management of substances hazardous to health

An Introduction to the

GUIDELINES FOR WORKPLACE HEALTH SURVEILLANCE

OCCUPATIONAL SAFETY & HEALTH SERVICE

DEPARTMENT OF LABOUR
TE TARI MAHI

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ABOUT THIS BOOKLET

These guidelines form part of a series of documents supporting the *Approved Code of Practice for the Management of Substances Hazardous to Health*. This booklet provides an introduction and general guidance on health surveillance of employees and others who may be exposed to hazardous substances. It should be read in conjunction with the more specific guidelines available for the following individual substances:

- Cadmium
- Inorganic arsenic
- Isocyanates
- Lead
- Mercury
- MOCA (4,4-Methylene bis (2-chloroaniline))
- Organophosphate pesticides

The guidelines for specific substances are available from your nearest OSH office (see p10). It is important to remember that the guidelines may be reviewed from time to time as more information becomes available, or the need for specific health surveillance for other substances is recognised.

GENERAL GUIDELINES FOR HEALTH SURVEILLANCE

These guidelines are to assist employers, and those providing health surveillance in the workplace, in deciding when surveillance should be carried out and what form it should take. The guidelines for individual substances should be read in conjunction with this introduction.

The information given in this guideline will help employers decide whether health surveillance is required or appropriate. Where, as an employer, you are unable to reach a conclusion about what surveillance is appropriate, you should obtain help from someone with expertise in occupational health. A list of individuals and organisations providing this service can be obtained from your nearest office of the Occupational Safety and Health Service.

The avoidance of work-related diseases should ideally be achieved by the prevention or control of exposure to hazardous substances in the workplace. In circumstances where this has not been effectively achieved, health surveillance of the people who are potentially exposed may be required.

Health surveillance includes **biological exposure monitoring**, which may be required to complement workplace exposure monitoring, and **biological effect monitoring**, the measurement of early biological effects in exposed workers.

SURVEILLANCE REQUIREMENTS AND RECOMMENDATIONS

WHO MAY REQUIRE HEALTH SURVEILLANCE?

Health surveillance is required for employees having:

(a) A risk to health from one or more of the hazardous substances or processes listed in section 4.2 of the *Approved Code of Practice for the Management of Substances Hazardous to Health* i.e, cadmium, inorganic arsenic, isocyanates, lead, mercury, 4,4-Methylene bis (2-chloroaniline), organophosphate pesticides and electroplating involving chromium and cadmium.

(b) Exposure to a substance hazardous to health for which:

(i) An identifiable disease or health effect may be related to the exposure;

(ii) There is a reasonable likelihood that the disease or health effect may occur under the particular conditions of work; and

(iii) There are valid techniques for detecting indicators of the disease or effect.

Health surveillance may also be required where a departmental medical practitioner requires medical examination of employees.

IS THERE AN IDENTIFIABLE DISEASE OR HEALTH EFFECT THAT MAY BE RELATED TO THE EXPOSURE?

The disease or health effect need not be uniquely related to the exposure, but before a routine surveillance programme is put in place a clear and plausible link between the parameters being monitored and exposure to the substance must have been established. General health checks on workers are also encouraged — this service should not be confused, however, with a programme that is specifically designed for the surveillance of workers exposed to a particular substance.

Health surveillance as required under the Health and Safety in Employment Act should also be separated from research that is undertaken to investigate relationships between exposure and effect, or to develop new monitoring techniques. This activity may be of no direct benefit to the individuals who take part.

IS THERE EVIDENCE THAT A HEALTH RISK EXISTS?

Where there is exposure to a substance listed in the *Approved Code of Practice for the Management of Substances Hazardous to Health* which presents a risk to health, or there is a reasonable likelihood that exposure to a substance may cause disease or health effects, consideration needs to be given to:

- The population at risk, and in particular the presence of a susceptible group;
- The variability and effectiveness of control of occupational exposure to the substance;
- The potential routes of exposure; and
- The relationship between the anticipated total exposure and the current Workplace Exposure Standard or Biological Exposure Index.

Consideration should be given to whether the controls in place can be adequately evaluated by environmental monitoring without the need for health surveillance. It is not possible to apply the same criteria to all substances, but as a general rule where the exposure is less than 10% of the Workplace Exposure Standard, and the major route of exposure is inhalation, then biological monitoring may not be necessary. Health surveillance and workplace exposure should not be thought of in isolation, however, and the best combination should be applied to ensure that the exposure to the hazard is controlled and unlikely to result in harm. Further more specific information is given in the guidelines for individual substances. Before any surveillance programme is developed it is recommended that advice and recommendations be sought from a specialist in occupational health.

ARE THERE HEALTH SURVEILLANCE TECHNIQUES AVAILABLE?

To be valid a technique must be sensitive, specific and able to be reproduced. With respect to biological monitoring, the ability to reproduce the test depends on the precision of the test itself, as well as the normal variation in the biochemical parameter being measured. A valid test must also be able to be interpreted. This usually requires that a standard reference range be available and a means of determining the significance of results that fall outside of this range.

For biological effect monitoring a test that allows for early detection of reversible effects is preferred. This allows for timely intervention.

TYPES OF HEALTH SURVEILLANCE AND THEIR PURPOSE

The types of procedure which may be followed include:

- Biological exposure monitoring;
- Biological effect monitoring;
- Medical tests;
- Medical examination;
- A review of present and past medical and work history;
- A review of medical records and occupational exposure;
- Self-reporting of symptoms; or
- Examination by a suitably qualified person (e.g, an occupational health nurse).

These procedures are not mutually exclusive, and the results from one procedure may indicate the need for another.

BIOLOGICAL EXPOSURE MONITORING

Biological exposure monitoring reflects absorption, not harmful or non-reversible effects. As part of a health surveillance programme it is used to:

- Provide information on the performance of the controls with respect to absorption of the substance;
- Assess absorption of hazardous substances into the body by measuring their concentration or those of their breakdown products (metabolites); and
- Identify individual workers who are absorbing excessive amounts of a hazardous substance. This is to enable their protection to be increased, or their removal from exposure until the concentration of the biological marker returns to a satisfactory level.

The methods commonly used measure the concentration of the substance or its metabolite in urine, blood, exhaled breath, or sweat. In situations where there is significant skin absorption or ingestion, biological monitoring may be the only way of confirming the adequacy of controls. Even where the exposure is predominantly through inhalation, and hence can be quantified using environmental monitoring, biological monitoring may provide additional information.

For substances with a relatively long half life in the biological medium that is used for the test, the result will reflect the average exposure over time (see the example below). The size of airborne particles, their chemical state and the work load, hence the breathing and blood circulation rate of the individual, all influence the relationship between the airborne concentration of the contaminant and the amount the person absorbs.

Biological exposure monitoring example

Blood lead monitoring is routinely used as an estimate of the lead absorbed by workers in a number of processes. The results are used to determine if controls need to be improved and when to remove anyone with excessive absorption from the job until their blood lead levels return to an acceptable value. It is generally accepted that blood lead monitoring provides more information on the risk presented by the cumulative poison than an environmental monitoring programme.

BIOLOGICAL EFFECT MONITORING

Biological effect monitoring involves the measurement of a biological change that is non-adverse and reversible. It should not be confused with medical monitoring that aims to measure early **signs and symptoms** of adverse effects. Biological effect monitoring is theoretically an ideal tool in preventing the development of disease related to chemical exposure, as it has the potential to take into account individual susceptibility in contrast to exposure monitoring. In practice it is not a commonly applied procedure. Cholinesterase monitoring for workers exposed to organophosphate pesticides (see example below) and markers of lead uptake that relate to its effect on haemoglobin synthesis, such as zinc protoporphyrin (ZPP) and delta-aminolevulinic acid dehydrase (ALA-d), are examples of the few commonly applied biological effect monitoring techniques.

Biological effect monitoring example

Exposure to organophosphate pesticides reduces the enzyme cholinesterase in the red cells and plasma. A lowering of blood cholinesterase levels in itself is not a harmful effect, but the blood result reflects enzyme levels at more critical sites and absorption of the pesticide. Gaining equivalent information from environmental monitoring would be difficult — especially considering that skin absorption is significant for pesticide workers.

Biological Exposure Indices (BEI) are listed in the New Zealand Workplace Exposure Standards. The BEI are linked to the WES by the following definition: “If a worker’s inhalation exposure is equal to the Workplace Exposure Standard (WES) and he/she is engaged in moderate work, then the BEI represents the expected level of the biological determinant”.

The number of possible biological monitoring procedures has grown considerably over the last two decades. Appendix A contains information on some of the more commonly used tests, the majority of which are listed in the *Workplace Exposure Standards* publication. Inclusion of a test in the list should not be taken as an indication that the procedure is recommended as a routine monitoring test — or even that it is a test that is currently offered by New Zealand laboratories.

EXAMINATIONS AND GATHERING MEDICAL HISTORY

The qualifications and experience required to carry out the functions involved with health surveillance vary with the task. Medical examinations, and a review of medical history and records should be undertaken by a medical practitioner with experience in occupational health. It is often practical in the industrial environment to carry out an initial collection of data concerning symptoms and signs of exposure by means of a suitably qualified person such as an occupational health nurse.

Regardless of who carries out the particular aspects of health surveillance, it is important that the information relating to exposure, work and medical history, signs and symptoms be collated and interpreted by a person who has an understanding of both the work activities and occupational health practice.

FURTHER INFORMATION

OSH PUBLICATIONS

Approved Code of Practice for the Management of Substances Hazardous to Health

Guidelines for the Medical Surveillance of Lead Workers, Occupational Safety and Health Information Series

Workplace Exposure Standards — Effective from 1994.

FURTHER READING

Lauwerys, R.R and Hoet, P. *Industrial Chemical Exposure, Guidelines for Biological Monitoring*, 2nd Edition, K\Lewis Publishers, Boca Raton, 1993.

American Conference of Governmental Industrial Hygienists (ACGIH) *Documentation of the Threshold Limit Values and Biological Exposure Indices*. 6th edition, ACGIH, Cincinnati, Ohio, 1991.

APPENDIX A BIOLOGICAL MONITORING

Chemical exposure	*Parameter measured*	*Biological sample*	*NZ BEI (see p6)*	*Comments*
Acetone	acetone	urine	proposed BEI 100 mg/litre	
Aluminium	aluminium	urine	no BEI listed	Occupational exposure to aluminium may result in a measurable increase in urinary excretion. While a biological limit of 200 ug/l has been proposed, there are complications that limit the usefulness of the test.
Arsenic (inorganic)	sum of inorganic arsenic, methylarsenic acid and dimethylarsenic acid	urine	1.3umol/litre (100ug/litre)	Urinary arsenic level provides a good estimation of recent uptake of inorganic arsenic. The result is not influenced by dietary intake of organic arsenic as found in fish.
Cadmium	cadmium cadmium	blood urine	10ug/litre 10ug/g creatinine	Blood and urinary cadmium levels are influenced by both exposure and body burden. With moderate occupational exposure cadmium in blood levels reflect mainly recent exposure[4]. For routine monitoring urinary cadmium tests are recommended.
Carbon monoxide	carboxyhaemoglobin	blood	3.5% of haemoglobin	Not an appropriate index of exposure in smokers. Methylene chloride exposure also results in elevated carboxyhaemoglobin levels.
Chromium	chromium	urine	0.6 umol/litre (30 ug/litre)	The BEI is applicable only to manual metal arc welding and operations where water-soluble chromium (VI) fume is present.
2-Ethoxyethanol and 2-Ethoxyethanol acetate	2-ethoxyacetic acid	urine	proposed BEI 100mg/g creatinine	
Fluoride	fluoride	urine	Pre-shift 160 umol/litre (3mg/litre)	The pre-shift sample results are indicative of fluoride accumulated in the body.
			Post-shift 530 umol/litre (10 mg/litre)	End of shift sample concentrations reflect recent exposure.
n-Hexane	2,5-hexanedione	urine	5 mg/litre	A relatively low background level may be found in the urine of unexposed individuals (less than 1 mg/litre).
Lead (inorganic)	lead	blood	A worker will normally be suspended by the departmental medical practitioner where: (a) A single blood lead result is 3.2 umol/litre whole blood or greater, or (b) Three consecutive monthly estimations are 2.6 umol/litre or above.	
		urine	0.72umol/litre (150ug/litre)	Being less invasive, the procedure may be used as an alternative to a blood lead test.
Lead (tetraalkyl)	lead	urine	0.48 umol/litre (100ug/litre)	With exposure to tetraalkyl lead, urinary lead is the preferred test.

Chemical exposure	*Parameter measured*	*Biological sample*	*NZ BEI (see p6)*	*Comments*
Manganese	manganese	urine	no BEI listed	Urinary manganese levels may be used to confirm absorption of manganese but little is known about the relationship with exposure.
Mercury	mercury	urine	0.25 umol/litre (50 ug/litre)	The urinary mercury level reflects exposure only after a certain body burden has been obtained — this may take several months.
Methanol	methanol	urine	15 mg/litre	No correction for urine volume required. Background level of up to approximately 3 mg/litre may be found in the urine of non-occupationally exposed individuals. Higher levels may result from drinking alcoholic beverages.
Methyl ethyl ketone (MEK)	MEK	urine	2 mg/litre No correction for	Coexposure to alcohol will increase the MEK concentration in urine. Exposure to alcohol should be recorded. No correction for urine volume required.
Methyl isobutyl ketone (MIBK)	MIBK	urine	proposed BEI 2 mg/litre	No correction for urine volume required.
Organophosphate pesticides	cholinesterase activity	blood	**less than 60%**	Suspend from working with pesticides which inhibit cholinesterase activity.
	A baseline must be estabilised for each person and it is recommended this takes place following at least 30 days without exposure.		**less than 80%**	Action level: repeat test to confirm result
			greater than 75%	Permit a previously suspended worker to recommence normal duties.
Pentachlorophenol	total PCP including conjugates	urine	1 mg/litre	Biolological monitoring provides reliable indication of long-term exposure. Uptake through skin likely to be more significant than inhalation.
Perchloroethylene	trichloroacetic acid	urine	proposed BEI 3.5 mg/litre	Exposure to other chlorinated hydrocarbons such as trichloroethylene will complicate interpretation of results. Trichloroethylene in blood may be used as a confirmatory test.
Selenium	selenium	urine	no BEI listed	Urinary selenium levels may be used to confirm absorption of selenium, but little is known about the relationship with exposure. The levels in non-occupationally exposed individuals are said to be generally below 30ug/litre.
Styrene	mandelic acid	urine	1 g/litre	Ethanol intake inhibits the metabolism of styrene to mandelic acid. Significant exposure to other solvents such as xylene, toluene and trichloroethylene will also interfere.
Trichloroethylene	trichloroacetic acid	urine	100 mg/litre	Samples should be collected after 4 or 5 days of exposure. Ethanol intake inhibits the metabolism of trichloroethylene to trichloroacetic acid.
Xylene	methylhippuric acid	urine	1.5 g/litre	Both aspirin and alcohol suppress the metabolism of xylenes to methylhippuric acid.

OSH BRANCH OFFICES

WHANGAREI

Manaia House, cnr Rathbone and Dent Streets,
Whangarei.
PH: 09 438 0552 FAX: 09 438 4874
Branch Manager: **Gordon Brown**

NORTH HARBOUR

5 Argus Place, Glenfield.
PH: 09 443 3460 FAX: 09 443 4246
Branch Manager: **Gordon Johnson**

WEST AUCKLAND

2nd Floor, Don Oliver Building, 2 Rankin Ave,
New Lynn, Auckland.
PH: 09 827 8550 FAX: 09 827 8553
Branch Manager: **Kevin Mottram** (acting)

PENROSE

1st Floor, 638 Great South Road, Penrose.
PH: 09 525 0268 FAX: 09 525 0372
Branch Manager: **Kevin Third**

MANUKAU
533 Great South Road, Papatoetoe South.
PH: 09 277 7415 FAX: 09 277 7394
Branch Manager: **John Bain**

HAMILTON

93 Collingwood Street, Hamilton.
PH: 07 838 1381 FAX: 07 838 0054
Branch Manager: **Kevin Webby**

ROTORUA

59/61 Haupapa Street, Rotorua.
PH: 07 347 9656 FAX: 07 346 0229
Branch Manager: **Jim Anderson**

TAURANGA

Durham Court, 148 Durham Street, Tauranga.
PH: 07 578 2090 FAX: 07 577 6396
Branch Manager: **John Belcher**

NAPIER

6 Taradale Road, Napier.
PH: 06 835 7017 FAX: 06 835 7102
Branch Manager: **Pauline Elliott**

NEW PLYMOUTH

97 Gill Street, New Plymouth.
PH: 06 758 0516 FAX: 06 757 8166
Branch Manager: **Murray Thomson**

PALMERSTON NORTH

3 Victoria Avenue, Palmerston North.
PH: 06 359 1919 FAX: 06 359-1431
Branch Manager: **Bruce Lambie**

LOWER HUTT

Woburn House, 40-44 Bloomfield Terrace,
Lower Hutt.
PH: 04 566 8962 FAX: 04 566 7363
Branch Manager: **Martha Rowbotham** (acting)

WELLINGTON

Ballantrae House, 192 Willis Street, Wellington.
PH: 04 385 7771 FAX: 04 382-9159
Branch Manager: **Keith Stewart** (acting)

NELSON

60 Vickerman Street, Nelson.
PH: 03 546 8180 FAX: 03 546-8136
Branch Manager: **Brian Stratford**

CHRISTCHURCH NORTH
Carter House, 81 Lichfield Street, Christchurch.
PH: 03 365 2600 FAX: 03 365-2616
Branch Manager: **Brian Smith**

CHRISTCHURCH SOUTH
Carter House, 81 Lichfield Street, Christchurch.
PH: 03 366 5500 FAX: 03 365-2616
Branch Manger: **Margaret Radford**

DUNEDIN
392 Hillside Road, Dunedin.
PH: 03 455 0855 FAX: 03 455-6680
Branch Manager: **Andrew Reddie**

INVERCARGILL

70 Victoria Avenue, Invercargill.
PH: 03 218 2126 FAX: 03 218-2152
Branch Manager: **Steve Jones**