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**NATIONAL INDUSTRIAL CHEMICALS NOTIFICATION
AND ASSESSMENT SCHEME**

FULL PUBLIC REPORT

Polymer in Disperbyk 140

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FULL PUBLIC REPORT**Polymer in Disperbyk 140****1. APPLICANT**

Nuplex Industries of 49-61 Stephen Road, BOTANY NSW 2019 (ACN 000 045 572) and Clariant (Australia) Pty Ltd of 675 Warrigal Road CHADSTONE VIC 3148 (ACN 069 435 552) have submitted a limited notification statement in support of their application for an assessment certificate for “Polymer in Disperbyk 140”.

2. IDENTITY OF THE CHEMICAL

The chemical name, CAS number, molecular and structural formulae, molecular weight, spectral data, details of the polymer composition and details of exact import volume have been exempted from publication in the Full Public Report and the Summary Report.

Marketing Name: Disperbyk 140
Sandosperse A products

3. PHYSICAL AND CHEMICAL PROPERTIES

The physical and chemical properties were determined from Disperbyk 140, which contains 52% notified polymer and 48% propylene glycol monomethyl ether acetate.

Appearance at 20°C & 101.3 kPa: A brown liquid with an ester-like odour.

Boiling Point: 200°C.

Specific Gravity: 1 020 kg/m³.

Vapour Pressure: 0.3 kPa at 20°C.

Water Solubility: Not determined.

**Partition Co-efficient
(n-octanol/water):** Not determined.

Hydrolysis as a Function of pH: Not determined.

Adsorption/Desorption: Not determined.

Dissociation Constant:	Not determined.
Particle Size:	The polymer manufactured in a solution.
Flash Point:	>100°C
Flammability Limits:	Not determined.
Autoignition Temperature:	Not determined.
Explosive Properties:	Expected to be non-explosive.
Reactivity/Stability:	Stable under 100°C.

3.1 Comments on Physico-Chemical Properties

The structure indicates a considerable proportion of amine groups which are expected to quaternize, as well as polar oxygen and phosphate groups, all suggesting significant solubility. However, the notifier states that the notified polymer is not water soluble because the lipophilic phosphoric acid counter ion envelopes the polymer core resulting in an insoluble product.

The notified polymer does not contain any groups expected to hydrolyse in the environmental pH range of 4 to 9.

The partition coefficient has not been determined due to the notified polymers water insolubility, and its apparent hydrophobic nature, indicative of partitioning into the *n*-octanol phase.

No adsorption/desorption tests were conducted for this notification. The notifier expects the notified polymer to be immobile in soil due its water insolubility.

While the vapour pressure of the notified polymer was not determined, it is likely to be relatively low considering the high molecular weight and ionic form of the polymer.

No dissociation constant tests were conducted for this notification although it appears ionic in nature. Presumably this was due to the low solubility.

Disperbyk 140 is Class 3 Dangerous Goods due to the high concentration of the solvent, propylene glycol monomethyl ether acetate.

4. PURITY OF THE CHEMICAL

Degree of Purity: High

Additives/Adjuvants:

Chemical name: Propylene glycol monomethyl ether acetate

<i>Synonyms:</i>	2-methoxy-1-methylethyl acetate
<i>CAS No.:</i>	108-65-6
<i>Weight percentage:</i>	48%
<i>Toxic properties:</i>	On the NOHSC <i>List of Designated Hazardous Substances</i> with R10 (Flammable) and R36 (Irritating to eye) (NOHSC, 1999a).

5. USE, VOLUME AND FORMULATION

The notified polymer is manufactured in a mixture of organic solvent and remains in solution. The solution (Disperbyk 140) is used as a dispersant in anticorrosive paints and primers for refinishing paints on cars. The notified polymer is about 52% in Disperbyk 140 and Disperbyk 140 is at 0.5-2% in solvent-based paint products. Thus, the notified polymer in the final Disperbyk 140 paint formulation is 0.25-1%. Disperbyk 140 is packaged in 25 kg or 200 kg steel drums and the formulated Disperbyk 140 products will be filled into 20 L steel pails or 200 L steel drums.

In addition, a range of pigment paste products containing the notified polymer, Sandosperse A products such as Sandosperse Blue A-B2G, will be imported. Sandosperse A products will be incorporated as pigments in epoxy, polyurethane or acrylic coatings for use in industrial painting. Sandosperse A products contain <10% notified polymer. The final industrial paint formulations contain <1% notified polymer. Sandosperse A products are packaged in 20 L steel drums, and the formulated products containing Sandosperse A will be filled in 4 L or 20 L cans containers.

The notifiers estimated that a total of less than 20 tonnes the notified polymer will be imported per year in the first 5 years.

6. OCCUPATIONAL EXPOSURE

Disperbyk 140 paint formulation

The notifier estimated occupational exposure data such as category of workers, number of workers and exposure duration for transport and storage workers, manufacture operators and spray painters.

<i>Category of Workers</i>	<i>Number of Workers</i>	<i>Exposure Duration</i>	
		<i>Hours/day</i>	<i>Days/year</i>
Transport & Storage	10		200
Paint manufacture			
Dispersing	40	4	30
Makeup	40	2	30
QC testing	10	8	30
Packaging	40	8	30

Paint application

Preparation	10	8	200
Spray painting	20	8	200
Equipment cleaning	30	2	200

Transport and storage

The polymer solution, Disperbyk 140, will be imported in 25 kg or 200 kg steel drums. It will be transferred from the docks to a licensed dangerous goods store and transferred by road transport to the formulation site. Waterfront, transport and warehouse workers are not expected to be exposed to the notified polymer except in the case of an accident involving spillage of the paint or resin solution.

Paint formulation

The reformulation into coatings will be carried out at a variety of companies located throughout Australia. The reformulation of polymer solution into paint components will involve paint mixing, quality control and drum or can filling. The mixers used for preparing the paint will be enclosed and fitted with local exhaust ventilation. Dermal exposure to the polymer will be possible at several points throughout the process; charging the polymer solution into the mixer, removal and testing of quality control samples, and drips and spills during the paint filtration and filling. Inhalation exposure is not expected due to the high molecular weight and low vapour pressure of the notified polymer.

Vacuum hoses will be used to empty containers automatically. The mixing and filling will be carried out under local exhaust ventilation to prevent exposure to the solvents. Workers will wear impervious gloves, overalls and goggles. During QC testing, workers will wear laboratory coats, safety glasses/goggles, protective gloves and safety boots.

Paint Application

The notifier indicated that industrial paint application of the products containing the notified polymer can be by spraying, roller coating or dipping. Spray painting has the potential to result in greatest occupational exposure.

The spray painters who will be exposed to the notified polymer would be expected to be TAFE trained. Typically the spray painter will measure the appropriate amounts of the different components required in a particular formulation into an open container and pour this mixture into a spray gun. The spraying of the automobile will be carried out in a laminar flow downdraft spray booth which is designed to rapidly remove aerosol particles and solvent vapour from the atmosphere. Several possible booth designs may be used. In a dry floor booth, the overspray will be collected in filters contained in the floor of the booth; any unremoved particulates will reach the exhaust stack with the solvent vapours. In a wet floor booth, overspray will collect in a pool of water below the grill floor or in a wet scrubber in the exhaust and will be removed with a filter. The residual solids will be disposed of to secure landfill. The spray booths are subject to AS/NZS/4114.1:1995 *Spray Painting Booths – Design, Construction and Testing* and AS/NZS/4114.1:1995 *Spray Painting Booths – Selection, Installation and Maintenance*. After application of the paint, the treated surface is heated to cure the coating.

Residual paint mixture is likely to be washed from the equipment manually, using recycled paint solvent, and the washings disposed of by solvent recyclers.

Once the final paint mixture has dried, the notified polymer will be irreversibly bound within the cured matrix and not separately available for exposure to workers.

Spray painters will wear appropriate personal protective equipment at all times; impervious gloves and anti-static flame retardant overalls while mixing the paint, and, in addition, a full face shield and respirator conforming to AS/NZS1715 and AS/1716 (or equivalent) while inside the spray booth.

The notifier also indicated that an effective filtered exhaust system will be in operation during other application methods such as roller coating and dipping, as well as filling containers.

Sandosperse A products

<i>Category of Workers</i>	<i>Number of Workers</i>	<i>Exposure Duration</i>	
		<i>Hours/day</i>	<i>Days/year</i>
Warehouse/Distribution	6	<1	100
Paint manufacture	10-15	<1	100
Quality control personnel	2	<1	100

Sandosperse A products are packaged in 20 L steel drums. During transport and distribution, transport and warehouse workers are not expected to be exposed to the notified polymer except when the package is breached.

Paint manufacturers will weigh and add Sandosperse A products into paint batches, supervise paint production and manually fill formulated paint into 4 L or 20 L containers. Quality control personnel will collect samples (approximately 500 g) of paint batches for analysis. Industrial controls and personal protective equipment for the paint manufacturers and quality control personnel is expected to be similar to that for Disperbyk 140 paint formulation.

The notifier did not provide occupational health and safety data for the end users. Industrial controls and personal protective equipment for the end users is expected to be similar to that for Disperbyk 140 paint formulation.

7. PUBLIC EXPOSURE

Dsyperbyk 140 will be imported in 25 or 200 kg steel drums. The MSDS advises that in the event of a spill all persons in the immediate area not wearing protective clothing should be evacuated and the chemical collected for later disposal in accordance with regulations. Public exposure during importation and transportation is negligible.

Processing to incorporate the notified polymer into paint products will generally take place in enclosed mixers. There is a chance of minor spillage during charging/discharging the mixing tanks, which will be contained within the processing plant by bunding. The formulated product will be packaged in 20 L steel pails or 200 L steel drums. Public exposure during

processing is negligible.

Paint may be applied via spray gun, roller or dripping. Spray painting will take place in spray painting booths designed to remove excess solid particles via filters. Similarly filtered exhaust systems will be used during other forms of paint application. Solid matter will be disposed of in landfill. Painting equipment will be washed with solvents and washings collected and disposed of via solvent recyclers. Public exposure through waste is negligible.

Dysperbyk 140 is used as a part of industrial anticorrosive paints and primers for refinishing paints on cars. The notified polymer is present in the product at concentrations <1%. Public exposure to the finished surfaces is significant, however, once dried the polymer will be bound within the paint matrix and not bioavailable.

8. ENVIRONMENTAL EXPOSURE

8.1 Release

During coatings production, the notifier estimates that up to 50 kg per annum of waste containing the notified polymer will be generated from cleaning up minor spills and cleaning out manufacturing equipment. The notifier further estimates that up to 10.5 tonnes per annum of the notified polymer will be disposed of during coating use and up to 300 kg of the notified polymer will be disposed of during drum cleaning.

8.2 Fate

The majority of the notified polymer will be crosslinked with other paint components to form a very high molecular weight and stable paint film. The notifier states that deterioration of the paint formulation is negligible over the average life (20 years) of a motor vehicle. Therefore, once incorporated into the paint formulation, the notified polymer is expected to be immobile and pose little risk to the environment.

The notified polymer in waste from spills, equipment cleaning and drum recycling will be collected by licensed waste disposal contractors and treated by a distillation process whereby, the solvent is reclaimed and the remaining solid containing the notified polymer will be disposed of in landfill. The notified polymer in overspray will also be disposed of in landfill. The notifier indicates that incineration of waste may also occur.

The notified polymer is not water soluble and therefore will not be mobile in either the terrestrial or aquatic compartments. As a consequence of its polycationic nature, the notified polymer is expected to eventually associate with the soil matrix and sediments. The notified polymer is not expected to cross biological membranes due to its high molecular weight and low water solubility and is therefore not expected to bioaccumulate (Connell 1990).

9. EVALUATION OF TOXICOLOGICAL DATA

The notified polymer was tested for eye irritation and mutagenic potential.

9.1 Acute Toxicity

9.1.1 Eye Irritation (Douds, 1998)

<i>Species/strain:</i>	Rabbit/New Zealand White
<i>Number/sex of animals:</i>	1 male and 2 females
<i>Observation period:</i>	7 days
<i>Method of administration:</i>	A dose of 0.1 g was applied to conjunctival sac of one eye. Untreated eye served as the control.
<i>Test method:</i>	OECD TG 405

Draize scores of unirrigated eyes:

	<i>Time after instillation</i>														
<i>Animal</i>	<i>1 hour</i>			<i>24 hours</i>			<i>48 hours</i>			<i>72 hours</i>			<i>7 days</i>		
<i>Cornea</i>	Zero scores were recorded for corneal effects in all animals at all time points.														
<i>Iris</i>															
1	1			0			0			0					
2	1			0			0			0			0		
3	0			0			0			0					
<i>Conjunctiva</i>	<i>r</i>	<i>c</i>	<i>d</i>	<i>r</i>	<i>c</i>	<i>d</i>	<i>r</i>	<i>c</i>	<i>d</i>	<i>r</i>	<i>c</i>	<i>d</i>	<i>r</i>	<i>c</i>	<i>d</i>
1	1	1	2	2	1	0	1	1	0	0	0	0			
2	1	1	2	1	1	0	1	1	0	1	1	0	0	0	0
3	1	0	0	0	1	0	1	0	0	0	0	0			

¹ see Attachment 1 for Draize scales

o = opacity a = area r = redness c = chemosis d = discharge

Comment: The test material was administered as a solid.

Fluorescein examination showed no retention of dye at 24 hour after dosing.

Result: The notified polymer was slightly irritating to the eyes of rabbits.

9.3 Genotoxicity

9.3.1 *Salmonella typhimurium* Reverse Mutation Assay (Fortunato, 1999)

<i>Strains:</i>	<i>S. typhimurium</i> TA98, TA100, TA1535 and TA 1537; <i>E. coli</i> WP2 uvrA.
<i>Metabolic activation:</i>	Liver fraction (S9 mix) from rats pretreated with Aroclor 1254.
<i>Concentration range:</i>	Two independent assays, both with and without S9 metabolic activation system, were conducted with all plating performed in triplicate. 5.0, 1.0, 0.5, 0.1 and 0.05 mg/plate (vehicle: ethanol) for all strains. Positive controls: (without S9 mix) Sodium azide for TA100 and TA1535; 2-nitrofluorene for TA98; 9-aminoacridine for TA1537; Methyl methanesulfonate for WP2uvrA. (with S9 mix) 2-aminoanthracene for all strains. Negative control: Ethanol for all strains.
<i>Test method:</i>	OECD TG 471
<i>Comment:</i>	The test material was found non-cytotoxic up to 5 mg/plate. No precipitation occurred in the study. Under the conditions of the study, the test material caused no substantial increases in revertant colony numbers over control counts at any concentration in either the presence or absence of the rat liver microsomal enzymes. All positive controls responded appropriately.
<i>Result:</i>	The notified polymer was non mutagenic under the conditions of the test.

9.4 Overall Assessment of Toxicological Data

The notifier provided two toxicological study reports. In an eye irritation study in rabbits, the test results showed that the notified polymer was a slight eye irritant. In a genotoxicity study, the notified polymer was non-mutagenic in bacteria.

There are insufficient toxicological data to classify the notified polymer according to NOHSC *Approved Criteria for Classifying Hazardous Substances* (NOHSC, 1999b). However, the notified polymer is of high molecular weight and low water solubility which prevents it from crossing biological membranes. The levels of residual monomers are below the concentrations that could render the notified polymer a hazardous substance.

10. ASSESSMENT OF ENVIRONMENTAL EFFECTS

No ecotoxicological data were provided for assessment.

11. ASSESSMENT OF ENVIRONMENTAL HAZARD

The majority of the notified polymer will be crosslinked with other paint components to form a very high molecular weight and stable paint film. Therefore, once incorporated into the paint formulation, the notified polymer is expected to be immobile and pose little risk to the environment.

The notified polymer in waste from spills, equipment cleaning and drum recycling will be collected by licensed waste disposal contractors and treated by a distillation process whereby the solvent is reclaimed and the remaining solid containing the notified polymer will be disposed of in landfill. The notified polymer in overspray will also be disposed of in landfill. The notifier indicates that incineration of waste may also occur.

The notified polymer is not water soluble and therefore will not be mobile in either the terrestrial or aquatic compartments. As a consequence of its polycationic nature, the notified polymer is expected to eventually associate with the soil matrix and sediments. The notified polymer is not expected to cross biological membranes due to its high molecular weight and low water solubility and is therefore not expected to bioaccumulate (Connell 1990).

The notified polymer is not likely to present a hazard to the environment when it is stored, transported and used in the proposed manner.

12. ASSESSMENT OF PUBLIC AND OCCUPATIONAL HEALTH AND SAFETY EFFECTS

Limit toxicological information has been provided for the notified polymer. It was a slight eye irritant in animals and was non-mutagenic in bacteria. There was insufficient toxicological data for a classification of the notified polymer according to NOHSC *Approved Criteria for Classifying Hazardous Substances* (NOHSC, 1999b). However, the notified polymer is of high molecular weight and low water solubility which prevents it from crossing biological membranes. The levels of residual monomers are low.

The polymer solution, Disperbyk 140, is a hazardous substance because of the high concentration of a solvent, 2-methoxy-1-methylethyl acetate. The risk phrases for Disperbyk 140 are R10 (Flammable) and R36 (Irritating to eye). The MSDS for the polymer solution Disperbyk 140 lists a number of potential health effects, namely skin, eye and respiratory irritation, headaches, dizziness, loss of consciousness, along with and damage to kidney,

liver, blood and/or bone marrow from repeated exposure. These relate to the solvent rather than the notified polymer.

The MSDS for Sandosperse Blue A-B2G, a Sandosperse A products, indicates that it is classified as a hazardous substance. It will cause eye irritation. Any inhalation exposure should be avoided.

Both Disperbyk 140 and Sandosperse Blue A-B2G are classed as a Class 3 dangerous good (flammable liquid) because of the solvent content.

Occupational Health and Safety

There is little potential for significant occupational exposure to the notified polymer in the transport and storage of the polymer solution and paint components containing this polymer unless the packaging is breached. The risk of adverse effects in these workers is minimal.

During the reformulation process, the main exposure route for the notified polymer will be dermal. The polymer is not expected to be hazardous by dermal exposure as the high molecular weight will preclude absorption through the skin. Protective measures used to prevent exposure to the hazardous solvents should provide sufficient protection against the notified polymer.

The final paint mix containing <1% notified polymer could contain a variety of additional ingredients, including solvents that may introduce additional human health hazards. The spraying procedure also produces a dense aerosol of paint particles which could adversely affect human health in the absence of additional hazardous components. It is also probable that professionals involved in the spray painting industry will use a number of different paint formulations.

For these reasons, the notified polymer must be assessed for the contribution it makes to the hazards associated with use of the spray paints. The presence of many potential and actual hazardous substances in the formulations requires the use of stringent engineering controls, such as a correctly constructed and maintained spray booth, and of a high level of personal protective equipment, such as impermeable overalls and gloves and a full face shield and respirator. The use of the paint containing the notified polymer should be in accordance with the NOHSC *National Guidance Material for Spray Painting* (NOHSC, 1999c). Employers will need to adhere to any relevant exposure standards. The level of protection from exposure afforded by the standard protective measures will provide adequate protection from the notified polymer, which is likely to be less intrinsically toxic than most of the solvents, pigments and other paint resins.

Once the applied final paint mix has hardened, the polymer will not be separately available for exposure or absorption.

The paint components containing the notified polymer are flammable due to their solvent content. Precautions must be taken to avoid sources of ignition, e.g. use of earthing leads. Operators should wear antistatic overalls and footwear.

Similar considerations apply in the disposal of the polymer. The wastes containing the notified polymer may be hazardous substances on the basis of the solvent and other resin content, and the precautions used on the basis of these additional materials should be

adequate for protection from the notified polymer. In addition, much of the polymer will be crosslinked, hardened and immobilised by the time of disposal.

Public Health

Public exposure to the notified polymer is essentially limited to dermal contact with the cured paint. Curing binds the polymer in the paint matrix and to the underlying primer. The notified chemical will therefore not be biologically available. The notified chemical also has a high molecular weight and is present at low concentrations, ¼ - 1%. As such the notified chemical is not likely to pose a significant risk to public health.

13. RECOMMENDATIONS

Regulatory controls

- Use the following risk phrases for Disperbyk 140 and Sandosperse A products containing the notified polymer:
 - R10 Flammable
 - R36 Irritating to eyes
- Disperbyk 140 and Sandosperse A products should be classified as follows under the ADG Code:
 - Class 3 Packaging group III

Control Measures

- Employers should implement the following engineering controls and safe work practices to minimise occupational exposure to Disperbyk 140 and Sandosperse A products containing the notified polymer:
 - The use of the paint containing the notified polymer should be in accordance with the NOHSC *National Guidance Material for Spray Painting*.
- Employers should ensure that the following personal protective equipment is used by workers to minimise occupational exposure to Disperbyk 140 and Sandosperse A products containing the notified polymer:
 - impervious gloves,
 - anti-static flame retardant overalls,
 - safety boots,
 - safety glasses/goggles,
 - full face shield and respirator while inside the spray booth.

Guidance in selection of personal protective equipment can be obtained from Australian, Australian/New Zealand or other approved standards.

- Atmospheric monitoring should be conducted to measure workplace concentrations during formulation and use of the paints containing the notified polymer. Exposures must be maintained at lower than the relevant NOHSC Exposure Standards.
- A copy of the MSDS should be easily accessible to employees.

- If products and mixtures containing the notified polymer are classified as hazardous to health in accordance with the NOHSC *Approved Criteria for Classifying Hazardous Substances*, workplace practices and control procedures consistent with provisions of State and Territory hazardous substances legislation must be in operation.

13.1 Secondary notification

The Director of Chemicals Notification and Assessment must be notified in writing within 28 days by the notifier, other importer or manufacturer:

- (1) Under Section 64(2) of the Act:
 - if any of the circumstances listed in the subsection arise.

The Director will then decide whether secondary notification is required.

No additional secondary notification conditions are stipulated.

14. MATERIAL SAFETY DATA SHEET

The MSDS for polymer solution and representative Sandosperse A products were provided in a format consistent with the *National Code of Practice for the Preparation of Material Safety Data Sheets* (NOHSC, 1994).

These MSDS were provided by the applicant as part of the notification statement. They are reproduced here as a matter of public record. The accuracy of this information remains the responsibility of the applicant.

15. REFERENCES

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

Douds DA (1998) A primary eye irritation study in rabbits with BYK-LP-N-6735, SLI Study No 3465.1, Springborn Laboratories Inc, USA.

Fortunato K (1999) Salmonella typhimurium and Escherichia coli reverse mutation assay of BYK-LP R 6795, Project No 71604, Nucro-Technics Inc, Canada.

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.

National Occupational Health and Safety Commission (1995) *Adopted National Exposure Standards for Atmospheric Contaminants in the Occupational Environment*, [NOHSC:1003(1995)]. In: *Exposure Standards for Atmospheric Contaminants in the*

Occupational Environment: Guidance Note and National Exposure Standards. Australian Government Publishing Service, Canberra.

National Occupational Health and Safety Commission (1999a) List of Designated Hazardous Substances [NOHSC:10005(1999)]. Australian Government Publishing Service, Canberra. In Press.

National Occupational Health and Safety Commission (1999b) Approved Criteria for Classifying Hazardous Substances [NOHSC:1008(1999)]. Australian Government Publishing Service, Canberra.

National Occupational Health and Safety Commission (1999c) National Guidance Material for Spray Painting. Australian Government Publishing Service, Canberra.

Attachment 1

The Draize Scale (Draize, 1959) for evaluation of skin reactions is as follows:

<i>Erythema Formation</i>	<i>Rating</i>	<i>Oedema Formation</i>	<i>Rating</i>
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 (Draize *et al.*, 1944) for evaluation of eye reactions is as follows:

CORNEA

<i>Opacity</i>	<i>Rating</i>	<i>Area of Cornea involved</i>	<i>Rating</i>
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

<i>Redness</i>	<i>Rating</i>	<i>Chemosis</i>	<i>Rating</i>	<i>Discharge</i>	<i>Rating</i>
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

<i>Values</i>	<i>Rating</i>
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

Draize, J. H., Woodward, G., Calvery, H. O. (1944) Methods for the Study of Irritation and Toxicity of Substances Applied Topically to the Skin and Mucous Membranes, J. Pharmacol. Exp. Ther. 82 : 377-390.

Draize J. H. (1959) Appraisal of the Safety of Chemicals in Foods, Drugs and Cosmetics. Association of Food and Drug Officials of the US, 49 : 2-56.