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## Petroleum Development Oman L.L.C.

### Engineering and Operations

# Specification for Onsite Mercury Management

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**i Document Authorisation**  
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## ii Revision History

The following is a brief summary of the 4 most recent revisions to this document. Details of all revisions prior to these are held on file by the issuing department.

Revision No.	Date	Author	Scope / Remarks
0	Jan-10	Robin Norman UOP6	Approved for Issue
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## iii Related Business Processes

Code	Business Process (EPBM 4.0)
EP.64	Design Construct, Modify and Decommission Facilities
EP.72	Maintain and Assure Facilities Integrity
EP.80	Manage Abandonment

## iv Related Corporate Management Frame Work (CMF) Documents

The related CMF Documents can be retrieved from the [CMF Business Control Portal](#).

CP-114	Maintenance and Integrity Management - CoP
CP-115	Operate Surface Product Flow Assets - CoP
CP-117	Project Engineering - CoP
CP-121	Production Chemistry - CoP
CP-122	Health, Safety and Environment Management System - CoP



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## 1 Introduction

### 1.1 Background

When natural gas is produced, each reservoir also produces metallic mercury, mercury compounds such as mercury salts and organic mercury compounds. For clarity of understanding this shall be referred to as Mercury.

The majority of the mercury will remain behind in the facility after process and therefore can be released during maintenance and modification activities, whenever the process equipment and pipework is opened.

Mercury is a poisonous substance and is hazardous to health and the environment. Requirements with respect to its management are covered in this specification.

The management of the mercury shall cover the whole life cycle (development, design and modification, operations and execution of maintenance and abandonment) of a facility. Therefore from concept, through design and operation, and up to and including abandonment, account must be taken of the presence of mercury.

### 1.2 Objective

The objective of this specification is to ensure that the risks associated with mercury are handled in a controlled manner throughout the life cycle of the facilities in which it occurs.

The specification should be referenced by:

- HSE Specialists to ensure that appropriate procedures are utilised by PDO staff and contractors when working on equipment that has conveyed or stored natural gas.
- PDO In-House / Contracted Designers and Engineers to ensure that account is taken of the occurrence or possible occurrence of mercury in the process medium during design and construction of new or modifications of existing facilities
- Delivery Team Leaders and Operations / Maintenance Supervisors when overseeing activities associated with mercury or preventing the release of mercury.
- Contract holders responsible for contracting out activities whereby personnel can come in contact with mercury.
- Personnel involved in activities such as sampling, analysis, cleaning, maintenance, packaging, treatment, processing, storage, transport and disposal of installation components, materials and residual substances that are or may be contaminated with mercury.

### 1.3 Compliance with Specification

For any deviation from this specification, a written agreement from the PDO Mercury Specialist shall be obtained prior to performing related engineering work.

Compliance with this specification for modifications or extension work of existing facilities may not always be possible; in such cases written instructions from PDO shall be obtained to indicate whether a deviation is acceptable.



#### **1.4 Review and Improvement**

The nominated Gas Directorate Mercury Specialist shall ensure that this specification is maintained current and reviewed and updated subject to changes and improvements within the Industry relating to Managing Mercury Risks in PDO oil and gas exploration and development

Users of the Specification who identify inaccuracy or ambiguity can notify the Mercury Specialist or a delegate and request changes be initiated.

The Expertise Holder shall ensure review and revalidation of this Specification every 4years.





## 2 Scope

The scope of this Specification shall cover the following:

- Information on Mercury and Requirements for Dealing with the Hazard
- Developing, Designing and Modifying Facilities and Wells with Mercury Risk
- Pre-qualifying, Contracting and Employing Vendors for Work with Mercury
- Preparing and Carrying Out Activities on Mercury-Contaminated Installations, Wells and Soil
- Handling, Packing, Transporting and the Handover of Mercury-Contaminated Substances

The scope of the Specification listed above shall be reviewed and enlarged as more experience is gained by PDO in the management of Mercury on-site. It will be the responsibility of all management and supervisory staff involved in working where there is a mercury risk, identified or potential, to provide feedback and suggestion as to how the risks can be more effectively managed.



### 3 Information on Mercury and Requirements for Dealing with the Hazard

#### 3.1 Mercury Contamination

All gas treatment facilities in PDO shall be considered as internally contaminated with mercury until proven otherwise through mapping and monitoring. Moreover, it is possible that the soil is contaminated at a number of locations outside of the facilities. The locations and degree of soil contamination in PDO may or may not be recorded or identified.

During maintenance, modification, abandonment or cleaning activities carried out on a gas treatment facility, and the wells, or pipelines connected to it, mercury contamination **must** be assumed to be present in all installation components that directly or indirectly (i.e. condensate and glycol) are in contact or have been in contact with the production flow in the low pressure system<sup>1</sup>. These installation components are by definition suspected of being contaminated with mercury.

Because mercury can collect in cavities that cannot be accessed during cleaning and because mercury can be absorbed in metal, there is no guarantee that even a cleaned installation component that has been in contact with the production flow for a long time is clean. It is always possible that mercury will be released as a result of it being sweated out of steel and when facility components are dismantled.

Contact with mercury is possible:

- Where leaks occur
- When carrying out activities to or in facilities or equipment that has been removed from the facility
- When carrying out activities on wells (for instance, workover activities, well services, production tests and abandonment)
- Excavation activities in contaminated zones
- In storage halls that contain mercury vapour released from scrap metal or waste

#### 3.2 Effects of Mercury on Humans and Environment

Mercury is toxic to human health and hazardous to the environment. By far the greatest risk of entry into humans is through inhalation, however organic mercury may be readily absorbed through the skin and all forms ingested due to poor hygiene.

Effects on humans (and animals) include:

- Failure of the nervous system
- Subtle changes in behaviour or brain function.
- Allergic reactions (tiredness, headache)

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<sup>1</sup> Experience from PDO Operations in Saih Naihayda has shown that high concentrations of mercury exist in the Low Temperature Separators due to pressure and temperature drops. Mercury recovery beds in existing facilities are installed downstream of the facilities to reduce mercury levels to customers. Future gas facility design shall aim to install mercury recovery beds before the facility to reduce the mercury risk.



- Reproductive effects; can damage the unborn child

Mercury vapours will readily release from open equipment in large quantities at ambient temperatures in Oman. Applied heat through activities such as hot work, welding or grinding in confined spaces may generate concentrations sufficient to render employees unconscious.

### 3.3 Roles and Responsibilities

In general, people must not be exposed to mercury and mercury must not be released into the environment. Responsibility for ensuring this shall be given to the following roles:

- The Contract Holders of Contractors / Vendors:
  - Prior to contracting out activities on (or with) mercury-contaminated material, agreement is obtained from the PDO Mercury Specialist / Focal Point regarding supplementary prequalification
  - Prior to granting a contract it shall be ensured that that the contractors / vendors have the experience, competence, resources and methods to be able to carry out the activities on or with mercury-contaminated materials.
  - Ensure that the contractors are aware of the possible presence of mercury at their workplace
  - Ensure that contractors are aware of the PDO specifications and procedures for mercury management
  - When necessary, include supplementary HSE conditions with respect to mercury in the contracts
- PDO Logistics Management and Contract Holders:
  - Ensure that haulers and drivers are instructed in the risks and the correct handling of mercury contaminated materials
  - Ensure that contractual arrangements are made concerning the contamination and use of equipment (i.e. trucks and cleaning equipment) that can become contaminated with mercury. Prevent the use of contaminated resources on clean locations. This to prevent the spread of mercury.
- Concept and Design Engineers:
  - Ensure that selection and design of new projects or modifications comply to PDO Specifications with regards to mercury
  - Consult with the Expertise Holder / FP Mercury on all matters regarding mercury safety
- Work Schedulers:
  - Ensure that effective scheduling of work where mercury is or could be present is carried out
  - Ensure that all risks are identified and that required HSE precautions are highlighted in a Job HSE Plan
  - Ensure that any work relating to mercury contamination is carried out by suitable qualified and trained personnel and that all necessary training and instruction is provided
- Operations Managers
  - Have an awareness of all mercury risks with the area



- Ensure that specification and procedures for management of mercury are adhered to within the area
- Delivery Team Leaders / Production Coordinators / Maintenance Coordinators
  - Ensure that prior to commencing the activities, the employees who can come in contact with mercury have been informed about the risks of mercury and the precautions that must be taken
  - Ensure that all risks are As Low As Reasonably Practicable (ALARP)
  - Check the effectiveness of the control measures in consultation with the Expertise Holder / FP Mercury
  - Ensure all workers who are required to wear respiratory protection for the control of mercury undergo health surveillance in accordance with the recommended protocol
  - Check that sufficient storage space is available at the designated area to accommodate the mercury-contaminated materials and waste that shall be generated.
- Line Supervisors and Permit Holders
  - Check that there is: a Permit to Work (PTW), correct Personal Protective Equipment (PPE), measuring equipment and qualified (certified) gas and mercury tester, and that the employees have had the required training and instruction
  - Discuss the risks and the protective measures with the employees concerned in the Toolbox Talk and ensure the Job Safety Plan reflects and records the details
  - Ensure decontamination stations are set up
  - Clean tools and equipment on location to restrict the spread of mercury contamination
- Contractors

Contractors will be adhere to this Specification and PR-1515 – On-Site Mercury Management Procedure; and any other relevant PDO Code of Practice, Specification, Procedure and Guideline to enable them to effectively manage mercury containment during work activities.

Contractors will be responsible for training their staff and sub-contractors to enable them to comply with this Specification and PR-1515 – On-Site Mercury Management Procedure and to effectively control exposures to mercury. This shall include:

  - Provision of approved and certified / calibrated metering equipment and personal dose meters
  - Mercury level metering using approved metering equipment
  - Collection, sealing / containment, labelling and transportation of mercury contaminated waste solid and liquid to an approved laydown area for shipment and disposal
  - Provision of the correct PPE and PTW for all workers who will or may be exposed to mercury during work activities
  - Monitoring and recording all activities relating to mercury throughout the course of the works (including contaminated equipment storage and transportation) and making the results available to the Asset Owner and / or delegate for entry in to mercury data base for the Asset



- Ensuring that discharges to the environment generated in the course of carrying out their contractual requirements, are managed in accordance with the requirements of this Specification and reported, when applicable
- Provision of 'fit-for-purpose' procedures for all works carried out and not already documented by PDO.

Specialist Contract companies, selected by the main contractor (EMC / ODC for instance), may be used to undertake decontamination or other works associated with mercury, however they (the specialist contractor) and any solvents / chemicals used will be approved by PDO in the normal manner.

**IMPORTANT NOTE:** Currently only Chemicals supplied by 'No Heat Resources' have been approved for use by PDO. For new chemicals a special approval procedure is to be followed. Contact should be made to the PDO Mercury Specialist or GGO22R for more details).

### 3.4 Training and Instruction

Training and risk assessment instruction is essential for all supervisors and personnel (PDO and Contractor) who shall be required to undertake the work. Instruction and training should cover the following:

- Hydrocarbon and Mercury measurement – Authorised mercury and gas testers shall be instructed in the use of detection equipment for mercury vapour. Only gas testers who have been trained shall be allowed to carry out gas testing in mercury sensitive environments.
- Management of Mercury – PDO and contract supervisors who shall be involved in activities with or to mercury-suspected or mercury-contaminated materials should be instructed the risks and hazards of mercury and the measures to take to control the risks. It shall be recommended that a refresher course be repeated at least every 2 years to maintain current awareness.
- Awareness Training - Personnel PDO and contractors, who are to carry out work in designated mercury risk areas or on systems / equipment that has a potential mercury risk shall be given Awareness training prior to carrying out any work. The Awareness Training should be accompanied with a mercury HSE Permit card.

All training undertaken shall be recorded on the PDO HSE Passport.



### 3.5 Personal Protective Equipment Use and Disposal

The working conditions and the results of mercury vapour measurements that are carried out prior to the activities shall determine the choice of protection equipment.

Mercury can bind to clothing and leather and as a result lead to mercury exposures through inhalation or skin contact and absorption if re-used. To prevent this occurring, the clothing and shoes that are worn must be made of a material to which mercury does not bind. The following materials are suitable: PVC (Polyvinylchloride), PP (Polypropylene) and PE (Polyethylene), Neoprene (Viton).

Uncleaned boots may only be transported in vapour-tight packaging.

**IMPORTANT NOTE: Contaminated clothing must not be taken outside of any exclusion zones unless packed in sealed containers or strong polythene bags.**

The decision on when PPE should be treated as 'hazardous' and disposed of in a controlled manner or whether it is safe to clean as normal will be at the discretion of the supervisory personnel. Personnel exposed to gaseous contamination, such as might be the case when breaking a containment flange on a prepared system are unlikely to be soil their coveralls, whereas personnel performing work in a confined space, where liquid or sludge containing possible mercury traces, will. Therefore in the latter the PPE should be removed, monitored and if required disposed of as 'hazardous'.

Regardless of what the exposure source all personnel will be monitored and all PPE removed before leaving the containment zone.

### 3.6 Mercury Measurement Plan and Report

On facilities known to have or suspected of having mercury contamination in the process streams a map of the facility with known / predicted exposure levels shall be prepared and maintained. This can be achieved in the following manner:

- a. Historical Data - Mapping the mercury contamination during a previous shutdown or when intrusive maintenance has been undertaken
- b. Predictive Data – Obtaining mercury contamination data from a facility that is operating under similar conditions and using this as a 'benchmark' **OR** using facility operating parameters and data from the industry to predict possible contamination levels and 'hot spots'.

Based on the above a Mercury Measurement Plan shall be initiated. The mercury measurement plan shall be agreed with the appropriate assets, who shall have the responsibility of carrying out the measurement. The plan shall describe where, when and how often the measurements are taken. The Expertise Holder Mercury shall oversee the drafting of the plan.

The Expertise Holder / FP Mercury must evaluate the measurement plan annually and report on the results of the measurements. Where necessary, the expertise holder will initiate actions to supplement or amend the control measures.

Data gathered from the measurement plan should be stored in an easily accessible way and shall indicate:

- Who is responsible for the data, and
- The period the data refers to

Mercury data shall be stored, preferably at a central location where it is readily accessible. Essentially all data on toxics i.e. NORM, H<sub>2</sub>S etc, should be stored together, the responsibility being handed to one source. Each asset will be responsible to collect and record the data, and then pass this on to the central source for storing.



For offplot and well engineering / C&WI activities, high risk wells will be monitored bi-annually and the results logged. Opportunity inspection and monitoring will be carried out on tubing strings and casings during workovers to provide data on downhole conditions.

Additionally all work on wellheads and flowlines in risk areas will be preceded by monitoring.

*NOTE: All currently held mercury data (by Production Chemistry) on wells will be collated in to the central data base.*

The above may necessitate an approved type meter being maintained by the drilling contractor, EMC / ODC contractor or C&WI with suitably trained personnel to undertake monitoring activities.

Contractors will be required to supply their own mercury monitors, of a type approved by PDO. The contractor shall also ensure that the meter(s) are maintained and calibrated.

Reference should be made to Appendix 2 for types of portable and fixed meters recommended for use in PDO.

### 3.7 Mercury Urine Tests (HgU)

Urine testing shall be conducted on personnel considered at risk to mercury contamination. The test will be conducted under the guidance of the MAF Clinic for PDO personnel and similarly by the contract companies.

#### 3.7.1 Introduction

Preventative measures shall be employed to prevent personnel carrying out unnecessary activities associated with mercury. The mercury urine test programme is a means of checking if the preventative measures are working. The programme is aimed at determining the amount of mercury absorbed into the body.

The objectives of the test are:

- To determine the concentration of mercury in urine as a parameter for the exposure to mercury.
- To examine whether the preventive measures are sufficiently effective to limit the exposure to mercury to the minimum (check of demonstrable control).
- In the event of an increased exposure of an employee, he/she can be removed from the job as soon as possible. In addition, the cause can be traced and corrective measures can be taken.

The test should target PDO and Contractor personnel who due to their activities have an increased risk of exposure to mercury.

*NOTE: If a worker is exposed to airborne concentrations of greater than half the occupational exposure limit, regardless of the controls, he shall undergo biological monitoring.*

#### 3.7.2 Considerations for Carrying Out HgU Tests

The type, nature and duration of the activities carried out are key criteria when making a selection of personnel who will be asked to take the mercury urine test.

Personnel who are eligible for the test are those who are occupied in:

- The repair, overhaul and maintenance of mercury-contaminated materials
- Cleaning mercury-containing installation components



- Clearing up mercury
- Cutting, welding and heating mercury-contaminated material
- Working in mercury-contaminated soil
- Work during periodic maintenance on gas treatment facilities where mercury can be present
- Removing gas filters

The employees must carry out the above-mentioned activities for several consecutive days to weeks or in a defined period.

*NOTE: Experience with HgU tests from Shell Operations in the Netherlands (NAM) has shown that in certain working situations samples from only a representative group of personnel is required to obtain the required results.*

In view of the extensive experience, it can be sufficient to only allow a limited number of representative employees to take the test.

### 3.7.3 HgU Measurement Plans

If it is considered necessary to carry out HgU tests, an HgU Measurement Plan will be initiated. The measurement plan includes the following:

- What is the purpose for undertaking the tests
- Why are the tests being carried out
- How are the tests to be carried out - (measurement strategy, at what times will samples be collected, who are the participants)
- How will the results be circulated
- Who is requesting the information
- Who will approve the test being undertaken

### 3.7.4 Execution of the HgU Measurement Plans

The HgU test for PDO employees shall be coordinated through PDO clinics (interior/coastal). The HgU test for contractor personnel shall be coordinated through the interior PAC clinics.

### 3.7.5 Limit Values and Action Values for Mercury in Urine

The Table indicates what actions must be started at what measurement values.

Value	HgU in µg / g creatinine	Action
Normal value	< 35	• None
Slight increase	36 – 75	<ul style="list-style-type: none"> <li>• Further investigation into the conditions that caused the increase and take corrective measures</li> <li>• Repeat the HgU test + visit to company doctor</li> <li>• Measure the NAG (N-Acetyl-Glucosamidase) enzyme. Check early effects.</li> </ul>





<b>Value</b>	<b>HgU in <math>\mu\text{g}</math> / g creatinine</b>	<b>Action</b>
Increase	> 75	<ul style="list-style-type: none"><li>• Further investigation into the conditions that caused the increase and take corrective measures</li><li>• Repeat the HgU test + visit to company doctor</li><li>• Measure the NAG (N-Acetyl-Glucosamidase) enzyme. Check early effects.</li><li>• The employee concerned will no longer be employed in activities that pose an increased risk of mercury exposure until the HgU content has dropped below the normal value</li></ul>



## 4 Developing, Designing and Modifying Facilities and Wells with Mercury Risk

### 4.1 Developing and Designing Wells and Facilities

The Concept Engineers shall consider in the design:

- Presence of mercury
- Measures that require to be taken to preventing the release of mercury and manage any mercury in a safe manner.
- Technical measures to control the risks resulting from mercury to ALARA
- Minimising the creation of mercury-containing waste
- Involvement and input from specialists with knowledge of mercury in the Operational, Maintenance and Waste disposal fields.
- Inclusion in design of mercury recovery units upstream of new facilities to prevent / reduce excessive mercury contamination.

For newly to be built gas treatment plants the following criteria apply:

Process Phase	Criteria	Comment
Mercury vapour in sales gas	Export to SUR 5 ppb	Measured ex PDO locations and inlet SUR
Mercury in condensate	No export limits in PDO contracts	Practical limit to make export to all locations possible ca 10-15 ppb.  <i>NOTE: Unwritten limit for refineries is 50 ppb due to sensitivity on catalyst</i>
Mercury in sour gas condensate	Export 5 ppb , less of an issue due to HgS formation as a solid	Normally less of a problem
Emissions to air	Local environmental law	Varies country to country
Emissions to the soil	150 mg/Kg	<b>RE-USE OF SLUDGE IN AGRICULTURE -CONDITIONS FOR APPLICATION TO LAND MD145/93</b>
Emissions to water	0.001 mg/L	<b>MD145/93</b>

### 4.2 Modification of Existing Facilities

When designing modifications to installations, the ALARP principle is followed for controlling the risks associated with the presence of mercury.



## 5 Pre-qualifying, Contracting and Employing Vendors for Work with Mercury

### 5.1 Vendors that Carry Out Work at a PDO location

Vendors that carry out work on (or with) suspected mercury-contaminated material at PDO locations, must satisfy this PDO specification by having developed mercury safe systems of work.. The safe system of work guarantee controlled execution of the activities. Contracts with Vendors must include the fact that the PDO specification and associated procedures concerning management of mercury apply.

### 5.2 Vendors that Carry Out Work at a Non-PDO Location

Vendors that carry out work on mercury-contaminated materials in a workshop at a non-PDO location will be required to reference to this Specification and PR-1515 – On-site Mercury Management. Additionally their employees should be instructed in the dangers and protection from mercury exposure and be audited by PDO as to their 'fitness' to undertake work on equipment that is or could be contaminated by mercury.

The audit will take place concurrently and be in accordance with the regular qualification.

*NOTE: For additional prequalification, the contract holders must contact the Expertise Holder Mercury.*

During the prequalification the following aspects are examined:

- Safe systems of working with mercury.
- occupational health and safety risk inventory and evaluation (for the tasks to be carried out),
- environmental permits (for the workshop),
- competencies (training),
- facilities and
- means and methods

The capacities of the Vendors shall be recorded.

During the selection, account is taken of the nature and scope of the activities to be carried out. Based on this it is determined whether the Vendor must satisfy the basic or other supplementary<sup>2</sup> conditions.

If an unknown Vendor is concerned or if there is any other doubt, these aspects must be verified at the workshop of the Vendor in question.

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<sup>2</sup> Supplementary conditions apply if activities with an additional risk, such as heating, welding, annealing and machining, are concerned



## 6 Preparing and Carrying Out Activities on Mercury-Contaminated Installations, Wells and Soil

### 6.1 Planning / Preparing the Activities

- Planning / preparation are essential when carrying out activities where mercury is possibly present. The following requirements must be satisfied:
  - Take an inventory and cover the risks resulting from the (possible) presence of mercury
  - Check whether personnel involved are competent and have been adequate work instructions (safe methods of work) to carry out the work
  - Personal hygiene is adhered to
  - Be alert to temperature increases or actions that will increase the temperature such as cutting and welding
- Based on the risk analysis that has been made, determine the measures that must be taken when the measurement value exceeds the action value. For example:
  - Employing a dedicated supervisor
  - Setting up clean and contaminated areas or making provisions for them to be set up
  - Selecting the correct personal protection equipment and making it available to all personnel that require it
  - Using extraction (if required with a filter)
  - Making provisions for the collection of mercury and other waste materials (in case of insufficient knowledge, MSE2 corporate environment).
  - Positioning plastic leak trays that are partially filled with water to collect the released mercury.

*NOTE: The water prevents mercury vapour occurring and the spread of mercury.*

  - Using plastic covers around and under equipment to contain spillage and prevent soil contamination

### 6.2 Measuring Mercury Vapour and Carrying Out Activities

Prior to and when working on mercury-suspected facilities, soils or return materials or confined areas, mercury vapour measurements must be taken to determine the presence of mercury vapour using a calibrated portable Jerome J405 mercury Analyser

Requirements with respect to mercury vapour measurements are:

- Measurements must be carried out by approved gas testers (qualified to carry out mercury vapour testing).
- Measurements shall be carried out using a Jerome 405 or Jerome 431-X mercury vapour monitor
- The measuring tools shall be calibrated annually by an approved vendor and be to at a minimum the manufacturer values guaranteed at delivery



- Measurement shall be taken in the expected breathing zone. The results of these measurements will determine whether to work with or without PPE. If during the measurement in the breathing zone a value is found that exceeds the action value, protective measures must be taken in accordance with recommendations from the Expertise Holder Mercury and / or MSE.

*NOTE: Internal measurements in dismantled equipment only give an indication of the cleanliness of the equipment concerned. This measurement shall not be used for determining whether the equipment is contaminated with mercury.*

The frequency of the measurements shall require to be continually reviewed. This is because the result of the measurements depends heavily on the circumstances (wind, temperature, nature of the activities).

Mercury vapour must always be measured:

- When opening installation components
- When maintenance, welding and cutting activities are carried out on installation components that are, or are suspected of being, contaminated with mercury
- When entering confined areas
- If there is any uncertainty
- When the working conditions changes (for instance after a break or in case of a temperature rise).

The number of times that measurements must be taken depends strongly on the circumstances. The following measurement strategy is recommended:

- The first measurement before work begins (the reference measurement, measurement of the background value)
- Second measurement when exposure occurs.
  - If result < 50% of the Occupational Exposure Limit (OEL) value: repeat measurement if required
  - If result  $\geq$  50% of the Occupational Exposure Limit (OEL) value: take required control measures, repeat the measurements
- Carry out additional measurements if there are major changes in climatic conditions.
- In case of doubt, always take additional measurements.
- Measurement results must be recorded on the Mercury Vapour Measurement Record Form (see Appendix 1). The measurement form will be kept with the PTW and the results entered in to the Mercury Database.
- If values are found that exceed the action value, the measures that were anticipated in the preparatory phase must be taken.

It is recommended that additional measurements are taken in warehouses, work areas and control, canteen and changing rooms. Areas concerned are those where due to a lack of personal hygiene or otherwise (for instance the storage of contaminated return material or contaminated equipment or waste) mercury vapour can be present.



## 7 Handling, Packing, Transporting and the Handover of Mercury-Contaminated Substances

Reference shall be made to [SP-1009 - HSE Specification - Waste Management](#) for details of Waste Management.

### 7.1 Handling Mercury-Contaminated Waste

*NOTE: Spent mercury absorbent (Chemicals) is waste, but will be recycled in Europe.*

All of the materials that require disposal and that have been in contact with the production process must be sampled for the presence of mercury.

Mercury-contaminated waste and waste that is not contaminated with mercury must be kept separately. Liquids and sludge's **must** be sampled and analysed in the QA laboratory using the Nippon Analyser before being stored at the waste site. This will enable comparison to the environmental limits for safe disposal.

*NOTE: Sludge contaminated with mercury is one of the most expensive categories of waste (several thousand Euros per tonne).*

Materials contaminated with Mercury shall be placed in thick gauge, impervious, double plastic bags, labelled and stored in a designated area within a waste management facility. All work for dismantling, packing, removal, transport and disposal must only be undertaken by a licensed hazardous waste contractor.

Labelling, packaging and readying for transport of waste must occur in accordance with the SAP Workorder instruction.

A container that is used to transport mercury-containing scrap must be visually inspected for the presence of metallic mercury. If required, an additional mercury vapour measurement is carried out. If mercury is found, the container must be cleaned in the same way as contaminated equipment (see Subsection 7.3).

PDO only owns mercury-containing waste arising from PDO locations. Mercury-containing waste coming from PDO property, but that is released at a non-PDO location, is the property of the contractor concerned and must be processed by the contractor concerned.

*NOTE: When dismantling facilities and after cleaning an inventory is made on site of the mercury-contaminated scrap using representative sampling. In order to correctly harmonise the activities, the production chemistry must be contacted and informed in the planning stage of the dismantling operation.*

**Transportation of Mercury Contaminated Waste** shall be carried out by a 'Licensed Hazardous Waste Transporter who has the appropriate Permit from the Ministry of Environment and Climate Affairs (MERCA) to transport such waste and accompanied by a Waste Consignment Note (see Appendix 3). The Waste consignment Note shall be raised by the Waste Originator / Generator for each load transported. The Waste Consignment Note shall be signed when the waste is received at the waste management facility and a signed copy shall be returned and retained to / by the Waste Originator / Generator as a record of safe arrival.

**IMPORTANT NOTE:** *The Waste Consignment Note is not to be used for the transportation of Mercury-Contaminated Return Materials.*

### 7.2 Transport of Mercury-Containing Filters

Filters that contain mercury should be considered and handled as being 'hazardous'. Filters must be packed in the liquid-tight containers intended for this purpose

Refer to **Transportation of Mercury Contaminated Waste** in Section 7.1.



### 7.3 Handling Mercury-Contaminated PPE

Contaminated PPE that is intended for one-time use will be disposed of as mercury-contaminated waste:

- Gloves and clothing are put in special containers and disposed of.
- Used filter containers must be sealed and disposed of as being mercury-contaminated waste.

The PPE that is to be cleaned is treated as follows:

- Filter masks are packed in their holders or in sealable plastic drums or thick-wall foil bags
- Viton suits are rinsed in a chemical / water solution dried and stored for re-use.
- Boots must be cleaned when leaving the contaminated area. They can be rinsed off with chemical / water solution, dried and stored for re-use.

Liquid waste from the rinsing exercise shall be collected and shipped in a sealed container to the waste site at QA where it shall be tested for contamination and disposed of in the approved manner.

### 7.4 Handling Mercury-Contaminated Tools and Equipment

Dry cloth is used as much as possible to clean tools and equipment that have been used in a contaminated environment.

Dispose of used cloths as being mercury-contaminated waste.

If cleaning must be done by hosing down, the rules applying to return materials must be followed.

All hosing down shall be conducted in a controlled manner into plastic lined sumps/collection points. It shall not go to ground.

### 7.5 Handling, Packaging, Transporting and the Handover of Mercury-Contaminated Return Materials

For the purpose of this Specification Mercury-Contaminated Return Materials shall be defined as:

“Material that have been in contact with a known mercury contaminated source, and that can not be effectively decontaminated on site. Such equipment may be valve assemblies, instrument transmitters that have been connected to the contaminated medium, pumping units used for flushing / circulating etc. All such equipment shall be monitored for contamination prior to transport and levels recorded”.

#### 7.5.1 Handling and Packaging

During handling and packaging of mercury the following shall apply:

- Take precautions (see work preparation/planning) to collect any spills during disassembly
- Clean return materials immediately after they become available on site. To prevent the formation of mist due to hosing down, dry cleaning is preferred (polish)
- If it is necessary to clean goods by hosing down, precautions must be taken for both man and the environment. The measures must be aimed at preventing soil pollution (using leak trays and slabs) and protecting the personnel (consider the wind direction). Rinsing water must be treated as mercury-contaminated waste



- Be aware that goods remain suspected of being contaminated with mercury even after cleaning
- Measuring mercury in equipment such as valves and pipes gives no information about the mercury concentrations that an employee is exposed to. The measurement results only give an indication of the degree of internal contamination of the equipment or pipe involved. These measurements do not give any information about the possible degree to which employees are exposed to mercury vapour
- Whether or not to take preventive measures depends on the result of the measurements taken in the breathing zone to be expected for the activities. If the value of this mercury vapour measurement is above the occupational exposure limit of 0.025 mg/m<sup>3</sup>, measures must be taken
- If a value greater than the action value is measured in the breathing zone of a piece of return material that is to be shipped, the material is contaminated with mercury. In this case, the breathing zone is meant to mean a distance of 0.30 m around the equipment concerned. If a value less than the action value is measured, the material is (remains) suspected of containing mercury
- Measurements taken in the equipment are useful to determine whether the cleaning has had any effect
- After the material has been cleaned as well as possible, all openings must be sealed. Preferably using gaskets and flanges
- An approved PDO equipment label must be attached to every piece of return material. The label shows whether the return material is not mercury contaminated, suspected of being mercury contaminated or mercury contaminated
- If measurement values are reported, the conditions under which the measurements were taken (temperature, presence of wind, sunlight) must also be given.
- Large pieces of equipment can, after the openings have been sealed, be transported without packaging.
- Small pieces of equipment will be packed in vapour tight strong foil (PE) and placed in crates or sealable drums before being transported.

### **7.5.2 Ready for Transport and Transporting**

Mercury-contaminated return materials are classed as 'Hazardous' cargo.

### **7.5.3 Handover**

To ensure that the receivers of the mercury-suspected or mercury-contaminated return materials are aware of the possible presence of mercury, mercury-contaminated materials or mercury-suspected return materials must be formally handed over to the receivers. Receivers of these materials must sign the transport documents for formal acceptance.





### Appendix 1 – Mercury Vapour Measurement Record Form



#### MERCURY VAPOUR MEASUREMENT RECORD FORM

This Form shall be used to record Mercury Vapour Readings when performing work that requires intrusive entries to the pressure envelope for systems and equipment where a known or suspected mercury contamination risk is present. On completion of the Work the findings shall be entered in to the Mercury Database for the Facility.

Asset / Facility:		PTA No:	
Location and Nature of Work (Brief Description):		Date:	
		Time:	
Measurement Performed: <i>(MUST be an Authorised Gas Tester)</i>			
Measurement Meter Used:	Weather Condition:	Comments:	
Mercury Vapour Measurement Results (ACTION Required > 0.025 mgm <sup>-3</sup> )			
Measurement Location / Area		Initial Vapour Measurement	
		Time	Reading
		Time	Reading
Subsequent Measurements (taken when / if exposure occurs)			
Time	Reading	Comment	
PPE / RPE Recommendation for undertaking the Work			
Authorisation and Endorsement	Name and Signature	Date	
Production Supervisor (Approve Work)			
Production Coordinator (Endorse Work)			



## Appendix 2 – Measurement Equipment - Types

### Jerome® J405 Mercury Vapor Analyzer



#### Applications for the Jerome® Mercury Vapor Analyzer:

*Mercury Spill Response & Cleanup*  
*Mercury Exclusion Testing*  
*Facility Monitoring*  
*Source Surveys*  
*Hazardous Waste Sites*  
*Fluorescent Lamps Disposal & Recycling*  
*Worker Safety*  
*Landfill Monitoring*  
*Exhaust Duct Monitoring*  
*Plant Environment Monitoring: light bulbs, mercury switches equipment*  
*Fish (Heated)*

#### Additional Features:

*Detection limit down to 0.5 µg/m<sup>3</sup>*  
*Meets EPA & ATSDR cleanup levels*  
*Longer sensor life*  
*Battery powered sensor regeneration*  
*On-board data logging (20,000 data points) (Upgraded Model)*  
*Auto time/date stamp (Upgraded Model)*  
*USB data output (Upgraded Model)*  
*SCADA interface capabilities via 4-20ma*



## Jerome 431-X



The Jerome 431-X Mercury Vapor Analyzer uses a gold film sensor for the detection and accurate measurement of toxic mercury vapor in the air.

A portable hand-held unit, the Jerome 431-X can easily be carried to locations of mercury concerns. Simple, push-button operation allows users to measure mercury levels in just seconds. The range of the 431-X is from 0.000 to 0.999 mg/m<sup>3</sup> Hg. The gold film sensor is inherently stable and selective to mercury, eliminating interference common to ultraviolet analyzers, such as water vapor and hydrocarbons.

The 431-X includes features not available in older Jerome models. When attached to either a data logger or computer, the analyzer automatically regenerates the sensor when it becomes saturated and then resumes sampling. An improved film regeneration circuit makes the sensor last even longer.

**Features**

Portable, rugged and easy to operate  
13 second response  
Automated sample cycle  
Inherently stable gold film sensor  
Operates up to six hours on fully charged nickel-cadmium battery  
Digital display in either mg/m<sup>3</sup> or ng  
One year limited parts and labor warranty

**Applications**

Mercury surveys  
Spill response  
Hazardous waste sites  
Mercury exclusion tests

**Specifications**

Accuracy: +/- 5% at 0.100 mg/m<sup>3</sup> Hg  
Sensitivity: 0.003 mg/m<sup>3</sup> Hg  
Range 0.000 to 0.999 mg/m<sup>3</sup> Hg  
Precision: 5% relative standard deviation at 0.100 mg/m<sup>3</sup> Hg  
Environmental Operating Range: 0-40 degrees C, non-condensing, non-explosive  
Response Time: Sample mode - 13 seconds; Survey mode - 4 seconds  
Flow Rate: 750cc/min.  
Weight: 7 pounds  
Dimensions: 6"W x 13"L x 4"H  
Case Design: Enform  
Power Requirements: 115VAC or 230VAC, 115 watts maximum

## Appendix 3 – Waste Consignment Note



### WASTE CONSIGNMENT NOTE

Number: \_\_\_\_\_

(Separate Waste Consignment Notes are required for Hazardous and Non- Hazardous Wastes)

<b>Section A: WASTE DETAILS</b>																
<p>1. Please tick (4) box below to indicate the type of waste you are transferring</p> <p><b>NON-HAZARDOUS WASTE TYPE</b></p> <table style="width: 100%; border: none;"> <tr> <td><input type="checkbox"/> Domestic Waste (kitchen refuse)</td> <td><input type="checkbox"/> Domestic waste (tree cuttings)</td> <td><input type="checkbox"/> Office waste</td> <td><input type="checkbox"/> Waste wood materials</td> </tr> <tr> <td><input type="checkbox"/> Non-Hazardous Chemical Waste</td> <td><input type="checkbox"/> Metal Drums</td> <td><input type="checkbox"/> Plastic Drums</td> <td><input type="checkbox"/> Construction debris</td> </tr> </table> <p>If other, please describe waste accurately here</p> <p>_____</p>	<input type="checkbox"/> Domestic Waste (kitchen refuse)	<input type="checkbox"/> Domestic waste (tree cuttings)	<input type="checkbox"/> Office waste	<input type="checkbox"/> Waste wood materials	<input type="checkbox"/> Non-Hazardous Chemical Waste	<input type="checkbox"/> Metal Drums	<input type="checkbox"/> Plastic Drums	<input type="checkbox"/> Construction debris								
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<input type="checkbox"/> Non-Hazardous Chemical Waste	<input type="checkbox"/> Metal Drums	<input type="checkbox"/> Plastic Drums	<input type="checkbox"/> Construction debris													
<p><b>HAZARDOUS WASTE TYPE</b></p> <table style="width: 100%; border: none;"> <tr> <td><input type="checkbox"/> Oily sand / soil</td> <td><input type="checkbox"/> Oily sludge</td> <td><input type="checkbox"/> Waste Lubricants</td> <td><input type="checkbox"/> Pigging sludge</td> </tr> <tr> <td><input type="checkbox"/> Hazardous chemicals waste</td> <td><input type="checkbox"/> Sewage sludge</td> <td><input type="checkbox"/> Batteries</td> <td><input type="checkbox"/> Clinical waste</td> </tr> <tr> <td><input type="checkbox"/> Hazardous Laboratory Chemicals</td> <td><input type="checkbox"/> Mercury-contaminated waste</td> <td><input type="checkbox"/> NORM waste</td> <td><input type="checkbox"/> OBM &amp; or OBM Cuttings</td> </tr> <tr> <td><input type="checkbox"/> Tyres (used)</td> <td><input type="checkbox"/> Other</td> <td><input type="checkbox"/> Asbestos</td> <td><input type="checkbox"/> Empty Drums contaminated with hazardous oil/chemicals</td> </tr> </table> <p>If other, please describe waste and physical state (solid, liquid or a combination) accurately here</p> <p>_____</p>	<input type="checkbox"/> Oily sand / soil	<input type="checkbox"/> Oily sludge	<input type="checkbox"/> Waste Lubricants	<input type="checkbox"/> Pigging sludge	<input type="checkbox"/> Hazardous chemicals waste	<input type="checkbox"/> Sewage sludge	<input type="checkbox"/> Batteries	<input type="checkbox"/> Clinical waste	<input type="checkbox"/> Hazardous Laboratory Chemicals	<input type="checkbox"/> Mercury-contaminated waste	<input type="checkbox"/> NORM waste	<input type="checkbox"/> OBM & or OBM Cuttings	<input type="checkbox"/> Tyres (used)	<input type="checkbox"/> Other	<input type="checkbox"/> Asbestos	<input type="checkbox"/> Empty Drums contaminated with hazardous oil/chemicals
<input type="checkbox"/> Oily sand / soil	<input type="checkbox"/> Oily sludge	<input type="checkbox"/> Waste Lubricants	<input type="checkbox"/> Pigging sludge													
<input type="checkbox"/> Hazardous chemicals waste	<input type="checkbox"/> Sewage sludge	<input type="checkbox"/> Batteries	<input type="checkbox"/> Clinical waste													
<input type="checkbox"/> Hazardous Laboratory Chemicals	<input type="checkbox"/> Mercury-contaminated waste	<input type="checkbox"/> NORM waste	<input type="checkbox"/> OBM & or OBM Cuttings													
<input type="checkbox"/> Tyres (used)	<input type="checkbox"/> Other	<input type="checkbox"/> Asbestos	<input type="checkbox"/> Empty Drums contaminated with hazardous oil/chemicals													
<p><b>2. Quantity:</b></p> <p>_____</p>																
<p><b>3. Additional Information</b> - Please provide any relevant information e.g. type of premises waste comes from, full analysis, process that produced the waste, including details of any problems your waste may present during the handling, containment, transportation, treatment or disposal by any subsequent holder:</p> <p>_____</p>																
<b>Section B1: WASTE ORIGINATOR (Asset )</b>																
<p>1. PDO Asset (Marmul, Nimr, Qarn Alam, Bahja-Rima, Yibal, Fahud-Lekhwair, Gas, Well Engineering, Infrastructure, Exploration, MAF Terminal , other) Please tick one (4)</p> <p>_____</p>																
<p>2. Location source of waste _____ Destination: _____</p> <p>Return white copy to Originator by a) Fax/Fax No _____ b) Mail c) Driver d) Monthly Waste Returns</p>																
<p>3. The waste has been verified as being unsuitable for reuse/recycling <input type="checkbox"/> Yes <input type="checkbox"/> No</p>																
<p>4. Signature ( Waste Originator) _____ Date: _____</p>																
<p>5. Full Name (Please print) _____</p>																
<p><b>* I, the undersigned confirm that the waste material declared above has no value and therefore can be disposed off.</b></p> <p><b>Full Name</b> _____ <b>Signature</b> _____ <b>Ref Ind:</b> _____ <b>Date:</b> _____</p> <p>* Supervisor level</p>																
<b>Section C: WASTE TRANSPORTER</b>																
<p>1. Company Name: _____</p>																
<p>2. Signature of Driver: _____ Date: _____</p>																
<p>3. Full name of Driver (Please print): _____</p>																
<b>Section D: WASTE DISPOSAL FACILITY</b>																
<p>1. Facility Location/Site: _____</p>																
<p>2. Date &amp; time waste received: _____</p>																
<p>3. Name of Waste Disposal Site Operator: _____</p>																
<p>4. Signature of Waste Disposal Site Operator _____</p>																

Distribution: Yellow Copy: **Originator**      Blue Copy: **Disposal Site**      White Copy : **Waste Contractor Return to Originator**  
(MESC Number 93.55.81.500.9)



Waste Consignment Note: EXPLANATORY NOTES  
(to be printed at the back page of the Waste Consignment Note)

**White Copy**  
( To be completed & handed to driver with blue copy for delivery to waste operator)

Section A: Waste details  
• Waste Generator fills out

Section B: Waste Generator  
• Waste Generator fills out

Section C: Waste  
• no action

Section D: Waste Disposal Facility  
• no action

White Copy  
Yellow Copy  
Blue Copy

**Yellow Copy**  
( To be retained by Waste originator)

Section A: Waste details  
• Filled out by Waste Generator

Section B: Waste Originator  
• Filled out by Waste Generator

Section C: Waste Transporter  
• Signed by Vehicle driver

Section D: Waste Disposal Facility  
• Signed by Waste Disposal Operator

Yellow Copy  
Blue Copy

**Blue Copy**  
( To be retained by Waste Disposal Operator )

Section A: Waste details  
• Filled out by Waste Generator

Section B: Waste Originator  
• Filled out by Waste Generator

Section C: Waste Transporter  
• Signed by Vehicle driver

Section D: Waste Disposal Facility  
• Signed by Waste Disposal Operator

Blue Copy

**Instructions to: Waste Generator, Vehicle Driver & Waste Disposal Operator**

1. Waste Generator fills Section A & B, retains Yellow Copy and gives the White & Blue Copies to the Vehicle Driver

2. Vehicle Driver signs Section C, gives the White and Blue Copies to Waste Disposal Operator.

3. Waste Disposal Operator signs Section D, gives the White Copy back to Waste Contractor

4. Waste Contractor gives the White Copy to the Waste Generator by either Fax, Mail or Driver

6. Waste Disposal Operator retains Blue Copy



## Appendix 4 – Reference Material

### PDO Related Documents

The following PDO procedures have interface with this specification.

[PR-1000 - Operations Handover Procedure](#)

[PR-1001x - Operations Variance and Change Management](#)

[PR-1073 - Gas Freeing, Purging & Leak Testing of Process Equipment \(Excluding Tanks\)](#)

[PR-1074 - Flowline Flushing Procedure](#)

[PR-1076 - Isolation of Process Equipment Procedure](#)

[PR-1077 - Preparation of Static Equipment for Internal Maintenance and Inspection](#)

[PR-1079 - Gas Freeing and Purging of Tanks Procedure](#)

[PR-1080 - Well Testing, Scheduling, Sampling and Validation](#)

[PR-1084 - Oil Spills Clean Up and Ground Restoration Procedure](#)

[PR-1096 - Sampling of Oilfield Liquids and Gases Procedure](#)

[PR-1148 - Entry into a Confined Space Procedure](#)

[PR-1154 - Gas Testing Procedure](#)

[PR-1515 - Onsite Mercury Management Procedure](#)

[SP-1009 - HSE Specification - Waste Management](#)

### International Documents

These documents may provide useful reference on the subject of Mercury Management.

[Specialist Mercury Waste Disposal Companies \(Worldwide\)](#)

[UNEP Guidance, Training Materials and Toolkits Relevant to Mercury](#)

[UNEP Toolkit For Identification and Quantification of Mercury Releases](#)

[Guide for Reducing Major Uses and Releases of Mercury](#)

[Standard Test Method for total Mercury in Water – ASTM D-3223-02 \(reapproved 2007\)](#)