# MERCURY SURVEILLANCE PROGRAM

*NASA Lewis Research Center*
*Occupational Medicine Service*

## Background

Mercury, in both its organic and inorganic forms, can be toxic to humans. Both forms of mercury, the inorganic metal and the organic compounds, are quite volatile at room temperature. Therefore, human exposure to mercury is most common because of inhalation of its vapor. It is likely that mercury also can be absorbed through the skin, but this mode of entry has proven to be insignificant.

The permissible exposure limit (PEL) from the National Institute for Occupational Safety and Health (NIOSH) for exposure to mercury vapor is a concentration of 0.05 mg/m3 as an 8-hour time-weighted average. OSHA previously had used 0.1 mg/m3 as the PEL for mercury exposure. There have been no symptoms of mercury toxicity reported at exposure concentrations less than 0.01 mg/m3 and, thus, this level is considered a "safe" concentration level.

There is an affinity of mercury for sulfur and sulfhydryl groups, and it readily binds with proteins in the body. Mercury accumulates almost anywhere in the body; however, the organs with the longest retention times -- thus demonstrating the greatest effects from toxicity -- are the kidneys, brain, and testicles.

Acute poisoning by mercury vapor is dose-dependent and causes primarily pulmonary problems ranging from erosive bronchitis, bronchiolitis, interstitial pneumonitis, and progressing on to respiratory insufficiency. Also, exposed patients can acutely demonstrate tremor, excitability, memory loss, insomnia, GI disturbances, and renal damage (ranging from tubular dysfunction of varying severity to acute tubular necrosis).

Chronic exposure to mercury vapors at low doses can cause a syndrome called "micromercurialism," which includes symptoms of weakness, fatigue, anorexia, weight loss, and gastrointestinal disturbances. Chronic exposure to higher concentrations of mercury can lead to inflammation of the gums; excessive salivation; fine trembling of

muscles; coarse shaking of fingers, eyelids, and lips (characteristic of an intentional tremor because these movements often disappear during sleep); severe personality and behavioral changes; increased excitability; loss of memory; insomnia; and dermatitis (including a generalized rash, pruritus, erythema, and desquamation of especially the hands, feet, and nose). The acute and long-term effects of exposure to organic mercury compounds (mercuric salts, phenylmercury compounds, and alkoxyalkylmercury compounds) are more likely to be gastrointestinal disturbances and renal damage.

The average half-time of mercury in the body is approximately 60 to 70 days, although part of the mercury accumulated in the brain is slowly eliminated with a biological half-time that may exceed several years. The mercury concentration in the urine per gram of creatinine is the best index available for evaluating an exposure. Symptoms of mercurialism are more prevalent when urinary concentrations exceed 50 micrograms ($\mu$g) mercury per liter of urine. On a group basis, high levels of mercury in the urine may be associated with prolonged exposures to high concentrations of mercury vapor, and, thus, a greater likelihood of signs and symptoms of poisoning.

## Purpose

The purpose of the Mercury Surveillance Program at the NASA Lewis Research Center shall be to:

1. Identify any Lewis employee who is exposed to mercury above the action level (AL) or at the physician's discretion.

2. Educate that employee about the nature of mercury, the proper use of respiratory protection and proper protective clothing when handling mercury, and appropriate sanitation practices when handling mercury.

3. Monitor those employees by obtaining an extensive past medical and occupational exposure history and then performing periodic physical examinations with twenty-four (24) hour urine collections for mercury concentrations to detect early signs and symptoms of mercurialism. When mercury exposure is anticipated, a baseline physical examination with a 24-hour urine collection for mercury shall be obtained.

## Medical Surveillance

The specifics of the Medical Surveillance Program for Mercury Exposure at the NASA Lewis Research Center will fulfill the criteria required by OSHA, and will incorporate recommendations from NIOSH and the Department of Defense.

The PEL for mercury as defined by NIOSH is 0.05 mg mercury/$m^3$ as measured during an 8-hour time-weighted average (TWA). The action level for mercury constituting an occupational exposure as defined by OSHA is 40 percent of the PEL, or 0.02 mg mercury/$m^3$ TWA.

NASA employees identified by the Office of Environmental Programs as having been exposed to the AL for mercury will be entered into the Medical Surveillance Program. As soon as possible, these employees will need:

1. **Medical and work histories**, with special attention to:
   - Loss of weight
   - Sleeplessness
   - Tremors
   - Personality/behavioral changes
   - CNS involvement (such as changes in handwriting)

2. **A complete physical examination**, with special attention to:
   - Central nervous system
   - Peripheral nervous system (strength, sensation, DTRs)
   - Kidneys
   - Respiratory system
   - Skin (rashes, erosions, ulcers, pigment changes, eczema, etc.).

3. **Laboratory evaluation**, to include:
   - Complete blood count (CBC) with differential
   - Serum chemistries to include renal function tests (BUN, Creatinine), and electrolytes (Na+, K+, Cl-, CO2)
   - Urinalysis with microscopy
   - 24-hour urine collection for mercury.

The above evaluation will be repeated each month for at least two (2) months regardless of the findings of the initial evaluation. This evaluation will be repeated then every other

month for as long as the employee's work environment has a mercury concentration at or above the AL as determined by the OEP. If there is a one-time exposure to mercury at or above the AL, then the initial evaluation with the two monthly follow-up evaluations is all that is needed.

In the event that the OEP determines that an employee is at an increased risk of mercury exposure at or above the AL because of the nature of the employee's job or the potential presence of mercury in the work environment, then that employee shall receive the above evaluation as a baseline before potential exposure and then annually thereafter until such time that the OEP determines that the employee is no longer at risk for mercury exposure.

If there is risk of any exposure to mercury in an employee's work environment (regardless if this potential exposure is deemed to be above or below the AL for mercury as determined by OEP), then that employee will receive annual mercury surveillance examinations (physical examination and 24-hour urine collection).

Upon completion or termination of employment, an employee who has been involved in an ongoing Mercury Medical Surveillance Program is entitled to an ongoing mercury surveillance examination with the appropriate laboratory studies. The Occupational Medicine Service (OMS) will not continue surveillance of an individual once they have either retired from NASA or are no longer employed by NASA but, during the final physical examination, recommendations will be given to the individual for continued medical surveillance to be completed by the individual's private doctor.

**Summary Table for Frequency of Mercury Surveillance Exams**

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| Acute exposure to mercury at or above PEL | Exam q2 months, until mercury level below the PE |
| Work environment with chronic mercury levels at or above the AL | Exam q6 months, until mercury level below the AL |
| Any risk to mercury exposure | Exam q year (annually). |

## References


1. Agocs, M.M., Etzel, R.A. et al. Mercury Exposure from Interior Latex Paint. *NEJM*, 1990, 323: 1096-1101.

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3. U.S. Department of Health and Human Services. Occupational Health Guideline for Inorganic Mercury. September, 1978.

4. Cooper, L.P. OSHA Medical and Workplace Surveillance Requirements and NIOSH Recommendations. NASA Contractor Report 3690, August 1983: 394-399.

5. *Medical Surveillance Procedures Manual and NOHIMS Medical Matrix (Edition 3)*, January 1989: 134.

6. Department of Defense, *Occupational Health Surveillance Manual*, July 1982: 2-37.