MANAGEMENT OF MERCURY CONTAMINATED SITES

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Euro Chlor

Euro Chlor is the European federation that represents the producers of chlorine and its primary derivatives.

Euro Chlor is working to:

- improve awareness and understanding of the contribution that chlorine chemistry has made to the thousands of products, which have improved our health, nutrition, standard of living and quality of life;

- maintain open and timely dialogue with regulators, politicians, scientists, the media and other interested stakeholders in the debate on chlorine;

- ensure our industry contributes actively to any public, regulatory or scientific debate and provides balanced and objective science-based information to help answer questions about chlorine and its derivatives;

- promote the best safety, health and environmental practices in the manufacture, handling and use of chlor-alkali products in order to assist our members in achieving continuous improvements (*Responsible Care).*

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Prior to 1990, Euro Chlor's technical activities took place under the name BITC (Bureau International Technique du Chlore). References to BITC documents may be assumed to be to Euro Chlor documents.

RESPONSIBLE CARE IN ACTION

Chlorine is essential in the chemical industry and consequently there is a need for chlorine to be produced, stored, transported and used. The chlorine industry has co-operated over many years to ensure the well-being of its employees, local communities and the wider environment. This document is one in a series which the European producers, acting through Euro Chlor, have drawn up to promote continuous improvement in the general standards of health, safety and the environment associated with chlorine manufacture in the spirit of *Responsible Care.*

The voluntary recommendations, techniques and standards presented in these documents are based on the experiences and best practices adopted by member companies of Euro Chlor at their date of issue. They can be taken into account in full or partly, whenever companies decide it individually, in the operation of existing processes and in the design of new installations. They are in no way intended as a substitute for the relevant national or international regulations which should be fully complied with.

It has been assumed in the preparation of these publications that the users will ensure that the contents are relevant to the application selected and are correctly applied by appropriately qualified and experienced people for whose guidance they have been prepared. The contents are based on the most authoritative information available at the time of writing and on good engineering, medical or technical practice but it is essential to take account of appropriate subsequent developments or legislation. As a result, the text may be modified in the future to incorporate evolution of these and other factors.

This document has been drawn up by the Environmental Protection Working Group to whom all suggestions concerning possible revision should be addressed through the offices of Euro Chlor.

Summary of the Main Modifications in this version

Section	Nature
All	General update based on recent developments
1.2 and 1.3	Addition of information on risk assessment and possible actions
2.1 and 2.2	Addition of more details on the site characterisation steps
5.	Addition of a short chapter on containment techniques

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FOREWORD

This document aims to give a state of the art of the management of mercury contaminated sites, showing which items have to be developed and/or confirmed in the practice. As actions are in progress in Europe and in North America (see USEPA study in ref. 0), this document will be periodically updated based on gained expertise.

It must be emphasized that the purpose of this document is not the creation of a contaminated site management guide, but that of providing managers with a relevant and updated review of techniques and trends in site characterisation, risk assessment and subsequent site management, including monitoring and remediation. Thereby the reader will encounter a useful toolbox from which to select, with the aid of qualified environmental professionals, and attending to specific local, regional and national regulations, the techniques and technologies which best suit each individual site, and which will undoubtedly be modulated by socio-economic and political considerations.

To protect workers' health, it is necessary to control exposure to mercury. For more detailed information about workers protection in case of exposure to mercury, it is advised to consult Euro Chlor document ***HEALTH 2 - Code of Practice: Control of Worker Exposure to Mercury in the Chlor-Alkali Industry*** (ref. 1)**.**

1 BACKGROUND

In Europe, about 38% of chlorine was still produced by the mercury process at the beginning of 2009. At some stage in the future, and in agreement with the Euro Chlor commitment, mercury cell chlor-alkali plants will be decommissioned by 2020 at the latest.

Efficient preventative provisions are at the present time taken at every plant to prevent soil contamination from spills and leaks and waste landfilling is implemented in a safe and traceable manner. Nevertheless, this has not always been the case in the past and, in some cases, historical mercury contamination in the subsoil is present. Additionally to the production unit area, consideration should also be taken for possible old and badly recognised (and investigated) waste landfills that may have occurred on some sites.

As far as contamination through atmospheric deposition is concerned, previous studies (Ref. 2 and 3), have shown that the levels of contamination within site limits are often rather low (generally less than 10 ppm) and limited to the superficial topsoil (~30 cm) in the surroundings of the mercury cells. This pathway is usually not expected to impact the groundwater quality, but should be confirmed case by case.

Moreover, experience has shown that concentration of mercury in the top soil 500 meters downwind from the cell room is typically less than 300 ppb and is usually of no concern (ref. 4), but also in this case the local situation should be assessed.

This paper deals only with subsoil contamination resulting from spills, leaks, waste disposal and not with the indirect pathway of soil contamination through atmospheric deposition.

Management of mercury contaminated sites will have to satisfy three main driving forces, according to the sustainability concept:

- Protection of human health and environment
- Responsible Care programme of the chemical industry
- Economics: an economic evaluation of the different possible solutions has to be set up to select the most cost effective solution.

This document is a general framework for the management of mercury contaminated sites. It is based on the three following points in order to support the decision making.

1.1 Define the current situation and the future use/development of the site

Knowing the actual use and any planned future use is necessary in order to develop relevant scenarios to be taken into account when evaluating the risk

1.2 Assess the risk associated with the contamination

In general, risk assessment consists in the determination of the potential consequence of a situation, and the probability that these consequences could occur.

In the context of contaminated land, a contamination (source) may represent a danger (toxicity, radioactivity, pathogenicity…). For any receptor (human, environmental), the probability of exposure to the danger represents the risk. In the case of chemical contamination, there must be an exposure pathway (link from the substance to the receptor) in order for a risk to occur.

At chlor-alkali plants, this means identifying

- the source (mercury concentration, localisation/-depth …)
- the pathway (exposure through vapour phase, groundwater, surface water migration …)
- the receptors (workers, residents, ecosystem …)

1.3 Decide the actions to be taken in case of risk

The risk management strives to break the link mentioned above by:

- source control (remediation), removing the source or reducing the danger (toxicity) associated with the contaminant (e.g. changing the speciation for metals)
- pathway control: barriers or cut off screens (capping, containment, immobilisation …)
- receptors control: restriction of use.

Monitoring allows verifying the objective of the actions taken is kept.

To our understanding a risk management/fit for purpose approach, as stated in the CLARINET-NICOLE statement, will give the best results in terms of risk reduction, environmental merit and financial impact (see http://www.nicole.org/publications/NICOLEjoint2.PDF). This approach was incorporated in the Commission proposal for the directive 2006/0086 (ref. 5) on contaminated soils management, but the Council decided to temporarily put in hold the decision process (progress report 1019/09 of June 2009).

The activities to be undertaken during these steps are site specific and dependent on such issues as pollution intensity and extent, local hydrogeology, presence of potentially threatened targets.

There are a range of existing tools which may be directly applied to mercury contaminated sites, others may need some adaptations and some may be not widely applicable at present. New techniques may need to be developed to ensure cost effective management.

Sharing resources, experiences and cooperative development of techniques would be the first step in setting up an efficient, cost effective management of mercury contaminated sites.

2 SITE CHARACTERISATION

The site characterisation is dealing also with the exposure scenarios and includes three major steps with the following objectives:

- *Desk study*: to identify, from the available data, all relevant potential source, pathway and receptor scenario for a specific site, and then using conceptual models and a preliminary hazard assessment to select the relevant scenarios and to eliminate the implausible ones.
- *Screening survey*: to assess the presence of contaminated areas using rapid and cost effective screening methods.

- *Confirmation survey:* when contaminated areas are identified, to quantify their extent and intensity.

In some cases, other data could be required (e.g., to perform a detailed risk assessment) and further characterisation may be necessary.

Due to the physico-chemical properties of metallic mercury, care must be taken when carrying out engineering work during the characterisation of the site to avoid the formation of preferential pathways or the mobilisation of contamination:

- Separated phase (mercury droplets) tend to sink down the profile during soil sampling (liquid state, hydrophobicity, superficial tension and high density)
- Metallic mercury droplets render the contamination highly heterogeneous at a very small scale, so mass balance is difficult to estimate
- Volatility of the metallic phase should not be overlooked (losses, health and safety issues).

Therefore standard tools for site characterisation may not be suited for mercury contamination. However, there are a number of technologies that have been employed with varying levels of success. For the three steps presented above, the following tables highlight what is available and what developments/adaptations are needed (shaded) to be applicable to mercury contamination.

2.1 Desk Study

	Comments	Status
Existing protocols and good practice manuals	Special attention needed to sewer and buried pipes as potential secondary point sources, past waste management and maintenance practices	Applicable to Hg contaminated sites