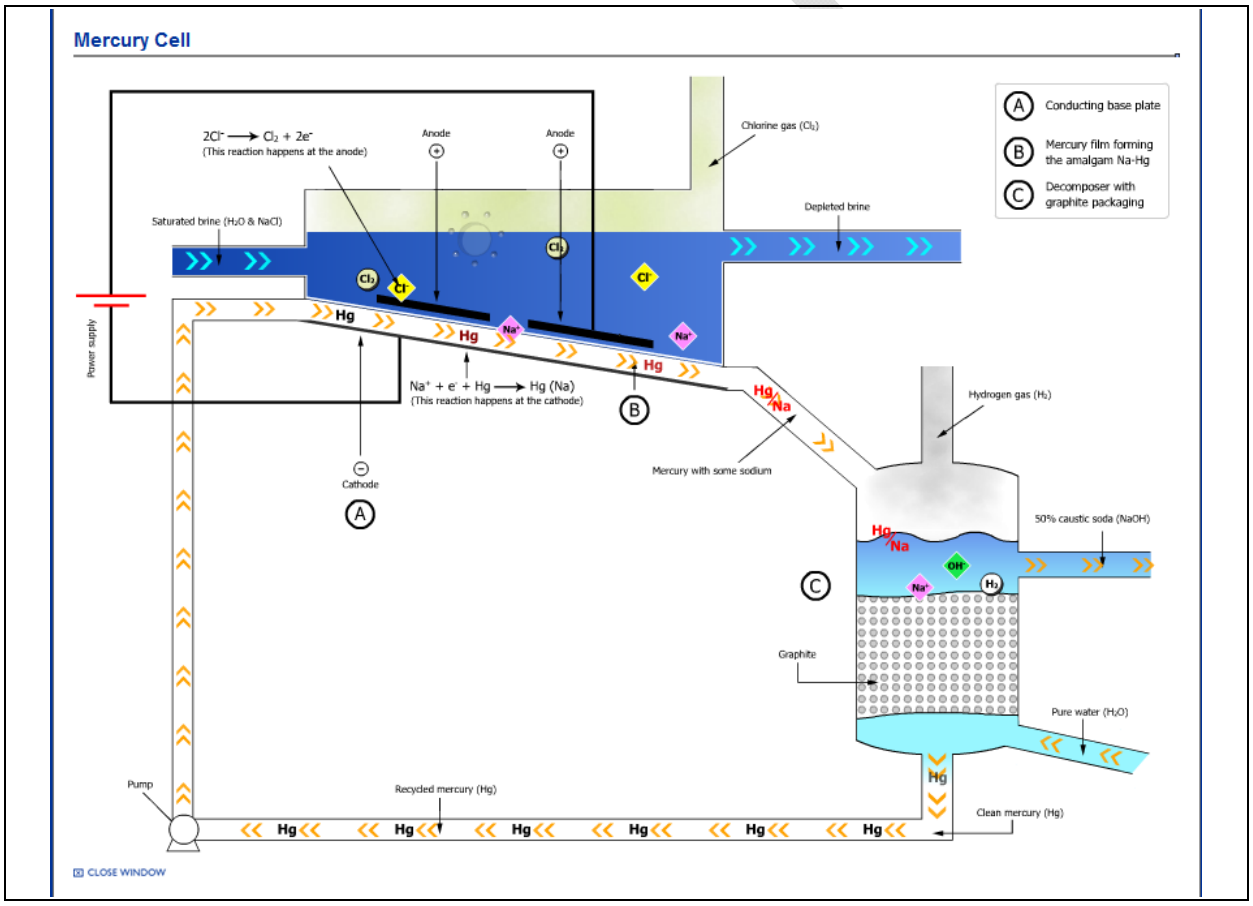
in cooperation with

Chloralkali Project - Uruguay

Final Report



UNEP/DTIE
Chemicals Branch
June 2011

Title page: Schematic drawing of the mercury cell process (courtesy Eurochlor)

The Government of Norway supported this pilot project through the Norway ODA grant funds 2010

Chloralkali Project - Uruguay

Final Report

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Abbreviations and Acronyms

BAT	Best Available Techniques
BCCC LAC	Basel Convention Coordinating Center for Latin America and the Caribbean
BEP	Best Environmental Practices
Clorosur	Latin American Chlor-Alkali and Derivatives Industry Associations
DINAMA	Dirección Nacional de Medio Ambiente (National Environmental Directorate of Uruguay
ESM	Environmentally Sound Management
EU	European Union
Hg	Mercury
Hg^{2+}	Mercury ion (2+)
(g)	Gas
GC	Governing Council (of UNEP)
ICCA	International Council of Chemical Associations
INC	Intergovernmental Negotiating Committee
POP	Persistent Organic Pollutant
SOP	Standard Operational Procedure
SSFA	Small-Scale Funding Agreement
T-Hg	Total mercury
UN	United Nations
UNEP	United Nations Environment Program
WCC	World Chlorine Council

Units

kg	kilogram
g	gram
mg	milligram
µg	microgram
ng	nanogram
mL	milliliter
µL	microliter
m^3	cubic meter
ppm	parts-per-million
t	ton
MT	metric ton

Summary

The Global Mercury Partnership is the primary vehicle for immediate action on mercury, contributing to the overall global mercury solution. The importance and urgency of immediate actions on mercury through the Global Mercury Partnership is clearly recognized by the UNEP Governing Council.

In the Consultation Meeting on Mercury Waste and Storage, held in Geneva, on 23 September 2010, this project was proposed. The aim is to provide for all chlorine-alkali plants for mercury technology, particularly in developing countries, a reliable guide, easy to use in the management of mercury. The mercury management in these plants aims protection of health and worker exposure to mercury, protecting the local environment and contributing to the global environment.

This project on assessment of the usefulness of the WCC guidelines on mercury in the chloralkali sector addresses issues included in three areas of the Global Mercury Partnership, namely:

– Mercury waste management

– Mercury reduction in the chloralkali sector, and

– Mercury supply and storage.

The Chloralkali Partnership states:
"Mercury cell chloralkali production is a significant user of mercury and a source of mercury releases to the environment. The mercury used in this process acts as an electrode in the chlorine production process. Mercury cell production facilities that close or convert to mercury-free technologies require environmentally sound management of mercury surplus and waste. Best practices, such as proper waste management, can minimize the release of mercury. Mercury-free technologies are also available in chloralkali production."

The World Chlorine Council presents guidelines on the best techniques and best practices in the management of mercury to plants in the industry. These guidelines are available and browse the website of UNEP.

The objectives of this project were:

1. To evaluate the adequacy (applicability) of WCC guidelines for use in chloralkali plant in development countries;
2. Presence and usefulness of the WCC guidelines at the chloralkali plant with respect to
   i) Occupational health management and workers exposure to mercury
   ii) Environment management related to mercury
3. Extension of the approach to other plants in the same sector and beyond.

This project is implemented by the United Nations Environment Program (UNEP) through its Global Mercury Partnership program jointly with the World Chlorine Council (WCC) with Clorosur, and the Government of Uruguay through DINAMA and Basel Convention Coordinating Center for training and technology transfer for Latin America and the Caribbean, and Efice S.A. Funds for the activities in Uruguay have been provided by the Government of Norway.

Checking 20 guidelines the WCC and plant participating in the project enable the observation of different aspects related to the applicability and application of the guidelines in developing countries, although the sample (one plant) was very limited.

The assessment approach included the following activities:
- Verification of WCC guidelines;
- Visit Efice facilities;
- Interviews with managers and other staff;
- Verification of records and other documents of relevance;
- Discussion of the WCC guidelines with managers and other staff
- Debriefing including all partners (Efice, DINAMA, WCC, UNEP)

Prior to the visit, the program had been agreed between Efice, WCC, DINAMA and UNEP. The basis for the assessment were (a) a checklist concerning the different activities, prepared by the WCC Expert and agreed with the partners, and (b) the WCC Guidelines.

The verification was carried out in the period of April 4-8, 2011, in the chloralkali plant of the EFICE S/A, in Uruguay, based on the Terms of Reference. The findings were:

- The WCC guidelines can be recommended for use in chloralkali plants to mercury technology in all countries. Some aspects of the guidelines may not fully meet what would be ideal for use in developing countries (for example, when the guidelines are in English version only, they were not subject to specific action of adaptation; all the guidelines do not include an introductory document to complete initial understanding on all the guidelines. However, this does not constitute a barrier that prevents the immediate use of guidelines). In addition to the aforementioned qualities, the basic elements to recommend its use consist in the fact that the techniques and recommended practices apply to all plants with this technology;

- Some guidelines are known and used in a number of plants in developing countries, particularly in those plants related to WCC institutions. However the set of guidelines are barely known, as well as its current availability on the website of UNEP.

The assessment performed allowed the identification of the following opportunities for better understanding and use of guidelines, particularly in plants located in developing countries:

- The development of a introduction document (guide) with information that enables an overview of the mercury management in chloralkali plants with mercury technology and regarding the content and use of available guidelines;

- The improvement in the mechanisms that promote the knowledge of the guidelines and forms of accessing and using them.

- The possibility for other chloralkali plants to reach WCC guidelines if they are not familiar to WCC or UNEP partnerships

In the performed assessment it was possible to conclude that the WCC guidelines should be recommended for use in plants from different regions. However, it is applicable for a better understanding of the user less familiar with these guidelines.

The study also allowed achieving a result that can be useful in advancing actions to some of

the goals pursued in international instruments and initiatives such as those of the Global Mercury Partnership, the Johannesburg Plan of Implementation and Strategic Approach to International Chemicals Management, the INC for a future Convention on the Mercury and the Basel Convention.

The project allowed the mobilization of different parts promoting interaction and speeding the flow of the actions, which complies, with the objective of the UNEP/WCC Mercury Partnership in Chloralkali plants.

1 INTRODUCTION

Governments initiated partnership activities addressing mercury at Governing Council 23 and have subsequently strengthened the role of partnerships to effectively deliver mercury activities. Governing Council 25/5 specified the UNEP Global Mercury Partnership as one of the main mechanisms for the delivery of immediate actions on mercury during the negotiation of the global mercury convention.

The Global Mercury Partnership is the primary vehicle for immediate action on mercury, contributing to the overall global mercury solution. The importance and urgency of immediate actions on mercury through the Global Mercury Partnership is clearly recognized by the UNEP Governing Council.

Partnership activities have been on-going since 2005; the Global Mercury Partnership was formalized through the development of the Overarching Framework in 2008, following extensive consultation with partners and stakeholders, and now operates through seven partnership areas that reflect the major mercury source categories.

1. Reducing Mercury in Artisanal and Small-Scale Gold Mining
2. Mercury Control from Coal Combustion
3. Mercury Reduction in the Chloralkali Sector
4. Mercury Reduction in Products
5. Mercury Air Transport and Fate Research
6. Mercury Waste Management
7. Mercury Supply and Storage

This project on assessment of the usefulness of the WCC guidelines on mercury in the chloralkali sector addresses issues included in three areas of the Global Mercury Partnerhsip, namely:

– Mercury waste management
– Mercury reduction in the chloralkali sector, and
– Mercury supply and storage.

It is clear that there are many important and strategic on-going actions that are contributing to the reduction of mercury in the environment today. The Global Mercury Partnership is implementing pilot projects, encouraging innovation, building scientific and guidance materials as well as raising awareness.

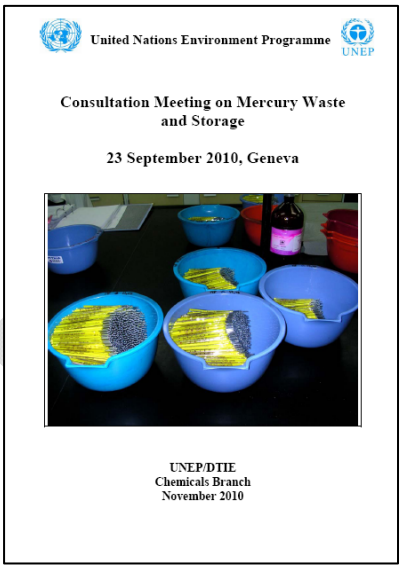
The Chloralkali Partnership states:

“Mercury cell chloralkali production is a significant user of mercury and a source of mercury releases to the environment. The mercury used in this process acts as an electrode in the chlorine production process. Mercury cell production facilities that close or convert to mercury-free technologies require environmentally sound management of mercury surplus and waste. Best practices, such as proper waste management, can minimize the release of mercury. Mercury-free technologies are also available in chloralkali production.”

Further reading:
http://www.unep.org/hazardoussubstances/Mercury/GlobalMercuryPartnership/tabid/1253/language/en-US/Default.aspx

This project is implemented by the United Nations Environment Programme (UNEP) through its Global Mercury Partnership programme jointly with the World Chlorine Council (WCC) with Clorosur, and the Government of Uruguay through DINAMA and LATU, and Efice S.A. Funds for the activities in Uruguay have been provided by the Norwegian Government.

The project has been initiated at the Consultation Meeting on Mercury Waste and Storage, held in Geneva, on 23 September 2010. The meeting intended linking UNEP projects on mercury waste and storage.


United Nations Environment Programme
UNEP

Consultation Meeting on Mercury Waste and Storage

23 September 2010, Geneva

UNEP/DTIE
Chemicals Branch
November 2010

Three pilot projects were proposed and implemented in 2011. They are intended to provide handy guidance and information on the following:

– Toolbox on awareness raising in households
– Health care sector (video)
– Chloralkali BEP application

The report can be viewed at the website of the Mercury Waste Management Partnership area: http://www.unep.org/hazardoussubstances/Portals/9/Mercury/Waste%20management/Report_Consultation%20mtg%20on%20Mercury%20waste%20and%20storage_Sep%202010.pdf .

The objectives of this project were:

1. To evaluate the adequacy (applicability) of WCC guidelines for use in chloralkali plant in development countries;
2. Presence and usefulness of the WCC guidelines at the chloralkali plant with respect to
   i) Occupational health management and workers exposure to mercury
   ii) Environment management related to mercury
3. Extension of the approach to other plants in the same sector and beyond.

The steps in the project include the following:

- Starting point: WCC guidance documents on how to handle metallic mercury
- Objectives
  – Check applicability and improve if relevant these existing guidelines
- Process – Plan: identify country, plant, consultant
- Check:
  – If company is aware of WCC guidelines, what they use, translation necessary?
  – Check flow of mercury – where would metallic mercury come from within the plant and would need to be handled safely through the process
  – Check interim/temporary storage on site facilities / spills handling?

- Implementation on site with the expert of the guidelines
  - Is the company implementing some guidelines already? Are they the same? If not what are the differences?
  - Are things missing from guidelines? how can these be improved?
  - Are they useful to the company?
  - What are the gaps in storage? Handling?
- Meeting with relevant authorities and industry and stakeholders for wider awareness raising.

2 INSTITUTIONAL ARRANGEMENTS

The project was implemented from November 2010 until June 2011. Participating institutions included the following (names and e-mail contacts are listed):

Uruguay

Dirección Nacional de Medio Ambiente (DINAMA), Montevideo, Uruguay

National Environment Director	Jorge Rucks
Department of Control and Environmental Performance Director	Silvia Aguinaga
Environment Emissions Department Technician	Verónica Gonzálvez
Department Responsible for Hazardous Substances	Judith Torres

World Chlorine Council (WCC)

Euro Chlor Technical Director	Jean-Pol Debelle
Consultant	Arseen Seys
Clorosur Executive Director	Martim Afonso Penna mpenna@abiclor.com.br

Efice S.A.

President	Nestor Gómez Alcorta ngo@efice.com.uy
Gerente Manager	Omar Parada onp@efice.com.uy
Operational Manager	Alfredo Infanzón aip@efice.com.uy
Production Manager	Gabriel Steiner gss@efice.com.uy
Quality System Manager ISO-9001	Alberto Barquet calidad@efice.com.uy
Integrated System Coordinator	Ing. Diego Pereyra csig@efice.com.uy
Control and Analysis Leader	Roberto Carraro rcp@efice.com.uy
Prevention Technical	Ing. Pablo Realini prevencionista@efice.com.uy
Physician Servicio de Medicina Preventiva – SEMM	Dr Ceni vigilanciasanitaria@efice.com.uy
Integrated System Coodinator PCRMA	Ing. Quím. Adriano Debali adi@efice.com.uy

Electrical Departament Leader	Tulio Ravaschio trd@efice.com.uy
Technical Leader	Dario Vigna dvs@efice.com.uy
Production Leader	Federico Corral fcg@efice.com.uy
Mercury Supervisor	Olverio Barbosa obo@efice.com.uy
Sales Supervisor	Andrea Novillo anl@efice.com.uy
Expert	Gilberto Marronato marronato@uol.com.br

United Nations Environment Programme

Division of Technology, Industry and Economics Chemicals Branch, Geneva, Switzerland	Dr. Heidelore Fiedler heidelore.fiedler@unep.org

3 USE OF MERCURY IN THE CHLORALKALI PROCESS

3.1 The Mercury Cell Process

Chlorine is produced by electrolysis when an electric current is passed through a solution of brine (common salt dissolved in water). Co-products are caustic soda (sodium hydroxide) and hydrogen. All three are highly reactive, and technology has been developed to separate them and keep them separate. Stringent operating conditions are maintained to protect the health of manufacturing staff and the environment. The following Figure 3-1 shows the mercury cell process.

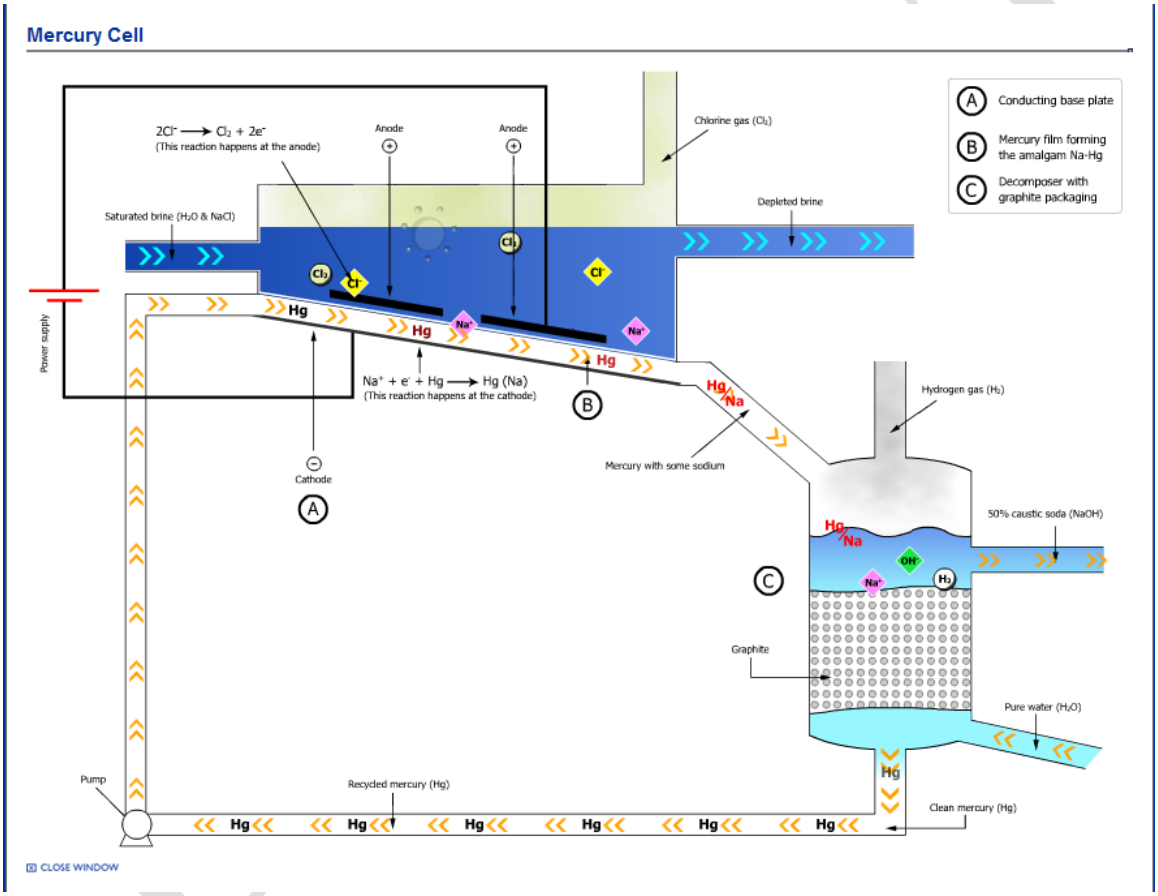


Figure 3-1: Schematic drawing of the mercury cell process (courtesy Eurochlor)

The electrolytic cell has titanium anodes located above a mercury cathode, which flows along the bottom of the cell. Under the action of a direct current on brine, chlorine is released at the anode and sodium dissolves in the mercury cathode to give an amalgam. The sodium amalgam passes out of the electrolytic cell into a separate reactor, away from the chlorine. Here, it reacts with water to give hydrogen and caustic soda. The Figure 3-2 shows the reactions in mercury cell process. This regenerates the mercury, which is then returned to the electrolytic cell. Salt is added to the brine leaving the cell and the brine is recirculated. Some 2.26 tonnes of 50% caustic soda and 312 cubic meters of hydrogen result from the production of one tonne of chlorine. The mercury process produces extremely pure, high quality caustic

Reaction in the electrolyser

$2\ Na+ + 2\ Cl- + 2\ Hg \rightarrow 2\ Na\text{-}Hg + Cl_2\ (g)$

Reaction in the decomposer

$2\ Na\text{-}Hg + 2\ H_2O \rightarrow 2\ Na+\ 2\ OH- + H_2\ (g) + 2\ Hg$

Figure 3-2: Reactions in mercury cell processes

3.2 Participation of Chloralkali Sector in the Global Mercury Partnership

The World Chlorine Council (WCC) became a partner in the Chloralkali partnership on 7 April 2009. WCC represents chloralkali producers. WCC is a committee of the International Council of Chemical Associations (ICCA) and congregate Producer Associations, Product Sector Associations and has Corresponding Associations (see Annex 7.6).

WCC has been systematically collecting data on the production capacity relying on mercury technology, on mercury use and emissions. Since 2006, using as starting date the year 2002, WCC issues the report "World Chlorine Council: Chloralkali emissions/ consumptions – Reporting to UNEP". There are different plant sizes in different locations – EU, USA, South America, Mexico, India and Russia providing their data. This corresponds to about 85% of the global production capacity with this technology. The time trend for mercury-based production capacity and the number of plants in the period 2002-2010 is shown in Figure 3-3. As can be seen, the number of plants using this technology decreased from 91 to 57 due to technology conversion.

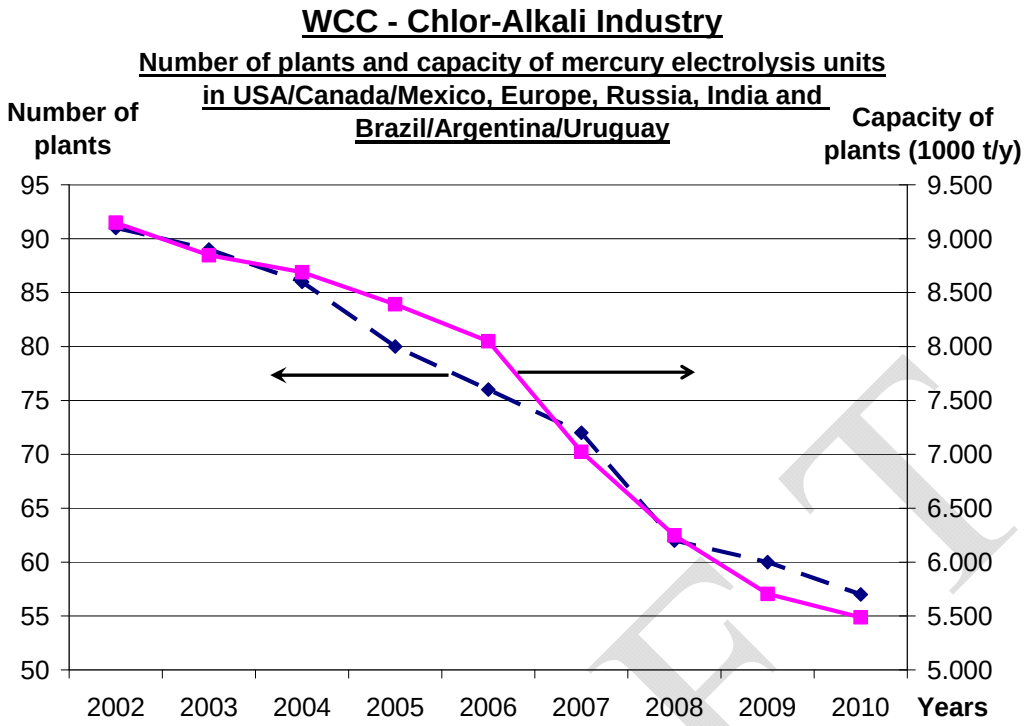


Figure 3-3: Mercury-based production capacity downtrend (Report WCC 2011)

The mercury emissions in the plants monitored by WCC declined from 24.6 t/year in 2002 to 6.7/t year in 2010 (see Figure 3-4).

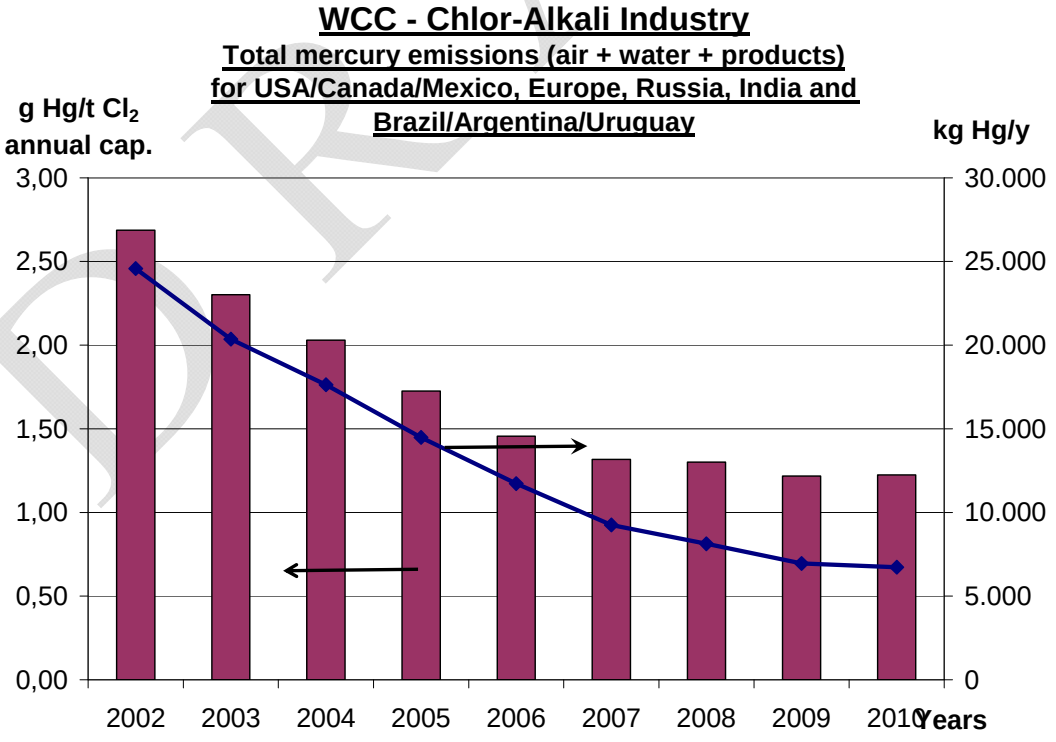


Figure 3-4: Global mercury emissions reduction (Report WCC 2011)

4 PROJECT IMPLEMENTATION

4.1 Pre-visit Arrangements and Timetable

The assessment approach included the following activities:

- Verification of WCC guidelines;
- Visit Efice facilities;
- Interviews with managers and other staff members;
- Discussion of the WCC guidelines with managers and other staff members;
- Verification of records and other documents of relevance;
- Debriefing including all partners (Efice, DINAMA, WCC, UNEP)

Prior to the visit, the program had been agreed between Efice, WCC, DINAMA and UNEP. The basis for the assessment were (a) a checklist concerning the different activities, prepared by the WCC Expert and agreed with the partners, and (b) the WCC Guidelines.

4.2 Physical Visit at the Chloralkali Plant

The physical visit of the plant to undertake the activities mentioned in section 4.1.took place from 4 to 8 April 2011.

The chloralkali plant of Efice S.A. has the following characteristics: The plant was established in the year 1958 and presently has an annual capacity of about 14,600 MT of chlorine. The organizational structure includes: Two managers (responsible for Production and Operation), six chiefs of departments, 83 persons in operation processes. Figure 7-1 and Figure 7-2 show the layout of the physical plant and Organigram of Efice. The company is an oversea production member of the Chlorine Institute since 1996, and it is a founder member of Clorosur in 1998. It joined the industry's Responsible Care in 1998; it is ISO 9001 certified (quality) and invests in the implementation of an integrated management system (environmental protection, occupational health, *etc.*). With respect to the Management of Mercury, the plant cooperates with the national authority (DINAMA). Further, the company contributes with the Annual Report of WCC: "Chloralkali mercury emissions/consumptions" sent to UNEP.

Before the site visit, an evaluation protocol has been agreed between all partners. The evaluation process include, site visit to plant and its installations, presentations by the evaluation team (UNEP, WCC Expert) and the company (Efice S.A), interviews, and meetings in larger groups, such as at the onset of the site visit and a debriefing at the plant.

4.3 Background and Briefings

The chlorine production using mercury technology has declined over the last decades. Since the 1980s, no new units with this technology have been constructed. The existing units are gradually being deactivated or replaced by mercury-free technologies. According to information WCC tracked 91 plants since 2002: during that year until 2010 thirty four plants were closed or converted to another technology. The substitution does not occur more rapidly due to the economic-financial difficulties, the losses to the enterprises are significant due to the costs for replacement. Therefore, it can be assumed that existing plants using the mercury technology may stay in operation over the next years.

According to information from the World Chlorine Council, about 10% of global capacity for chlorine depends on the mercury process. In response to a recommendation of the UNEP Global Mercury Partnership Advisory Group in 2009, the partnership area has updated a 2004 database of global mercury cell chlorine capacity. According to data compiled, some 100 facilities in 44 nations today have some industrial mercury cell chlorine capacity. Figure 4-1 and Figure 4-2 present the distribution of facilities and installed capacity of production by region with this technology; more details in the Table 7-2.

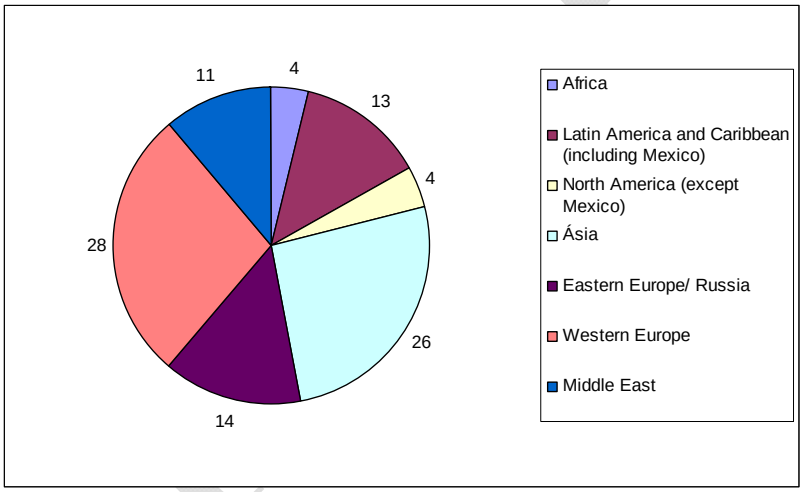


Figure 4-1: Number of facilities with mercury technology by region

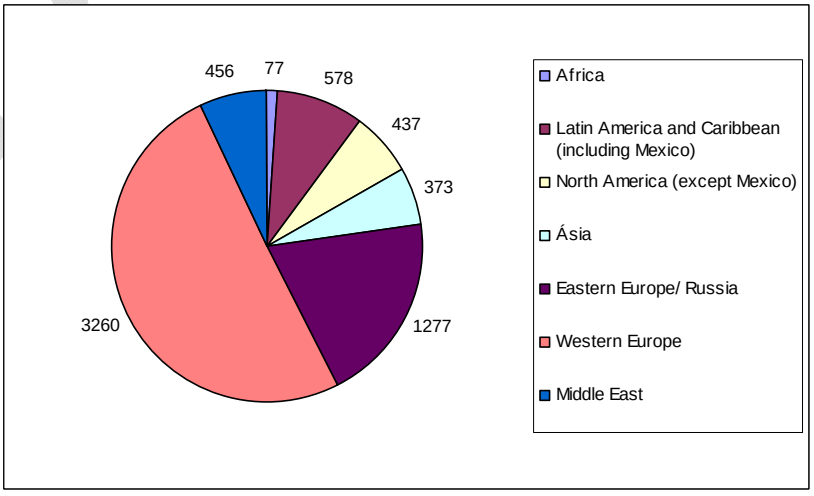


Figure 4-2: Thousands of metric tons of chlorine capacity by region

Plants with Mercury technology have their installed capacity varying considerable. Table 7-2 shows the predominance of plants with capacities up to 25,000 MT/year of chlorine in Asia and Africa (more than 25 plants). Plants with capacities above 100,000 MT/year are located in West Europe, East Europe and USA (more than 30 plants). In Latin American and the Caribbean region and Middle East capacities vary.

In this scenario, the purpose of this project is to provide guidelines on the safe management of mercury in chloralkali plants, which still have this technology, particularly in developing countries. The guidelines should be adequate to meet the needs and desires of the plants and be used effectively.

Together with it's members, WCC has developed guidelines for the mercury management and its intended use in all chlorine-alkali plants. The WCC guidelines – see Section 7.2 - include 20 documents that address important issues such as best practices for occupational health, workers exposure to mercury, mercury analysis, and environmental management. They were developed by the Chlorine Institute, for use in U.S. plants, and by Euro Chlor, for plants in Europe. Some guidelines are known and used in a number of plants in developing countries, particularly in those plants related to WCC institutions. However the set of guidelines are barely known, as well as its current availability on the website of UNEP.

The guidelines apply to both plants in operation and plants being decommissioned. The closure or conversion of mercury plants in the world could result in the need to recover a major volume of mercury contained in existing cells. According to WCC the following estimated mercury quantities (base year 2010) are available in the cells of its member companies: 7,500 tonnes in Europe, 1,200 tonnes in North America (USA + Mexico); 600 tonnes in Latin America (except Mexico) and Caribbean regions; 200 tonnes in India and 800 tonnes in Russia". Careful planning and co-operation between industry and the authorities would be essential in ensuring proper storage, use or disposal of this valuable, high-quality mercury.

In examining the adequacy of the WCC guidelines for its intended use, as well as the knowledge and use of guidelines, particularly in plants located in developing countries and other aspects of the project were considered relevant:

4.3.1 General Characteristics of Chloralkali Plants

The use of the same basic process (shown in Figure 3-1) makes possible the use of guideline in all plants. The significant differences that exist between them (e.g., plant age, capacity, mechanical integrity of facilities and level of modernization for better productivity in mercury management) can lead to different needs and priorities, but not prevent the use of guidelines. Another difference is the raw material used (sodium chloride or potassium chloride), which also does not constitute problems in the use of guidelines.

It is important to mention that there is other type of electrolysis that make use of Mercury and for which the guidelines are not directed. They are electrolysis processes employed to alkoxides, dithionites, sodium and potassium metals. However, great part of the guidelines content can be useful.

4.3.2 Guidelines Availability

The WCC guidelines are accessible at UNEP's website on the Global Mercury Partnership http://www.unep.org/hazardoussubstances/Mercury/PrioritiesforAction/ChloralkaliSector/Reports/tabid/4495/language/en-US/Default.aspx . However, not all concerned stakeholders are aware of this free access and availability.

4.3.3 Content

The content of all guidelines is very wide-ranging. Its recommendations apply to virtually the entire flow of mercury in the plant (from the purchased mercury storage, use of cell decomposers, product treatment facilities, effluents and waste). It also applies to different specific objectives (workers´ health protection, environment, quality, process management). The guidelines deal mainly with techniques and control and monitoring practices to reduce risks. They can also be useful for situation check (audits) and as a support in improving personnel training.

The contents of each guide is very clear and includes the technical and / or practices that effectively lead to the proposed results. For some topics there are two versions of guidelines (Euro Chlor and Chlorine Institute). The use of any of them leads to progress.

It is missing in the guidelines an introductory document that allows the user, particularly those less familiar, an overview of all the guidelines including a content and application of each.

4.3.4 Update

The guidelines, in their updated version, were published between years 2000 and 2010. Over 70% of them have been subject to revision at least one time. Their recommendations remain valid in their entirety for use in chlor-alkali plants in different regions, in combination with local regulations that must prevail, as pointed out in the guidelines.

4.3.5 Adaptation of Guidelines for Use in Plants Located in Developing Countries

The WCC guidelines were provided to UNEP in its original form. Even considering an adaptation, the guidelines must meet fairly satisfying the needs and desires of the plants in developing countries; besides it already occurs in some cases. Although the guidelines have been designed for use in plants of the United States or Europe, the techniques and practices that are assembled in them are of general application.

It is important to mention that these guidelines may include, in some cases, patterns or connections with American or European rules and regulations. The users must certainly employ those applicable their country, the guidelines bring this counsel. However, it is not uncommon in the absence of these regulations and standards, or even as additional reference for management, users consult American and European standards and regulations; in general they are available on the Web.

4.3.6 Guidelines Reliability

The origin of the guidelines is one factor in the reliability of them. The Chlorine Institute, Euro Chlor and the WCC are distinguished by the expertise and the commitment to the safe management of mercury and chlorine-alkali facilities. A second factor is that the guidelines offer the best techniques and practices developed and tested in several chloralkali plants. This has permitted the plants to achieve high standards of management and performance.

4.3.7 Feasibility of Techniques and Practices

Technically the guidelines recommendations are all viable. In recent decades, in a scenario of long life of these plants they were also considered socio-economically viable in the whole. Even in a scenario that considers a short time of operation, the socio-economic analysis may show that many recommendations remain viable for the reasons listed below.

The set of techniques and practices in the guidelines is very broad. There are different possibilities of use in improving management and performance related to health and exposure of workers and environmental protection, including contributions to the global environment improvement.

The required investment for implementation or improvement is quite variable. In many cases, the measures are on the improvements in procedures and work rules, with some investment in equipment and staff training. In others, it includes the implementation of retention and/ or recovery techniques of mercury inside and outside the site. These investments are also variable depending on the technique. Investments may also include the contraction of outside expertise for specific activities, for which there are no professionals in the plant.

4.3.8 Other Aspects about Guidelines

Some guidelines connect to others that are not included in the set provided to UNEP. For example:

- GEST 92/171 – Personnel Protective Equipment for Use with Chlorine;
- TSEM 05/311: Decommissioning of a Mercury Chlor-Alkali Plant.

The guidelines for the Optimization of Mercury Treatment – Ed 1 – Final Dec 2003, is listed on the website, but access is not possible.

4.3.9 Understanding the Guidelines

The guidelines, individually, have a structure, clear and objective message and recommendations. They can be well understood by practitioners of the plant for which they are intended. Even when the user is not expert in the subject matter of the guide, he can easily comprehend. This is favorable for those in charge of general management functions or those who need to specify conditions for hiring external services.

As previously mentioned, the absence of an introduction document (guide) complicates the understanding of a set of guidelines on the mercury management.

The WCC guidelines exist only in English version. This can be a barrier or a difficulty in the comprehension of guidelines use, but the real need of translation is indefinable. Any translation should consider the selection of guidelines by its importance in mercury management and potential users in the plant. For example, the "Code of practice mercury housekeeping" and / or the "Guidelines for mercury cell chlor-alkali plants emission control: practices and techniques" may be overriding. They are basic in management and are often used by managers, supervisors and workers who operate in the setting rules and safe work methods in the plant.

In the case studied, the guidelines are used in its original language by the management and supervisors. Specific instructive and guidelines in Spanish are developed for the workers as a part of the Quality System.

4.3.10 Easiness of Identification and Handling the Guidelines

The user may easily identify the desired topic by the title shown on page of the website where they are listed. In some cases there are two versions (Euro Chlor´s and Chlorine Institute´s versions). When the topic can not be identified by title (e.g., storage of mercury) it will be necessary to search the contents of each guide that may likely contain the theme. An index/reference list could help in the introductory document.

While managing guidelines individually, the user should not face difficulties; guidelines are divided into well defined volumes considering its purpose, the content is clear, as already noted and when there is additional information to highlight, there are links mentioned in the guidelines.

4.3.11 Guidelines: Knowledge and Usage in the Plants

According to Clorosur, the Latin America and Caribbean plants that belong to international North American companies know and use more the Chlorine Institute guidelines while the plants that belong to international European companies know and use more the Euro Chlor guidelines. The non-international plants related to Clorosur know some Chlorine Institute guidelines. During the WCC- Clorosur Mercury Workshop promoted by WCC/ Clorosur, in September, 8th and 9th, 2003 in São Paulo the Chlorine Institute guidelines on mercury were distributed and discussed with the participant plants, including Chlorine Institute, Euro Chlor; Alkali Manufacturer’s of India; University of Brasilia; EPA representatives and regional plants. Regarding the Latin America and Caribbean plants non-related to Clorosur, the institution does not dispose of information on possible knowledge and usage of those guidelines.

The guidelines can be useful for several professionals in the plant. For example, the production, engineering and maintenance managers and other key personnel in the risks reduction thought the implantation and improvement of techniques and practices of control and monitoring; specific program coordinators (safety, environment protection, etc) for situation analysis and orientation of actions in the programs, the hygienist and the physician can find in these guidelines specific orientations related to employees exposure to Mercury. The leader can also find in the guide helpful elements in decisions making. Other uses may be

considered, however they are not the aim of the guidelines; it includes the delivery of useful information to personnel training, and contracting specialized services not covered by plant personnel and contact with stakeholders.

4.3.12 Case Study: Use of WCC Guidelines in Chloralkali Plants Located in Developing Countries

The study was carried out in Efice S/A plant located in Uruguay. The profile of the company is described in section 4.2.

The managers knew all Chlorine Institute Guidelines. The company is an oversea member of the CI since 1996 and uses as a policy, these guidelines and additional materials from other sources when needed, for example documents from Eurochlor, EPA, the European Commission. Also visits were carried out in plants in Brazil regarding Best Practices.

Regarding the effective use of WCC guidelines, a relevant example is related to occupational health. Three years in the past, the company decided to improve the employee's medical vigilance management. For this, the used the Pamphlet 125 of Chlorine Institute: Guidelines – Medical Surveillance and Hygiene Monitoring Practices for Control of Worker Exposure to Mercury in the Chlor-Alkali Industry. The medical expert is from outside the company. Before beginning, the meetings were held with employees and Workers Committee. Some questions and guide information have arisen, and the expert's knowledge was important to correct the plan. In the first year of analysis of urinary mercury, four employees (out of a total of sixty two) showed values, for which the Pamphlet 125 recommends a review regarding working procedures, personnel hygiene practices and protective equipment practices. The measures for improvement includes staff training, and information in the guide were used. The following campaigns demonstrate normal values. For the implementation of this monitoring plan, the company hired a lab in Spain, with experience in analysis of mercury and creatinine; this requires a special logistics in relation to air transport of samples, but is running smoothly.

According to Efice, these results are possible, because the company has undergone a continuous improvement in mercury management for a long time, which includes the complete redesign –structure and materials-, of the mercury cells, allowing a smooth operation with minimal need of cell opening [1].

Other important aspect to be mentioned is the constant contact between the plant and the national authorities (DINAMA) and BCCC LAC to discuss the mercury management. A recent action was the fulfillment of the analysis campaign at the plant during six months to generate data to fill out the survey of emissions (UNEP Toolkit level 2, March 2010) of Uruguay. Improvement actions in the mercury management are also planned in the annual plan of the company.

During the visit it was possible to observe that there are several specific techniques implemented, but the guidelines' content allows the identification of several advancement opportunities for the plant in the management of mercury context. With regard to the needs or

[1] Efice has a manufacturing shop for some cell parts. This own development allowed the Company in year 2004 to close an agreement with *De Nora do Brasil*, main provider of chlor-alkali technology, to produce components of cells for mercury chlor-alkali plants in South America

desires of the plant, virtually all aspects are covered except for the need for storage of waste containing mercury during relatively long time. It is a local matter, unusual in most plants that regularly destine the waste to treatment and / or industrial landfills. In this case, waste from more than twenty years is stored on site.

It was noticed during the visit that the leader, team management and operators are sensitized to the issue of mercury and what actions are ongoing progress. Specific opportunities identified by the verification team are the subject of a brief report to the plant.

The participation from the chloralkali plant was very positive and finally, more than 20 staff members took actively part in the project. These included the president of Efice, CEO, department chiefs, manager, and operational staff. Nevertheless, it should be understood, that this pilot project was implemented in only one plant. Further efforts should be applied in order to identify other aspects that could contribute with the applicability or application of the guidelines and were not possible identified in this limited one-case study.

4.3.13 Remarks

The comments below are related to objective number 3 (Chapter 1 - Introduction) - “extension of the approach to other plants in the same sector and beyond”.

The decision to do the Efice assessment to meet together UNEP, local government, WCC/Clorosur and plant people. It provided an opportunity to rapidly implement measures to comply with the UNEP/WCC Global Mercury Partnership objectives.

The involvement of participants, the transparency and the open dialogue, and the way the preparation process was conducted (understanding and project structuring) and its implementation were important factors in the success of the assessment.

The project is a result of various inputs aiming to promote the WCC BAT/BEP guidelines on mercury handling in chlor-alkali plants. It can be replicated in different countries particularly were there are medium and small size plant, members of WCC or not.

Also, the same procedure can be adopted to assess other different industrial sectors which handles metallic mercury, as for example: lamps manufacturing, treatment and recovery of mercury wastes, others.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Technical Conclusions

The project has generated the following outputs:

- The basic process conception is the same one for the chloralkali plants in other locations; this fact makes the WCC guidelines instruments of global application.

- The WCC guidelines can be recommended for use in chloralkali plants with mercury technology in all countries;

- The following guide qualities favor its application: the guidelines cover technical and / or practices that apply to the entire flow of mercury in the plant, including waste and products containing it; they apply the goals of safety and occupational health, environment protection and contributions to the global environment. Each guide contains in a clear and objective language, guidelines that effectively lead to the proposed results. The guidelines are enough updated. They are reliable. They are available;

- In the case study, a recent application of techniques and practices based on one of the guidelines (125 Pamphlet Chlorine Institute) resulted in full success;

- The guidelines were not subject to adaptation for use in developing countries. This, however, should not constitute obstacles to the use of the guide. Techniques and practices are universal. The difference lies in the fact that citations of patterns and connections to American or European regulations should not be a big problem;

- There are numerous possibilities for application of techniques and practices. The investments are variable, some abbreviate administrative measures and material expenses, and others may require investment in techniques that demands a specific socio-economic analysis;

- The appropriateness of translation is difficult to measure. If so, a list of priority guidelines based on user and importance of the guidelines should be considered. More than 60% of the plants are in Asia, Eastern Europe / Russia, Middle East, Africa and Latin America;

- Many potential users probably do not know the guidelines and / or the existence of the entire collection on the website of UNEP. Access by keywords does not lead to the website;

- The lack of an explanatory document (Getting Started) is not conducive to proper understanding about the guidelines and other aspects of running mercury.

- The project allowed the mobilization of different parts promoting interaction and speeding the flow of the actions, which complies with the objective of the UNEP/WCC Mercury Partnership in Chloralkali plants.

5.2 Results in International Context

The instruments and initiatives of international interest in this study includes: the Global Mercury Partnership, the Johannesburg Plan of Implementation and Strategic Approach to International Chemicals Management, the INC for a future Convention on the Mercury and the Basel Convention.

This study achieved some results that may be useful for the purposes of these instruments. Considering the appropriate guidelines for use in all chloroalkali plants, particularly those in developing countries, and identifying improvement opportunities for the dissemination, understanding and use of guidelines, it opens a range of actions in the field of voluntary actions for risk reduction in the use and handling of mercury, improvement of information and knowledge, and technical cooperation in the transfer of successful methods. The smooth operation to the arrangement used in this pilot study, the involvement of UNEP, government, WCC and plants can be a way to be considered in the actions of continuity.

5.3 Recommendations

- Examine the possibility of drafting a introductory text (guide) for the set of WCC guidelines to explain the WCC guidelines (similar to the guidelines on POPs, but directed structure to mercury);

- Include available guidelines regarding mercury in the set of UNEP guidelines (refer to Section 4.3.8).

- Examine alternatives to make better known the existence of guidelines and / or ways to access the site; specially for those potential users that are not part or the WWC.

- Examine the possibility of consulting the countries regarding possible needs of plants for the management of mercury, including useful guidelines in English and / or translated versions.

- Evaluate the extension of the approach of the Uruguayan Project to other chloralkali plants.

- Evaluate the same approach of the Uruguayan Project to other industrial sectors.

- Include an information event for government actors and stakeholders so as to sensitize on the mercury issue as well as informing what it is being done to improve chloralkali industry.

- Organize a meeting of the three partnership areas - waste, chlor alkali and products/Storage - to build on this project and develop a workplan of immediate next steps.

6 REFERENCES

Documents marked with (*) are accessible at the following Web Page:
http://www.unep.org/hazardoussubstances/Mercury/PrioritiesforAction/ChloralkaliSector/Reports/tabid/4495/language/en-US/Default.aspx

6.1 Euro Chlor Publications

Audit Questionnaire Mercury, 2nd Edition. Euro Chlor Publication – Health 6, Brussels, Belgium. March 2006. (*)

Code of Practice Control of Worker Exposure to Mercury in the Chlor-Alkali Industry, 6th Edition. Euro Chlor Publication – Health 2, Brussels, Belgium. May 2010. (*)

Code of Practice Mercury Housekeeping, 5th Edition. Euro Chlor Publication – Environmental Protection 11, Brussels, Belgium, April 2004. (*)

Determination of the Total Weight of Mercury in the Electrolysis Cells by Radioisotopes, 2nd Edition. Euro Chlor Publication – Analytical 10, Brussels, Belgium. January 2003. (*)

Determination of Mercury and Creatinine in Urine; 1st Edition. Euro Chlor Publication – Analytical 11, Brussels, Belgium, February 2007. (*)

Determination of Mercury in Gasses, 3rd Edition. Euro Chlor Publication – Analytical 6, Brussels, Belgium. June 2003. (*)

Determination of Mercury in Liquids, 3rd Edition. Euro Chlor Publication – Analytical 7, Brussels, Belgium. May 2009. (*)

Determination of Mercury in Solids, 3rd Edition. Euro Chlor Publication – Analytical 3, Brussels, Belgium. September 2009. (*)

Guideline for Decommissioning of Mercury Chlor-Alkali Plants, 5th Edition. Euro Chlor Publication – Environmental Protection 3, Brussels, Belgium. September 2009. (*)

Guidelines for Making a Mercury Balance in a Chlorine Plant, 5th Edition. Euro Chlor Publication – Environmental Protection 12, Brussels, Belgium. March 2010. (*)

Guidelines for Preparing an Audit of the Mercury Balance in a Chlorine Plant, 1st Edition. Euro Chlor Publication – Environmental Protection 17, Brussels, Belgium. January 2003. (*)

Guidelines for the Measurement of Air Flow and Mercury in Cell Room Ventilation, 3rd Edition. Euro Chlor Publication – Environmental Protection 5, Brussels, Belgium. January 2009. (*)

Guidelines for the Preparation for Permanent Storage of Metallic Mercury Above Ground or in Underground Mines, 1st Edition. Euro Chlor Publication – Environmental Protection 19, Brussels, Belgium. October 2007. (*)

Guidelines for the Minimization of Mercury Emissions and Wastes from Mercury Chlor-Alkali Plants, 2nd Edition. Euro Chlor Publication – Environmental Protection 13, Brussels, Belgium. November 2006. (*)

Management of Mercury Contaminated Sites, 2nd Edition. Euro Chlor Publication – Environmental Protection 15, Brussels, Belgium. November 2009. (*)

Standardization of Methods for the Determination of Traces of Mercury, 2nd Edition. Euro Chlor Publication – Analytical 3-7, Brussels, Belgium, 1998.

6.2 Chlorine Institute Publications

Guidelines for Conducting a Mercury Balance, Internal Document; The Chlorine Institute, Inc., Arlington, VA, USA, 1999. (*)

Guidelines for Mercury Cell Chlor-Alkali Plants Emission Control: Practices and Techniques; Internal Document. The Chlorine Institute, Inc., Arlington, VA, USA, April 2001. (*)

Guidelines for Technologies to Reduce Mercury in Sodium Hydroxide; Internal Document. The Chlorine Institute, Inc., VA, USA. April 2000. (*)

Guidelines for The Optimization of Mercury Treatment (Sulfide Precipitation Process) Systems; Edition 1, Internal Guidance Document – Draft 4. The Chlorine Institute, Inc., VA, Arlington, USA. July 2003. (*)

Guidelines – Medical Surveillance and Hygiene Monitoring Practices for Control of Worker Exposure to Mercury in The Chlor-Alkali Industry, Edition 4; Pamphlet 125. The Chlorine Institute, Inc., Arlington, VA, USA, January 2004. (*)

6.3 Other References

Abiclor (2008): Controle do Mercúrio pelo Setor Cloro-Alcális – Ações voluntárias (in Portuguese).

Asnong W. 2005. *Personal Protective Equipment for Chlorine and Mercury*. Euro Chlor Six Technical Seminar Improving Health, Safety and Environmental Practices In the Chlor-Alkali Industry, 19-22 January 2005, Prague. Euro Chlor TSEM 05 305.

Arantes N. 1994. *Sistemas de Gestão Empresarial: Conceitos Permanentes na Administração de Empresas Válidas*; Editora Atlas S.A. (in Portuguese).

European Commission (2001): Integrated Pollution Prevention and Control (IPPC) – Reference Documento on Best Available Techniques in the Chlor-Alkali Manufacturing Industry. Available at http://eippcb.jrc.es/Fmembers.htm

ICCA (2007): Global Product Strategy (GPS) – Products Stewardship Guidance, Internal Document-Draft. The International Council of Chemicals Associations – ICCA.

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SBC (2010): Technical Guidelines for the Environmentally Sound Management of Waste consisting of Elemental Mercury and Wastes Containing or Contaminated with Mercury – 5th Draft. May 2010. http://www.basel.int/

The Stockholm Convention (2006): Revised Draft Guidelines on Best Available Techniques and Provisional Guidance on Best Environmental Practices Relevant to Article 5 and Annex of the Stockholm Convention on Persistent Organic Pollutants, http://www.pops.int/documents/guidance/batbep/batbepguide_en.pdf.

UNECE (2007): UN Recommendations on the Transport of Dangerous Goods (Model Regulations) http://www.unece.org/gc/gc21/Documents/K0100275-E0GC21.doc

UNEP (2005): Toolkit for Identification and Quantification of Mercury Releases, UNEP, Geneva, Switzerland, http://www.chem.unep.ch/MERCURY/Toolkit/UNEP-final-draft-toolkit-Dec05.pdf

UNEP (2006b): Guide for Reducing Major Uses and Releases of Mercury. Available at http://www.chem.unep.ch/mercury/Sector%20Guide%202006.pdf.

UNEP (2008): UNEP (DTIE)/Hg/Partnership. 1/INF.6 – Draft Business Plan of the Proposed Mercury Waste Managenment Partnership Area. http://www.chem.unep.ch/mercury/UGMP/INF%206.doc

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UNEP (2010b): Global Estimate of Global Mercury Cell Chlorine Capacity. UNEP Global Mercury Parnership Advisory Group, http://www.unep.org/hazardoussubstances/Mercury/PrioritiesforAction/ChloralkaliSector/Reports/tabid/4495/language/en-US/Default.aspx.

US Department of Energy (2009): Interim Guidance on Packaging, Transportation, Receipt, Management, and Long-Term Storage of Elemental Mercury. http://www.em.doe.gov/pdfs/Elementalmercurystorage%20Interim%20Guidance

US EPA (2008): 40 CFR 63 – National Emission Standards for Hazardous Air Pollutants: Mercury Emissions from Mercury Cell Chlor-Alkali Plants, Proposed Rule. http://www.epa.gov/ttn/atw/hgcellcl/hgcellclpg.ntml

WCC (2007): World Chlorine Council Report to UNEP on Chlor-Alkali Partnership – Data 2006. (*)

WCC (2011): World Chlorine Council Report to UNEP on Chlor-Alkali Partnership – Data 2010. (*)

7 ANNEXES

7.1 Pilot Project Proposal

A Working Group established at the Consultation meeting on Mercury Waste and Storage, which was held on 23 September 2010, presented the following proposal for a pilot study (see Final Report Consultation Meeting on Mercury Waste and Storage, 23 September 2010, pages 8-9):

Industrial sector – Rapporteur: Elena Lymberidi-Settimo

Implementation of guidance document in the chloralkali sector (related to mercury handling, storage and waste)

- The World Chlorine Council has developed guidance documents on how to handle metallic mercury (*e.g.*, when emptying cells and how /where to store temporarily on site safely)

Objectives

- Considering time/budget constraints, the objective would be to implement and check applicability and improve if relevant these existing guidelines.

Process – Plan

- Country to be selected (potentially with many plants, so experiences can be shared – or depending on availability of volunteers)
- Consultant/expert to be found
- Company/plant to be chosen
- Check if company is aware of the WCC guidelines, what they use and if the WCC Guidelines would need to be translated.
- Check flow of mercury – where would metallic mercury come from within the plant (pipes, cells, *etc.*) and would need to be handled safely through the process (to eventually end up in temporary on site storage)
- Check interim/temporary storage on site facilities / spills handling?
- Inform/involve industry, NGOs, different departments/ministries, UNEP regional offices, Basel Regional centers/ other agencies/ other companies in country/region
- Implementation on site with the expert of the guidelines
    - Is the company implementing some guidelines already? Are they the same? If not what are the differences?
    - Are things missing from guidelines? how can these be improved?
    - Are they useful to the company?
    - What are the gaps in storage?/handling?
- Meeting with relevant authorities and industry
- Later open meeting potentially with other stakeholders for wider awareness raising

- -filming possible? Check with WCC

Potential benefits

- Applicability of guidelines validated and improved
- Plant assisted to apply safe handling
- Transparency provided for government, public etc
- Potential reduction on mercury emissions from handling/storage
- Increased awareness

Potential countries for project implementation and their respective tonnes of annual chlorine capacity are:

- Argentina – 122
- Azerbaijan – 145
- Brazil - 217
- India – 188
- Mexico – 120
- Uruguay – 14
- Pakistan (no WCC member) - 33

7.2 Industry Guidelines with Relevance to Mercury Handling

The following guidelines have been authored by and are distributed – among others – through the UNEP Chemicals WebSite under the Chloralkali Partnership:

Publications and Guidelines for Facilities:

1. Determination of Mercury in Gasses
2. Determination of Mercury in Liquids
3. Determination of Mercury in Solids
4. Determination of the total weight of mercury in the electrolysis cells by radiosotopes
5. Determination of Mercury and Creatinine in Urine
6. Decommissioning of Mercury Chlor-Alkali Plants
7. Guidelines for the measurement of air flow and mercury in cellroom ventilation
8. Code of practice mercury housekeeping
9. Code of practice: Control of worker exposure to mercury in the Chlor-alkali industry
10. Guidelines for making a mercury balance in a chlorine plant
11. Guideline for the minimisation of mercury emissions and wastes from mercury chlor-alkali plants

12. Management of mercury contaminated sites
13. Guideline for preparing an audit of the mercury balance in a chlorine plant
14. Guidelines for the preparation for permanent storage of metallic mercury above ground or in underground mines
15. Audit questionnaire Mercury

Chlorine Institute publications:

1. Guidelines for Conducting a Mercury Balance
2. Guidelines for Mercury Cell Chlor-Alkali Plants Emission Control - Practices and Techniques
3. Guidelines for Technologies to Reduce Mercury in Sodium Hydroxide
4. Guidelines for the Optimization of Mercury Treatment - Ed 1 - Final Dec 2003
5. Pamphlet 125 - Medical Surveillance and Hygiene Monitoring Practices - Mercury - Ed 4 - (JAN 2004)

All of the above documents are available for consultation or download from: http://www.unep.org/hazardoussubstances/Mercury/PrioritiesforAction/ChloralkaliSector/Reports/tabid/4495/language/en-US/Default.aspx

7.3 Checklist for on-site Visit

The checklist, which is available for download (as pdf-document and in MsWord from http://www.unep.org/hazardoussubstances/Mercury/PrioritiesforAction/WasteManagement/Activities/tabid/4500/language/en-US/Default.aspx) contained the following issues:

I	General organization and planning of he company
II	Occupational health coordination (mercury exposure)
II	Indusrial hygiene coordination (mercury exposure)
IV	Environmental coordination (mercury)
V	Acquisition
VI	Mercury: special and urgent situations
VII	Handling of mercury and products, pieces, and residues containing mercury
VII	Mercury and mercury waste transportation
IX	Mercury collection and storage
X	Electrolysis process – Cell room
XI	Maintenance – Cell room
XII	Cleaning of cell room and other places
XII	Process – Other facilities

XIV Communication with interested parties
XV Soil
XVI Working procedures (tasks)
XVII Capacitating – Personnel training
XVIII Norms and regulations related to mercury
XIX Hygiene measures
XX Behavioral measures
XXI Personal protective equipment
XXII Inspections
XXIII Exposure monitoring and/or air quality in working environment
XXIV Mercury measurement methods
XXV Balance of mercury use and emissions in the plant
XXVI Decommissioning
XXVII Long-term mercury storage
XXVIII Communication with interested parties

7.4 Information on Efice S.A.

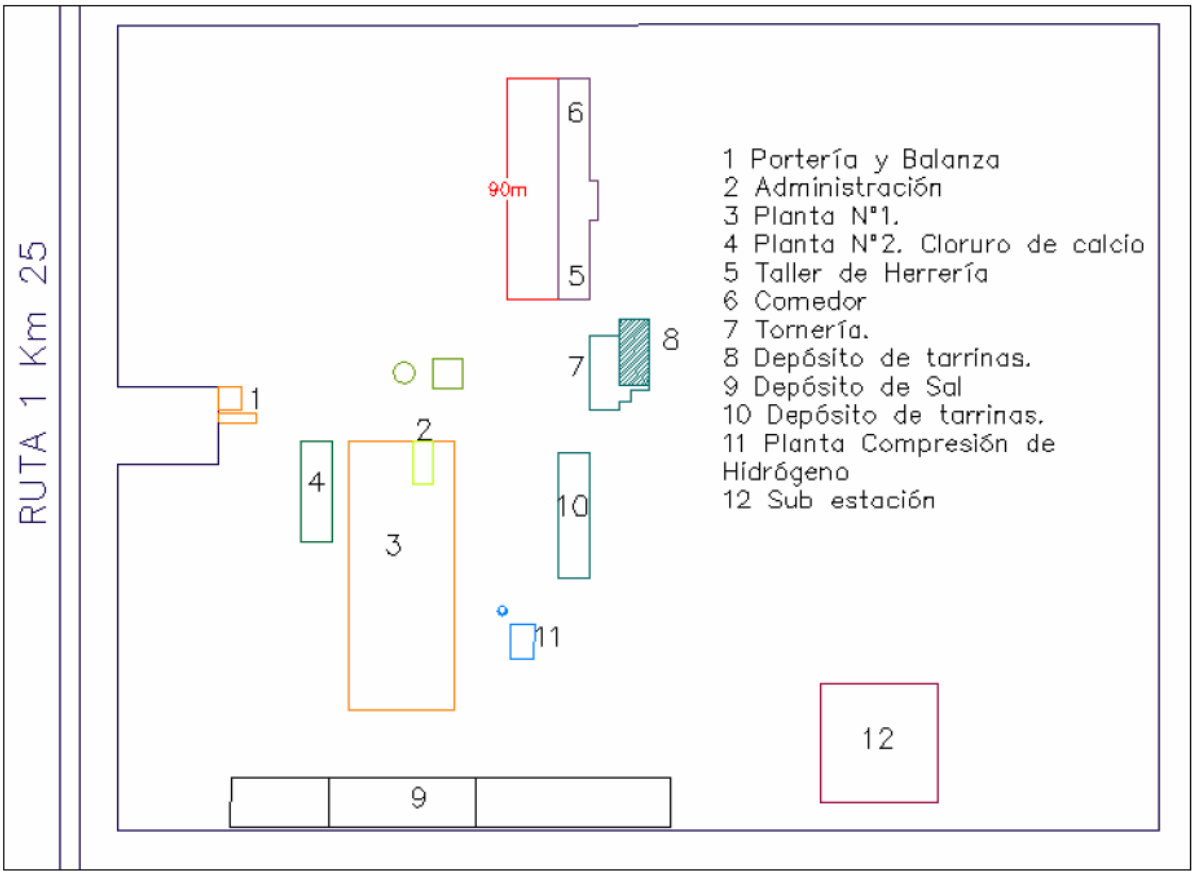

Figure 7-1: Layout of the physical plant

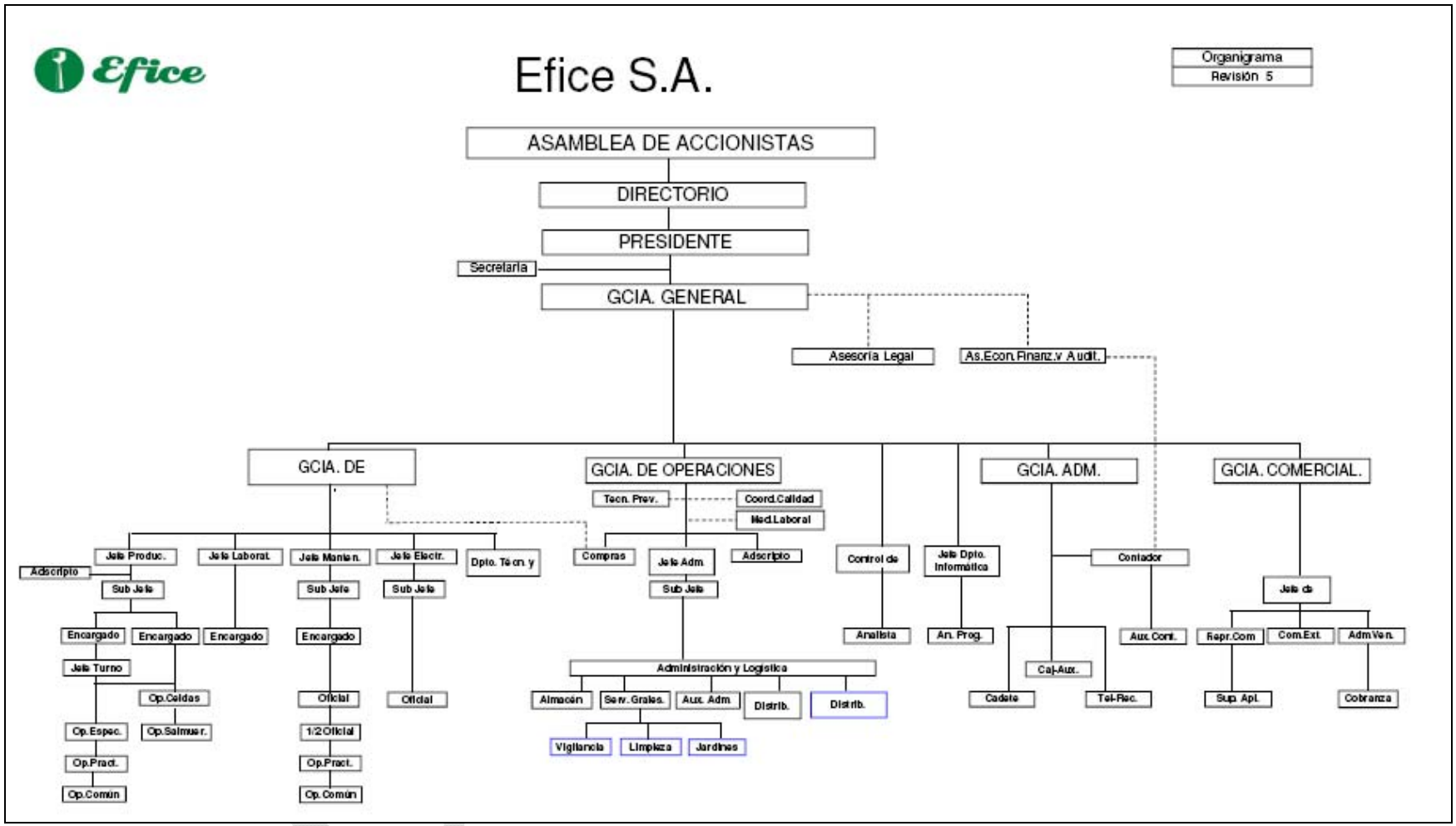

Figure 7-2: Organigram of Efice S.A.

7.5 Global Mercury Cell Production Data by Region and Country

Table 7-1: Global Mercury Cell Production Data by Region (2010)

Region	Number of facilities with mercury technology	Thousands of metric tons of chlorine capacity
Africa	4	77
Latin America and Caribbean (including Mexico)	13	578
North America (except Mexico)	4	437
Ásia	26	373
Eastern Europe/ Russia	14	1277
Western Europe	28	3260
Middle East	11	456
Total	**100**	**6458**

Note: Data extracted from Inventory Mercury Global Mercury Partnership (2010); total of installed capacity of global chlorine production using mercury technology of 6,458 MT/year (2010)

Note: Total of installed capacity of global de chlorine production using all technologies 62,800 MT/year (2008). Source: Chemical Week (May 2009, basis 2008)

Table 7-2: Global Mercury Cell Production Data by region and country (2010)

Africa	Number of facilities with mercury technology	Thousands of metric tons of chlorine capacity
Algeria	01	14
Angola	01	10
Libya	01	45
Morroco	01	08
Total	**04**	**77**

Latin America and Caribbean	Number of facilities with mercury technology	Thousands of metric tons of chlorine capacity
Argentina	02	122
Brazil	04	217
Columbia	01	22
Cuba	01	07
Mexico	02	120
Peru	02	76
Uruguay	01	14
Total	**13**	**578**

Table 7-2 (cont'd)

North America	Number of facilities with mercury technology	Thousands of metric tons of chlorine capacity
United States	04	437
Total	**04**	**437**

Asia	Number of facilities with mercury technology	Thousands of metric tons of chlorine capacity
China	06	81
India	08	188
Indonesia	05	25
Myanmar	01	07
North Korea	02	25
Pakistan	01	33
Philippines	02	14
Turkmenistan	01	?
Total	**26**	**373**

Western Europe	Number of facilities with mercury technology	Thousands of metric tons of chlorine capacity
Belgium	02	420
Finland	01	42
France	06	690
Germany	06	870
Greece	01	40
Italy	01	42
Spain	07	732
Sweden	01	120
Switzerland	02	27
United Kingdon	01	277
Total	**28**	**3,260**

Eastern Europe / Russia	Number of facilities with mercury technology	Thousands of metric tons of chlorine capacity
Azerbaijan	01	145
Czech Republic	02	197
Hungary	01	137
Poland	01	125
Romania	01	186
Russia	03	401
Serbia and Montenegro	04	10
Slovakia	01	76
Total	**14**	**1,277**

Table 7-2 (cont'd)

Middle East	Number of facilities with mercury technology	Thousands of metric tons of chlorine capacity
Iran	04	332
Iraq	03	68
Israel	01	33
Syria	01	14
United Arab Emirates	02	09
Total	**11**	**456**

7.6 Members of the World Chlorine Council (WCC)

WCC is a committee of the International Council of Chemical Associations (ICCA).

7.6.1 Producer Associations

Alkali Manufacturer's Association of India
Asociacion Nacional de la Industria Quimica (Mexico)
Canadian Chlorine Chemistry Council
Chlorine Chemistry Division of the American Chemistry Council ((USA)
The Chlorine Institute, Inc, (North America)
Clorosur (Latin America)
Euro Chlor (Europe)
Japan Soda Industry Association
Korea Chlor-Alkali Industry Association (contact address)
Plastic & Chemicals Industry Association of Australia

7.6.2 Product Sector Associations

Asia-Pacific Vinyl Network
European Council of Vinyl Manufacturers
Halogenated Solvents Industry Alliance (USA)
Vinyl Council of Australia
Vinyl Council of Canada
Vinyl Environmental Council (Japan)
Vinyl Institute (USA)

7.6.3 Corresponding Associations

RusChlor, the Russian chlor-alkali association
China Chlor-Alkali Industry Association (pending)