

**File No: PLC/84**

**July 1998**

**NATIONAL INDUSTRIAL CHEMICALS NOTIFICATION  
AND ASSESSMENT SCHEME**

**FULL PUBLIC REPORT**

**M440**

This Assessment has been compiled in accordance with the provisions of the *Industrial Chemicals (Notification and Assessment) Act 1989* (the Act) and Regulations. This legislation is an Act of the Commonwealth of Australia. The National Industrial Chemicals Notification and Assessment Scheme (NICNAS) is administered by the National Occupational Health and Safety Commission which also conducts the occupational health & safety assessment. The assessment of environmental hazard is conducted by the Department of the Environment and the assessment of public health is conducted by the Department of Health and Family Services.

For the purposes of subsection 78(1) of the Act, copies of this full public report may be inspected by the public at the Library, National Occupational Health and Safety Commission, 92-94 Parramatta Road, Camperdown NSW 2050, between the following hours:

Monday – Wednesday	8.30 am - 5.00 pm
Thursday	8.30 am - 8.00 pm
Friday	8.30 am - 5.00 pm

Copies of the full public report may also be requested, free of charge, by contacting the Administration Coordinator.

Please direct enquiries or requests for full public reports to the Administration Coordinator at:

*Street Address:* 92 Parramatta Road, CAMPERDOWN NSW 2050,  
AUSTRALIA

*Postal Address:* GPO Box 58, SYDNEY NSW 2001, AUSTRALIA

*Telephone:* (61) (02) 9577 9514

*Facsimile:* (61) (02) 9577 9465

Director  
Chemicals Notification and Assessment

**FULL PUBLIC REPORT****M440****APPLICANT**

The Valspar (Australia) Corporation Pty Ltd of 203 Power Street GLENDENNING NSW 2761 has submitted a notification statement accompanying their application for assessment of a Synthetic Polymer of Low Concern, M440.

**2. IDENTITY OF THE CHEMICAL**

Claims were made and accepted for the identity of M440 to be exempt from publication in the Full Public Report. The data items were:

- chemical name;
- CAS number;
- molecular and structural formulae;
- molecular weight;
- maximum percentage of low molecular weight species
- spectral data;
- polymer constituents and impurities; and
- residual monomer content.

M440 is considered not to be hazardous based on the nature of the chemical and the data provided.

**Method of Detection  
and Determination:**

data from Infra-red spectrophotometry and gel permeation chromatography analyses have been provided for the notified polymer

### 3. PHYSICAL AND CHEMICAL PROPERTIES

The notified polymer exists mainly as a xylene solution up to 50%. Unless otherwise indicated the physicochemical properties quoted below refer to the solution.

<b>Appearance at 20°C and 101.3 kPa:</b>	clear, viscous pale yellow solution; yellow thick mass or hard film when dry
<b>Boiling Point:</b>	~138-142°C (that of xylene)
<b>Density:</b>	0.972 g/cm <sup>3</sup> (of the resin solution) 1.0 g/cm <sup>3</sup> (of the resin M440; calculated by deduction)
<b>Hydrolysis:</b>	not expected
<b>Water Solubility:</b>	< 1 mg/L at 25°C, see comments below
<b>Particle Size Distribution</b>	the notified polymer solution in the dry state appears as a film and does not form particulate matter
<b>Stability:</b>	stable under normal conditions
<b>Charge density:</b>	not polycationic
<b>Cationic/Anionic potential in pH range 4 to 9:</b>	not expected under normal conditions
<b>Reactive Functional Groups:</b>	functional groups present in the notified polymer are not expected to undergo further reaction under normal conditions

#### Comments on Physico-Chemical Properties

The data provided for the notified polymer satisfies the criteria of Regulation 4A of the Industrial Chemicals (Notification and Assessment) Regulations for the notification category of Synthetic Polymer of Low Concern.

M440 is manufactured in up to a 50% w/w solution in the aromatic hydrocarbon solvent xylene. If allowed to dry (when all xylene evaporates) at room temperature and pressure, M440 will appear as a yellow thick mass or hard film.

The notified polymer is a high molecular weight, alkyd polymer in xylene. The notifier claims that the solvent interferes with the application of the analytical techniques required by OECD Test Method 105 (Determination of Water Solubility) (Organisation for Economic Co Operation and Development (OECD), 1995). Thus, the results of an alternative, simple bench test were submitted. The technique and results appear satisfactory. Calculations determined the water solubility to be 0.3 mg/230 mL ± 1 mg/L.

The notifier claims that due to the nature of its end use, the notified polymer should not hydrolyse, and should not undergo photo or thermal degradation or depolymerisation during use or storage. Whilst the notified polymer does contain a number of ester linkages, hydrolysis in the environmental pH range of 4 to 9 would be precluded by the low water solubility.

#### **4. USE, VOLUME, MANUFACTURE AND FORMULATION**

The notified polymer will be manufactured and formulated into protective and decorative coatings at one particular site in Glendenning, NSW. The polymer will not be distributed in any uncompounded form.

It is estimated that the volume of notified polymer manufactured in Australia in the first year will be approximately 12 tonnes (as solid resin) or less than 30 tonnes as resin solution (in xylene) and depending on market demand may reach 20 tonnes (solid resin) in years 2 to 5.

The notified polymer will be used in-house (at the site of manufacture) to prepare industrial protective and decorative coatings (industrial Fast Dry Enamels).

##### *Manufacture*

The polymer will be manufactured in an enclosed heated reaction vessel fitted with stirring and over-head condenser system. The vessel is also fitted with a vacuum pump and facilities for input of an inert gas blanket. All charging and vent lines associated with the reactor are connected to a vapour extraction system which is discharged to atmosphere through an exhaust vent incinerator. The incinerator controls emissions from the polymerisation process.

Raw materials are added to the reactor vessel in two batches separated by a period of heating. Liquid ingredients enter the reactor from either sealed bulk storage tanks or drums via dedicated closed lines held under negative pressure. Solids are weighed and added through a chute of the reactor from sealed 20 and 25 kg bags and bulker (1 tonne) bags using a hoist, under local exhaust ventilation. The reactor is sealed, heat is applied and then the reactor is allowed to cool to 80°C. A second batch of ingredients is then added to the vessel as described above. The vessel is held at 140°C for two hours.

Once the polymer ingredients are mixed and reacted, the batch (resin) is dropped into a closed thinning tank containing xylene and then drummed off through a filter into 200 L closed head steel drums.

##### *Formulation*

To produce the pigmented surface coating, the resin is added to pigments and grinding media in fixed, open paint pots fitted with automated stirrers. On completion of mixing, the coating product is dispensed into 200 L closed head drums via a tap at the base of the pot. The final coating product, containing up to 35% of the notified polymer, will be packaged in 20 L non-returnable pails or 200 L non-returnable steel drums.

##### *End-use*

It is expected that the product will be used in industrial spraying workshops. General public use is not anticipated. Approximately 95% of the formulated coating will be used to paint

gas cylinders. Examples of other articles that may be coated are engines, electric motors, car boots, electricity fuse boxes and advertising/warning signs. Once dry, between 60 to 90% of the notified polymer will be present in the dry coating, depending on the colour. General public use is not expected.

## **5. OCCUPATIONAL EXPOSURE**

The notified polymer will be manufactured, then formulated into pigmented coatings at the notifier site. The pigmented surface coatings will be sold and transported by road to customers for industrial applications.

During manufacture the number and categories of workers with a potential to be exposed to the notified polymer and pigmented coatings are as follows: batch processing and reaction vessel operators (6 personnel); store attendant/fork lift truck (4 personnel); supervisors (2 personnel); quality control technicians (2 personnel); and drivers (2 personnel). The polymer is produced four times annually, with the production process completed in less than a day.

The notifier indicates that workers involved in manufacture and formulation are required to wear chemical goggles, gloves and overalls. In addition, depending on the stage of production, personal protective equipment may include chrome leather gloves, face shield, dust mask, or air supplied hood.

### *Manufacture*

In the first stage of manufacture the potential for eye, skin and inhalation exposure exists as the vessel operator positions the ingredient bags at the vessel chute opening, prior to release of contents into the reactor. A slight negative pressure will operate at the chute of the vessel, which will draw back any nuisance dust back into the vessel. Local exhaust ventilation is in place.

During the polymerisation reaction, a technician will sample the reactor contents via a sampling valve at the base of the reactor. The sample is collected in a pail, and allowed to cool. Once the sample has solidified it is taken to the laboratory where solvent is added. Analysis occurs under fume extraction.

In the second stage of manufacture, the polymer is added to a thinning tank containing xylene. Workers will manually position drums at the base of the tank for filling into 200L drums. Drum filling takes less than 30 minutes to complete. The potential for skin and inhalation exposure to xylene liquid and vapour exists during this activity. Xylene vapour emission into the workplace is controlled by use of closed mixers and mechanical exhaustion of fumes in the working area to the atmosphere. In addition, xylene is pumped in directly through closed lines.

### *Formulation*

The final stage of the process involves the production of surface coatings from the polymer/xylene mixture. During surface coating production, there is potential for eye, skin and inhalation exposure to the notified polymer and xylene as workers position the drums at the pot and operate the tap. Drum filling takes less than 30 minutes to complete. Mixing and drum filling occurs under local exhaust ventilation.

Storage and transport (truck and forklift drivers) workers will handle sealed drums containing the notified polymer and coating product containing the notified polymer. During these activities worker exposure is unlikely except in the event of a spillage.

#### *End use*

Industrial application (metal coating) by customers: the coating product containing the notified polymer is a fast-drying enamel, which requires either no baking or low-temperature baking. The coating product can be applied either by brush or spray gun application. Skin and inhalation exposure to the notified polymer and xylene may occur during preparation of the coating mixture for spraying, spraying and clean up. To minimise exposure during spray application the notifier recommends that the coating product be applied in spray booths and in any case in accordance with the spray-painting provisions promulgated by the appropriate local state or territory occupational health and safety authority.

No other information or exposure controls operating during industrial application was provided.

## **6. PUBLIC EXPOSURE**

There is negligible potential for public exposure arising from industrial use, waste disposal and transport. The notified polymer will be processed into surface coatings on the same site. The pigmented coating containing the notified polymer is transported by road in steel pails as resin solution or in bags as solid material to customer's premises. In the event of an accidental spill, the notified polymer is to be absorbed by inert material, scraped up and placed into suitable containers for disposal under local disposal regulations.

All charging and vent lines associated with the reactor are connected to a vapour extraction system which is discharged to atmosphere through an exhaust vent incinerator, which will limit contact with the polymer.

The notifier estimates that there will be approximately 23.8 kg of distillate per 2 tonne batch of resin solution (or 0.88 kg per day), most of which will be water (5% organics, 95% water). All distillate from the reaction vessel condenser and other aqueous waste is neutralised, sedimented and treated in an aerobic digester prior to discharge of the treated water phase to the sewer system (0.84 kg per day average or 305 kg per annum). Organic sludge from the water treatment system (0.05 kg per day average or 16.0 kg per annum) will be taken for disposal under EPA consent. The notifier estimates that volatile organic compounds to atmosphere will be 2.03 kg per day (xylene from subsequent processing). Solid waste from mixing and packaging is disposed of in an approved landfill. In industrial spraying shops, there will be solid waste generated due to over-spraying of the metal substrate with the coating. This overspray is normally captured on a layer of an inert absorbent material covering the filters and floor of the spraying stations or booths where it dries up to form a solid inert mass that can be sent to an approved landfill site. The quantity of the notified polymer which is lost in overspray is 6.5 kg per day (2.4 tonnes per year) based on a 12 tonne per year usage.

Most of the notified polymer will enter the public domain as a finished coating on products

such as gas cylinders. Little public contact with gas cylinders is expected and in any case the notified polymer will be in the form of an unreactive coating which would not be bioavailable.

## 7. ENVIRONMENTAL EXPOSURE

### Release

During polymer manufacture, all distillate (23.8 L kg per 2 tonne batch) from the reaction vessel condenser and other aqueous wastes are neutralised, sedimented and treated in an aerobic digester prior to discharge of the treated water phase to the sewer system (under licence). Organic sludge from the water treatment system will be disposed of at the Lidcombe Waste Plant, also under licence. Gases from the reflux condenser and vapours from the vacuum pump are drawn into an in-line incinerator. The 200 L drums are rinsed and transported to a local drum recycler.

Waste resin produced during the coating mixing and packing process will become a dry inert solid waste at the time of disposal. The notifier claims that the quantity of solid waste from the process will mainly consist of rags which have been used to clean equipment and wipe up resin or coating spills. Solid waste will be disposed of in the solid waste system and goes to an approved landfill.

The coating products will be applied at industrial spraying workshops. Any overspray generated will be captured by filters and on a layer of absorbent material covering the floor of the spraying station or booth. The coating is expected to dry to form a solid inert mass that will be sent to an approved landfill site. Spent filters are also expected to be disposed of to landfill. Residues of coating product in empty containers are likely to be washed out with thinners and used. The notifier claims that these containers are then usually used as rubbish bins around the factory. *Environment Australia* expects that they will eventually be recycled or disposed of to landfill.

### Fate

Polymer sent to the in-line incinerator is expected to be completely combusted, forming water vapour and oxides of carbon. Aqueous wastes are neutralised and treated in an aerobic digester on site. Due to its low water solubility, the polymer is likely to be removed during this process, and disposed of to an approved industrial waste plant. Any remaining polymer in the liquid waste will be sent to sewer. Should dry polymer be sent to landfill leaching is not expected because the polymer has low water solubility.

Waste polymer coating from the product formulation and application processes will dry to an inert product. If such products are consigned to landfill, the polymer is expected to persist, but remain immobile in the cured product. Any chips and flakes of the coating that occur (due to stone chips, accidents, wear and tear, etc.) will be inert, diffuse and form part of the soil or sediments.

The notifier claims that as the notified polymer is an acrylic-alkyd resin, normally in combination with other materials to “form a coating resistant to weather and environmental conditions, biodegradation will be an extremely slow process, persisting in the environment

for a long time". Bioaccumulation of the polymer is unlikely due to the high molecular weight of the polymer, even before curing (Connell, 1989).

## **8. EVALUATION OF TOXICOLOGICAL DATA**

No toxicology data were provided. None are specifically requested for a Synthetic Polymer of Low Concern.

## **9. ASSESSMENT OF ENVIRONMENTAL EFFECTS**

No ecotoxicology data were provided. None are specifically requested for a Synthetic Polymer of Low Concern.

## **10. ASSESSMENT OF ENVIRONMENTAL HAZARD**

The notifier estimates that during polymer manufacture the amount of waste distillate (containing 5% organics and 95% water) produced, based on maximum manufacturing rates, will be 23.8 kg per 2 tonne batch (or 0.88 kg per day). These and other aqueous wastes are treated on site in an aerobic digester prior to discharge to the sewer. Approximately 0.05 kg of solid polymer per day will be directly disposed of to landfill, and should remain immobile.

The majority of the notified polymer is not expected to be released to the environment until it has been cured into a solid polymer matrix. Waste generated during mixing and packing should not average more than 0.33 kg per day (120 kg per annum at maximum manufacturing rates). Overspray and other wastes generated during application are estimated by the notifier at 20% (highly efficient guns having an overspray of 15%, less efficient 25%). Therefore, the quantity of polymer lost in overspray is 2.4 tonnes per year, or 6.5 kg per day. Disposal of the notified polymer to landfill either as an inert solid or cured paint is unlikely to present a hazard to the environment, as it will be in a solid matrix that is not expected to biodegrade or leach.

The main environmental hazard would arise through spillage in transport accidents that may release small quantities of the polymer to drains and waterways. However, the polymer should quickly become immobile on association with the soil/sediment layer.

The low environmental exposure of the polymer as a result of the proposed use indicates the overall environmental hazard should be low.

## **11. ASSESSMENT OF PUBLIC AND OCCUPATIONAL HEALTH AND SAFETY EFFECTS**

The notified polymer is not water soluble and since it has a number average molecular weight



greater than 1 000, it is unlikely to readily cross biological membranes. The percentage of low molecular weight species below 1 000 is low. The notified polymer does not contain any reactive functional groups so toxicity from this source is unlikely. Some of the constituent monomers of the notified polymer are classified as hazardous on the National Occupational Health and Safety Commission (NOHSC) *List of Designated Hazardous Substances* (National Occupational Health and Safety Commission, 1994a). Manufacturers of the notified polymer using these constituent monomers will need to adopt workplace controls as given in the NOHSC *Model Regulations for the Control of Workplace Hazardous Substances* (National Occupational Health and Safety Commission, 1994b). In the polymer, however, the residual monomer content for each of the constituents is stated to be below 0.1%. Certain constituent monomers have national exposure standards, identified in NOHSC *Exposure Standards for Atmospheric Contaminants in the Occupational Environment* (National Occupational Health and Safety Commission, 1995). Employers are responsible for ensuring that the exposure standards are not exceeded in the workplace.

The notifier states that no adverse health effects have been reported in the production of similar polymers at the site. On the information provided, the notified polymer is not considered hazardous and is unlikely to pose a health risk to workers.

The main health risk associated with the handling and use of the notified polymer solution is related to the solvent, xylene, present (at least) at 30%. The health hazard classification applicable to xylene is: harmful by inhalation and in contact with skin (R20/21) at and above 25% and irritating to skin (R38) at and above 20% (National Occupational Health and Safety Commission, 1994a).

The notified polymer will be manufactured and formulated in Australia. The duration and frequency of the production run is one day, every three months. Ingredients are added via open pouring (solids) or closed lines (liquid). The production of the notified polymer will occur in closed vessels and lines held under negative pressure. This will serve to control the potential for worker exposure.

During production of the polymer, xylene and the notified polymer are held and transferred in an enclosed system. However, during drum filling and coating formulation, skin, eye and inhalation exposure to the notified polymer and xylene could occur. These activities are carried out under local exhaust ventilation. In addition to engineering controls, the wearing of recommended protective clothing, gloves, goggles and appropriate respiratory protection (see Section 12) by workers involved in polymer production and coating formulation should control the potential for eye, skin and inhalation exposure and consequently any adverse health effects, to solvent and raw ingredients.

The occupational health risk posed to laboratory staff is minimal, given that typical sampling procedures from closed systems should not result in substantial exposure, and analysis occurs under fume extraction. The occupational health risk posed to storage and transport workers is negligible, given that exposure is not expected to occur except in the event of a spill.

The notifier indicates that a health surveillance program is operative at the site. The program consists of a pre-employment medical examination and biological monitoring for specific substances during employment. Information gained from the health surveillance program will serve to reduce risk or prevent further exposure and progression of any adverse health effect from hazardous substance exposure.

During end use of the notified polymer during spraying of the coating product, there is potential for skin, eye and inhalation exposure to the notified polymer and xylene. To minimise the occupational health risk the notifier recommends that spray-painting occur within spray booths. Spray painting should be in accordance with the spray-painting provisions promulgated by the appropriate state or territory occupational health and safety authority.

In accordance with the *Australian Code for the Transport of Dangerous Goods by Road and Rail* (Federal Office of Road Safety, 1998), both the notified polymer in xylene and coating product containing the notified polymer are classified as Dangerous Goods (Class 3) because of the xylene content. Therefore, appropriate precautions should be taken during transport, storage and handling. These are outlined in the notifier's MSDS.

The notified polymer is incorporated with xylene, which has a NOHSC exposure standard of 80 ppm TWA, 150 ppm STEL (National Occupational Health and Safety Commission, 1995). The employer is responsible for ensuring that the exposure standard for xylene is not exceeded.

In addition, xylene in either the vapour or liquid form is readily absorbed via the dermal and inhalation routes. Consequently, biological monitoring for xylene should be considered to ensure that overexposure does not take place. Although NOHSC has not established biological monitoring reference values, Regulation 14(1)(c) of the NOHSC *Model Regulations for the Control of Workplace Hazardous Substances* (National Occupational Health and Safety Commission, 1994b) provides for biological monitoring. In the absence of national values, consideration can be given to the Biological Exposure Index (BEI) for xylene adopted by the American Conference of Governmental Industrial Hygienists (American Conference of Governmental Industrial Hygienists, 1997), as a guidance value in the interpretation of biological monitoring results. This is 100 mg/L in urine, end of shift, for xylene

There is negligible potential for public exposure to the notified polymer arising from use in industrial protective and decorative coatings. There may be widespread public contact with the notified polymer on the painted surfaces of treated products, but its adhesion to the substrate and physico-chemical properties will be sufficient to preclude absorption across the skin or other biological membranes.

## 12. RECOMMENDATIONS

To minimise occupational exposure to the monomers of the notified polymer and xylene the following guidelines and precautions should be observed:

- Respirators should be selected and fitted in accordance with Australia/New Zealand Standard 1715-1994: *Use and Maintenance and Respiratory Protective Devices* (Standards Australia/Standards New Zealand, 1994a) and Australian/New Zealand Standard 1716-1991 *Respiratory Protective Devices* (Standards Australia/Standards New Zealand, 1994b);

- Safety goggles should be selected and fitted in accordance with Australian Standard (AS) 1336 (Standards Australia, 1994) to comply with Australian/New Zealand Standard (AS/NZS) 1337 (Standards Australia/Standards New Zealand, 1992);
- Industrial clothing should conform to the specifications detailed in AS 2919 (Standards Australia, 1987) and AS 3765.1 (Standards Australia, 1990);
- Impermeable gloves or mittens should conform to AS 2161.2 (Standards Australia, 1998);
- All occupational footwear should conform to AS/NZS 2210 (Standards Australia/Standards New Zealand, 1994c);
- Spillage of the notified chemical should be avoided. Spillages should be cleaned up promptly with absorbents which should then be put into containers for disposal;
- Good personal hygiene should be practised to minimise the potential for ingestion;
- A copy of the MSDS should be easily accessible to employees.

During manufacture of the notified polymer, the NOHSC exposure standards (National Occupational Health and Safety Commission, 1995) and NOHSC workplace guidance (National Occupational Health and Safety Commission, 1994b) for the relevant monomer ingredients should be adopted. During subsequent handling of the notified polymer/xylene mixture, the NOHSC exposure standard for xylene (80 ppm TWA, 150 ppm STEL) should be adhered to in the workplace. Biological monitoring exposure for xylene against ACGIH criteria should be considered.

The assessment has been based on the assumption that residual monomer levels in the polymer are low. However, six of the monomers are listed on the NOHSC *List of Designated Hazardous Substances* (National Occupational Health and Safety Commission, 1994a). Therefore, this report recommends that the notifier provides the Director with a summary of the results of residual monomer analyses within six months of commencement of production of the notified polymer.

### **13. MATERIAL SAFETY DATA SHEET**

The MSDS for the notified polymer in xylene was provided in accordance with the NOHSC *Code of Practice for the Preparation of Material Safety Data Sheets* (National Occupational Health and Safety Commission, 1994b).

This MSDS was provided by the applicant as part of the notification statement. It is reproduced here as a matter of public record. The accuracy of this information remains the responsibility of the applicant.

## 14. REQUIREMENTS FOR SECONDARY NOTIFICATION

Under the Act, secondary notification of the notified chemical shall be required if any of the circumstances stipulated under subsection 64(2) of the Act arise. No other specific conditions are prescribed.

## 15. REFERENCES

American Conference of Governmental Industrial Hygienists (1997) 1997 TLV's and BEI's: Threshold Limit Values and Physical Agents; Biological Exposure Indices. Cincinnati, American Conference of Governmental Industrial Hygienists (ACGIH).

Connell DW (1989) General characteristics of organic compounds which exhibit bioaccumulation. In: D. W. Connell ed. Bioaccumulation of Xenobiotic Compounds. CRC Press, Boca Raton, USA.

Federal Office of Road Safety (1998) Australian Code for the Transport of Dangerous Goods by Road and Rail. Canberra, Australian Government Publishing Service.

National Occupational Health and Safety Commission (1994a) List of Designated Hazardous Substances [NOHSC:10005(1994)]. Canberra, Australian Government Publishing Service.

National Occupational Health and Safety Commission (1994b) National Code of Practice for the Preparation of Material Safety Data Sheets [NOHSC:2011(1994)]. Canberra, Australian Government Publishing Service.

National Occupational Health and Safety Commission (1994c) National Model Regulations for the Control of Workplace Hazardous Substances [NOHSC:1005(1994)]. Canberra, Australian Government Publishing Service.

National Occupational Health and Safety Commission (1995) Adopted National Exposure Standards for Atmospheric Contaminants in the Occupational Environment, [NOHSC:1003(1995)]. In: ed. Exposure Standards for Atmospheric Contaminants in the Occupational Environment: Guidance Note and National Exposure Standards. Australian Government Publishing Service, Canberra, .

Organisation for Economic Co Operation and Development (OECD) (1995) OECD Test Method 105 Determination of Water Solubility. Paris, OECD.

Standards Australia (1987) AS 2919-1987, Australian Standard Industrial Clothing. Sydney, Standards Australia.

Standards Australia (1990) AS 3765.1-1990, Australian Standard Clothing for Protection against Hazardous Chemicals Part 1 Protection Against General or Specific Chemicals. Sydney, Standards Australia.

Standards Australia (1994) AS 1336-1994, Australian Standard Eye protection in the Industrial Environment. Sydney, Standards Australia.

Standards Australia (1998) AS/NZS 2161.2:1998, Australian/New Zealand Standard Occupational Protective Gloves Part 2: General Requirements. Sydney/Wellington, Standards Australia and Standards New Zealand.

Standards Australia/Standards New Zealand (1992) AS/NZS 1337-1992, Australian/New Zealand Standard Eye Protectors for Industrial Applications. Sydney/Wellington, Standards Australia and Standards New Zealand.

Standards Australia/Standards New Zealand (1994a) AS/NZS 1715-1994, Australian/New Zealand Standard Selection, Use and Maintenance of Respiratory Protective Devices. Sydney/Wellington, Standards Australia and Standards New Zealand.

Standards Australia/Standards New Zealand (1994b) AS/NZS 1716-1994, Australian/New Zealand Standard Respiratory Protective Devices. Sydney/Wellington, Standards Australia and Standards New Zealand.

Standards Australia/Standards New Zealand (1994c) AS/NZS 2210-1994, Australian/New Zealand Standard Occupational Protective Footwear. Sydney/Wellington, Standards Australia and Standards New Zealand.