

POLYCYCLIC AROMATIC HYDROCARBONS (PAH)

BASELINE HEALTH MONITORING BEFORE STARTING WORK IN A PAH PROCESS

1. Work history

2. Medical history

The following details about the worker's medical history will be collected by the medical practitioner:

- records of personal exposure, including photosensitivity
- presence of symptoms, see supplementary information in this Guide
- smoking history.

3. Physical examination

A physical examination will be conducted if indicated by work and medical history.

DURING EXPOSURE TO A PAH PROCESS

4. Photosensitivity

Photosensitivity is a known symptom of exposure to PAH. Where workers report photosensitivity, an appointment should be arranged with the medical practitioner and workers should receive additional counselling on the potential health effects of PAH on the skin.

Where a health monitoring report indicates photosensitivity or other health effects related to exposure, the person conducting a business or undertaking must review control measures and carry out recommended remedial action. The worker must be informed of the results of the health monitoring.

5. Monitoring exposure to PAH

The assessment of work-related exposure to PAH is difficult because workers are exposed to a mixture of compounds. However, the metabolite of pyrene, 1-hydroxypyrene (1-HP) in urine, is most often used as the biomarker for PAH exposure as pyrene is a very thermodynamically stable compound and therefore most abundant in a PAH mixture.

The registered medical practitioner may choose to assess exposure to PAH through urine analysis. Where urine analysis is undertaken, the following values should be considered when assessing exposure to PAH:

Biological level	Source
1 µg 1-HP/L urine	Workcover NSW Biological Occupational Exposure Limit (BOEL) Committee. <i>Note: this value is under review.</i>
< 0.3 µg 1-HP/L urine - unexposed non-smokers 0.5 µg 1-HP/L urine - median for non-exposed smokers 1 µg 1-HP/L urine (benchmark value)	American Conference of Governmental Industrial Hygienists (ACGIH)
4 µmol 1-HP/mol creatinine in urine (benchmark guidance value)	Health and Safety Executive (UK)

Note: 1.0 µg of 1-HP/L urine = 1.4 µmol of 1-HP/mol creatinine

Where results of urine testing indicate there may be high workplace exposure to PAH, the registered medical practitioner should consider providing the person conducting the business or undertaking (PCBU) with the following recommendations:

- the worker should be removed from PAH work
- the PCBU should review control measures and carry out recommended remedial action
- the worker must be informed of the results of the health monitoring.

OTHER INFORMATION

Measurement of airborne levels of PAHs fails to take into account the potential pathway of skin absorption, which can contribute significantly to the total internal dose. The levels of 1-hydroxypyrene in the urine can increase during the course of a workday, reaching maximum values three to nine hours after the end of exposure. If the contribution of dermal exposure is important, post-shift 1-hydroxypyrene excretion can be lower than pre-shift levels when the worker has been exposed to PAH on the day prior to sampling. The difference between beginning and end of workweek excretion gives an indication of the average exposure over the workweek.

Note: Other hydroxylated metabolites of PAH have been proposed as markers of PAH exposure, however, currently correlation between metabolite levels and exposure have not been determined.

AT TERMINATION OF WORK IN A PAH PROCESS

6. Final medical examination

A final medical examination will be conducted and will include health advice including the recognition of photosensitivity and skin changes.

SUPPLEMENTARY INFORMATION ON PAH

7. Work activities that may represent a high risk exposure

PAH are organic compounds consisting of two or more fused benzene rings containing only carbon and hydrogen. They are formed during the combustion of organic material.

Examples of work activities involving PAH exposure which require special attention when assessing exposure include:

- coke plant work
- aluminium primary plants
- tar roofing
- asphalt road surfacing
- diesel emissions.

8. Non-work sources

PAHs are released during incomplete combustion of coal, oil and gas, garbage, or other organic substances like tobacco or charbroiled meat. They are found throughout the environment in the air, water and soil.

Exposure occurs by breathing air containing PAHs from cigarette smoke, wood smoke, vehicle exhausts and agricultural burn smoke. Exposure can also occur by eating grilled or charred meats, contaminated cereals, flour, bread, vegetables, fruits or meats and drinking contaminated water.

Psoriasis patients treated with coal-tar are also exposed to PAHs.

POTENTIAL HEALTH EFFECTS FOLLOWING EXPOSURE TO PAH

9. Route of entry into the body

The routes of PAH entry into the body are through inhalation, ingestion and percutaneous absorption.

10. Target organ/effect

There is evidence workers exposed to high airborne levels of some PAHs show increased risk of lung, kidney, bladder, gastrointestinal and skin cancers.

Photosensitivity is an abnormally high reactivity in the skin or eyes to ultraviolet radiation or natural sunlight. It may be induced by ingestion, inhalation or skin contact with certain substances known as photosensitisers. Symptoms will vary with the amount of ultraviolet radiation, type and amount of photosensitiser, skin type, and age and gender of the person exposed.

Photosensitisation of the skin and eyes can be caused by exposure to specific industrial chemicals. The skin can be affected by dermal exposure or inhalation. The eyes can be affected by volatile fumes. In certain occupations, the risk from exposure to particular photosensitising chemicals and solar ultraviolet radiation is severe. For example exposure to tar and sunlight can cause precancerous and cancerous skin lesions. Exposure to coal tar fumes can cause simultaneous inflammation of the conjunctiva and cornea.

11. Acute effects

The systemic effects of naphthalene (moth-repellent) are known from numerous cases of accidental intake, particularly by children. The typical effect after dermal or oral exposure is acute haemolytic anaemia. The lethal oral dose is 5000 to 15 000 mg for adults and 2000 mg taken over two days for a child.

12. Chronic effects

Dermal toxic effects of PAH are enhanced by exposure to ultraviolet light. The skin is prone to erythema, photosensitivity and skin lesions on sun exposed areas with progression to skin cancer. PAH are irritating to the eyes and can cause photosensitivity. Cough, chronic bronchitis and haematuria have also been noted.

13. Carcinogenicity

There is sufficient evidence PAH are carcinogenic to experimental animals. Work-related exposure to soot as a cause of scrotal cancer was noted for the first time in 1775 [1]. Later, work-related exposure to tars and paraffin was reported to induce skin cancer. There is evidence workers exposed to high airborne levels of some PAH show excess rates of lung, kidney, bladder, gastrointestinal and skin cancers.

Epidemiologic studies have been conducted of workers exposed at coke ovens during coal coking and coal gasification, at asphalt works, foundries, and aluminium smelters and workers exposed to diesel exhaust. Increased lung tumour rates due to exposure to PAH have been found in coke oven workers, asphalt workers and workers in pot rooms of aluminium reduction plants. The highest risk was found for coke oven workers, with a standardised mortality ratio of 195.

The lung is now the main site of PAH-induced cancer, whereas skin tumours have become rarer because of better personal hygiene.

Some well-known carcinogenic PAH are benzo[a]pyrene, benz[a]anthracene and dibenz[a,h]anthracene.

14. Carcinogen, germ cell mutagen and reproductive toxicant classifications¹

Benzo[a]pyrene, benz[a]anthracene and dibenz[a,h]anthracene are classified according to the GHS as Carcinogenicity Category 1B (May cause cancer).

Benzo[a]pyrene is also classified as a Germ Cell Mutagenicity Category 1B (May cause genetic defects) and Reproductive Toxicity Category 1B (May damage fertility, may damage the unborn child).

REFERENCED DOCUMENTS

1. Brown JR, Thornton JL, 'Percivall Pott (1714 -1788) and Chimney Sweepers' Cancer of the Scrotum', *British Journal of Industrial Medicine*, vol 14(1), pp 68-70, 1957.

FURTHER READING

Agency for Toxic Substances and Disease Registry, *Toxicological Profile Polycyclic Aromatic Hydrocarbons*, Agency for Toxic Substances and Disease Registry, United States Department of Health and Human Services, Public Health Service, Atlanta, 1995.

Australian Safety and Compensation Council, *Guidance Note for the Protection of Workers from the Ultraviolet Radiation in Sunlight*, Australian Safety and Compensation Council, 2008.

International Agency for Research on Cancer, *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Volume 92: Some Non-heterocyclic Polycyclic Aromatic Hydrocarbons and Some Related Exposures*, International Agency for Research on Cancer, Lyon, 2010.

International Programme on Chemical Safety, *Environmental Health Criteria 202, Selected Non-Heterocyclic Polycyclic Aromatic Hydrocarbons*, International Programme on Chemical Safety, World Health Organization, Geneva, 1998.

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

■ 1 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 POLYCYCLIC AROMATIC HYDROCARBONS (PAH)

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 PAH RISK WORK (✓) all relevant boxes			
1. <input type="checkbox"/> New to PAH work			
2. <input type="checkbox"/> New worker but not new to PAH work			
3. <input type="checkbox"/> Current worker continuing in PAH work			
4. Worked with PAH 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 POLYCYCLIC AROMATIC HYDROCARBONS (PAH)

5. WORK ENVIRONMENT ASSESSMENT		(✓) all relevant boxes
Date of assessment: DD/MM/YYYY		
PAH Industry		
<input type="checkbox"/> Coke Plant <input type="checkbox"/> Aluminium Plant <input type="checkbox"/> Roofing Industry <input type="checkbox"/> Road Surfacing <input type="checkbox"/> Automotive Industry (diesel) <input type="checkbox"/> Other (specify):	Controls: Wear gloves <input type="checkbox"/> Yes <input type="checkbox"/> No Respirator use <input type="checkbox"/> Yes <input type="checkbox"/> No Local exhaust ventilation <input type="checkbox"/> Yes <input type="checkbox"/> No Overalls / work clothing <input type="checkbox"/> Yes <input type="checkbox"/> No Laundering by employer <input type="checkbox"/> Yes <input type="checkbox"/> No Wash basins & showers (with hot & cold water) <input type="checkbox"/> Yes <input type="checkbox"/> No 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		
7. RECOMMENDATIONS (by Medical Practitioner)		(✓) all relevant boxes
1. <input type="checkbox"/> Suitable for work with PAH		
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)		

HEALTH MONITORING REPORT POLYCYCLIC AROMATIC HYDROCARBONS (PAH)

5. <input type="checkbox"/> Removal from work with PAH	On DD/MM/YYYY	
6. <input type="checkbox"/> Medical examination by Medical Practitioner	On DD/MM/YYYY	
7. <input type="checkbox"/> Fit to resume PAH 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 POLYCYCLIC AROMATIC HYDROCARBONS (PAH)

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		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Eyes		<input type="checkbox"/> Yes	<input type="checkbox"/> No
Photosensitivity		<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

HEALTH MONITORING REPORT POLYCYCLIC AROMATIC HYDROCARBONS (PAH)

Others		<input type="checkbox"/> Yes <input type="checkbox"/> No
Height ____cm Weight ____kg Bp ____/____ mmHg		<input type="checkbox"/> Yes <input type="checkbox"/> No
5. OTHER MEDICAL HISTORY, FAMILY MEDICAL HISTORY, CURRENT MEDICATION, COMMENTS, TESTS OR RECOMMENDATIONS (use separate sheet if necessary)		
Medical Practitioner (responsible for supervising health monitoring)		
Name:	Signature	Date: DD/MM/YYYY
Tel:	Fax:	Registration Number:
Medical Practice:		
Address:		
Suburb:	Postcode:	