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NATIONAL INDUSTRIAL CHEMICALS NOTIFICATION AND ASSESSMENT SCHEME

FULL PUBLIC REPORT

2-methyl-1,3-propanediol

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 Worksafe Australia which also conducts the occupational health & safety assessment. The assessment of environmental hazard is conducted by the Department of the Environment, Sport, and Territories and the assessment of public health is conducted by the Department of Health and Family Services.

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Director
Chemicals Notification and Assessment

FULL PUBLIC REPORT

2-methyl-1,3-propanediol

1. APPLICANT

Chemical Australia Pty Ltd of Suite 1 Level 3 845 Pacific Highway CHATSWOOD NSW 2067 has submitted a limited notification statement with their application for an assessment certificate for 2-methyl-1,3-propanediol.
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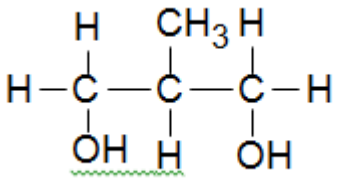
2. IDENTITY OF THE CHEMICAL

2-methyl-1,3-propanediol is not considered to be hazardous based on the nature of the chemical and the data provided. Therefore details of the polymer composition and details of exact import volume and customers have been exempted from publication in the Full Public Report and the Summary Report.

Chemical Name:	2-methyl-1,3-propanediol
Chemical Abstracts Service (CAS) Registry No.:	2163-42-0
Other Names:	1,3-propanediol, 2-methyl β-hydroxyisobutanol
Trade Name:	MPDiol® Glycol Arcol® Polyol DP 1022
Molecular Formula:	$C_4H_{10}O_2$

Structural Formula:



Molecular Weight:	90
Method of Detection and Determination:	ultraviolet/visible (UV/Vis), infrared (IR) and nuclear magnetic resonance (NMR)

Spectral Data:	UV/Vis, a maximum peak was only recorded under acidic conditions, at 209 nm IR major characteristic peaks were 1 035.8, 1 465.6, 2 926.8, 3 333.8 cm^{-1}, other minor characteristic peaks were observed. NMR, peaks corresponding to the structure of 2-methyl-1,3-propanediol

3. PHYSICAL AND CHEMICAL PROPERTIES

Appearance at 20°C and 101.3 kPa:	clear liquid
Freezing Point:	none to 219 K (OECD 102 / EEC A1(1))
Boiling Point:	485 ± 0.5 K (212 °C) (OECD 103 / EEC A2(1))
Density:	D^{20}_4 = 1.01 at 20°C (pycnometer)
Vapour Pressure:	2.8 ± 0.2 Pa (static technique)at 25°C
Water Solubility:	> 100 000 mg/L (visual observation)
Partition Co-efficient (n-octanol/water):	log P_{ow} = -0.6 (flask shaking method)
Hydrolysis as a Function of pH:	not determined
Adsorption/Desorption:	not determined
Dissociation Constant:	not determined (no active hydrogens)
Surface Tension:	72.2 mN/M at 0.996 g/L (rising tensiometer)
Fat Solubility:	940 mg/100 g at 37°C. (OECD 116 / EEC A7(1))
Flash Point:	127 °C (closed cup, Pensky Martens)
Flammability Limits:	not readily flammable
Autoignition Temperature:	380°C
Explosive Properties:	not considered explosive based on structure
Reactivity/Stability:	considered stable under normal conditions

Comments on Physico-Chemical Properties

No full test for water solubility was performed. The chemical was mixed with double distilled water at a ratio of 1:1, 3:1 and 1:3, and in all instances was fully miscible.

There are no hydrolysable groups on the compound, and it would therefore not be expected to hydrolyse under normal environmental conditions.

Adsorption/desorption tests were not performed, but the high water solubility and low partition coefficient suggest the chemical will not readily adsorb to soils or sediment. The chemical is not considered to be surface active.

4. PURITY OF THE CHEMICAL

Degree of purity: high

Toxic or hazardous impurities: present at levels below that requiring a hazardous classification (2)

Non-hazardous impurities (> 1% by weight):

Chemical Name	*CAS No.*	*Weight % typical/lower/upper*
2-methyl-1,3-pentanediol	149-31-5	0.48 (0.10-1.50)
* confidential		

*No reference to hazardous effects was available for the above chemicals in any of the readily available toxicity databases (2,3,4).

Additives/adjuvants: none

5. USE, VOLUME AND FORMULATION

The notified substance will not be manufactured in Australia. It will be supplied in bulk containers.

Projected import volumes are > 10 tonnes/annum for the next five years. The chemical will be used as a monomer in the production of polyester resins for gel coats and coatings, polymer modifiers and/or additives, synthetic lubricants, corrosion inhibitors and other ester products.

6. OCCUPATIONAL EXPOSURE

2-Methyl-1,3-propanediol will not be manufactured in Australia but will be imported in bulk containers. These will be transported by road direct to the notifier's customers for incorporation into the end-use polymer. Occupational exposure is unlikely during warehousing and transport as the bulk containers will only be unsealed prior to use for the formulation of the end-use polymer. Occupational exposure will only occur if the bulk containers leak or are breached. This is only likely to occur in the event of an accident.

The notified monomer is pumped from the bulk shipping container direct to the reaction vessel. Other components used in formulating the end-use polymer are added via a chute. The process is completed at elevated temperatures and the resultant product is transferred in a closed system to storage tanks. After the reaction, the chemical will form part of a polymer with a high molecular weight and will be immobilised in this polymer after final application and will not pose an occupational risk.

There is potential for exposure to the notified monomer during the formulation to the end-use polymer. The notifier indicates that dusts and vapours are minimised due to negative pressure that draws them back into the reactor. In addition all charge and vent lines associated with the reactor are connected to a vapour extraction system which is discharged to the atmosphere through an exhaust vent incinerator. Occupational exposure to the notified monomer can also occur during connection/disconnection of the pump lines. The staff who will be potentially exposed are the reactor operator, who will load and sample the reactor, and the quality control technicians who will test the process and product. As the notified chemical is a liquid and the vapour pressure is low the likely exposure route will be dermal. The molecular weight would not preclude dermal absorption. Eye and inhalational exposure could occur through inadvertent exposure; for instance if the notified chemical is splashed or forms a mist as may occur if there was a leak in a pressurised line.

The notified monomer will replace monomers currently used for the production of polymers such as resin used to manufacture polyester. In this instance other hazardous ingredients may be used such as 2,5-furandione (CAS# 108-31-6), the personnel protective equipment and engineering controls required to minimise exposure to the hazardous ingredients will also reduce exposure to the notified monomer when used in these processes.

7. PUBLIC EXPOSURE

The notified polymer will be imported and incorporated into polyester resins for use in a range of products. The synthesised polymer will have a number-average molecular weight (NAMW) greater than 1 000, and the notified chemical will be stabilised in the polymer matrix when cured. As such contact with products coated with the polymer will result in negligible public exposure.

Minor public exposure may result from disposal of unused chemical or polymer, or accidental spillage of the notified chemical during reformulation, transport and storage. However, adequate measures are described by the notifier to minimise the risk of public exposure during disposal, or in the event of accidental spillage.

8. ENVIRONMENTAL EXPOSURE

Release

The notified chemical is imported in bulk containers where it is transported by road to customer sites for incorporation into the end-use polymer.

Manufacturing end-use polymers takes place in closed systems. Typically, the notified chemical is pumped from the bulk storage tank to the reactor through closed lines. Solid ingredients used in the polymer production are added through a hatch or chute to the reactor. The reactor is sealed and heat applied. The reaction proceeds with evolution of water vapour as the condensation by-product, which is collected at the base of the condenser.

All vapours from the reaction vessel will be passed to the inline incinerator. All gases and vapours from the water treatment system are also drawn into the incinerator, which is a thermal oxidising unit. Gas emissions are typically oxides of carbon and nitrogen.

After the completion of the reaction and cooling of the resin, the final resin is pumped directly from the solvent storage tank through closed lines. The resulting resin solution is then pumped into a storage tank from where it will be transferred through closed lines to produce industrial enamels and composites as required.

Through this process, there is little opportunity for exposure of the notified product. After the reaction, the chemical will form part of a polymer with a typical average molecular weight of 5 000 - 10 000. It will be immobilised in this polymer after final application.

The condensed water by-product is separated and sent through a biotreatment tank. Treated water is discharged to sewer, and sludge is incinerated and disposed of to landfill. The notifier has estimated 4 000 kgs of water will be released to the sewer, and 200 kg of solids will be disposed of to landfill for every 10 tonnes of the notified chemical used. The notified chemical is highly soluble in water, and it is likely that it will be contained in water condensed through the reaction process.

The notifier claims the polyester will contain less than 0.1% of the notified chemical as an impurity

Fate

A wide range of uses were reported in the submission. The most likely application is the use in producing polyester resins for gel coats and coatings. In this instance, the majority of the imported chemical will share the fate of the polyesters and be immobilised through the application of and curing as paints and coatings. Any paint lost through chipping or flaking will be inert and form part of the sediments. Paint lost through the application process is likely to be collected through scrubbing systems and end up as landfill.

No details have been provided on the extent of other uses. If used as polymer modifiers, additives or other ester products, the chemical is still likely to be incorporated into high molecular weight polymers where it remain immobilised.

In the example provided by the notifier, 0.1% of the imported chemical is expected to remain in the polyester resin as unreacted monomers. This would be expected to still be immobilised through application. Because water is a by-product of the reaction a further amount of the chemical is likely to remain in monomer form and will be released to sewer.

Following the modified Sturm test, over 50% of the notified chemical was degraded after 28 days at 10 mg/L but only 6% at 20 mg/L. No clear explanation could be provided for the greatly reduced degradation at the higher concentration. During inhibition testing, using 20 mg/L substantial degradation of the monomer was observed (63%). The monomer is not considered readily biodegradable under the Sturm test. ASTER calculates a half-life for this chemical of between 2 and 16 days (5). Further testing showed the chemical does not inhibit bacteria.

The substance has a high water solubility. This together with a log P_{ow} = -0.6 indicate that the potential for bioaccumulation is low.

9. EVALUATION OF TOXICOLOGICAL DATA

9.1 Acute Toxicity

Summary of the acute toxicity of 2-methyl-1,3-propanediol

Test	*Species*	*Outcome*	*Reference*
acute oral toxicity	rat	LD_{50} > 5 000 mg/kg	6
acute dermal toxicity	rabbit	LD_{50} > 2 000 mg/kg	7
skin irritation	rabbit	not a skin irritant	9
eye irritation	rabbit	not an eye irritant	11
skin sensitisation	guinea pig	not a skin sensitiser	12

9.1.1 Oral Toxicity (6)

Species/strain:	Wistar rat
Number/sex of animals, m/f:	5/5
Observation period:	14 days
Method of administration:	orally by syringe
Clinical observations:	diarrhoea and chromorhinorrhea noted in three animals
Mortality:	none
Morphological findings:	no change in body weight compared to controls, one male animal at necropsy had pink fluid in the urinary bladder
Test method:	similar to OECD Guidelines for Testing Chemicals (1)
LD_{50}:	> 5 000 mg/kg
Result:	low oral toxicity

9.1.2 Dermal Toxicity (7)

Species/strain:	New Zealand white rabbit
Number/sex of animals, m/f:	5/5
Observation period:	14 days
Method of administration:	semi-occlusive for 24 hours
Clinical observations:	slight erythema in 2 animals on day 1; diarrhoea (4 males), yellow nasal discharge (1 male), few faeces (2 male, 1 female), bloated abdomen and soiling of the anogenital area; decedant has abnormal lungs, pleural cavity, liver and gastrointestinal tract
Mortality:	1 on day 12 with no previously observed effect (not considered treatment related)
Morphological findings:	abnormalities of the kidneys and gastrointestinal tract were noted in 5/9 animals at necropsy, 1 animal exhibited a tissue mass and haemorrhagic areas on the dorsal abdominal cavity; 2 animals lost weight during study
Draize scores (8):	not stated, nil to slight dermal reaction evident on day 1 in 2 rabbits, absent on day 7
Test method:	similar to OECD Guidelines for Testing Chemicals (1)
Result:	evidence of systemic toxicity indicating dermal absorption, however the LD_{50} was > 2 000 mg/kg and therefore considered to have low dermal toxicity

9.1.4 Skin Irritation (9)

Species/strain:	New Zealand white rabbit
Number of animals:	6
Observation period:	72 hours
Method of administration:	semi-occlusive 0.5 ml for 24 hours at each site, total dose/animal 2.0 ml; 4 sites/animal 2 abraded and 2 intact
Draize scores (8): [a] see Attachment 1 for Draize scales	0
Test method:	similar to OECD Guidelines for Testing Chemicals (1), note method of administration
Result:	not a skin irritant according to Worksafe Australia's *Approved Criteria for Classifying Hazardous Substances* (10)

9.1.5 Eye Irritation (11)

Species/strain:	New Zealand white rabbit
Number/sex of animals:	6
Observation period:	72 hours
Method of administration:	0.1 ml in conjunctival sac of one eye
Draize scores (8) of eyes: [1] see Attachment 1 for Draize scales	0
Test method:	similar to OECD Guidelines for Testing Chemicals (1)
Result:	not an eye irritant according to Worksafe Australia's *Approved Criteria for Classifying Hazardous Substances* (10)

9.1.6 Skin Sensitisation (12)

Species/strain:	Himalayan guinea pig
Number of animals:	20 in test group, 10 in negative control
Induction procedure:	Intradermal injections of: 0.1 ml of 10% test material in physiological saline, 50:50 FCA

	and distilled water and 20% test material emulsified in FCA; day 6 treated with 10% sodium-dodecyl-sulfate in petrolatum; day 7 0.5 ml of 100% test material as epidermal application for 48 hours (on patch) over injection sites
Challenge procedure:	14 days after epidermal application test material in distilled water at 0, 25, 50 and 100%

	Test animals		***Control animals***	
Challenge concentration	***24 hrs****	***48 hrs****	***24 hrs***	***48 hrs***
0%	0**	0	0	0
25%	1	1	0	0
50%	1	3	0	0
100%	0	1	0	0

* time after patch removal
** number of animals exhibiting positive response

Test method:	according to OECD Guidelines for Testing Chemicals (1)
Result:	mild sensitisation potential, however not classified as hazardous on the basis of sensitisation potential according to Worksafe Australia's *Approved Criteria for Classifying Hazardous Substances* (10); this criteria requires 30% whereas in this study only 15% positive

9.2.1 Repeated Dose Toxicity 14 days, (13)

Species/strain:	Wistar rat
Number/sex of animals:	5/5 per dose
Method of administration:	oral gavage
Dose/Study duration::	0, 300, 600, 1 000 mg/kg/day, 7 days/week for 14 days
Clinical observations:	no treatment related effects
Clinical	none

chemistry/Haematology	
Histopathology:	no treatment related effects
Test method:	according to OECD Guidelines for Testing Chemicals (1)
Result:	no treatment related effects at maximum dose rate of 1 000 mg/kg/day

9.2.2 Repeated Dose Toxicity 90 days, (14)

Species/strain:	Wistar rat
Number/sex of animals, m/f:	10/10 per dose
Method of administration:	oral gavage
Dose/Study duration::	0, 300, 600, 1 000 mg/kg/day, 7 days/week for 90 days
Clinical observations:	no treatment related effects
Clinical chemistry/Haematology	small increase in partial thromboplastin time was noted in high dose females; 10-14% decrease in ALT and AST in high dose males; decrease in inorganic phosphate in high dose males and females
Histopathology:	no treatment related effects
Test method:	according to OECD Guidelines for Testing Chemicals (1)
Result:	NOEL was 600 mg/kg/day

9.3 Genotoxicity

9.3.1 *Salmonella typhimurium* Reverse Mutation Assay (15)

Strains:	*S. typhimurium* TA 98, TA 100, TA 1535, TA 1537
Concentration range:	100-5 000 μg/ plate with or without rat liver S9
Test method:	according to OECD Guidelines for Testing Chemicals (1)
Result:	not mutagenic under test conditions

9.3.2 Chromosome Aberration Test in V79 Chinese hamster cells *In Vitro* (16)

Doses:	333-5 000 μg/plate with and without metabolic activation, positive controls ethylmethane-sulphonate (6 mM) and dimethylnitrosamine (8 mM)
Test method:	in accordance with OECD Guidelines for Testing Chemicals (1)
Result:	negative result, no significant dose related increase in the mutant frequency at the HPRT-locus; controls gave appropriate response (8-10 increase in frequency)

9.3.2 Chromosome Aberration Test in Human Lymphocytes *In Vitro* (16)

Doses:	333-5 000 μg/plate with rat liver S9 and 10-5 000 without rat liver S9
Method of administration:	test article vehicle was F10 medium buffered with 20 mM HEPES and added to lymphocyte cultures; control using F10 medium buffered with 20 mM HEPES and positive controls; mitomycin C and cyclophosphamide exposure period with metabolic activation, 3 hours; without 24 and 48 hours
Test method:	in accordance with OECD Guidelines for Testing Chemicals (1)
Result:	non clastogenic; controls gave appropriate response

9.4 Overall Assessment of Toxicological Data

The notified chemical has a low oral toxicity to rats with an LD_{50} of > 5 000 mg/kg. Although the dermal toxicity to rats is also classified as low with an LD_{50} of > 2 000 mg/kg, there were a range of systemic effects indicating transmission of the notified chemical across the skin. The low molecular weight (< 500 daltons) would not preclude this mode of transmission however the low fat solubility and log P_{ow} are not favourable for dermal absorption or bioaccumulation. The effects included diarrhoea in 3 animals and abnormalities of the kidneys and gastrointestinal tract in 5 of 9 animals at post mortem. In addition one of the animals had a tissue mass and haemorrhagic areas in the dorsal abdominal cavity, one animal died at day 12 (death not considered treatment related) and erythema was present in 2 animals 24 hours after the application of the notified chemical.

The notified chemical was not a skin or eye irritant in rabbits. In a skin sensitisation tests using guinea pigs 15% of the test animals had positive responses at challenge concentrations of 50% of the notified chemical. This was below the 30% threshold for classification of the chemical as hazardous according to Worksafe Australia's *Approved Criteria for Classifying Hazardous Substances* (10).

The results of two repeat dose toxicity studies in rats were submitted, with a duration of 14 and 90 days. In both studies the rats were dosed daily at rates up to 1 000 mg/kg/day. There were no treatment related effects in the 14 day study. In the 90 day study there were treatment related effects at the highest dose rate. These included a small increase in partial thromboplastin time in high dose females; 10-14% decrease in ALT and AST in high dose males and a decrease in inorganic phosphate in high dose males and females. The NOEL was determined to be 600 mg/kg/day.

In the genotoxicity studies all results were negative. The studies were:
A *Salmonella typhimurium* reverse mutation assay, with and without S9 activation at doses up to 5 000 μg/plate; a chromosome aberration test in V79 Chinese hamster cells *in vitro*, with and without S9 activation at doses up to 5000 μg/plate; a chromosome aberration test in human lymphocytes i*n vitro.*

10. ASSESSMENT OF ENVIRONMENTAL EFFECTS

Test	***Species/system***	***Results***
96 h acute toxicity	Carp (*Cyprinus carpio*)	LC_{50} > 1 000
		NOEC > 1 000
72h algal growth inhibition	*Scenedesmus subspicatus*	E_bC_{50} > 1 000
		E_rC_{50} > 1 000
0.5 h. microbe inhibition	waste water bacteria	IC_{50} > 100
48 h acute toxicity	*Daphnia magna*	EC_{50} > 1 000

* NOEC - no observable effect concentration
All tests were carried out according to OECD guidelines.

Mean measured concentrations during the test on Carp were between 86 to 104% of the nominal concentration. Gas chromatography was used to determine the measured concentration. Only one concentration of 1000 mg/L was tested.

During the testing on Daphnia, the actual concentration remained constant and was in agreement with the nominal concentration. As no effects were found at the acute aquatic tests, and because of the low log Pow of the chemical, no long term effects or accumulation were anticipated by the notifier. As such, no chronic test was performed. It should be noted, that a 21 day chronic test for *Daphnia magna* has been requested by UK authorities when the volume level into the EU reaches 100 tonnes per year.

11. ASSESSMENT OF ENVIRONMENTAL HAZARD

The main environmental hazard could be expected to arise through unreacted monomer units. The notified chemical is water soluble, and it is likely that significant amounts of unreacted monomer will be incorporated into water produced during reaction, released as steam, than remain in the resin.

For a worst case situation, we will assume that, due to the high water solubility, 10% of the unreacted monomer partitions with water produced through the polymerisation reaction. The company has provided figures of 4 000 L of water produced for every 10 tonnes of monomer used. For 10 tonnes of monomer, with 10% being unreacted, 1 000 kg would be expected to be released as unreacted monomeric units.

The predicted environmental concentration (PEC) in a city sewage treatment plant is 3.3 ppm. This assumes 10% of the imported monomer is released to the sewer. Even before dilution in receiving waters, the PEC is several orders of magnitude below the worst environmental concentration of > 1 000 ppm. The aquatic hazard can be described as negligible.

The Material Safety Data Sheet (MSDS) contains instructions adequate for rinsing of receptacles before re-use or disposal, and in the event of accidental spillage.

12. ASSESSMENT OF PUBLIC AND OCCUPATIONAL HEALTH AND SAFETY EFFECTS

The toxicological profile of the notified monomer indicates that although it is not classifiable as hazardous according to Worksafe Australia's *Approved Criteria for Classifying Hazardous Substances* (10), there are a number of effects that should be noted. The notified chemical has a low acute oral toxicity in rats this was also demonstrated in a longer term (90 day) study. The acute dermal toxicity is also low in rabbits (LD_{50} > 2 000 mg/kg) however there were a range of systemic effects indicating transmission of the notified chemical across the skin in the dermal study. The low molecular weight (< 500 daltons) would not preclude this mode of transmission however the log P_{ow} is not favourable for dermal absorption and accumulation. In the dermal study the effects included diarrhoea in animals and abnormalities of the kidneys and gastrointestinal tract, mild erythema was also noted in a minority of the test animals.

Although the notified chemical was not a skin or eye irritant in rabbits, it was a slight skin sensitiser in guinea pigs however the effect was below the threshold for classification of the chemical as hazardous according to Worksafe Australia's *Approved Criteria for Classifying Hazardous Substances* (10).

The results of the above studies indicate that although the notified chemical is not classifiable as hazardous it would be appropriate to minimise the potential for

dermal contact through occupational exposure. Occupational exposure is only likely to occur during formulation of end-use polymers. Exposure during transport and warehousing will only occur in the event of an accident. The notified monomer will replace existing monomers in the production of a range of polymers including polyester resins. The systems employed to formulate these polymers are usually closed and appropriate ventilation is employed in areas where occupational exposure is possible. The personnel most likely to come into contact with the notified polymer during reformulation include batch and reactor operators as well as quality assurance personnel. The most likely exposure pathway is dermal and the toxicological results of significance relate to dermal effects. The potential for dermal exposure should therefore be minimised.

The chemical will not be available for the general public. Negligible public exposure will result following contact with goods coated with the polyester since the chemical will be stabilised in the polymer matrix. Accordingly, there is negligible public risk associated with the use of this chemical. The potential for minor public exposure exists during reformulation, transport and disposal of the chemical/formulated polymer if accidentally spilt. This is minimised by the recommended practices during storage and transportation.

13. RECOMMENDATIONS

To minimise occupational exposure to 2-methyl-1,3-propanediol the following guidelines and precautions should be observed:

- Safety goggles should be selected and fitted in accordance with Australian Standard (AS) 1336 (17) to comply with Australian/New Zealand Standard (AS/NZS) 1337 (18);
- Industrial clothing should conform to the specifications detailed in AS 2919 (19) and AS 3765.1 (20);
- Impermeable gloves or mittens should conform to AS 2161 (21);
- All occupational footwear should conform to AS/NZS 2210 (22);
- 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 potential exposure.
- A copy of the MSDS should be easily accessible to employees.

14. MATERIAL SAFETY DATA SHEET

The MSDS for the notified chemical was provided in accordance with the *National Code of Practice for the Preparation of Material Safety Data Sheets* (23).

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.

15. 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.

16. REFERENCES

1. Organisation for Economic Co-operation and Development, *OECD Guidelines for Testing of Chemicals*, OECD, Paris.

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15. van de Wart E J 1993, Project No. 091722, Evaluation of the Mutagenic Activity of MP Diol Glycol in the Ames *Salmonella*/Microsome Test (with independent Repeat). RCC NOTOX B V, Hertogenbosch, Netherlands.

16. van de Wart E J 1993, Project No. 091531, Evaluation of the Mutagenic Activity of MP Diol Glycol in an *in vitro* Mammalian Cell Gene Mutation Test with V79 Chinese Hamster Cells (with independent Repeat). RCC NOTOX B V, Hertogenbosch, Netherlands.

17. Standards Australia 1994, *Australian Standard 1336-1994*, *Eye protection in the Industrial Environment*, Standards Association of Australia Publ., Sydney.

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19. Standards Australia 1987, *Australian Standard 2919-1987, Industrial Clothing,* Standards Association of Australian Publ., Sydney.

20. Standards Australia 1990, *Australian Standard 3765.1-1990, Clothing for Protection against Hazardous Chemicals Part 1 Protection against General or Specific Chemicals,* Standards Association of Australia Publ., Sydney.

21. Standards Australia 1978, *Australian Standard 2161-1978, Industrial Safety Gloves and Mittens (excluding electrical and medical gloves),* Standards Association of Australia Publ., Sydney.

22. Standards Australia/Standards New Zealand 1994, *Australian/New Zealand Standard 2210-1994, Occupational Protective Footwear,* Standards Association of Australia Publ., Sydney, Standards Association of New Zealand Publ, Wellington.

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

Attachment 1

The Draize Scale for evaluation of skin reactions is as follows:

Erythema Formation	*Rating*	*Oedema Formation*	*Rating*
No erythema	0	No oedema	0
Very slight erythema (barely perceptible)	1	Very slight oedema (barely perceptible)	1
Well-defined erythema	2	Slight oedema (edges of area well-defined by definite raising	2
Moderate to severe erythema	3	Moderate oedema (raised approx. 1 mm)	3
Severe erythema (beet redness)	4	Severe oedema (raised more than 1 mm and extending beyond area of exposure)	4

The Draize scale for evaluation of eye reactions is as follows:

CORNEA

Opacity	*Rating*	*Area of Cornea involved*	*Rating*
No opacity	0 none	25% or less (not zero)	1
Diffuse area, details of iris clearly visible	1 slight	25% to 50%	2
Easily visible translucent areas, details of iris slightly obscure	2 mild	50% to 75%	3
Opalescent areas, no details of iris visible, size of pupil barely discernible	3 moderate	Greater than 75%	4
Opaque, iris invisible	4 severe		

CONJUNCTIVAE

Redness	*Rating*	*Chemosis*	*Rating*	*Discharge*	*Rating*
Vessels normal	0 none	No swelling	0 none	No discharge	0 none
Vessels definitely injected above normal	1 slight	Any swelling above normal	1 slight	Any amount different from normal	1 slight
More diffuse, deeper crimson red with individual vessels not easily discernible	2 mod.	Obvious swelling with partial eversion of lids	2 mild	Discharge with moistening of lids and adjacent hairs	2 mod.
Diffuse beefy red	3 severe	Swelling with lids half-closed	3 mod.	Discharge with moistening of lids and hairs and considerable area around eye	3 severe
		Swelling with lids half-closed to completely closed	4 severe		

IRIS

Values	*Rating*
Normal	0 none
Folds above normal, congestion, swelling, circumcorneal injection, iris reacts to light	1 slight
No reaction to light, haemorrhage, gross destruction	2 severe