

MERCURY (INORGANIC)

BASELINE HEALTH MONITORING BEFORE STARTING WORK IN AN INORGANIC MERCURY PROCESS

1. **Collection of Demographic Data**
2. **Work History**
3. **Medical History**
4. **Physical Examination**

A physical examination will be conducted with an emphasis on the dermatological, gastrointestinal, neurological and renal systems.

5. **Investigation**

Spot urine for inorganic mercury will be used to test the worker's baseline exposure. The result is corrected for creatinine, for example mercury concentration in micrograms per gram of creatinine. Where there is 50 µg of inorganic mercury or more per gram of creatinine, a repeat spot urine test should be performed at the same time of the day.

BACKGROUND INFORMATION ON MERCURY EXPOSURE

Concentrations of inorganic mercury in urine correlate with long-lasting exposures reflecting average exposure over the previous few months in those chronically exposed, while levels in blood reflect only the recent exposure. Recent visits to the dentist for amalgam fillings, use of disinfectants containing organomercury, and recent treatment with penicillin type antibiotics should be recorded as they can affect results.

Urine total mercury in the non-work exposed population is generally < 20µg/L¹.

DURING EXPOSURE TO INORGANIC MERCURY

6. **Monitoring exposure to inorganic mercury**

Urinary mercury is an indicator of average exposure during the past month rather than exposure at the time of urine collection. Throughout the day, the level of mercury in urine can vary. Occasional high levels of mercury in the urine should not be cause for immediate alarm and new samples should be taken. Acute exposure to mercury, for example through an accidental spill should be measured via blood testing.

It is recommended testing should occur after one month, three months, six months and thereafter at regular intervals at the discretion of the supervising medical practitioner, depending on the test results obtained. More frequent testing may be necessary where symptoms of exposure are evident or where test results indicate significant concern exists or workplace controls are not working.

However, a six-monthly testing pattern is recommended where the level is <25 µg inorganic mercury per gram of creatinine.

Sampling prior to a work shift assists in minimising the risk of external contamination.

■ 1 To convert µg/L to µmol mercury/mol creatinine multiply by $\frac{\text{MW creatinine}}{\text{MW mercury}} = \frac{113.12}{200.59}$
For example 20 µg/L urine total mercury = 11.3 µmol mercury/mol creatinine.

ACTION LEVEL

Where testing shows a level of 25 µg inorganic mercury or more per gram of creatinine in urine, this may indicate the worker has been exposed². In these instances:

- a repeat spot urine test should be performed at the same time of the day
- a medical examination should be conducted, with emphasis on the neurological, gastrointestinal, renal and dermatological systems
- the person conducting a business or undertaking should review control measures and carry out recommended remedial action
- the worker must be informed of the results of the health monitoring
- repeat spot urine for inorganic mercury tests should be conducted every six weeks until the level of inorganic mercury per gram of creatinine in urine falls below 25 µg inorganic mercury or more per gram of creatinine in urine.

Blood mercury should only be measured if an acute exposure, like during an accidental spill, has occurred within the last three to 20 days. The total inorganic mercury in blood at end of the shift at end of work week should be less than 15 µg/L. Eating seafood can interfere with the blood test results.

REMOVAL LEVEL

Although no significant sign of adverse health effects have been observed at urinary concentrations below 100 µg of mercury per gram of creatinine, altered psychological performance and renal enzyme activities have been reported between 35-100 µg mercury per gram of creatinine. On this basis it is recommended the worker is removed from mercury work when the level of mercury in urine is greater than 35 µg per gram of creatinine.

Where a worker shows signs of mercury poisoning or the level of inorganic mercury in urine is greater than 35 µg per gram of creatinine, the worker should immediately be removed from mercury work.

The worker's health should be monitored every 30 days until the level falls below 35 µg inorganic mercury per gram of creatinine on two successive occasions. Testing should occur every six weeks until the level of inorganic mercury in urine is less than 25 µg per gram of creatinine.

RETURN TO WORK

The worker must not return to mercury work until they have been assessed as medically fit to return to work by the medical practitioner supervising the health monitoring.

AT TERMINATION OF WORK IN AN INORGANIC MERCURY PROCESS

7. Final physical examination

A medical examination should be conducted to determine whether the worker has neurological or renal dysfunction due to exposure to inorganic mercury.

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- 2 The American Conference of Governmental Industrial Hygienists (ACGIH) recommended biological exposure index (BEI) for a pre-shift end of work week is 35 µg/g creatinine (= 20 µmol/mol creatinine). The WorkCover NSW Biological Occupational Exposure Limit (BOEL) Committee also recommends this value.

SUPPLEMENTARY INFORMATION ON MERCURY (INORGANIC)

8. Work activities that may represent a high risk exposure

Mercury exists in three forms: liquid and vapour states (Hg^0) and inorganic mercury salts (Hg^{1+} and Hg^{2+}).

Examples of work activities involving inorganic mercury and its compounds which require special attention when assessing exposure include:

- manufacture of amalgams, for example tin amalgam, amalgam of gold, copper and zinc used in dentistry for filling teeth, amalgamated zinc used in electric batteries and sodium amalgam used in the laboratory in conjunction with water as a reducing agent
- dental work involving mercury
- manufacture of pigments and antifouling paints (mercuric oxide) and vermilion (mercuric sulphide) in the paint and colour industry
- extraction of gold and silver from roasted pyrites (mercuric sulphate)
- extraction of gold from tailings
- laboratory work with mercury in closed or confined spaces
- the use of mercury-containing fungicides
- exploration/production, refining and processing of natural gas
- the use of fluorescent lamps and electrical meters.

Special attention should be given to acute exposures, including mercury spills that may occur in the above processes.

9. Non-work sources

A significant amount of organic mercury can be ingested in seafood as methyl mercury—the average intake for adults is seven micrograms per day. Release of mercury from dental amalgam fillings is about 3.5 micrograms per day [1]. The major source of temporarily increased levels of inorganic mercury in blood and urine is fresh dental amalgams. Urine and blood mercury concentrations transiently increase over a period of a week or more when dental restoration involving mercury amalgams is performed.

Inorganic mercury excretion may also be increased after exposure to disinfectants, for example mouthwash, and paints containing inorganic mercury. Mercury compounds are used in water-based latex paint to prevent mildew after the paint has been applied and as a preservative for paint in storage. Recent penicillin type antibiotics can increase urinary excretion of mercury, as the main degradation product of penicillin, penicillamine, enhances this process. Some skin lightening creams contain mercury. Mercury is ubiquitous in the environment, for example in ash or vapour from coal combustion.

POTENTIAL HEALTH EFFECTS FOLLOWING EXPOSURE TO INORGANIC MERCURY

10. Route of Entry into the Body

The absorption and toxicity of inorganic mercury in the body depends on its chemical and physical form.

Generally, liquid elemental mercury (Hg^0) is poorly absorbed through the intestinal tract—less than one per cent—and skin. About 75-80 per cent of inhaled mercury vapour is absorbed across alveolar membranes into the bloodstream. Percutaneous absorption of mercury vapour is minimal. Absorbed mercury vapour readily crosses the blood-brain barrier and the placenta.

Small amounts, less than 10 per cent, of mercurous (Hg^{1+}) and mercuric (Hg^{2+}) salts are absorbed following ingestion. Percutaneous absorption of ionic mercury salts can cause toxicity. Generally, mercuric salts are more soluble and more toxic than mercurous salts.

11. Target organ/effect

Nervous system – muscular tremor, increased excitability, memory loss, emotional ability, peripheral neuropathy.

Kidney – renal tubular necrosis.

Respiratory tract – irritation, pneumonitis, metal fume fever, dyspnoea, pulmonary fibrosis.

Gastrointestinal tract – acute gastroenteritis, stomatitis, metallic taste, excess salivation, ulceration or bleeding of gums.

Skin – corrosive blisters, contact dermatitis.

Hearing – potential ototoxin.

ACUTE EFFECTS

In acute poisoning, the respiratory system is affected by inhaled mercury vapour and the gastrointestinal system is affected by ingested mercury salts.

Acute inhalation exposure to inorganic mercury vapour may rapidly produce cough, chest pain, dyspnoea, fever, nausea, vomiting, diarrhoea and a metallic taste in the mouth. Stomatitis, colitis, nephrotic syndrome and salivation may occur. High concentrations cause corrosive bronchitis and interstitial pneumonitis. The uptake of mercury vapour into the central nervous system produces tremor and increased excitability. In milder cases the patient will recover in one to two weeks. High exposures have resulted in death.

Acute mercurial poisoning is usually the outcome of ingestion. The acute lethal dose of most mercury salts is one to four grams for an adult. The gastrointestinal tract and kidney are affected by ingestion of mercury salts. Ingestion of corrosive mercury salts results in immediate gastroenteritis. Mercurial stomatitis characterised by glossitis and ulcerative gingivitis may appear within 24 to 36 hours. Renal tubular necrosis may progress from transient polyuria to anuria.

In some people, metallic mercury has been shown to cause an allergic skin reaction.

CHRONIC EFFECTS

The primary organ system affected by chronic exposure to elemental mercury is the nervous system, and the kidney is the primary organ affected by chronic exposure to mercury salts. No significant sign of adverse health effects have been observed at urinary concentrations of mercury below 100 $\mu\text{g/g}$ creatinine. Occasionally, altered psychological performance and renal enzyme activities are reported at concentrations between 35 and 100 $\mu\text{g/g}$ creatinine [2].

In chronic poisoning resulting from exposure to elemental mercury or the dust of inorganic mercurial compounds, early symptoms may include nausea, frequent headaches, tiredness and chronic diarrhoea. The characteristic features are stomatitis, muscular tremors and psychotic disturbances. Effects on the mouth may vary from a mere metallic taste to

excessive salivation, bleeding of the gums, ulceration and loosening of the teeth. Muscular tremors appear early, often starting in the fingers and spreading to the tongue, lips, eyes and lower limbs. These become apparent when the individual performs a defined action like writing, which may become so disordered by the tremor that it is illegible. The neurological disturbance or mercurial erethism manifests itself in abnormal shyness and loss of confidence, coupled with irritability, vague fears and depression. In advanced cases, there may be loss of memory, psychotic changes, like hallucination, or intellectual deterioration.

Kidney dysfunction sometimes develops, especially in workers exposed to elemental mercury. However, the development of kidney dysfunction is not clearly linked with the intensity of exposure. After inorganic salts are ingested, a large amount of mercury may accumulate in the kidneys, producing a generalised increase in the permeability of the tubular epithelium.

Soluble inorganic mercury salts, like mercuric chloride, will devitalise tissue by denaturation and precipitation of the proteins present. Phenyl mercury acetate has a strong corrosive action and will cause local blistering of the skin. Mercury fulminate is particularly prone to cause a vesicular dermatitis, especially affecting the fingers, and irritation of the eyes and eyelids. Workers exposed to mercury vapour may be found to have a discolouration of the lens of the eye, which is indicative of mercury exposure rather than of intoxication.

12. Germ cell mutagen and reproductive toxicant classifications³

Mercury is classified according to the GHS as Reproductive Toxicity Category 1B (May damage the unborn child). Mercury dichloride is classified as Germ Cell Mutagenicity Category 2 (Suspected of causing genetic defects) and Reproductive Toxicity Category 2 (Suspected of damaging fertility).

REFERENCED DOCUMENTS

1. National Health and Medical Research Council (NHMRC), *Dental Amalgam and Mercury in Dentistry*, Report of a NHMRC working party, 1999. <http://www.nhmrc.gov.au> and search on 'mercury and dentistry'.
2. American Conference of Governmental Industrial Hygienists (ACGIH), *Documentation of the Biological Exposure Indices*, 7th Ed, Cincinnati, 2011.

FURTHER READING

Agency for Toxic Substances and Disease Registry, *Toxicological Profile for Mercury*, Agency for Toxic Substances and Disease Registry, United States Department of Health and Human Services, Public Health Service, Atlanta, 1999.

American Conference of Governmental Industrial Hygienists (ACGIH), *Documentation of the Threshold Limit Values for Chemical Substances*, 7th Ed, Cincinnati, 2011.

Centers for Disease Control and Prevention, *Registry of Toxic Effects of Chemical Substances*. <http://www.cdc.gov/niosh/rtecs>

International Agency for Research on Cancer, *IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans, Volume 58: Beryllium, Cadmium, Mercury and Exposures in the Glass Manufacturing Industry*, International Agency for Research on Cancer, Lyon, 1993.

Lauwerys RR, Hoet P, *Industrial Chemical Exposure Guidelines for Biological Monitoring*, 3rd Ed, Lewis Publishers, Boca Raton, 2001.

■ 3 This classification information is provided on an advisory basis and is taken from the European Union's Annex VI to Regulation (EC) No 1272/2008, updated by the 1st Adaption to Technical Progress to the Regulation. Other hazard classes and categories may apply - see <http://esis.jrc.ec.europa.eu/index.php?PGM=cla>. These classifications are legally binding within the European Union.

HEALTH MONITORING REPORT MERCURY (INORGANIC)

This health monitoring report is a **confidential** health record and must not be disclosed to another person except in accordance with the Work Health and Safety Regulations or with the consent of the worker.

There are two sections. Complete both sections and all questions if applicable.

Section 1 is to be forwarded to the PCBU who has engaged your services. A copy of laboratory report(s) must be attached > > >

Section 2 may contain confidential information which may not be relevant to the health monitoring program being carried out. This section should be retained by the medical practitioner. Information which is required to be given to the PCBU should be summarised in part 7 of section 1.

SECTION 1 - THIS SECTION TO BE RETURNED TO THE PCBU			
1. PERSON CONDUCTING A BUSINESS OR UNDERTAKING			
Company / Organisation name:			
Site address:			
Suburb:			Postcode:
Site Tel:	Site Fax:	Contact Name:	
2. OTHER BUSINESSES OR UNDERTAKINGS ENGAGING THE WORKER			
Company / Organisation name:			
Site address:			
Suburb:			Postcode:
Site Tel:	Site Fax:	Contact Name:	
3. WORKER (✓) all relevant boxes			
Surname:		Given names:	
Date of birth: DD/MM/YYYY	Sex:	<input type="checkbox"/> Male	<input type="checkbox"/> Female
Address:			
Suburb:			Postcode:
Current Job:	Tel(H):	Mob:	
Date started employment : DD/MM/YYYY			
4. EMPLOYMENT IN MERCURY (INORGANIC) RISK WORK (✓) all relevant boxes			
1. <input type="checkbox"/> New to mercury (inorganic) work			
2. <input type="checkbox"/> New worker but not new to mercury (inorganic) work			
3. <input type="checkbox"/> Current worker continuing in mercury (inorganic) work			
4. Worked with mercury (inorganic) since DD/MM/YYYY			

HEALTH MONITORING REPORT MERCURY (INORGANIC)

5. Satisfactory personal hygiene (for example nail biting, frequency of hand washing)	<input type="checkbox"/> Yes	<input type="checkbox"/> No
6. Risk assessment completed	<input type="checkbox"/> Yes	<input type="checkbox"/> No
5. WORK ENVIRONMENT ASSESSMENT (✓) all relevant boxes		
Date of assessment: DD/MM/YYYY		
Mercury (inorganic) Industry		
<input type="checkbox"/> Manufacture of Amalgams	Controls:	
<input type="checkbox"/> Dental Work	Wear gloves	<input type="checkbox"/> Yes <input type="checkbox"/> No
<input type="checkbox"/> Manufacture of Paints	Respirator use	<input type="checkbox"/> Yes <input type="checkbox"/> No
<input type="checkbox"/> Gold/Silver Extraction	Local exhaust ventilation	<input type="checkbox"/> Yes <input type="checkbox"/> No
<input type="checkbox"/> Laboratory Work	Overalls / work clothing	<input type="checkbox"/> Yes <input type="checkbox"/> No
<input type="checkbox"/> Fungicides	Laundrying by employer	<input type="checkbox"/> Yes <input type="checkbox"/> No
<input type="checkbox"/> Natural Gas Industry	Wash basins & showers (with hot & cold water)	<input type="checkbox"/> Yes <input type="checkbox"/> No
<input type="checkbox"/> Other (specify):	Smoking or eating in workshop	<input type="checkbox"/> Yes <input type="checkbox"/> No
	Personal hygiene:	
	Clean Shaven	<input type="checkbox"/> Yes <input type="checkbox"/> No
	Shower & change into clean clothes at end of shift	<input type="checkbox"/> Yes <input type="checkbox"/> No
6. BIOLOGICAL MONITORING RESULTS Include at least the previous two test results (if available)		
Date	Tests performed	Recommended Action and/or Comment
1. DD/MM/YYYY		
2. DD/MM/YYYY		
3. DD/MM/YYYY		
4. DD/MM/YYYY		
5. DD/MM/YYYY		
6. DD/MM/YYYY		
7. DD/MM/YYYY		

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7. RECOMMENDATIONS (by Medical Practitioner)		(✓) all relevant boxes
1. <input type="checkbox"/>	Suitable for work with mercury (inorganic)	
2. <input type="checkbox"/>	Counselling required	
3. <input type="checkbox"/>	Review workplace controls	
4. <input type="checkbox"/>	Repeat health assessment in _____ month(s) / _____ week(s)	
5. <input type="checkbox"/>	Removal from work with mercury (inorganic)	On DD/MM/YYYY
6. <input type="checkbox"/>	Medical examination by Medical Practitioner	On DD/MM/YYYY
7. <input type="checkbox"/>	Fit to resume mercury (inorganic) risk work	From DD/MM/YYYY
8. <input type="checkbox"/>	Referred to Medical Specialist (respiratory/dermatology/other):	On DD/MM/YYYY
Specialist's name:		
Additional comments or recommendations arising from health monitoring:		
Medical Practitioner (responsible for supervising health monitoring)		
Name:	Signature	Date: DD/MM/YYYY
Tel:	Fax:	Registration Number:
Medical Practice:		
Address:		
Suburb:	Postcode:	

HEALTH MONITORING REPORT MERCURY (INORGANIC)

SECTION 2 - THIS SECTION TO BE RETAINED BY THE MEDICAL PRACTITIONER			
1. PERSON CONDUCTING A BUSINESS OR UNDERTAKING			
Company / Organisation name:			
Site address:			
Suburb:			Postcode:
Site Tel:	Site Fax:	Contact Name:	
2. OTHER BUSINESSES OR UNDERTAKINGS ENGAGING THE WORKER			
Company / Organisation name:			
Site address:			
Suburb:			Postcode:
Site Tel:	Site Fax:	Contact Name:	
3. WORKER (✓) all relevant boxes			
Surname:		Given names:	
Date of birth: DD/MM/YYYY	Sex:	<input type="checkbox"/> Male	<input type="checkbox"/> Female
		<input type="checkbox"/> Pregnant/Breast Feeding?	
Address:			
Suburb:			Postcode:
Current Job:	Tel(H):	Mob:	
Date started employment : DD/MM/YYYY			
4. GENERAL HEALTH ASSESSMENT (if applicable)			
Symptoms of:	Comments	Further testing?	
Skin disorders		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Headaches, dizziness		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Respiratory tract/GIT		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Irritation of eyes, nose or throat		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Cough		<input type="checkbox"/> Yes	<input type="checkbox"/> No
CNS		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Others		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Height ____cm			
Weight ____kg			
Bp ____/____ mmHg		<input type="checkbox"/> Yes	<input type="checkbox"/> No

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5. OTHER MEDICAL HISTORY, FAMILY MEDICAL HISTORY, CURRENT MEDICATION, COMMENTS, TESTS OR RECOMMENDATIONS (use separate sheet if necessary)

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Medical Practitioner (responsible for supervising health monitoring)

Name:		Signature		Date: DD/MM/YYYY
Tel:		Fax:		Registration Number:
Medical Practice:				
Address:				
Suburb:			Postcode:	