

# CHROMIUM (INORGANIC)

## BASELINE HEALTH MONITORING BEFORE STARTING WORK IN AN INORGANIC CHROMIUM PROCESS

1. **Collection of demographic data**
2. **Work history**
3. **Medical history**
4. **Physical examination**

A physical examination will be conducted, with emphasis on the respiratory system and skin.

## DURING EXPOSURE TO AN INORGANIC CHROMIUM PROCESS

### 5. **Workplace skin care program**

The medical practitioner should tell the person conducting a business or undertaking before the worker starts work with inorganic chromium, that they must ensure the worker's skin is inspected weekly by a competent person. Particular attention should be placed on the skin of the hands and forearms. Where skin abnormalities occur, the person conducting a business or undertaking must arrange for the worker to see the medical practitioner.

### 6. **Respiratory symptoms**

The PCBU should be advised that any respiratory symptoms exhibited by the worker should be reported to the registered medical practitioner.

### 7. **Monitoring exposure to chromium**

The registered medical practitioner may also choose to monitor a worker's exposure to chromium via urinary chromium level. Where urine analysis is carried out, the following values should be considered when assessing exposure to inorganic chromium:

Biological level	Source
10 $\mu\text{mol}$ chromium/mol creatinine in urine = 5 $\mu\text{g/L}$	Workcover NSW Biological Occupational Exposure Limit (BOEL) Committee.
	British Health and Safety Executive Biological Guidance Value
Urine samples should be taken either: <ul style="list-style-type: none"><li>■ pre-shift and post-shift (to measure the increase in urinary chromium during the work shift); or</li><li>■ at the end of a work shift at the end of the work week.</li></ul>	

Where there is an increase in the pre-shift and post-shift urinary chromium (increase during shift) of more than 10  $\mu\text{g/L}$ <sup>1</sup> or where the end of shift at end of work week urinary chromium is more than 25 $\mu\text{g/L}$ , a repeat urinary chromium should be done and work practices should be reviewed. The half life for chromium in urine is 15-41 hours and should be taken into account when interpreting the results.

■ 1 ACGIH Biological Exposure Indices 2007

These levels correspond to the TWA for Chromium VI of 0.05 mg/m<sup>3</sup> for an eight hour shift in workers with chronic chromium exposure. Given the same level of air exposure the concentration of chromium in newly exposed workers is expected to be lower (7 µg/L) and the increase during the workshift 5 µg/L. Note that the concentration of chromium in urine in pre-shift samples reflects past exposure, whereas the post-shift sample values reflect both past and current exposures.

These levels do not protect against acute irritation exposure (nasal chrome ulcers) where exposure is to water soluble Cr VI mist like in electroplating.

Biological monitoring results greater than the above values mean workplace exposure is not being adequately controlled and a review of control measures should be carried out immediately to reduce worker exposure. Although workers with high biological monitoring results may not be showing signs of ill health, affected workers should be removed from further potential exposure until controls are improved.

Analysis of chromium in red blood cells has been proposed by some as a specific marker for chromium (VI) exposure. However, interpretation of the test results can be problematic as variability in the analysis and inter-individual variability has been reported.

## AT TERMINATION OF WORK IN A CHROMIUM (INORGANIC) PROCESS

### 8. Final medical examination

The final medical examination will include urinary chromium testing and a physical examination by the medical practitioner.

## SUPPLEMENTARY INFORMATION ON CHROMIUM (INORGANIC)

Chromium exists in a series of oxidation states from 0 valence to 6+. The most important stable states are elemental metal (Cr<sup>0</sup>), trivalent (Cr<sup>3+</sup>) and hexavalent (Cr<sup>6+</sup>).

### 9. Work activities that may represent a high risk exposure

Examples of work activities involving inorganic chromium and its compounds which require special attention include:

- welding, cutting and hard-facing of stainless steel
- manual metal arc welding of high chromium steels
- chrome plating
- refractory production
- addition of cement to gravel and sand to make concrete
- leather tanning
- timber preservation using, for example, copper chrome arsenic
- chromate use in the textile industry
- chrome pigment use, for example in paints.

### 10. Non-work sources

Chromium (III) is a naturally-occurring element found in rocks, plants and soil. In urban areas, chromium is in the air from fossil fuel combustion. Chromium is an essential nutrient and foods high in chromium include green beans, broccoli and high bran breakfast cereals. The average adult ingestion is 50–200 µg/day.

## POTENTIAL HEALTH EFFECTS FOLLOWING EXPOSURE TO INORGANIC CHROMIUM

The adverse effects of chromium and its inorganic compounds vary according to valence state, water solubility and dose. However, the hexavalent chromium compounds—chromates, dichromates and chromic acid—are of most concern in both acute exposures and chronic exposure to lower concentrations.

### 11. Route of entry into the body

The routes of inorganic chromium entry into the body are through inhalation, ingestion and percutaneous absorption. Work-related exposure generally occurs through inhalation and dermal contact. The absorption of chromium is dependent on the valence and water-solubility of the chromium compound. Soluble forms of hexavalent chromium are readily absorbed by inhalation. Dermal absorption may also occur. Absorption of water-soluble hexavalent chromium through the gastrointestinal tract is about 10 per cent.

### 12. Target organ/effect

**Skin irritant** – irritant contact dermatitis, skin and mucous ulcerations, perforation of nasal septum.

**Skin sensitivity** – allergic contact dermatitis.

**Respiratory tract** – irritation, allergic asthma.

**Gastrointestinal tract** – irritation.

**Kidney** – renal tubule damage.

**Carcinogen** – for hexavalent chromium compounds there is an increase in the risk of lung cancer and case reports of sinonasal cancer.

### 13. Acute and chronic effects

#### **HEXAVALENT CHROMIUM**

##### **Irritant and corrosive effects**

Chromium (VI) (aerosols, dusts, liquid) irritates or even corrodes the skin and the mucous membranes of the eyes and respiratory tract. The spraying of chromic acid can give rise to serious eye lesions and intense exposure to chromic acid particulates may give rise to pulmonary oedema. Also acute oral Cr(VI) toxicity is probably a result of bleeding due to irritation and corrosion (gastroenteritis, hepatic necrosis, acute tubular necrosis with renal failure).

##### **Chrome ulcers (chrome “holes”)**

Deep, round holes, clearly marked, usually at the base of the nails, the finger joints, the skin between the fingers, the back of the hand and the forearm (may also appear at other sites). The lesions are only slightly painful, tend to be clean but they take a long time to heal and scars are left.

**Perforation of the nasal septum**

Intense Cr(VI) airborne exposure for two weeks, or less intense exposure for several months may cause painless ulceration, accompanied by foul nasal discharge.

**ALLERGIC EFFECTS****Allergic dermatitis**

At concentrations below those resulting in irritation, skin sensitivity is the most common effect following exposure to chromium compounds. Chromium is one of the most common contact sensitisers in industrialised countries. Allergic dermatitis is well known in printers, cement workers, metal workers, painters, textile workers and leather tanners [1]. Chromate sensitivity, once induced, may prove difficult to deal with in multiple settings and is very persistent once developed.

Cr(VI) penetrates undamaged skin (the ulcer does not seem to bear a relationship to the development of allergic sensitisation) and subsequently combines with proteins. Contact hypersensitivity due to chromium compounds is caused by a direct effect as haptene into the skin, where chromium is conjugated with autologous proteins to form a full antigen.

**Asthma**

Inhaled chromium is a respiratory tract irritant resulting in airway irritation and airway obstruction. Respiratory sensitisation may develop with chemical substances of low molecular mass. This results in generalised bronchospasm and typical asthmatic attacks occurring on subsequent low exposure levels to dusts, aerosols or welding fumes.

**SYSTEMIC EFFECTS****Chronic obstructive pulmonary disease**

Prolonged inhalation of Cr(VI) particulates can cause chronic respiratory irritation with hyperaemia, chronic inflammation of the lung, chronic bronchitis, bronchopneumonia, and emphysema. The effect on respiratory function could be a reduction in FEV<sub>1</sub><sup>2</sup> and maximal expiratory flow. There is a possibility of complication in the form of an infection.

Studies of welders and chromium platers have shown workers exposed to high levels of chromium show damage to renal tubules. Chronic chromium exposure results in transient renal effects. Nephrotoxicity is the primary cause of death from acute dermal exposure.

Acute chromium exposures can result in hepatic necrosis. Limited data indicate chronic exposure to chromium compounds can cause hepatic effects.

**TRIVALENT CHROMIUM**

Trivalent compounds are generally poorly absorbed through intact skin. However, once the skin is broken, absorption may occur. The trivalent compounds are allergenic, but much less so than the hexavalent compounds. In animal studies, inhalation of trivalent chromium compounds has affected the respiratory system, for example in a study with rabbits there was a decrease in functional and metabolic activity of the macrophage.

**14. Carcinogenicity**

There is considerable epidemiological evidence exposures to hexavalent chromium compounds of sparing to high solubility in chromate production, chromium plating and zinc chromate pigment manufacture have led to a clear excess in mortality from lung cancer.

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■ 2 Forced expiratory volume in one second

The International Agency for Research on Cancer's [2] classification for hexavalent chromium compounds is Group 1. According to the International Agency for Research on Cancer, this category is used only when there is sufficient evidence of carcinogenicity in humans. Carcinogenesis may result from the formation of mutagenic oxidative DNA lesions consequential to the intracellular reduction to the trivalent form. Carcinogenicity by the oral route of exposure cannot be determined.

Metallic chromium and trivalent compounds have an International Agency for Research on Cancer classification of Group 3, and mutagenicity and epidemiological data do not rule out carcinogenic activity of trivalent compounds. There is also discussion in the literature on the carcinogenic potential of trivalent salts and insoluble chromium compounds which appear to accumulate in human lung tissue after inhalation [3].

Cases of sinonasal cancer have been reported in epidemiological studies of chromate production, chromate pigment production and chromium platers.

#### 15. Carcinogen, germ cell mutagen and reproductive toxicant classifications<sup>3</sup>

The following are some chromium-containing chemicals with GHS carcinogen, germ cell mutagen and reproductive toxicant classifications:

- Chromium (VI) trioxide: Carc. 1A , Muta. 1B, Repr. 2 (Suspected of damaging fertility)
- Zinc chromates including zinc potassium chromate: Carc. 1A
- Ammonium dichromate: Carc. 1B, Muta. 1B, Repr. 1B (May damage fertility, may damage the unborn child)
- Calcium chromate: Carc. 1B
- Chromic oxychloride: Carc. 1B, Muta. 1B
- Chromium-III-chromate: Carc. 1B
- Chromium (VI) compounds, with the exception of barium chromate and of compounds specified elsewhere in AnnexVI: Carc. 1B
- Lead sulfochromate yellow [C.I. Pigment Yellow 34]: Carc. 1B, Repr. 1A (May damage the unborn child, suspected of damaging fertility)
- Lead chromate: Carc. 1B, Repr. 1A (May damage the unborn child, suspected of damaging fertility)
- Lead chromate molybdate sulfate red [C.I. Pigment Red 104]: Carc. 1B, Repr. 1A (May damage the unborn child, suspected of damaging fertility)
- Potassium chromate: Carc. 1B, Muta. 1B
- Potassium dichromate: Carc. 1B, Muta. 1B, Repr. 1B (May damage fertility, may damage the unborn child)
- Sodium chromate (VI): Carc. 1B, Muta. 1B, Repr. 1B (May damage fertility, may damage the unborn child)
- Sodium dichromate: Carc. 1B, Muta. 1B, Repr. 1B (May damage fertility, may damage the unborn child)

■ 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.

- Strontium chromate: Carc. 1B
- A 2:1 mixture of: 4-(7-hydroxy-2,4,4-trimethyl-2-chromanyl)resorcinol-4-yl-tris(6-diazo-5,6-dihydro-5-oxonaphthalen-1-sulfonate) and 4-(7-hydroxy-2,4,4-trimethyl-2-chromanyl)resorcinolbis(6-diazo-5,6-dihydro-5-oxonaphthalen-1-sulfonate): Carc. 2
- Trisodium-bis(7-acetamido-2-(4-nitro-2-oxidophenylazo)-3-sulphonato-1-naphtholato)chromate(1-): Muta. 2.

**Key**

Abbreviation	Meaning	Hazard statement
Carc. 1A	Carcinogenicity Category 1A	May cause cancer
Carc. 1B	Carcinogenicity Category 1B	May cause cancer
Carc. 2	Carcinogenicity Category 2	Suspected of causing cancer
Muta. 1B	Germ Cell Mutagenicity Category 1B	May cause genetic defects
Muta. 2	Germ Cell Mutagenicity Category 2	Suspected of causing genetic defects
Repr. 1A	Reproductive Toxicity Category 1A	Hazard statements vary between chemicals. See the information above.
Repr. 1B	Reproductive Toxicity Category 1B	Hazard statements vary between chemicals. See the information above.
Repr. 2	Reproductive Toxicity Category 2	Hazard statements vary between chemicals. See the information above.

**REFERENCED DOCUMENTS**

1. Baruthio F, 'Toxic Effects of Chromium and its Compounds', *Biological Trace Element Research*, vol 32, pp 145-53, 1992.
2. International Agency for Research on Cancer, *IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans, Volume 49: Chromium, Nickel and Welding*, International Agency for Research on Cancer, Lyon, 1990.
3. Norseth T, 'The Carcinogenicity of Chromium and its Salts—editorial', *British Journal of Industrial Medicine*, vol 43, pp 649-51, 1986.

**FURTHER READING**

Agency for Toxic Substances and Disease Registry, *Toxicological Profile for Chromium*, Agency for Toxic Substances and Disease Registry, United States Department of Health and Human Services, Public Health Service, Atlanta, 2000.

American Conference of Governmental Industrial Hygienists (ACGIH), *Documentation of the Threshold Limit Values and Biological Exposure Indices*, 7th Ed, Cincinnati, 2011.

Rosenman KD, Stanbury M, 'Risk of Lung Cancer Among Former Chromium Smelter Workers', *American Journal of Industrial Medicine*, vol 29(5), pp 491-500, 1996.

## HEALTH MONITORING REPORT CHROMIUM (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.

<b>SECTION 1 - THIS SECTION TO BE RETURNED TO THE PCBU</b>			
<b>1. PERSON CONDUCTING A BUSINESS OR UNDERTAKING</b>			
Company / Organisation name:			
Site address:			
Suburb:			Postcode:
Site Tel:	Site Fax:	Contact Name:	
<b>2. OTHER BUSINESSES OR UNDERTAKINGS ENGAGING THE WORKER</b>			
Company / Organisation name:			
Site address:			
Suburb:			Postcode:
Site Tel:	Site Fax:	Contact Name:	
<b>3. WORKER</b>		(✓) 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			
<b>4. EMPLOYMENT IN CHROMIUM (INORGANIC) RISK WORK</b>		(✓) all relevant boxes	
1. <input type="checkbox"/> New to chromium (inorganic) work			
2. <input type="checkbox"/> New worker but not new to chromium (inorganic) work			
3. <input type="checkbox"/> Current worker continuing in chromium (inorganic) work			
4. Worked with chromium (inorganic) since DD/MM/YYYY			
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

## HEALTH MONITORING REPORT CHROMIUM (INORGANIC)

<b>5. WORK ENVIRONMENT ASSESSMENT</b>		(✓) all relevant boxes
Date of assessment: DD/MM/YYYY		
<b>Chromium (Inorganic) Industry</b>		
<input type="checkbox"/> Welding/Fabrication	<b>Controls:</b>	
<input type="checkbox"/> Chrome plating	Wear gloves	<input type="checkbox"/> Yes <input type="checkbox"/> No
<input type="checkbox"/> Refractory Production	Respirator use	<input type="checkbox"/> Yes <input type="checkbox"/> No
<input type="checkbox"/> Concreting	Local exhaust ventilation	<input type="checkbox"/> Yes <input type="checkbox"/> No
<input type="checkbox"/> Leather Industry	Overalls / work clothing	<input type="checkbox"/> Yes <input type="checkbox"/> No
<input type="checkbox"/> Timber preservation	Laundering by employer	<input type="checkbox"/> Yes <input type="checkbox"/> No
<input type="checkbox"/> Textile Industry	Wash basins & showers (with hot & cold water)	<input type="checkbox"/> Yes <input type="checkbox"/> No
<input type="checkbox"/> Chrome Pigment Manufacture/Use (e.g. in paints)	Smoking or eating in workshop	<input type="checkbox"/> Yes <input type="checkbox"/> No
<input type="checkbox"/> Other (specify):	Weekly inspection of skin on hands/arms	<input type="checkbox"/> Yes <input type="checkbox"/> No
	<b>Personal hygiene:</b>	
	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
<b>6. BIOLOGICAL MONITORING RESULTS</b> 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		
8. DD/MM/YYYY		

## HEALTH MONITORING REPORT CHROMIUM (INORGANIC)

<b>7. RECOMMENDATIONS</b> (by Medical Practitioner)      (✓) all relevant boxes	
1. <input type="checkbox"/>	Suitable for work with chromium (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 chromium (inorganic) <span style="float: right;">On DD/MM/YYYY</span>
6. <input type="checkbox"/>	Medical examination by Medical Practitioner <span style="float: right;">On DD/MM/YYYY</span>
7. <input type="checkbox"/>	Fit to resume work <span style="float: right;">From DD/MM/YYYY</span>
8. <input type="checkbox"/>	Referred to Medical Specialist (respiratory/dermatology/other): <span style="float: right;">On DD/MM/YYYY</span>
Specialist's name:	
<b>Additional comments or recommendations arising from health monitoring:</b>	
<b>Medical Practitioner</b> (responsible for supervising health monitoring)	
Name:	Signature <span style="float: right;">Date: DD/MM/YYYY</span>
Tel:	Fax: <span style="float: right;">Registration Number:</span>
Medical Practice:	
Address:	
Suburb:	Postcode:

## HEALTH MONITORING REPORT CHROMIUM (INORGANIC)

<b>SECTION 2 - THIS SECTION TO BE RETAINED BY THE MEDICAL PRACTITIONER</b>			
<b>1. PERSON CONDUCTING A BUSINESS OR UNDERTAKING</b>			
Company / Organisation name:			
Site address:			
Suburb:			Postcode:
Site Tel:	Site Fax:	Contact Name:	
<b>2. OTHER BUSINESSES OR UNDERTAKINGS ENGAGING THE WORKER</b>			
Company / Organisation name:			
Site address:			
Suburb:		Postcode:	
Site Tel:	Site Fax:	Contact Name:	
<b>3. WORKER</b> <span style="float: right;">(✓) all relevant boxes</span>			
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			
<b>4. GENERAL HEALTH ASSESSMENT</b> (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
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

## HEALTH MONITORING REPORT CHROMIUM (INORGANIC)

### 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:	