be revealed.
37. The obligation of confidentiality set out herein shall subsist for all partners beyond the duration of their membership to the Partnership.

Public Information

38. Information released on behalf of the Partnership shall be agreed to by all partners. Such information shall be released through the Secretariat of the Basel Convention.

[Financing Mechanism

39. The Officers shall develop an annual budget and work-plan, based on the available resources and mandate provided by the Conference of the Parties to the Basel Convention, and shall submit the draft budget and work-plan to the Working Group of the Partnership for approval.
40. Upon approving the budget, the Partnership shall agree to an equitable division of contributions to meet the budgetary requirements of the Partnership for that year.
41. Contributions from partners shall be paid promptly and, at the latest, four months from the date of approval of the budget by the partners.
42. The funds for the Partnership shall be held on trust for the Partnership in the Basel Convention Trust Fund. The Officers and the Secretariat shall liaise to provide a financial report in relation to these funds at the second ordinary meeting of the Partnership each year.

43. [On the date of commencement of their membership of the Partnership, each partner shall enter into a Memorandum of Understanding with the Secretariat, acting on behalf of the Conference of the Parties, detailing their financial obligations to the Partnership. Amendments to the Memorandum shall become effective only by agreement of both parties.]]

[11]

Publications and Logos

44. For documents that are produced by the Partnership, but which will not be approved or adopted by the Conference of the Parties to the Basel Convention, or the Open-ended Working Group as directed by the Conference of the Parties, the following shall apply:

    i. The Basel Convention logo shall be placed on the front cover,

    ii. Partnership specific graphics can be used as part of the design of the front cover, and

    iii. Names and logos of partners shall appear under a list of acknowledgements on the inside cover.

45. For documents that are produced by the Partnership, but which will be approved or adopted by the Conference of the Parties to the Basel Convention, or the Open-ended Working Group as directed by the Conference of the Parties, the following shall apply:

    i. The logos of the Basel Convention, United Nations Environment Programme and United Nations shall be placed on the front cover,

    ii. Partnership specific graphics can be used as part of the design of the front cover, and

    iii. Names and logos of partners shall appear under a list of acknowledgements on the inside cover.

46. Partners shall not use the names or logos of the Basel Convention, United Nations Environment Programme and the United Nations in their own publication without the prior written authorization of each of those organizations in relation to each specific use.

Legal Liability

47. Neither the Partnership nor any of the partners shall be held liable for any direct, incidental, consequential, indirect or punitive damages arising out of any activity, policy, and or other action undertaken by any party, including partners, in the context of the Partnership and its functioning.

48. The United Nations, the United Nations Environment Programme, the Conference of the Parties to the Basel Convention and the Secretariat of the Basel Convention shall not be responsible for dealing with any legal action, claim or other demand arising from or attributable to the operation of this Partnership, or the activities implemented thereunder.

49. Nothing under the Partnership shall be deemed a waiver of any privileges and immunities of the United Nations.

Conflict Resolution / Arbitration

50. In the event of a conflict, dispute or difference that arises between partners, which is not covered under the present Terms of Reference, the following process shall be followed:

    i. Partners with grievances shall submit their respective grievances to the Officers.

    ii. The Officers shall discuss the situation with the complainant partner and the aggrieved partner, and then come to a decision regarding the conflict. If resolution is not achieved, the voting mechanism under the Basel Rules of Procedure[12] will be invoked as a way to resolve the conflict.

    iii. In order to continue membership with the Partnership, the partners concerned shall comply with the decision arrived at by the Officers using the above-mentioned procedure.

Overriding Authority of the Conference of the Parties to the Basel Convention

[11] This will be discussed further once the small working group of the Interim Group on PACE presents its conclusions.
[12] Rules 39 – 51 of the Rules of Procedure of the Basel Convention

51. The Conference of the Parties to the Basel Convention shall have overriding authority over all activities under the Partnership.

52. In the event of ambiguity in the present Terms of Reference, the Rules of Procedure of the Basel Convention shall apply.

Annex 1

WORK PLAN 2009-2010

A set of activities have been identified that would assist, in particular developing countries and countries with economies in transition, to manage the used and end-of-life computing equipment in an environmentally sound manner:

1. Develop tools (inter alia guidelines) and activities on environmentally sound refurbishment/repair, including criteria for testing, certification and labelling;
2. Develop tools (inter alia guidelines) and activities on environmentally sound recycling and material recovery, including facility certification;
3. Develop and promote pilot schemes for environmentally sound management of used and end-of-life computing equipment towards the achievement of the Millennium Development Goals;
4. Develop awareness raising and training programme activities.

Annex 2

DUTIES OF THE WORKING GROUP TO PACE

The Working Group shall oversee the execution of the 2009-2010 Work Plan for PACE and take the lead in awareness raising, outreach, coordination and resource mobilization in relation to activities undertaken by the Project Groups of PACE;

Other such activities as agreed by consensus of the Partnership and approved by the Conference of the Parties or the Open-ended Working Group of the Basel Convention.

The Officers of the Working Group of the Partnership for Action on Computing Equipment shall be responsible for and liaise with the Secretariat of the Basel Convention to fulfil the following duties:

Administration

- Develop an annual work plan to be [presented / proposed] to the Partnership for its approval;
- Ensuring timely implementation of the work plan adopted by the Partnership;
- Coordinate activities within the Partnership, in particular between the Project Groups and the Working Group;
- Liaise with the Secretariat in relation to the functions carried out by the Secretariat to facilitate the activities of the Partnership.

Membership

- Receive and consider requests for membership of the Partnership, as communicated to the Secretariat;
- Review membership of the Partnership for the purpose of making recommendations to the Working Group of the Partnership;
- Transmit any objections or recommendations relating to requests for membership to the Working Group of the Partnership.

Financial

- Prepare appropriate and sustainable financing mechanism proposals for the Partnership;
- Liaise with the Secretariat to provide financial reports on the Partnership funds retained in the Basel Convention Trust Fund and prepare an annual budget for the Partnership;
- Liaise with the Secretariat to conclude Memoranda of Understanding with all partners on entry to the Partnership.

Annex V

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Item 7 (h) of the provisional agenda*

Implementation of the decisions adopted by the Conference of the Parties at its eighth meeting: technical matters

Draft technical guidelines on the environmentally sound management of mercury wastes

Note by the Secretariat

1. The annex to this document contains the third version, dated 25 October 2007, of the draft technical guidelines on the environmentally sound management of mercury wastes as prepared for the Secretariat, for consideration by the meeting. This document has not been formally edited by the Secretariat.

2. A compilation of comments received by the Secretariat on the above draft that have not been incorporated into the present draft document is set out in the following documents:

(a) UNEP/CHW.9/INF/25 – Comments received from Canada;

(b) UNEP/CHW.9/INF/25/Add. 1 – Comments received from Basel Action Network (BAN);

(c) UNEP/CHW.9/INF/25/Add.2 – Comments received from Germany and the GEF/UNDP advisor.

* UNEP/CHW.9/1.

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Annex

Draft technical guidelines on the environmentally sound management of mercury wastes

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Acronyms and Abbreviations

3R	Reduce, reuse and recycle
ASM	Artisanal and small scale gold mining
BAT	Best available techniques
BMP	Best management practices
BEP	Best environmental practices
BOD	Biochemical oxygen demand
bw	Body weight
BrCl	Bromine chloride
C_2H_6	Ethane
CCO	Chemical control order
CDI	Case development inspection
CETEM	Centre for Mineral Technology
CH_3-Hg^+ or MeHg	Monomethylmercury, commonly called methylmercury
$(CH_3)_2Hg$	Dimethyl mercury
CME	Comprehensive groundwater monitoring evaluation
CO_2	Carbon dioxide
COP	Conference of the parties
CRMs	Certified reference materials
CSOs	Civil society organization
CH_4	Methane
CVAAS	Cold vapour atomic absorption spectrometry
CVAFS	Cold-vapour atomic fluorescence spectrometer
DER	Department of Environment and Natural Resources
DfE	Design for Environment
DHA	Docosahexaenoic acid
EPR	Extended producer responsibility
EMS	Environmental management system
ESM	Environmentally sound management
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GMP	Global Mercury Project
GTG	General technical guidelines
HEPA	High efficiency particulate arrestor
Hf	High frequency
Hg	Mercury
Hg(0) or Hg^0	Elemental mercury
Hg(I)	Monovalent mercury
Hg(II) or Hg^{2+}	Divalent mercury
$HgCl_2$	Mercury dichloride
HgS	Mercury sulphide
$HgSO_4$	Mercury sulphate
HID	High intensity discharge
IAEA	International Atomic Energy Agency
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
ICCM	International Conference on Chemicals Management
IGO	Intergovernmental organizations
ILO	International Labour Organization
IMO	International Maritime Organization
IOMC	Inter-Organization Programme for the Sound Management of Chemicals
J-Moss	Marking of presence of the specific chemical substances for electrical and electronic equipment
JECFA	The FAO/WHO Expert Committee on Food Additives
JLT	The Japanese Standardized Leaching Test
LOAEL	Lowest-observed-adverse-effect-level
MDL	Method detection limit

MeHg	Methylmercury
MFOs	Multinational foundation organizations
MMSD	Mining, Minerals and Sustainable Development
MSW	Municipal solid waste
MVM	Mercury vapour monitor
NEWMOA	The Northeast Waste Management Officials' Association
NGOs	Non-governmental organizations
NIES	National Institute for Environmental Studies
NIMD	National Institute for Minamata Disease
NIST	National Institute for Standards and Technologies
NRCC	National Research Council of Canada
ODA	Official Development Assistance
OEWG	Open-ended Working Group
OECD	Organization for economic Cooperation and Development
OSPAR	The Convention for the Protection of the Marine Environment of the North-East Atlantic
QC	Quality control
PAC	Powdered activated carbon
PBB	Polybrominated biphenyls
PBDE	Polybrominated diphenyl ethers
PM	Particulate matter
PMA	Phenylmercuric acetate
POPs	Persistent organic pollutants
PPP	Polluter pays principle
PR	Public relation
PTWI	Provisional tolerable weekly intake
RfD	Reference of dose
RoHS	Restriction of the use of certain hazardous substances in electrical and electronic equipment
SAICM	Strategic Approach to International Chemicals Management
SBC	Secretariat of the Basel Convention
SPC	Sulphur polymer cement
SPSS	Sulphur polymer stabilization/solidification
S/S	Cementitious stabilization/solidification
TBM	Transboundary movement
TGM	Total gaseous mercury
THg	Total mercury
TWA	Time weighted average
TWI	Tolerable weekly intake
UN	United Nations
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
UNITAR	United Nations Institute for Training and Research
USA	United State of America
USEPA	United States Environmental Protection Agency
VCM	Vinyl chloride monomer
WHO	World Health Organization

1.0 Introduction

1.1 Background

1. Mercury is a chemical element and exists as liquid at room temperature and pressure. Mercury is widely used in products, such as thermometers, barometers, fluorescent lamps, etc and in industrial processes, such as chlor-alkali production, vinyl-chloride-monomer (VCM) production, acetaldehyde production, etc, because of its unique characteristics. However, mercury and methylmercury (one of the organometallic forms) triggered the tragic incidents which caused the deadly damage to human health and the environment in Minamata City, Japan (1950-60’s), in many rural areas, Iraq (1950’s and 1972) and Sihanouk Ville, Cambodia (1998) (Amin-Zaki 1978; Ministry of the Environment 2002; NIMD 1999).

2. It is globally recognised that mercury is one of the global hazardous pollutants due to the anthropogenic mercury emission. Once mercury is released into the environment, mercury is never broken down to a harmless form and exists in the atmosphere, soil and aquatic phase, and pat of mercury in the environment ends at the food chain. This means that mercury is finally taken by people.

3. Although mercury-containing products and industrial mercury uses are tend to be phased out because of the issue of mercury as a global pollutant and are known as one of the anthropogenic sources of mercury emission as mercury waste, some of mercury-containing products are important products for human society, such as fluorescent lamps (a replacement of incandescent lamps as a strategy for low carbon society), back-light for liquid crystal displays (high demand of information technology), etc.

4. For example, taking into consideration climate change, as one of the CO_2 reduction programmes, the replacement programme of fluorescent lamps to high frequency (Hf) fluorescent lamps (35% higher frequency and 1.5 longer life than normal types) are being implemented in several countries, particularly in the parties to the Kyoto Protocol (Team -6% Committee & Ministry of the Environment 2007). In this programme, a large number of used fluorescent lamps become mercury waste. Waste fluorescent lamps should be treated on the environmentally sound management (ESM) without any breakage. It is therefore important to comprehensively plan a replacement programme and recycling/disposal plans.

5. In order to reduce risk of mercury pollution to human health and the environment as well as the environmentally sound use of mercury-containing products, it is necessary to consider, introduce and fully implement ESM of mercury waste. Technical Guidelines on Environmentally Sound Management of Mercury Waste guides the environmentally unsound management of mercury waste to ESM.

1.2 Purpose

6. The present technical guidelines follow the decision VIII/33 of the Conference of the Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, namely the programme to support the implementation of the Strategic Plan focus area: B9 mercury waste.

7. The programme on mercury waste under the decision focuses on: a) developing partnerships around the theme of environmentally friendly technologies and awareness raising regarding avoidance, use and disposal of mercury waste; b) developing capacity-building and technical assistance programmes to reduce and prevent pollution from mercury waste; and c) developing guidelines on the ESM of mercury waste with emphasis on the development of sound disposal and remediation practices.

8. The present technical guidelines provide guidance for ESM of mercury waste and give comprehensive information about mercury waste, including the chemistry and toxicology of mercury, source of mercury and mercury waste, adverse effects to human health and the environment caused by the environmentally unsound management of mercury. These guidelines provide knowledge and expertise on ESM of mercury waste and provisions for mercury waste under the legal instruments.

1.3 Definition of Mercury Waste under the Basel Convention

1.3.1 Scope

9. The present technical guidelines focus on mercury and mercury compounds listed at Y 29 in Annex I to the Basel Convention as categories of wastes to be controlled. In addition, the technical guidelines focus on metal and metal-bearing wastes at A1010, namely mercury and mercury-bearing wastes, wastes having as constituents or contaminants any of mercury and mercury compounds at A1030, waste electrical and electronic assemblies or scrap containing components such as mercury switches or contaminated with mercury at A1180 in Annex VIII of the Basel Convention as categories of wastes to be controlled.

10. Taking into consideration mercury poisoning if mercury waste is burned or accidentally spilled (such as mercury in thermometers), the following hazardous characteristics in Annex III of the Basel Convention are considered:

- Poisonous (Acute) (United Nations (UN) Class: 6.1; Code: H6.1): Substances or wastes liable either to cause death or serious injury or to harm human health if swallowed or inhaled or by skin contact; and
- Toxic (Delayed or chronic) (UN Class: 9; Code H11): Substances or wastes which, if they are inhaled or ingested or if they penetrate the skin, may involve delayed or chronic effects, including carcinogenicity.

11. Taking into consideration mercury poisoning because of bioaccumulation and biomagnification if mercury in wastes is released into the environment and bioconverted to methylmercury, the following hazardous characteristic is also considered:

- Ecotoxic (UN Class: 9; Code: H12 in Annex III to the Basel Convention): Substances or wastes which if related present or may present immediate or delayed adverse impacts to the environment by means of bioaccumulation and/or toxic effects upon biotic systems.

12. Taking into consideration ESM of mercury waste, the following disposal operations which do not lead to the possibility of resource recovery, recycling, reclamation, direct re-use or alternative uses in Annex IV of the Basel Convention are considered: D1: Deposit into or onto land; D2: Land treatment; D3: Deep injection; D4: Surface impoundment; D5: Specially engineering landfill; D12: Permanent storage; and D15: Storage pending any of the operation in Section A.

13. In addition, any operation, which may lead to resource, recovery, recycling, reclamation, direct reuse or alternative uses, in Section B in Annex IV of the Basel Convention is considered under the guidelines.

1.3.2 General Guidance on ESM of Mercury Waste

14. The Basel Convention is the world's most comprehensive environmental agreement on hazardous and other wastes and aims at protecting human health and the environment from the inappropriate management of hazardous and other wastes. There are 170 Parties as of May 2007. The Convention regulates the movement of hazardous waste and obliges its members to ensure that such wastes are managed and disposed of in an environmentally sound manner. It covers toxic, poisonous, explosive, corrosive, flammable, ecotoxic, and infectious wastes that are being moved from one country to another. Governments are also expected to minimize the quantities that are transported, to treat and dispose of wastes as close as possible to their place of generation and to minimize the generation of hazardous waste at source.

15. ESM of mercury waste means taking all practicable steps to ensure that mercury waste is managed in a manner which will protect human health and the environment against the adverse effects which may result from such waste. The criteria of ESM under the Basel Convention are to ensure that:

- Generation of mercury waste within it is reduced to a minimum, taking into account social, technological and economic aspects;
- Availability of adequate disposal facilities, for ESM of mercury waste, that shall be located, to the extent possible, within it, whatever the place of their disposal;
- Persons involved in the management of mercury waste within it take such steps as are necessary to prevent pollution due to mercury waste arising from such management and, if such pollution occurs, to minimize the consequences thereof for human health and the environment;
- Transboundary movement of mercury waste is reduced to the minimum consistent with the environmentally sound and efficient management of such waste, and is conducted in a manner which will protect human health and the environment against the adverse effects which may result from such movement;
- International cooperation is implemented in activities among parties, interested organisations of both public and private sectors for information exchange and technical cooperation on ESM of mercury waste;
- Appropriate legal, administrative and other measures to prevent and punish conduct in contravention of the Basel Convention are implemented and enforced; and
- Transboundary movement of mercury waste is strictly controlled under the Basel Convention.

1.4 About Mercury

1.4.1 Chemical Properties

16. Mercury is a metal and atomic number 80. Mercury generally exists as elemental mercury (Hg(0) or Hg^0), monovalent mercury (Hg(I)), divalent mercury (Hg(II) or Hg^{2+}) and monomethylmercury (CH_3-Hg^+, commonly called methylmercury (MeHg)). Monovalent and divalent mercury is compound form between mercury and other compounds. Many inorganic and organic compounds of mercury can be formed from Hg(II). Mercury also forms organometallic compounds which are a covalently-bonded compound and does not include mercury bound to proteins nor salts formed with organic acids. These organometallic compounds are stable, though some are readily broken down by living organisms (Japan Public Health Association 2001).

17. Elemental (Metallic) mercury is a dense, silvery-white, shiny metal and normally liquid at normal temperature and pressure. It has a relative molecular mass of 200.59, a melting point of -38.87°C, a boiling point of 356.72°C, and a density of 13.534 g/cm^3 at 25°C (WHO 2003). Elemental mercury is the most volatile form of mercury. It has a vapour pressure of 0.3 Pa at 25°C and transforms into the vapour phase at room temperatures (WHO 2003). In particularly, if elemental mercury is not enclosed, elemental mercury evaporates and forms mercury vapours which dissolve only slightly in water (56 µg/litre at 25°C) (WHO 2003). Mercury vapours are colourless and odourless (WHO 2003). The higher temperature, the more vapours are released from liquid elemental mercury (UNEP 2002). Elemental mercury is used to extract gold from ore at the amalgamation process of artisanal and small scale gold mining in a lot of countries, and mercury vapour is released into the atmosphere when the amalgam is burned (Spiegel 2006).

18. Monovalent mercury (Hg(I)) includes mercury (I) oxide (mercurous oxide or dimercury monoxide) and mercury (I) chloride (mercurous chloride). Mercury (I) oxide is Hg_2O and unstable and easily decomposes into metallic mercury and divalent mercury (Japan Public Health Association 2001). Chemical formula of mercury (I) chloride is Hg_2Cl_2. Mercury (I) chloride is odourless solid, which is the principal example of mercury (I) compound, and known as calomel or mercurous chloride (ILO 2000).

19. Divalent mercury (Hg(II) or Hg^{2+}) includes mercury (II) chloride (mercuric chloride), mercury (II) oxide (mercuric oxide, mercuric oxide red and mercuric oxide yellow) (Japan Public Health Association 2001). Mercury (II) chloride is $HgCl_2$ (well known as corrosive sublimate) and a poisonous white soluble crystalline salt of mercury (ILO 2000). In some countries, it was used to use in insecticides, batteries and as antiseptic, disinfectant, etc (Galligan 2003; United States National Library of Medicine). Mercury (II) oxide is HgO and exists as an irregularly shaped, orange-yellow powder (yellow precipitate) or/and orange-red powder (red precipitate) with high lustre (Japan Public Health Association 2001). It is still used as a material for anodes for mercury batteries (ILO 2001).

20. Methylmercury (MeHg) is CH_3Hg^+ and one of organometallic form. It can bioaccumulate up the food chain and is recognised as a bioaccumulative environment toxicant. Due to a bioaccumulative environmental toxicant, methylmercury is accumulated at high concentration in predatory fish which is a very important source of protein and other nutrients for human, particularly for Japanese and other Asians, as well as for people in the Arctic region and other self-sustaining people living along rivers, lakes and coasts (Honda 2006a). Methylmercury has very high affinity for sulphur-containing anions, particularly the sulfhydryl (-SH) groups on the amino acid cysteine and hence in proteins containing cysteine, forming a covalent bond (Oliveira 1998). In the past, methylmercury was produced directly and indirectly as part of several industrial processes such as the manufacture of acetaldehyde (Tajima 1970).

1.4.2 Behaviour in the Environment

21. Mercury is a persistent, mobile and bioaccumulative element in the environment and retained in organisms. Because mercury is an element it is ultimately persistent; it cannot be converted to a non-mercury compound. Mercury in the aquatic environment is changed to various forms, mainly methylmercury methylated from mercury. Once mercury enters into the environment, mercury permanently exists in the environment by changing its chemical forms depending on the environment. Fig. 1-1 shows the mercury species and transformation in the environment.

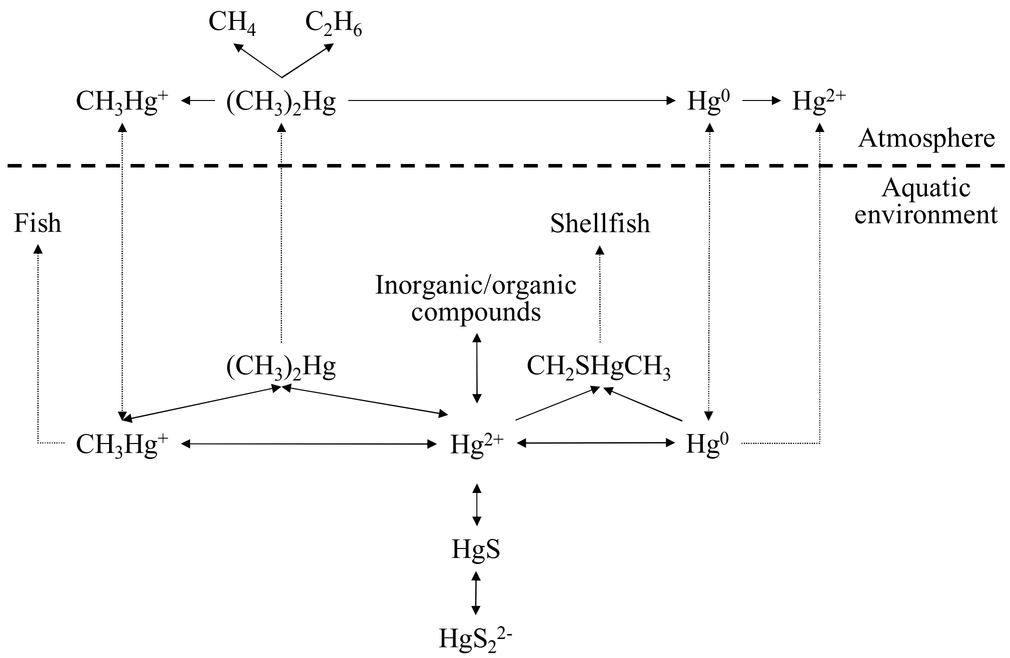

Fig. 1-1 Dynamics of mercury in the environment (Beijer 1979)

22. Mercury in the atmosphere is broadly divided into gas form and particulate form. Most of mercury in the general atmosphere is in gas form (95% or more). Gaseous mercury includes mercury vapour, inorganic compounds (chlorides and oxides), and alkyl mercury (primarily methylmercury). However, 90-95% or more of the gaseous mercury is mercury vapour (Japan Public Health Association 2001).

23. In the aquatic environment under the suitable conditions, mercury is bioconverted to methylmercury, called methylation (Wood 1974). Methylmercury is bioaccumulated within organisms from both biotic (other organisms) and abiotic (soil, air, and water) sources and biomagnified on the food chain. Therefore, methylation is the source of mercury exposure to human and its mercury exposure is chronic exposure to human health through consuming fish and seafood. This means that methylation triggers mercury exposure to human, and its mercury exposure is chronic exposure to human health through consuming fish and seafood.

1.4.3 Health Effects

1.4.3.1 Methylmercury

1.4.3.1.1 General Information

24. In the aquatic environment, elemental mercury is bioconverted into methylmercury which is the environmental neurotoxicant with well-defined neuropathological and developmental effects (Ozonoff 2006). Methylmercury bioaccumulates, is biomagnified in the food web and enters the human body mainly through the consumption of fish and seafood, particularly large predatory fish species such as tuna, swordfish, shark, whale, etc (Sanborn 2006). Most humans, particularly high-fish-consuming population, are exposed to methylmercury through fish and seafood consumption (Sakamoto 2005).

25. Ingested methylmercury in the human body is readily and completely absorbed by the gastrointestinal tract, almost completely absorbed into the bloodstream and distributed to all tissues within about 4 days (WHO 1990). Methylmercury is accumulated in the liver and kidney. In addition, methylmercury transported into tissues combines with cysteine which is an amino acid found in most protein and appears to be mediated by the formation of a methylmercury-cysteine conjugate, also called as methionine, which is transported into cells via a neutral amino acid carrier protein (Kanai 2003). A methylmercury-cysteine conjugate can pass through not only the blood-brain barrier but also the placenta via an amino acid transporter (Kerper 1992). Methylmercury can achieve to the brain where methylmercury is oxidized and accumulated and eventually causes the chronic exposure to human health (Mottet 1985; Sakamoto 2004).

1.4.3.1.2 Thresholds for Onset of Methylmercury Symptoms in Adults

26. The large-scale poisoning incidents from 1972 to 1973 in Iraq were caused by wheat seed disinfected with methylmercury, and the main symptoms shown were similar to those shown in Minamata disease (UNEP 2002;

WHO 1990). A study on Iraqi case showed that the thresholds of mercury body burden at diagnosis of patients were as follows: abnormal sensory, about 25 mg (equivalent to a mercury concentration in blood of 250 μg/l); ataxia, about 50 mg; articulation disorders, about 90 mg; hearing loss, about 180 mg; death, more than about 200 mg. Table 1-1 shows the summary of the thresholds for which the first neurological symptoms appear in adults with the highest susceptibility according to WHO (WHO 1990).

Table 1-1 Indices showing thresholds for onset of neurological symptoms in human body (level at which neurological symptoms would appear in the most susceptible individuals) (WHO 1990)

Index	Threshold
Average daily intake	3-7 μg·Hg/kg
Body burden	15-30 mg·Hg（50 kg body weight）
Total mercury in blood	20-50 μg·Hg/100 ml
Total mercury in hair	50-125 μg·Hg/g

1.4.3.1.3 Thresholds for Onset of Methylmercury Symptoms for Sensitive Group

27. Unlikely the cases of methylmercury symptoms in adults, the sensitive group, namely pregnant women and child-bearing women, exposed to methylmercury should be separately considered, because methylmercury as methylmercury-cysteine conjugate can pass not only the blood-brain barrier but also the placenta and causes the adverse effects to the fetus.

28. The threshold for the onset of symptoms for methylmercury is about 10 μg·Hg/g in maternal hair (Grandjean 1997). The FAO/WHO Expert Committee on Food Additives (JECFA) calculated the threshold as 12 μg·Hg/g in maternal hair and established a provisional tolerable weekly intake (PTWI) for methylmercury of 1.6 μg·Hg/kg·body weight (bw)/week (equivalent to a hair mercury concentration of about 2.3 μg·Hg/g) using an total uncertain factor of 6.4 (2 [the distribution of hair:blood mercury ratio on the overall average] × 3.2 [the pharmacokinetic ratio of methylmercury at the steady concentration of mercury]) (Bellinger 2004).

29. The United States Environmental Protection Agency (US EPA) set the limit to 0.1 μg·Hg/kg bw/day (equivalent to a hair mercury concentration of 1.0 μg·Hg/g) using an uncertain factor 10 as reference of dose (RfD) which estimates a daily oral exposure to the human population including sensitive subgroups that is likely to be without an appreciable risk of deleterious effects during a life time (US EPA 2007a).

30. The amount of fish and other seafood consumed by people in Japan and other Asian countries bordering the sea is higher than that consumed by most European and American people. In 2003, the Ministry of Health, Labour and Welfare, Japan, issued standards for the tolerable intake (TWI) of tooth whales, red snapper, swordfish, bluefin tuna and other seafood for pregnant women, owing to the fact that a certain percentage of fish and other seafood contains high methylmercury concentration as a result of biomagnification. In 2005, the Food Safety Commission, which was requested by the Ministry of Health, Labour and Welfare, Japan, to evaluate TWI, established the methylmercury TWI to 2.0 μg·Hg/kg bw/week using an uncertain factor 4, corresponding to a hair mercury concentration of about 2.8 μg·Hg/g (Food Safety Commission 2005).

31. TWI is important for an advisory of fish consumption pattern, particularly for the subpopulation (pregnant women and child-bearing women), taking into consideration fetuses as a high risk group. However, pregnant women, in particular, should not give up eating fish and forgo its nutritional benefits, because fish and seafood are a very important source of protein and other nutrients, particularly docosahexaenoic acid (DHA) which is one of the most important n-3 polyunsaturated fatty acids for normal brain development and function of fetuses. It is important to consume smaller fish and avoid top predatory species to lower methylmercury intake, thereby balancing the risks and benefits of fish consumption (Food Safety Commission 2005).

1.4.3.1.4 Methylmercury in Fish

32. FAO/WHO Codex Alimentarius defines 0.5 mg·methylmercury/kg for all fish except predatory fish and 1 mg·methylmercury/kg for predatory fish, such as shark, swordfish, tuna, pike, etc. The guideline levels are intended for methylmercury in fresh or processed fish and fish products moving in international trade (FAO/WHO 1991).

1.4.3.2 Elemental Mercury

33. Most cases of the adverse effects to human health caused by elemental mercury are due to inhalation of mercury vapour via the lungs (Oikawa 1983). Elemental mercury exposure is triggered by the spillage of mercury-containing products, such as breakage of fluorescent lamps and thermometers, or occurred by the environmentally unsound uses and manners of elemental mercury, such as mercury vapour released from artisanal and small scale gold mining (ASM) (Hylander 2005). Elemental mercury spilled by these accidents becomes mercury vapour at normal room temperature (Bull 2006). In addition, dental amalgam is one of another source to causes elemental mercury exposure (Gay 1979).

34. Approximately 80% of mercury vapour crosses the alveolar membrane and is rapidly absorbed into the blood (WHO 1990). Absorbed elemental mercury is rapidly distributed to all tissues, although it accumulates to the greatest extent in the kidney (WHO 1990; 1991). Due to the high lipophilicity, elemental mercury vapour passes the blood-brain barrier and the placenta (WHO 1991).

35. When mercury is accidentally swallowed, the gastrointestinal absorption of elemental mercury is very low (less than 0.01%) (Japan Public Health Association 2001). Most of it is excreted in the faeces (Canadian Centre for Occupational Health and Safety 1998).

36. An acute exposure (>0.1 mg·mercury/m^3) to mercury vapour causes respiratory effects such as cough, dyspnoea and chest tightness as well as bronchitis and bronchiolitis with interstitial pneumonitis, airway obstruction, and decreased pulmonary function. In addition, pulmonary oedema, respiratory distress and fibrosis would occur (WHO 1991; 2003).

37. The WHO air quality guideline for mercury is 1 μg·Hg/m^3 (annual average) (WHO 2003). The recommended health-based exposure limit for metallic mercury is 25 μg·Hg/m^3 for long-term exposure as the time weighted average (TWA) which means the time weighted average concentration for a normal 8 hour-day and 40 hour-workweek, to which nearly all workers can be repeatedly exposed without adverse effect (WHO 1991).

1.4.3.3 Inorganic Mercury

38. Exposure to inorganic mercury compounds occurs due to accidental ingestion of mercury (II) chloride or ingestion with the intent of suicide (Japan Public Health Association 2001). In human, about 5-10% of inorganic mercury in food is absorbed after ingestion (WHO 1972). Inorganic mercury is distributed to all tissues following absorption, but due to the poor lipid solubility only a small fraction crosses the blood-brain barrier and the placenta (Asano 2000). As is the case for elemental mercury, the largest systemic deposition of inorganic mercury occurs in the kidney (Asano 2000). The main pathway of excretion of inorganic mercury is via the urine and faeces, with the half-life of about 70 days (WHO 1990; 1991).

39. With ingestion of inorganic mercury at high concentration, the corrosive effects first damage the digestive tract, cause vomiting and stomach pain, and, in severe cases, may result in shock (Japan Public Health Association 2001). Finally, renal tubule degeneration, kidney dysfunction and nephritic syndrome may be seen (Japan Public Health Association 2001). Mercurochrome, which was previously used, also contains mercury and may cause poisoning when spread in large quantities, as with abdominal wall hernia treatment (Japan Public Health Association 2001).

40. The occupational exposure limit of inorganic compounds is 25 μg·Hg/m^3 which are same as that of elemental mercury as the lowest-observed-adverse-effect-level (LOAEL) (ILO 2000). Exposure to inorganic compounds (1-5% contents) may cause irritation, vesiculation, contact dermatitis and corrosion of the skin (WHO 1991; 2003).

1.4.4 Mercury Pollution

1.4.4.1 Minamata Disease

41. Minamata disease, which is a typical example of the pollution-related adverse effects to human health and the environment, was officially reported in 1956 around Minamata Bay, Kumamoto, Japan, and occurred in 1965 in the Agano river basin, Nigata, Japan. The causal substance was methylmercury which was produced as a by-product of acetaldehyde discarded from Chisso Corporation into Minamata bay and from Showa Denko Company into the Agano river basin. Methylmercury released from both factories had been bioaccumulated and biomagnified heavily in fish and seafood which were the main source of food for local people (Ministry of the Environment 2002). Minamata disease was caused by consuming those fish and seafood polluted with methylmercury.

42. The signs and symptoms of the Minamata disease patients are sensory disturbance in the distal portions of four extremities, ataxia, concentric contraction of the visual field, etc. At the end of March 2006, 2,955 Minamata disease patients have been certified, of which 2,265 patients have been located on Yatsushiro sea coast (Ministry of the Environment 2006). Because of the clinical and protective measures taken after the discovery of Minamata

disease, Minamata disease no longer seems to occur in Japan. However, many persons with Minamata disease still are present in Japan.

43. The lessons learned from Minamata disease is:

> From the incidence of Minamata disease, Japan has learned a very important lesson on how activities that place priority on the economy, but lack of considerations for the environment can cause great damage to the environment and society, and how it is difficult to recover from sever environmental pollution and settle society later on. From the purely economic standpoint, too, a large amount of cost and a great deal of time are required to deal with such damages, and, when we compare these costs incurred vs. the cost of the measures that could have prevented the pollution, allowing such pollution is certainly not an economically advisable option. In Japan, with the experience of suffering from disastrous damage by pollution including the Minamata disease as a turning point, measures to protect the environment have made dramatic progress. However the sacrifices incurred on the way were truly huge, indeed. Japan sincerely hopes that Japan's experience can be utilized as a vital lesson by other countries, that consideration is paid to the importance of the environment, and that pollution will be prevented without ever undergoing this kind of tragic pollution-related damage (Ministry of the Environment 1997).

1.4.4.2 Iraq Mercury Poisoning

44. Methyl- and ethylmercury poisonings occurred in Iraq following consumption of seed grain that had been treated with fungicides containing these alkylmercury compounds. The first outbreaks were caused by ethylmercury and occurred in 1956 and 1959-1960, and about 1,000 people were adversely affected. The second outbreak was caused by methylmercury and occurred in 1972. Imported mercury-treated seed grains arrived after the planting season and were subsequently used as grain to make into flour that was baked into bread. Unlike the long-term exposures in Japan, the epidemic of methylmercury poisoning in Iraq was short in duration, but the magnitude of the exposure was high. Because many of the people exposed to methylmercury in this way lived in small villages in very rural areas (and some were nomads), these incidents afflicted more than 6,000 people and resulted in 400 deaths (UNEP 2002).

1.4.4.3 Illegal Transboundary Movement of Mercury Waste - Paradise Poisoned Sihanouk Ville, Cambodia

45. In November 1998, the infamous incident, the illegal transboundary movement of toxic waste which was mainly composed of byproducts of battery production containing mercury, was happened. It was imported from Taiwan to Sihanoukville, Cambodia. The amount of hazardous waste was about 3,000 tonnes. Unfortunately, Taiwan and Cambodia were not the party to the Basel Convention at that time. The transboundary movement of the event was dealt with no legal agreement between both countries because the private sectors dealt with all transactions. The highest of mercury concentration in the waste sample reached to 4,000 μg/g. This event made a lot of the adverse effects to human health and the environment as well as the social scandal. One of the actions by local people was to steal the plastic bags encasing hazardous waste containing mercury, because local people or scavengers could make money to sell plastic bags to dealers as their income. However, this action made those persons directly contact with hazardous waste containing mercury, and eventually most of them complained about somatise, dizziness, weakness, visual trouble, headache, etc. At least, 10 local people were hospitalised. All toxic waste was retransported to Taiwan in 1999 (Honda 2006b; NIMD 1999).

1.4.4.3 Environmental Pollution around a Dump Site – Nairobi, Kenya

46. A dumping site, located to the East of Nairobi, is the main dumping site for most of the solid waste from Nairobi area. Surrounding the dump are informal settlements and the residential estates. Over 2,000 tonnes of waste generated and collected from various locations in Nairobi and its environs are deposited on a daily basis into the dumpsite and what initially was to be refilling of an old quarry has given rise to a big mountain of garbage. Dumping at the site is unrestricted and industrial, agricultural, domestic and medical wastes (including used syringes) are seen strewn all over the dumping site. The Nairobi River also passes beside the dumpsite. Some of the waste from the dump ends up into the River thus extending environmental and health risks to the communities living within the vicinity as well as those living downstream who could be using the water for domestic and agricultural purposes like irrigation. According to the case study, mercury concentration in the samples collected from the waste dump exhibited a value of 46.7 ppm while those collected along the river bank registered a value of 18.6 ppm. Both of these values greatly exceeded the WHO acceptable exposure level of 2 ppm. The rest of the samples were inconclusive due to the fact that the analytical method used was only capable of detecting high levels of mercury (15 ppm and above). From the environmental evaluation conducted, it was determined that the dumpsite exposes the residents around it to unacceptable levels of environmental pollutants with adverse health impacts. A high number of children and adolescents living around the dumping site had illnesses related to the respiratory,

gastrointestinal and dermatological systems such as upper respiratory tract infections, chronic bronchitis, asthma, fungal infections, allergic and unspecified dermatitis/pruritis – inflammation and itchiness of the skin (UNEP 2007).

2.0 Sources and Types of Mercury Waste

2.1 Introduction

47. Mercury has the long history to be used at human society as important industrial element, because mercury is the unique element. There are so many kinds of mercury uses, such as mercury-containing products (thermometers, barometers, fluorescent lamps, batteries, switches, dental amalgams, chemical regents, etc), as well as many kinds of unintentional mercury uses (coal fired power plants, cement production, incineration, etc). Unfortunately, there had been very limited knowledge that mercury caused the serious adverse effects to human health and the environment until the outbreak of Minamata disease in Japan (1950's) and Iraq mercury poisoning (1950's and 1970's) were occurred.

48. Many research activities on mercury and its adverse effects to human health and the environment have been undertaken since these infamous incidents were occurred. Information about mercury poisoning and the adverse effects to human health and the environment opened people eyes to recognise that mercury was the hazardous element to human health when it was dealt with on the environmentally unsound management. Although the situation of mercury uses is being changed to mercury-free industrial processes and mercury-free products, it is practically impossible to completely substitute all mercury uses. In addition, it should be noted that mercury-containing products and mercury used in industrial processes become mercury waste when those products and industrial mercury uses are substituted by mercury-free products and processes.

49. Therefore, it is important to understand what kinds of products and industrial processes use mercury, need to continue mercury uses because of no practical alternatives, can be substituted by mercury-free products and industrial processes. This chapter describes the patterns of mercury uses, mercury containing products and incidental emission.

2.2 Sources and Types of Mercury Waste

50. United Nations Environment Programme (UNEP) Chemicals published Global Mercury Assessment (UNEP 2002), Toolkit for Identification and Quantification of Mercury Releases (UNEP 2005b), Guide for Reducing Major Uses and Releases of Mercury (UNEP 2006a) and Summary of Supply, Trade and Demand Information on Mercury (UNEP 2006b). These materials clearly provide and describe information about the sources of mercury emission and types of mercury waste as well as mercury trade statistics and international mercury trade. See these materials for further detailed information. According to these materials, the sources and types of mercury waste are categorised in Table 2-1.

51. It is noted, in some countries, that some of the industrial sources (Category 1, 2, 3, 4 and 7, except the processes using mercury) of mercury waste in Table 2-1 do not use mercury and discard mercury waste at all. Industrial processes are depended on country's technological and social issues whether technology of mercury-free processes is introduced for environmental issues.

Table 2-1 Sources and types of mercury waste (UNEP 2002; 2005b; 2006a; 2006b)

Source of mercury waste	Types of mercury waste	Causal factors of mercury waste
1. Extraction and use of fuels/energy sources		
1.1. Coal combustion in power plants	Residue, ashes	• Combustion of natural mercury impurities in raw materials; • Accumulation in solid incineration residues and flue gas cleaning residues.
1.2. Other coal combustion	Flue gas cleaning residues, ashes, slag	
1.3. Extraction, refining and use of mineral oil	Incineration residues, refinery products/byproducts, various process wastes, sludge	
1.4. Extraction, refining and use of natural gas	Gas cleaning residues, condensates	
1.5. Extraction and use of other fossil fuels	Combustion residues, ashes	
1.6. Biomass fired power and heat production	Ashes, residues	
2. Primary (virgin) metal production		
2.1. Primary extraction and processing of mercury	Smelting residue	• Pyrometallurgy of mercury ore
2.2. Metal (aluminium, copper, gold, lead,	Tailings, extraction process residues, exhaust gas cleaning	• Industrial processing; • Thermal treatment of ore; and

manganese, mercury, zinc, primary ferrous metal, other non-ferrous metals) extraction and initial processing	residues, wastewater treatment residues	• Amalgamation.
3. Production of other minerals and materials with mercury impurities		
3.1. Cement production	Process residues, exhaust gas cleaning residues, sludge	• Pyroprocessing of natural mercury impurities in raw materials
3.2. Pulp and paper production		• Combustion of natural mercury impurities in raw materials
3.3. Lime production and light weight aggregate kilns		• Calcination of natural mercury impurities in raw materials
4. Intentional use of mercury in industrial processes		
4.1. Chlor-alkali production with mercury-technology	Solid waste contaminated with mercury, elemental mercury, process residues	• Mercury cell; • Mercury recovery units (retort).
4.2. Vinyl-chloride-monomer (VCM) production with mercury-dichloride ($HgCl_2$) as catalyst	Process residues	• Mercuric chloride process
4.3. Acetaldehyde production with mercury-sulphate ($HgSO_4$) as catalyst	Wastewater	• Mercury-sulphate process
4.4. Other production of chemicals and polymers with mercury compounds as catalysts	Process residues, solid waste, wastewater	• Mercury catalyst process
5. Consumer products with intentional use of mercury		
5.1. Thermometers and other measuring devices with mercury	Used, obsolete or broken products	• Liquid mercury
5.2. Electrical and electronic switches, contacts and relays with mercury		
5.3. Light sources with mercury (7.5 mercury·mg/unit on average)		• Vapour-phase elemental mercury • Divalent mercury adsorbed on the phosphor powder
5.4. Batteries containing mercury		• Mercury oxide
5.5. Biocides and pesticides	Stockpiles (obsolete pesticides), soil and solid waste contaminated with mercury	• Mercury compounds (mainly ethylmercury chloride)
5.6. Paints	Stockpiles (obsolete paints), solid waste contaminated with mercury, wastewater treatment residues	• Phenylmercuric acetate and similar mercury compounds
5.7. Pharmaceuticals for human and veterinary uses	Stockpiles (obsolete pharmaceuticals), medical waste	• Thimerosal; • Mercuric chloride; • Phenyl mercuric nitrate; • Mercurochrome, etc
5.8. Cosmetics and related products	Stockpiles	• Mercury iodide; • Ammoniated mercury, etc
6. Other intentional product/process uses		
6.1. Dental mercury-amalgam fillings	Stockpiles, wastewater treatment residues	• Alloys of mercury, silver, copper and tin

6.2. Manometers and gauges	Used, obsolete or broken products	• Liquid mercury
6.3. Laboratory chemicals and equipment	Stockpiles, wastewater treatment residues, laboratory wastes	• Liquid mercury; • Mercury chloride, etc
6.4. Mercury metal use in religious rituals and folklore medicine	Solid waste, wastewater treatment residues	• Liquid mercury
6.5. Miscellaneous product uses, mercury metal uses, and other sources	Stockpiles, wastewater treatment residues, solid wastes	• Infra red detection semiconductors with mercury; • Bougie and Cantor tubes; • Educational uses, etc
7. Production of recycled metals (secondary metal production)		
7.1. Production of recycled mercury (secondary production)	Extraction process residues, exhaust gas cleaning residues, wastewater treatment residues	• Dismantling of chlor-alkali facilities; • Recovery from mercury meters used in natural gas pipelines; • Recovery from manometers, thermometers, and other equipment
7.2. Production of recycled ferrous metals (iron and steel)		• Shredding; • Smelting of materials containing mercury.
7.3. Production of other recycled metals		• Other mercury-containing materials or products /components
8. Waste incineration		
8.1. Incineration of municipal/general waste	Exhaust gas cleaning residues, wastewater treatment residues	• Intentionally used mercury in discarded products and process waste; • Natural mercury impurities in high volume materials (plastics, paper, etc.) and minerals; • Mercury as a human-generated trace pollutant in high volume materials
8.2. Incineration of hazardous waste		
8.3. Incineration of medical waste		
8.4. Sewage sludge incineration		
8.5. Informal waste incineration		
9. Waste deposition/landfilling and wastewater treatment		
9.1. Controlled landfills/deposits	Exhaust gas cleaning residues, wastewater treatment residues, solid waste contaminated or mixed with mercury	• Intentionally used mercury in spent products and process waste; • Natural mercury impurities in bulk materials (plastics, tin cans, etc.) and minerals; • Mercury as an anthropogenic trace pollutant in bulk materials.
9.2. Diffuse deposition under some control		
9.3. Informal local disposal of industrial production waste		
9.4. Informal dumping of general waste		
9.5. Wastewater system/treatment	Wastewater treatment residues, slurry	• Intentionally used mercury in spent products and process waste; • Mercury as an anthropogenic trace pollutant in bulk materials.
10. Crematoria and cemeteries		
10.1. Crematoria	Exhaust gas cleaning residues, wastewater treatment residues	• Dental amalgam fillings
10.2. Cemeteries	Soil contaminated with mercury	

2.3 Common Process and Source on Causal Factors of Mercury Waste

52. The causal factors of mercury waste are categorised into 4 categories of common mechanism as follows:

I. Industrial equipments using mercury and consumer products;

II. Wastewater treatment process;

III. Thermal process of natural mercury impurities in raw materials; and

IV. Process at Artisanal and Small Scale Gold Mining.

2.3.1 Industrial Processes using Mercury or for Consumer Products

53. Industrial mercury processes (equipments using mercury) and mercury-containing products tend to be phased out. As this result, a large amount of equipments for industrial mercury processes and mercury-containing products become mercury waste. Although these mercury wastes should be separately dealt with on the environmentally sound management (ESM), it is expected that mercury is easily mixed with municipal solid waste (MSW) due to no collection mechanism for mercury-containing products or no (or less) awareness on mercury-containing products. Once mercury waste as MSW enters waste stream on the environmentally unsound management, this means that mercury enters the environment because mercury waste on the environmentally unsound management includes incineration and landfilling which are the most basic solid waste treatments. It is noted that mercury waste as well as other hazardous wastes is collected and treated as MSW in many developing countries, and this means that mercury waste is dumped at landfill sites or open dumping sites without any proper treatments.

54. In addition, it is expected that liquid mercury used at industrial processes and contained in products, particularly dental amalgam, are intentionally or accidentally discharged into wastewater. In this case, mercury reaches to wastewater treatment plants and ends as sludge or ash, or directly enters the aquatic environment if there is no wastewater treatment facility.

2.3.2 Wastewater Treatment Process

55. As the above-mentioned reason, liquid mercury released from mercury waste, such as thermometers, barometers, dental amalgams, etc, can enter into wastewater, due to intentional or accidental discharging, and ends at wastewater treatment plants. In addition, mercury used in industrial processes would be leaked to wastewater because of mercury uses as catalyst. Mercury as catalyst is itself not consumed by overall processes and theoretically possible to be completely reused. However, mercury reuse as catalyst is not fully implemented because of obsolete process (not enough process mechanism to reuse mercury) or decreasing of mercury price. Furthermore, mercury used in industrial processes might be accidentally released into wastewater because of the current mercury phase-out situation of industrial mercury processes (demolition of these facilities).

56. At wastewater treatment plants, the dynamics of mercury are: 1) During collection and transport of wastewater to the treatment plant, Hg(II) is likely subjected to reducing conditions (caused by anoxia) and various bacteria, resulting in some conversion to elemental mercury; 2) In the primary settling tank, mercury adsorbed to and incorporated into settleable solids is removed in the sludge; 3) In the mixed liquor aeration basin or other biological unit, bacteria, protozoa and other microorganisms proliferatively and effectively convert dissolved organic material and colloidal particles with associated mercury to a flocculent biological material which is eventually removed as waste sludge; 4) Bacterial action in anaerobic or aerobic digestion to stabilize sludge would produce additional transformations of elemental mercury. Elemental mercury formed may be stripped from solution by gas mixing systems (in the case of anaerobic digesters) or forced aeration. After stabilization, sewage sludge is often thickened or dewatered to reduce volume prior to ultimate disposal by land spreading, landfilling or incineration which are the anthropogenic sources of mercury emission (Huber 1997).

2.3.3 Thermal Process of Natural Mercury Impurities in Raw Materials and Mercury Waste

57. Thermal process includes calcinations, combustion, crematoria, incineration, pyroprocessing, pyrometallurgy, retort, roasting, melting and smelting. Thermal process means to burn raw materials containing trace amount of mercury. For example, coal containing a trace amount of mercury is burned at coal fired power plant for energy production, raw materials such as lime, coal, oil etc, which contain a trace amount of mercury, are thermally processed for cement production, or mercury waste, such as mercury-containing thermometers, batteries, etc., is accidentally or intentionally mixed with municipal solid waste destined for incineration.

58. In a thermal and incineration mechanism, only elemental mercury (Hg^0) exists in the flue gas leaving the incinerator at about 700°C, because of the thermo-chemical instability of the mercury compounds. Mercury is highly volatile and is present almost exclusively in the vapour phase in the flue gas. Depending on the other flue gas components, the temperature and the ash composition part of the elemental mercury (Hg^0) react to several mercurous (Hg_2^{2+}) and mercuric (Hg^{2+}) compounds while the flue gas cools down on its way through the boiler. Elemental mercury reacts in the presence of activated carbon quickly with oxygen to HgO, also quickly with Cl or HCl to $HgCl_2$ or Hg_2Cl_2 but slowly with NO_2 to HgO. No reaction of the elemental mercury with NH_3, N_2O, SO_2 or H_2S was observed (Saenger 1999).

59. As these results, mercury is released into environment. On the other cases, mercury vapour can also be generated from leaks in pressurized equipment, maintenance work and dysfunction, absent of any visual appearance of liquid mercury. In addition, mercury accumulates in solid incineration residues and flue gas cleaning residues, ash and slag which are finally landfilled, stabilised as concrete, or recycled as construction materials.

2.3.4 Process at Artisanal and Small Scale Gold Mining

60. Mercury waste, called as "tailings", released from artisanal and small scale gold mining (ASM) activities has been becoming as one of the hot issues, because almost all ASM activities are in developing countries and countries with economies in transition, and almost all miners of ASM do not consider environmental pollution due to their activities. ASM activities are a poverty-driven activity that provides an important source of livelihood for rural communities because of increasing of gold price. This means that those miners have to do ASM activities whatever mercury used at ASM activities causes the adverse effects to their health and the environment around them.

61. Mercury use at ASM is to form an amalgam or bind with gold. The wetting of gold by mercury is not alloying, but a phenomenon of moderately deep sorption, involving some interpenetration of the two elements. As the surface tension of mercury is greater than that of water, but less than that of gold, mercury adsorbs onto the surface of gold particles. In addition, mercury acts as a dense medium; gold sinks into the mercury while the lighter gangue material floats on top. When the resulting amalgam is heated, the mercury vaporizes, leaving gold. Gold, in particular, can combine with mercury to form a wide range of compounds from $AuHg_2$ and Au_8Hg. The three principal gold amalgams are: $AuHg_2$, Au_2Hg and Au_3Hg. Mercury can also solubilise from 0.14% to 0.65% gold at room temperature and 100°C respectively (GMP 2004).

62. Mercury is usually discharged with tailings and/or volatilized into the atmosphere. The magnitude of loss and means of mercury release from a specific site are defined by the Au-Hg separation procedures. A variety of amalgamation methods are used in artisanal mining operations. Typical amalgamation methods used by ASM are as follows (GMP 2004):

- Whole ore amalgamation: Mercury is mixed with the whole ore in pump boxes; introduced in sluices during gravity concentration; added to the grinding circuit; or the whole ore is amalgamated using copper plates; and
- Amalgamation of only gravity concentrates: mercury is mixed with concentrates in blenders or barrels; separation of amalgam from heavy minerals is accomplished by panning in water-boxes, in pools or at creek margins.

63. Not all the mercury added to the amalgamation process combines with gold and forms amalgam. The excess mercury must be removed and can be reused. The most common system used by miners is to squeeze off the excess mercury through a piece of fabric. However, squeezing with bare hands is not enough to reuse all excess mercury and let a part of excess mercury to escape to the environment as tailings (GMP 2006).

3.0 Provisions for Mercury in the UNEP and the Basel Convention

3.1 Introduction

64. Only a limited numbers of countries have a capacity to treat mercury waste or used mercury-containing products, such as used fluorescent lamps, on the environmentally sound management (ESM) because a facility with advanced technologies is necessary to treat these wastes. Unfortunately, most mercury wastes or used mercury-containing products are treated by the environmentally unsound management, such as mixing with other wastes (e.g. municipal solid waste), open dumping or open burning, in particularly developing countries and countries with economies in transition which do not have enough capacity to treat mercury wastes. For ESM, there are two options: 1) development and implementation of domestic ESM taking into account international framework and cooperation; and/or 2) international trade under the Basel Convention.

3.2 UNEP Governing Council Decisions

65. UNEP Governing Council notes that releases of mercury have harmful effects on human health and may damage ecosystems of environmental and economic importance, and has decided a number of decisions on mercury issues, taking into consideration global adverse effects to human health and the environment caused by mercury. Based on the UNEP Governing Council decisions, UNEP Chemicals have undertaken various remarkable activities to tackle global mercury issues. Table 3-1 shows the main decisions of UNEP Governing Councils on mercury issues. For further information, see Appendix B: UNEP Governing Council Decisions.

Table 3-1 UNEP Governing Council Decisions on mercury (UNEP 2001; 2003a; 2005a; 2007)

Session	Year	Main decision on mercury
21	2001	Development of a global assessment of mercury in order to consider international actions on mercury
22	2003	Technical assistance and capacity-building activities to support the efforts of countries to take action regarding mercury pollution
23	2005	Initiating national, regional and global actions and partnership, both immediate and long-term, to protect human health and the environment against mercury, in order to eliminate releases of mercury and its compounds into the environment in collaboration with all stakeholders.
24	2007	Establishment of an ad hoc open-ended working group of governments, regional economic integration organisations and stakeholder representatives to review and assess options for enhanced voluntary measures and new or existing international legal instruments.

3.3 SAICM Global Plan of Action

66. In the decision 21/7, the 21st session of the UNEP Governing Council confirmed that there was the need for a strategic approach to international chemicals management, taking into consideration undertaking a comprehensive chemical sound management (UNEP 2001). The World Summit on Sustainable Development in Johannesburg, 2002, decided to renew the commitment, as advanced in Agenda 21, to sound management of chemicals throughout their life cycle and of hazardous wastes for sustainable development as well as for the protection of human health and the environment, inter alia, aiming to achieve, by 2020, that chemicals are used and produced in ways that lead to the minimization of significant adverse effects on human health and the environment (UN 2002).

67. SAICM comprises three core texts:

- The Dubai Declaration: the commitment to SAICM by Ministers, heads of delegation and representatives of civil society and the private sector;
- The Overarching Policy Strategy: the scope of SAICM, the needs it addresses and objectives for risk reduction, knowledge and information, governance, capacity-building and technical cooperation and illegal international traffic, as well as underlying principles and financial and institutional arrangements. The International Conference on Chemicals Management (ICCM) adopted the Overarching Policy Strategy which together with the Dubai Declaration constitutes a firm commitment to SAICM and its implementation; and

- A Global Plan of Action: the proposal of "work areas and activities" for implementation of the Strategic Approach. The ICCM recommended the use and further development of the Global Plan of Action as a working tool and guidance document.

68. The principle for ESM of mercury waste under SAICM is said as the following phrase:

> Mercury-containing product has a possibility to cause the adverse effect to human health and the environment when mercury in mercury-containing product and industrial mercury uses is leaked out to the environment. Mercury-containing product is the global production, and mercury-waste exists globally, therefore the promotion on the sound management of mercury-containing product and mercury waste should be implemented. Although ESM of mercury-containing product and mercury waste have been made progress but insufficient internationally, in particularly developing countries and countries with economies in transition where most residents are under the poverty-line. A long-term strategy on ESM of mercury waste is necessary since mercury is never broken down to harmless substance and exists in the environment and causes the long-term adverse effects to human health and the environment. In addition, it is possible that mercury is bioconverted into methylmercury in the aquatic environment, which can easily pass the blood-brain barrier and the placenta in human body and causes the deadly adverse effects to adults, children, infants and fetuses. Therefore, it is necessary to implement international management of mercury among all stakeholders.

69. For further information, see Appendix C: SAICM Global Plan of Action.

3.4 Basel Convention

3.4.1 General Provisions

70. The fundamental principles of the Basel Convention are waste minimization, disposal at the country where the waste is generated, ESM of hazardous wastes and cradle-to-grave monitoring by means of an international control system towards an integrated approach to pollution control.

71. All parties are required to take appropriate measures to ensure the reduction of the generation of hazardous waste to a minimum. Due to lack of the capacity to undertake appropriate measures on waste minimization, parties, particularly, those of developing countries and countries with economies in transition, must cooperate in the development and implementation of new or advanced low-waste technologies with a view to eliminating, as far as practicable, the generation of hazardous wastes.

72. Each party must endeavour to ensure the availability of disposal facilities located within and deal with hazardous wastes as close as possible to the source of generation; exports must be minimized. Hazardous wastes may be exported only if the state of export does not have the technical capacity and facilities to dispose of them on ESM, or if the wastes are required as raw material for recycling or recovery industries in the state of import, or in accordance with criteria, to be determined by the party states.

73. Parties must require that hazardous wastes subject to transboundary movement are managed in an environmentally sound manner, whatever the place of their disposal. Thus, in accordance with the principle of non-discrimination, the same rules and standards must be applied to hazardous wastes moved out of the state of generation as to those disposed of domestically. Article 4-10 prohibits the transfer, "under any circumstances", of the generating state's obligation to ensure ESM of hazardous wastes to the states of import or transit. By implication, the duty to ensure ESM is allocated primary to the generating state. That state may not allow the export of hazardous wastes if it has a reason to believe that their ESM and disposal would not be guaranteed in the prospective state of import.

74. Each Party shall take appropriate legal, administrative and other measures to implement and enforce the provisions of this Convention, including measures to prevent and punish conduct in contravention of the Convention.

75. Each party is required to establish an authorization system for persons handling hazardous wastes, and to ensure that every hazardous waste transport is accompanied from start to finish by movement document containing information specified in Annex VB. Parties must establish requirements for packaging, labelling and transport in conformity with relevant international rules, standards and practices.

3.4.2 Classification of Mercury Waste

76. The classification of mercury waste under the Basel Convention can see at the subsection 1.3.1 Scope. All wastes having mercury, mercury compounds and mercury vapour are hazardous wastes under the Basel Convention and are controlled by the Basel Convention if there is a need of transboundary movement of mercury waste distend for recycling or final disposal on ESM to destination nations which have ESM and the environmentally sound recycling technologies and demands to recycle materials or chemicals as raw materials.

3.4.3 Transboundary Movement Control

77. The main reason for the international transfer of hazardous wastes is the potential value as secondary raw materials of certain wastes. Hazardous wastes with an economic value are treated as a tradable commodity and are exported in order to be subjected to operations leading to resource recovery, recycling, reclamation, reuse or alternative use. This accounts for a significant proportion of the movement of hazardous wastes across national borders, and there is a substantial trade in hazardous wastes destined for recycling and recovery (Kummer 1995).

78. Recycling can slow down the depletion of limited natural resources and reduce the quantity and hazard potential of wastes going to final disposal if it is on ESM. Provided the country of destination has more environmentally sound facilities and higher environmental standards than the country of origin, export of hazardous wastes for recycling can ultimately lead to an overall reduction of air and water pollution. From an economic viewpoint, recycling of certain wastes leads to the recovery of valuable raw materials. In this case, there usually is an established market for the wastes in question, and the relevant trade has substantive economic significance (Kummer 1995). Recently, with the increase in gold prices, mercury has established itself as a highly-traded commodity in the global market.

79. Under the Basel Convention, illegal traffic occurs if the transboundary movement of hazardous wastes is taking place under the following conditions:

- Without notification pursuant to the provisions of the Convention to all States concerned;
- Without the consent of a State concerned;
- Through consent obtained by falsification, misrepresentation or fraud;
- When movement does not conform in a material way with the documents; or
- When movement results in deliberate disposal of hazardous wastes in contravention of the Convention and of general principles of international law.

Common methods of illegal traffic include making false declarations, the concealment, mixture or double layering of the materials in a shipment and the mislabelling of individual containers. Such methods seek to misrepresent the actual contents of a said shipment and, because of this, the meticulous and thorough scrutiny of national enforcement officers is required to detect cases of illegal traffic (SBC 2007).

80. Raw mercury or mercury in used mercury products, such as thermometers, is the important mercury source for ASM in developing countries and countries with economies in transition. It is expected that mercury waste as used mercury products could be on illegal transboundary movement from developed countries, where mercury free products are available and most mercury-containing products are phased out, to developing countries and countries with economies in transition where ASM activities or other activities relating to mercury are managed in an the environmentally unsound manner. In addition, elemental mercury as commodity is also moving from developed countries, to developing countries generally for use in artisenal and small scale fold mining.

81. In order to tackle illegal transboundary movement of mercury waste, it is important for authorities (1) to implement the Basel convention strictly, especially inspection at the port, and (2) to strengthen network among authorities concerned to share information on mercury waste in each country.

4.0 Chemical Analysis of Mercury in Waste

4.1 Introduction

82. Obtaining reliable analytical data for mercury requires the following: appropriate sample collection; pretreatment for analysis; the selection of a measurement method and preparation method for sample test solutions suited to the samples; experience in their use; and confirmation of the reliability of one's own analytical data. In addition, when performing an analysis, one must regularly pay attention to preventing contamination of the samples by keeping the laboratory clean; providing appropriate ventilation; and adequately washing glassware, tools, and containers (Ministry of the Environment 2004).

83. A number of analytical methods are available to determine mercury concentration, and an analytical method is depended on various factors, such as an analytical regulation of each country, laboratory skills, analytical equipment, etc. Whatever to use any analytical methods, it is important to practice careful quality control/quality assurance of the obtained data, including simultaneous determination of suitable certified reference materials (CRMs). Currently, the CRMs prepared for the quality control/quality assurance of analytical values for mercury as well as methylmercury in various biological and environmental matrices are commercially available from several organizations, including the IAEA (International Atomic Energy Agency), NIST (National Institute of Standards and Technology, Office of Standard Reference Materials, USA), NRCC (National Research Council of Canada), and NIES (National Institute for Environmental Studies, Japan) (Ministry of the Environment 2004).

84. This chapter aims at the chemical analysis of mercury in waste. For information about chemical analysis of mercury in other samples, such as fish and seafood samples, environmental samples (water, solid, and atmosphere) and human samples (hair, urine and blood), see Appendix A: Chemical Analysis of Mercury.

4.2 Analytical Procedure

85. Chemical analysis of mercury generally involves the following steps:

1) Sampling;
2) Sample pretreatment;
3) Preparation of sample test solution; and
4) Quantification.

4.3 Chemical Analysis of Mercury in Waste

4.3.1 Leaching Test Method – The Japanese Standardized Leaching Test No. 13 (JLT-13) (Ministry of the Environment Notification No. 13)

4.3.1.1 Introduction

86. The Japanese Standardized Leaching Test No. 13 (JLT-13) aims to determine hazardous elements and substances (ex., alkyl mercury, mercury, mercury compounds, cadmium, lead, arsenic, trichloroethylene, tetrachloromethane, etc) in waste destined for landfilling, based on the hypothesis that seawater containing these hazardous elements and substances and 10 times higher volume than these elements and substances is released to sea. And this hypothesis was adapted to leachate released from landfill sites. This method leaches these target hazardous elements and substances from solid samples to solution which is test solution to analyse concentrations of these elements and substances. Under this hypothesis, a standard of a safe level of mercury concentration to allow landfilling is 0.005 mg·total mercury/mL (Ministry of the Environment 1973; 2004).

4.3.1.2 Samples and sampling

87. Mercury waste is wastes consisting of, containing or contaminated with mercury, such as residues, ashes, slag, wastewater treatment residues and other solid waste. General sampling methods are to collect original samples and to remove stones and other impurities (to crush into 0.5 to 5 mm if original samples are more than 5 mm). Water contents in samples should be analysed by drying 10-20 g samples in a drying oven at 105°C for 2 to 3 hours. Samples can be stored a polyethylene bottle sealed by a lid at room temperature (Ministry of the Environment 1973; 2004).

4.3.1.3 Pretreatment

88. Sample is taken to a polyethylene bottle. Distillated water (pH: 5.8-6.3) is added to the sample. Ratio between sample weight and weight of distillated water is 10%, and total volume should be more than 0.5 L. Mixed

solution is shaken at 200 rpm (a vibration width: 4-5 cm)/min for 6 hours. After shaking, solution is filtered by an ashless quantitative filter paper (pore size: 0.45 μm) (Ministry of the Environment 1973; 2004).

4.3.1.4 Preparation of sample test solution

89. 200 mL of filtered solution is taken into a flask, 10 mL sulphuric acid and 5 mL nitric acid are added to the flask, and all solutions are mixed well. 20 mL of potassium permanganate (5w/v%) is added, mixed with solution and stranded for 15 minutes. If the colour of potassium permanganate disappears within 15 minutes, extra potassium permanganate solution is added. 10 mL of potassium peroxodisulfate or ammonium peroxodisulfate (5w/v%) are added and heated at 95°C for 2 hours. After cooling down, 8 mL of hydroxylammonium chlorideis (10w/v%) is added and mixed to reduce to reduce the excess potassium permanganate. The sample is diluted to a volume of 100 mL with distillated water (Ministry of the Environment 1973; 2004).

4.3.1.5 Quantification – Cold Vapour Atomic Absorption Spectrometry (CVAAS)

90. The analytical method for total mercury involving reduction and CVAAS (circulation-open air flow system) is, in principle, similar to the conventional circulation system in that the method includes the following: reduction of Hg^{2+} ions in the sample test solution with stannous chloride to generate elemental mercury vapour (Hg^0); and the introduction of mercury vapour into the photo-absorption cell for the measurement of absorbance at 253.7 nm. It is a much more sensitive method as compared with conventional flame atomic absorption spectrometry. Other advantages include its ability to measure mercury in the samples with a UV spectrophotometer or a simple mercury lamp. It is roughly classified into the reduction/aeration procedure and the sample combustion procedure according to the generation mode for mercury in the elemental form. The former involves wet digestion with a mixture of strong acids followed by the addition of a reducing agent to generate elemental mercury vapour (Hg^0). In the latter, elemental mercury vapour (Hg^0) is generated through direct combustion of the sample to be analyzed. Currently, the most common method is based on the former technique (Ministry of the Environment 1973; 2004).

4.3.2 US EPA Method 7471A

4.3.2.1 Introduction

91. Method 7471A is a procedure for determining the concentration of mercury in solid or semisolid waste. All samples must be subjected to an appropriate dissolution step prior to analysis. If this dissolution procedure is not sufficient to dissolve a specific matrix type or sample, then this method is not applicable for that matrix (US EPA 1994).

4.3.2.2 Digestion Procedures

92. US EPA Method 7471A describes that 0.2 g portions of sample are weighted and placed in the bottom of a biochemical oxygen demand (BOD) bottle. 5 mL of mercury-free water and 5 mL of HCl-HNO_3 (3+1) are added. The bottle is heated for 2 minutes in a water bath at 95°C. After cooling down, 50 mL of mercury-free water and 15 mL of potassium permanganate solution are added in each sample bottle. The bottle is mixed thoroughly and placed in the water bath for 30 minutes at 95°C. After cooling down, 6 mL of chloride-hydroxylamine sulphate is added to reduce the excess permanganate (US EPA 1994).

93. As an alternative digestion procedure of US EPA Method, an autoclave may also be used. In this method, 5 mL of concentrated H_2SO_4 and 2 mL of concentrated HNO_3 are added to the 0.2 g of sample. 5 mL of saturated $KMnO_4$ solution is added, and the sample is covered with a piece of aluminium foil. The samples are autoclaved at 121°C for 15 minutes. After Cooling down, the sample is diluted to a volume of 100 mL with mercury-free water, and 6 mL of sodium chloride-hydroxylamine sulphate solution is added to reduce the excess permanganate (US EPA 1994).

4.3.3 Other Analytical Methods

94. In fact there are several methods for digesting and determining total mercury in mercury waste. There are other 2 methods which would be used for measuring total mercury in mercury waste:

1) Direct mercury analysis; and
2) Cold vapour atomic fluorescence spectrometry (CVAFS).

4.3.4 Direct Mercury Analysis

95. Direct Mercury Analysis is the represent by US EPA Method 7473, Mercury in Solids and Solutions by Thermal Decomposition, Amalgamation and Atomic Absorption Spectrophotometry. One of the significant advantages of this method is that instruments such as Milestone or LUMEX are available. The sample is analyzed directly, without the requirement of acid digestion to release the mercury into solution. This minimizes the time

required per analysis and reduces the risks of volatile losses or contamination. With direct mercury analysis, less than 1 gram of sample is dried, then thermally decomposed. Some instruments use oxygen (Milestone) and others use air to carry the decomposition product. Milestone uses a gold trap in which the gaseous decomposition products pass through and mercury is preferentially trapped. The gold film is then heated to release the Hg, which is detected in a gas cell at 253.7 nm similar to CVAAS. The US EPA method 7473 that analyzes total Hg by direct pyrolisis using Milestone, has a Method Detection Limit (MDL) of 0.1 ng of Hg. Maximum sample capacity is 700 mg for solids (GMP 2004; US EPA 2003b).

96. Zeeman mercury spectrometer RA-915+ is suitable for the direct determination (without the preconcentration step in the absorption trap) of mercury concentrations in various samples, such as air, water, soil, food, coal, oil and so on with background levels detection limits. The mercury concentrations were determined by the same RA-915+ spectrometer using different attachments to convert bound mercury to its atomic form. To determine mercury concentrations in samples with complex matrix without pre-treatment (whole blood, hair, crude oil, vegetation, food), a two-chamber pyrolytic atomiser was developed. Its design allows to separate the processes of evaporation and dissociation of mercury compounds as well as to simplify the matrix components in the gaseous phase in real time (Sholupov 2004).

4.3.5 Measurement of Total Mercury Using CVAFS

97. Atomic fluorescence spectroscopy is much more sensitive than atomic absorbance. An incident radiation (mercury lamp) is used to excite atoms in the gaseous current entering the analytical equipment and subsequently, the atoms re-radiate photons at a characteristic wavelength. Fluorescence radiation is generally measured at a 90° angle to lamp emission. Atomic fluorescence is extremely sensitive and usually used to analyze very low concentrations of Hg (e.g. in water). The sensitivity can increase, to reach sub-ppt (parts-per-trillion) levels, if Hg^0 vapour is pre-concentrated on a gold foil (West Coast Analytical Service 2004). The main concern of this technique is the contamination of the samples during the digestion process as well as the laboratory environment. Measurement of total mercury using CVAFS is well described in USEPA (US EPA 2001a; 2002). The USEPA Method 1631 (US EPA 2002) is for determination of Hg in the range of 0.5 - 100 ng/L. The detection limit using this method is usually dependent on the level of interference rather than instrumental limitations and has been determined to be 0.2 ng/L when no interferences are present. MDL as low as 0.05 ng/L can be achieved for low Hg samples by using a larger sample volume, a lower BrCl level (0.2%) and extra caution in sample handling. The USEPA Method 245.7 (US EPA 2001a) is for determination of Hg in filtered and unfiltered water by CVAFS in surface and ground waters, marine water, and industrial and municipal wastewater. The highest MDL is 1.8 ng/L. This method may be used to determine Hg up to 200 ng/L and may be extended by dilution of the sample (GMP 2004).

5.0 Guidance on Environmentally Sound Management (ESM) Criteria and Practices of Mercury Waste

5.1 Introduction

98. Global mercury issue is one of the centre issues at UNEP Governing Councils as discussions at the chapter 3 in the technical guidelines. UNEP Governing Council in February 2004 concluded that further long-term international action was required to reduce risks to human health and the environment and that, for this reason, the options of enhanced voluntary measures and new or existing international legal instruments would be reviewed and assessed in order to make progress in addressing this issue. The Governing Council committed to increased efforts to address the global challenges to reduce risks from releases of mercury, taking into account in particular the following priorities: to find environmentally sound solutions for the management of waste containing mercury and mercury compounds; to find environmentally sound storage solutions for mercury; to increase knowledge on areas such as inventories, human and environmental exposure, environmental monitoring and socio-economic impact (UNEP 2007).

99. In order to develop a mechanism on a legal-binding environmentally sound management (ESM) of mercury waste in countries where there is no mechanism on ESM of mercury waste, it is important to refer the presence international guidance on ESM criteria and practices of mercury waste and develop and enforce a comprehensive mechanism of a legal-binding ESM of mercury waste. This chapter describes the present international guidance on ESM criteria and practices of mercury waste.

5.2 Basel Convention – Technical Guidelines on Recycling/Reclamation of Metals and Metal Compounds (R4) of the Basel Convention

100. These guidelines aim at providing guidance on recycling and reclamation of metal compounds on ESM. These guidelines focus mainly on the recycling and reclamation of metals and metal compounds that are listed in Annex I to the Basel Convention as categories of wastes to be controlled. Those categories include the following metals and their compounds: antimony (Sb), arsenic (As), beryllium (Be), cadmium (Cd), lead (Pb), mercury (Hg), selenium (Se), tellurium (Te) and thallium (Tl). They also include compounds of copper, zinc and hexavalent chromium, but not the metals themselves. These metals and metal compounds may be referred to as Annex I metals and metal compounds or, more simply, as Annex I metals. Materials that contain them are controlled under the Basel Convention if they fall within the Convention's definition of waste, unless they do not possess any of the hazardous characteristics listed in Annex III to the Convention (SBC 2004).

101. The contents of these guidelines are the definition of waste containing metal and metal compounds, information of recovery and reclamation for waste metal on ESM, basic expertise how to establish a recycling, recovery and reclamation facility for waste metal, environmental and health consideration due to the environmentally unsound management of waste metal, assessment of predicted environmental impacts, waste prevention and cleaner production, potential environmental hazards and their control and shut-down of metals reclamation facilities (SBC 2004).

102. It may be possible to recycle mercury waste, particularly elemental mercury, in special facilities which have the advanced recycling technology especially for mercury waste. However, mercury would be released from recycling process because of its characteristics that mercury is easily vaporized at room temperature. In addition, recycled mercury is sold on the international commodities market, where it re-enters the environment, mostly in developing countries. In order to stop recirculation of mercury in society, some countries have developed ESM of mercury waste, and other countries have been considering and developing ESM of mercury wastes, such as aboveground, monitored and retrievable secure storage, together with mercury reduction policies, marketing and uses (SBC 2004).

5.3 OECD – Core Performance Elements of ESM for Government and Industry

103. Core Performance Elements of ESM Guidelines are useful to develop ESM mechanism and provide the guidance to recover wastes, including the preceding transport, storage, treatment and subsequent storage, transport and disposal of residues, and providing the basis for ESM of recoverable waste. The following core performance elements of ESM guidelines would apply to waste recovery facilities including preceding collection, transport, treatment and storage and subsequent storage, transport, treatment and/or disposal of pertinent residues (OECD 2003).

104. Core Performance Elements compose of the following 9 elements. For further information, see Appendix D: OECD – Core Performance Elements of Environmentally Sound Management (ESM) for Government and Industry:

1) Adequate regulatory infrastructure and enforcement should exist to ensure compliance with applicable regulations;
2) Recovery facility should be authorised ;
3) Recovery facility should take adequate measures to safeguard occupational and environmental health and safety ;
4) Recovery facility should have an applicable environmental management system (EMS) in place;
5) Recovery facility should have an operative monitoring, recording and reporting programme;
6) Facility shall have an appropriate and operative training programme for the personnel ;
7) Recovery facility should have an information exchange programme to optimise recovery;
8) Recovery facility should have a verified emergency plan; and
9) Recovery facility should have a plan for closure and after-care

5.4 Application of Best Available Techniques (BAT) & Best Environmental Practices (BEP)

5.4.1 Application of Best Available Techniques (BAT)

105. The concept of Best Available Techniques (BAT) was introduced as a key principle in the Directive 96/61/EC, “Concerning Integrated Pollution Prevention and Control (IPPC Directive)”. The IPPC Directives provides an integrated approach to reduce environmental pollution, establish pollution prevention activities and achieve integrated prevention and control of pollution arising from the activities. The directive describes measures designed to prevent or, where that is not practicable, to reduce emissions in the air, water and land from the abovementioned activities, including measures concerning waste, in order to achieve a high level of protection of the environment taken as a whole. In essence, the IPPC Directive is about minimising pollution from various point sources throughout the European Union (European Council 1996).

106. BAT means to take the most effective and advanced stage in the development of activities and their methods of operation which indicate the practical suitability of particular techniques for providing in principle the basis for emission limit values designed to prevent and, where that is not practicable, generally to reduce emissions and the impact on the environment as a whole (European Council 1996):

- “Techniques” shall include both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned;
- “Available” techniques shall mean those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the Member State in question, as long as they are reasonably accessible to the operator; and
- “Best” shall mean most effective in achieving a high general level of protection of the environment as a whole.

107. Annex IV of the IPPC Directive gives the special consideration on the definitions BAT as follows:

1) The use of low-waste technology;
2) The use of less hazardous substances;
3) The furthering of recovery and recycling substances generated and used in the process and of waste, where appropriate;
4) Comparable processes, facilities or methods of operation which have been tried with success on an industrial scales;
5) Technological advances and changes in scientific knowledge and understanding;
6) The nature, effects and volume of the emissions concerned;
7) The commissioning dates for new or existing installations;
8) The length of time needed to introduce BAT;
9) The consumption and nature of raw materials (including water) used in the process and their energy efficiency;
10) The need to prevent or reduce to a minimum the overall impact of the emissions on the environment and the risks to it;

11) The need to prevent accidents and to minimize the consequences for the environment; and

12) The information published by the Commission or by international organizations.

5.4.2 Application of Best Environmental Practices (BEP)

108. Best Environmental Practices (BEP) means the application of the most appropriate combination of measures on environmental issues. There are various ranges of measures on BEP as follows (Baltic Marine Environment Protection Commission 1992):

- Provision of information and education to the public, to users and to producers about the environmental consequences of choice of particular activities and choice of products, their use and ultimate disposal;
- The development and application of Codes of Good Environmental Practice which covers all aspects of the activity in the product's life;
- Mandatory labels informing users of environmental risks related to a product, its use and ultimate disposal;
- Availability of collection and disposal systems;
- Saving of resources, including energy;
- Recycling, recovery and re-use;
- Avoiding the use of hazardous substances and products and the generation of hazardous waste;
- Application of economic instruments to activities, products or groups of products; and
- A system of licensing which involves a range of restrictions or a ban.

109. In addition, there are more specific consideration as follows (Baltic Marine Environment Protection Commission 1992):

- Environmental hazard of the product, its production, its use and ultimate disposal;
- Substitution by less polluting activities or substances;
- Scale of use;
- Potential environmental benefit or penalty of substitute materials or activities;
- Advances and changes in scientific knowledge and understanding;
- Time limits for implementation;
- Social and economic implications; and
- The precautionary principle, i.e., taking preventive measures when there is reason to assume that mercury would be directly or indirectly released into the environment and may create hazards to human health, harm living resources and ecosystems.

110. Main programme for mercury-containing product and mercury waste on BEP is mercury reduction programme. The framework for mercury reduction programme is geared towards the promotion and implementation of BEP and BAT for the management of mercury-containing products. The key elements of the framework are as follows (Emmanuel 2005):

- Development of model areas with the goal replicating the programme at mercury-containing products;
- Building capacity including management systems and storage structures;
- Awareness-raising, training and education; and
- Information dissemination as a successful story on a mercury awareness programme.

111. The overall method is to encourage innovation while establishing principles that allow site-specific approaches that are drawn from basic principles and that are replicable. BEP includes (Emmanuel 2005):

I. Practices for waste minimization and pollution prevention, such as:

   - Procurement policies that favour reusable equipment and supplies, when these can be deployed in a cost-effective manner without compromising safety and sanitation;
   - Site-specific procurement policies and practices aimed at identifying safe and effective supplies, chemicals and instruments that do not contain mercury, and/or that avoid material components or packaging materials mostly likely to contribute to formation and/or release of mercury during their life cycle;
   - Promotion of safe reuse and recycling of materials to keep mercury-containing products out of the waste stream;
   - Instituting safe practices for use and management of existing mercury-containing equipment to reduce breakage or leaks while the equipment is still in use; and
   - Instituting best practices for the cleanup of mercury spills, ensuring safety and minimizing waste.

II. Waste separation and segregation including:

- Rigorous segregation of mercury waste from ordinary wastes;
- Identification of products and packaging containing mercury and segregation of mercury, whenever safely manageable, into waste streams that are recyclable or are disposed of in a manner that ensures no burning; and
- Training and education to ensure that mercury waste does not end up in other waste streams, but are treated as a hazardous chemical waste.

112. In order to practically implement mercury reduction programme, there are six core activities as follows (Emmanuel 2005):

I. Documentation of existing mercury waste management practices and policies, the assessment of current mercury products and manufacturing sectors, including purchasing and product utilization policies;

II. Documentation of national policies, laws and regulations regarding mercury waste management, including the import and export of mercury waste and recycled mercury;

III. Establishment of mercury waste minimization and mercury waste management objectives, and adoption of modifications in current practices and policies aimed at achieving full implementation of ESM;

IV. Creation of institutional capability to carry out the new policies and practices by implementing capacity-building activities;

V. Establishment of management structures and management practices to assure that new policies and practices introduced continue to be properly carried out; and

VI. Selection and development of appropriate mercury waste treatment approaches.

6.0 Legislative and Regulatory Framework

6.1 Introduction

113. In order to stop the anthropogenic mercury releases from mercury waste, it is important to eliminate non-essential uses of mercury in consumer, household, and commercial products, thereby reducing potential mercury releases to the environment associated with the production, uses, and disposal of mercury-containing products.

114. A legislative and regulatory framework, such as a standard mercury level in the environment (water, soil and air), exists in most of countries, taking into consideration mercury pollution. In order to meet the standard mercury level in the environment, the principle is not to use mercury or to produce mercury-free products or mercury-containing products that mercury content is as low as possible. As the consequence, uses of mercury and mercury-containing products tend to be phased out.

6.2 Phase-out Production and Use of Mercury

115. An enforcement of a legislative or regulatory framework for phase-out programme is recommended. A concept of a legislative or regulatory framework for phase-out programme is to set a certain date that uses of mercury and mercury-containing products, except mercury-containing products which are no-alternatives technically and practically, is completely phased out at industry and market, respectively, with collection and treatment schemes on the environmentally sound management (ESM) in cooperation with all stakeholders. This approach promotes large scale users and producers of mercury and mercury-containing products to meet the requirements to undertake a mercury phase-out programme. Also, it is recommended to undertake this approach with other activities involving the general public, such as a take-back programme.

116. As an example of a framework on phase-out production, the European Union Directive, the restriction of the use of certain hazardous substances in electrical and electronic equipment, so-called “RoHS”, is the directive to restrict uses of lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB) and polybrominated diphenyl ethers (PBDE) for electrical and electronic equipment, except the several products (e.g. fluorescent lamps) which are no alternatives practically. All mercury-containing products, except some mercury-containing products, have been phased out in EU market (European Union 2003).

6.3 Identification and Inventories of Mercury Waste

117. Identification of mercury waste is the first step to develop not only an inventory of standardized mercury source but also develop/enforce a legal framework on mercury waste and used mercury-containing products. Identification of mercury waste in a country is preferably, however, it is recommended to be in an area (province, prefecture, etc), city, community at the first step for a national inventory programme, particularly for developing countries and countries with economies in transition where there is no inventory programme of mercury waste. There are 10 categories with sub categories for identification and inventories of mercury waste (see Table 2-1) (UNEP 2005b):

118. After identifying source and type of mercury waste, activity volume date (“activity rates”) and process-specific information and data are gathered to be used to calculate estimated mercury waste from the identified source and type of mercury waste in a country (or area, community, etc). An estimation of the average annual release of mercury from mercury waste to each pathway or vector (mercury in mercury waste, such as residues, solid waste, etc) can be calculated by the following basic equation (UNEP 2005b):

Estimated mercury release to path way = activity rate × input factor × output distribution factor for pathway

119. For estimation of mercury-containing products, a number of obsolete mercury-containing product can be roughly estimated by the following equations:

Obsolete mercury-containing products per year (after an average life span) = a number of mercury-containing product users (e.g., per 1,000 people) in a certain year × population in the certain year: or

Obsolete mercury-containing products per year (after an average life span) = a number of mercury-containing products in a certain year after an average life span

If both of new and secondhand products or secondhand products are main consumer products, particularly developing countries and countries with economies in transition, each item should be estimated separately and finally combined together.

120. Although an estimation of mercury waste and obsolete mercury-containing products can roughly calculated the above-mentioned equations, it is very difficult to collect necessary data to estimate mercury waste and obsolete mercury-containing products, particularly in developing countries and countries with economies in transition due to

lack (or no) of data. In addition, in those countries, small scale facilities for mercury waste and factories to manufacture mercury-containing products would be main actors who do not collect weight of mercury waste or a number of manufactured mercury-containing products. In this case, a pilot programme for developing inventories is necessary in a limited area. Its programme would be composed of questionnaires to ask facilities and factories about weight of treated mercury waste or number of manufactured mercury-containing products (annually or monthly) and estimated weight of mercury waste and a number of mercury-containing products based on questioners.

121. It is recommended to refer the Toolkit for Identification and Quantification of Mercury Releases issued by UNEP Chemicals for further detailed information on an inventory programme of mercury waste (UNEP 2005b).

6.4 Purchasing Practices

122. In order to promote uses of mercury-free products, a legal approach of purchasing practices is important. The concept of purchasing practices on mercury waste is "to purchase mercury-free products", "to change mercury-containing products into mercury-free products" or "to purchase product that mercury contents are minimized", except mercury-containing products whose alternatives are practically or technologically impossible.

123. Larger users of mercury-containing products, such as hospitals, or public sectors which are the side to enforce a legal framework can be involved at the beginning of a legal approach of purchasing practices. Under a legal approach of purchasing practices, these targeted organizations have to purchase mercury-free products or mercury-less containing products to reduce amount of mercury waste. In order to effectively enforce a legal approach of purchasing practices, it is recommended that government or other public sectors subsidies the targeted organizations to purchase mercury-free products or mercury-less containing products. This approach is expected to enhance use of mercury-free products and promote to phase out mercury-containing products as well as to disseminate the concept not to use mercury-containing products into other end users of mercury-containing products.

6.5 Control of Exports or Imports of Mercury Waste

124. Under the Basel Convention, all wastes containing mercury are subject to hazardous wastes. This means that a transboundary movement of mercury waste should be to countries where there are facilities on ESM, pursuant to the Article 6 of the Basel Convention. Therefore, it is possible that parties to the Basel Convention prohibit imports of mercury waste under the Article 4 of the Basel Convention.

125. For example, if a party to the Basel Convention establish a national legislation to prohibit importing of mercury waste, and report the information in accordance with para 1 (a) of the Article 4, other parties to the Basel Convention cannot export mercury waste to the party.

6.6 Registration of Mercury Waste Generators

126. As one of the approaches to fully control mercury waste, it is recommended to register large scale mercury waste generators, such as hospitals, medical clinics, dentists, research institutes, collectors of mercury waste, etc. The registration of mercury waste generators is possible to clear origins of mercury waste stream as well as kinds and volume of mercury waste (or a number of used mercury-containing products).

127. The necessary information of mercury waste generators are generator name, address, responsible person, type of business, amount of mercury waste generation, kind of mercury waste, collection scheme of mercury waste, how mercury waste is finally handed out to collectors or dealt with. Mercury waste generators have to inform and update this information to public sectors (central or local government) regularly. In addition, it is recommended that mercury waste generators inform data and kinds of mercury waste so that inventory programmes of mercury waste can be possible to be developed.

6.7 Authorization of Treatment and Disposal Facilities

128. Mercury waste should be dealt with on ESM defined as taking all practicable steps to ensure that mercury waste is managed in a manner which will protect human health and the environment against the adverse effects which may result from mercury waste. Otherwise, mercury in mercury waste is leaked out and on the global mercury cycle that mercury exists not only in the environment but also on the food chain. Therefore, mercury waste should be dealt with by facilities which have ESM, preferably ESM facilities exclusive for mercury waste.

129. Authorization of treatment and disposal facilities for mercury waste is important to implement ESM of mercury waste. The criteria to authorize treatment and disposal facilities for mercury waste is whether:

- Mercury processing and final treatment schemes are enough to deal with mercury waste on ESM;
- Treatment facilities completely dealt with mercury waste on ESM without emission of mercury during processing;
- Equipments in the facilities are regularly maintained;
- Employees always use protective tools;

- Employees are trained;
- There are manuals including emergency (e.g., spillage of mercury) to deal with mercury waste on ESM; and
- An amount of mercury waste is documented.

6.8 Inspections and Monitoring of Treatment and Disposal Facilities

130. There are four different types of inspections used to monitor treatment and disposal facilities (US EPA 2006):

1) Compliance evaluation inspection

   The compliance evaluation inspection (CEI) is an on-site evaluation of a mercury waste handler's compliance. The purpose of the CEI is to gather information necessary to determine compliance and support enforcement actions. The inspection includes:
   - A characterization of the handler's activities;
   - Identification of the types of mercury waste managed on-site;
   - A record review of reports;
   - Documents, and on-site plans; and
   - Identification of any units that generate, treat, store, or dispose of mercury waste.

2) Compliance sampling inspection

   A compliance sampling inspection is necessary to inspect a facility in order to collect samples for laboratory analysis. These sampling inspections can scientifically clear mercury exposure level to human health (using human samples) and the environment (using environmental samples) by analyzing total and/or methylmercury concentrations.

3) Case development inspection

   The case development inspection (CDI) is an intensive investigation that is conducted to gather sufficient information to support an enforcement action. The CDI can be used to collect supplemental data to support a forthcoming enforcement action.

4) Information gathering

   Authorities concerns collect specific information, such as any person who generates, stores, treats, transports, disposes of, or otherwise handles or has handled mercury waste. It is better that this information is transparency so that the public can access information.

6.9 Employee Training

131. Employees of treatment and disposal facilities are one of the important actors on ESM of mercury waste. They have two important responsibilities: 1) an actual actor on ESM of mercury waste; and 2) a final actor to deal with mercury waste before final disposal (or recycling). Therefore, employee training is mandate to not only effectively implement mercury waste processing on ESM but also ensure employee's safety against mercury exposure and accidental injury during mercury waste processing.

132. As basic knowledge of mercury waste, employees should know:

- The definition of mercury waste and chemical aspects of mercury with its adverse effects;
- How to segregate mercury waste from other wastes;
- Uses of personal protective equipments, such as body covering, eyes and face protection, globes and respiratory protection;
- Proper labelling and storage requirements, container compatibility and dating requirements, closed-container requirements;
- How to technically deal with mercury waste by using equipments at facilities, particularly used liquid mercury-containing products, such as thermometers, barometers, etc;
- Uses of engineering controls in minimizing exposure; and
- How to take emergency response if mercury in mercury waste or used mercury-containing products is accidentally spilled.

The above-mentioned items should be documented as a manual in local language.

6.10 Mercury Spill Prevention, Response, and Emergency Measures

133. Spillage of mercury is accidentally occurred when mercury-containing products are broken. Most of this case seems to be mercury-containing glass thermometers which are globally scattered but easily broken. Although mercury in each glass thermometer is about 0.5-3 g and does not usually lead to serious health problem, mercury spills should be considered hazardous and should be cleaned up with caution. If somebody shows any complains after mercury spill, immediately contact medical doctor and/or environmental health authorities.

134. In order to prevent mercury spill, mercury-containing products should be carefully and safely handled, used and disposed of until mercury waste is dealt with on ESM. If the spill is small and on a non-porous area such as linoleum or hardwood flooring, or on a porous item that you can throw away (like a small rug or mat), it can be possible to clean it up personally. If the spill is large, or on a rug that cannot be discarded, on upholstery or in cracks or crevices, it may be necessary to hire a professional. Large spills involving more than the amount of mercury found in a typical household product should be reported to local environmental health authorities. If it is not sure whether a spill would be classified as “large”, contact local environmental health authorities to be on the safe side. Under certain circumstances, it may be advisable to obtain the assistance of qualified personnel for professional clean up or air monitoring, regardless of spill size (Environment Canada 2002a).

6.11 Liability and Compensation Provisions

135. Because of mercury properties, dealing with mercury waste would have the risk of damage to human health and the environment. In addition, mercury waste or used mercury-containing products may be concerned about the problem of illegal transboundary traffic. It could be expected that mercury in mercury waste and/or mercury-containing products is accidentally spilled into the environment during mercury waste processing. Therefore, a mechanism of liability and compensation is necessary for damage resulting from mercury waste processing or illegal transboundary movement.

136. Liability and compensation should consider all damages from generation of mercury waste and/or used mercury-containing products to its final treatment including recycling or final disposal (stabilization, long-term storage, etc) on ESM. However, it might be necessary to consider damages after final disposal because mercury is a mobile element and never broken down into harmless material. In a case of the adverse effects to human health due to mercury waste, it causes fatal damages, such as central nervous system symptoms (at high concentration exposure by mercury vapour or chronic exposure by methylmercury). On the other hands, in a case of the environmental pollution caused by mercury waste, mercury would be widely contaminated into the aquatic phase, solid phase and atmosphere because of its mobile property. It is expected that mercury pollution in the environment causes the serious damages that reclamation of the polluted environment needs a few decades at least with significant amount of budget.

137. In the case of Minamata disease, as of March 2006, a total payment of the compensation for the certified patients (2,955 patients) was 144 billion Japanese yen (JPY) (about 1.17 billion US Dollar (USD)), and a total cost for restoring Minamata bay (about 580,000 m^2) which had been severely pollute with mercury and methylmercury was about 48 billion JPY (about 390 million USD) (Ministry of the Environment 2006). This case indicates that cost of prior investment for ESM of mercury waste is much cheaper than that of compensation for serious damage.

6.12 Compliance Promotion

138. Compliance promotion is any activity that encourages voluntary compliance with environmental requirements. Promotion helps overcome some of the barriers to compliance, such as economic aspects, social/moral issues, personal issues, management problem and technological matters. Most compliance strategies involve both activities to promote an enforce requirements. Policymakers need to determine the most effective mix of compliance promotion and enforcement response. The past experience has shown that promotion alone is often not effective. Enforcement is important to create an atmosphere in which stakeholders have clear incentives to make use of the opportunities and resources provided by promotion (US EPA 1992).

139. There are the six basic approaches to compliance promotion as follows (US EPA 1992):

1) Providing education and technical assistance to community;
   Education and technical assistance lay the groundwork for voluntary compliance and are essential to overcome barriers of ignorance and inability that otherwise would prevent compliance. These assistances make it easier and more possible for stakeholders to comply by providing information about the requirements and how to meet then, and by providing assistance to help authorized facilities take the necessary steps for compliance.

2) Building public support;
   The public can be a powerful ally in promoting compliance, and its support can help create a social ethic of compliance. The public can also serve as watchdogs that alert officials to non-compliance. Building public support would be particularly important groundwork in societies where personal economic concerns compete with concern for environmental quality, or where there is a general lack of awareness about or concern for environmental problems on mercury waste.

3) Publicizing success stories;
   Programme officials can provide an incentive for stakeholders to comply by publicizing information about facilities that have been particularly successful in achieving compliance. In societies where the

public does support environmental protection, positive publicity about a firm's compliance success can enhance its reputation and public image. Such publicity helps create a positive social atmosphere that encourages compliance.

4) Creative financing arrangements;
One barrier to compliance is cost to deal with mercury waste. Facility managers would want to comply but would not be able to afford the cost of fulfilling the requirements. Creative financing arrangements that can help solve this problem include offset requirements, peer matching, sales of shares, loans and environmental bonds.

5) Providing economic incentives
Environmental programmes can encourage compliance by providing economic incentives for compliance. This would be an effective approach in public agencies, which are less likely to be deterred by monetary penalties, since they are funded by the government. The benefit from compliance can be applied to the facility generally, or to an individual based on its performance.

6) Building environmental management capability within stakeholders
Most of successful stories on ESM promote the concept of building internal environmental management capabilities within facilities to promote compliance and generally improve environmental quality. One of the approaches is environmental auditing which is a periodic and comprehensive evaluation of the management systems and practices within a firm that affect environmental compliance.

6.13 Penalties for Non Compliance

140. If a legal framework to control mercury waste and used mercury-containing products exists and is enforced, types of non compliance on mercury waste are no certificate of approval, fail to comply with certificate of approval, fail to comply with certificate of approval, fail to register, fail to submit necessary documents, manifesting errors, no certificate of approval, etc. Although there are administrative fails and errors, these no compliances might link to the adverse effect to human health and the environment because it is suspected that actors cannot fully implement ESM or meet the requirements under the legal framework. In this case, the actors should be complied with a penal regulation in order to avoid reoccur same fails and errors.

141. The types of penalties for no compliance are a fine, imprisonment and temporal (or permanent) suspension of all operations until an improvement on fails and errors can be confirmed. In addition, all information about not only fails, errors and its measurements but also an identification of actors should be opened to the public.

142. On the other hand, if there is no legal framework and/or no definition about penalties against the environmental pollution caused by mercury waste and used mercury-containing products, authorities concerned (such as central government who is responsibility for environmental issues) should be a main actor to legally deal with all circumstances. In order to undertake appropriately legal actions, the Polluter Pays Principle (PPP) should be considered. PPP is principle in international environmental law where the polluting party pays for the damage done to the natural environment.

7.0 Application for Mercury Waste Prevention and Minimization (including Reduction of Discharge and Emission)

7.1 Introduction

143. Following a conventional waste minimization approach, techniques and technologies for reducing mercury waste emissions are prioritized in three broad categories:

1) Source Reduction – Using alternative materials or alternative processes not requiring mercury:
2) Waste Minimization – Using mercury in existing processes more efficiently or completely; and
3) Emission Reduction/Treatment – Using end-of-pipe engineering controls to capture mercury before it can be emitted or treatment to reduce the amount or toxicity of the waste.

This section reviews important processes that generate mercury waste and reviews alternative techniques and technologies available to reduce mercury emissions.

7.2 Source Reduction (Alternative Processes or Materials)

7.2.1 Introduction

144. Awareness and action regarding the environmental and health effects of mercury are more and more common in both developed and developing countries around the world. In developed countries, much of the activity revolves around installing better engineering controls on coal-fired power plants and identifying and managing mercury-containing products already in the stream of commerce. As examples, Fig. 7-1 and Fig. 7-2 show the steady decline of mercury demand in Japan and USA, respectively. With a few exceptions like energy efficient lighting, legislation and public awareness have significantly reduced the entry of new mercury-containing products into the market. The developing world still suffers the effects of mercury emissions from industrial process using older technologies (e.g., chlor-alkali chlorine plants) and uncontrolled use of mercury emitting techniques (e.g., mercury amalgamation of gold in artisanal and small scale mining).

7.2.2 Intentional Uses of Mercury in Industrial Process

7.2.2.1 Chlor-Alkali Chlorine and Caustic Soda Manufacturing

145. Three types of processes are used worldwide to manufacture chlorine and caustic soda (Table 7-1):

- Mercury cell;
- Diaphragm cell; and
- Membrane cell.

146. Membrane cell technology is the most cost efficient because of lower electricity input required and also eliminates the use and emission of mercury during manufacture – as a result, as older mercury cell factories are closed, membrane cell plants are reducing the amount of mercury emissions from chlorine and caustic soda manufacture. As of 2006, there were less than 10 mercury cell chlor alkali plants operating in the U.S., and approximately 40 operating in Europe. And in Japan, mercury cell process was no longer in use by 1984. Public pressure, governmental action, and industry actions have prompted to the change. Currently, about 50% of European production of chlorine use mercury cell technology. An example of this shift away from mercury cell production is evident in the European chlorine manufacturers committing to replace all mercury cell plants by 2020. Using the same example, Euro Chlor (the industry organization of chlorine manufacturers) committed to reduce mercury emissions to 1.0 gram of mercury emissions per tonne of mercury cell capacity by 2007; see Fig. 7-3 for their progress through 2005 and Fig. 7-4 for the analysis of mercury emissions in Europe by the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR).

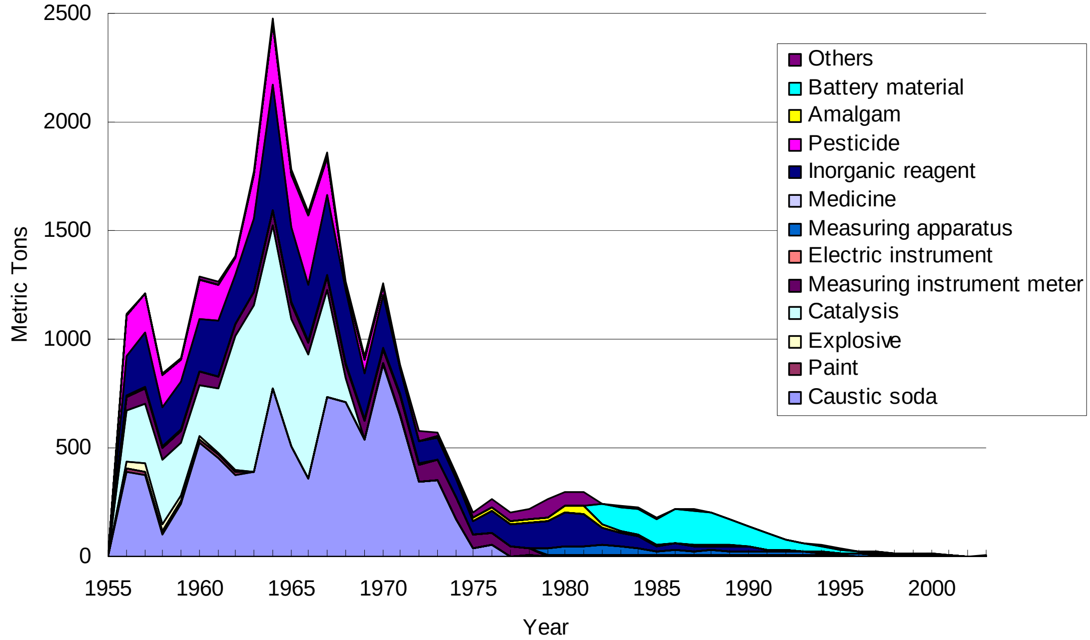

Fig. 7-1 Japanese industrial mercury demand in the period 1956-2003 (Ministry of International Trade and Industry 1956-1974; 1995-2003)

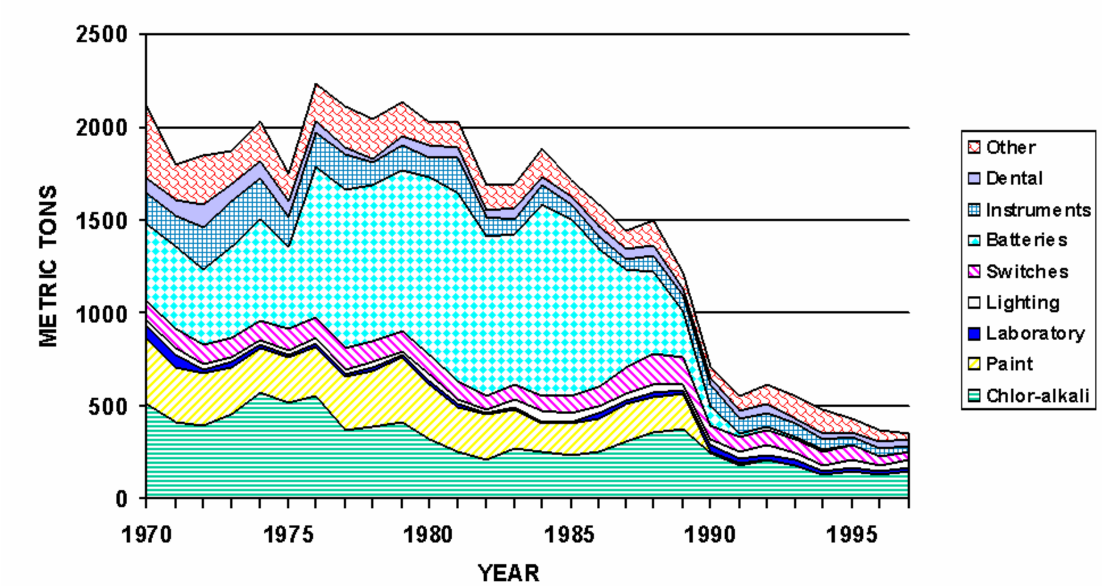

Fig. 7-2 US industrial reported consumption of mercury in the period 1970-1997, distributed among industrial sectors (Sznopek 2000)

Table 7-1 Comparison of mercury and membrane cell chlor-alkali processes

Process	Comments
1. Mercury Cell	**Advantages:** ▪ Existing technology at older plants; no capital cost for upgrade to membrane cell; and ▪ Produces high-quality caustic soda. **Disadvantages:** ▪ Less efficient process – requires more energy than membrane cell (3,560 kilowatt-hours per metric ton of chlorine [kWh/t]); ▪ Used in over 50% of all industrial chemical processes (World Chlorine Council 2006); and ▪ Produces mercury emissions and associated environmental liability and attention.
2. Diaphragm Cell	**Advantages:** ▪ Existing technology at older plants, particularly in USA; no capital cost for upgrade to membrane cell. **Disadvantages:** ▪ Less efficient process – requires more energy than membrane cell (2,970 kWh/t of chlorine); and ▪ Uses asbestos in cells with the potential for release into the air and the associated environmental liability and attention.
3. Membrane Cell	**Advantages:** ▪ More energy efficient process –2790 (kWh/t of chlorine); and ▪ No mercury or asbestos emissions. **Disadvantages:** ▪ Requires complete overhaul of older processes and associated capital costs

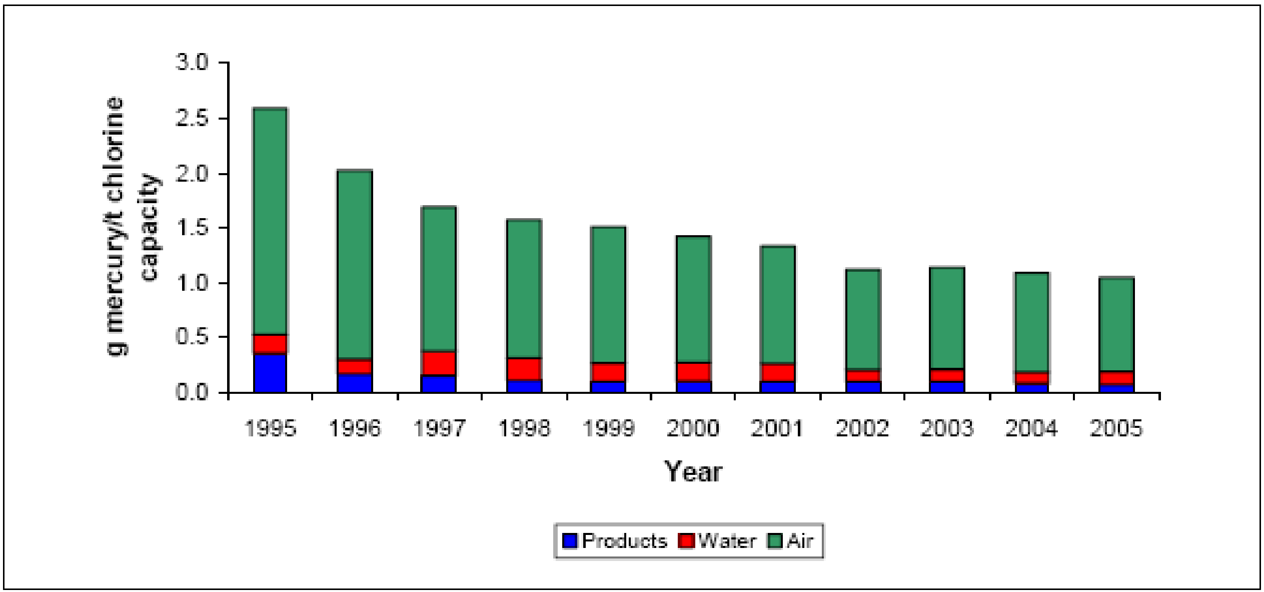

Fig. 7-3 Mercury emissions – European mercury cell chlorine factories (Euro Chlor 2006)

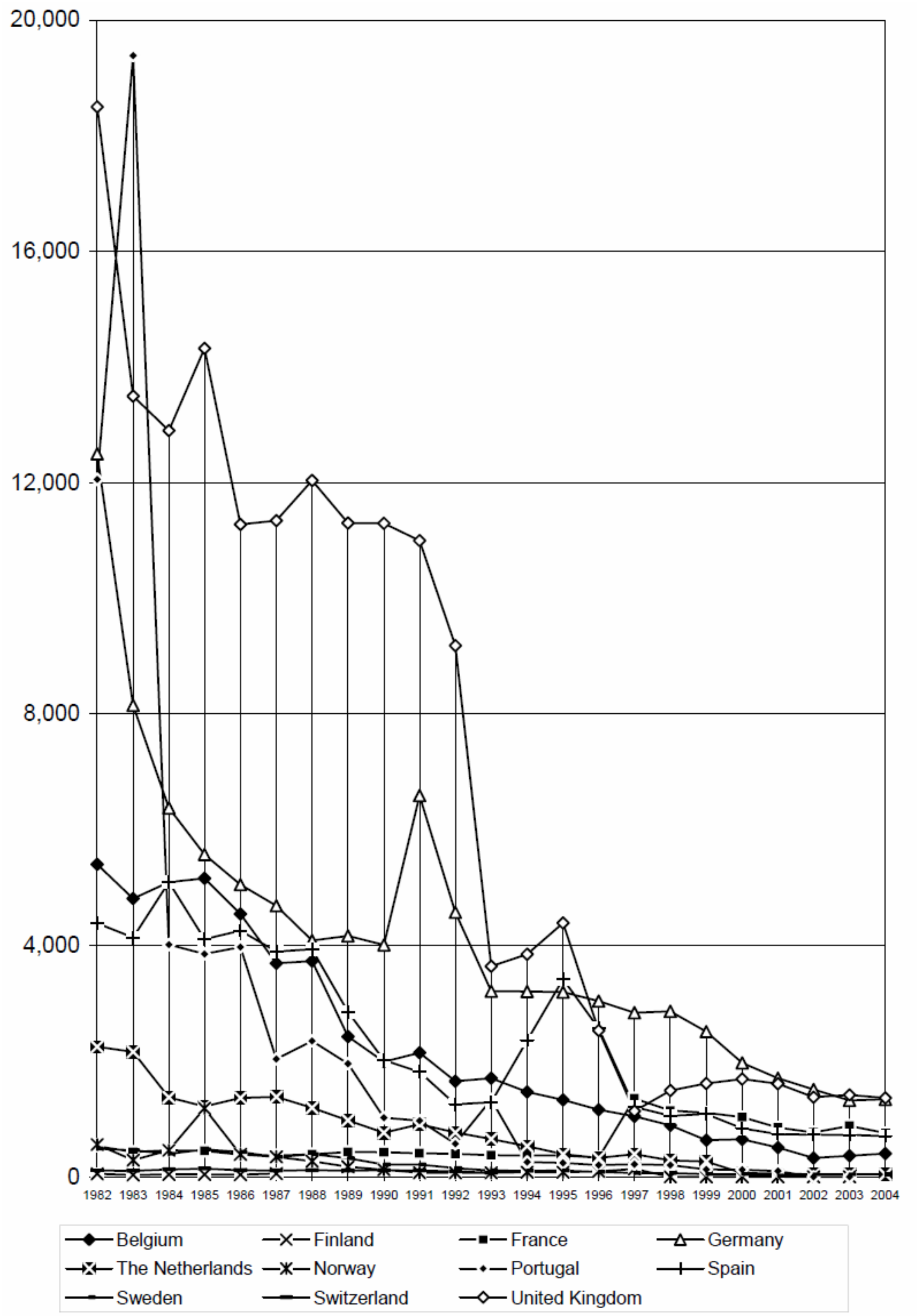

Fig. 7-4 Mercury losses through product, wastewater and air (OSPAR Commission 2006) (in kg/yr, sum of mercury losses to product and wastewater from national plants discharging into the OSPAR catchment area plus atmospheric emissions from all national plants)

7.2.2.2 Vinyl Chloride Monomer (VCM) Production

147. Two processes are used to manufacture vinyl chloride. One process (acetylene process) uses mercuric chloride on carbon pellets as a catalyst, and the other (mercury-free) is based on the oxychlorination of ethylene.

148. There is an economically and technically viable option to the mercuric chloride process, although the choice of process has traditionally had more to do with a variety of other factors. Normally, the amount of catalyst consumed will be the amount that goes to waste. In addition, during vinyl chloride refining, activated carbon is often used to adsorb minor mercuric chloride remaining in VCM. The mercury-containing wastewater produced in the production process is also treated by using activated carbon as adsorbent. This activated carbon waste is mixed into the waste mercury catalysts for joint treatment.

149. If it is not disposed of, mercuric chloride catalyst may be recycled. A lime or caustic soda solution reacts with the mercuric chloride catalyst when heated to boiling. The reaction generates mercury vapour inside the distillation column. The flue gases should also be treated with an activated carbon filter. Mercury-saturated activated carbon from all sources may be regenerated and the mercury distilled off. Mercury recovered from the condensation process has a purity of 99.9% (UNEP 2006a).

7.2.3 Artisanal and Small Scale Gold Mining

150. Studies of elemental mercury releases into the environment from artisanal and small scale gold mining (ASM) carry a high degree of uncertainty because the practice occurs in many different countries and widely varying circumstances and techniques. In addition, many artisanal miners practice their craft individually or in small groups and in parts of the world with reduced governmental or industrial involvement. Estimates vary from 300 tonnes annually to much higher amounts (UNEP 2002). Whatever the actual amount, there are documented successful means for reducing mercury emissions to the environment from ASM.

151. Before describing the technical details of methods that can reduce mercury emissions from ASM, there is wide consensus that they will only be successful in concert with a robust initiative to educate artisanal miners, their families, and the surrounding communities of: (a) the health dangers; and (b) environmental destruction from mercury use in ASM. Indeed, the Final Report on Mining, Minerals and Sustainable Development (MMSD) Project, 2002, made the following conclusion (MMSD Project 2002):

> "… But given the scattered and informal nature of much of this activity, governments are unlikely to be able to raise standards immediately simply through legislation and enforcement. A more realistic approach is raise awareness of the risks and to demonstrate less dangerous alternatives that are appropriate to local circumstances – social, cultural, and economic – and that allow mining communities to make better informed choices. A first step should be to alert people to the dangers – to themselves, their children, and the environment in general – of, for example, using mercury to extract gold and to encourage them to use a simple method to capture the mercury vapour…. Another option is to introduce alternative forms of gold extraction that do not involve mercury at all…. For miners to take up a new process like this, there must be immediate and obvious financial or time-saving benefits."

7.2.4 Mercury-free Artisanal and Small Scale Gold Mining (ASM)

152. Studies and literature identify a variety of approaches for reducing mercury emissions from ASM; unfortunately, most, like those using cyanide are more technical or require additional equipment, are less effective than using mercury amalgamation, or economically infeasible for widespread implementation. As a result, the most commonly cited alternative, processing gold using cyanide, is only typically successful with a local cooperative or collective organization (many miners pooling resources to minimize processing and handling cost) that is typically subsidized entirely or in large part by a government or NGO. Nonetheless, researchers correctly continue to pursue alternatives to mercury amalgamation as summarized in Table 7-2; in cases where organized alternatives are unavailable, the best interim solution is to promote the Best management practices (BMP) summarized in the subsection 7.3.

Table 7-2 ASM – Mercury-free techniques (GMP 2006)

Technique	Comments
Cyanide Processing	**Advantages:** ▪ Requires relatively small amounts of cyanide, usually less than 1 kg of cyanide per tonne of rock; ▪ Cyanide is very selective leaching gold and only minor amounts of other minerals in the ore; ▪ Cyanide leaches coarse and very fine gold as well as gold that is attached to the rock; ▪ Tank leaching normally takes less than one day; ▪ Cyanide remaining in the waste (tailings) product can be destroyed to minimize the environmental impact; ▪ Ultraviolet light degrades cyanide to less toxic forms, but complete destruction of cyanide requires chemical treatment; ▪ Used responsibly, the risk of cyanide poisoning can be minimized ▪ Cyanide does not accumulate in animals or plant life; **Disadvantages:** ▪ Requires much more skill and technical control than amalgamation and not usually within the reach of individual or dispersed artisanal miners; ▪ Cyanide is highly toxic and at high concentrations will kill fish, birds and mammals (including humans); ▪ Cyanide reacts with mercury to produce soluble chemical compounds is easily transported with water; and ▪ When cyanide reacts with mercury, it converts the mercury to a form in which it more easily enters the food chain and becomes more harmful.
Gravimetric Methods (CleanGold®)	▪ Uses magnetism in a simple sluice to create riffles with ferromagnetic components of the ore. ▪ In case the ore does not contain ferromagnetic components, the surface of the sluice can be charged with inexpensive, recyclable magnetic materials, such as black sand containing magnetite or iron grains from manmade sources (e.g. iron lost from welding and grinding). ▪ Claimed gold capture efficiency of 90% after two passes performed over 5 minutes; further field studies unpublished. ▪ Equipment is simple, but more than 75-150 USD per miner.
Mintek – Minataur Process (MMSD Project 2002)	▪ Experimental process; not implementable on a wide scale; ▪ Ore is treated with hydrochloric acid in the presence of sodium hypochlorite; ▪ Precipitate the gold out of the concentrate using sodium metabisulphate or oxalic acid; and ▪ Resulting concentrate is 99.5% fine gold powder.
Centre for Mineral Technology (CETEM) 1. Electrolytic process to leach gold mixed with sodium chloride (1 mol/L); 2. Mixture is transformed by electrolysis into a mixture of sodium hypochoritechlorate; 3. >95% of the gold dissolves within 4 hours and is collected on a graphite cathode	▪ Treatment solution is recycled minimizing effluent discharge; ▪ The NaCl and energy consumptions are 100 kg/tonne of ore and 170 kwh/kg of gold respectively; ▪ Relatively uncomplicated process using plastic leaching tanks; and ▪ Trained personnel are required to control operating variables (pH, current density, etc).
Combining Non-Mercury Methods	Recent studies show that the types of ore and gold particles (e.g., oxidation, physical structure) affect the recovery rates of mining techniques. One study on gold-bearing ore from the Philippines (Hylander et al., 2007) showed that mercury amalgamation was less efficient in removing gold than cyanide

Technique	Comments
	processing and in an effort to increase recovery, miners were combining both methods. But the study data revealed the highest recovery rates for the particular ore-gold combination was a gravimetric method followed by cyanide processing. While the analytical resources used in the study would not be available to most ASM operations, simple experimentation with combined methodologies could yield higher recovery rates and – as in the study case described above – eliminate mercury amalgamation processing entirely as inefficient.

7.2.5 Mercury-free Products

153. There are two types of mercury-containing products as follows (The Quicksilver Caucus 2006):

1) Formulated mercury-containing products: chemical products, including laboratory chemicals, cleaning products, cosmetics, pharmaceuticals, and coating materials that are sold as a consistent mixture of chemicals; and

2) Fabricated mercury-containing products: a combination of individual components, one or more of which has mercury added, that combine to make a single unit (e.g., automobiles, thermostats, battery-operated products, electronics, and others).

154. Depending on the product and country, some barriers exist for phasing out mercury-containing products and replacing them with alternatives that use less mercury or are mercury free. The barriers associate with the alternatives include: cost, efficacy, and ease of use, as well as difficulties associated with locating and identifying mercury-added products. Table 7-3 summarizes the products used worldwide that typically contain mercury and the mercury-free alternatives (UNEP 2002). The goal of EMS is to help countries remove these barriers for finding mercury-free alternatives.

155. Current (and regularly updated) lists of mercury-containing products accessible in a searchable database organized by industry sector is maintained by The Northeast Waste Management Officials' Association (NEWMOA) and accessible at:

http://www.newmoa.org/prevention/mercury/imerc/notification/

Table 7-3 Mercury-free alternatives to Mercury-containing products (UNEP 2002; 2006a): The numbers link to Table 2-1.

5. Consumer products with intentional use of mercury		
Products	**Comments**	**Alternative cost**
5.1. Thermometers and other measuring devices with mercury	There are many alternatives to clinical mercury-thermometers, including electrical and electronic thermometers, "disposables" designed for a single use, glass thermometers containing a Ga/In/Sn "alloy", etc.	Used mostly for measuring body temperature, electronic thermometers have become standard in Denmark and other countries. While they remain somewhat more expensive than glass mercury thermometers, their price has come down substantially in recent years. Other alternatives are also more expensive, although the recently introduced Ga/In/Sn thermometer should approach the cost of old mercury thermometers over time.
5.2. Electrical and electronic switches, contacts and relays with mercury	With very few exceptions, there are no technical obstacles to replacing electrical components, conventional relays and other contacts (even when these are contained in level switches, pressure switches, thermostats, etc.) with equivalent mercury-free components.	There are no significant price differences between conventional mercury and mercury-free relays and contacts, except for very specific applications. There are also examples of mercury components, which are more expensive than the alternatives (Gustafsson 2001).

5.3. Light sources with mercury	Currently, few mercury-free energy-efficient alternatives exist on the market. European Commission Decision 1999/568/EC (amended 9 September 2002) requires a manufacturer be allowed to use the European Ecolabel on a single-ended compact fluorescent lamp, mercury content must not exceed 4 mg, and the life of the lamp must exceed 10,000 hours. The LED has been developed for the alternative of the fluorescent lamp, but is still under development because the light is still weak for the whole room lighting purpose (Matsushita Electric Works Ltd. 2007b).	Low-mercury lamps are slightly more expensive than those with a bit more mercury. Incandescent and some other alternative lamps are less expensive than energy-efficient lamps, but they have a much higher energy/operating cost (Falk 1994; Gustafsson 2001)
5.4. Batteries containing mercury	Virtually mercury-free zinc-air batteries and other button-cell alternatives have been available for several years. Many manufacturers no longer produce mercuric-oxide and mercury-zinc batteries, but they remain a significant problem in the municipal waste stream of most countries. Should clarify that even zinc air button cell batteries have up to 25 mg mercury, which given high production volumes can add up to significant mercury. Technology has been developed to make button cells without any added mercury—U.S. manufacturers have committed to phasing out mercury in button cells by 2011. Battery Association of Japan has set up the Environmental Action Program through which the member companies shall contribute to global environmental preservation and the realization of a sustainable development society. One of the actions is to reduce mercury content in button-type batteries less than 0.8% as of 2001 (Battery Association of Japan 2004).	May often be higher than the mercuric-oxide and mercury-zinc batteries, but municipalities can avoid expensive collection and disposal schemes.
5.5. Biocides and pesticides	The use of mercury in pesticides and biocides has been discontinued or banned in many countries. Two main alternatives have been promoted in their place: 1) Use of processes not requiring chemical pesticides/biocides, and 2) Easily degradable, narrow-targeted substances with minimal environmental impact.	These alternatives are in place in many countries. The range of products and applications is too diverse to make definitive statements about cost comparisons, although it is likely that in the majority of cases costs are roughly comparable, and environmental benefits are considerable.
5.6. Paints	Phenyl mercuric acetate (PMA) and similar mercury compounds were formerly widely added as biocide to water based paints and may still be used in some countries. These compounds were used	Mercury-free paint is now available, and it becomes more popular than mercury-containing paint. Cost of mercury-free paint is comparable other paints.

	to extend shelf-life by controlling bacterial fermentation in the can (in-can preservatives) and to retard fungus attacks upon painted surfaces under damp conditions (fungicides).	
5.7. Pharmaceuticals for human and veterinary uses	Mercury has been used in various pharmaceuticals such as vaccines, eye drops, and other products, mainly as a preservative. For example, thimerosal (ethyl thiosalicylate, also known as thiomersal) has been used for decades in (mostly multi-dose) vaccines to prevent growth of various pathogens after the seal is broken. According to WHO, there are other chemicals such as 2-phenoxy-ethanol also used as vaccine preservatives; however, WHO believes that thimerosal is better than the alternative preservatives.	Single-dose vaccines are generally produced without preservatives, but they are typically about 50% more expensive than multi-dose vaccines. • The issue of mercury in vaccines, especially, has proven to be a contentious and emotional one, including claims, for example, that there may be a link to the rise in cases of autism in children. This should be kept in mind during any stakeholder discussion of the issue.
5.8. Cosmetics and related products	The use of mercury-containing cosmetics has in recent years been banned in many countries, and their widespread use may no longer take place. The most common alternative to mercury as an active ingredient in skin lightening soaps and cosmetics is hydroquinone, although corticosteroids are also widely used.	• The mercury-free products are not so expensive than mercury containing products. The costs are comparable (Kuiken 2002).
6. Other intentional product/process uses		
6.1. Dental mercury-amalgam fillings	Newer alternatives to mercury amalgam fillings are available: cold silver, gallium, ceramic, porcelain, polymers, composites, glass ionomers, etc. Many industrialized countries have already transitioned in large part away from mercury-containing amalgam dental fillings; e.g., Swedish dentists use amalgam for less than 6% of fillings (KEMI, 2005). Yet, in other countries with dentists that have access to the alternatives, amalgam use still remains; e.g., In 2005 estimates for U.S. dentists are amalgam use for 30% of fillings (Zentz, 2006).	▪ Some are less expensive, some are more expensive; ▪ Some are as easy to apply and others are more difficult; and • None require the specialized wastewater treatment equipment required to meet environmental regulations in many countries (Gustafsson 2001; KEMI - National Chemicals Inspectorate 1998; US EPA 1997) • Equipment for mercury-free alternatives is generally too expensive for dentists outside industrialized countries and not widely available.
6.2. Manometers and gauges	It is often used to refer specifically to liquid column hydrostatic instruments. Manometers are used to measure air, gas, and water pressure. The mercury in manometers responds to air pressure in a precise way that can be calibrated on a scale. Manometers are used in laboratories, the dairy industry milking process, and for calibrating outboard motors and motorcycle carburetors.	• The three alternatives to a mercury manometer include the needle/bourdon gauge, the aneroid manometer, and the digital manometer. The needle/bourdon gauge operates under a vacuum with a needle indicator as a method to measure pressure. The aneroid manometer operates in a similar fashion to the needle/bourdon gauge. The digital manometer uses a digital computer programmed

		memory and gauges to measure the pressure.
6.3. Laboratory chemicals and equipment	It is entirely possible to restrict mercury use in school or university laboratories to a few specific, controllable uses (mainly references and standard reagents).	• This initiative has already been implemented in Swedish and Danish legislation. The alternatives are generally no more expensive, and the need for control of mercury sources in the laboratory is greatly reduced.
6.4. Mercury metal use in religious rituals and folklore medicine	Elemental mercury is used in certain cultural and religious practices in Afro-Caribbean, Latin America, etc. despite no medical effects. Uses include carrying it in a sealed pouch or in a pocket as an amulet, sprinkling mercury on floors of homes or automobiles, burning it in candles, and mixing it with perfumes (Riley 2001).	• Many alternatives are available. The most important thing is to give opportunity community involvement, outreach, and education to be aware how dangerous mercury is.

7.3 Waste Minimization (Reduction of Discharges)

7.3.1 Introduction

156. While the previous section reviewed "source reduction" by using mercury-free alternatives in place of current processes and products using mercury, this section summarizes initiatives to use less mercury or use it more efficiently thereby reducing mercury emissions from current sources in three areas: (1) industrial processes; (2) ASM; and (3) mercury-added products.

7.3.2 Reduction of Discharge in Industrial Process

7.3.2.1 Reduction of Discharge in Mercury Cell Chlor-Alkali Manufacturing

157. In the long-term, most or all of the mercury cell chlor-alkali chlorine plants will be replaced, but given the long useful life of the plants, the process will take decades. In the intervening time, there are many well documented BMP that can be implemented to reduce mercury emissions. Table 7-4 summarizes those recommended BMP.

Table 7-4 Recommended BMP – Mercury cell chlorine and caustic soda plants

Source	Summary
Code of Practices - Mercury Housekeeping (Euro Chlor 1998) Euro Chlor is the European federation representing the producers of chlorine and its primary derivatives. Could also consult Chlorine Institute, April 2001, Guidelines for Mercury Cell Chlor-alkali Plants Emissions Control (The Chlorine Institute 2001).	The document describes a variety of practical BMP and "helpful hints" for operating a mercury cell chlorine plant with an emphasis on detection and cleanup of mercury leaks and emissions within the plant. Areas covered include: ▪ Cell Room: Cells and Supporting Structures, Vessels/Pumps/End-boxes, Floor Areas, Flow Gutters, Floor Protection, Storage in Cellroom, Colllection of Mercury; ▪ Maintenance: Work Areas, Activity Planning, Hot Work, Cell Cleaning, Leak Detection; ▪ Mercury Storage; and ▪ Measuring Mercury In Air

<table>
<tr><th>Source</th><th>Summary</th></tr>
<tr><td>Integrated Pollution Prevention and Control (European Commission 2001)</td><td>This document details various pollution prevention and control technologies and techniques for all three types of chlor-alkali manufacturing facilities. Section 4.2 contains mercury emissions reductions for mercury cell plants; the recommendations are summarized below:
Monitoring of possible leakages and recovery of mercury (Aim: React as quickly as possible to avoid mercury evaporation)
▪ Continuous monitoring of mercury concentration in cell room
▪ Removal of mercury spillage
o Daily housekeeping
o Vacuum cleaners for mercury recovery
o Immediate intervention at leakage (aided by appropriate housekeeping and continuous monitoring) and immediate isolation of mercury in closed vessels
▪ Use water for cleaning: avoid too high pressure which may generate micro droplets difficult to detect, in particular when cleaning upper floors of the cell room
Good Housekeeping (Aim: Avoid as much as possible any accumulation of mercury)
▪ Design of the cell room
o Smooth floor without cracks and regularly cleaned
o No obstacles (avoid all types of storage)
o Cell room concrete coated with a material resistant to absorption of mercury (e.g. epoxy/acrylate resin) and coloured to see droplets
o No wood in the cell room
o Avoid hidden mercury traps on pipe supports and cable trails (e.g. hang cable trays vertically)
o Powerful lighting system (mercury shines)
Influence of human factors (Aim: Motivation, education and training of staff for overall reduction of emissions)
▪ Development of housekeeping methodologies
▪ Personal hygiene
▪ Daily cleaning of clothes of personnel
▪ Detailed routines for service jobs and hygiene in cell rooms reduction of emissions
End-of-pipe measures (Aim: Recover mercury emitted during process or maintenance)
▪ Mercury removal from hydrogen gas
▪ Mercury removal from caustic soda
▪ Evacuation/treatment of mercury-containing process gases from:
o Closed end boxes and separate end box ventilation
o Vacuum cleaners
o Mercury pump seals
o Brine circuit and salt dissolver
o Off-gas from mercury recovery retort
▪ Mercury removal from waste water
▪ Closed storage of mercury-contaminated wastes and parts operations</td></tr>
<tr><td></td><td>During Normal Operation (Aim: Avoid opening of cells)
▪ Use of salt with low impurity content
▪ Verify and clean the inter-cell buss for good current distribution</td></tr>
</table>

Source	Summary
	▪ Monitoring of mercury pressure More constant operation of cells and less waste produced ▪ More constant operation of cells and less waste produced ▪ Optimum quantity of mercury in cells ▪ Adjustable anodes over different segments of the cell ▪ Lower frequency of opening cells for removal of mercury butter ▪ Computerized control of electrode gap, current and voltage - less heat development results in lower mercury emissions ▪ Consider graphite reactivation without opening decomposer (e.g., sodium molybdate treatment, ferric sulphate treatment, cobalt treatment) to increase carbon life in the decomposer ▪ Computer data base system for tracking life of cell components
	During operations that require opening of the cells (Aim: Reduce mercury evaporation and get better control emissions) ▪ Detailed routines and planning for dismantling of cells ▪ Cells cooled prior to and during opening ▪ Reduce duration of cell opening: o Replacement parts available o Manpower available o If practical, spare decomposer completely assembled with carbon ▪ Cell bottom cleaned and covered during repair ▪ Dedicated areas for maintenance and repair or mobile screening with suction ducts led to mercury removal ▪ Avoid the use of rubber hoses to transfer mercury because of difficulty of decontamination ▪ Stepping into the cell bottom should be minimized since decontamination of boots is difficult ▪ In case of interruption of operation, all parts that might evaporate mercury should be covered

7.3.2.2 Reduction of Discharge in VCM Production

158. VCM production using the acetylene process employs mercuric chloride as a catalyst. Waste minimization opportunities exist and fall into two primary categories: (a) alternative, mercury-free manufacturing methods; and (b) environmental controls to capture and recycle mercury-containing wastes.

159. Mercury-Free VCM Manufacturing: VCM is manufactured in a variety of ways including mercury-free methods based on the oxychlorination of ethylene. While the mercury-free alternatives are used in various places in the world, the largest factor in its use in place of the mercuric chloride process has typically been the price of mercury (and therefore the incentive to recycle it) and the increasing environmental concerns.

160. Environmental Controls: Mercury used in VCM production can be released into the environmental as a contaminant in waste produced during manufacturing. Mercury-containing wastes include wastewater, air emissions, solid waste, and hazardous wastes. Waste minimization opportunities are focused on installing and operating environmental controls including:

- Wastewater: Mercury-containing wastewater is produced from VCM manufacturing and should be treated to remove mercury using activated carbon that can subsequently be processed to remove and recover mercury; and
- Air Emissions: Air pollution controls consisting of activated carbon should be used to adsorb mercuric chloride in flue gases for regeneration and mercury recycling.

161. Spent Catalyst: Spent catalyst containing mercury should be treated with lime or caustic soda solution and heated to drive off mercury vapours that can be treated with activated carbon and then regenerated to remove mercury for reuse.

7.3.3 Waste Minimization in ASM

162. Studies of ASM in developing countries have consistently concluded that mercury amalgamation will likely persist because: (a) mercury is inexpensive and widely available; (b) the technique is simple and the required equipment is rudimentary and inexpensive; and (c) the miners, their families, and the community are not aware of the health and environmental consequences. As a result, Table 7-5 summarizes techniques for using mercury more efficiently in ASM.

Table 7-5 ASM – BMP mercury techniques (GMP 2006)

Technique	Comments
Centralized Processing Centres Miners bring gravity concentrates to a centralized facility for amalgamation by trained personnel and under controlled conditions.	▪ Must be coupled with extensive education and promotion campaign to establish trust and understanding with miners; ▪ Requires 5 trained staff to operate the equipment; ▪ Increased security staff required to prevent raids of concentrated gold; ▪ Large initial expense from equipment, training, and construction; ▪ Reduces mercury exposure to miners to insignificant levels; ▪ Gold recovery from gravity concentrates is improved; ▪ Cost reduction in the processing plant; ▪ Better price of gold sold to banks or dealers (gold is already melted in the Centres); ▪ Mercury vapour exposure is greatly reduced, but still present at 5 mg Hg/m^3 in air 5 to 15 m downwind of the centres (Oliveira 2004); and ▪ Miners do not need to buy mercury illegally.
BMP using Mercury	▪ Cover mercury with water inside closed containers to reduce mercury vapours formation; ▪ Do not use mercury in riffles: it DOES NOT increase gold recovery; ▪ Use gravity concentrates whenever possible to reduce the mercury required for amalgamation; o Mix for at least 15 minutes, but never longer than 2 hours (to avoid flouring); and o Use a few grams of soda or soap to clean natural fats or grease (1g/kg concentrate). ▪ Amalgamate away from water courses. Use water boxes, or amalgamation ponds, and carefully dispose of tailings; ▪ Maximize amalgamation efficiency; ensure mercury contact by: o Clean or activate the surface of the mercury by putting it in salty water and connecting a radio or car battery: the positive wire to the water and the negative wire to the mercury for 10-20 minutes; use this mercury within 1 hour. ▪ Excess mercury can be removed from amalgam by centrifuges or presses; ▪ Use retorts to capture mercury vapour and recover and reuse up to 95% of mercury o Remove the condensing tube from the water before removing from the heat to avoid sucking water into the crucible and exploding the retort. ▪ Use a torch when using retorts, or a campfire with a blower to speed the retorting.

7.3.4 Reduction of Discharge from Mercury-Containing Products

163. After instituting mercury-free alternatives and outright bans on mercury-containing products more commonly found in developed countries, reducing incidental releases from incinerators and landfills can best be accomplished by segregation of mercury-containing wastes from the waste stream. The two most common waste streams containing mercury are regular solid waste and waste generated at healthcare facilities. Relying on “end-of-pipe” engineering controls that scrub incinerator emissions or treat landfill leachate are necessary precautions, but it

is much preferable to prevent mercury contamination of the waste streams in the first place. This is most successfully implemented by (a) product labelling to prompt proper end-of-life recycling and disposal; and (b) collection and “take back” initiatives for common mercury-added products.

7.3.5 Products Labelling

164. The Quicksilver Caucus (a U.S.-based coalition of state associations formed to address and resolve health and environmental problems resulting from the release of mercury to the environment) recommends a robust system of product labelling to any “mercury-added product” to:

1) Inform consumers at the point of purchase that the product contains mercury and may require special handling at end-of-life;
2) Identify the products at the point of disposal so that they can be kept out of the waste stream destined for landfill or incineration and be recycled;
3) Inform consumers that a product contains mercury, so that they will have information that will lead them to seek safer alternatives; and
4) Provide right-to-know disclosure for a toxic substance.

165. While governments and industry sectors have taken different approaches to what and how product labelling is most effective, the 1998 Conference of the New England Governors and Eastern Canadian Premiers developed guidelines in support of the Quicksilver Caucus’s four labelling goals outlined above. The general categories are summarized below and more details are available at;

http://www.newmoa.org/prevention/mercury/imerc/labelinginfo.cfm (NEWMOA 2004)

a. Deadline: Product labeling required by a certain date;
b. Products containing mercury must be labeled with sufficient detail so that it may be readily located for removal;
c. Labels must be clearly visible prior to sale and provide information regarding proper end-of-life handling and disposal;
d. Labels should be affixed and constructed to remain legible for the useful life of the product;
e. Sellers of mercury-containing products must inform buyers when mercury labels are not visible at point-of-sale including catalogue, telephone, and internet sales; and
f. The manufacturer has responsibility for product and package labels and not wholesalers or retailers.

166. In addition, under the Law for Promotion of Effective Utilization of Resources in Japan, manufactures and importers must label a symbol (J-Moss symbol: Fig. 7-5) if any of the product listed below contains lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB) and/or polybrominated diphenyl ethers (PBDE). The purpose for the labelling is to promote the use of recyclable resources and parts through providing information on the specific substances contained in electrical and electronic equipment, and to promote Design for Environment (DfE) is required for importers, not only manufactures.

- Personal computer;
- Air conditioners;
- Television sets;
- Refrigerator;
- Washing machines;
- Microwaves; and
- Home drier.

Fig. 7-5 J-Moss symbol

7.3.6 Collection of Mercury-Containing Products for Reuse and Recycling

167. In both developed and developing countries, governments and non-governmental organizations (NGOs) have increased efforts to identify and collect mercury-added products still in use and keep them out of waste streams (solid waste, medical waste, and hazardous waste) that may more commonly be incinerated or otherwise release mercury emissions to the environment. The section 8 (8.0 Handling, Collection, Storage (Interim), and Transportation of Mercury Waste) includes a more detailed discussion of programmes for collection of mercury-added devices, how to plan and implement a collection event, and proper handling of the mercury-added products collected.

7.4 How to Minimize Exposure

168. Spills of elemental mercury in the course of commercial activities and in the home have the potential to expose workers and the general public to hazardous mercury vapours. In addition, the spills are costly to clean up and disruptive. Table 7-6 summarizes USEPA's cleanup procedures for small mercury spills.

169. Critical to determining what type of response is appropriate for any mercury spill is evaluating its size and dispersal and whether the needed cleanup resources and expertise are available. If in doubt about the any part, solicit skilled and/or professional help if:

- The amount of mercury could be more than 2 tablespoons (30 milliliters): In the U.S. and many other countries, larger spills must be reported to authorities for oversight and follow-up;
- The spill area is undetermined: If the spill was not witnessed or the extent of the spill is hard to determine, there could be small amounts of mercury that are hard to detect and that elude cleanup efforts;
- The spill area contains surfaces that are porous or semi-porous: Surfaces such as carpet and acoustic tiles can absorb the spilled mercury and make cleanup impossible short of complete removal and disposal of the surface; and
- The spill occurs near a drain, fan, ventilation system or other conduit: Mercury and mercury vapors can quickly move away from the spill site and contaminate other areas without easy detection.

7.5 Training and Cleaner Production

170. Workers handling or exposed to mercury during any part of a product's lifecycle including manufacture, maintenance, management, and disposal/recycling should have basic training to help them understand cleaner production principles, and be able to systematically evaluate systems and processes for pollution prevention/waste minimization opportunities. Of course, training and education related to the process or product at hand is most valuable and often is best handled during formal and informal reviews of operations, quality, and efficiency studies. The following internet resources provide some publicly available training topics and modules appropriate for a general understanding of the subject; they are generally targeted at managers and employees with literacy skills and collegiate education:

- Chlor Alkali Cleaner Production: "Energy and Environmental Issues in Chlor-Alkali Industry – An Overview. Federation of Indian Chambers of Commerce (Virendra 2007); and
- ASM: "Removal of Barriers to the Introduction of Cleaner Artisanal Gold Mining and Extraction Technologies: Gold Mercury Project." (Huidobro 2005)

Table 7-6 Mercury spill cleanup for house-hold or minor spills (US EPA 2007b)

Mercury Spill Size	Comments
Up to the amount in a thermometer	▪ Make everyone leave the area making sure to not walk through the mercury; ▪ Remove pets from the area; ▪ Open all windows and doors to the outside; shut all doors to other parts of the building/house; ▪ DO NOT allow children to help you clean up the spill; ▪ DO NOT sweep or vacuum the spill; ▪ Mercury can be cleaned up easily from the following surfaces: wood, ▪ linoleum, tile and any similarly smooth surfaces; and ▪ Carpet, curtains, upholstery or other absorbent surfaces, contaminated items

Mercury Spill Size	Comments
	should be thrown away in accordance with the disposal rules.
More than a thermometer, but <2 tablespoons (30 ml)	Follow the precautions for smaller spills, and… ▪ Turn down the temperature; ▪ Shut all doors to other parts of the house, and leave the area; and ▪ Call your local fire department or emergency response agency. If they are unable to assist you, contact your local or state health or environmental agency.
>2 tablespoons (30 ml)	Notify emergency response agency and fire department with the approximate size of the spill.

8.0 Handling, Collection, Storage (Interim), and Transportation of Mercury Waste

8.1 Introduction

171. Handling, collection, interim storage, and transportation of mercury wastes are similar to those for hazardous wastes. Mercury has some physical and chemical properties that require additional precautions and handling techniques, but mercury in its elemental form is widely recognizable and there exist sophisticated and accurate field and laboratory measurement techniques and equipment that, if available, make detection and monitoring for spills relatively straightforward.

172. This section contains a brief overview of the basic concerns for moving mercury wastes through the steps from identification and location to transportation to a disposal or recycling facility. The summary follows the general guidelines provided in the Basel Convention - General technical guidelines (GTG) for the environmentally sound management (ESM) of wastes consisting of, containing or contaminated with persistent organic pollutants (POPs) (Basel Convention GTG) (SBC 2006), adopted at the Eighth Meeting of the Conference of the Parties (COP8) to the Basel Convention.

173. Specific guidance on handling mercury wastes are provided in this section, but it is imperative that generators consult and adhere to their own country's as well as local government's specific requirements. The Basel Convention GTG identifies the following reference documents for transport and transboundary movement of hazardous wastes:

a) Basel Convention: Manual for Implementation (SBC 1995b);

b) International Maritime Dangerous Goods Code (IMO 2002);

c) International Civil Aviation Organization (ICAO) Technical Instructions for the Transport of Dangerous Goods (ICAO 2001); and

d) International Air Transport Association (IATA) Dangerous Goods Regulations (IATA 2007) and the United Nations Recommendations on the Transport of Dangerous Goods Model Regulations (Orange Book) (UN 2001).

174. The classification of mercury waste under the Basel Convention can be found at the subsection 1.3 Definition of Mercury Waste under the Basel Convention.

8.2 Collection

175. Collecting mercury wastes from the point of generation falls into two categories: (a) collection of mercury-containing products; and (b) collection of mercury or mercury-contaminated materials from a spill or site where mercury is used in manufacturing.

8.2.1 Mercury-containing Product Collection

176. The Basel Convention GTG identifies the following overall suggestions for implementing a collection event:

a) Advertise the programme, depot locations, and collection time periods to all potential holders of mercury-containing products;

b) Allow enough time of operation of collection programmes for the complete collection of all mercury-containing products;

c) Include in the programme, to the extent practical, collection of all mercury-containing products;

d) Make available acceptable containers and safe-transport materials to owners for those mercury-containing products that need to be repackaged or made safe for transport;

e) Establish simple, low-cost mechanisms for collection;

f) Ensure the safety both of those delivering mercury-containing products to depots and workers at the depots;

g) Ensure that the operators of depots are using an accepted method of disposal;

h) Ensure that the programme and facilities meet all applicable legislative requirements; and

i) Ensure separation of mercury containing products from other waste streams.

177. Table 8-1 summarizes the mercury-added products typically the subject of collection programs and includes resources required for planning and implementation.

Table 8-1 Mercury-containing product collection

Mercury-containing Product	Resources
Vehicle Switches and Sensors	Products include automatic braking sensors and tilt switches used for trunks and doors. ▪ U.S. EPA Program: www.epa.gov/mercury/switch.htm ▪ Mercury Removal Instructions: www.elvsolutions.org/Elvs%20Brochure%20v11.pdf ▪ List of vehicles and the mercury added sensors and switches they contain: www.elvsolutions.org/educational.html
Mercury-Containing Medical Devices	Healthcare facilities typically contain large amounts of mercury-containing devices (sphygmomanometers, bougie tubes, etc.) that are still in use, but that can be replaced at end-of-life or proactively. ▪ Comprehensive guides to locating mercury-containing products in healthcare facilities: www.dtsc.ca.gov/PollutionPrevention/upload/guide-to-mercury-assessment-in-healthcare-facilities.pdf and http://sustainableproduction.org/downloads/ ▪ Vendor exchange of mercury-containing products like sphygmomanometers are often available through manufacturers (e.g. www.adctoday.com/support/mercuryexh.php); collection and mercury reclamation can be made part of the procurement of new mercury-free products ▪ U.S. EPA Factsheet on Mercury-Containing Medical Devices in Hospitals www.epa.gov/region09/waste/p2/projects/hospital/mercury.pdf ▪ Conference Presentation: Mercury: What's Easy, What's Left… www.westp2net.org/hospital/azhospitalp2.cfm
Patient Thermometers	Many U.S. municipalities and hospitals conduct mercury thermometer collection and exchange programs; the programs are typically sponsored by the local environmental agencies and solid waste contractors. ▪ US EPA Program lists of State and Local Mercury Collection Programs: www.epa.gov/epaoswer/hazwaste/mercury/collect.htm ▪ Planning and Holding a Mercury Thermometer Exchange (Healthcare for a Healthy Environment): www.noharm.org/us/mercury/exchange
Batteries and High Efficiency Lights	Generators of these mercury-containing products are typically allowed to dispose of them in solid waste or household hazardous waste programs or through an organized segregation program sponsored by municipalities and typically operated as part of the solid waste management program.

8.2.2 Collection of Mercury and Mercury Waste from Spills and Manufacturing Sites

178. Detailed planning and removal of mercury from spills and manufacturing sites should be captured in a written plan that takes into account the resources and personnel skills available, the urgency of the situation, and the scope of the mercury contamination. Conventional hazardous waste response and site cleanup procedures are widely available and generally appropriate as well for sites contaminated with mercury; this section summarizes the issues and equipment required specifically for assessing and monitoring a mercury cleanup.

a) Field screening equipment (US EPA 2001b):

- Jerome Mercury Vapour Analyzer Model 411 (0.001 to 1.999 mg/m^3 Hg and Model 431 (0.001 to 0.999 mg/m^3 Hg) uses a gold film sensor to measure mercury vapour in the air. The sensitivity of both instruments is 0.003 mg/m^3 Hg, and the accuracy of both instruments is ± 5% at 0.100 mg/m^3 Hg;

- Lumex RA-915+ Mercury Vapour Analyzer determines the mercury vapour content in ambient air, water, soil, and natural and stack gases; detection range is 2 ng/m^3 to 26 µg/m^3 in air (Sholupov 2004);
- VM-3000 Mercury Vapour Monitor (MVM) does continuous measurement of mercury vapour; measuring range can be adjusted from 0.1 to 100 µg/m^3, 1 to 1,000 µg/m^3, or 1 to 2,000 µg/m^3; and
- Nippon Portable Mercury Survey Meter.

b) Air sampling equipment:

- Gilian MSA Flow-Lite with optional Gemini "low flow" adapter; and
- SKC air sampling pumps.

c) Worker/occupant exposure and personal protective equipment:

- Nitrile gloves, safety glasses, closed-toe shoes, and respirator with mercury cartridges; and
- U.S. Occupational Safety and Health Administration mercury guidelines (US Department of Labor 1996)

d) Mercury Cleanup Equipment

- Mercury vacuum designed especially for mercury spill cleanup; and
- Mercury spill cleanup kit.

8.2.3 Take-back Programmes

179. Take-back programmes are one of the Best Environmental Practices (BEP). Generally, take-back programmes give manufactures the physical responsibility for products and/or packaging at the end of their useful lives. By accepting used products, manufactures can acquire low-cost feedstock for new manufacture or remanufacture, and offer a valued-added service to the buyer. Take-back programmes are voluntary or under requirements or guidelines. In addition, a take-back programme promotes local stakeholders, in particularly local producers and local large-scale consumers who have not had any opportunity to implement mercury waste collection programme in developing countries and countries with economies in transition.

180. Generally, take-back programmes focus on household (obsolete or used) products which are widely scattered but have the adverse potential to cause the environmental pollution if they are dealt with on the environmentally unsound management (Honda 2005). The main purposes of a take-back programme for mercury-containing products are to phase out mercury-containing products and to promote using mercury-free products or mercury-containing products whose mercury contents are as low as practically possible, to protect the adverse effects to human health and the environment due to mercury spillage. Of mercury-containing products, fluorescent lamps and other mercury-containing lamps, thermometers, mercury-containing batteries and mercury switches are main target of a take-back programme, because these products are widely used and have the high potential to be reused and recycled. At this moment, it is impossible to phase put use of fluorescent lamps and other mercury-containing lamps. Alternatives of mercury-containing thermometers and batteries are already available.

181. In order to collect mercury batteries which had been widely used in Japan, the Environment Agency, Japan (the former organization of Ministry of the Environment, Japan) initiated the measurement against used mercury batteries in 1981 (Environmental Agency 1981). This initiation aimed at collection of used mercury batteries and promotion of a phase-out programme to manufactures and other industrial sectors. The activities on the initiative were as follows:

1) Collection of mercury batteries: 111,100 bins exclusive for used mercury batteries were set at retail shops throughout Japan;
2) Public relation (PR) activities: posters and documents to inform mercury battery collection were disseminated to almost all residents through municipal authorities. Media and other publicity were used;
3) Cooperation among all stakeholders: all stakeholders, e.g., public sectors and provate sectors, associations, etc, were involved;
4) Collection and treatment mechanism: A collection scheme was established as a reverse route of the selling route, namely retail shops → distributers → manufactures. Manufactures was responsible to collect mercury batteries and send them to recyclers;

5) Monitoring: A regular monitoring was implemented once a each 3 month; and

6) Research: Research to develop mercury-free batteries was started in 1981, and mercury-free batteries were put on the market as soon as developed.

182. A new style take-back service of fluorescent lamps is implemented in Japan. The principle of this service is to only provide light to clients. A company lends fluorescent lamps to clients until users stop using fluorescent lamps. Users can return used fluorescent lamps to the company which is responsible to manage all used fluorescent lamps under a regulation and send all used fluorescent lamps to recycling facilities on the environmentally sound management (ESM). This programme targets mainly organisations, particularly organisations at large scale where a number of fluorescent lamps are used. Clients can reduce management cost and tasks of discarding large numbers of use fluorescent lamps by introducing this programme (Matsushita Electric Works Ltd. 2007a).

183. Take-back programmes are being implemented in many countries and local communities. A good example of a take-back pilot project includes the collection of mercury fever thermometers in Ontario, Canada in 2002. Residents in the participating cities could return their unbroken mercury fever thermometers in their original carrying cases or in a shatterproof container to participating retailers. Consumers were asked not to throw mercury products like fever thermometers directly into household garbage. If a broken fever thermometer was found in the home, consult the local poison information centre and household hazardous waste would depot to determine a safe clean-up and disposal method (Environment Canada 2002b).

8.3 Handling

184. Handling mercury-containing products collected from consumers or mercury-contaminated waste from spills requires workers to follow hazardous waste handling procedures with special attention to the characteristics and dangers associate with mercury, namely, the hazard associated with its vapour phase and its potential for wide dispersal that may be difficult to detect. Mercury handling, whether associated with mercury-containing products or spilled elemental mercury should follow some basic precautions outlined in Table 8-2.

Table 8-2 Handling requirements for mercury-containing wastes

Mercury Waste Guidelines:

Containers: Containers for mercury, mercury compounds, and mercury-bearing or mercury-contaminated wastes should be corrosion-resistant, and strong enough to withstand breakage during normal handling, transport and storage. For residential and small mercury spills from mercury-added products (thermometers, etc.), most plastic containers with a tight-fitting, screw top are sufficient; for larger spills and cleanup of mercury-contaminated products, steel or polyethylene drums typically used for hazardous waste are appropriate. However, the containers should be selected based on the property of the mercury wastes.

Packing: Most inert packaging material available is acceptable for mercury-containing devices; it should be used to limit movement and prevent breakage while in transport.

Basel Convention Hazardous Waste General Handling Guidelines

(a) Inspect containers for leaks, holes, rust or high temperature, and repackage and replace labels as necessary;

(b) Handle wastes at temperatures below 25°C, if possible, because of the increased volatility at higher temperatures;

(c) Ensure that spill containment measures are adequate and would contain liquid wastes if spilled;

(d) Place plastic sheeting or absorbent mats under containers before opening them if the surface of the containment area is not coated with a smooth surface material (paint, urethane or epoxy);

(e) Remove liquid wastes either by removing the drain plug or by pumping with a peristaltic pump and suitable chemical-resistant tubing;

(f) Use dedicated pumps, tubing and drums, not used for any other purpose, to transfer liquid wastes;

(g) Clean up any spills with cloths, paper towels or absorbent;

(h) Triple rinse contaminated surfaces with a solvent such as kerosene; and

(i) Treat all absorbents and solvent from triple rinsing, disposable protective clothing and plastic sheeting as contaminated.

8.4 Storage

185. Storing mercury wastes is similar in many ways to storing other hazardous wastes. Following local, state, and country regulations for proper containerization, containment, packing, labelling, inspection, and monitoring of wastes during storage will generally be appropriate for mercury wastes as well. Table 8-3 summarizes storage requirements for mercury wastes.

Table 8-3 Mercury waste storage requirements (adapted from Basel General ESM of POP Wastes and Philippine Mercury Management Chemical Control Order No. 38)

Aspect	Requirements
General	▪ Storage sites inside multi-purpose buildings should be in a locked dedicated room or partition that is not in an area of high use; ▪ Outdoor dedicated storage buildings or containers should be stored inside a lockable fenced enclosure; ▪ Separate storage areas, rooms or buildings should be used for each type of waste, unless specific approval has been given for joint storage; ▪ Wastes should not be stored on or near "sensitive sites" (e.g. hospitals or other medical care facilities, schools, residences, food processing facilities, animal feed storage or processing facilities, agricultural operations, or facilities located near or within sensitive environmental sites); ▪ Storage rooms, buildings and containers should be located and maintained in conditions that will minimize volatilization; ▪ Ventilating a site with carbon filtration of exhaust gases is considered when exposure to vapours for those who work in the site and those living and working in the vicinity of the site is a concern; ▪ Sealing and venting a site so that only well-filtered exhaust gases are released to outside air is considered when environmental concerns are paramount; ▪ Dedicated buildings or containers should be in good condition and made of hard plastic or metal, not wood, fiberboard, drywall, plaster or insulation; ▪ The roof of dedicated buildings or containers and surrounding land should be sloped so as to provide drainage away from the site; ▪ The floors of storage sites inside buildings should be concrete or durable (e.g., 6 mm) plastic sheeting. Concrete should be coated with a durable epoxy; ▪ The storage area should be marked or delineated clearly by fencing, posts, or walls in order to limit access to it; ▪ A recording system on the condition of the storage area should be established, details of which shall include the observations, name of inspector, date inspected, etc; ▪ The storage area should have adequate roof and walls to prevent rain water from reaching the mercury and mercury-containing material; ▪ The storage area should be free of cracks or openings of any kind in the containment floor or walls; ▪ Floors of the storage area should be constructed of impervious material such as concrete or steel, and if the mercury is in liquid form, should provide secondary containment; ▪ Visible warning signs and notices must be placed in conspicuous areas in the premises; ▪ Drainage facilities should be installed in premises where mercury and related compounds are used and handled to contain possible spillage or releases; ▪ The outside of the storage site should be labelled as a waste storage site; and ▪ The site should be subjected to routine inspection for leaks, degradation of container materials, vandalism, integrity of fire alarms and fire suppression systems and general status

Aspect	Requirements
	of the site.
Waste Management	▪ A written plan for management of the storage area with: ▪ Statement that movement of wastes should be minimized to avoid risk to employees, spill, and injury; and ▪ Printable documentation of each waste container in the storage including: waste material, container type and condition, initial storage date, monitoring completed, and any other pertinent information. ▪ Each container should be have a visible and durable label with the following information: ▪ Chemical name of the material; ▪ Chemical composition/formula; ▪ Initial storage date; and ▪ Warning statement; e.g., “Contains a Toxic Material”. ▪ Liquid wastes should be placed in containment trays or a curbed, leak-proof area. The liquid containment volume should be at least 125% of the liquid waste volume, taking into account the space taken up by stored items in the containment area; ▪ Contaminated solids should be stored in sealed containers such as barrels or pails, steel waste containers or in specially constructed trays or containers; ▪ Proper loading or unloading of containers should be observed; ▪ Segregation, adequate ventilation and ideal condition for storage of the chemical should be maintained in the area; ▪ A copy of the Material Safety Data Sheet should be available in the area; and ▪ Only trained personnel should be handling containers in storage as well as in the transport of such substances or mixtures.
Emergency Equipment	▪ Emergency showers and eyewash units with adequate water supply should be available; ▪ Storage sites should have a fire alarm system; and ▪ Storage sites inside buildings should have a fire suppression system preferably a non-water system. If the fire suppressant is water, then the floor of the storage room should be curbed and the floor drainage system should not lead to the sewer or storm-sewer or directly to surface water but should have its own collection system, such as a sump.
Security	▪ Access to mercury and its compounds should be restricted to those with adequate training for such purpose including recognition, mercury-specific hazards and handling; ▪ Adequate security siting and access to the area should be ensured; and ▪ A workable emergency plan must be in place and implemented immediately in case of accidental spillage and other emergencies.

8.5 Transportation

186. Transporting mercury wastes within the country, it was generated follows the same regulations associated with transporting hazardous wastes. In the event of transporting mercury waste between countries, in addition to the requirements of the local country, generators and recipients must also follow Basel Convention regulations (more detailed guidance is provided in The Manual for the Implementation of the Basel Convention (SBC 1995b)).

9.0 Treatment of Mercury Waste and Recovery of Mercury

9.1 Introduction

187. Mercury-containing products and industrial uses of mercury tend to be phased out in many countries, particularly developed countries. On the other words, a number of used mercury-containing products tend to be increased, and mercury for industrial uses is no longer uses. Mercury used in mercury-containing products and industrial processes should be treated on the environmentally sound management (ESM) to fully avoid the adverse effects to human health and the environment, because mercury used in mercury-containing products and industrial process would be released into the environment if it is on the environmentally unsound management. Compared to other waste treatments, such as E-waste, used cars, etc, in some countries where a legal-binding ESM exists, mercury waste management does not attract private sectors to treat mercury waste because of a small amount of waste and the decreasing tendency of demand of mercury uses.

188. A legal-binding ESM, ESM-framework subsidised by government and/or ESM implemented by internationally technical cooperation are important to promote and introduce recycling and treatment of mercury waste. It is recommended to coordinate ESM with other ESM of other hazardous wastes taking into consideration an integrated hazardous waste management. In addition, a transboundary movement of mercury waste under the Basel Convention would be the other option. Due to the tight profit business of mercury waste and costly recycling and treatment, a regional approach of recycling and treatment of mercury waste might be better.

9.2 Mercury Recovering Process – Solid Type of Mercury Waste

9.2.1 Introduction

189. Mercury recovering process generally composes of 3 processes: 1) Pretreatment; 2) Roasting process; and 3) Purification, shown in Fig. 9-1. Each process is summarized in the following sections. In order to protect any mercury emission from mercury recovering process, a facility should be a closed-system. Throughout entire process, a negative vacuum is maintained in the system to prevent leakage of mercury vapour into the processing area. The small amount of exhausted air that is used in the process passes through a series of particulate filters and a carbon bed which absorbs the mercury prior to exhausting to the environment. Exposure level of mercury vapour to workers is 25 $\mu g \cdot Hg/m^3$ for long-term exposure as the time weighted average (TWA) which means TWA concentration for a normal 8 hour-day and 40 hour-workweek, to which nearly all workers can be repeatedly exposed without adverse effect (WHO 1991).

9.2.2 Pretreatment

9.2.2.1 Fluorescent Lamps

9.2.2.1.1 Mechanical Crushing

190. Fig. 9-2 shows the recovering flow of mercury from fluorescent lamps by mechanical crushing at pretreatment. Used/obsolete mercury-containing lamps are processed in a machine which crushes and separates the lamps into three categories: glass, end-caps and a mercury/phosphor powder mixture. This is accomplished by injecting the lamps into a sealed crushing and sieving chamber. Upon completion, the chamber automatically removes the end products to eliminate the possibility of cross contamination. End-caps and glass are removed and sent for reuse in manufacturing. Mercury-phosphor powder is further processed to separate the mercury from the phosphor (Nomura Kohsan Co. Ltd. 2007).

9.2.2.1.2 Air Separation

191. Aluminium end caps of fluorescent lamps (straight, circular and compact tubes) are cut by hydrogen burners (Fig. 9-3). Air blowing flows into the cut fluorescent lamps from the bottom to remove mercury-phosphor powder. Mercury-phosphor powder is collected at a precipitator collects, grass parts are crushed and washed acidly, and mercury-phosphor powder adsorbed on glass is completely removed. In addition, end-caps are crushed and magnetically separated to aluminium, iron and plastics for recycling (Kobelco Eco-Solutions Co. Ltd. 2001; Ogaki 2004).

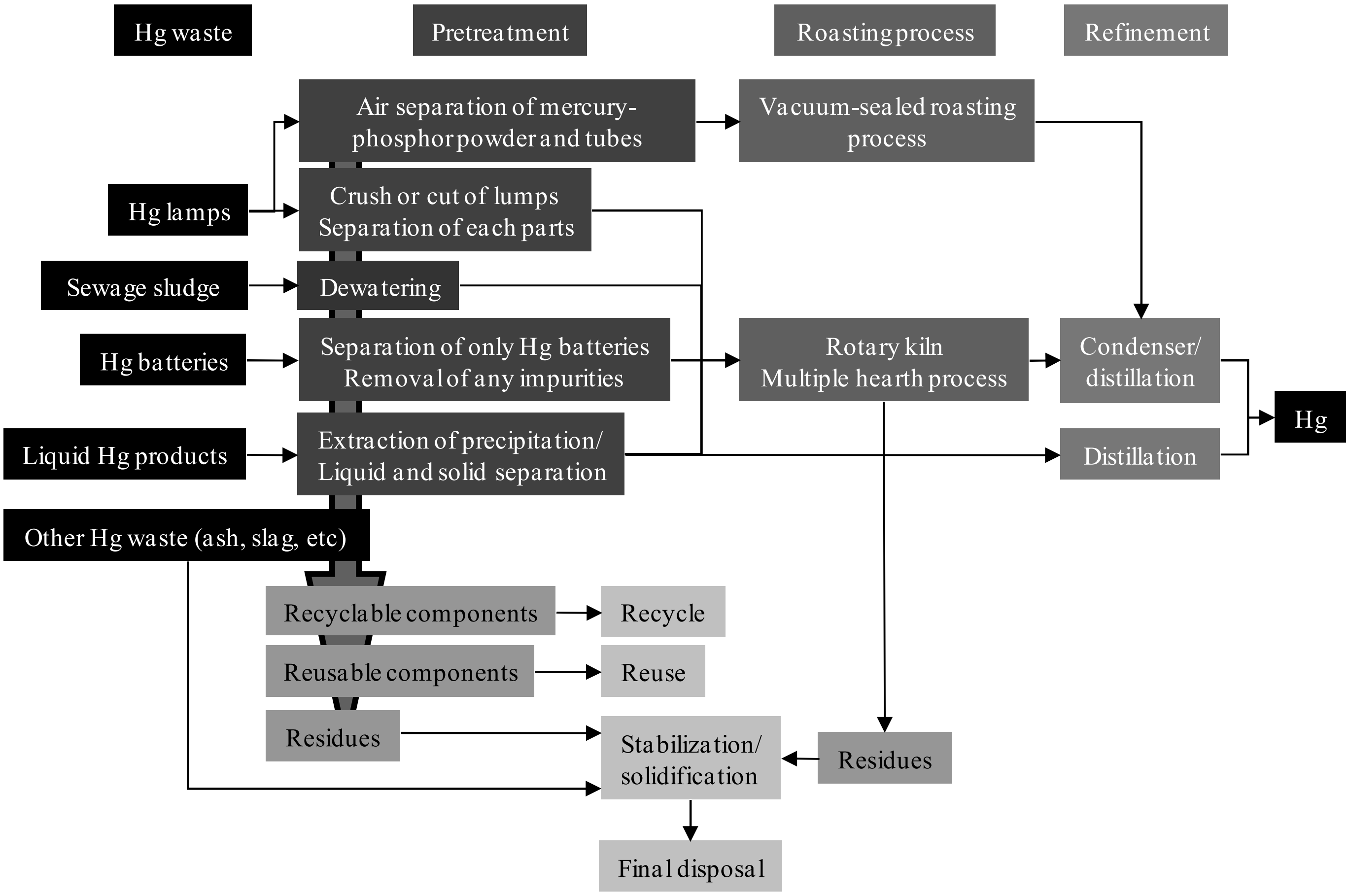

Fig. 9-1 Flow of mercury waste treatment (Nomura Kohsan Co. Ltd. 2007)

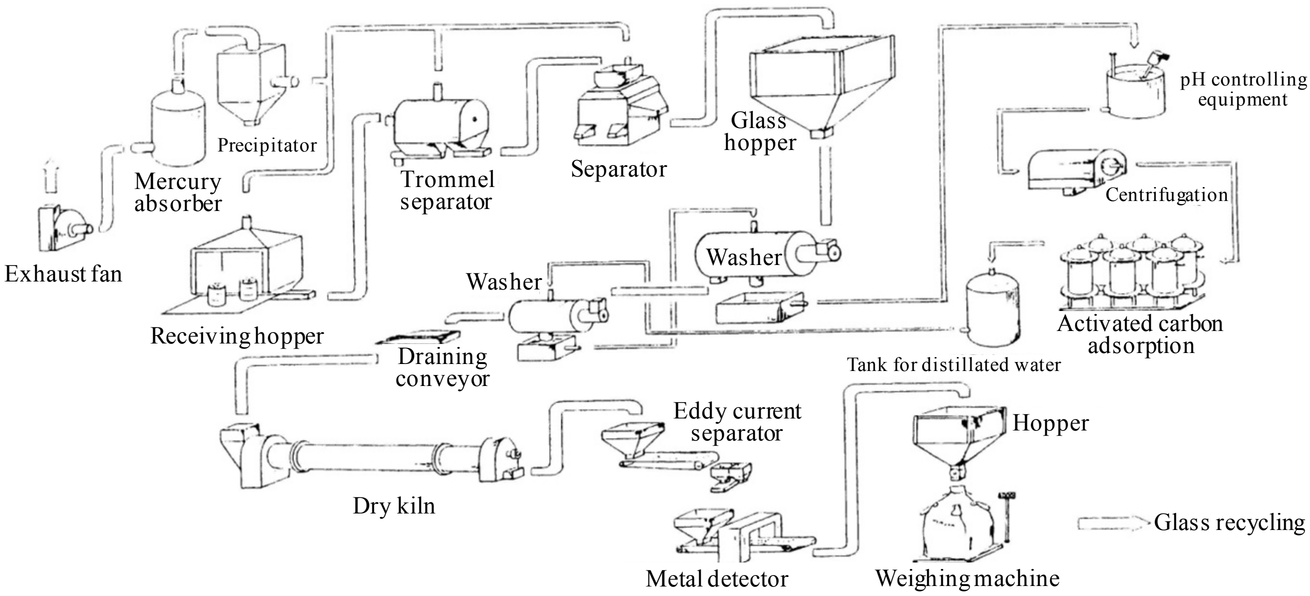

Fig. 9-2 Recovering flow of mercury from fluorescent lamps – Mechanical Crushing (Nomura Kohsan Co. Ltd. 2007)

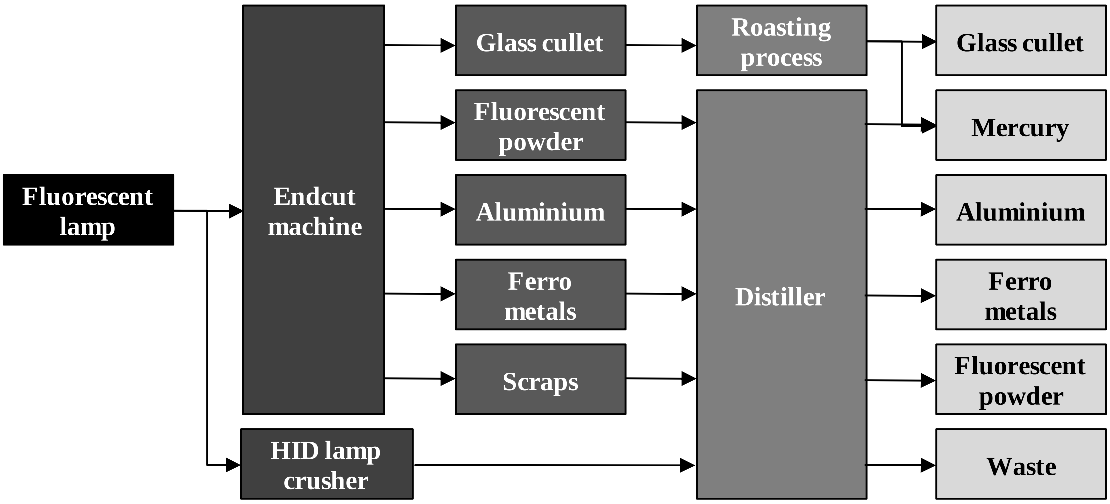

Fig. 9-3 Recovering flow of mercury from fluorescent lamps – Air separation (Kobelco Eco-Solutions Co. Ltd. 2001)

9.2.2.2 Mercury Batteries

192. In order to recycle mercury in mercury batteries, mercury batteries should be separately collected or segregated before a recycling treatment. However, mercury batteries are easily mixed with other types of batteries during a battery collection scheme. The reason is that most cases of a collection scheme for mercury batteries are as a battery waste mixed with other types of batteries, a hazardous waste mixed with various hazardous wastes, a non-combustible waste mixed with other wastes, or a municipal solid waste. It is important to remove any impurities mixed with and adsorbed onto mercury batteries. In addition, mechanical screening of size of mercury batteries is necessary for an effective roasting process. The process to recover mercury from mercury batteries is same as that of fluorescent lamps, except pretreatment (Nomura Kohsan Co. Ltd. 2007).

9.2.2.3 Sewage Sludge

193. Sewage sludge is high water content (more than 95%) and needs to be dewatered before any thermal treatments until it is about 20 to 35 percent solids. After dewatering, sewage sludge is further preceded to roasting process (Fig. 9-4) (Nomura Kohsan Co. Ltd. 2007; US EPA 1997).

9.2.2.4 Liquid Mercury-containing Products

194. Liquid mercury (elemental mercury)-containing products, such as thermometers, barometers, etc, should be collected without any breakage. Otherwise, it is impossible that liquid-mercury-containing products are on ESM. After collection of liquid mercury-containing products, liquid mercury inside of the products is extracted, and extracted liquid mercury directly goes to distillation for purification under negative air pressure.

9.2.3 Roasting Process

9.2.3.1 Introduction

195. The pretreated mercury waste, such as mercury/phosphor powder, cleaned mercury-batteries, dewatered sewage sludge, screened soil, etc. can be dealt with by roasting/retorting treatments, such as rotary kiln and multiple hearth process equipped with a mercury vapour collection technology. There are 4 important item on roasting process (WHO 1999):

- Use of an automatic loading device for bags and containers of mercury waste, rather than manual loading, would protect the safety of workers;
- The combustion efficiency should be checked. It should be at least 97% during incineration of mercury waste;

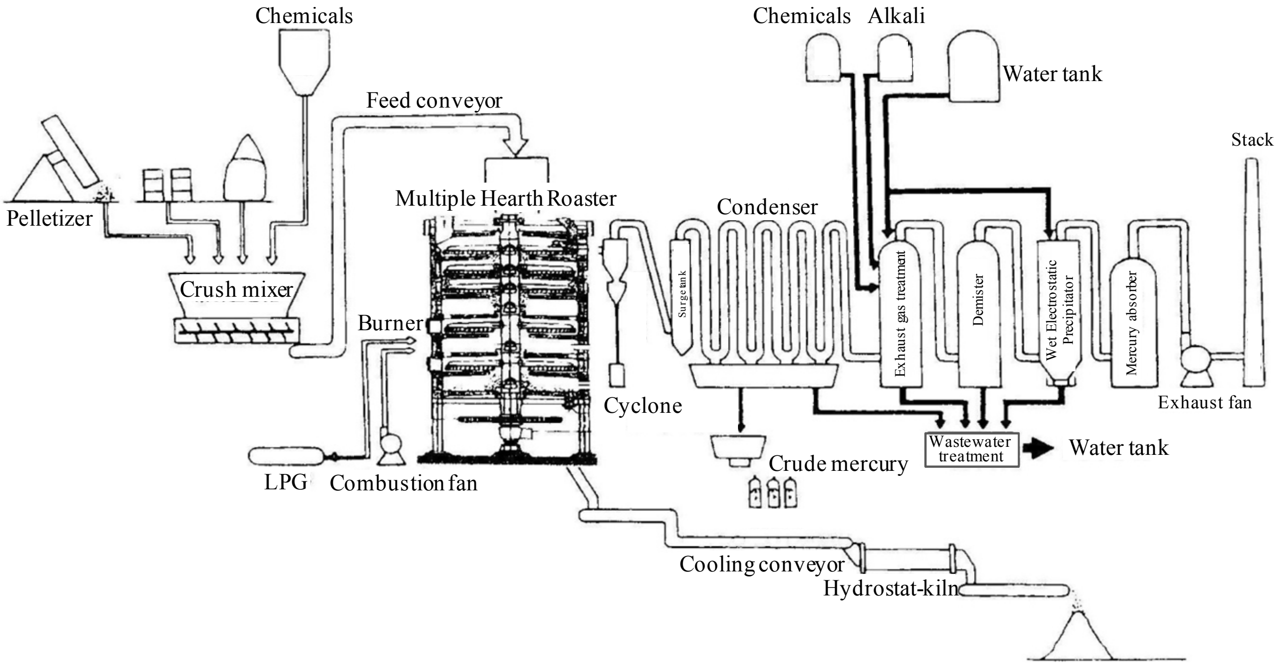

Fig. 9-4 Mercury recovering process from sewage sludge (Nomura Kohsan Co. Ltd. 2007)

- Mercury waste should be introduced into the furnace only when the normal conditions of process have been established – never during start-up or shutdown of the combustion process; and
- The process should be designed to prevent contamination of ashes or wastewater by mercury waste.

9.2.3.2 Vacuum-sealed Roasting Technology

196. A vacuum-sealed thermal process consists of a retort (electric furnace), water-cooled condenser, vacuum pump and activated carbon filters. Mercury-phosphor powder is heated under decompression, and only mercury is vaporized. And then, mercury is re-condensed and recovered as elemental mercury (Muroya 2001).

9.2.3.3 Rotary Kiln

197. A rotary kiln furnace incinerates combustible the pretreated mercury waste as well as industrial wastes, particularly wastes containing a high percentage of plastic wastes and can reduce volume of wastes and decompose most of hazardous materials into harmless except heavy metals. Mercury waste is fed into the inclined rotary kiln, and all mercury waste passes through the kiln with rotary motions (kiln action), wastes except heavy metal are thermally decomposed by heat radiation (600-800°C) from a re-combustion chamber, and residues are burned at the rear end of the kiln and by the after-kiln. During the processing, mercury in mercury waste becomes mercury vapour during heat radiation processing at 600-800°C. A vacuum carries the vapour to a cooling area, where the mercury is condensed to a liquid state. The mercury then passes through several other separator features prior to being decanted at the removal (Japan Society of Industrial Machinery Manufacturers 2001; Nomura Kohsan Co. Ltd. 2007). For further information, see the Basel Convention Technical Guidelines on Incineration on Land (SBC 1997).

9.2.3.4 Multiple Hearth Roaster

198. Multiple hearth roasters are a vertical cylindrical refractory lined steel shell furnace. It contains from 6 to 12 horizontal hearths and a rotating centre shaft with rabble arms. Mercury waste enters the top hearth and flows downward while combustion air flows from the bottom to the top. Mercury waste is burned in the centre hearths and releases heat and combustion gas. The upper hearths comprise the drying zone in which mercury in mercury waste and some organic compounds are evaporated. The middle hearths comprise the combustion zone, in which temperature is typically 800 to 850°C. A series of burners are installed in the combustion zone to maintain the combustion temperature. The lower hearths form the cooling zone. In this zone, the ash is cooled as its heat is transferred to the incoming combustion air. The temperature in this zone is typically from 400 to 460°C. In the drying zone, some volatiles including mercury vapour are released from the mercury waste and exit the furnace without exposure to the full combustion temperatures (Dangtran 2000; Nomura Kohsan Co. Ltd. 2007; SBC 1997).

9.2.4 Recovery of Mercury – Purification

199. Mercury vapour emitted from mercury waste during thermal treatment directly goes to condenser (s) and condensed by cold water (10°C or less are preferred) of heat exchanger supplied from a chiller. Roasting mercury waste involves introducing air to the hot waste which oxidizes mercury compounds and helps transport them to a condenser. Collected mercury is subsequently purified by successive distillation for resale or reuse (US EPA 2000). Purified mercury can be traded as a commodity and utilised for mercury-containing products.

9.2.5 Other Processes

9.2.5.1 Application of Thermal Processes

200. It is possible to use other types of incineration to treat mercury waste and collect mercury. General incinerators are available when a condenser to condense mercury in mercury vapour is equipped with other necessary equipment because of mercury characteristics in incineration (see the subsection 2.3.3 Thermal Process of Natural Mercury Impurities in Raw Materials and Mercury Waste). This means that mercury in any wastes destined for incineration is possible to be recovered if an incinerator is equipped with a condenser for mercury recovering.

201. On the other hand, almost all incinerators are equipped with exhaust gas treatment devices not to release NO_x, SO_2 and particulate matter (PM) as well as mercury vapour and particulate-bound mercury as a co-benefit air pollution technology. The main technology is powdered activated carbon (PAC) injection which is one of the advanced technologies for mercury removal at incinerators or coal fired power plant. Mercury adsorbed on activated carbons can be stabilised or solidified as a final treatment (see the subsection 9.4 Stabilization/Solidification: Encapsulation Technologies).

9.2.5.2 Chemical Leaching/Acid Leaching

202. Chemical leaching is an aqueous process that depends on the ability of a leaching solution to solubilise mercury and remove it from the waste matrix. The solubilised mercury ideally partitions to the liquid phase, which is filtered off for further treatment (e.g., precipitation, ion exchange, carbon adsorption). A chemical leaching process brings mercury-contaminated materials into contact with a leaching solution that generates an ionic soluble form of mercury. This process can remove inorganic forms of mercury from inorganic waste matrices, but it is less effective for removing nonreactive elemental mercury unless the leaching formula is capable of ionizing mercury to an extractable form. The mercury-containing leachant is typically removed from the contaminated materials for further treatment (e.g., precipitation) (Science Applications International Corporation 1998).

203. Acid leaching is used most commonly to remove mercury from inorganic media. For solid sand sludges, aqueous slurry must be prepared to ensure thorough contact of the acid with the wastes. Acid leaching typically uses strong acids such as sulphuric, hydrochloric, or hydrobromic. The mercury compounds most suited for acid leaching are inorganic mercury compounds such as oxides, hydroxides, halides, and sulphides. The removal of mercury from aqueous media may be performed using one or more acid washes. Acid leaching renders mercury soluble so that it partitions to the liquid phase. The wastewater generated is then separated and sent for further treatment, which is commonly sulphide precipitation (Science Applications International Corporation 1998).

9.2.5.3 Further Options

204. The environmentally sound technologies for solid type of mercury waste described in this section are one of the instances which are currently available. Other options would be available. However, it is noted that mercury should not be released into the environment (at least under a national standard level) whatever technologies of mercury waste are used.

9.3 Mercury Recovering Process – Mercury in Wastewater and Other Liquid Mercury Waste or Air Gas

9.3.1 Introduction

205. Mercury exists in wastewater due to accidental or intentional discharging of liquid mercury from thermometers, dental amalgams, or other industrial processes using mercury or mercury compounds as a catalyst (see the subsection 2.3.2 Wastewater Treatment Process). Mercury in wastewater should not be released into the aquatic environment where mercury is methylated into methylmercury which is bioaccumulated and biomagnified in the food chain and the causal toxic substance of Minamata disease. This section briefly descries the mercury recovering processes from wastewater and other liquid mercury waste.

9.3.2 Chemical Oxidation

206. Chemical oxidation of elemental mercury and organomercury compounds is to destroy the organics, to convert mercury to a soluble form and to form mercury halide compounds. It is effective in treating mercury-containing waste. Chemical oxidation processes are useful for aqueous wastes containing mercury, slurry and tailings. Oxidizing reagents used in these processes include sodium hypochlorite, ozone, hydrogen peroxide, chlorine dioxide, free chlorine (gas), and proprietary reagents. Chemical oxidation may be conducted as a continuous or a batch process in mixing tanks or plug flow reactors. Mercury halide compounds formed in the oxidation process are separated from the waste matrix and treated and sent for subsequent treatment, such as acid leaching and precipitation (Science Applications International Corporation 1998).

9.3.3 Chemical Precipitation

207. Precipitation reactions are typically the final step in the mercury treatment process after all organic content has been destroyed. Precipitation reagents include lie ($Ca(OH)_2$), caustic (NaOH), sodium sulphide (Na_2S), and, to a lesser extent, soda ash (Na_2CO_3), phosphate, and ferrous sulphide (FeS). Sulphide is preferred because it forms the most stable complex. It is important, however, that alkali constituents, such as sodium, do not precipitate in the mercury-sulphide matrix because they contaminate the matrix, which makes it more susceptible to the effects of acid-oxidative leaching. Sulphide precipitation is preferable to hydroxide precipitation using hydrazine because mercury hydroxide is susceptible to matrix dissolution over a wide range of pH under oxidizing conditions (Science Applications International Corporation 1998).

9.3.4 Adsorption Treatment

9.3.4.1 Ion Exchange Resin

208. Ion exchange resins have proven to be useful in removing mercury from aqueous streams, particularly at concentrations on the order of 1 to 10 parts per billion. Ion exchange applications usually treat mercuric salts, such as mercuric chlorides, found in wastewaters. This process involves suspending a medium, either a synthetic resin or mineral, into a solution where suspended metal ions are exchanged onto the medium. The anion exchange resin can be regenerated with strong acid solutions, but this is difficult since the mercury salts are not highly ionized and are not readily cleaned from the resin. Thus the resin would have to be treated or disposed. In addition, organic mercury compounds do not ionize, so they are not easily removed by using conventional ion exchange. If a selective resin is used, the adsorption process is usually irreversible and the resin must be disposed in a hazardous waste unit.

9.3.4.2 Chelating Resin

209. Chelating resin is an ion-exchange resin that has been developed as a functional polymer, which selectively catches ions from solution including various metal ions and separates them. It is made of a polymer base of three-dimensional mesh construction, with a functional group that chelate-combines metal ions. As the material of the polymer base, polystyrene is most common, followed by phenolic plastic and epoxy resin. Chelating resins are used to treat plating wastewater to remove mercury and other heavy metals remaining after neutralization and coagulating sedimentation or to collect metal ions by adsorption from wastewater whose metal-ion concentration is relatively low. Chelating resin of mercury adsorption type can effectively catch mercury in wastewater (Japan Small and Medium Enterprise Cooperation 2001).

9.3.4.3 Activated Carbon

210. Activated carbon is a carbonic material having many fine openings connected with each other. It can typically be of a wooden base (coconut shells and sawdust), oil base or coal base. It can be classified, based on its shape, into powdery activated carbon and granular activated carbon. Many products are commercially available, offering the features of the individual materials. Activated carbon adsorb mercury and other heavy metals as well as organic substances (Japan Small and Medium Enterprise Cooperation 2001).

9.3.5 Amalgamation

211. US EPA specifies amalgamation as the treatment method for radioactively contaminated elemental mercury. US EPA defines as amalgamation of liquid, elemental mercury contaminated with radioactive materials utilizing inorganic agents such as copper, zinc, nickel, gold, and sulphur that result in a nonliquid, semisolid amalgam and thereby reducing potential emissions of elemental mercury vapours to the air. Amalgamation process as the first treatment step is operated at ambient temperature and pressure in a fully enclosed, ventilated hood. Amalgamation stabilises elemental mercury that waste may contain by the amalgamating inorganic agents. The second treatment step is a chemical stabilization process using a proprietary reagent to break mercury complexes and allow for removal of the mercury from the waste slurry as a stable precipitant. Accordingly, the elemental mercury requires land disposal after treatment using amalgamation, which is the specified technology applicable to radioactive elemental mercury (US Department of Energy 1999).

9.4 Stabilization/Solidification: Encapsulation Technologies

9.4.1 Introduction

212. Mercury stabilization and solidification is one of the conventional treatments of mercury; however, these methods are not one-hundred percent effective at the long-term stabilization of mercury. The definitions of stabilization and solidification are:

- Stabilization refers to techniques that chemically reduce the hazard potential of a waste by converting the contaminants into less soluble, mobile, or toxic forms. The physical nature and handling characteristics of the waste are not necessarily changed by stabilization (US EPA 1999); and
- Solidification refers to techniques that encapsulate the waste, forming a solid material, and does not necessarily involve a chemical interaction between the contaminants and the solidifying additives. The product of solidification, often known as the waste form, may be a monolithic block, a clay-like material, a granular particulate, or some other physical form commonly considered "solid" (US EPA 1999).

213. Stabilization and solidification are usually used for various mercury wastes, such as sewage sludge, incinerator ash, liquids adsorbed of mercury, soils contaminated with mercury etc. Mercury from these wastes is not easily accessible to leaching agents or thermal desorption but is leachable when the stabilized mercury waste is landfilled and kept at landfill site for a long time as well as other metals and organic compounds can leach (i.e., dissolve and move from the stabilized mercury waste through liquids in the landfill), migrate into ground water or nearby surface water and vaporise into the atmosphere under many plausible management conditions. Therefore, a suitable technology is needed to stabilize mercury, and research on these technologies should remain a priority to participating countries.

9.4.2 Grout/Portland Cement Stabilization

214. Cementitious stabilization/solidification (S/S) is one of the most widely used techniques for the treatment and ultimate disposal of hazardous waste and low-level radioactive waste. Cementitious materials are the predominant materials of choice because of their low associated processing costs, compatibility with a wide variety of disposal scenarios, and ability to meet stringent processing and performance requirements. Cementitious materials include cement, ground granulated blast furnace slag, fly ash, lime, and silica fume. Various clays and additives are used to help immobilize contaminants or otherwise enhance the waste form properties. Treatment of the waste to precipitate soluble mercury as the sulphide may be desirable prior to S/S. Amalgamation is the suggested stabilization technique. It is desirable to remove and recycle (preferable) or amalgamate metallic mercury from contaminated waste. In general, high temperature stabilization techniques (e.g., vitrification, thermoplastic encapsulation) must remove mercury prior to stabilization or risk contaminating the offgas with mercury (Center for Remediation Technology and Tools-US EPA 1996).

9.4.3 Sulphur Polymer Stabilization/Solidification (SPSS)

215. The Sulphur Polymer Stabilization/Solidification (SPSS) is considered to be an encapsulating process for an immobilization of hazardous and radioactive wastes and one of the major stabilization/solidification processes. In SPSS, elemental mercury or mercury-containing waste is reacted with sulphur polymer cement (SPC) (a thermoplastic material composed of 95 wt% elemental sulphur) to form a stable mercury sulphide compound with significantly reduced leachability and, for elemental mercury, lower vapour pressure. The reacted mixture is then melted, mixed, and cooled to form a monolithic solid waste form in which the stabilized mercury sulphide particles are microencapsulated within a sulphur polymer matrix (Adams 2004). SPSS mercury treatment is conducted in two steps (Initiatives Online 1999):

- Stabilization: In the first step, mercury and powdered SPC react and form mercuric sulphide. The reaction vessel is placed under an inert gas atmosphere to prevent the formation of mercuric oxide, a water soluble and highly leachable compound. The reaction vessel is heated to about 40°C to accelerate the reaction, and the materials are mixed until the mercury is completely reacted with the sulphur; and
- Solidification: When the mercury is chemically stabilized, additional SPC is added, and the mixture is heated to 130°C until a homogeneous molten mixture is formed. It is then poured into a suitable mold, where it cools to form a solid waste form.

10.0 Long Term Storage and Disposal of Mercury Waste

10.1 Introduction

216. Due to the decrease of demand of mercury use, it is expected that most part of mercury are to destine for a permanent storage site where mercury itself are stored permanently or a final disposal at landfill where mercury waste is disposed of. Regardless the methodology to store mercury for a long term, it is important to prevent environmental damage by spilling mercury from the storage areas.

217. 24th session of UNEP Governing Council recognised that the one of the priorities was to find environmentally sound storage solutions for mercury, because technology for long-term storage of mercury is currently limited despite the fact that mercury stockpiles are expected to be increased. Therefore, long-term storage of mercury is the core technological item for the current global mercury situation and the future strategy of mercury.

10.2 Long Term Storage

10.2.1 Overpacking the Mercury-Filled Flasks into Steel Barrels (the instance in USA)

218. Mercury is injected into carbon steel flasks (Width: 13 cm; Height: 33 cm; Capacity: 34 kg)). Flasks are produced by cold cupping and drawing to produce a seamless shell, the open end of which is necked by hot forming. Other materials, such as stainless steel, could be used to fabricate the containers, but would be considerably more expensive. Still, stainless steel would not rush and would not need to be pained and therefore, may be a lower maintenance material for long-term storage of mercury (Defense Logistics Agency 2000).

219. Mercury is poured down the loading funnel into a main storage tank. From there, mercury is pumped up into a head tank. An overflow line is provided to return suspended solids back to the storage tank. By opening a series of valves, mercury can flow by gravity from the head tank into the metering tank and then into a storage flaks. The flask can be filled on a scale to ensure that the proper quantity of mercury is placed in each flask. Lot integrity can be maintained by processing each lot as a batch, and cleaning the tanks and process lines between lots (Defense Logistics Agency 2000).

220. Carbon steel drums (e.g. thirty-gallon with removable head constructed from sixteen-gauge steel) are used to place the mercury-filled flasks. The inside of the drums is separated by cardboard dividers to separately place each flask and provide cushioning. A pre-cut absorbent mat would be used as cushioning material on the bottom of the drums. The flasks must be packed, secured and cushioned to prevent damage by controlling the flask’s movement within the drum and to provide absorption for accidental mercury spillage. The drums are lined with an epoxy-phenolic coating. Each drum lid has sponge rubber O-ring (gasket) around its edge, which provides a seal between the drum and its lid. A steel locking ring with bolt compresses the gasket to maintain the steel. Each lid has a bung-hole with a leak-proof lid, which permit sampling of the air inside the drum. The drums should be labelled to indicate the contents, packed date, responsible persons (organization), etc. The drums are placed on pallets which is placed a drip pan. The pallets provide cushioning designed to hold the drums without causing friction among the drums (Defense Logistics Agency 2001).

221. During the overpacking process, the following spill-prevention measures should be taken (Defense Logistics Agency 2001):

- Pallet transfer containment pans are used to prevent or minimize contamination of floors;
- Secondary containment pans for the process lines are used;
- Containment booms are available for use in the unlikely event of a large spill; and
- Mercury monitors are present to detect any mercury vapours.

222. The palleted drums are located to warehouse with concrete floor slab separated by asphaltic expansion joints with solid block wall construction, ceiling air vents, and multiple points of entry and exit through secure doors. Each warehouse is equipped with a dry-pipe (water supply) fire suppression system as well as emergency response equipment. There are no floor drains through which leaked or spilled materials may escape to the environment. The floors have been sealed with a leak-proof polyurea elastomeric surfacing system, which will not allow penetration by mercury. This coating is a high tensile strength, seamless, and flexible system which forms an impervious water-proof surface. Prior to the installation of the coating, the floors were prepared by sandblasting to remove any loose concrete, and cracks and expansion joints were filled with silicon (Defense Logistics Agency 2001).

223. For long-term storage of mercury, it is important to build warehouses for mercury storage at which there is almost no effects of natural disasters, e.g. earthquake, typhoon, hurricane, flood, etc, or strong ground against natural disasters. In addition, warehouse for mercury storage should be built far away from residential areas against

accidental mercury spillage or mercury spillage by natural disasters. In order for emergency incidents, an emergency manual for mercury spillage from warehouse for mercury storage should be prepared.

10.2.2 European Mercury Storage Solution – Stocks of Mercury at Almadén (the instance in Europe)

224. There is a large amount of surplus mercury in Europe (almost half (48%) of the chlorine capacity in Europe currently depends on a process that utilises mercury). In order to stock surplus mercury, the European Chlorine Industry Association (Euro Chlor) signed an agreement with the state-owned Miñas de Almadén of Spain, one of the world's most important mercury producers and marketers. This agreement stipulates that Miñas de Almadén accepts all surplus mercury from western European chlorine producers, under the condition that it displaces, ton for ton, mercury that would otherwise have been newly mined and smelted to satisfy legitimate uses (UNEP 2002). 1,500 tonnes of pure mercury from decommissioned plants has been returned to the Spanish mining and trading company Minas de Almadén, which has used it to replace metal that would otherwise be mined. The method of mercury storage at Miñas de Almadén is the steel flasks with lacquered interiors and put on suitably strapped wooden pallets (Euro Chlor 2005).

225. A strategy being prepared by Euro Chlor is a development and enforcement of a legally-binding sound management of mercury: 1) no export ban earlier than 2011; 2) storage in underground salt mines of excess mercury would be permanent; 3) certain exemptions from existing directives to be permitted (e.g. to allow mercury to be stored as a liquid); and 4) legal certainty that the transport of mercury between Member States will be authorised.

10.3 Landfill

226. There are 4 mercury waste streams which might end at a specially engineered landfill:

1) Mercury waste under uncontrolled waste mechanism;
2) Mercury waste mixed with other solid wastes;
3) Stabilized/solidified mercury waste; or
4) Mercury contained in residue/ash of incineration.

227. A specially engineered landfill should be used when disposing mercury containing waste to the landfill site. In principle, and for a defined time period, a landfill site can be engineered to be environmentally safe subject to appropriate site with proper precautions and efficient management. Preparation, management and control of the landfill must be of the highest standard to minimize the risks to human health and the environment. Such preparation, management and control procedures should apply equally to the process of site selection, design and construction, operation and monitoring, closure and post closure care (SBC 1995a).

228. For example, the landfill sites should be completely shut off from the outside natural world. The entire landfill is enclosed in watertight and reinforced concrete, and covered with the sort of equipment which prevents rainwater inflow such as a roof and a rainwater drainage system (Fig. 10-1). Any types of mercury waste or waste containing mercury should be placed at a specially engineered landfill (Ministry of the Environment 2007).

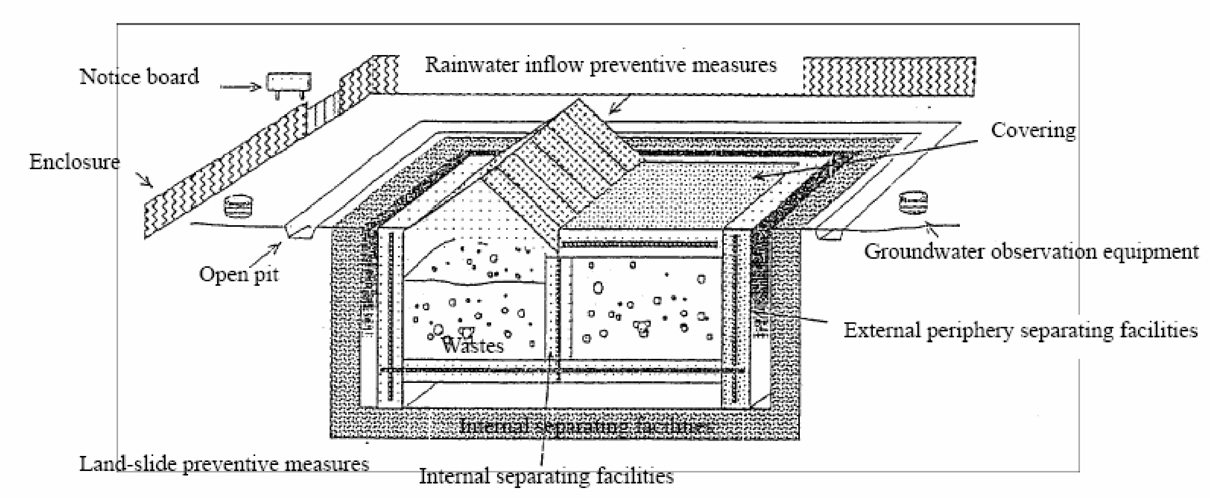

Fig. 10-1 Specially engineered landfill (Ministry of the Environment 2007)

229. Unless the waste meets a standard which regulates a safe level of mercury concentration to allow landfilling as a non-mercury waste, which is 0.005 mg·total mercury/mL by the Japanese standardized leaching test No. 13 (JLT-13) described at the subsection 4.3.1, by pretreatment, mercury waste should be disposed at the specially engineered landfill.

230. For further information about specially engineered landfills, refer the Basel Convention Technical Guidelines on Specially Engineered Landfill (D5) (SBC 1995a).

11.0 Remediation of Sites Contaminated with Mercury

11.1 Introduction

231. Sites contaminated with mercury are widespread around the world and are largely the result of industrial activities, primarily mining, chlorine production, and the manufacture of mercury-added products. And of those sites, the vast majority of contamination is the result of large- and artisanal small-scale mining (ASM) of gold using mercury that has largely ceased or has regulatory and engineering controls in developing countries, but that continues in the developing world at large sites and in the form of ASM. The result of both historic and current operation is sites with mercury-contaminated soils and large mine tailings, or sites with widely dispersed areas of contamination that has migrated via water courses and other elements. This section summarizes: (a) the overarching remediation efforts underway to address these sites (primarily mining sites), (b) both the established and newer remediation techniques available for cleanup, and (c) the emergency response actions appropriate when a new site is discovered.

11.2 Remediation Programmes

232. In the last decade, countries around the world have begun to put forth significant effort to better understand the nature and extent of the mercury problem and also have worked collaboratively to coordinate research and assistance efforts, especially between developed and developing countries. The amount and variety of mercury-added products in the USA and Europe has declined significantly, but there remain many activities in developing countries that continue to consume and emit mercury. As a result, there are contaminated sites requiring characterization and remediation that are from past activities worldwide, ongoing manufacturing, and especially coal-burning power plants and ASM.

233. While both developed and most developing countries have environmental standards governing ongoing activities using mercury and containment and cleanup of mercury-contaminated sites, many in developing countries go unenforced or unmonitored. Cleanup of mercury-contaminated sites in developed countries is mostly underway and there are many levels of federal and state programs dictating activities. Unfortunately, developing countries typically must rely on outside expertise and money to address their contaminated sites.

234. Worldwide collaboration on mercury issues has resulted in a number of programmes that focus primarily on pollution prevention and emissions reduction from the use of mercury, but some of the same programmes also have components that address remediation and cleanup of existing mercury-contaminated sites. Table 11-1 provides a summary of these programmes:

Table 11-1 Worldwide programmes for mercury-contaminated sites remediation

Programme	Remediation Component
The World Bank - Environmentally Sustainable ASM	4. The world bank has funded various projects one of which relates to remedial technologies and cleanup of sites: • The Urgent Environmental Investment Project - Azerbaijan is demonstrating mercury cleanup technologies and procedures by decontaminating one heavily polluted area and testing pilot-scale sludge treatment; developing a low-technology method for mercury recovery; transporting wastes; constructing a safe, new landfill; designing and implementing a monitoring program for mercury releases, and conducting follow-up assessments
North American Regional Action Plan on Mercury	The Action Plan has many components limiting the use of mercury, and one goal concerning remediation of mercury-contaminated sites: • Encouraging development and use of effective mercury waste-stabilization and disposal techniques and methods

11.3 Remediation techniques

235. Remedial actions (cleanups) for mercury-contaminated sites are dependent on a variety of factors that define the site and the potential environmental and health impact. In selecting an initial group of treatment technologies for screening and then choosing one or a combination of techniques and technologies, factors that affect selection include:

Environmental Factors:

- The amount of mercury released during operations – is the contamination the result of ASM (if so, what type), large-scale mining, or manufacture of mercury-added products?;
- The number, size, and location of mercury hotspots (requiring remediation);
- For mining operations, the properties from which the mercury is mined including, soil characteristics, etc.;
- Methylation potential of the mercury;
- Leaching potential of mercury from the contaminated media (e.g., soils and sediments);
- Background mercury contamination - regional atmospheric mercury deposition not related to localized sources;
- Mercury mobility in aquatic system; and
- Local/State/Federal Cleanup Standards: Water, soils/sediment, air.

Receptor Factors:

- Bioavailability to aquatic biota, invertebrates, edible plants; and
- Mercury levels in receptors – human, animal and plants to indicate uptake and bioaccumulation.

236. Once these factors have been assessed, then a more complete analysis of the appropriate remedial techniques can commence. Depending on the severity, size, levels and type of mercury contamination, other contaminants present, and the receptors, it is likely that a remedial plan that utilizes several techniques may be developed that most efficiently and effectively reduces the toxicity, availability and amount of mercury contamination at the site. A summary of remediation technologies for mercury-contaminated sites is summarized in Table 11-2.

Table 11-2 Mercury contaminated sites – remediation techniques (Hinton 2001)

Remedial Alternative	Comments
Excavation and Treatment: Collect contaminated soil for centralized treatment; technically simple using conventional mechanized equipment; excavation can be complicated and more expensive based on site conditions including overlying structures, surround land features (lakes, creeks, etc.) and groundwater level.	
Physical Separation 1. Use sieving to remove rubble and coarse portions; 2. Water rinse to remove medium fractions (50 mm to >0.1 mm); 3. Use hydrocyclones, spiral and classifiers, and fluidized beds to remove fines (silts, clays or organics, etc.) (Hempel 1998); and 4. Dewater and isolate the remaining Mercury-enriched sludge or fine fraction using treatment methods such as thermal methods	▪ Well established; ▪ Effective at reducing the volume of contaminated soils; ▪ Generally does not require the use of other chemicals; ▪ Most effective for soils dominated by coarse materials (i.e. sand and gravel) with some (< 20%) fines; and ▪ Requires additional treatment of resulting mercury-containing sludge.
Thermal Treatment 1. Dry excavated soil at 100°C; 2. Transfer to a heating drum and maintain temperature of 600°C; 3. Heat exhaust gas in afterburner to 800-900°C and then collect the hot exhaust gas and cool to it 150°C; 4. Use filter to remove dust and air scrubber to remove SO_2; and 5. Recover mercury from the gas phase using a gas washing system (Hempel 1998), charcoal filter (Renner 1995), iodine impregnated scrubber or through condensation.	▪ Potential effective means for Mercury recovery from contaminated soil; and ▪ Organic contaminated soils are commonly treated using thermal processes.

Remedial Alternative	Comments
Hydrometallurgical Treatment 1. Apply leaching agents to excavated materials; 2. Capture leaching liquid including leaching agent and leached mercury; and 3. Chemically separate mercury from leaching agent.	▪ The two most promising hydrometallurgical techniques are electrokinetic or electroleaching and leaching methods; and ▪ Commonly applied leaching agents include halide compounds such as hypochlorite or hydrobromic acid, iodine in the form of potassium iodine, and a mixture of nitric acid and NaCl (Hempel 1998)
In-Situ Recovery: Treat contaminated soil in place; less established techniques and more uncertainty regarding the effectiveness of in-situ compared to ex-situ treatments due to subsurface heterogeneity; clean-up times tend to be longer than ex-situ treatments; may become more cost-effective than excavation and treatment methods for many mercury-contaminated sites because contaminated soil and groundwater remain in the subsurface.	
Soil Vapour Extraction 1. Cover ground surface with a tarpaulin or other cover system; 2. Ensure lateral airflow through the impacted area; and 3. Use a vacuum to force air through the unsaturated zone.	▪ Effectiveness is primarily dictated by contaminant volatility and availability to air channel; ▪ Soil heating can be costly over large areas; and ▪ Soil heating combined with soil vapour extraction may become an effective means of mercury removal in the vadose zone.

Permeable Reactive Walls
1. Install permeable reactive walls below the ground surface perpendicular to the flow of contaminated groundwater; and
2. Dissolved compounds react with wall constituents to precipitate contaminants into relatively benign or immobile compounds.
	▪ Employed at many organic and metal impacted sites
	▪ Walls are geochemically engineered to transform relatively benign and/or immobile form and ideally can operate passively for extended periods with little or no maintenance
	▪ Wall constituents include:
	  ▪ Zero-valent iron for various organic and inorganic contaminants; and
	  ▪ Proposed: hydroxyapatite, zeolites, hydrous ferric oxides and bone char phosphate.

In-situ Leaching and Extraction 1. Inject solubility-enhancing chemicals upgradient from the zone of contamination to enhance mercury solubility in groundwater; and 2. Remove contaminants using pump-and-treat systems.	▪ Reduces clean-up time; ▪ Improves recovery rate from groundwater; ▪ Generally limited to treatment of contaminants impacting groundwater in a dissolved form (HgCl-, HgS or as a non-aqueous phase liquid; ▪ Not well demonstrated; and ▪ Injection of leaching agents into the subsurface for enhanced contaminant mobility is often unacceptable.
Electro-Kinetic Separation 1. Transform metal into a soluble form with or without the injection of solutions; 2. Electric current mobilizes the solubilised metal towards an electrode; and 3. Collect accumulated metals at the electrode, typically through excavation.	▪ Heavy metals such as mercury migrate towards electrodes placed in the soil where they accumulate and can be removed at a lower cost than excavating the entire impacted area; ▪ Higher cost, longer time; and ▪ Effectiveness is highly dependent on soil type.
Interceptor Systems Install interceptor system such as trenches and drains	▪ Extremely simple and effective at recovering mercury as free product; ▪ Limited by topography and stratigraphy; and ▪ Mercury in residual saturation not addressed.

Remedial Alternative	Comments
Phytoremediation Plants assimilate and concentrate mercury from soils	▪ Promising, but unproven technology; ▪ Cost effective remediation of shallow soils over a fairly widespread area; and ▪ Limited access to vegetation by wildlife and time required for clean-up.
Passive Remediation-Wetlands Use wetlands for mercury immobilization	▪ Controversial as wetland-type environments are intrinsically amenable to the conversion of mercury to methylmercury; and ▪ Wetland can ultimately treat up to 1 million gallons of water daily.
Containment: Inhibit contaminants mobilization and minimize ecological and human exposure; cleanup of many contaminated sites is often not feasible due to financial or technical reason.	
Pump-and-Treat Install extraction wells below the water table within or slightly down-gradient from the zone of contamination.	▪ Frequently employed cost-effective alternative; ▪ Must operate in perpetuity to prevent off-site migration; ▪ Well placement and pumping rate chosen to ensure capture of contaminated groundwater and limit recovery of clean water; and ▪ Monitoring wells installed around the contaminant plume required to assess containment and hydrogeochemical conditions.
Impermeable Barriers, Surface Seals and Drains Install impermeable barrier, surface seas, or drains to prevent off-site migration of the contaminants	▪ Geo-technically engineered approaches; and ▪ Each system has limitations with respect to emplacement depth and uncertainty concerning permeability and barriers may surround the contaminated zone entirely remove the potential for groundwater flow through the source.
Stabilization and Solidification Mix impacted soil with additives to reduce mobility or leachability of contaminants	▪ Stabilization binds contaminants to the solid and is often accomplished by reduction in soil permeability; ▪ Solidification technique improve physical characteristics of materials for easier excavation and transport; ▪ Subsurface mixing is less established than aboveground techniques; and ▪ In-situ stabilization may become an effective solution for difficult to access contamination.
Sediment Capping Place subaqueous cap of clean and ideally isolating material over contaminated sediments	▪ Increased solubility and diffusability of methylmercury must be considered; and ▪ Site specific issues must be assessed prior to cap design including: qualities of the watercourse (bathymetry, currents, wave energies and seasonal variability, etc.); functions of the waterway (water supply, wastewater discharge, recreational use, etc.); and geoenvironmental properties (sediment, soil, and rock stratigraphy and individual attributes, hydrogeologic conditions, etc)

11.4 Emergency Response

237. Discovery of a mercury-contaminated site with immediate threat to human health or the environment occurs through the following observations:

- Visual observation of the site conditions or attendant contaminant sources;
- Visual observation of manufacturing or other operations known to use or emit a particularly dangerous contaminant;
- Observed adverse effects in humans, flora, or fauna presumably caused by proximity to the site;
- Physical (e.g., pH) or analytical results showing contaminant levels; and

- Reports from the community to authorities of suspected releases.

238. No matter how detected, mercury-contaminated sites are similar to other contaminated sites in that mercury can reach receptors in a variety of ways. Mercury is particularly problematic because of its dangerous vapour phase, its low level of observable effects on animals, and different toxicity depending of form (i.e., elemental mercury vs. methylmercury). Fortunately, mercury is also readily detectable using a combination of field instruments and laboratory analysis.

239. The first priority is to isolate the contamination from the receptors to the extent possible to minimize further exposure. In this way, mercury-contaminated sites are similar to a site with another potentially mobile, toxic contaminant.

240. If the site is residential and a relatively small site, ample guidance for emergency response is available from U.S. EPA in their Mercury Response Guidebook written to address small-to medium-sized spills in residences (US EPA 2001b).

241. Alternately, for larger sites resulting from informal mercury use in developing countries (e.g., ASM), good recommendations for response are outlined in *Protocols for Environmental and Health Assessment of Mercury Released by Artisanal and Small –Scale Gold Miners* (GMP 2004).

11.5 Restoration of Minamata Bay – The Damage Caused by Mercury Poisoning

242. Chisso Corporation had used mercury as a catalyst to produce acetaldehyde and vinyl chloride and discharged wastewater containing mercury and methylmercury into Minamata bay for about 40 years. The total amount of mercury discharged into Minamata bay was estimated about 70 – 150 mercury·tonnes and 616 methylmercury·kg for the period. There were more than 1,500,000 m^3 (2,090,000 m^2) of the bottom sediment polluted with more than 25 ppm of mercury concentration (Minamata City Hall 2000).

243. In order to restore Minamata bay polluted with mercury, the Kumamoto Prefecture Government had implemented the restoration project in Minamata bay from 1974 to 1990. The area where mercury concentration in sediment was more than 25 ppm was divided by steel sheet piles. The other area where mercury concentration in sediment was less than 25 ppm was dredged by the dredgers, and the dredged sediment was reclaimed inside the area divided by the steel sheet piles. The surface on the reclaimed area was treated by the liner sheets and Shirasu deposit (white arenaceous sediment). Then, the surface was covered by cover soil as the landfill containment (Minamata City Hall 2000). The total cost for restoration, as of May 2001, was about 48 billion JPY (about 390 million USD) (Ministry of the Environment 2002), and it shows that restoration needs vast amounts of money. The restoration cost can see at the subsection 6.11 Liability and Compensation Provisions. That area is now the public park.

12.0 Public Awareness and Participation

12.1 Introduction

244. Waste management services in most developing countries do not satisfy the full demand in urban areas. In the poorest countries, the service sometimes reaches only 10% to 40% of the urban population. In the better-organized middle-income countries, the services reach from 50% to 85% of the urban population. Most of the waste collected including hazardous waste and mercury waste is discharged to open dumping sites, which are often characterized by open burning and waste picking for recyclables. Mercury in wastes placed in open dumping sites would leak out, enter the environment, particularly the aquatic environment, be bioaccumulated and biomagnified and be finally taken by human through consuming fish and seafood (Honda 2005).

245. On the other hand, waste management services in developed countries which enforce a legal-binding environmentally sound management (ESM) of not only municipal solid wastes but also hazardous wastes might not be able to fully satisfy an advanced demand on ESM, because waste management services on ESM requires advanced technologies and techniques to treat (recycle as much as possible) wastes. Although those services provide a minimum package including waste collection and final disposal, recycling and reusing of hazardous wastes in those countries are limited. For example, fluorescent lamps are discharged as a municipal solid waste or glass waste because of no (or lack of) collection system, no recycling facilities or no (or lack of) public awareness on hazardous waste despite the fact that a legal-binding ESM exists. This causes that mercury is contaminated into municipal solid waste destined for landfilling or incineration which are the anthropogenic sources of mercury emission. Therefore, public awareness and participations are the key role to succeed a legal-binding ESM.

246. Mercury-containing products, such as fluorescent lamps and other lamps, mercury-containing thermometers and mercury-containing batteries, are globally scatted, and most users of these products are the general people who finally dispose of used mercury-containing products. This means that general people are the most important key players on ESM of mercury-containing products, because they are the final persons to choose how to dispose of mercury-containing wastes by ESM or environmentally unsound management even if general people do not know how to dispose of. Therefore, public participation is the most important element in order to implement various activities for mercury waste on ESM.

247. Public awareness is a key issue on waste management, particularly waste segregation at sources, such as households, waste stations and end users of products. Waste segregation at sources can enhance the homogeneity of the waste recovered and minimise its level of contamination. Both the technical and economic hurdles for recycling can then be lowered and this increases the recycling viability. Even if there is a legal-binding ESM, it is expected that wastes are not properly collected to recyclers if public awareness is low. Therefore, the higher public awareness improves waste management to more effective way.

248. For example, fluorescent lamps are not fully recognised, particularly in developing countries, that fluorescent lamps contain a trace amount of mercury which is a toxic element. Or most people misunderstand that mercury in a fluorescent lamp is no problem to discharge into the environment because of a trace amount of mercury. In these cases, used fluorescent lamps would be mixed with municipal solid wastes destined for incineration or landfilling, and then mercury is released into the environment. Although a trace amount (5-10 mg) of mercury in a fluorescent lamp does not immediately cause health problem or environmental pollution, it is important to open people eyes that mercury of toxic element eventually causes the adverse effects to human health through the food chain and the environment when mercury is released into the environment.

249. For promoting public participation into ESM of mercury waste as well as raising public-awareness, awareness-raising and sensitization campaigns for local communities and citizens are very important elements. In order to raise the awareness of the citizens on the issues of mercury waste, authorities concerned, e.g. local governments, need to initiate various awareness raising and sensitization campaigns to assist the citizens to have interesting in the issues of mercury waste to protect the adverse effects to human health and the environment. In addition, it is important to involve community based societies to the campaigns because they have closer relationship to residents and other stakeholders in the communities (Honda 2005).

250. Table 12-1 shows the example of campaign programmes. There are three elements: publication, environmental education programme and public relation (PR) activities that citizens can easily access activities at public places (Honda 2005).

Table 12-1 Programmes for public participation (Honda 2005)

	Contents	Expected results
Publications	• Booklet, magazines, posters, web sites, etc to easily explain mercury issues • Guidebooks how to dispose of mercury waste	• Knowledge sources • Explanation how people can dispose of waste
Environmental Education Programmes	• Voluntary seminars • Demonstration of recycling programme • Scientific studies • Environmental tours to facilities, etc • eLearning	• Raising knowledge • Sharing common issues • Opportunities to directly expose environmental issues
Activities	• Take-back programmes • Mercury-free product campaigns • Waste minimization campaigns • House-to-house visit	• Implementation of environmental activities among all partners • Environmental appeal for citizens • Closer communications
Risk Communication	• Mercury exposure in general living environment • Safe level of mercury exposure • Mercury pollution levels • Fish consumption advisories	• Proper understanding of safe and risk levels of mercury exposure • Avoidances of overreactions

12.2 Programmes

251. Publications for environmental activities are the basic element but plays as the most important tool to disseminate information about environmental issues, particularly for environmental education programmes. Publications provide basic knowledge of mercury properties, mercury toxicology, the adverse effects to human health and the environment, issues on mercury waste and mercury exposure way from mercury waste as well as how to deal with and dispose of mercury waste.

252. Environmental education programme is to develop a public that is aware of and concerned about, the environment and its associated problems, and which has the knowledge, skills, attitudes, motivations, and commitment to work individually and collectively toward solutions of current problems and the prevention of new ones (UNESCO 1977). Environmental education programmes can enhance critical thinking, problem solving, effect decision-making skills how to segregate mercury waste and enable individuals to think about environmental issues with regard to mercury waste. The components of environmental educations on mercury waste are as follows (Honda 2005):

- Awareness and sensitivity to the environment and environmental challenges;
- Knowledge and understanding of the environment and environmental challenges;
- Attitudes of concern for the environment and a motivation to improve or maintain environmental quality;
- Skills to identify and help resolve environmental challenges; and
- Participation in activities that lead to the resolution of environmental challenges.

253. Environmental education increases public awareness and knowledge about environmental issues or problems. In doing so, it provides the public with the necessary skills to make informed decisions and take responsible action. Environmental education does not advocate a particular viewpoint or course of action. Rather, environmental education teaches individuals how to weigh various sides of an issue through critical thinking and it enhances their own problem-solving and decision-making skills (Honda 2005).

254. Activities of public participations into mercury waste management should be implemented after environmental education programmes (after disseminating information about mercury waste). It is recommended that a demonstration programme of mercury waste is first implemented in a limited area before implementing large scale of activities. The activities of public participations into mercury waste management are a take-bake-programme and mercury-free product campaigns.

255. Risk communication is a tool for creating that understanding, closing the gap between lay people and experts, and helping people make more informed and healthier choices. It is sometimes happened that information about the adverse effects to human health and the environment strongly impress people to overreact against an environmental issue even if a pollution level is much lower than a regulation or standard. In order to avoid misunderstanding about

environmental issues, it is important to provide information about safe and risk levels of mercury exposure in general living environment as well as accidental mercury exposure, particularly to at-risk populations.

12.3 Identification of Players on Programmes of Public Participation

256. The partners for programmes on public participation are summarized as follows (Honda 2005):

1) Officials and staff in governments who work for environmental issues;

2) People who are interested in environmental problems and have high potential to understand quickly and disseminate to others:
    - Children and students at schools, undergraduate students at universities;
    - Teachers of primary and middle schools, sometimes the University professors;
    - Women at local communities and groups; and
    - Retire person with a suitable education;

3) People who work at environmental fields of local and community level:
    - Non-governmental organizations (NGOs);
    - Small and medium enterprises;
    - Local producers, collectors and recyclers, the disposal facility owners of mercury waste.

4) People who used to live at polluted sites:
    - Local organizations;
    - City residents;
    - Enterprises.

12.4 Type II Initiative

257. In order to effectively implement programmes on public participation into ESM of mercury waste, it is important to collaborate among all stakeholders, such as governmental sectors, private sectors (producers of mercury-containing products), local communities, and consumers, namely a public-private partnership programme. Type II Initiative is the concept of "Local Capacity-Building and Training for Sustainable Urbanization: Public-Private Partnership", namely the collaboration among all sectors to tackle common environmental issues. The type II Initiative is one of the most important concepts for ESM of mercury waste (Honda 2005; UNITAR 2006).

258. Type II Initiative is one of the most attractive tools being used help address the urban environmental crisis and is effective tool to implement ESM of mercury waste. In addition, Type II Initiative helps governments and private sectors craft the approach that best fits their local needs for ESM of mercury waste. The model to develop a Type II Initiative is summarized in Table 12-2. As the example, the contents of the Type II initiative are as follows (Honda 2005):

Preamble: Mercury waste and mercury-containing products may cause the adverse effects to human health and the environment. In order to implement ESM of mercury waste and mercury-containing products, we all agree:

- Producers shall plan to phase out use of mercury to manufacture products or use mercury as low as possible if mercury-free alternatives are not available, and participate in or support a recycling programme on used mercury-containing product;
- Recyclers shall deal with used mercury-containing products and recycle those products as much as possible, and store or stabilize mercury collected from used mercury-containing products on the environmentally sound technologies if recycling is not available;
- Collectors and transporters shall ensure a safety transportation of mercury waste and used-mercury containing products;
- Users shall appropriately segregate and dispose of mercury-containing products;
- Government shall fully enforce the environmental law and enhance the national capacity of mercury waste;
- Public sectors shall supervise and manage all activities of dischargers and dealers of mercury waste.

Table 12-2 Model to develop a public-private partnership for mercury waste (Honda 2005)

Stage 1: Development of master plan and strategic plan	
Contents	**Model**
• Identification of the current problems on mercury waste; • Decision of target and goal; • Master plan: the basic objective to set up a mercury waste management by municipality or central government. Its basic concept is “ESM” of mercury waste; • Strategic plan: Materialization of the master plan to identify progress, stakeholders, donors, etc in detail. • The elements and aspects on mercury waste are as follows: o Elements: generation, separation, separate collection, transfer/transportation, reusing/recycling, reduction, treatment/disposal; • Aspects: technology, technique, knowledge, the environmental affect, human health, financial mechanism, resource mobilization, legal framework.	• There is legal framework of solid waste management, but no legal framework of mercury waste despite the current problem on mercury waste; • A public-private partnership aims to introduce and implement mercury waste mechanism on ESM; • Master plan: o Development of a mercury waste management mechanism by public-private partnership on ESM. The responsibilities of each sector are as follows: ▪ Public sector: all legal/political matters, such as legal framework, resource mobilizations, financial mechanism, supervision; ▪ Private sector: all technical matters, such as separate collection, infrastructure, reusing/recycling, final disposal, operation of infrastructure; ▪ Civil society organizations (CSOs): community level activities, such as environmental education, demonstration of separate collection, dissemination of knowledge; ▪ Citizens: separate collection, tax payment; ▪ Media: PR activities on the environment. o Implementation of separate collection; o Licensing mechanism for collectors, transporters, recyclers and disposers; o Regular assessment or reporting system by authorities concerned. • Strategic plan o Political strategic plan ▪ Step 1: Preparation of a national legal framework appropriate for a national capacity, taking into account the international standard; ▪ Step 2: Demonstration programme and synchronisation with technical matter; ▪ Step 3: Public comments; ▪ Step 4: PR activities to disseminate a legal framework, including environmental education programme; ▪ Step 5: Full enforcement. o Technical strategic plan ▪ Step 1: Identification how a national technology is lack compared to ESM; ▪ Step 2: Research and development and/or technology transfer; ▪ Step 3: Demonstration programme and synchronisation with political matter; ▪ Step 4: Improvement and/or update of technology and construction of facility with other technical matters such as collection system; ▪ Step 5: Full implementation. o Overall strategic plan synchronised with the political and technical plans: ▪ Short-term strategic plan (1-2 years) which indicates one aim every 1-2 years; ▪ Long-term strategic plan (5-10 years) which mentions one aim every 5-10 years.
Stage 2: Identification of stakeholders and organisation of stakeholder framework	
Contents	**Model**
• Identification of stakeholders aimed at public-private partnership. Players on mercury waste are as follows: o Central government; o Local government;	• Stakeholders can be decide based on the responsibility under the master plan and strategic plan as follows: o Central government responsible for the environmental legal framework; o Local government responsible for the environmental legal framework at local level, such as municipalities responsible for ordinances, city

o Agencies; o Private sectors; o Research sectors (universities, institutes, etc.); o Local players; o NGOs/CBOs; o Media; o Donar agencies (IGOs, MFOs, etc); o National/city level bilateral cooperation with another country. • Mobilising stakeholders; • Establishment of a steering committee among stakeholders; • Type II Initiative.	hall responsible for regulations; o Agencies responsible for mercury waste or mercury-containing products; o Private sectors regarding mercury waste management, such as producers manufacturing mercury-containing products, smelting facilities, recyclers, collectors, transporters, dealers, venture business which has great potential to become a key player, etc; o Research sectors which technically and politically research and develop a mercury waste mechanism on ESM or has the cooperation programme with another foreign research sector; o Local players who are key person but not fully supervised/controlled by the legal framework, such as scavengers, local collectors, dealer of micro-level trading of mercury waste, etc; o NGOs/CBOs who implement the environmental activities, educational programme and voluntary contribution; o Media responsible for PR activities and environmental education programme, such as TV stations, radio stations, publishers, newspapers, etc. o Donor agencies which can support financial matters, such as official development assistance (ODA), project funding by IGOs and MFOs. In addition, private sectors could also be recognised as one of the donor agencies based on the Extended Producer Responsibility (EPR); o Partners on the national/city level bilateral cooperation with another country, which can provide technology, techniques and knowledge of the environmentally sound management for mercury waste. • Mobilising stakeholders: o Identification of focal person in each stakeholder; o Establishment of a focal channel to exchange information among stakeholders, such as a mailing list and website restricted to stakeholders; o Basic information mobilisation among stakeholders to understand each other; o Organisation of pre-committee meeting which invites not only focal persons but also their college or project teams. • Organisation of a steering committee: o Regular organisations, for example once a 2, 3 or 4 month in 1st implementing year. • Type II Initiative o Organising preliminary discussions with all stakeholders who may sign Type II Initiative; o Deciding on stakeholders to sign Type II Initiative; o Negotiating roles, responsibilities and contributions with the stakeholders; o Preparing a draft Type II Initiative; o Discussing the draft Type II Initiative among stakeholders; o Finalising the context of Type II Initiative; o Signing the Type II Initiative.

13.0 Recommendations on Policies Dealing with Environmentally Sound Management of Mercury Waste

259. Mercury is a persistent chemical and never broken down into a harmless chemical. Because of its chemical characteristics, mercury is used as a useful metal for many kinds of industrial uses. However, methylmercury methylated from mercury in the aquatic phase caused the deadly damage to human health and the severe environmental pollution. Mercury and mercury-containing products tend to be phased out from industrial uses and markets, respectively, particularly in developed countries where a legal-binding environmentally sound management (ESM) of hazardous waste including mercury waste is enforced.

260. However, on the other hand, mercury is still used at small scale industrial activities, particularly at artisanal and small scale gold mining (ASM) in developing countries, because mercury uses at ASM is the traditional method to extract gold from ore and the most effective and economic process, and then the ASM activities using mercury cause the adverse effects to human health and the environment due to releasing mercury waste into the environment. If environmentally unsound management of mercury waste is not protected properly, an incident of mercury poisoning to human and environmental pollution will be occurred in the same way as the past infamous mercury incidents.

261. There is no practical alternative of some mercury-containing products, such as fluorescent lamps. Some mercury-containing products, such as mercury-containing thermometers, are still used, particularly developing countries. It is also practically impossible to collect all mercury-containing products on ESM and completely prevent accidental and incidental mercury spillages from mercury-containing products. However, using fluorescent lamps of high frequency (Hf) rather than incandescent lamps contribute to reduce carbon emission, taking into consideration climate change. Therefore, it is important to consider a comprehensive strategy on ESM of mercury waste.

262. Mercury waste including used mercury-containing products should be strictly controlled under a legal framework with ESM to prevent incidental mercury emission into the environment and protect human health and the environment against the adverse effects. However, even if there is no legal framework and/or a mechanism for ESM of mercury waste, mercury waste should be dealt with by the environmentally sound way as much as possible.

263. It is important to consider about geographical/climate properties and national and historical background, in order to develop a legal-binding ESM of mercury waste as well as other wastes in a country or an area. Although an approach, knowledge, expertise and technology on ESM of mercury waste in the countries which implement a legal-binding ESM of mercury waste are useful for other countries which have not introduced a legal-binding ESM of mercury waste, it is expected that a legal-binding ESM system of mercury waste and other wastes in countries which have already implemented is completely not fit for developing countries and countries with economies in transition because of difference of country situations. In order to implement ESM of mercury waste, there are 7 core elements that should be considered, introduced and implemented by all stakeholders.

Legal framework

1. **Definition/identification of mercury waste and an inventory programme:**
   Definition/identification of mercury waste is an important element to understand mercury waste situation and take any activities for mercury waste on ESM. A standard definition of mercury waste is all wastes consisting of, containing or contaminated with mercury. It is important to include all mercury-containing product and industrial mercury uses into the definition of mercury waste as a category of future waste, because mercury-containing product and industrial mercury uses tend to be phased out, and mercury spillage directly causes the adverse effects to human health and the environment.

2. **Policy instruments:**
   A policy instrument is the most important element because it defines a basic legal rule to deal with mercury waste on ESM. Policy instruments are a national legal framework of mercury waste (ideally, an integrated legal framework of hazardous wastes, including the concepts and strategy of mercury waste minimization, disposal at the country where waste is generated, phase out of mercury uses and mercury-containing products, promotion of mercury-free products and industrial processing, environmentally sound technologies, monitoring of mercury pollution and awareness-raising programme), as well as the international treaty and framework (e.g., UNEP Governing Council Decisions, the Basel Convention and SAICM) and regional framework (e.g., RoHS: Restriction of the use of certain hazardous substances in electrical and electronic equipment), and introduction of the

concepts on ESM (e.g., OECD – Core performance elements, the 3R (Reduce, reuse and recycle) Initiative and EPR (Extended producer responsibility), etc).

3. **Legislative and administrative arrangements (legal arrangement):**
   Legislative and administrative arrangements mean to coordinate all stakeholders to effectively implement ESM of mercury waste under a policy instrument. There are numbers of stakeholders who work on ESM of mercury waste, such as central and local governmental organizations, private sectors, local communities, and people. For effective implementation of ESM of mercury waste, it is important to make legislative and administrative arrangements and to develop a coordination mechanism among all stakeholders to implement ESM of mercury waste. The more effective legislative and administrative arrangements are made, the more effect ESM of mercury waste is implemented.

Activities

4. **Mercury waste minimization:**
   In order to reduce the amount of mercury waste, one approach is mercury waste minimization. Waste minimization is any action that reduces the amount and/or toxicity of chemical wastes that must be controlled. Approaches of mercury waste minimization are a phase out programme of mercury-containing products and mercury industrial uses and a promotion of mercury-free products and industrial processing. Both of two approaches should be back-to-back implementation. The most important thing on mercury waste minimization is to reduce the amount of anthropogenic mercury sources.

5. **Environmentally sound technologies and techniques:**
   Environmentally sound technologies and techniques of mercury waste include collection, handling, storage (short- and long-term), transportation and treatment. A number of countries implement the environmentally sound technologies and techniques of mercury waste, such as the treatment facilities for fluorescent lumps on ESM. Many advanced technologies and techniques for mercury waste are available currently. Contribution from private sector is necessary. However, it is noted that such state-of-the arts technologies and techniques do not work in the countries where there is no hazardous waste mechanism on ESM or hazardous waste management, because of no capacity to operate the technologies and techniques. It is important that those countries should fully establish and enforce a national (or local) policy instrument with a plan how to introduce advanced technologies and techniques for mercury waste. As the other option, a regional cooperation on ESM of mercury waste is recommended.

6. **Scientific programmes on mercury pollution:**
   In order to monitor whether mercury pollution is occurred or not, mercury pollution monitoring is necessary. Mercury pollution monitoring composes of sampling (environmental samples: fish and shellfish, water, sediment and soil, and atmosphere and air; and human samples: hair, blood and urine). Advanced knowledge, expertise and experiences with special analytical equipment are necessary for mercury analysis and mercury pollution monitoring. International collaborating research work is important to carry out mercury analysis and implement mercury pollution monitoring.

7. **Public participation and partnership programme:**
   Public participation is also important because people are the end of users of mercury-containing products and have final responsibility to discharge those products. Even if a policy instrument and environmentally sound technologies and techniques are introduced, its mechanism is never succeeded if there is no public participation into the mechanism. Awareness-raising programme is recommended to promote public participation in mercury waste management by disseminating basic information about mercury, how to discharge of mercury-containing products, how to respond if mercury in mercury-containing products is accidentally (or intentionally) spilled. In addition, a partnership programme, particularly a public-private partnership programme, is a key programme to collaborate among all stakeholders to tackle the common programme on mercury waste.

264. Fig. 13-1 summarises the 7 core elements for ESM of mercury waste and mercury flow. Definition/identification of mercury waste and an inventory programme, policy instruments and legislative and administrative arrangements (legal arrangement) are a fundamental framework which defines a legal framework to control mercury waste as well as mercury-containing products and industrial mercury uses. In order to enforce a legal framework, the 4 strategies are necessary, namely mercury waste minimisation, environmentally sound technologies and techniques, scientific programmes on mercury pollution, and public participation and partnership programme. In order to introduce and implement ESM of mercury waste, it is important to undertake a synergetic approach of these 4 strategies on a legal framework.

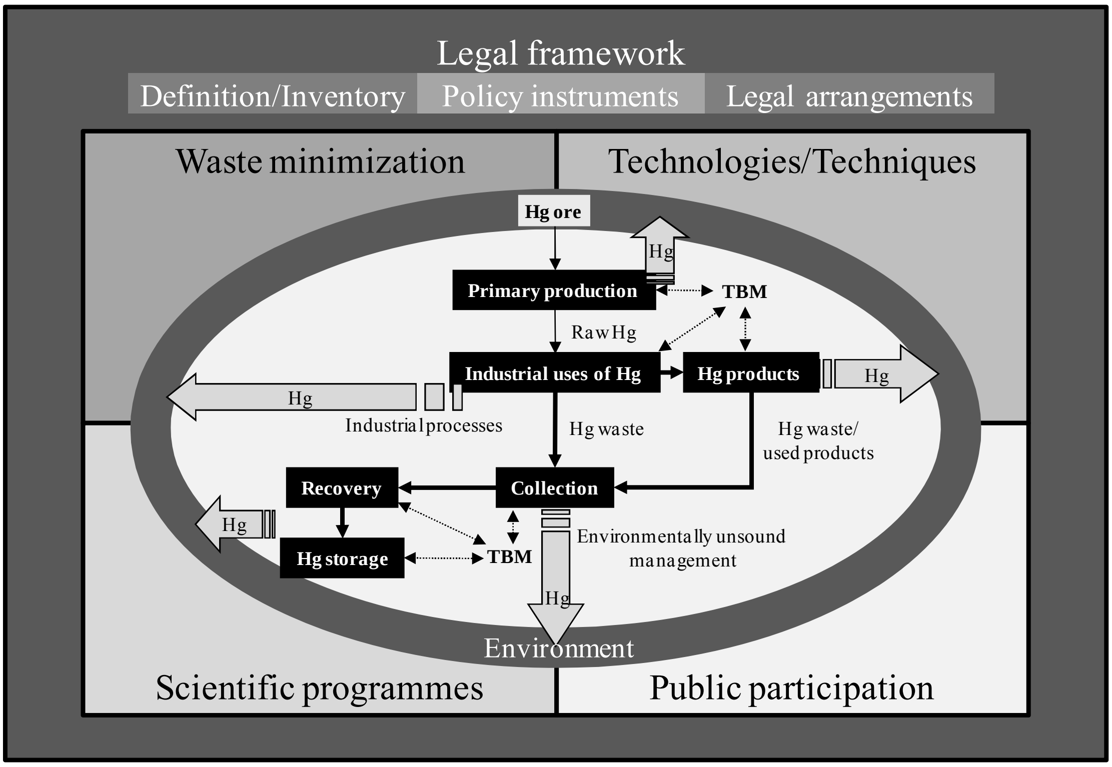

Fig. 13-1 Seven core elements for ESM of mercury waste and mercury flow

Appendix A: Chemical Analysis of Mercury

A.1 Introduction

265. Mercury pollution due to mercury waste is occurring when mercury in waste or obsolete mercury-containing products is released into the environment and on the environmentally unsound management, such as breakage of mercury-containing products, burning of mercury waste or mercury-containing products, natural degradation of mercury waste, etc. Mercury released from mercury waste exists in the environment (water, sediment, soil, plants and air) or accumulates in the food chain and is taken by human through consuming fish and seafood, or mercury vapour directly enters into human body or is adsorbed on human hair. In order to monitor mercury level with due to mercury waste, it is necessary to analyze various samples, such as biological samples (fish and shellfish), environmental samples (water, sediment, soil and air), plants and human samples (hair, blood and urine).

266. Obtaining reliable analytical data for mercury requires the following: appropriate sample collection; pre-treatment for analysis; the selection of a measurement method and preparation method for sample test solutions suited to the samples; experience in their use; and confirmation of the reliability of one's own analytical data. In addition, when performing an analysis, one must regularly pay attention to preventing contamination of the samples by keeping the laboratory clean; providing appropriate ventilation; and adequately washing glassware, tools, and containers (Ministry of the Environment 2004).

267. When evaluating the adverse health effects of mercury and clarifying its dynamics and pathways in humans and in the environment, in addition to performing a quantitative analysis for total mercury, one should also perform separate quantitative analyses for methylmercury and inorganic mercury. This appendix first provides a description of sampling followed by descriptions of the analytical methods for total mercury and methylmercury for each target sample (Ministry of the Environment 2004).

268. Although many kinds of analytical methods are available for mercury analysis, suitable certified reference materials (CRMs) should be used. See the subsection 4.1 in Chapter 4.0 (4.0 Chemical Analysis of Mercury in Waste) for further information.

A.2 Sampling

A.2.1 Environmental Samples

A.2.1.1 Fish and Shellfish

269. Water pollution caused by methylmercury can be monitored conveniently by measuring the bioaccumulation of mercury in fish. Further, monitoring the mercury in fish and shellfish eaten most often by people in a particular region is a suitable means of evaluating human exposure levels, because human exposure to methylmercury occurs mostly through the consumption of fish and shellfish. In addition, since most mercury present in fish is in the form of methylmercury, the measurement of total mercury in fish can be used to evaluate methylmercury intake by humans. However, methylmercury should also be measured in cases where extremely high values appear and in cases involving consumption of whale meat and organ tissues whose proportion of methylmercury to total mercury is not always constant (Ministry of the Environment 2004).

270. When collecting fish samples, record the sampling date, location, species, and ages. Also measure the weight and length and the like. For fish, collect 10-20 grams of the edible portion, place it in polyethylene bags, and store it in a freezer. For shellfish, divide the muscle, digestive tract contents, and adductor muscle (for snails, which lack an adductor muscle, divide the edible portion), place the portions in polyethylene bags, and store in a freezer. Since particles of bottom sediment are often contained in the digestive tracts of shellfish, remove these particles before storage (Ministry of the Environment 2004).

A.2.1.2 Water

271. When the source of contamination is directly connected to a river, lake, marsh, or ocean, or when contamination is expected to have spread from a river to a lake, marsh, or ocean, take water samples from the various areas. Use a Bandon water sampler or the like to collect the water samples, preferably at 20-30 cm below the surface. Take great care to prevent bottom sediment from entering water samples collected near the bottom. In principle, collect seawater samples at high tide and avoid windy or rainy days. For lakes, marshes, and ocean regions, clearly state the collection date, location, general water quality, position relative to contamination source, and other information. Keep water samples in a sealable glass or Teflon container that has been well washed with hydrochloric acid or other agents before being transported (Ministry of the Environment 2004).

A.2.1.3 Sediment/soil

272. In most pollution situations, collect one sample per 100 m^2 (based on a 10 m × 10 m grid). At sites where the pollution record suggests the risk of pollution is not extreme, obtain one sample by mixing samples obtained at five spots per 900 m^2 (based on a 30 m × 30 m grid). With this five-spot mixing method, collect individual samples from a total of five spots: the centre point of each grid and four subpoints set around it. Combine these five samples to obtain one final composite sample. This enhances the representativeness of the soil samples obtained from each grid. Although the locations of the four subpoints are not precisely set out, it is desirable to collect the four samples at points north, south, east, and west of the centre point. At each sampling point, collect the soil samples between the soil surface and 50 cm below the soil. Specifically, collect the individual samples from two separate regions, one between the soil surface and a point 5 cm below the surface, and the other in the area from 5 cm to 50 cm below the soil surface. After collecting the soil samples, remove most foreign objects (pebbles, roots, etc.) from each sample and homogenize each sample by mixing with the quarter method. After homogenization, mix an equal weight of each sample to obtain a final composite sample. Similarly, for the five-spot mixing method, mix an equal weight of each of the five samples (homogenized with the soil pre-treatment method mentioned above) to obtain one composite sample for the mercury analyses (Ministry of the Environment 2004).

273. For rivers, sampling points allowing easy collection of the bottom sediment are chosen at intervals of 50-200 m downstream from the discharge point of industrial wastewater or city drains; moreover, it is desirable that about two points upstream be set for collection of bottom sediment as the control. The collection spots for the sediment samples are usually specified as both riverbanks and the centre of the river. Where the river is wide, increase the number of sampling points (Ministry of the Environment 2004).

274. For lakes, marshes, and ocean areas, radially centre the sampling points on the release point or mouth of the river and conduct a grid survey as needed (Ministry of the Environment 2004).

275. As for the sampling methods, the Ekman dredge sampler is used for collection of the surface layer sediment of rivers, lakes, marshes, and seashores, whereas the core sediment sampler is used to collect columnar samples that allow for estimation of the sedimentary state and the history of mercury contamination and accumulation. Clean the collected bottom sediment of wood pieces, pebbles, shells, and dust and pass it through a 2-mm mesh sieve to prepare a sample. If the sample has high water content, centrifuge it to remove the supernatant and mix well to homogenize it before submitting it for analysis. Record the date, location, and general conditions (appearance, colour, smell, impurities, etc.). Although glass containers are best for the collected samples, other sealed containers may also be used. Wash the containers well beforehand with hydrochloric acid or another agent. Store the samples in a cool dark place. Samples containing metallic mercury or divalent mercury should be stored in a freezer.

A.2.1.4 Plants

276. Plants normally exhibit little biological magnification of heavy metals and therefore are not suitable for evaluating contamination. However, lichens have various properties that make them suitable as a biological indicator of air pollutants. As with other rootless air plants, they absorb nutrients directly from the air, accumulate metals efficiently, and exhibit resistance to high concentrations of metals in their tissues (Ministry of the Environment 2004).

277. Lichens are widely distributed geographically, making them suitable for not only domestic but also international evaluations of air pollution. In fact, lichens (including the Parmelia and Usunera species) have often been used in research to evaluate air pollution caused by mercury and various other heavy metal pollutants. Lichens, which usually grow on trees or branches, are collected, washed well with water, cleaned of wood pieces and dust, and air-dried to make a sample. For mercury analysis, place a few grams of the sample in a vial and cut it into pieces with dissection scissors (Ministry of the Environment 2004).

A.2.1.5 Atmosphere/air

278. Air samples are collected when mercury pollution is believed to be present in the atmosphere or indoor environment. Since mercury concentrations in the atmosphere vary greatly, sampling points must be selected in order to clarify the mercury distribution with consideration given to prevailing winds and the distance from the contamination source. To obtain air samples from the general indoor environment and indoor environment of workrooms, etc., divide the room into a grid of 3 m square (with the width of the grid adjusted to accommodate the scale of the work environment) and collect samples at the intersections of the grids. In consideration of possible human exposure, set sampling points at 1 to 2 m above ground. To collect mercury in the atmosphere or in the indoor air, place an absorbing solution comprising 20 ml of 0.1% potassium permanganate and 1N sulphuric acid in an impinger or similar bubbler. To sample the air, use a suction pump to draw the air into the absorbing solution from the sampling point at a flow rate of 1 L/min. for a given time (Ministry of the Environment 2004).

279. If the absorbing solution has evaporated and decreased in volume after the air samples have been drawn, top up the absorbing solution to a fixed volume to make a test sample. Separately from this sample, take two identical volumes of absorbing solution that have not been aerated. Set aside one volume as a blank test solution; to the other, add a fixed volume of inorganic mercury (II) standard solution to create a standard test solution. At measurement, add 10% hydroxylamine hydrochloride dropwise to decolorize the potassium permanganate; determine the mercury concentration in the sample test solution by cold vapour atomic absorption spectrometry, as with the other samples. Using the volume of air collected, calculate the mercury concentration in the air sample. This method can be widely applied to tests of the environmental atmosphere, the air of a work environment, and the gas discharged from an emission source or the like. (Ministry of the Environment 2004).

A.2.2 Human Samples

A.2.2.1 Hair

280. The mercury concentration in hair is often used as a biomarker for methylmercury exposure because it reflects the concentration in the blood at the time the hair was formed. At the same time, a hair sample provides a simple and noninvasive sampling method as well as a storage method offering good sample preservation. Since the hair grows at a rate of roughly 1 cm per month, evaluation of past exposure is possible. However, the mercury concentration in hair can increase as a result of adhesion of external mercury vapour and inorganic mercury, decrease as a result of hair treatments such as permanents, and be influenced by the sample collection site. Hair samples should be obtained from the occipital area of the head and should include at least 20 strands of hair measuring 1 cm long (about 10 mg in total) cut with scissors at the hair root. Tie the root ends of the sampled hair strands together with a cotton thread or affix to adhesive tape or the like so that the root ends can be identified. Place the sample in a polyethylene bag and store at room temperature (Ministry of the Environment 2004).

A.2.2.2 Blood

281. For people who eat large quantities of fish and shellfish, the mercury concentration ratio of red blood cells to plasma (serum) is approximately 10:1, and most mercury contained in the red blood cells is in the form of methylmercury; therefore, the methylmercury exposure can be evaluated by measuring total mercury in blood. It is believed that 50% of inorganic mercury is present in the plasma and the mercury concentration in the plasma increases in relation to the amount of inorganic mercury accumulated in the kidneys. Thus, the exposure to inorganic mercury/mercury vapour can be evaluated by measuring the total mercury in plasma. A blood sample in the range of several millilitres is collected as usual from a vein into an injection tube already containing an anticoagulant (heparin) and transferred into a sealed container. The sample is then centrifuged at 3,000 rpm for 10 minutes to separate the red blood cells from plasma. Samples to be stored for a long period of time should be frozen (Ministry of the Environment 2004).

A.2.2.3 Urine

282. Most mercury present in the urine is in the form of inorganic mercury. The mercury concentration in the urine increases in relation to the level of inorganic mercury accumulated in the kidneys. Accordingly, the total mercury value in the urine is an important biomarker for evaluating inorganic mercury/mercury vapour exposure. On the other hand, leaking of methylmercury into urine may occur in those with renal disease (Ministry of the Environment 2004).

283. Generally, as in usual urinalysis, 50-100 ml of urine is collected as a sample in a paper cup in the early morning. The sample is then stored under refrigeration in a polyethylene container. Samples to be stored for more than one month should be frozen. Since urine contains many inorganic salts, even fresh urine may generate precipitate. Thus, the sample must be homogenized by shaking before analysis. A method also exists where the solubility of the salts is increased by lowering the pH of the urine sample by adding a small amount of hydrochloric acid. Take steps to ensure that microorganisms do not proliferate, as they may cause inorganic mercury to reduce to mercury vapour, which will escape and be lost (Ministry of the Environment 2004).

A.3 Digestion Procedures

284. There are a number of digestion procedures to solubilise mercury. Ministry of the Environment, Japan, described an analytical method to analyze total Hg in soils and sediments in which the digestion method is essentially the same as the one used for biological samples (fish, hair, blood, urine). About 0.5 g of finely pulverized sample is leached with 2 mL of nitric-perchloric acid (1+1). Then, 5 mL of sulphuric acid and 1 mL of water are added and heated to 230-250 °C on a hot plate for 20 minutes. After cooling, the digested sample is made up to 50 mL with mercury-free water. An aliquot of the solution is introduced into the analyzer (cold vapour or atomic fluorescence) where a solution of 10% stannous chloride is used to reduce the mercury. Using air or nitrogen as a carrying gas, the sample is analyzed. The detection limit of the method is 1 ppb (ng/g) for 0.5 g of sample (Ministry of the Environment 2004).

285. USEPA Method 7471B describes a method in which 0.5 to 0.6 g of homogenized soil samples is digested for 30 minutes at 95°C in a hot block digester with 5 mL of *aqua regia* and 5 mL water in the presence of 15 mL of a potassium permanganate solution. The digestion oxidizes all forms of mercury to Hg (II). After adding 6 mL of sodium chloride-hydroxylamine sulphate to reduce the excess permanganate, the Hg (II) is reduced with stannous sulphate to elemental mercury, which is detected by atomic absorption (US EPA 2003a).

286. Sediment samples can also be analyzed following the method of Bloom and Crecelius. Samples are homogenized with a clean stainless steel spatula and weight 1 mL sub-samples into acid cleaned test tubes. About 10 mL of a 1:2.5 nitric/sulphuric acid mixture is added and heated at 180°C for 6 hr in an aluminium hot block. After cooling, 200 µL of bromine chloride (BrCl) are added and sample volume completed to 25 mL with low mercury deionized water. Aliquots (usually 100 or 200 µL) are analyzed and processed as for water samples. Matrix spikes/spike duplicates are performed as necessary to determine mercury recoveries. The average of these recoveries should be used to correct values. Sediment reference materials should also be concurrently digested and analyzed in duplicate. The detection limit is in the order of 1 ng Hg per gram (0.001 µg/g) wet sediment (Bloom 1983).

287. USEPA Method 245.7 describes a method in which inorganic Hg compounds and organomercury species are oxidized by a potassium bromate/potassium bromide reagent. After oxidation, the sample is sequentially pre-reduced with NH_2OH-HCl to destroy the excess bromine, then the ionic Hg is reduced with $SnCl_2$ to convert Hg(II) to volatile Hg^0. The Hg^0 carried by, high-purity argon, passes into an inert gas stream that carries the released Hg^0 into the cell of a cold-vapour atomic fluorescence spectrometer (CVAFS) for detection at 253.7 nm (US EPA 2001a).

288. Cava-Montesinos *et al* describes a digestion method using an ultrasound water bath in the presence of 8% (v/v) aqua regia, 2% (v/v) antifoam A and 1% (m/v) hydroxilamine hydrochloride to analyze Hg in milk. After the ultrasound, the solution is treated with 8 mmol l.1 KBr and 1.6 mmol l.1 $KBrO_3$ in a hydrochloric medium and Hg measurements obtained by cold vapour atomic fluorescence spectrometry (Cava-Montesinos 2004).

A.4 Analytical Method for Total Mercury

289. Although there are several methods for digesting and determining total Hg in solid and liquid samples, the main three methods used for measuring total mercury are:

1) Direct mercury analysis (see the subsection 4.3.4 Direct Mercury Analysis);
2) Cold vapour atomic absorption spectrometry (CVAAS) (see the subsection 4.3.1.5 Quantification – Cold Vapour Atomic Absorption Spectrometry (CVAAS)); and
3) Cold vapour atomic fluorescence spectrometry (CVAFS) (see the subsection 4.3.5 Measurement of Total Mercury Using CVAFS);

A.5 Analytical Method for Methylmercury

290. For measurement of organic mercury, gas-liquid chromatography with electron capture detection (GLC-ECD) is used for selective analysis of methylmercury and other organomercury compounds. Because this technique provides good separation and superior sensitivity for analyzing organomercury halides, it has been widely used for the determination of methylmercury in various kinds of biological and environmental samples (Ministry of the Environment 2004).

291. Briefly, the analytical procedure involves the extraction of methylmercury in the samples as its halide into an organic solvent after acidification; the back-extraction into a cysteine- or glutathione-aqueous solution; the re-extraction into an organic solvent; and measurement of methylmercury by GLC-ECD. As an alternative, methylmercury can be determined by CVAAS, which measures elemental mercury vapour generated from a heated sample test solution obtained from similar methylmercury extraction procedures. However, in this direct extraction procedure with organic solvent, a solid emulsion is often formed during the extraction process, particularly with fish and other biological samples. This makes the following steps complicated and causes the extraction efficiency of methylmercury to vary with the type of sample. While several pre-treatment methods are proposed to overcome the above drawbacks, we describe herein the following two methods: determination by the dithizone extraction/GLC-ECD method, which is suitable for methylmercury in various types of biological and environmental specimens; and the hydrochloric acid leaching/toluene extraction/GLC-ECD method for the determination of methylmercury in hair (Ministry of the Environment 2004).

292. The dithizone extraction/GLC-ECD method was established as an analytical method for methylmercury in various biological and environmental matrices. It is based on the following two advantages of dithizone extraction, which was widely used for colorimetry of inorganic and organic mercury species prior to the introduction of atomic absorption in the late 1960s: it has much higher extraction efficiency than that of direct solvent extraction,

facilitating the extraction separations of trace amounts of mercury from samples with a small portion of the solution; and alkyl mercuric dithizonate, as soon as it is injected into GLC, reacts with Cl- in the column to give its chloride form for quantitative detection (Ministry of the Environment 2004).

293. This method involves the following steps: pre-treatment of the sample, dithizone extraction, back-extraction into alkaline sodium sulphide, dithizone re-extraction, and GLC measurement. Appropriate pre-treatment to accommodate the characteristics of the composition of each sample enables efficient extraction of methylmercury with a small portion of dithizone-toluene solution. After dithizone-toluene extraction, test solutions are prepared with all common procedures, followed by measurement with GLC-ECD. To accommodate the principle used for this method, pack several centimetres of sodium chloride at the injection port of the column on top of the packing material for GLC (Ministry of the Environment 2004).

A.6 Emergency Countermeasures

294. Environmental contamination resulting in methylmercury exposure and adverse human health effects can be expected through ingestion of fish from the contaminated water system. On the other hand, poisoning by mercury vapour can be caused through air contamination in the work environment. Mercury contamination cases are therefore broadly divided into methylmercury (A) and mercury vapour (B) and countermeasures against adverse health effects for each case are shown in Fig. A-1.

295. In addition, when people have been or may have been exposed to methylmercury from an unknown source, countermeasures based on the mercury values in biological samples are shown directly in A. When people have been or may have been exposed to mercury vapour or inorganic mercury, countermeasures based on the mercury values in human biological samples are shown directly in B (Japan Public Health Association 2001).

296. Since environment and human exposure evaluations are done when executing countermeasures for emergency mercury contamination, measurement of methylmercury is not absolutely necessary. Measurement of total mercury alone is sufficient because nearly all of the mercury detected from edible (meat) parts of fish can be considered to be in methylmercury form. In addition, as long as there is no mercury vapour or inorganic mercury adhering to the sample from the outside, mercury in hair samples can also be considered as all methylmercury. Nearly all mercury in urine can be considered to be inorganic (Japan Public Health Association 2001).

A.7 Environmental Survey

A.7.1.1 Identification of Contamination Source

297. In the absence of reported health complaints, mapping the properties of various samples obtained in a survey of the local populace is helpful in identifying a contamination source. Identification of the species of contaminating mercury as metallic mercury, inorganic mercury, or methylmercury is also helpful in identifying the contamination source. Normally, the total mercury concentration in blood is 1/250 of the concentration in scalp hair. When this ratio is less than 1/500, methylmercury exposure can be ruled out as a possible cause. In addition, mercury accumulated in scalp hair due to mercury exposure through food is primarily methylmercury. When the proportion of inorganic mercury in scalp hair is more than 20% of the total mercury concentration, the adherence of metallic mercury is probably the cause (Japan Public Health Association 2001).

298. The determination of mercury in blood serum and red blood cells is also useful in identifying the contamination source. In addition, with exposure to metallic and inorganic mercury, the total mercury concentration in urine increases immediately after the event. Normally, the ratio of total mercury concentration in serum compared to red blood cells is about 0.1. When this ratio exceeds 0.2, exposure to inorganic mercury is suspected. In the analysis of scalp hair, the sample is cut into 1 cm length from the base, and each section is analyzed individually. If there are no changes caused by the ingestion of fish and the mercury concentration is constant for all sections, inorganic mercury contamination, including metallic mercury, is highly probable. This type of direct mercury exposure to hair can occur as a result of using paints, skin whitening soaps, and creams that contain mercury, and from amalgams used in dental treatments, and work exposure to mercury in mines and in industry (Japan Public Health Association 2001).

A.7.1.2 Identification of Exposure Source

299. Epidemiological studies are useful for determining the source of exposure when a patient population has been identified. An epidemiological survey for mercury poisoning consists of the following procedures: 1) medical examinations; 2) measurements of total and inorganic mercury levels in blood, urine and hair; and 3) questionnaire surveys. Mercury poisoning patients are identified on the basis of neurological findings, and mercury exposure levels, distinguishing between organic and inorganic mercury poisoning. Patients are then compared with unaffected groups to identify the differences in demographic characteristics (gender, age, race and ethnicity), residence place of living, occupation, family history, dietary habits and so on (Japan Public Health Association 2001).

300. Neurological findings are the most useful information for identifying methylmercury poisoning, followed by the mercury levels in hair. Inorganic mercury may be methylated in the natural environment. Once methylmercury produced by the methylation of inorganic mercury in the soil reaches the water system, methylmercury is biologically concentrated by the food chain and can reach high levels. Therefore, even inorganic mercury contamination may give rise to patients with methylmercury poisoning. However, the methylation of inorganic mercury and subsequent biological concentration occurs over a long time period (several months to years). Therefore, methylmercury poisoning is unlikely to occur in the early phases of inorganic mercury contamination of the environment (Japan Public Health Association 2001).

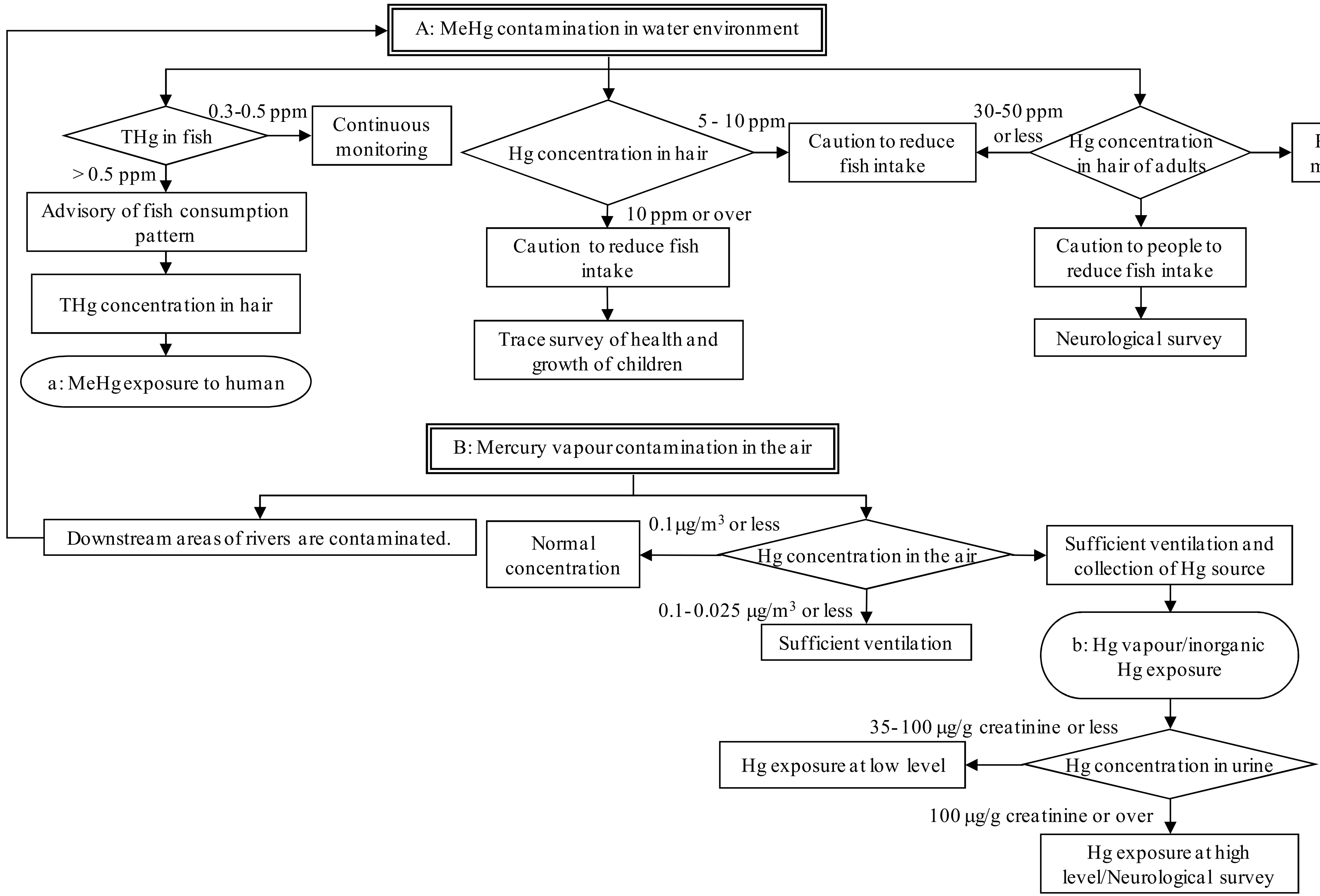

Fig. A-1 Emergency countermeasures for mercury contamination (A: Methylmercury contamination; B: Mercury vapour contamination)

Appendix B: UNEP Governing Council Decisions

B.1 21st session in February 2001

301. The decision 21/5 recognised that mercury cycles on a global scale should be addressed scientifically against global adverse effects to human health and the environment through international initiative. The Governing Council initiated the development of a global assessment of mercury in order to consider international actions on mercury (UNEP 2001). A global assessment of mercury and its compounds, headed by UNEP, would be in cooperation with other members of the Inter-Organization Programme for the Sound Management of Chemicals (IOMC) (UNEP 2001). The Global Mercury Assessment was issued in December 2002 and showed the key findings as follows (UNEP 2002):

1) Mercury is present throughout the environment;
2) Mercury is persistent and cycles globally;
3) Mercury exposure has serious effects;
4) Intervention can be successful;
5) Global cycling of mercury increases the problem;
6) Mercury has an impact on global fishing;
7) Mercury may be more problematic to less-developed regions;
8) Mercury is subject to significant international use ad commerce;
9) Mercury exposes human and wildlife by various exposure ways;
10) Mercury is emitted from both the primary sources and anthropogenic sources;
11) Mercury releases from anthropogenic sources should be released; and
12) A comprehensive approach should be implemented in collaboration among nations and international organizations.

B.2 22nd session in February 2003

302. In decision 22/4, the Governing Council accepted the key findings of the global mercury assessment and found that there were sufficient evidence of significant global adverse impacts from mercury and its compounds to warrant further international action to reduce the risks to human health and the environment from the release of mercury and its compounds to the environment. In order to assist all countries, in particular developing countries and countries with economies in transition, the following objectives relating to mercury waste were suggested for the programmes on international actions on mercury (UNEP 2003b):

a) Reduce anthropogenic releases of mercury that impact human health and the environment including, but not limited to, reductions from combustion sources, commercial processes, operations, products, and waste streams;
b) Reduce the demand for and the uses of mercury that impact human health and the environment (such as, work towards reduction of uses of mercury, giving consideration to application of feasible alternatives);
c) Improve global collection and exchange of information on mercury exposure, use, production, trade, disposal and release; and
d) Identify environmentally harmful subsidization of mercury mining and encourage a phase-down and eventual removal of such subsidization.

303. The decision 22/4 also suggested the priority to support capacity-building, particularly for developing countries and countries with economies in transition as follows (with regard to mercury waste) (UNEP 2003a):

a) Initiating a process to assist countries in understanding the nature and magnitude of the mercury problem and in developing tools and strategies to mitigate mercury pollution. This could include establishing national implementation plans; promoting public awareness; developing use, release and contaminated site inventories; developing waste management regimes, developing appropriate regulatory structures; and supporting regional information exchange and promoting pilot projects, where appropriate;
b) Increasing awareness and promotion of mercury-free products, technologies and processes, using and/or with environmentally friendly alternatives;

c) Promoting information exchange and collaboration on mercury-related monitoring, research, and assessment issues; and

d) Promoting awareness of alternative livelihood options and transfer of appropriate technology for the small-scale artisanal mining sector which uses mercury, taking into account the ongoing activities of the United Nations Industrial Development Organization (UNIDO) in this field.

B.3 23rd session in February 2005

304. In decision 23/9, the Governing Council suggested initiating national, regional and global actions, both immediate and long-term, to protect human health and the environment against mercury, in order to eliminate releases of mercury and its compounds into the environment in collaboration with all stakeholders. In addition, it was suggested to develop further mercury programme, such as partnerships on global mercury pollution, preparation of guidance document for mercury inventory programme taking into consideration a life-cycle approach on mercury-containing product, etc (UNEP 2005a).

305. Possible actions include: application of and sharing of information on best available techniques (BAT) and measures to reduce mercury emissions from point sources, taking action related to mercury in products (such as batteries) and production processes (such as chlor-alkali facilities) through, for example, when warranted, introduction of bans or restrictions of uses, and considering curbing primary production and the introduction into commerce of excess mercury supply (SAICM 2005).

B.4 24th session in February 2007

306. In decision 24/3, the Governing Council concluded that further long-term international action was required to reduce risks to human health and the environment and that, for this reason, the options of enhanced voluntary measures and new or existing international legal instruments would be reviewed and assessed in order to make progress in addressing global mercury pollution. In addition, it was recognised that a range of activities would be necessary to address the challenges posed by mercury, taking into consideration priorities as follows (UNEP 2007):

a) To reduce atmospheric mercury emissions from human sources;

b) To find environmentally sound solutions for the management of waste containing mercury and mercury compounds;

c) To reduce global mercury demand related to use in products and production processes;

d) To reduce the global mercury supply, including considering curbing primary mining and taking into account a hierarchy of sources;

e) To find environmentally sound storage solutions for mercury;

f) To address, considering the results of the analysis of information on the extent of contaminated sites, the risks to public and environmental health of mercury compound releases from such sites, environmentally sound mitigation options and associated costs and the contribution of contaminated sites to global releases; and

g) To increase knowledge on areas such as inventories, human and environmental exposure, environmental monitoring and socio-economic impacts.

307. The decision urged governments to gather information on means to reduce risk that may be caused by the supply of mercury as follows:

a) Reduced reliance on primary mercury mining in favour of environmentally preferable sources of mercury such as recycled mercury;

b) Options and solutions for the long-term storage of mercury;

c) Regional activities to improve data on imports and exports of mercury and enforcement of customs control through, for example, the Green Customs initiative; and

d) The market and socio-economic effects of the activities contemplated above.

308. The decision decided to establish an ad hoc open-ended working group of governments, regional economic integration organizations and stakeholder representatives to review and assess options for enhanced voluntary measures and new or existing international legal instruments. The ad hoc open-ended working group will focus on feasibility and effectiveness of voluntary and legally binding approaches, implementation options, costs and benefits of response measures and strategies, etc. The ad hoc open-ended working group will provide a final report to the

25th session of the Governing Council in 2009 which will take a decision on the matter (International Institute for Sustainable Development 2007; UNEP 2007)

Appendix C: SAICM Global Plan of Action

C.1 SAICM three core texts:

- The Dubai Declaration: the commitment to SAICM by Ministers, heads of delegation and representatives of civil society and the private sector;
- The Overarching Policy Strategy: the scope of SAICM, the needs it addresses and objectives for risk reduction, knowledge and information, governance, capacity-building and technical cooperation and illegal international traffic, as well as underlying principles and financial and institutional arrangements. The International Conference on Chemicals Management (ICCM) adopted the Overarching Policy Strategy which together with the Dubai Declaration constitutes a firm commitment to SAICM and its implementation; and
- A Global Plan of Action: the proposal of "work areas and activities" for implementation of the Strategic Approach. The ICCM recommended the use and further development of the Global Plan of Action as a working tool and guidance document.

C.2 The Dubai Declaration

309. The Dubai Declaration, "High-Level Declaration", affirms 30 declarations that the sound management of chemicals is essential for the achievement of sustainable development, including the eradication of poverty and disease and the improvement of human health and the environment (SAICM 2006).

C.3 The Overarching Policy Strategy

310. The Overarching Policy Strategy provides the needs that it addresses and objectives for risk reduction, knowledge and information, governance, capacity-building and technical cooperation and illegal international traffic, as well as underlying principles and financial and institutional arrangements. The scopes of the Strategic Approach are environmental, economic, social, health and labour aspects of chemical safety and agricultural and industrial chemicals, with a view to promoting sustainable development and covering chemicals at all stages of their life-cycle, including in products (SAICM 2006).

311. The objectives include issues regarding risk reduction (to minimize risk to human health and the environment, to reduce the generation of mercury waste, to ensure the environmentally sound management (ESM) of mercury waste, to promote the environmentally sound recovery and recycling of mercury waste, etc), knowledge and information (to ensure to adequately assess and manage knowledge and information on mercury, to make objective scientific information available into risk assessments especially for vulnerable sub-populations), governance (to achieve the sound management of mercury by comprehensive approach under legal framework), capacity-building and technical cooperation (to increase the capacity for the sound management of mercury and to encourage stakeholders on technical development), illegal international traffic (to prevent illegal international traffic in toxic, hazardous, banned and severely restricted mercury, such as mercury waste and used mercury-containing product) (SAICM 2006).

C.4 Global Plan of Action

312. A Global Plan of Action shows the activities that may be undertaken voluntarily by stakeholders in order to pursue the commitments and objectives expressed in the Dubai Declaration on International Chemicals Management and the Overarching Policy Strategy. Within the Global Plan of Action (273 activities), possible work areas and their associated activities, actors, targets and timeframes, indicators of progress and implementation aspects are grouped according to five categories of objectives contained in the Overarching Policy Strategy of the Strategic Approach, namely, risk reduction, knowledge and information, governance, capacity-building and technical assistance and illegal international traffic (SAICM 2006).

313. The objectives are: A: measures to support risk reduction that work areas aimed at protecting human health and the environment would include the development f action plans to address priority concerns in relation to groups with specific vulnerabilities; B: Strengthening knowledge and information which would include improved education, training and awareness-raising activities aimed at those who may be exposed to toxic substances; C: Governance, namely strengthening of institutions, laws and policy which would be measures to review national legislation in order to ratify and implement existing international agreements dealing with chemicals and hazardous wastes; D: Enhancing capacity-building whose measures include training of personnel in order to provide the necessary skills to support the systematic implementation of the Strategic Approach: E: Addressing illegal traffic whose actions are needed to prevent and detect illegal trafficking of chemicals and hazardous wastes; and F: Improved general practices whose activities are to improve general chemicals management practices (SAICM 2006).

314. Possible work areas and their associated activities for mercury waste are categorised in Table C-1 and Table C-2 (SAICM 2006):

Table C-1 Possible work areas and their associated activities for mercury waste management and minimization (SAICM 2006)

Activities	Main actors	Indication of progress	Implementation aspects
Facilitate the identification and disposal of obsolete stocks of mercury	SBC, BCRCs, Stockholm Convention Secretariat, IOMC (ILO, FAO, WHO, UNIDO, OECD, UNDP, World Bank), Montreal Protocol, National Governments, Industry, Trade unions, NGOs	• All obsolete stocks of pesticides and other chemicals are identified and disposed of.	• Identification of stockpiles of other chemicals; • Demonstration and promotion of appropriate stabilization technologies and long-term storage capabilities.
Establish and implement national action plans with respect to waste minimization and waste disposal, taking into consideration relevant international agreements and by using the cradle-to-cradle and cradle-to-grave approaches.	National Governments, BCRCs, Trade unions, NGOs	• National action plans with respect to waste minimization and waste disposal are developed and implemented in all countries.	• Model action plans; • Training
Prevent and minimize hazardous waste generation through the application of best practices, including the use of alternatives that pose less risk.	Industry, IOMC (UNEP, ILO, FAO, WHO, UNIDO, OECD, UNDP, World Bank), SBC, National cleaner production centres, Trade unions, NGOs	Alternatives are identified and introduced.	• Assessment methodology • Training Development and promotion of safer alternatives
Implement the Basel Convention and waste reduction measures at source and identify other waste issues that require full cradle-to-cradle and cradle-to-grave consideration of the fate of chemicals in production and at the end of the useful life of products in which they are present.	Industry, BCRCs, National cleaner production centres, IOMC (ILO, FAO, WHO, UNIDO, OECD, UNDP, World Bank), Montreal Protocol, Trade unions, NGOs	• Waste reduction measures at source are implemented in all chemical plants; • The Basel Convention is implemented in all countries.	• Training; • Awareness-raising; • Development and promotion of best available techniques.
Carry out measures that will inform, educate and protect waste handlers and small-scale recyclers from the hazards of handling and recycling chemical waste.	National Governments, Trade unions, NGOs, IOMC (ILO), SBC, United Nations Disaster Assessment and Coordination Team Unit	• Measures to inform, educate and protect waste handlers and small-scale recyclers are carried out.	• Particular attention to waste pickers and other actors in the informal recycling sector; • Infrastructure for dissemination of Information; • Awareness-raising.
Promote waste prevention and minimization by encouraging production of reusable/recyclable consumer goods and biodegradable products and developing the infrastructure required.	National Governments, National cleaner production centres, IOMC (UNEP, ILO, FAO, WHO, UNIDO, OECD, UNDP, World Bank), SBC, Industry, Trade unions, NGOs	• Mechanisms to encourage production of reusable/recyclable consumer goods and biodegradable products are in place in all countries.	• National cleaner production centres; • Information on successful initiatives; • Eco-design.

Table C-2 Possible work areas and their associated activities for mercury and mercury-containing products (SAICM 2006)

Activities	Main actors Indication of progress Implementation aspects
Promote reduction of the risks posed to human health and the environment caused by mercury, by ESM, including a thorough review of relevant studies such as the UNEP global assessment of mercury and its compounds.	National Governments, NGOs, Industry, IOMC (UNEP, WHO, UNIDO, UNITAR, OECD, UNDP, World Bank)
	• Risks posed by mercury that are harmful to human health and the environment are reduced in all countries. Relevant studies are identified and documented. A review of relevant studies is carried out and the results published and disseminated. Environmentally sound technologies for reduction of risks associated with mercury, especially for small recycling enterprises, are put in place and are in use.
	• Risk assessment methodology; • Training available
Consider the need for further action on mercury, considering a full range of options, including the possibility of a legally binding instrument, partnerships and other actions	IOMC (UNEP, UNIDO), (Cleaner production centres)
	• Further action on mercury is taken.
	• Analysis of options; • Technical capacity
Take immediate action to reduce the risk to human health and the environment posed on a global scale by mercury in products and production processes	IOMC (UNEP, UNIDO), (Cleaner production centres)
	• Further action is taken.
	• Legislation
Consider the review of scientific information, focusing especially on long-range environmental transport, to inform future discussions on the need for global action in relation to mercury	IOMC (UNEP) National Governments
	• Necessary actions are initiated.
	• Assessment of the need for global action

315. Possible work areas addressing knowledge and information for mercury-containing product are categorised in Table C-3 (SAICM 2006):

Table C-3 Possible work areas addressing knowledge and information for mercury-containing product (SAICM 2006)

Activities	Main actors Indication of progress Implementation aspects
Undertake research into alternatives for other lead-based products.	Industry, Academia
	• Alternatives to lead are used in products; • Improved technologies for small-scale recycling industries are in place and used.
	• Technical and scientific capacity.

Appendix D: OECD – Core Performance Elements of Environmentally Sound Management (ESM) for Government and Industry

D.1 Adequate Regulatory Infrastructure and Enforcement Should Exist to Ensure Compliance with Applicable Regulations

316. A regulatory infrastructure and enforcement at some governmental level should exist, that would ensure compliance with applicable regulations. It is, however, understood that the legal requirements, e.g. authorisation/license/permit requirements and conditions, may vary from country to country and from operation to operation (OECD 2003).

317. A regulatory framework and national environmental and/or waste legislation are considered to be prerequisites for controlling transboundary and/or domestic movements and recovery of wastes. Legislation and measures adopted at the national level should also include provisions on the enforcement. National legislation should also consider relevant international agreements, principles and standards for ensuring that a due account has taken to save natural resources and protect human health and the environment.

D.2 Recovery Facility Should Be Authorised

318. The recovery facility should be authorised under applicable domestic law for receiving waste from domestic and/or transboundary sources and perform recovery operations on them, including their intermediate storage and submission of pertinent residues to further recovery and/or final disposal. In addition, the recovery facility should fully record in-coming waste and out-going elemental mercury in order to understand global mercury flows and track mercury markets. In relation to the recovery process concerned, the authorisation should list the wastes categories that can be recovered and specify emission controls and/or limits to air, land and water, including wastes. In addition, the authorisation shall describe the recovery and storage capacity of the facility, in particular the amount of unprocessed hazardous wastes as well as their residues that may be temporarily stored on site (OECD 2003).

319. The authorisation should require the recovery facility to apply available “state-of-the-art" techniques (= BAT: Best Available Techniques) with technical and operational feasibility and economical viability, i.e. technology, processes, equipment and operations that are based on relevant scientific knowledge, whose functional value has been successfully tested in operative comparable plants (OECD 2003).

320. The competent authorities should conduct regular inspections for controlling compliance with all legal requirements taking into account enforcement priorities and available resources. The authorities should then also consider the need for amending the authorisation requirements, their continuity in the existing form, length of the their extension and/or termination in case of imminent danger to human health and/or the environment due to the emission(s) exceeding controls and/or limits, severe mismanagement or fraud of monitoring results (OECD 2003).

D.3 Recovery Facility Should Take Adequate Measures to Safeguard Occupational and Environmental Health and Safety

321. Workers of recovery facilities may be exposed to occupational health and accident risks, related to the content of the materials they are handling, emissions from those materials and the equipment being used. The recoverable materials may include radioactivity, hazardous chemicals, heavy metals; they may emit toxic gases or release harmful dust. Workers may have to handle heavy loads, be exposed to vibration and noise of machinery. Also, the risk of fire, explosion, etc. may exist in some cases. Consequently, adequate measures should be taken against these occupational health and safety risks (OECD 2003).

322. People living and working in the vicinity of a recovery and/or disposal facility may also be exposed to environmental health and accident risks. These risks relate mainly to the emissions, including noise, from the recovery process and transport to and from the facility. Therefore, adequate measures should be taken to minimise also these impacts to human health (OECD 2003).

D.4 Recovery Facility Should have an Applicable Environmental Management System (EMS) in Place

323. All recovery facilities should be certified/verified by an independent verifier/third party certifier under an applicable environmental management system (EMS), including (OECD 2003):

- Measurable objectives and, where appropriate, targets for continual improvements in environmental performance, including periodical review of the continuing relevance of these objectives;
- Regular monitoring and verification of progress toward environmental, health and safety objectives; and

- Collection and evaluation of adequate and timely information regarding the environmental, health and safety impacts of their activities.

324. Large recovery facilities should conduct regular inspections and/or audits to verify compliance with rules and regulations. These should be carried out through external independent “Auditors” (e.g. European Eco-Management and Audit Scheme (EMAS); ISO 14 000 Environmental Management) (OECD 2003).

325. Regular audits may create a burden and impose excessive costs on small and medium size enterprises (SMEs). Therefore, the audits of SMEs normally are less complicated and carried out less frequently than those of large facilities (OECD 2003).

D.5 Recovery Facility Should Have an Operative Monitoring, Recording and Reporting Programme

326. A Recovery facility shall have an operative monitoring and recording programme which covers (OECD 2003):

- Monitoring and recording of process parameters and compliance with the safety requirements;
- Monitoring and recording of the authorisation requirements;
- Monitoring and recording of effluents and emissions; and
- Monitoring and recording of incoming and outgoing wastes and materials and, in particular stored stocks and residues of hazardous waste.

327. All relevant environmental records should be maintained and made available to competent authorities according to the national legislation and authorisation requirements. Recovery facilities recovering (and generating) hazardous wastes shall report origin, types, amounts and location of hazardous wastes to the competent authorities (OECD 2003).

328. On-site recovery or disposal of wastes generated by the process concerned must be carried out in compliance with the relevant authorisation requirements and recorded appropriately. In case of off-site recovery or disposal, outgoing wastes shall be recorded appropriately and handed over only to environmentally sound recovery and/or disposal operations (OECD 2003).

329. Taking into account business confidentiality and the protection of intellectual property rights, the environmental, health and safety impacts of the activities of the recovery facility should be reported to the public in a reliable and timely manner. The report should also include information on the progress in improving environmental performance of the recovery facility (OECD 2003).

D.6 Facility Shall Have an Appropriate and Operative Training Programme for the Personnel

330. A facility shall have a system in place for proper identification and handling of any hazardous components in incoming wastes. Personnel involved in the management of wastes and materials, in particular hazardous wastes and materials, must be capable and adequately trained to be able to handle properly the materials, equipments and processes, eliminate risk situations, control releases and carry out safety and emergency procedures (OECD 2003).

331. Responsibility, authority and interrelations of key personnel who manage, perform and monitor the activities which may have adverse effects on the environment must be defined and documented (OECD 2003).

332. Adequate operative training programme for the personnel shall be in place and properly documented (OECD 2003).

D.7 Recovery Facility Should Have an Information Exchange Programme to Optimise Recovery

333. The recovery facility should establish and maintain an information exchange programme with the waste producers with the aim to optimise the recovery rate and quality of the product and minimise the generation of waste from the recovery process. Correspondingly, the recovery facility should get feedback also from the subsequent recovery and/or disposal facility concerning the optimum composition of his wastes. The purpose of this programme is to adjust the type and quality of the recoverable waste to facilitate improvements in the recovery process (OECD 2003).

334. This programme should cover all types and amounts of waste accumulating in the recovery facility and indicate options for optimal recovery and practical prevention and reduction of waste. Waste streams should be treated distinctively which would facilitate identification of optimised solutions, thus entailing advantages, such as savings on disposal costs. The programme should be constantly updated in order to be able to monitor the waste management on a continuous basis and evaluate the effects of measures taken (OECD 2003).

D.8 Recovery Facility Should Have a Verified Emergency Plan

335. A facility shall have a constantly updated plan for monitoring, reporting and responding to accidental or otherwise exceptional pollutant releases, including emergencies such as accidents, incidents, fires, explosion, abnormal operating conditions etc. The emergency plan should be based on the evaluation of existing and potential risks. An emergency co-ordinator should be designated to handle hazardous wastes. Large facilities would need a complete contingency plan. The plan should cover both the short-term and long-term remedial activities (OECD 2003).

D.9 Recovery Facility Should Have a Plan for Closure and After-care

336. For the case of closure the recovery facility should have a periodically updated plan for the cleanup and after-care of the facility site. An adequate financial guarantee (e.g. insurance, fund, earmarked fees) should be provided by large recovery facilities to assure clean up of the facility site in case of major pollutant releases, severe mismanagement of wastes and materials, and/or closure of the facility (OECD 2003).

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