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Occupational Health Programs Manual – Chapter 6

Elemental Mercury

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Change Record

Rev.	Effective Date	Expiration Date	GRC25, Change Request #	Description
H	5/14/2012	5/14/2017	290	Bi-annual review/revisions
Change 1	4/11/2014	5/14/2017	N/A	Administrative change to add front cover and change history log to comply with NPR 1400.1, deleted “To implement this policy, all personnel must comply with the requirements of this chapter” and added “The GRC shall implement requirements of NPR1800.1D ” in Section 4.0 Policy.
Change 2	9/30/2015	5/14/2017	N/A	Administrative change to remove hyperlinks.
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***Include all information for each revision. Do not remove old revision data. Add new rows to table when space runs out by pressing the tab key in the last row, far right column.*

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Chapter 6—Elemental Mercury

NOTE: The current version of this chapter is maintained and approved by the Safety and Health Division (SHeD). The last revision date of this chapter was May 2023. If you are referencing paper copies, please verify that it is the most current version before use. The current version is located on the Glenn Research Center(GRC) intranet within the BMS Library. Approved by Chief of Safety and Health Division.

1.0 PURPOSE

The purpose of this chapter is to eliminate or minimize employee exposure to mercury-containing materials through a system of administrative and engineering controls and safe work practices. The intent is to protect NASA property and the surrounding environment from mercury contamination by setting forth the policies and procedures to manage and clean up uncontrolled releases of mercury. The minimum requirements are established for the handling, using, removing, and disposing of mercury-containing materials at the NASA Glenn Research Center (GRC) and Neil A. Armstrong Test Facility (GRC-ATF).

2.0 APPLICABILITY

2.1 This chapter is applicable to all personnel and operations at the GRC and GRC-ATF facilities. Contractors working at the GRC, and GRC-ATF facilities are required to follow GRC operational procedures to protect NASA property and equipment. Contractors are required to have their own policies to protect employee health.

2.2 This document pertains to the elemental form of mercury; if you work with inorganic or organomercury compounds, please contact the SHeD hygienist for work procedure evaluation.

3.0 BACKGROUND

3.1 Elemental mercury, a silvery, odorless, heavy liquid, was used at GRC in thermometers, manometers, barometers, electrical equipment, and as a propellant in ion propulsion systems. It is also found in mercoïd electrical switches and mercury vapor and fluorescent lamps. Elemental mercury, also known as quicksilver, is not highly toxic as an acute poison, although inhaling high concentrations of mercury vapor for relatively brief periods can cause severe problems in the lungs and digestive system. Chronic exposure to mercury affects the nervous system, resulting in tremors, irritability, anxiety, manic depressive psychotic disturbances, and appetite and weight loss.

3.2 The current American Conference of Governmental Industrial Hygienists (ACGIH) and the GRC 8-hour, time- weighted average exposure limit for elemental mercury is 0.025 milligram per cubic meter (mg/m³). The Occupational Safety and Health Administration (OSHA) and GRC have also established a ceiling (C) concentration of 0.1 mg/m³, which may not be exceeded for any time period.

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4.0 POLICY

4.1 The policy of GRC is to comply with all applicable regulations regarding elemental mercury to prevent illness to workers, contamination of NASA property, and damage to the environment from its use and disposal. The GRC shall follow the requirements of NASA Procedural Requirement (NPR) 1800.1.

4.2 Whenever possible, a substitute for mercury-containing devices, such as mercoide switches, thermometers, gauges, and so forth should be made. All unnecessary mercury sources including but not limited to mercury manometers, thermometers, and other mercury-contaminated materials shall be removed and properly disposed of from the GRC and GRC-ATF by completing a GRC 260A Waste Disposal form (access via. <https://shedapps.grc.nasa.gov/CMS/DisposalRequests/WasteC260DataEntry.cfm>) and contacting Waste Management.

4.3 Contaminated areas shall be identified and cleaned up by personnel trained in the hazards of mercury and proper handling, cleanup, and disposal procedures.

4.4 GRC policy defines mercury-contaminated surfaces as those which yield a mercury vapor level at or greater than 0.005 mg/m^3 when mechanically agitated.

4.5 It is GRC policy that mercury decontamination within areas controlled by research organizations be funded by those organizations.

5.0 RESPONSIBILITIES

It is the responsibility of civil servants, researchers, and support service contractors to ensure that mercury be removed or handled only by properly trained personnel.

5.1 Senior Industrial Hygienist

The senior industrial hygienist provides guidance on Federal, State, and local occupational health regulations.

- a. Helps Center personnel identify mercury-contaminated areas
- b. Conducts mercury surveys
- c. Supports industrial hygiene in mercury use, spill cleanup, and remediation projects
- d. Measures employee exposure levels, suggests procedures and personal protective equipment to minimize exposures, and recommends employees for inclusion in a mercury medical surveillance and monitoring program.
- e. Gives mercury awareness training
- f. Provides sampling and analysis to identify mercury contamination of vacuum pumps and other equipment
- g. Maintains a calibration station for mercury air monitoring equipment and calibrates equipment as needed
- h. Manages and administers the medical surveillance program for civil servant employees exposed to mercury

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5.2 SHeD

The SHeD provides guidance on the applicable Federal, State, and local environmental regulations.

- a. Maintains records of mercury disposal through Waste Management
- b. Reviews chemical purchases
- c. Notifies SHeD when a standard operating procedure is submitted with mercury-containing material in use
- d. Conducts hazard communication training
- e. Provides guidance and oversight on the disposal of mercury through Waste Management within SHeD.
- f. Assesses and makes recommendations on air, water, or soil pollution
- g. Oversees spill cleanup and soil and water remediation projects
- h. Performs some types of analysis of mercury contamination in various mediums

5.3 Environmental Management Office (Code FE)

- a. Provides guidance on and oversight of the disposal of mercury-containing materials and wastes
- b. Ensures that mercury-contaminated material be properly packaged and stored prior to disposal
- c. Coordinates mercury-spill cleanups and decontamination by contractors
- d. Provides guidance on the requirements of Federal, State, local, GRC transportation and environmental disposal requirements
- e. Performs decontamination for small spills
- f. Maintains records of mercury disposal

5.4 Facilities Infrastructure Division, Project Managers, Facilities Engineers, and Facilities Operations Personnel

As part of their role in construction, demolition, and rehabilitation projects, these personnel identify and provide remediation of mercury contamination.

- a. Ensure that areas contaminated or possibly contaminated with mercury be managed to minimize employee exposure to mercury
- b. Ensure that renovation project plans identify mercury-contaminated areas and provide for cleanup
- c. Identify areas with suspected mercury contamination not listed in the original scope of work but surface during construction activities
- d. Arrange for testing to determine the level of mercury contamination
- e. Ensure cleanup of any contamination by a qualified contractor

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- f. Ensure that mercury-related work be performed in accordance with all applicable regulations and SHed guidance

5.5 Medical Director, Occupational Medicine Services

The Director of Medical Services is responsible for overseeing medical records and programs for employees exposed to hazardous substances.

- a. Maintains medical surveillance programs for employees exposed to hazardous chemicals that require medical monitoring
- b. Keeps complete, accurate records of all medical examinations for personnel in the medical surveillance program; retains the records for at least 30 years; discusses the results of examinations with employees as needed
- c. Notifies employees of medical surveillance results
- d. Notifies the appropriate SHed industrial hygienist about employees who may require an exposure evaluation based on clinical findings

5.6 Logistics and Technical Information Division (Code CO)

Each department supervisor is responsible for procuring alternative devices to those containing mercury.

5.7 Supervisor

- a. Notifies SHed of operations involving exposure to mercury
- b. Enforces requirements for the use of engineering and work practice controls and personal protective equipment

5.8 Employees

- a. Report to Waste Management (FE) quantities of mercury stored in vials, bottles, or equipment
- b. Notify SHed of operations involving mercury
- c. Use appropriately the engineering controls, work practice controls, and personal protective equipment specified for their operations
- d. Dispose of properly all mercury-containing devices (i.e., thermometers, mercooid switches, barometers, etc.) through Waste Management.
- e. Fill out the GRC 260A form and submit it to Code FE.
- f. Shall receive mercury awareness training if mercury use is specified for their operations.

6.0 REQUIREMENTS

It is the responsibility of all civil servants and support service contractors to ensure that mercury be removed or handled only by employees who are properly trained. Contractors must develop their own mercury compliance plan.

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6.1 The following regulation applies: OSHA 29 Code of Federal Regulations (CFR) 1910.1000)

6.2 Use of Current Materials

The SHeD shall be kept apprised of mercury use throughout the lab.

6.3 Hazard Assessment

6.3.1 A hazard assessment shall be required by an industrial hygienist when the following conditions exist.

- A request for a purchase of mercury
- A process that uses mercury changes
- A planned new task not previously assessed uses mercury
- A plan to use equipment known or suspected of containing mercury
- Areas known or suspected of being contaminated by mercury
- Individuals who currently use mercury and need to schedule a hazard assessment to be performed during the next planned use

6.3.2 The user or area supervisor shall contact SHeD prior to use and arrange for an industrial hygienist to observe the handling of the material, assess the hazards, and perform exposure monitoring if necessary.

6.3.3 Results from the hazard assessment will be reported in writing with findings and recommendations. In addition, any equipment suspected of containing mercury will be tagged with the results of the survey.

6.4 Assessment of Vacuum Pumps

Prior to the dismantling, repairing, removing, or altering of vacuum pumps, they shall be tested for mercury contamination. Contact Code FE for testing the pump oil to determine if the pump is mercury contaminated.

6.5 Disposal of Mercury-Contaminated Equipment

All mercury-containing equipment be disposed of shall be drained and the mercury reclaimed. To dispose of mercury-containing or contaminated equipment, submit a NASA GRC 260A form to property disposal. Code FE maintains the records for disposal of mercury and mercury-contaminated wastes.

6.6 Mercury Spill Response Procedures

6.6.1 It is imperative that employees shall not attempt to clean up a mercury spill by themselves because they can inadvertently spread the contamination. Regular vacuum cleaners, mops, and brooms must never be used to clean up a mercury spill. Heat from the vacuum motor will increase the amount of mercury vapor in the air. Mops and brooms will spread the mercury, making proper cleanup more difficult and costly. The vacuum cleaner, mop, or broom will become contaminated and require disposal as hazardous waste. Mercury cannot be disposed of down the drain or in the trash.

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6.6.2 Appendix C (MERCURY SPILLS and AREA CLEARANCE TESTING) presents recommended practices to address mercury spills and associated clearance testing. Equivalent methods may be used but shall be reviewed and approved by the SHed program lead (443–5501) prior to implementation.

6.6.3 Containing Spills

- Evacuate the area and prevent traffic from going through the spill area.
- Before people leave, direct them to a nearby location away from the spill and ask them to stay there until the contamination can be assessed.
- Dupont Tyvek® booties will be provided to anyone entering the spill area to prevent the contamination of shoes and to reduce the spread of mercury.

6.6.4 Reporting Spills to Emergency Dispatch

Call 9–1–1 from a NASA phone or call (216) 433–8888 for Lewis field from a cell phone to report a spill and give the following information. For GRC-ATF call 9-1-1 from a NASA phone or call (419) 621-3222 and give the following information.

- Your name
- Phone number where you can be contacted
- Department, building, and room number where the mercury is located

6.7 Reducing the Risk

6.7.1 The most effective method of reducing personal exposure to mercury and avoiding a costly spill cleanup is to properly dispose of all mercury-containing devices and replace them with less toxic alternatives.

- For disposal of mercury-containing equipment, simply complete a GRC 260A form, and Waste Management personnel will remove and dispose of the equipment at no cost.
- For assistance with replacing mercury-containing equipment and devices with mercury-free alternatives, contact the mercury program lead at (216) 433-5501.

6.7.2 If you must work with mercury as part of your research, consult with the mercury program lead at (216) 433–5501 to develop work practices that minimize the risk of exposure.

7.0 RECORDS

The SHed maintains the following records:

- Hazard assessments
- Survey monitoring data sheets
- Hazard/exposure assessment database
- Calibration documents for the mercury vapor analyzer

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8.0 REFERENCES

Document number	Document name
29 CFR 1910.1000	U.S. Department of Labor, Occupational Safety & Health Administration (OSHA), Air Contaminants
Memo, November 8, 1989	From director of Technical Services and chairman of the Environmental Pollution Control Board regarding use of mercury manometers for pressure measurement
Memo, June 2, 1993	From director of Technical Services and chairman of the Environmental Pollution Control Board regarding use of mercury manometers for pressure measurement
Memo, August 12, 1991	From GRC mercury coordinator regarding recall of all mercury

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APPENDIX A. DEFINITIONS

Action level.—Concentration or level of an agent at which it is deemed that some specific action should be taken; in general, the setting of one-half the adopted occupational exposure limit (OEL)

High-efficiency particulate air filter.—Filter that can trap and retain at least 99.97 percent of all monodispersed particles 0.3 μm in diameter

Manometer.—Instrument used for measuring pressure; a U-tube partially filled with a liquid (usually water, mercury, or a light oil), constructed such that the amount of liquid displaced indicates the pressure exerted on the instrument

Mercury-contaminated surface.—Surface on which the mercury vapor level is at or is greater than 0.005 mg/m^3 when mechanically agitated

Neurotoxin.—Substance harmful to the nervous system or brain

Occupational exposure limit.—Health-based workplace standard that protects workers from adverse exposure (e.g., PEL and TLV).

Permissible exposure limit.—OSHA term that establishes maximum allowable concentrations in air of substances to which nearly all workers may be repeatedly exposed for 8 hours a day, 40 hours a week, for 30 years without suffering adverse effects. The three categories of PELs are:

- a. **PEL-ceiling (C).**—Limit that cannot be exceeded at any time during the work shift
- b. **PEL-short-term exposure limit (STEL).**—5-minute, time-weighted average (TWA) exposure that shall not be exceeded at any time during the workday unless another time limit is specified
- c. **PEL-8-hour, time-weighted average (TWA).**—Maximum allowable concentration in air of a substance averaged over an 8-hour period

Skin notation.—Denotes the possibility that dermal absorption may be a significant contribution to the overall body burden

Systemic effect.—Adverse effect other than that at the site of contact

Target organs.—Organs of the body most affected by exposure to a particular substance

Threshold limit value.—ACGIH recommended exposure limits under which it is believed that most people can work 8 hours a day, day after day, with no harmful effects. The three categories of TLVs are:

- a. **TLV-ceiling (C).**—Concentration that should not be exceeded during any part of the workday exposure
- b. **TLV-short-term exposure limit (STEL).**—15-minute TWA exposure that should not be exceeded at any time during a workday, even if the 8-hour TWA is within the TLV-TWA. Exposures above the TLV-TWA up to the STEL should not be longer than 15 minutes, should occur no more than four times per day, and should be at least 60 minutes between successive exposures. An averaging period other than 15 minutes may be recommended when warranted.

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- c. **TLV-8-hour, time-weighted average (TWA).**—Maximum allowable concentration in air of a substance averaged over an 8-hour period

Time-weighted average.—Average concentration for an 8-hour workday, 40-hour workweek

Toxicity.—Inherent property of a chemical agent, its harmful effects on some biologic systems, and the conditions under which the effects occur

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APPENDIX B. ACRONYMS

ACGIH	American Conference of Governmental Industrial Hygienists
C	Ceiling
EPA	Environmental Protection Agency
GRC	Glenn Research Center
GRC-ATF	Neil A. Armstrong Test Facility
HEPA	High-efficiency particulate air (HEPA) filter
LTID	Logistics and Technical Information Division
mg/m ³	Milligram per cubic meter
OEL	Occupational exposure limit
OSHA	Occupational Safety & Health Administration
PEL	Permissible exposure limit
PPE	Personal protective equipment
SHeD	Safety and Health Division
STEL	Short-term exposure limit
TLV	Threshold limit value
TWA	Time-weighted average

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APPENDIX C. MERCURY SPILLS AND AREA CLEARANCE TESTING

This appendix is a condensed outline of the mercury spill and area clearance testing procedure conducted at Brookhaven National Laboratory (BNL). The BNL procedure has been adapted to meet the requirements and goals of GRC and GRC-ATF and is presented herein as recommended practice.

C.1 Purpose and Scope

This procedure documents the building re-occupancy testing and clearance criteria for spills of *elemental* mercury in indoor locations. It is used after cleanup with high-efficiency particulate air (HEPA) filtration and/or mercury adsorbents. This procedure is not intended for use in measuring employee exposure levels during routine or emergency situations, or to measure the environmental consequences of releases, or to determine the status of environmental compliance release of the area.

C.2 Responsibilities

This procedure will be implemented through SHed (or an alternative method approved by the lead industrial hygienist). Only persons, who thoroughly understand this procedure and are competent to operate the detection equipment, as determined by the lead industrial hygienist, should conduct this testing.

C.3 Prerequisites

Prior to testing, the detection equipment must be in good working order and be calibrated per manufacturer recommendations.

C.3.1 Hazard Assessment of Area

- a. Using a direct-reading meter does not pose significant employee health risks, but this procedure may be performed in areas with mercury contamination. Do not perform sampling until a competent individual has assessed the hazards of the area.
- b. Handling the indicator powder is hazardous, and protective equipment must be used.

C.3.2 Personal Protective Equipment

Appropriate personal protective equipment for collecting the sample, handling the indicator powder, and working around spilled mercury follows.

- a. Hand
 - (1) Use disposable, exam-style, splash gloves made from acceptable elastomers, such as nitrile, polyvinyl chloride (PVC), and natural rubber.
 - (2) Remove and dispose of the gloves immediately after spreading the indicator powder. Then put on a second pair of gloves to further handle equipment.
- b. Body
 - (1) Use a disposable suit if body contact with contaminated surfaces is anticipated. Acceptable materials are DuPont Tyvek®, Kimberly-Clark KLEENGUARD™, and cotton.

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- (2) Disposable garments must be discarded as mercury waste if suspected contact with contamination has occurred.
- (3) If personal clothing items become contaminated, they must be surrendered to Waste Management for disposal.

c. Foot

- (1) Use disposable shoe coverings, boots, or booties if foot contact with contaminated surfaces is anticipated. Acceptable materials are DuPont Tyvek®, Kimberly-Clark KLEENGUARD™, and rubber.
- (2) If personal shoes become contaminated, they must be surrendered to Waste Management for disposal.

d. Eye

- (1) Use safety glasses with side shields as required in all laboratories, construction, and general industry work areas.
- (2) Use vapor-proof goggles or full-face respirators if exposure is above the occupational exposure limit (PEL/TLV).

e. Respiratory

- (1) Respiratory protection is not required under normal use.
- (2) Respirators are required if mercury in the area exceeds (as indicated by the direct-reading meter) or is likely to exceed the OSHA or ACGIH standards.
- (3) An OSHA-competent person must conduct the respirator evaluation and selection.

f. Environmental impact and waste disposal

- (1) Direct-reading meters do not adversely impact the environmental or create waste for disposal.
- (2) Indicator powders are considered hazardous waste and must be handled, transported, and disposed of in accordance with Waste Management requirements.

C.4 Precautions

- a. Verify that testing personnel will not be exposed to hazardous airborne levels of mercury by testing the highest probability source first. Move slowly and systematically to allow the meter to respond to mercury vapors.
- b. Use appropriate respiratory protection if indicated by the airborne vapor levels. The appropriate respiratory protection equipment used must be reviewed by the senior industrial hygienist of SHED.
- c. Test all sources in a manner so as not to place the tester's breathing zone in the vicinity of a suspected spill source.

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C.5 Procedure

C.5.1 Equipment

- Appropriate PPE
- Mercury indicator powder, J.T. Baker product number 4509–01 or equivalent
- Jerome® Mercury Meter 431X or equivalent

C.5.2 Monitoring, Cleanup, and Testing

- Observe that the cleanup of the spill follows an approved procedure and that appropriate PPE and exposure monitoring are conducted.
- Initiate clearance testing after appropriate abatement is accomplished.

C.5.2.1 Airborne Vapor Test

- Use a direct-reading meter to sample at a height of one inch above the entire surface of the spill area.
- Mechanically agitate the test surfaces with a wire brush. If no concentration above 0.005 mg/m³ is detected, the surface passes the airborne vapor test.

C.5.2.2 Visual Inspection Test

- Use a flashlight or lamp at an oblique angle to visually examine surfaces and crevices for shiny, silvery droplets of mercury. If no droplets are observed, proceed to indicator powder testing.
- If droplets are observed, instruct the appropriate personnel to repeat the approved cleanup procedure.

C.5.2.3 Indicator Powder Test

- This test is required in lieu of the airborne vapor test.
- Spread the indicator powder in a thin film over the entire surface of the spill area and extend at least six inches beyond areas cleaned on all sides. Minimize dust generation when spreading the powder.
- Make sure to spread powder into cracks and crevices and low spots.
- Remove the cabinet drawers to access the space behind cabinet kickboards, if appropriate.
- Mix the powder with water and paint the mixture on vertical surfaces. Allow the indicator powder to set on the surfaces.
- Strong positive responses (change to black) may occur as soon as 5 minutes. After hours, if no color change occurs in the powder (i.e., from white to pink, orange, or black spots in any part of the powder), the surface passes the indicator powder test.
- Remove the indicator powder from surfaces after the test. Appropriate personnel should use a mercury-designated HEPA vacuum to clean up the area. Handle the powder residue in the vacuum cleaner as per instructions from Waste Management.

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- h. Instruct the appropriate personnel to repeat the approved cleanup procedure if the area fails either the indicator powder test or the airborne vapor test. Then repeat the airborne vapor test or indicator powder test.
- i. Submit all field observations and test results to the lead industrial hygienist within SHed for review prior to releasing the area to the general public.