National Occupational Health and Safety Commission

PREVENTION OF EYE DAMAGE

December 1989

Australian Government Publishing Service
Canberra

WAP 89/033
GS 010-1989

ISBN 0 644 09151 7

The National Commission's address is:

National Occupational Health and Safety Commission
Level 30, St Martins Tower
31 Market Street
Sydney NSW 2000
GPO Box 58
Sydney NSW 2001
Tel: (02) 265 7555
Facsimile: (02) 265 7538
Telex: 177243

Printed in Australia by Alken Press Pty. Ltd. - Smithfield

Foreword

The National Occupational Health and Safety Commission, Worksafe Australia, is a tripartite body established by the Commonwealth Government to develop, facilitate and implement a national approach to occupational health and safety.

The National Commission comprises representatives of the peak employee and employer bodies - the Australian Council of Trade Unions (ACTU) and Confederation of Australian Industry (CAI) - as well as the Commonwealth, State and Territory governments.

Since its establishment, the National Commission has produced occupational health guides. Before the National Commission was established, a series of similar guides was published by the National Health and Medical Research Council.

This Guide has been reviewed and endorsed by a working group of the National Commission as part of the co-ordinated effort by the Commonwealth, State and Territory governments and employee and employer organisations to make Australian workplaces safe and healthy.

Although this Guide has been endorsed by the National Commission, it is an advisory document only. It is produced and distributed in the interests of providing useful information on occupational health and safety for employers, employees and others. This document does not replace statutory requirements under relevant State and Territory legislation.

This Guide is aimed primarily at workers and managers but should also be useful to occupational health and safety personnel and others. It may be used in conjunction with appropriate training and consultation, in line with good management practice.

Contents

Introduction

Nearly all cases of eye damage that occur in Australia each year are preventable. Damage to the eye can be avoided by suitable design and engineering controls, following well-established safe working procedures and, where necessary, wearing suitable eye protection.

This Guide summarises the most important aspects of recognition, identification and control of the harmful agents that may cause eye damage or loss of eyesight.

The following publications should be used in conjunction with this Guide:

- *Atmospheric Contaminants*, Worksafe Australia Guide; and
- *Occupational First Aid*, National Health and Medical Research Council.

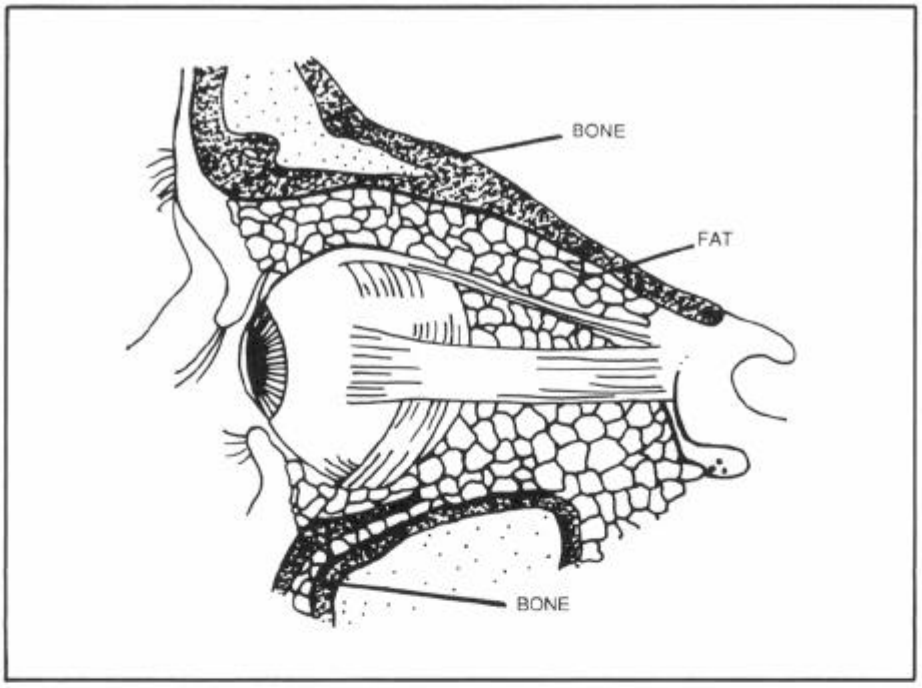
The National Commission publication, *Exposure Standards for Atmospheric Contaminants in the Occupational Environment* (latest edition), should also be consulted.

Australian Standards which are relevant to this Guide include:

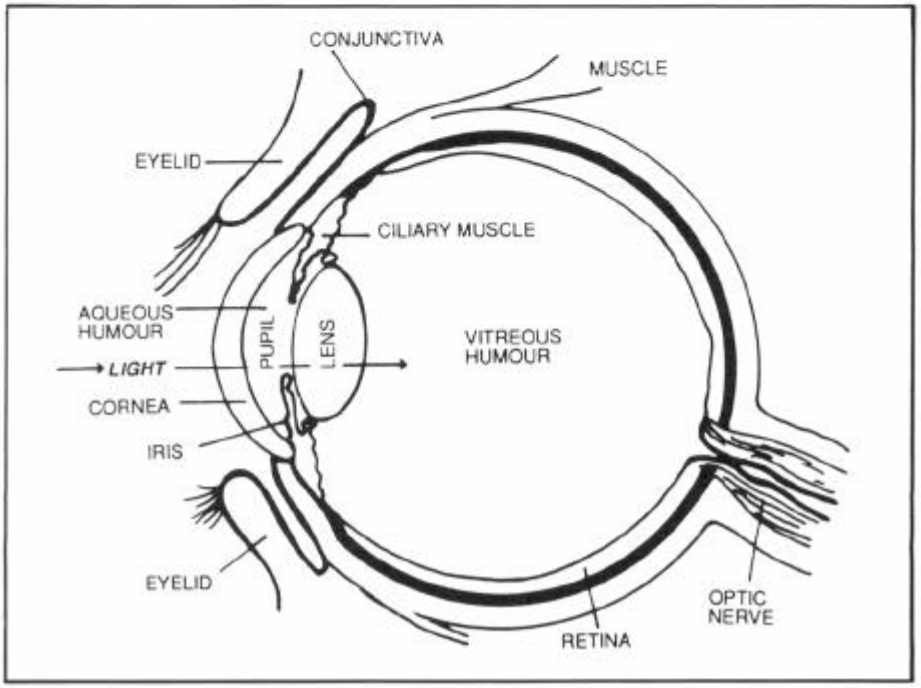
- AS 1336 *Recommended Practices for Eye Protection in the Industrial Environment*;
- AS 1337 *Eye Protectors for Industrial Application*;
- AS 1338 *Filters for Eye Protectors*;
- AS 2211 *Laser Safety*; and
- AS 2397 *Guide to the Use of Lasers in the Construction Industry*.

The structure and function of the eye

The diagrams on the following page illustrate the position of the eye in its cavity and its structure.



The eye in its cavity



Structure of the human eye

The eye is a soft globular structure placed in the orbit of the skull. The outer parts of the eye include the eyelids, the conjuctiva, the tear glands and tear sac.

The conjuctiva is a membrane that lines the inside of the eyelids and extends over the front of the eyeball except the cornea. The tear gland lies at the upper outer corner of each eye cavity which produces a fluid that lubricates the eyeball.

The front of the eyeball is protected by the eyelids. Eyelashes on the eyelids screen out some of the dust and other particles that might otherwise enter the eye. Any sudden movement in front of the eye or sudden increase in light intensity causes the eyelids to blink in a protective reflex action.

The inner parts of the eye include the cornea, aqueous humour, ciliary muscle, lens, vitreous humour, retina and optic nerve.

Light rays enter the eye through the cornea and aqueous humour. The ciliary muscles adjust the shape of the lens to enable focusing. The lens focuses the light through the vitreous humour on to the retina.

Light-sensitive cells in the retina absorb light rays and change them into electrical signals. Nerve fibres join at the centre of the back of the retina and form the optic nerve. The optic nerve carries the electrical signals produced in the retina to the brain which interprets them as visual images.

Identification

There are many occupations where eyes are at risk. Workers at risk include those who work with:

- mechanical equipment;
- chemicals; and
- sources of radiation, mainly ultraviolet radiation from welding and infra-red radiation from furnaces.

The danger is greatest where various particles are caused to become airborne at speed and particularly near personnel.

Workplaces where chemicals are handled or where high levels of radiation are generated in the work process, for example, most forms of welding, must be carefully assessed to prevent eye injuries, since in these work situations there is an inherent risk of injury to the eye.

Health Hazards

When considering the hazards associated with any workplace, it is essential to understand the relationship between 'hazard', 'exposure' and 'risk'.

'Hazard' is the potential for an agent or process to do harm. 'Risk' is the likelihood that an agent will produce injury or disease under specified conditions.

Health effects can only occur if a worker is actually exposed to the hazard. The risk of injury or disease usually increases with the duration and frequency of exposure to the agent, and the intensity/concentration and toxicity of the agent.

Toxicity refers to the capacity of an agent to produce disease or injury. The evaluation of toxicity takes into account the route of exposure and the actual concentration of an agent in the body.

Agents of eye damage

Agents of eye damage may be broadly classified into the following four categories:

- impact or blunt force;
- foreign bodies;
- chemicals injurious to the eye; and
- radiation.

Impact or blunt force

Normally the eyelids close as a reflex action before being struck by any object approaching them. A blow to the eye can therefore cause internal damage without any apparent injury to the surface of the eyeball. Haemorrhage into the aqueous humour may occur. If any doubts exist, seek medical advice. Symptoms would include impaired, especially blurred or double, vision.

Foreign bodies

Small foreign bodies may settle on, or become embedded in, the eye. These include dust, flying particles and molten metal splashes. Some foreign bodies have physical effects while some have biological effects and these may interfere with the normal processes of the eye. If not removed,

foreign bodies may cause serious damage.

Foreign bodies with high impact force can penetrate the surface of the eye. Penetration by a small particle may not always be obvious if it leaves only a minute mark on the conjunctiva or cornea. This is often difficult to see. Examples of work activities where foreign bodies with high impact force may be present include:

- grinding;
- polishing;
- chipping;
- drilling;
- machine tooling;
- cutting;
- impact of steel on steel;
- impact of steel on other materials;
- welding, brazing and soldering;
- sandblasting;
- saw milling;
- use of rotary mowers;
- spraying paint or molten metal; and
- use of any high-speed rotating device that may break or disintegrate.

Chemicals injurious to the eye

Many chemicals can cause eye damage. The severity of the damage will increase with the concentration of the offending chemical and with the duration of contact with the eye.

Strong alkalis are exceedingly dangerous. Strong acids are more likely to cause damage than solvents, thinners and degreasers.

Commonly used chemical substances causing eye irritation/damage include:

- acids:
  - sulphuric,
  - hydrochloric,
  - nitric,
  - hydrofluoric,
  - glacial acetic, and
  - chromic;
- alkalis:
  - sodium hydroxide (caustic soda),
  - potassium hydroxide,
  - calcium oxide,
  - calcium hydroxide, and
  - lime and cement mix;
- corrosive chemicals:
  - phenols,
  - ferric chloride, and
  - aluminium chloride;
- organic solvents (mode of action could be splashes or exposure to vapours over a long period):
  - thinners,
  - paint solvents,
  - drycleaning solvents,
  - degreasers,
  - petrol, and
  - kerosene;
- surface active agents:
  - liquid or powder detergents,
  - cutting oils, and
  - paint removers;
- allergens; and
- others:
  - ammonia,
  - phosphorus, and
  - household bleach (sodium hypochlorite).

Some chemicals handled in pharmaceutical factories and in biological laboratories, for example, atropine, organotin compounds, vaccines and enzymes, present specific hazards that may result in eye damage. Health authorities should be consulted about specific safe working procedures in these cases.

Radiation

Exposure to various sources of radiation can cause serious eye damage, particularly to the cornea, lens and retina. Generally both eyes are affected. Types of radiation that may cause damage include:

- ultraviolet;
- infra-red;
- laser;
- microwave; and
- ionising.

Ultraviolet radiation may damage the cornea, the window of the eye. Infra-red radiation can cause cataracts, or opacity of the lens, on prolonged, heavy exposure. Exposure to light from lasers may result in damage to the retina.

Ultraviolet light generated during electric welding can result in painful burns to the eyes known as ‘welder's flash’ or ‘arc eye’. A ‘flash’ should not be considered until the eye has been examined for the presence of a foreign body and this has been eliminated. Glass workers' cataracts are an example of eye damage caused by exposure to high doses of infra-red radiation.

Intense visible light or glare can result in dazzle or light stroke. The momentary disorientation may lead to further accidents in the workplace.

Prevention and Control Measures

Following the identification of a hazard, evaluation of work practices and conditions must be undertaken so that effective prevention and control measures can be implemented. This should be considered an integral part of management's responsibilities.

The working environment should be critically analysed to identify any potentially hazardous processes or situations that may result in eye damage. The following steps may be useful in such an evaluation:

- identification of the potentially hazardous areas;
- removal or containment of the hazards; and
- enclosure of processes that use dangerous chemicals or generate harmful radiation.

If containment is not possible:

- designate hazardous areas;
- sign-post the designated areas clearly;
- define, and mark clearly, safe working distances;
- provide appropriate eye protection; and
- train staff in the use and care of eye protective devices.

Having identified hazardous areas or situations, all efforts should be made to eliminate the risk of eye damage.

Control measures

Where there is a likelihood of worker exposure to eye damage hazards, steps should be taken to minimise that exposure as far as practicable. A thorough examination of work practices is essential. Procedures should be adopted to ensure that workers are not unnecessarily exposed to the hazard. Control measures include, but are not limited to, the following, which are ranked in priority of their effectiveness:

- elimination/substitution and process modification;
- engineering controls;
- administrative controls; and
- use of personal protective equipment.

Engineering controls

Engineering control measures may include the following:

- use of mechanical handling methods and automation;
- application of local exhaust ventilation to the point of origin of the contaminant;
- mechanical, general ventilation;
- isolation, segregation or enclosure of operations producing the contaminant;
- dust suppression; and
- safe storage of all potentially dangerous substances.

Warning signs requiring the use of specific eye protection should be placed near the entrance to, and in, the work areas where the eye damage hazard has been identified. In areas where chemicals are used, eye protection should be worn at all times. Readily accessible eye irrigation facilities should be available in all such places. For further information on this matter, refer to the section on first aid.

Fixed or mobile screens should be used to eliminate exposure of workers not directly involved in the work process.

Safe working distances between the worker and the work process should be established for specific tasks.

Good lighting is also important in order to:

- assist in hazard recognition;
- maximise the working distance;
- keep the pupil diameter as small as possible (to minimise the amount of damaging radiation that can enter the eye); and
- make the use of eye protectors less restricting.

Administrative controls

Regular ophthalmic examination of potentially exposed individuals is advisable to recognise initial signs of eye damage, for example, the early formation of cataracts. Affected workers should be given other duties and a reassessment made of the exposure involved with their current and past work. The consequences of single eye damage to someone already having partial loss of sight in one eye are potentially more serious than for others. Their duties should be selected for minimum risk.

Evaluation

Environmental sampling and analysis should be undertaken at regular intervals by qualified occupational health and safety professionals in accordance with the methods recommended by the appropriate occupational health authority.

Exposure standards

Worker exposure to atmospheric contaminants should be kept as low as workable. Every attempt should be made to keep exposures well below the exposure standards listed in the National Commission publication, *Exposure Standards for Atmospheric Contaminants in the Occupational Environment* (latest edition).

The exposure standards represent airborne concentrations of individual chemical substances which, according to current knowledge, should neither impair the health of, nor cause undue discomfort to, nearly all workers. Additionally, the exposure standards are believed to guard against narcosis or irritation which could precipitate industrial accidents.

Except where modified by consideration of excursion limits, exposure standards apply to long-term exposure to a substance over an eight-hour day for a normal working week, over an entire working life.

The exposure standards do not represent 'no effect' levels which guarantee protection to every worker.

Personal protective equipment

In certain circumstances, personal protection of the individual may be required as a supplement to other preventive action. It should not be regarded as a substitute for other control measures and must only be used in conjunction with substitution and elimination measures.

Personal protective equipment must be appropriately selected, individually fitted and workers trained in correct use and maintenance. Personal protective equipment must be regularly checked and maintained to ensure that the worker is being protected.

Where personal protection is necessary, the eye protection should be selected according to:

- the nature of the hazard, for example, flying particles, and chemical or molten metal splashes; and
- the work process, for example, welding, grinding, spray painting or working with power tools.

Protective devices

Specific protective devices for eyes for various work processes are set out in table 4.2 of Australian Standard AS 1336. Typical eye protectors are:

- safety spectacles;
- goggles;
- face shields;
- hoods; and
- helmets.

Transparent face shields will provide better protection against mechanical hazards when used in addition to safety spectacles or goggles. Faceshields, however, are not primary eye protective devices and their use should be supplemented by goggles or safety glasses.

Eye protectors with appropriate lenses are designed for protection against medium to high velocity impact of flying particles, fragments, dusts, splashing materials, molten metals and harmful gases and vapours. The impact, chemical and heat resistant properties of these devices should meet the requirements of Australian Standard AS 1337.

For the selection of the correct type and grade of filters against optical radiation generated during industrial processes, the recommendations of Australian Standard AS 1338 should be followed. This standard specifies requirements for:

- filters for protection against radiation generated in welding and allied industries;
- filters for protection against ultraviolet radiation; and
- filters for protection against infra-red radiation.

Labelling of eye protecting devices

Safety devices for eye protection should have a permanently affixed label providing information specified in Australian Standard AS 1337. The label should state the manufacturer's name, the purpose of the lens (filter shade number), the purpose of the assembled eye protector and the type of welding operation for which the eye protector is appropriate.

Optical glasses

Workers requiring corrective optical lenses should wear protective goggles over the corrective spectacles or wear goggles that incorporate the corrective properties of the prescribed lenses. When goggles are worn over spectacles, clarity of vision must not be impaired. It is preferable for workers who wear prescription glasses to be provided with glasses/lenses and frames with prescription lenses which meet Australian Standard AS 1337 when working in designated eye protection areas.

Contact lenses

The wearing of contact lenses in the workplace is satisfactory, provided that the appropriate eye protection is used in addition to the contact lenses. Contact lenses should not be regarded as a form of eye protection. Eye protection of welders with contact lenses is the same as that recommended for welders generally.

It is in the interest of the person who wears contact lenses to inform the appropriate people, for example, the nurse or supervisor, because in case of an eye injury, the first aid procedure will have to make provision for the medically safe removal of the contact lenses.

Lasers

Laser devices produce intense light beams by Light Amplification by Stimulated Emission of Radiation (LASER). This light or laser radiation has certain properties which distinguish it from other sources. It is emitted from the laser as a narrow beam and can be many times brighter than the sun. The wave-length of the laser radiation can range from the invisible ultraviolet, through the visible, to the invisible infra-red.

Lasers have many uses. Typically, lasers may be used in optical systems for transferring energy to material, for example, cutting and drilling, and for alignment and levelling in the construction industry.

If used without appropriate safety measures, lasers can cause serious eye damage, even blindness.

Laser lights in the visible and near infra-red red region are focussed by the cornea and lens of the eye on the retina and this will result in serious burns of the retina if the exposure is sufficiently intense. Invisible infra-red radiation can also damage the cornea and the lens and may lead to the formation of cataracts. Ultraviolet radiation absorbed by the cornea can result in spasm of the ciliary muscles. The damage to the cornea itself by ultraviolet laser light may take 24 hours to become noticeable. In contrast, the lens damage caused by infra-red laser light is not as immediately apparent and the long term effects may be serious.

Lasers are classified according to their maximum radiant power and maximum accessible emission limits. All laser products should have a permanently affixed label identifying the classification of the laser and no unclassified laser should be used.

Hazards associated with laser work are summarised in section 2.3 of Australian Standard AS 2397 which reads:

> A system of classification of laser devices is specified in AS 2211. That system of classification ranks the potential hazards of lasers, either in direct exposure or specular reflections, as follows:
>
> (a) Class 1 lasers are safe for use under all conditions of exposure.
>
> (b) Class 2 lasers are low-power devices the use of which requires some administrative controls but presents little or no potential hazard, e.g. eye protection is normally

afforded by normal blink and aversion responses.

(c) Class 3A lasers emit higher levels of light, e.g. visible radiation, and their use requires more stringent engineering and administrative precautions than those necessary with Class 2.

(d) Class 3B lasers emit either invisible or visible radiation potentially hazardous to the eye and skin.

(e) Class 4 lasers are high power devices capable of producing diffuse reflections hazardous to the eye; skin exposure to the direct beam of a Class 4 laser is also hazardous.

Work practices varying according to the laser's classification should be followed to prevent serious eye damage. Australian Standard AS 2211 lists these work practices.

Where Class 3B and 4 lasers are used, eye protection meeting the requirements of section 3.5.2 of Australian Standard AS 2211 must be worn at all times. Class 3A, 3B and 4 lasers can cause eye injury when beams are reflected by smooth mirror-like surfaces.

Low-powered lasers emitting visible light radiation are potentially less dangerous. Australian Standard AS 2397 sets out safety procedures that should be followed when working with Class 1, 2 and 3A lasers.

Lasers similar to those used in the construction industry are also used in mining, land surveying, marine surveying and in similar applications.

In accordance with Australian Standard AS 2397, where Class 2 and 3A lasers are used, a suitably trained laser safety officer should be appointed to carry out an assessment of the potential radiation hazard and implementation of controls appropriate to these classes of lasers.

All laser operators should be trained in their tasks. In particular, operators of Class 3 and 4 laser systems should receive training to an appropriate level in accordance with section 3.6 of Australian Standard AS 2211.

Preliminary eye examinations should be conducted prior to the employment of personnel required to work with Class 3B and 4 laser products. A medical examination, conducted by a qualified specialist, must be undertaken immediately following accidental exposure of the eye to a laser. Such an examination should be in accordance with paragraph D2 of Australian Standard AS 2211.

Warning signs, appropriate to the laser's classification, must be displayed both inside and outside the work area and on doors giving access to the work area where lasers of Class 2 or above are used. The wording and format of these signs should follow section 3.4 of Australian Standard AS 2211.

First Aid

As with other injuries, the type and extent of first aid given for eye injuries will depend on the qualifications, training and experience of the first aid provider and on the extent of the injury.

If any doubt exists about the seriousness or the severity of the injury, the person should be referred for medical assessment. For example, penetrating eye injuries may cause little or no signs or symptoms.

Signs and symptoms depend on the nature and the amount of the chemical substance which gets into the eye. These are:

- moderate to extreme pain;
- moderate to intense spasm of the eyelid;
- irritation, producing watering, redness of the eye;
- photophobia, sensitivity to light; and
- signs of burning of the eye over the affected or splashed area.

In all workplaces where chemicals are present, automatic eye showers or eye-wash bottles must be available at strategic locations. If activity is carried out on site or out of doors, these first aid facilities must be near the work area. Eye showers must be capable of providing a copious volume of clean water under low, even pressure. With chemical burns to the eyes, the most important single first aid measure is on-the-spot decontamination by continuous irrigation. The irrigation of the eye should continue for a minimum period of 15-20 minutes, if the offending agent is strong alkali or phenol, or for 5-10 minutes, if the agent is an acid or a less injurious chemical. This not only dilutes the chemical but also helps to flush out any foreign matter still present in the eye. *Do not waste time trying to find a suitable neutraliser. Large quantities of clean water are the best form of first aid for chemical contaminants of the eye.* Eye showers should be checked regularly to ensure correct functioning in an emergency. Antiseptic or anaesthetic drops or ointments should not be administered without medical advice.

All workers in chemical plants, or in other workplaces where chemicals are used, should be trained in the on-the-spot decontamination of the eye by eye showers or eye-wash bottles. The time delay involved in removing the injured person from the work area to the first-aid room could mean the difference between saving or losing the sight of the injured worker.

It cannot be over-emphasised that the maintenance of the eye showers and eye wash bottles in the highest degree of cleanliness is essential. This is an important management responsibility.

It is very difficult to see glass particles embedded in the eye. If the situation is such that glass may be involved in the accident, medical attention should be sought immediately. In these circumstances, *do not* attempt to examine or treat the eye.

Specific first aid procedures must be established for eye injuries in contact lens wearers. The first aid station should have a medically approved suction-type contact lens removing device and the first aid provider must be trained in its operation. The following steps must be followed:

- flush injured eye/eyes immediately with water;
- remove contact lenses (if the injured person is unable to remove contact lenses, the first aid provider should remove them, using a medically approved device);
- flush eyes again with water for a minimum of 10 minutes; and
- obtain medical assistance.

Further Reading

Fox, S.L., *Industrial and Occupational Ophthalmology*, Charles C. Thomas, Springfield, USA, 1973.

Lindlth, H. and Anderson, L., 'Contact Lens Wear in an Environment Contaminated with Metal Particles', *Acta Ophthalmologica*, vol. 61, pp 882-88, 1983.

Ng, T.G., Rogers, J.S. and Kelly, M., *Eye Injuries in Adults in New South Wales, II - Injuries Related to Work*, Research Report No. 4, Commonwealth Institute of Health, The University of Sydney, The Royal Australian College of Ophthalmologists, The Australian and New Zealand Society of Occupational Medicine, Sydney, 1983.

Randolph, S.A. and Zavon, M.R., 'Guidelines for Contact Lens Use in Industry', Journal of Occupational Medicine, vol. 3, no. 29, pp. 237-42, March 1987.

Roussell, D.F., *Eye Protection*, The Royal Society for the Prevention of Accidents, publication number IS 126, 1979.

Standards Australia, AS 1067 *Sunglasses and Fashion Spectacles - Non-prescription Types*, Sydney.

- AS 1336 *Recommended Practices for Eye Protection in the Industrial Environment*, Sydney.
- AS 1337 *Eye Protectors for Industrial Applications*, Sydney.
- AS 1338 *Filters for Eye Protectors*, Sydney.

  Part 1 *Filters for Protection Against Radiation Generated in Welding and Allied Operations*, Sydney.

  Part 2 *Filters for Protection Against Ultraviolet Radiation*, Sydney.

  Part 3 *Filters for Protection Against Infrared Radiation*, Sydney.
- AS 1887 *Contact Lenses*, Sydney.

- AS 2211 *Code of Practice for Laser Safety*, Sydney.
- AS 2228 *Spectacle Lenses*, Sydney.
- AS 2397 *Guide to the Safe Use of Lasers in the Construction Industry*, Sydney.