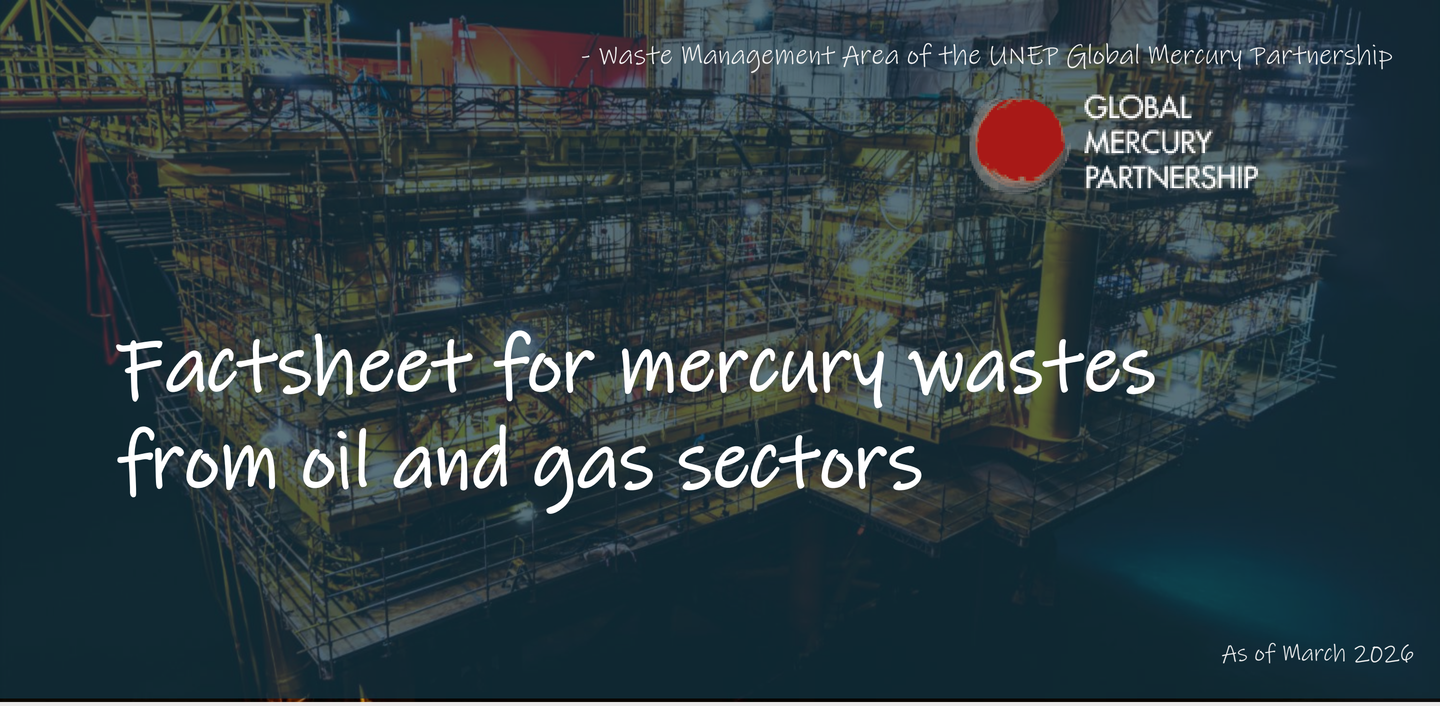

- Waste Management Area of the UNEP Global Mercury Partnership

GLOBAL MERCURY PARTNERSHIP

Factsheet for mercury wastes from oil and gas sectors

As of March 2026

Introduction

Mercury is a chemical element that is highly toxic to humans and the environment. It is released into the environment through natural sources and human activities, and it cannot be destroyed. Mercury waste needs to be carefully managed to prevent emissions and releases into the environment.

The oil and gas industry is a major and often underestimated source of mercury waste, presenting unique challenges (large volumes, low concentrations, complex matrices, NORM co-occurrence). Mercury is naturally occurring, found in almost all oil & gas reservoirs. Typically, the mercury is present in an elemental metallic or vapour form (Hg^0), but will react to form complex species during production and processing. The mercury present in production fluids (gas, oil and water and contaminants from the well) can vary from sub ppb to ppm concentrations.

Although typically concentrations in process fluids are in the ppb range, due to the large volumes of gas and oil produced, there can be significant quantities of mercury removed in waste streams. Waste streams contain mercury at concentrations ranging from parts per million (ppm) to percent (%) levels.

> A trillion cubic metre gas reservoir, with 10 µg/m^3 of Hg can produce
>
> **10 tonnes of Hg**
>
> Over its lifetime.

It is important that the oil & gas facilities measure mercury in their process fluids to understand the concentrations present, what species transformations occur and where there may be accumulation, adsorption to process infrastructure or emissions to the environment. It is advised that specialist advice is sought as the sampling and analysis of trace Hg in oil & gas can be complex and erroneous results may be obtained if not done correctly.

This factsheet was written and prepared by David Hunter (HgOps), Dr. Tom Creswell (ANSTO), Stuart Baker (Qa3), Philippe Zanettin (Batrec), Jorge Veciana (1econ industries), Kishor Parajuli (EX Research Institute), Kaspert Brakenhoff (BMT), Maurice Heijnen (BMT), Dr. Pathe Dieye (University Iba Der Thiam Thies Senegal).

Where does the mercury waste in the oil & gas industry come from?

All parts of the oil & gas supply chain can generate mercury containing waste. Mercury is known to be present in oil & gas facilities from exploration, production, pipelines, storage, transport, service equipment, maintenance facilities, laboratories, accommodation and even in gas supply networks.

During exploration and drilling, mercury may be present in drilling muds, cuttings, and formation fluids mobilised from geological strata. In the production phase, mercury can accumulate in process fluids, equipment, catalysts, absorbents and filtration systems, leading to contaminated sludges, scales, solid materials and scrap metal to be treated as mercury waste.

As facilities reach the end of their operational life, decommissioning activities generate additional mercury-bearing wastes through the cleaning, removal, and disposal of pipelines, vessels, assets and processing units. These wastes are diverse in composition, ranging from liquid hydrocarbons, aqueous fluids, metallic scales, produced sands and physical equipment. Mercury wastes also co-occur with Naturally Occurring Radioactive Material (NORM).

The variability of waste types and mercury concentrations underscores the need for tailored monitoring, handling, and disposal practices to prevent environmental release and support sound mercury management in line with international standards.

The Minamata COP6 sets the threshold for wastes contaminated with mercury at:

15 mg/kg of Hg

Treatment overview

Environmentally sound management of mercury-containing wastes, as outlined in the Basel Convention (technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with mercury or mercury compounds) emphasises treatment approaches that minimize environmental and human health risks while ensuring full traceability from generation to final disposal. Best practice involves removing mercury from contaminated matrices through appropriate thermal, physical or chemical separation techniques, followed by **conversion and stabilisation**; most commonly this means converting mercury to mercury sulfide (HgS), which is the most stable compound of mercury. Stabilised and solidified mercury can then be securely disposed of in long-term or permanent engineered facilities. It's important to note that blending and dilution are not considered best practice.

The removal of mercury from waste streams can allow material recycling and minimise volumes to be disposed of as hazardous waste. Where feasible, recycling **or recovery of usable materials** (such as metals, catalysts, or hydrocarbon fractions) should be integrated into treatment processes to reduce overall waste volumes and support resource efficiency.

Although recycling of mercury is permitted under certain conditions outlined in the Minamata Convention (see Article 3 on mercury supply and trade and Article 11 on mercury wastes), best practice remains the full, permanent disposal of mercury through stabilisation and secure long-term storage to prevent its re-entry into commerce or the environment. Some national legislations fully ban the re-use of mercury from these sources (such as the EU ban on re-use of mercury recovered from the cleaning of natural gas).

Treatment methods vary depending on waste characteristics and may include vacuum distillation, directly or indirectly heated thermal desorption, roasting, retorting, chemical washing or physical separation. Global capacity for Environmentally Sound Management of mercury waste remains limited, particularly for high-volume and complex industrial wastes.

Environmentally Sound Management of mercury waste should ideally be carried out as close as possible to the site of waste generation, minimising transboundary movement. Facilities for the environmentally sound management (ESM) of mercury-containing wastes are often in separate geographical locations from waste generation, requiring transport of waste under the Basel Convention. Alternatively, mobile treatment facilities can be deployed when conditions are correct.

Pre-verification of the waste value chain will help ensure that mercury is managed safely and that its movement is tracked accurately throughout the entire lifecycle from generation to final disposal.

Factsheet for the mercury wastes from oil and gas

Safety when handling mercury and mercury containing wastes

The oil & gas industry takes pride in developing safe practices to protect worker health. This is extremely important for handling of mercury and mercury wastes as there are unique challenges and dangers, particularly associated with mercury vapour. It is advised that experienced personnel and contractors are engaged in the development of appropriate procedures. Some examples of unique procedures include (but are not limited to):

- **Engineered safety controls**: The most important personnel safety control is to minimise the risk of exposure situations. A key method is to install mercury removal equipment as far upstream in a process as possible to minimise the impact of mercury downstream.
- **Mercury Vapour Monitoring**: It is important to always know the concentration of mercury vapour in the workplace to adopt appropriate safety procedures. A good practice is to deploy real-time, personal mercury monitors which act both as a personal Hg vapour alarm and data recorder for workers.
- **Hot Work**: When cutting, welding or otherwise heating mercury contaminated steel, even trace mercury contamination can result in a concentrated cloud of mercury vapour. This can lead to personnel exposure and cross contamination and must be carefully managed.
- **Personal Protective Equipment**: Masks with appropriate filters, positive air hoods, chemical suits, gloves and boots are available and should be selected for any procedure with mercury vapour exposure risks. In addition, any contact between mercury waste and the skin must be avoided. This should be carried out by a qualified HSE or Occupational Hygiene professional. Only with good information and risk assessment can the appropriate PPE be chosen. Any absorbent materials in contact with mercury vapour can be cross contaminated and become an exposure vector. A common example is welders who wear leather protection during hot work which absorbs mercury vapour and then expose the wearer, and potentially others, after the work is complete.
- **Biomonitoring**: Where there is a work activity that carries a risk of mercury exposure, it is advised that accredited laboratories are used to take biological (normally urine) samples before, during and after the work activity. It is important to create a suitable plan with an experienced and qualified occupational health professional to ensure that biomonitoring is effective in catching exposures quickly.
- **Supervision, Management and Training**: It is strongly recommended that experienced specialists are present during work with mercury exposure potential to advise, audit and manage the risks and that all staff undertake mercury awareness training.

Figure; Example of good use of light PPE during mercury waste handling operations

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Storage

The appropriate practices for the storage of waste may vary depending on the location and situation. Compliance with the requirements of the relevant regulatory authority is critical. In addition, the following general considerations should be made.

Facility	• Locate storage facilities in areas less prone to natural disasters. • Provide signage at storage facilities. • Minimize the risk of theft of mercury by storing in secured locations accessible only to authorised personnel. • Should be accessible for fire-fighting and other emergency procedures. • Drains should be closed to avoid leakage into other systems. • All equipment and containers should be accessible for inspection. • Measurement of mercury vapour should be considered.
Container	• Use appropriate containers to prevent damage and spillage. • UN approved packaging in accordance with ADR and IMDG (regulations for transport of dangerous goods by road and sea) is recommended (and mandatory for transport by road and sea).
Storage	• Should be stored in a manner that protects from weather. • Should be stored in such a manner that prevents contact with any chemically incompatible materials (e.g. strong acids and bases).

Traceability and Chain of custody

The environmentally sound management of mercury-containing waste requires a structured, documented, and auditable approach to sampling, analysis, and traceability in accordance with the Basel Convention Technical Guidelines on the Environmentally Sound Management of Mercury Wastes. Sampling should be undertaken prior to any movement or treatment step and must follow statistically robust, representative sampling plans appropriate to the specific waste.

Sampling equipment must be inert and contamination-free, and procedures must prevent volatilisation or loss of fine particulates. All samples must be handled and stored in a manner to avoid losses of Hg and should be logged and tracked. Analytical characterisation should include total mercury concentrations and, where relevant, speciation analysis. Laboratories must be adequately quality controlled and third party verification should be considered.

Traceability must be maintained throughout the entire waste lifecycle: from generation, initial containment, and onsite storage, through repacking, transport, interim operations, treatment, and final disposal. Documentation required under the Basel Convention such as movement documents, notification forms, packaging and labelling records and contracts should accompany each consignment and form part of the final traceability program. Electronic tracking systems may be used to strengthen the chain of custody.

For mercury recovery and stabilisation processes, facilities must record treatment parameters, emissions control performance, residuals characterisation, and final disposal pathways. This can be reported as part of a mercury mass balance to show the quantified mercury upon arrival at the treatment facility and then what leaves the facility in any other form. Stabilised mercury such as that converted to HgS must be verified as meeting necessary leachability and stability criteria prior to disposal in engineered hazardous waste storage sites or landfills. This is often conducted by a third party.

Throughout the process, operators must retain complete traceability records sufficient for regulatory audits, international reporting obligations, and long-term accountability.

Packing and labelling of wastes for the oil & gas industry

It is recommended (and in many cases obligatory) that the UN Recommendations on the Transportation of Dangerous Goods are followed for packaging, labelling and transport of each waste product, taking into account the nature of the waste and other hazards present, e.g. flammable hydrocarbons, self-heating materials or corrosive properties. Packaging should be constructed of suitable material, and of adequate strength and design in relation to the capacity and its intended use. The use of sealed inner liners or bags of strong leakproof and puncture resistant material impervious to mercury which will prevent escape of the substance from the package irrespective of the position or the orientation of the package are recommended.

Factors that will determine the correct packaging and labelling are: Waste characteristics, local and international regulations such as ADR, IMDG and IATA, transport types and acceptance criteria of the treatment or disposal facilities. It is recommended that experts are consulted as incorrect packaging or labelling can result in delays, fines and costly waste rejections and returns.

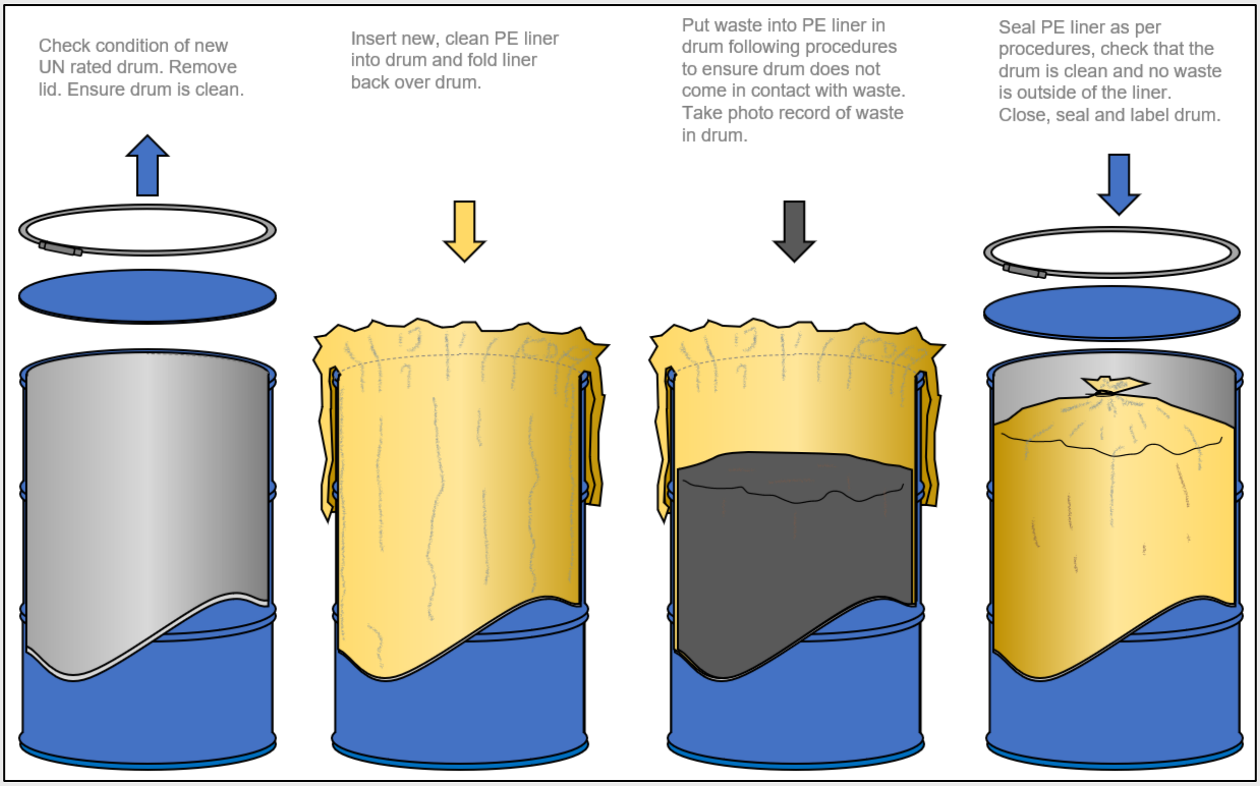

Figure: Example of waste packaging method

Transport to ESM facilities vs local capacity building

Where capacity for ESM treatment of mercury wastes is available locally then it must be used in preference over transboundary transport of waste to other facilities. A technical evaluation of facilities against waste types to ensure compatibility and acceptance is essential as not all licensed mercury waste treatment facilities can treat all types of wastes.

ESM of mercury waste is ideally carried out as close as possible to the site of waste generation, minimising transboundary movement. Treatment facilities that can treat mercury waste in an environmentally sound manner are often in separate geographical locations from waste generation, requiring transport of waste under the Basel Convention and with permission from national regulators. Alternatively, mobile treatment facilities can be deployed, particularly for higher volumes. When considering whether to transport waste or to deploy local capacity, key factors will be: traceability, cost, legislation, local knowledge, carbon-footprint and the location of final disposal and recycling outlets for the treated fractions.

Where possible capacity in regional areas should be developed. Capacity development can mean installation of equipment but also other parts of the supply chain including essential traceability measures. It can also include the development of knowledge and understanding for the collection, storage and transport of wastes to ESM facilities overseas.

In most cases the establishment of such capacity will depend on economic arguments such as the local demand for mercury waste treatment being able to justify the cost of installation of equipment and development of the supply chain.

The development of local capacity can greatly reduce the carbon footprint of transport of wastes overseas.

When deciding on the development of treatment facilities understanding and planning for the final disposal routes for mercury is essential.

Typical mercury containing wastes, considerations and treatment methods

Treatment methodologies below have been gathered from known operators who treat mercury wastes in accordance with the Basel Technical Guidelines. These methods are those which have been used in real case scenarios.

Oily Sludges and Contaminated Hydrocarbons

These wastes arise from pigging operations, maintenance, tank cleaning, decommissioning and inspection of storage vessels amongst other sources. Mercury may be present as elemental mercury adsorbed to solids, inorganic mercury compounds, or organo-mercury species dissolved in hydrocarbons. It is also possible, in some scenarios to find free liquid elemental mercury recovered during these operations.

ESM Treatment Methods: Any free elemental mercury should be physically separated where possible. Vacuum distillation, indirectly heated thermal desorption or retorting of sludges to separate volatile mercury while allowing hydrocarbon fractions to be recovered is considered best practice. Processes conducted in a non-oxidative atmosphere, such as nitrogen, are generally considered safer. While thermal treatments using direct fire and high temperatures (>400° C) oxidize hydrocarbons to carbon dioxide (CO_2), indirectly heated processes at lower temperatures under an inert atmosphere and vacuum allow the recovery of oil from sludges, though in some thermal treatments the hydrocarbons are oxidised to CO2 in the process. Physio-chemical pre-treatment of sludges to remove moisture and concentrate mercury containing fractions can be beneficial when handling large volumes.

There are projects known to separate and concentrate mercury in oil before re-injection to underground disposal wells. Separated mercury is stabilised before disposal. Residual solids should be treated and disposed of in secure facilities.

Figure: Sludges obtained during pipeline “pigging” operations

Drill Cuttings and Mud

Generated during drilling, these materials can contain mercury naturally occurring in the additives of the drilling fluids such as barite and bentonite but also from geological formations drilled through and present in drill cuttings. Mercury may be present as inorganic salts or bound to fine solids and barite.

ESM Treatment: Washing, thermal treatment, or physical separation to remove mercury-bearing fines.

Indirectly heated distillation allows the recovery of oil from oil-based muds along with other evaporable components, such as mercury and water. The recovered oil can be reused as fuel. Mercury recovered must be treated further.

Other technologies such as washing, thermo-mechanical treatment, or centrifugation can concentrate the mercury containing fraction for further treatment.

Treated mercury free solids may be reused or disposed of appropriately as long as there is no further risk to human health or the environment. Special consideration of the mercury content and its impact on the marine environment should be undertaken if drilling projects are licensed to dispose of drilling fluids, solids or cuttings directly in the sea.

Chemical sludges and cleaning fluids

Formed from process cleaning, decontamination or other chemicals. Mercury can be present as precipitated or dissolved mercury compounds.

ESM Treatment Methods: Chemical precipitation, or solid/liquid separation, with mercury recovery and stabilisation. Thermal incineration is possible in some cases. Remaining chemicals may require neutralisation before disposal. Concentrated mercury removed can be treated as mercury containing sludges.

Water

Produced water, wash water, and effluents can contain dissolved inorganic mercury, particulate-bound mercury, or trace organo-mercury species.

ESM Treatment Methods: Correct analysis and speciation of mercury is key in designing a water treatment process. Advanced filtration, precipitation, ion exchange, or activated carbon treatment can remove dissolved mercury. The water can be released or re-used when it meets the release threshold criteria as defined by relevant licensing and regulation. Mercury containing filter media, filter cartridges or sludges will be generated for further treatment as necessary.

Filters from Process Chemical Units

In most oil & gas processing plants it is common to find glycol units, which are used to either inhibit hydrate formation or remove moisture from gas. It is also common to find amine units which are used to remove hydrogen sulphide and carbon dioxide from natural gas. Mercury present in the gas is absorbed by these chemicals and it is expected that the filters used in the regeneration section of these units will have significant mercury contamination, typically present as HgS, often in % concentrations. The thermal regeneration of these fluids in process systems can drive off mercury as vapour which should be measured and managed to avoid emissions. Although there is insufficient data, it is understood that this process could be a significant source of mercury emissions in the oil and gas industry.

ESM Treatment Methods: The treatment of such filters can be complex and should be assessed by an expert to create a treatment plan. Direct thermal treatment is possible with complete combustion of the filters in a closed system designed to treat both organic and mercury wastes. Vacuum distillation and recovery without combustion is possible in some plants. In some situations, manual dismantling and cleaning of the filters before treatment may be necessary depending on the waste constitution and facility acceptance criteria. Mercury collected can then be stabilised as necessary before disposal.

Absorbents (Activated Carbon and Mercury Guards)

These specialised materials capture mercury from gas and liquid streams. Mercury is typically present as tightly bound elemental or ionic species within porous media on carbon and zeolite substrates or as bound mercury sulphide in the case of metal sulphide based mercury guards.

ESM Treatment Methods: Mercury Guards can contain valuable metals such as copper, which can be recycled after the thermal removal of mercury, partially offsetting the treatment cost. As these materials often contain sulphur as an active component, this should be managed to avoid the generation and release of SO_2 during treatment. Roasting of mercury guards with capture of mercury and sulphur is deemed best practice and the most efficient method. Retorting and vacuum distillation are viable though high temperatures are often needed to break the Hg-S bond.

Figure: Ceramic balls associated with Hg Guards

Ion Exchange Resins

Used for water treatment and polishing, these resins accumulate mercury in ionic form on functional groups.

ESM Treatment Methods: Regeneration or thermal/chemical treatment to remove mercury, followed by stabilisation. In some cases, direct stabilisation of mercury on the resin materials or direct disposal may be possible. This will depend on analysis of the materials and disposal routes.

Steel from Decommissioning

Pipelines, vessels, and processing equipment may contain mercury contamination as films, trapped droplets, or most commonly as adherent scales. Such production equipment and pipelines at end of life may contain mercury at concentrations ranging from ppm up to % levels. Even when present only in trace amounts, mercury concentrations may still be too high to:

i. leave in-situ, with potential risk to ecosystems from subsequent release as the steel degrades and mercury enters the environment; or

ii. be sent for smelting where the high temperatures result in a rapid release of mercury. (note - many recycling smelters have no specifications for mercury as they have no way to capture and remove it after liberation in the furnace).

Figure : Pathway for mercury from steel to contaminate steel smelters

ESM Treatment Methods: Decontamination by chemical cleaning, surface removal (normally by blasting or high-pressure water jetting) or high-temperature treatment. During these processes the **risk of mercury vapour exposure of personnel can be high** and all precautions should be taken including expert advice, training and auditing. Mercury containing residues are collected with the cleaning media for treatment as chemical or solid wastes.

Steel may then be recycled only when it is verified that the mercury levels present are such that it can legally be sent as a recyclable material and meet the acceptance thresholds of the smelter without the risk of worker exposure. It is important to fully audit any smelter, even if this part of the supply chain is not within the control of the waste generator as mercury exposure and release can be expected in uncontrolled facilities.

There is debate on the exact concentration of mercury in steel which should be targeted after decontamination. Both the total mercury in mg/kg is important as this measurement will help in assessing the smelters capacity to deal with vapours but also the surface concentration in mg/cm2 because this will determine the mercury vapour release during the hot cutting of steel into segments to fit the smelter (often 30cm or 50cm square sections) which is often done by hand with cutting torches. **Mercury vapour should be monitored during all parts of this process due to high personnel exposure risk**. Note that steel can be considered category C mercury waste under the Minamata Convention and the 15 mg/kg Hg threshold applies.

PPE, Filters, and Miscellaneous Items

Used protective equipment, rags and other solid wastes and filters may carry particulate or adsorbed mercury residues.

ESM Treatment Methods: Controlled incineration, vacuum distillation or thermal treatment with emission capture. Mercury collected from off-gases is stabilised. Ashes and residues are disposed of in secure landfills.

Mercury wastes containing (Te) NORM

It is possible for mercury containing wastes from the oil & gas industry to contain other contaminants of concern which have their own complex treatment requirements such as Naturally Occuring Radioactive Matrials NORM. Specialist companies have the licenses and technology to treat these materials however, effective NORM/TENORM management options remain geographically limited, with many sites relying on temporary storage.

ESM Treatment Methods: Indirectly heated vacuum distillation and stabilisation of the resulting solids for secure disposal is considered as a best practice. This reduces NORM waste volume, removes mercury and de-oils the material, enabling effective curing and long-term immobilization with chemical binders. It is important to consider treatment methods that do not generate dusts or particles in the surrounding environment, ensuring operational safety. Volume-reduction methods, such as physical and chemical separation, have been used to lower disposal burdens.

It is of particular importance to understand and verify the final disposal of the mercury and to ensure that all mercury sent to the treatment facility is disposed of and recorded in a mercury mass balance. A typical mercury mass balance will involve sampling and analysing the waste to quantify the total mercury expected and to do the same with the final disposal waste matrix (normally HgS plus treated residues) to ensure that these figures are balanced within reasonable expectations and mercury has not left the system. Documentation should be kept; ensuring that proper traceability and control measures are maintained throughout waste handling and disposal.

Liquid Mercury

Free elemental mercury recovered from process equipment or from mercury waste treatment.

ESM Treatment Methods: Mercury should be converted to a stable compound and solidified to ensure that there cannot be risk of environmental discharge before final permanent disposal in a licensed, audited, engineered facility in accordance with the Basel Convention Guidelines. The preferred mercury compound for stabilisation is HgS as it is the most stable form.

Mercury Sulphide can often be analysed, packaged and disposed of directly in engineered underground landfills (such as those in former salt mines in Germany).

For eventual disposal in a licensed, engineered surface landfill, stabilised mercury should undergo an additional consolidation step, transforming it from a particulate to a solid matrix capable of withstanding the necessary leachability tests. This approach mitigates the risk of environmental dispersion and enhances long-term chemical stability.

Methods such as chemical conversion followed by deep well injection have also been used in limited cases.

It is a critical part of the process to have complete, documented, traceability of the mercury to ensure that it is fully disposed of as planned.

Reference

- Minamata Convention on Mercury
- The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal
  - Basel Convention technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with mercury or mercury compounds.
- Consolidated text: Regulation (EU) 2017/852 of the European Parliament and of the Council of 17 May 2017 on mercury, and repealing Regulation (EC) No 1102/2008 (Text with EEA relevance)
- UN Recommendations on the Transportation of Dangerous Goods