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1.0 INTRODUCTION

1.1 Purpose

This procedure is intended to provide general information on precautions for mercury that may be found inside Anacortes Refinery process equipment and instrumentation. All applicable federal, state, and local laws and regulations shall be followed.

1.2 Scope

This procedure is used by the Anacortes Refinery to evaluate responses to mercury that may accumulate inside process equipment or be spilled from mercury-containing instrumentation.

2.0 REFERENCES

2.1 Marathon Standards, Policies & Procedures

- LAB-1820-008 Safe Handling of Mercury in Laboratories

2.2 Government Regulations

- OSHA 29 CFR 1910 Occupational Safety and Health Standards
- RCW 70.95M Mercury
- DOE WAC 173-303-573 Standards for Universal Waste Management
- WAC 296-841-20025 Permissible Exposure Limits

3.0 DEFINITIONS

The following definitions are applicable to this procedure.

Table 1 Definitions

Term	Description
Mercury (Hg)	Metallic mercury is a shiny, silver-white, odorless, naturally occurring liquid metal that may be found in trace amounts in some crude oils. In an oil refinery, mercury may accumulate in equipment after processing large amounts of crude oil. See Section 4.1 for a complete list of the forms of mercury that may be in crude oil.
Mercury Exposure	In a petroleum refinery, two potential routes of exposure are expected to exist. Metallic mercury can evaporate to generate airborne mercury vapor, which can create an inhalation hazard. Respiratory protection, including supplied air respirators or air purifying respirators with mercury vapor cartridges, can reduce or prevent inhalation of mercury vapor. Dust or fumes from mercury containing compounds in scale, ash or sludge may also present an inhalation exposure potential. Metallic mercury and mercury vapor are considered a skin contact hazard as absorption into the body through intact skin can occur.

Table 1 Definitions

Term	Description
Mercury Exposure Limits	WAC established 0.05 mg/m³ as an 8-hour permissible exposure limit (PEL), and 0.15 mg/m³ as the short-term exposure limit (STEL). Federal OSHA currently has an acceptable ceiling limit of 0.1 mg/m³. The IDLH concentration published by NIOSH is 10 mg/m³.
Mercury Toxicity	Short-term exposure to high levels of mercury vapor may cause lung damage, nausea, vomiting, diarrhea, increases in blood pressure or heart rate, skin rashes, and eye irritation and tissue burns. Prolonged exposure to high levels of mercury can permanently damage the blood, kidneys, liver, brain, central nervous system, and in the case of pregnant workers, the developing fetus. Brain function effects may result in irritability, shyness, tremors, and changes in vision or hearing, as well as memory problems.
Mercury Vapor	Liquid metallic mercury can release invisible and odorless mercury vapor into the atmosphere. The rate of mercury vapor generation increases as the temperature of liquid mercury increases.

4.0 MERCURY IN REFINERIES

Mercury is a naturally occurring metal that may be found in trace amounts in some crude oils. In an oil refinery, mercury may accumulate in equipment after processing large amounts of crude oil. Metallic mercury is a shiny, silver-white, odorless liquid. Mercury vapor is colorless and odorless. Mercury may combine with other elements to form organic or inorganic salts. These salts can be soluble in oil or water and have various colors and appearances. To date, metallic mercury is the form of mercury that has been found in some refinery process equipment. During crude oil distillation, mercury enters the vapor phase, allowing some vapor to condense with small amounts accumulating in process equipment. Metallic mercury, mercury amalgams and mercury salts may be present in bottoms and ash. Additionally, trace amounts of mercury vapor may exist in refinery fuel gas as well as in combustion products from heaters and boilers.

4.1 Mercury in Crude Oil & Refinery Equipment

Instrumentation and equipment such as thermometers, batteries, manometers, barometers, fluorescent light bulbs and certain paints can contain mercury. In some cases, mercury-containing equipment can be replaced with less hazardous alternative equipment to remove a potential source of mercury spills and exposure.

Forms of mercury in crude oil that may accumulate in refinery process equipment include the following:

- Metallic mercury can be dissolved in crude oil and can precipitate out inside refinery equipment. Visible pools or globules of silvery liquid metal indicate the presence of mercury that requires decontamination of equipment before inspection or maintenance is done. Liquid mercury left undisturbed can release mercury vapor and generate concentrations above exposure limits inside confined areas with limited air exchanges.
- Metallic mercury can also be found in some process and Laboratory instrumentation, including thermometers, manometers, barometers and switches. Usually this type of equipment is not expected to cause exposure issues unless the mercury-containing device is broken or not sealed.

- Dialkyl mercury, more toxic than metallic mercury, is theorized to possibly be dissolved in hydrocarbon liquids, but has reported as non-detectable in crude oil and refinery process streams.
- Mercuric sulfide (HgS) and mercuric chloride (HgCl2) are two forms of ionic mercury that may be dissolved or suspended in crude oil.
- Asphaltene or aryl mercury (mercury combined with an aromatic hydrocarbon) can be a major mercury component of some crude oils but is not detectable in other crude oils.
- Complexed ionic mercury, such as methyl mercury chloride, is considered to be a possible form of mercury that may be in crude oil.
- Metallic amalgams that contain mercury, such as aluminum and mercury mixtures, may be found in scale or corroded metal interiors of process equipment. Heating by welding or torch cutting such mixtures can generate high airborne concentrations of mercury if corrosion or scale is not first removed.

4.2 Concerns from Mercury in Crude Oil

Mercury in crude oil can cause problems in refineries, including:

- Poisoning catalysts and reducing their service life.
- Reducing quality of refined products.
- Mercury concentrations in wastewater and solid waste can exceed regulatory limits.
- Mercury can deposit inside equipment creating health and safety issues during inspection and maintenance operations.

4.3 Mercury Testing

Anyone visually inspecting the inside of refinery process equipment should be alert for the presence of elemental mercury, especially in the crude unit overhead, desalting and sour water systems. Low spots in process equipment are typically where mercury has been found. The presence of mercury should be reported to Supervision and the Health & Safety Department immediately, if found.

If rust, scale, ash, or residue covers the bottom of process equipment and the presence of mercury is suspected, a length of copper tubing or wire can be used to probe the residue for mercury. If the copper is corroded or discolored, the end to be inserted into the residue should first be sanded or otherwise cleaned to restore a bright copper appearance. The cleaned portion of the copper will become plated with silver appearing mercury if the copper comes into contact with pooled mercury that is hidden under residue inside equipment.

Air testing to check for mercury contamination or to confirm the adequacy of respiratory protection requirements can be done by several methods, including those which require off-site analysis and those which provide more immediate results. Air testing should be done during the highest expected temperature as airborne mercury vapor concentrations can increase as temperature increases.

Mercury Check Swab can be used for testing of mercury contamination on surfaces. Residual mercury can remain on inside surfaces of emptied process equipment as plated metallic mercury or as a component of residual scale. If the presence of mercury is

suspected, Mercury Check Swabs can be used to test for mercury on the interior surfaces. The surfaces to be tested with Mercury Check Swabs should be pre-treated with bleach solution if the presence of metallic mercury is suspected. Along with air testing, this type of test could be useful for determining if mercury precautions are needed for hot work inside equipment that may have contained mercury.

Instrumentation used for mercury detection should be appropriately maintained and calibrated if applicable and used only by employees trained on how to use the equipment. Contact the Health & Safety Department for Industrial Hygiene monitoring and information.

4.4 Exposure Limits

A worker's exposure to mercury must be less than the OSHA and WAC exposure limits. If there are conflicting limits, then the lowest conservative number shall be utilized. The current mercury exposure limits are the following:

- 0.05 mg/m³ 8-hour permissible exposure limit (PEL)
- 0.15 mg/m³ 15-minute short-term exposure limit (STEL)
- 0.1 mg/m³ ceiling limit

4.5 Process Equipment Mercury Precautions

Typical precautions for when mercury is unexpectedly found inside process equipment being opened for maintenance or inspection is listed below:

- Stop work on the process equipment and inform supervision of its presence.
- Notify the refinery Health & Safety Department.
- Without touching the mercury, prevent it from entering sewer systems.
- Using caution tape, restrict access to the area around the equipment to people trained in the hazards of mercury.
- For work on the equipment to continue, a new work permit should be issued that includes information on precautions and requirements for working on mercury containing equipment. Section 4.7 presents more information for mercury decontamination work.
- Decontaminating mercury from the equipment and area will allow normal work practices to resume.

4.6 Working on Possible Mercury Containing Equipment

Typical requirements for opening or working on equipment known to have contained mercury include the following:

- Only personnel who have successfully completed mercury training and who are wearing appropriate personal protective equipment are to work on mercury-contaminated equipment, until decontamination is complete. See Section 4.11 for a discussion on PPE.
- Employees who have not been mercury trained should stay out of rooms, immediate work areas or confined spaces where mercury contamination is found, until decontamination is completed.

- Never take away from the work area any clothing, equipment, or material that may be mercury contaminated.
- Do not wash mercury or mercury contaminated material to the process sewer system.
- Small spills of less than one pound of mercury (i.e. a broken thermometer) may be neutralized by trained personnel with a mercury spill clean–up kit. See Section 4.10 for small scale mercury spill clean-ups.
- Contact the Health & Safety Department or the Environmental Department for treatment, confirmation of decontamination, and mercury disposal if there is any doubt on what procedures to use.
- Removing hydrocarbon liquids before opening equipment is believed to remove the potential for exposure to dialkyl mercury. Removing sludge, bottoms, scale, corroded metal and ash from inside process equipment is effective for preventing exposures to mercury during activities such as welding or hot work.
- Another precaution for preventing possible over-exposure to mercury, including dialkyl mercury, is to avoid skin contact with crude oil. Skin contact with all crude oil should be avoided.

4.7 Decontamination of Mercury Containing Process Equipment

For work in process equipment cleaned of hydrocarbons, but with remaining mercury contamination, the following precautions are appropriate:

- Decontamination may include procedures such as:
  - Vacuuming with special dedicated mercury vacuums[1] to remove visible mercury, combined with air testing, may be sufficient for inspection and non-hot work.
  - High pressure water blasting or abrasive blasting of surfaces to be worked on may remove residual mercury contamination that is not visible.
  - Treating suspect surfaces with bleach and then testing with Mercury Swabs can confirm the removal of mercury before hot work such as torch cutting or welding. See Section 4.8 for guidelines on performing hot work on equipment that may have mercury contamination.
- Employees with the potential for skin or eye contact with mercury should wear personal protective equipment as needed to prevent contact. See R-11-023 for a discussion of PPE.
- For work inside a confined space, until decontamination is completed, all personnel inside the confined space must wear supplied air respirators.
- The confined space must be ventilated to not expose other personnel working nearby.
- If mercury contamination is present in sludge, scale or bottoms, the process of removal may create the potential for exposure and should be done by mercury-trained workers. Removal of the sludge, scale or bottoms sludge may eliminate the potential for exposure to mercury and allow normal hot procedures.

[1] The Anacortes Refinery mercury vacuum is a Minuteman Model MRS 1-4, and it is located in Shop 2.

4.8 Hot Work on Mercury Contaminated Equipment

- If mercury contamination is present, equipment must be decontaminated prior to hot work, such as welding or torch cutting.
- Visible pools or globules of mercury provide an obvious indication that hot work should not proceed until the equipment is decontaminated.
- The hot work permit should indicate that mercury was present and the equipment has been decontaminated.
- All personnel within 10 feet of the hot work should wear supplied air respirators.
- Scale, sludge, or ash may hide the presence of mercury on surfaces that may be torch cut or welded. All such residue should be cleaned from the equipment before hot work is allowed.
- If there is any question about mercury contamination remaining on a surface, the Mercury Swab Tests (see Section 4.3) can be combined with air testing to confirm the absence of mercury contamination on surfaces for hot work.

4.9 Accidental Mercury Exposure

Typical response procedures for accidental exposure to mercury include the following:

- Evacuate the area to prevent exposure of unprotected persons.
- Immediately notify your supervisor and Health & Safety Department.
- Using caution tape, restrict access to the area around the equipment to people trained in the hazards of mercury, and wearing appropriate PPE.
- Liberally wash skin that may have contacted mercury with soap and water for 15 minutes.
- Remove any contaminated clothing and seal it in a labeled bag.
- Evaluation of exposure potential will be coordinated by the Health & Safety or Medical Departments. If an over-exposure is suspected, any personnel that may have been over-exposed should report to Medical.
- Contact Environmental for cleanup and disposal of mercury contaminated material. Do not attempt to decontaminate process equipment or clean up the spill without proper personal protective equipment and mercury hazard training. See Section 4.10 and R-11-023.

4.10 Small Scale Mercury Spills & Clean-Up

Typical precautions include:

- Clean-up and disposal should be conducted under area supervision and/or per a Health & Safety Department representative.
- See R-11-023 for minimum PPE requirements for small scale clean-ups of mercury. Mercury vapor cartridge respirators and nitrile gloves should be worn prior to entering the spill area.
- The number of individuals utilized for clean-up should be minimized. Only employees utilizing protective equipment are to be allowed entrance. Only employees cognizant

of the hazards and precautions necessary for proper and safe cleanup of mercury should perform such tasks.

- Mercury spill kits for small spills are located in the Q/A Laboratory. They should be used according to manufacturer's instructions.
- In QA/QC Labs, if a mercury spill is contained within an exhaust hood, turn on the exhaust hood to minimize vapors released into the room. Maintain hood door in closed position until actual clean-up is being conducted. If a spill occurs in the open room or is leaking from a hood into the open room, shut down any air circulation system, such as fans, to prevent the spread of vapors into adjacent rooms and other work areas.
- Amalgamation powder used to absorb mercury is to be shoveled or picked up and put into properly labeled and sealed containers. Contact Safety or Environmental for assistance with disposal.
- All contaminated surfaces should be thoroughly washed with soap and water.
- All contaminated materials, and tools used for clean-up should be disposed of in labeled sealed containers or cleaned with soap and water.
- After clean-up and prior to resuming normal work activities in this work area, the Health & Safety Department should conduct mercury monitoring to verify that clean-up was adequate and that the mercury levels are within acceptable limits.

4.11 Personal Protective Equipment (PPE)

Minimum respiratory protection for personnel entering a mercury spill or equipment decontamination area would be a half-mask air-purifying respirator equipped with mercury cartridges. Air monitoring to confirm that mercury vapor is not above 10 times the PEL may be necessary to allow the use of mercury cartridge respirators. Airborne mercury vapor must be no more than 0.5 mg/m³ for using cartridge respirators (See R-11-023). If there is any doubt over the adequacy of mercury vapor cartridge respirators, supplied air respiratory protection should be used.

Along with normal PPE, the minimum additional skin protection for mercury work would be nitrile gloves. Additional skin protection should be required, if needed, to prevent the possibility of skin or eye contact with mercury. Wearing a PVC suit, polyethylene-coated Tyvek, or nitrile suit, and rubber boots may be necessary. Goggles and face shields are required, if needed, to prevent the possibility of face and eye contact.

Safety showers and eye wash stations should be located close to work that involves mercury decontamination or spill clean-up.

Mercury-contaminated personal protective equipment should be decontaminated or discarded when leaving a mercury clean-up or removal area.

4.12 Tracking Mercury Equipment

The Zone Operations Supervisor is responsible for tracking equipment where mercury has been found and shall notify the Health & Safety Department of any equipment newly identified as containing mercury. The Health & Safety Department will update the potential mercury-containing equipment list. See Appendix 1.

5.0 RECORDKEEPING

Results of employee exposure monitoring and results of air testing (i.e., to determine the ambient mercury concentration where employees are working) should be retained permanently (i.e., 30 years required by OSHA; Length of employment plus 30 years required by company policy). Training recordkeeping requirements are within Section 6.0.

6.0 TRAINING

Training should be provided to all employees who may be exposed to mercury. Records of employee hazard communication training on mercury should be retained for the current year plus 5 years. Contractor employees should also receive training prior to work that may expose them to mercury.

Employees who potentially may be exposed to mercury should be trained in the hazards and controls before initial assignment. Training should include at least the following areas:

- Safe handling of mercury
- Mercury hazards
- Cleanup of small spills
- Use of PPE, including respirator training
- Summoning emergency response services, and incident notification/reporting
- Hazard Communication, PPE

7.0 REVIEW AND REVISION HISTORY

Revision #	Preparer	Date	Description
0	Mark Willand	11/12/2021	Reformatted and Numbered per Document Control Policy, R-63-001.

8.0 ATTACHMENT 1 – EQUIPMENT PREVIOUSLY CONTAINING MERCURY

- Crude Column Over Head Condensers: E-115s
- Crude Column Overhead Accumulator: V-101
- SR Debut Overhead Condensers: E-124s
- SR Debut Overhead Accumulator: V-120
- SR Depropanizer Column: C-105
- SR Depropanizer Overhead Condenser: E-114s
- SR Depropanizer Overhead Accumulator: V-103
- SR Depropanizer feed Train Exchangers: E-111, E-112
- SR Depropanizer Reboiler: E-113
- Crude Unit Flare/MDO Knock out vessel: V-110
- Crude Tankage in Logistics Department