

File No: NA/297

Date: 5 December 1995

**NATIONAL INDUSTRIAL CHEMICALS NOTIFICATION  
AND ASSESSMENT SCHEME**

**FULL PUBLIC REPORT**

**COAGULANT 122**

This Assessment has been compiled in accordance with the provisions of *the Industrial Chemicals (Notification and Assessment) Act 1989*, 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 Human Services and Health.

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, Worksafe Australia, 92-94 Parramatta Road, Camperdown NSW 2050, between the hours of 10.00 a.m. and 12.00 noon and 2.00 p.m. and 4.00 p.m. each week day except on public holidays.

For Enquiries please contact the Administration Coordinator at:

**Street Address:** 92 Parramatta Rd Camperdown, NSW 2050, AUSTRALIA

**Postal Address:** GPO Box 58, Sydney 2001, AUSTRALIA

**Telephone:** (61) (02) 565-9466 **FAX (61) (02) 565-9465**

Director  
Chemicals Notification and Assessment

**FULL PUBLIC REPORT****COAGULANT 122****1. APPLICANT**

Betz Laboratories Pty Ltd of 69-77 Williamson Road, Ingleburn, NSW, 2565 has applied for a standard notification of Coagulant 122. The notified chemical will be used as a polymerisation inhibitor in the production of styrene monomers.

**2. IDENTITY OF THE CHEMICAL**

According to Worksafe Approved Criteria for Classifying Hazardous Substances (1) Coagulant 122, is considered to be non-hazardous. Therefore, the chemical identity, identity of impurities, specific use, import volume and methods of detection have been exempted from publication in the Full Public Report and the Summary Report.

**Trade names:** Coagulant 122 (50% solution), Coagulant 122C (76% solution), or Styrex.

**3. PHYSICAL AND CHEMICAL PROPERTIES**

The following physicochemical parameters refer to Coagulant 122 (solid) unless otherwise stated.

<b>Appearance at 20°C and 101.3 kPa:</b>	yellow to amber liquid
<b>Odour:</b>	not distinctive
<b>Melting Point:</b>	13-38°C
<b>Relative Density:</b>	1077.7 kg/m <sup>3</sup>
<b>Vapour Pressure:</b>	1.35 x 10 <sup>-5</sup> kPa at 25°C
<b>Water Solubility:</b>	> 92.6 % w/w at 20°C
<b>Fat Solubility:</b>	not determined
<b>Partition Co-efficient (n-octanol/water) log P<sub>ow</sub>:</b>	-0.53
<b>Hydrolysis as a function of pH:</b>	not determined.
<b>Adsorption/Desorption log K<sub>oc</sub>:</b>	-0.260
<b>Dissociation Constant</b>	

<b>pK<sub>a</sub>:</b>	9.51
<b>Flash Point:</b>	109°C
<b>Flammability Limits:</b>	not determined
<b>Decomposition Temperature:</b>	97-92°C
<b>Autoignition Temperature:</b>	does not self ignite up to 400°C
<b>Explosive Properties:</b>	not explosive
<b>Particle size distribution:</b>	not applicable. Notified substance is imported as an aqueous solution.
<b>Surface Tension:</b>	71.9 mN/m at 18.5°C (50% solution)
<b>Viscosity:</b>	29 cps at 21°C (50% solution)
<b>pH:</b>	10.5 (50% solution)

#### **Comments on Physico-Chemical Properties**

The notifier has provided the following statements, with which the conclusions are agreed.

Hydrolysis was not determined. Anecdotal evidence suggests that Coagulant 122 is stable in aqueous solutions at concentrations >1000 ppm. At lower concentrations, Coagulant 122 appears to decompose at a rate inversely proportional to the concentration. After 5 days, the degradation of Coagulant 122 in aqueous solution was 2% and 20% for 1000 and 50 ppm solutions, respectively.

The notified substance is a relatively small and highly polar molecule which is able to coordinate to metal ions. Therefore, the adsorption to organic matter in soils is estimated to be low, but it may interact with clays by coordinating to metal ions, H-bonding, or cation exchange (the molecule is expected to be substantially protonated within the environmental pH range).

#### **4. PURITY OF THE CHEMICAL**

<b>Degree of purity:</b>	93.5-94.5 %
--------------------------	-------------

## **5. INDUSTRIAL USE**

Coagulant 122 or 122c will be imported as either a 50% solution finished product or as a 76% solution requiring reformulation (Coagulant 122c). Coagulant 122 will be used as a polymerisation inhibitor in the production of styrene monomers. It will be used as a replacement for existing dinitrophenolic compounds to prevent monomer formation, improve yields and reduce monomer tars.

The estimated import volume of Coagulant 122 is expected to be > 20 tonnes a year.

## **6. OCCUPATIONAL EXPOSURE**

Coagulant 122 will be imported and repackaged into 1500 L IBC's (known as Semi-Bulk Containers -SBC's) containing an inner chemically resistant lining. These would then be loaded onto trucks for road transport to a warehouse facility in Sydney where they will be stored in a purpose built containment area. One to two waterside workers and transport drivers are expected to be exposed during the unloading and transport of the notified chemical with between 6 to 10 workers being potentially exposed at the warehouse. Potential exposure is anticipated to be for 3-4 hours per day as per the number of days required to import and store the notified chemical. Under normal circumstances exposure to Coagulant 122 by dermal or oral routes will be minimal, with major exposure only occurring in the event of a spill. While in storage at the site of application, a nitrogen positive pressure blanketing system will be used to prevent vapour release.

If the product requires to be reformulated, Coagulant 122 or 122c will be automatically transferred from storage containers to a standard sealed mixing vessel and will be diluted and/or mixed with other additives. The reformulated product will then be automatically transferred to Betz storage and transport containers. This process will be carried out using a partially sealed system with local and general ventilation.

Customer handling of the notified chemical has been eliminated by utilising a Customised Delivery System (CDS) operated solely by Betz personnel. Operators at the customer site also have the potential for exposure (once per day for 0.5 to 1 hour/day, between 1-3 shifts per day, up to 200 days per year). Operators will be exposed to the notified chemical (as an aqueous solution) while handling the product containers (SBC's) and connecting up pumping equipment. Coagulant 122 will be automatically pumped from the on-site storage containers and injected directly into the process stream. There is a potential here for dermal or oral exposure via splashing. The same risks are also applicable to operators during sampling for quality control and equipment maintenance. The feed system has been designed to allow full isolation and purging of the feed system before maintenance is carried out. Filters are also utilised to reduce the requirement for pump maintenance and a dual feed system is used to allow automatic switching between pumps to minimise manual operation of pumps and valves.

There will be no further exposure to Coagulant 122 as the notified chemical is totally consumed in the reaction for the production of styrene monomers, and in boiler applications the diluted Coagulant 122 will be released through the waste system.

Engineering controls such as local and general ventilation will be used to capture emissions during transfer of Coagulant 122. Operators will be required to wear impermeable gloves, safety goggles and overalls. If ventilation is inadequate then respiratory devices will be utilised.

## **7. PUBLIC EXPOSURE**

The potential for public exposure to Coagulant 122 is low. The chemical will not be sold to the public and is to be used only for industrial application. The chemical is consumed in the application (styrene monomer processing), and will not be released directly into the environment.

## **8. ENVIRONMENTAL EXPOSURE**

### *Release*

Coagulant 122 will be automatically pumped from transport containers into on-site storage containers and then into the styrene manufacturing process stream at the single site where it will be used. Various engineering controls (eg dual pump system, isolation and purge controls, automatic metering), and the use of trained personnel to operate this "customised delivery system", decreases the chance of spillage and wastage. The concentration of Coagulant 122 used is <15 ppm, and this will be totally consumed in the reaction process. The notifier states that it is likely that it decomposes through oxidative decomposition to organic acids and ammonia with hydroxylamines and beta hydroxyaldehydes as intermediate products.

Coagulant 122 could be released to the waste water system when used in industrial boiler applications through a blowdown (ie release of excess water). No information was given as to the delivery of Coagulant 122 to the boiler, although it is likely that it will be simply pumped into the boiler, perhaps being first mixed with water, to give a final concentration of about 20 ppm.

Other possible releases of the chemical could occur during re-formulating, sampling, during dosing, or cleaning of empty containers (rinsed with water). These operations are done on industrial sites using appropriate equipment designed to reduce possible spills etc. This, together with the instructions on the clean-up of spills in the MSDS, should minimise the possibility of environmental release during these processes. The notifier estimates that 2-10 kg Coagulant 122 would be lost on cleaning of a 1500 L bulk container.

## Fate

The main use of the chemical is to prevent polymerisation in monomer production, and in such a process it would be completely consumed leaving no residues. A minor application will involve its use as an oxygen scavenger in industrial boilers. Any significant residues from this application are likely to be associated with the waste water stream. The extent to which it will bind to metal ions and be associated with any boiler sludge is unclear. Such sludge is expected to be disposed of to landfill.

Using OECD test guideline 301D (closed bottle test), Coagulant 122 (solid - see above) can be classified as readily biodegradable, with 123% biodegradation attained after 28 days. However, other results given by the notifier for Coagulant 122C (76% solution) indicated that Coagulant 122 was not readily biodegradable, with only 57% degradation in a 28 day closed bottle test, and 7% degradation in a 28 day Zahn-Wellens test. These test reports were not available at the time of assessment.

No bioaccumulation of the chemical is expected because its very high water solubility and low octanol/water partition coefficient.

## 9. EVALUATION OF TOXICOLOGICAL DATA

### 9.1 Acute Toxicity

**Table 1 Summary of the acute toxicity of Coagulant 122**

Test	Species	Outcome	Reference
Acute oral toxicity	Rat	LD <sub>50</sub> >5 g/kg	(2)
Acute dermal toxicity	Rat	LD <sub>50</sub> >2 g/kg	(4)
Skin Irritation	Rabbit	non irritant	(5)
Eye irritation	Rabbit	non irritant	(7)
Skin sensitisation	Guinea-pig	non sensitiser	(8)

#### 9.1.1 Oral Toxicity (2)

<i>LD<sub>50</sub>:</i>	5 g/kg
<i>Species/strain:</i>	Sprague-Dawley rats
<i>Number/sex of animals:</i>	5/sex
<i>Observation period:</i>	14 days
<i>Method of administration (vehicle):</i>	direct administration of Coagulant 122 (50% solution, pH 10.5) to stomach via gavage at <1.00 mL/100 g of body weight.
<i>Clinical observations:</i>	all animals appeared normal throughout 14 day observation period.

*Mortality:* none

*Morphological findings:* no gross abnormalities were observed for the animals necropsied at the conclusion of the 14 day observation period.

*Test method:* based on USEPA Health Effects Testing Guidelines (3).

#### **9.1.2 Dermal Toxicity (4)**

*LD<sub>50</sub>:*

>2.0 g/kg

*Species/strain:*

New Zealand White Rabbits

*Number/sex of animals:* 5/sex

*Observation period:* 14 days

*Method of administration (vehicle):*

test article (50% solution, pH 10.5, 2.0 g/kg) on a gauze patch wrapped in occlusive dressing .

*Clinical observations:* after 24 hours slight to well defined erythema was observed but no oedema. No erythema or oedema was observed for 2/5 males and 3/5 females after Day 4 and 5/5 males and females by Day 6. A dead female was found on Day 8. All other animals appeared normal for 14 day observation period.

*Mortality:* one female died (Day 8), no mortality amongst other animals.

*Morphological findings:* No gross abnormalities were observed in any of the surviving animals necropsied at the conclusion of the 14 day observation period. The female that died on Day 8 had signs of possible mucoid enteritis and had no formed faeces

*Test Method:* based on USEPA Health Effects Testing Guidelines (3).

#### **9.1.3 Skin Irritation (5)**

**Result:** Coagulant 122 is not a skin irritant

**Species/strain:** New Zealand White rabbits

**Number of animals:** 6

**Method of administration:** 0.5 mL of the test article (50% solution, pH 10.5) was applied dermally to the test site with an adjacent area of untreated skin serving as a control. Gauze patches were placed on test sites wrapped in semi-occlusive dressing.

**Test Method:** based on USEPA Health Effects Testing Guidelines (3).

**Table 2 Draize (6) Scores<sup>1</sup>:**

Animal	Time after decontamination			
	4 hours	1 day	2 days	3 days
<b>ERYTHEMA</b>				
1	1	0	0	0
2	2	0	0	0
3	1	0	0	0
4	0	0	0	0
5	1	0	0	0
6	1	1	0	0
<b>OEDEMA</b>				
1	0	0	0	0
2	1	0	0	0
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0

#### 9.1.4 Eye Irritation (7)

**Result:** Coagulant 122 is not classed as an eye irritant but may produce mild irritating effects.

**Species:** New Zealand White rabbits

**Number of animals:** 9  
(6 unwashed eyes, 3 washed eyes).

**Method of administration:** 0.1 mL of test article (50% solution, pH10.5) was instilled into one eye of the test animals while the other eye remained untreated to serve as a control. The treated eyes of the first six rabbits were not washed subsequent to instillation of the test article. Both the test and control eyes of the remaining three rabbits were washed after 30 second contact with water for one minute.

**Test Method:** based on USEPA Health Effects Testing Guidelines (3).



**Table 3 Draize (6) Scores<sup>ii</sup>**

animal	time after instillation											
	1 hour			1 day			2 days			3 days		
cornea	opacity area			opacity area			opacity area			opacity area		
1	0	0		0	0		0	0		0	0	
2	0	0		0	0		0	0		0	0	
3	0	0		0	0		0	0		0	0	
4	0	0		0	0		0	0		0	0	
5	0	0		0	0		0	0		0	0	
6	0	0		0	0		0	0		0	0	
iris												
1	0			0			0			0		
2	0			0			0			0		
3	0			0			0			0		
4	0			0			0			0		
5	0			0			0			0		
6	0			0			0			0		
conjunctiv a	r <sup>a</sup>	c <sup>b</sup>	d <sup>c</sup>	r <sup>a</sup>	c <sup>b</sup>	d <sup>c</sup>	r <sup>a</sup>	c <sup>b</sup>	d <sup>c</sup>	r <sup>a</sup>	c <sup>b</sup>	d <sup>c</sup>
1	1	1	1	1	1	0	0	0	0	0	0	0
2	1	1	1	1	0	0	0	0	0	0	0	0
3	1	1	1	1	1	0	1	1	0	0	0	0
4	2	1	1	1	1	0	1	1	0	0	0	0
5	1	1	1	1	1	1	1	0	0	0	0	0
6	1	1	2	1	1	0	0	0	0	0	0	0

<sup>a</sup> redness   <sup>b</sup> chemosis   <sup>c</sup> discharge

### 9.1.5 Skin Sensitisation (8)

**Result:** Coagulant 122 is not a skin sensitiser in guinea-pigs.

**Species/strain:** Hartley Guinea-Pig

**Number of animals:**  
17 males (12 test  
article, 5 control)

**Induction:** 0.5 mL of test article (100%) was applied to the clipped skin under semi-occlusive dressing for 24 hours. A 6-hour contact period was used for subsequent induction applications. The animals were treated with the test article 3 times per week for 3 weeks (total of 9 applications).

**Challenge:** The animals were challenged dermally with the solid test substance for 24 hours 2 weeks after the last induction dose.

**Results:****Table 4**

Challenge Concentration	24 hrs		48hrs	
	test	control	test	control
100%	0	0	0	0

Coagulant 122 when applied dermally does not appear to be a dermal sensitiser.

**Test Method:** Modified Buehler Method from USEPA Health Effects Testing Guidelines (3).

**9.2 Repeated Dose Toxicity :** not performed. Considering that the levels of exposure to Coagulant 122 should be minimal due to protective equipment or mechanical ventilation, it is not considered that any exposure will occur that will reflect repeated dose conditions.

### 9.3 Genotoxicity

#### 9.3.1 *Salmonella typhimurium* Reverse Mutation Assay (9)

**Result:** Coagulant 122 was not found to be mutagenic.

**Strains:** *Salmonella typhimurium* (strains TA1535, TA1537, TA98 & TA 100)

**Concentration range:** 50, 150, 500 or 1500 µg/ plate of Coagulant 122 (solid) with and without metabolic activation using rat liver S9.

**Test Method:** Complies with OECD Guidelines for Testing of Chemicals (10).

#### 9.3.2 Chromosome Aberration Assay in Cultured Human Lymphocytes (11)

**Result:** Coagulant 122 (solid) produced a significant increase in the number of aberrant cells but only at the highest concentrations tested, and only in the absence of S9. In the absence of S9 the mitotic index was reduced to 33% and 51% at 5000 and 2500 µg/mL respectively.

**Species:** Cultured Human Lymphocytes

**Doses:** First test- 0, 625, 1250 and 2500 µg/mL; Second test- 0, 1250, 2500, 5000 µg/mL.

**Test Method:** Complies with OECD Guidelines for Testing Chemicals (10).

### 9.4 Overall Assessment of Toxicological Data

Coagulant 122 was of low acute oral toxicity in rats (LD<sub>50</sub> >5.0g/kg) and low acute dermal toxicity in rabbits (LD<sub>50</sub>>2.0 g/kg). It was not found to be a skin irritant in rabbits and was not a skin sensitiser in guinea-pigs. Coagulant 122 was not mutagenic in *S.typhimurium* using *in vitro* bacterial reverse mutation assays.

Coagulant 122 (solid) showed clastogenic activity in an *in vitro* Chromosome Aberration Assay in Cultured Human Lymphocytes, but only at relatively high cytotoxic concentrations.

Coagulant 122 produced mild eye irritancy effects indicating it's potential as a slight eye irritant. It would be expected that irritant effects on eyes, skin and respiratory tract might be observed due to Coagulant 122's high pH (10.5).

The notified chemical is not classed as hazardous according to Worksafe Australia's Approved Criteria for the Classifying of Hazardous Substances (11) in relation to the toxicity data provided.

## 10. ASSESSMENT OF ENVIRONMENTAL EFFECTS

The ecotoxicity studies were conducted using Coagulant 122 (various formulations) dissolved in water. The results in Table 5 were provided by the notifier, using nominal concentrations only.

The data shows that Coagulant 122 is potentially moderately toxic to algae ( $E_B C_{50} = 13.6 \text{ mg/L}$ ). Examination of the growth curves indicate that growth is affected by Coagulant 122 in the first 24 h period, possibly due to the chelation of metal nutrients. The growth rate in the 24-72 h period in all treatments appeared to be little different from that of the control, further indicating that Coagulant 122 might have an effect through chelation of key nutrients.

**Table 5. Ecotoxicity test results**

Species	Test	Result <sup>1</sup> (nominal product concentration)
Fathead minnow ( <i>Pimephales promelas</i> )	48 h acute screening <sup>C122</sup>	$LC_{50} > 1000 \text{ mg/L}$ (500 mg/L)
Water Flea ( <i>Daphnia magna</i> )	48 h acute <sup>C122</sup>	$EC_{50} > 1000 \text{ mg/L}$ (500 mg/L)
Green Alga ( <i>Selenastrum capricornutum</i> )	72 hour growth <sup>C122S</sup>	$E_B C_{50} = 17 \text{ mg/L}$ (13.6 mg/L) $E_R C_{50} = > 206 \text{ mg/L}$ (165 mg/L)
Activated sewage sludge	3 h respiration inhibition <sup>C122C</sup>	$EC_{50} > 100 \text{ mg/L}$ (total solids) (76 mg/L)

<sup>1</sup> Nominal concentration of Coagulant 122 given in brackets; C122 = Coagulant 122 (about 50% aqueous solution); C122S = Coagulant 122 (solid containing 80% Coagulant 122); C122C = Coagulant 122C (about 76% aqueous solution)

## **11. ASSESSMENT OF ENVIRONMENTAL HAZARD**

Coagulant 122 is intended to be used mainly in the production of styrene, in which it is expected to be completely consumed and leave no residual Coagulant 122. It can also be used as an oxygen scavenger, where there is potential for its release to the environment in effluent which could lead to wide-spread environmental exposure. The notifier estimates that on release with waste water, there would be a typical dilution of 100-1000 times, giving a concentration of 20-200 ppb. Further dilution would be expected at any sewage treatment works and on release to receiving waters, with a further dilution of 10-100 typical. The concentration of Coagulant 122 in receiving waters might therefore be in the 0.2-20 ppb range. The degree to which it might adsorb to particulate matter such as clay particles is unknown, nor likely to be a major source of loss given its high water solubility and low dissociation constant.

The worst case environmental concentration (ie in receiving waters) therefore would be 20 ppb, several orders of magnitude below the lowest effect concentration (green algae,  $E_{B}C_{50} = 13.6 \text{ mg/L}$ ). Therefore, the use of Coagulant 122 is not likely to cause any significant environmental impact when used in minor quantities as an oxygen scavenger in industrial boiler applications.

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

The notified chemical is not classed as hazardous according to Worksafe Australia's Approved Criteria for the Classifying of Hazardous Substances (11) in relation to the toxicity data provided.

The levels of exposure to Coagulant 122 during shipping and transport to the warehouse is expected to be negligible as the notified chemical will be in sealed containment with chemical resistant lining. Significant exposure to the notified chemical via the dermal or oral route is only likely to occur in the event of a spill. Within the warehouse, the notified chemical will be stored in purpose built areas. Storage at the site of application will utilise a nitrogen positive pressure blanket to prevent vapour release.

There is not expected to be any exposure to chemicals during the reformulation of Coagulant 122 as the process takes place in a partially closed system with local and general ventilation.

There will be minimal customer handling of Coagulant 122 as generally all on site applications of the notified chemical will be performed by the notifier's personnel. There is potential here for exposure to workers handling the chemical from splashing when handling the product containers, connecting up the pumping equipment, sampling for quality control and cleaning the pumps. This exposure should be minimised by the automated pumping system reducing the requirement for manual pumping, the purging and isolation of the feed system prior to maintenance and cleaning, local and general exhaust ventilation during transfer of Coagulant 122, and

personal protective equipment. Splashing or any other cause of dermal or eye contact should be prevented because of the high pH.

The potential for public health exposure to Coagulant 122 is low. The chemical will not be sold to the public and is to be used only for industrial applications. The chemical is consumed in the application ( monomer processing), and will not be released directly into the environment.

In the case of accidental spillage during transport, the public may be exposed to Coagulant 122. This is minimised by the recommended practices for storage and transportation. Emergency procedures for the containment and clean up, such as using an inert absorbent material like sand, clay or vermiculite, are detailed in the MSDS.

Coagulant 122 is expected to pose a minimum risk due to its low levels of toxicity and limited occupational exposure.

### **13. RECOMMENDATIONS**

To minimise occupational exposure to Coagulant 122 the following guidelines and precautions should be observed:

if engineering controls and work practices are insufficient to reduce exposure to Coagulant 122 to a safe level, then the following personal protective equipment which conforms to Australian Standard (AS) or Australian/New Zealand Standard (AS/NZS) should be worn:

a respirator with dust/mist cartridges should be selected and used in accordance to AS/NZS 1715 (12) and should comply to AS/NZS 1716 (13).

safety goggles should be selected and fitted in accordance to AS 1336 (14) to comply with AS/NZS 1337 (15).

industrial clothing must conform to the specifications detailed in AS 2919 (16) and AS 3765.1 (17).

impermeable gloves or mittens conforming to AS 2161 (18) and AS 3765.1 (17).

all occupational footwear should conform AS/NZS 2210 (19).

spillage of the notified chemical should be avoided.

good personal hygiene should be practised to minimise the potential for ingestion.

a copy of the Material Safety Data Sheet should be easily accessible to employees.

#### **14. MATERIAL SAFETY DATA SHEET**

The Material Safety Data Sheet (MSDS) for Coagulant 122 was provided in an acceptable format (20)

This MSDS was provided by Betz Laboratories Pty Ltd as part of their notification statement. The accuracy of this information remains the responsibility of Betz Laboratories Pty Ltd.

#### **15. REQUIREMENTS FOR SECONDARY NOTIFICATION**

Under the *Industrial Chemicals (Notification and Assessment) Act 1989*, secondary notification of Coagulant 122 shall be required if any of the circumstances stipulated under subsection 64(2) of the Act arise.

The notifier has indicated that Coagulant 122 may find future applications in the manufacture of other monomers such as ethylene. In this event, the notifier should submit a secondary notification.

#### **16. REFERENCES**

1. Gabriel D, 1991, *Coagulant 122 Acute Oral Toxicity, LD50 - Rats (TSCA)*. Biosearch Incorporated, Project No. 90-7173A.
2. Environmental Protection Agency (US), 1985, 40 CFR Part 798, EPA Health Effects Testing Guidelines.
3. Gabriel D, 1991, *Coagulant 122 Acute Dermal Toxicity, LD50 - Rabbits (TSCA)*. Biosearch Incorporated, Project No. 90-7173A.
4. Romanelli P, 1991, *Coagulant 122 Primary Skin Irritation - Rabbits*. Biosearch Incorporated, Project No. 90-7173A.
5. Draize JH, 1959, 'Appraisal of the Safety of Chemicals in Foods, Drugs and Cosmetics', *Association of Food and Drug Officials of the US*, **49**.
6. Bielucke J, 1991, *Coagulant 122 Primary Eye Irritation, 6 Unwashed & 3 Washed - Rabbits*. Biosearch Incorporated, Project No. 90-7173A.
7. Romanelli P, 1991, *Coagulant 122 Guinea Pig Dermal Sensitization - Modified Beuhler Method*. Biosearch Incorporated, Project No. 90-7173A.
8. Kitching J, 1995, *Coagulant 122 (Solid) Bacterial Mutation Assay*. Huntingdon Research Centre Ltd., Project No. BTZ 54/941671.

9. Organisation for Economic Co-operation and Development, *OECD Guidelines for Testing of Chemicals*, OECD, Paris, France.
10. Akhurst LC and Greer JV, 1995, *Coagulant 122 (Solid) Metaphase Chromosome Analysis of Human Lymphocytes Cultured In Vitro*. Huntingdon Research Centre Ltd. Project No. BTZ 53/950310.
11. National Occupational Health and Safety Commission, 1994, *Approved Criteria for Classifying Hazardous Substances [NOHSC:1008(1994)]*, AGPS, Canberra.
12. Standards Australia, Standards New Zealand, 1994, *Australian/New Zealand Standard 1715 - 1994 Selection, Use and Maintenance of Respiratory Protective Devices*, Standards Association of Australia Publ., Sydney, Australia, Standards Association of New Zealand Publ., Wellington, New Zealand.
13. Standards Australia/ Standards New Zealand, 1991, *Australian/New Zealand Standard 1716 - 1991 Respiratory Protective Devices*, Standards Association of Australia Publ., Sydney, Australia.
14. Standards Australia, 1994, *Australian Standard 1336-1994, Recommended Practices for Eye Protection in the Industrial Environment*, Standards Association of Australia Publ., Sydney, Australia.
15. Standards Australia, Standards New Zealand 1992, *Australian/ New Zealand Standard 1337-1992, Eye Protectors for Industrial Applications*, Standards Association of Australia Publ., Sydney, Australia, Standards Association of New Zealand Publ. Wellington, New Zealand.
16. Standards Australia, 1987, *Australian Standard 2919 - 1987 Industrial Clothing*, Standards Association of Australia Publ., Sydney, Australia.
17. Standards Australia, 1990, *Australian Standard 3765-1990 Clothing for Protection Against Chemical Hazards, Part 1 Protection Against General or Specific Chemicals, Part 2 Limited Protection Against Specific Chemicals*, Standards Association of Australia Publ., Sydney, Australia.
18. Standards Australia, 1978, *Australian Standard 2161-1978, Industrial Safety Gloves and Mittens (excluding Electrical and Medical Gloves)*, Standards Association of Australia Publ., Sydney, Australia.
19. Standards Australia, Standards New Zealand 1994, *Australian/ New Zealand Standard 2210 - 1994 Occupational Protective Footwear, Part 1: Guide to Selection, Care and Use. Part 2: Specifications*, Standards Association of Australia Publ., Sydney, Australia, Standards Association of New Zealand Publ. Wellington, New Zealand.
20. National Occupational Health and Safety Commission, 1990, *Guidance Note for the Completion of a Material Safety Data Sheet*, 2nd. edition, AGPS,

Canberra.



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

<b>Erythema Formation</b>	<b>rating</b>	<b>Oedema Formation</b>	<b>rating</b>
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 2 by definite raising)	2
Moderate to severe erythema	3	Moderate oedema (raised approx. 1mm)	3
Severe erythema (beet redness)	4	Severe oedema (raised more than 1 mm and extending beyond area of exposure)	4

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

<b>CORNEA</b>			
<b>Opacity</b>	<b>rating</b>	<b>Area of Cornea involved</b>	<b>rating</b>
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		

<b>CONJUNCTIVAE</b>					
<b>Redness</b>	<b>rating</b>	<b>Chemosis</b>	<b>rating</b>	<b>Discharge</b>	<b>rating</b>
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		

<b>IRIS</b>	
<b>Values</b>	<b>rating</b>
Normal none	0
Folds above normal, congestion, swelling, circumcorneal injection, iris reacts to light	1 slight
No reaction to light, haemorrhage, gross destruction	2 severe