Anthraquinone-based dyes with limited data availability: Human health tier II assessment

24 April 2015

Chemicals in this assessment

Chemical Name in the Inventory	CAS Number
9,10-Anthracenedione, 1-amino-2-methyl-	82-28-0
9,10-Anthracenedione, 1-amino-4-hydroxy-	116-85-8
9,10-Anthracenedione, 1-amino-4-(methylamino)-	1220-94-6
9,10-Anthracenedione, 1-hydroxy-4-[[4-[(methylsulfonyl)oxy]phenyl]amino]-	1594-08-7
9,10-Anthracenedione, 1,4-bis(methylamino)-	2475-44-7
C. I. Disperse Blue 3	2475-46-9
9,10-Anthracenedione, 1-amino-4-(phenylamino)-	4395-65-7
9,10-Anthracenedione, 1-[(3-aminopropyl)amino]-	13556-29-1
9,10-Anthracenedione, 1,4-bis(butylamino)-	17354-14-2

Chemical Name in the Inventory	CAS Number
9,10-Anthracenedione, 1-amino-4-hydroxy-2-(2-hydroxyethoxy)-	17869-07-7
9,10-Anthracenedione, 1,8-dihydroxy-4-nitro-5-(phenylamino)-	20241-76-3
9,10-Anthracenedione, 1-[(3-aminopropyl)amino]-4-(methylamino)-	22366-99-0
9,10-Anthracenedione, 1-amino-4,5-dihydroxy-8-(methylamino)-	56524-77-7
9,10-Anthracenedione, 1-amino-4-[[4-[(dimethylamino)methyl]phenyl]amino]-, monohydrochloride	67905-56-0
9,10-Anthracenedione, 1,8-dihydroxy-4-[[4-[2-hydroxy-1-(hydroxymethyl)ethyl]phenyl]amino]-5-nitro-	114565-66-1
9,10-Anthracenedione, 1-[(2-hydroxyethyl)amino]-4-(methylamino)-	86722-66-9

Preface

This assessment was carried out by staff of the National Industrial Chemicals Notification and Assessment Scheme (NICNAS) using the Inventory Multi-tiered Assessment and Prioritisation (IMAP) framework.

The IMAP framework addresses the human health and environmental impacts of previously unassessed industrial chemicals listed on the Australian Inventory of Chemical Substances (the Inventory).

The framework was developed with significant input from stakeholders and provides a more rapid, flexible and transparent approach for the assessment of chemicals listed on the Inventory.

Stage One of the implementation of this framework, which lasted four years from 1 July 2012, examined 3000 chemicals meeting characteristics identified by stakeholders as needing priority assessment. This included chemicals for which NICNAS already held exposure information, chemicals identified as a concern or for which regulatory action had been taken overseas, and chemicals detected in international studies analysing chemicals present in babies' umbilical cord blood.

Stage Two of IMAP began in July 2016. We are continuing to assess chemicals on the Inventory, including chemicals identified as a concern for which action has been taken overseas and chemicals that can be rapidly identified and assessed by using Stage One information. We are also continuing to publish information for chemicals on the Inventory that pose a low risk to human health or the environment or both. This work provides efficiencies and enables us to identify higher risk chemicals requiring assessment.

The IMAP framework is a science and risk-based model designed to align the assessment effort with the human health and environmental impacts of chemicals. It has three tiers of assessment, with the assessment effort increasing with each tier. The Tier I assessment is a high throughput approach using tabulated electronic data. The Tier II assessment is an evaluation of risk on a substance-by-substance or chemical category-by-category basis. Tier III assessments are conducted to address specific concerns that could not be resolved during the Tier II assessment.

These assessments are carried out by staff employed by the Australian Government Department of Health and the Australian Government Department of the Environment and Energy. The human health and environment risk assessments are conducted and published separately, using information available at the time, and may be undertaken at different tiers.

This chemical or group of chemicals are being assessed at Tier II because the Tier I assessment indicated that it needed further investigation.

For more detail on this program please visit:**www.nicnas.gov.au**

Disclaimer

ACRONYMS & ABBREVIATIONS

Grouping Rationale

The critical health concern for the chemicals in this group is the potential for carcinogenic effects following exposure.

All the chemicals in this group are diversely functionalised anthraquinones containing an anthracene-9,10-dione—an anthracene derivative with two ketone groups attached to the central benzene ring. The chemicals in this group could contain one or more functional groups that differ for each chemical, although all include amine substituents. These chemicals have similar physical–chemical properties and have similar uses. However, due to the range of functional groups present in the chemicals being assessed, they are not considered to be toxicologically similar for local toxicity effects, including sensitisation.

Toxicological data for the chemicals in this group are limited. For such chemicals, NICNAS will commonly use the principles of 'read across' in accordance with the Organisation for Economic Co-operation and Development (OECD) *Guidance on grouping of chemicals* (OECD, 2014) based on known properties of similar chemicals (analogues). The quality of the data used depends on the similarity of the analogues to the chemicals.

Import, Manufacture and Use

Australian

The chemicals, C.I. Disperse Red 15 (CAS No. 116-85-8); C.I. Disperse Violet 4 (CAS No. 1220-94-6); C.I. Disperse Blue 3 (CAS No. 2475-46-9); HC Red No. 8 (CAS No. 13556-29-1); and HC Blue No. 8 (CAS No. 22366-99-0) are included in the ‘List of chemicals used as dyes in permanent and semi-permanent hair dyes in Australia’ (NICNAS, 2007).

International

The following international uses have been identified through:

- Galleria Chemica;
- the Substances and Preparations in Nordic countries (SPIN) database;
- the European Commission Cosmetic Ingredients and Substances (CosIng) database;

- the United States (US) Personal Care Product Council International Nomenclature of Cosmetic Ingredients (INCI) Dictionary;
- the US National Library of Medicine's Hazardous Substances Data Bank (HSDB); and
- various international assessments (NTP, 2014; Haz-Map; HPD).

The following chemicals have reported cosmetic uses as hair dye substances in oxidative and/or oxidative hair dye products: C. I. Disperse Red 15; C.I. Disperse Violet 4; C.I. Disperse Blue 3; HC Red No. 8; HC Blue No. 8; C.I. Solvent Blue 35 (CAS No. 17354-14-2); Toray blue (CAS No. 86722-66-9); and CAS No. 67905-56-0.

C.I. Disperse Blue 3 has reported domestic, commercial and site-limited uses as a dye for synthetic fibres (e.g., acetate, nylon, and acrylic), wool sheepskins, furs, and plastics. In the European Union (EU), this chemical has been used in gloves (RAPEX, 2015).

C.I. Disperse Orange 11 (CAS No. 82-28-0) is used a dye and an intermediate in manufacturing anthraquinone dyes (NCI, 1978; NTP, 2014). It is also used to dye a variety of synthetic fibres as well as wool, sheepskins and furs, and additionally, for surface dyeing thermoplastics (NCI, 1978). It is no longer commercially produced or imported in the US (NTP, 2014).

C.I. Disperse Blue 14 (CAS No. 2475-44-7) has reported commercial use in lubricants and additives.

CAS No. 20241-76-3 has reported domestic use as a colouring agent (SPIN).

C.I. Solvent 35 has site-limited, commercial and domestic uses in lubricants and additives; cleaning and washing agents; surface treatments; construction materials; anti-condensation agents; and adhesive binding agents.

Restrictions

Australian

No known restrictions have been identified.

International

The following chemicals are restricted in the EU Cosmetics Regulation 1223/2009 Annex II—List of substances prohibited in cosmetic products: C.I. Disperse Red 15; C.I. Disperse Violet 4; C.I. Disperse Blue 3; C.I. Solvent Blue 35; HC Blue No. 8; HC Red No. 8; Toray blue; CAS No. 67905-56-0; and CAS No. 114565-66-1 (CosIng).

The chemicals C.I. Disperse Red 15 and HC Red No. 8 are listed in the following (Galleria Chemica):

- ASEAN Cosmetic Directive Annex II Part 1: List of substances which must not form part of the composition of cosmetic products; and
- New Zealand Cosmetic Products Group Standard—Schedule 4: Components cosmetic products must not contain.

C.I. Solvent Blue 35 is listed in the following (Galleria Chemica):

- ASEAN Cosmetic Directive Annex II Part 1: List of substances which must not form part of the composition of cosmetic products; and
- Health Canada List of prohibited and restricted cosmetic ingredients (The Cosmetic Ingredient ‘Hotlist’); and
- Chile List of banned substances for use in cosmetics.

CAS No. 114565-66-1 is listed in the following (Galleria Chemica):

- ASEAN Cosmetic Directive Annex II Part 1: List of substances which must not form part of the composition of cosmetic products;
- New Zealand Cosmetic Products Group Standard—Schedule 4: Components cosmetic products must not contain; and
- Chile List of banned substances for use in cosmetics.

For C.I. Disperse Blue 3, the New Zealand Environmental Protection Agency recommends that tattoo and permanent make up substances should not contain or release the chemical (NZ EPA, 2012).

Existing Worker Health and Safety Controls

Hazard Classification

CAS No. 114565-66-1 is classified as hazardous, with the following risk phrases for human health in the Hazardous Substances Information System (HSIS) (Safe Work Australia):

- Xi; R43 (sensitisation)
- R40 Carc. Cat 3 (carcinogenicity)

Exposure Standards

Australian

No specific exposure standards are available.

International

No specific exposure standards are available.

Health Hazard Information

Based on a review of publicly available hazard information in accordance with the Inventory Multi-Tiered Assessment and Prioritisation (IMAP) Framework (NICNAS, 2013), a lack of empirical toxicokinetics and toxicological data were identified for all of the chemicals in this group. Hence, read across information from the following structurally-related chemicals will be considered in the current assessment:

- CAS No. 84-65-1 (anthraquinone) (NICNASa);
- CAS No. 2475-45-8 (C.I. Disperse Blue 1) (NICNASb);
- CAS No. 117-10-2 (Danthron) (NICNASc); and
- CAS No. 81-49-2 (ADBAQ) (NICNASd).

Based on the critical health effects of these chemicals, the focus of this assessment is carcinogenicity.

Toxicokinetics

Generally, anthraquinones can enter the body via oral, dermal and inhalation routes.

Anthraquinones are generally lipophobic and hydrophobic (Jaskot & Costa, 1994). Although data for absorption, distribution, and metabolism for these chemicals are limited, anthraquinones undergo metabolic transformation via one or two electron reductions facilitated by flavoenzymes in the presence of suitable electron donors (Bolton et al., 2000). Anthraquinones can undergo one-electron reduction by oxidoreductases (NADPH-cytochrome P450, NADH dehydrogenase, or xanthine oxidase) to produce a semi-quinone free radical. Upon auto-oxidation, this free radical can produce cytotoxic reactive oxygen species (Doi et al., 2005). Ring hydroxylation could also occur as observed in the parent compound 9,10-anthracenedione (anthraquinone; CAS No. 84-65-1) (NICNASa). However, this metabolic process could be potentially sterically hindered (Doi et al. 2005).

Based on the read across information from amine-substituted anthraquinones (C.I. Disperse Blue 1 and ADBAQ), the chemicals in this group are likely to undergo metabolism similarly to aromatic amines. Metabolically, aromatic amines undergo ring oxidation, N-glucuronidation, N-acetylation, and N-oxidation (SCCNFP, 2002). The toxicity of these chemicals is largely influenced by N-oxidation, a process primarily mediated by cytochrome P450 enzymes, such as CYP1A2 and CYP3A4, although other enzymes could also play a role. The resulting metabolic products are demonstrated to be highly reactive and are capable of DNA binding.

Metabolically, the halogen- and nitro-bearing anthraquinones can undergo reductive dehalogenation and nitroreduction. Additionally, planar anthraquinones have been reported to be aryl hydrocarbon receptor (AhR) agonists (Amakura et al., 2014).

Doi et al. (2005) reported that the metabolism, toxicity and the target organs, especially for carcinogenicity of anthraquinones, are determined by the functional groups of the chemicals. The amino and methyl functional groups are *ortho* and *para* directors. The amino groups are considered strong activators, while the methyl groups are weak activators. Hence, an anthraquinone containing both functional groups is likely to be more reactive because of the ensuing additive effects (Doi et al., 2005). The order of mutagenicity of the functionalised anthraquinones have been reported to be NO_2> OH>NH_2 (Brown & Brown, 1976). Based on the data from all analogues, the target organs for toxicity can include the liver, kidney and urinary bladder, forestomach, intestines, and lungs (Doi et., 2005; NICNASa; NICNASb, NICNASd).

Sensitisation

Skin Sensitisation

Data are limited for the chemicals in this group. However, CAS No. 114565-66-1 is classified as hazardous with the risk phrase ‘May cause sensitisation by skin contact’ (R43) in the HSIS (Safe Work Australia). No data are available to support this classification.

C.I. Disperse Blue 3 is included in the list of 20 dyestuffs that are classified as allergenic. According to the EU-based Oko-tex Standard 100 edition 01/2008 (an independent test and certification system for all types of textiles), 'textiles are not allowed to contain more than 50 mg/kg of the chemical' (Starink, 2012).

The parent anthraquinone and C.I. Disperse Blue 1 are skin sensitisers (NICNASa; NICNASb).

Genotoxicity

Based on the limited data available, it is not possible to draw a definite conclusion about the genotoxicity of the chemicals in this group. The metabolic reactions identified above are consistent with the mutagenic action of a range of aromatic amines. The data on the other anthraquinone derivatives assessed under IMAP are also ambivalent, without any clear evidence of genotoxicity. Although available data are neither sufficient nor adequately comprehensive for classification, a genotoxic mode of action cannot be ruled out for any of the chemicals in this group.

The chemical, C.I. Disperse Orange 11, was mutagenic in the Ames test (*Salmonella typhimurium*) in strain TA1537 with or without metabolic activation and induced sister chromatid exchange (SCE) and chromosomal aberrations (CA) in V79 hamster cell lines (Simi et al., 1995). When tested in V79 cells containing only the reductive pathway enzymes, the chemical caused weak SCE induction (Simi et al., 1995). Without metabolic activation, the chemical tested positive in a mouse lymphoma cell

mutagenicity assay and micronuclei formation (NTP, 2002). Additionally, HC Red No. 8 was mutagenic in *S. typhimurium* strain TA1535 with or without metabolic activation (SCCNFP, 2003).

Several of these chemicals are suggested to be mutagenic in the three different patterns:

1. direct frameshift mutations by certain derivatives bearing free hydroxyl groups;
2. frameshift mutagenesis by certain derivatives with primary (and in a few cases, secondary) amine groups (potentiated by microsomal activation); and
3. anthraquinones with one or more nitro groups showed least specificity with regard to *S. typhimurium* tester strains and to microsomal activation (all nitro-bearing anthraquinones tested were mutagenic) (Brown & Brown, 1976).

Limited data are available for in the vivo genotoxicity of the chemicals in this group.

Carcinogenicity

Limited data are available for the carcinogenic potential of the chemicals in this group.

The chemical, CAS No. 114565-66-1, is classified as hazardous—Category 3 carcinogenic substance—with the risk phrase 'Limited evidence of carcinogenic effect' (Xn; R40 in the HSIS (Safe Work Australia). While there are no available data to support the classification, in the absence of more comprehensive information, there is insufficient evidence to recommend removal of the current HSIS classification.

The chemical, C.I. Disperse Orange 11, has been reported to induce tumours in rats and mice. Long-term oral exposure of Fischer 344 (F344) rats and B6C3F1 mice to C.I. Disperse Orange 11 increased the prevalence of hepatocellular and renal neoplasms (NCI, 1978). Consistently with other anthraquinones (NICNASa; NICNASb; NICNASc; NICNASd), rats were more sensitive to the tumourigenic effect of the chemical than mice. In rats, exposure to C.I. Disperse Orange 11 resulted in liver cancer in males and females and a combined incidence of tubular-cell adenoma and carcinoma (benign and malignant kidney tumours) in males only (NTP, 2014). In female mice, a combined incidence of hepatocellular adenoma and carcinoma was observed following exposure to C.I. Disperse Orange 11. In addition to cancer effects, chronic exposure to the chemical caused renal tract alterations such as glomerulonephritis and interstitial nephritis. These effects have been attributed to the intermediate formation of an N-hydroxylated compound (Marrs et al., 1988). The data are considered sufficient to warrant classification for this chemical.

The National Toxicological Program (NTP) has classified C.I. Disperse Orange 11 as 'reasonably anticipated to be a human carcinogen' based on sufficient evidence of carcinogenicity from studies in experimental animals (NTP, 2014).

Although data are not available for the other chemicals in this group, the structurally-related compounds, the parent anthraquinone and the substituted forms, C.I. Disperse Blue 1, Danthron and ADBAQ are carcinogens (NICNASa; NICNASb; NICNASc; NICNASd).

It has been suggested that functional group substitution of anthraquinones can influence toxicity and the target organs, especially for carcinogenicity (Doi et al., 2005; NICNASa; NICNASb; NICNASc; NICNASd). The target organs for carcinogenicity appear to differ for each functional group(s) as follows:

- liver, kidney and urinary bladder—parent anthraquinone (CAS No. 84-65-1);
- liver and urinary bladder—amino group (NH_2);
- liver and kidney—methyl + amino groups (CH_3, NH_2);
- liver, kidney, urinary bladder, and intestines—amino + halogen groups (dibromo) (NH_2, Br);
- liver—nitro group (NO_2); and
- liver, urinary bladder, and intestine—hydroxyl group (OH).

All of the chemicals in this group include amine functional groups, with some also containing substituted alkyl, hydroxyl and nitro groups.

Anthraquinones have the potential to promote tumour induction in rodents. This was demonstrated by the increased incidence and multiplicity of colon and liver adenomas in mice following oral co-exposure to both a substituted anthraquinone (e.g. CAS No. 117-10-2) and a tumour initiator, the 1,2-dimethylhydrazine (DMH) (NICNASc).

There are no epidemiological studies available to demonstrate a direct association between exposure to anthraquinone dyes and human cancer. However, an increased incidence of bladder cancer has been observed among textile workers in Leeds with suspected C.I. Disperse Orange 11 exposure (NCI, 1978). In two cohort studies, significant increases of oesophageal and prostate cancer were reported in workers in a Scottish dyestuff plant, and statistically significant risks were reported for lung and central nervous system cancers in workers in a New Jersey manufacturing plant that produced anthraquinone dyes and their intermediates, azo dyes and epichlorohydrin (NICNASd). However, these studies had a number of limitations including the small study size, the lack of exposure measurements and exposure to multiple chemicals (NICNASa; NICNASd). Therefore, no conclusion could be drawn.

Although the mechanism of action for the long-term systemic toxicity of the chemicals in this group (carcinogenicity) remains unclear, anthraquinones can interact directly with DNA via intercalation due to the size and planarity of the rings (Simi et al., 1995; ECHA, 2015). DNA intercalation has been suggested to be one of the mechanisms responsible for the toxicity of anthraquinones (Simi et al., 1995).

Quinones are highly redox active molecules capable of mediating formation of oxygen radicals via redox cycling, which results in lipid peroxidation, DNA damage and oxidation of protein thiols (Wolfe et al., 1990). In one study, a substituted anthraquinone (CAS No. 81-49-2; ADBAQ) was highly toxic following irradiation with visible and simulated solar light sources in *Daphnia magna*. The observed photosensitisation response is likely to be due to formation of highly reactive free radicals such as superoxide anion and singlet oxygen species, which could ultimately cause tissue damage. Levels of the reactive oxygen species were reduced after treatment with anti-oxidants such as vitamins C and E and beta-carotene (NICNASd). This suggests that oxidative DNA damage is likely to play a role in the toxicity of the chemicals in the group.

Additionally, the enzyme-mediated formation of active metabolites and the impurities produced during synthesis of anthraquinones could also play a role in the carcinogenity of the chemicals (Doi et al., 2005; ECHA, 2015). A genotoxic mode of action cannot be ruled out.

Based on the data for CAS No. 114565-66-1, and information for the parent anthraquinone and the substituted anthraquiones (C.I. Disperse Orange 11, Danthron, C.I. Disperse Blue 1 and ADBAQ), the chemicals in this group are likely to have carcinogenic properties.

Risk Characterisation

Critical Health Effects

Based on the limited data available, the chemicals have been identified as having the potential to cause a systemic long-term effect (carcinogenicity). Whilst the mechanism of action for the carcinogenicity of the anthraquinones is still unclear, a genotoxic mode of action cannot be ruled out. Some of the chemicals in this group could also have the potential to cause skin sensitisation. Other health hazards have not been considered in this assessment.

Public Risk Characterisation

The public could be exposed to the chemicals in this group if they are used in hair dye preparations in Australia. The extent of current usage is unknown.

The directions for use in hair dye preparations normally include instructions for pre-testing for skin sensitisation. Therefore, the local effects, including skin sensitisation, are not a high priority for further assessment compared with the concerns about carcinogenicity which, if validated, would be expected to be the dominant driver for appropriate risk management measures.

The following chemicals have been identified as having potential cosmetic use (in hair dyes) in Australia: C.I. Disperse Red 15; C.I. Disperse Violet 4; C.I. Disperse Blue 3; HC Red No. 8; and HC Blue No. 8. These chemicals, including CAS No. 17354-14-

2; CAS No. 67905-56-0 and CAS No. 86722-66-9, were reported to have cosmetic use overseas and several are restricted internationally, particularly for use in cosmetics (see **Restrictions: International**).

Overall, there is sufficient uncertainty regarding the safety of these chemicals in cosmetic products and, therefore, a Tier III assessment, including consultation with industry to determine the extent of use and the availability of further sensitisation and carcinogenicity data, is recommended (see **NICNAS Recommendation**). In the absence of additional information, a conservative assessment based on Quantitative Structure Activity Relationship (QSAR) and inference from analogue information could be undertaken and relevant recommendations made.

Occupational Risk Characterisation

During product formulation, exposure of workers to the chemicals may occur, particularly where manual or open processes are used. These can include transfer and blending activities, quality control analysis, and cleaning and maintaining equipment. Worker exposure to the chemical at lower concentrations can also occur while using formulated products containing the chemical. The level and route of exposure will vary depending on the method of application and work practices employed.

The occupations as a hairdresser or barber have been classified by the International Agency for Research on Cancer (IARC) as a Group 2A (Probably carcinogenic to humans) carcinogen (IARC, 2012).

Overall, there is sufficient uncertainty regarding the hazards of these chemicals in the workplace; therefore, a Tier III assessment is required (see **NICNAS Recommendation**) to determine the appropriate occupational controls.

NICNAS Recommendation

The chemicals in this group are recommended for Tier III assessment to determine whether:

- the chemicals are still used in hair dye preparations in Australia considering the prohibitions and/or restrictions overseas;
- there are any other uses of the chemicals in Australia;
- there is any available toxicological information that is not accessible in the publicly-available literature to better characterise the hazards of the chemicals; and
- risk management controls are required.

Regulatory Control

Work Health and Safety

A classification for skin sensitisation applies for CAS No. 114565-66-1.

The classification for carcinogenicity applies for CAS Nos. 114565-66-1 and 82-28-0.

Further classification for skin sensitisation, genotoxicity and carcinogenicity could follow from Tier III assessments.

Hazard	Approved Criteria (HSIS)[a]	GHS Classification (HCIS)[b]
Sensitisation	May cause sensitisation by skin contact (Xi; R43)*	May cause an allergic skin reaction - Cat. 1 (H317)

Hazard	Approved Criteria (HSIS)[a]	GHS Classification (HCIS)[b]
Carcinogenicity	Carc. Cat 3 - Limited evidence of a carcinogenic effect (Xn; R40)	Suspected of causing cancer - Cat. 2 (H351)

[a] Approved Criteria for Classifying Hazardous Substances [NOHSC:1008(2004)].

[b] Globally Harmonized System of Classification and Labelling of Chemicals (GHS) United Nations, 2009. Third Edition.

[*] Existing Hazard Classification. No change recommended to this classification

Advice for industry

Control measures

Control measures to minimise the risk from dermal and inhalation exposure to the chemicals should be implemented in accordance with the hierarchy of controls. Approaches to minimise risk include substitution, isolation and engineering controls. Measures required to eliminate, or minimise risk arising from storing, handling and using a hazardous chemical depend on the physical form and the manner in which the chemical is used. Examples of control measures which could minimise the risk include, but are not limited to:

- using closed systems or isolating operations;
- health monitoring for any worker who is at risk of exposure to the chemical, if valid techniques are available to monitor the effect on the worker's health;
- minimising manual processes and work tasks through automating processes;
- work procedures that minimise splashes and spills;
- regularly cleaning equipment and work areas; and
- using protective equipment that is designed, constructed, and operated to ensure that the worker does not come into contact with the chemical.

Guidance on managing risks from hazardous chemicals are provided in the *Managing risks of hazardous chemicals in the workplace—Code of practice* available on the Safe Work Australia website.

Personal protective equipment should not solely be relied upon to control risk and should only be used when all other reasonably practicable control measures do not eliminate or sufficiently minimise risk. Guidance in selecting personal protective equipment can be obtained from Australian, Australian/New Zealand or other approved standards.

Obligations under workplace health and safety legislation

Information in this report should be taken into account to help meet obligations under workplace health and safety legislation as adopted by the relevant state or territory. This includes, but is not limited to:

- ensuring that hazardous chemicals are correctly classified and labelled;
- ensuring that (material) safety data sheets ((M)SDS) containing accurate information about the hazards (relating to both health hazards and physicochemical (physical) hazards) of the chemical are prepared; and
- managing risks arising from storing, handling and using a hazardous chemical.

Your work health and safety regulator should be contacted for information on the work health and safety laws in your jurisdiction.

Information on how to prepare an (M)SDS and how to label containers of hazardous chemicals are provided in relevant codes of practice such as the *Preparation of safety data sheets for hazardous chemicals—Code of practice* and *Labelling of workplace*

hazardous chemicals—Code of practice, respectively. These codes of practice are available from the Safe Work Australia website.

A review of the physical hazards of the chemicals has not been undertaken as part of this assessment.

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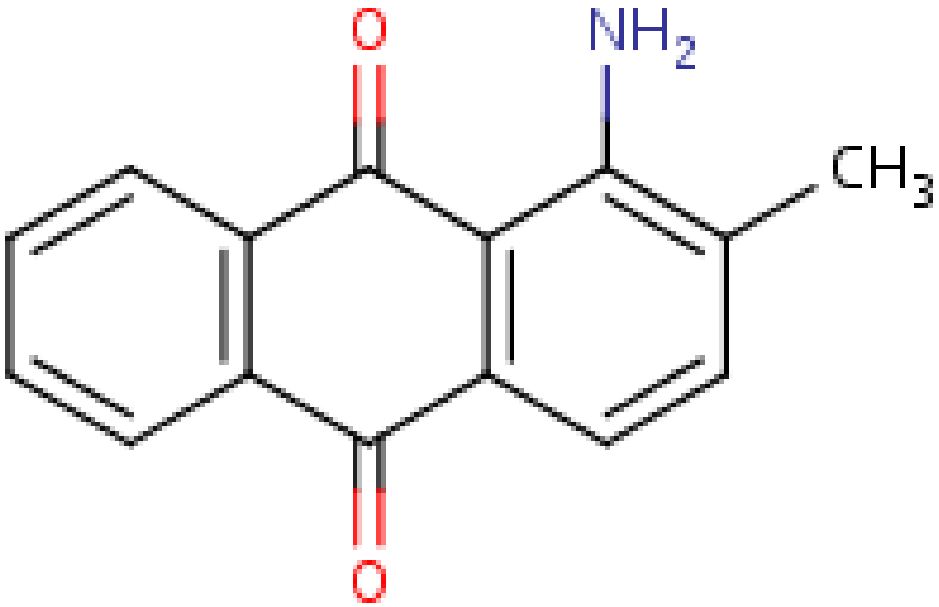
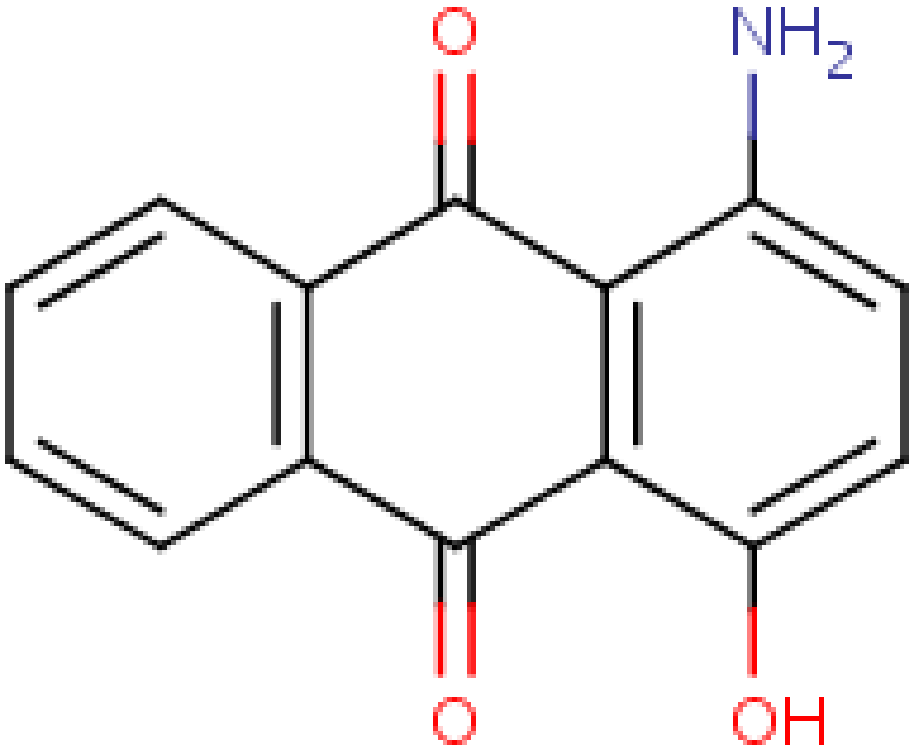
Last Update 24 April 2015

Chemical Identities

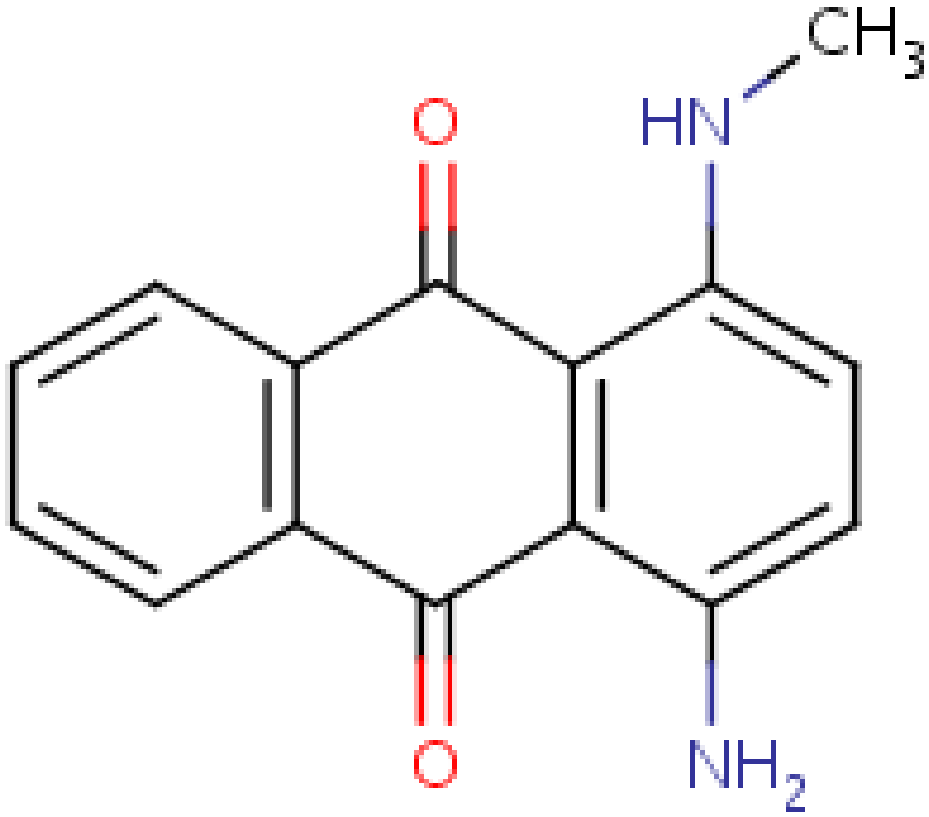
Chemical Name in the	**9,10-Anthracenedione, 1-amino-2-methyl-**

Inventory and Synonyms	1-amino-2-methylanthraquinone C.I. Disperse Orange 11 Anthraquinone, 1-amino-2-methyl- 1-amino-2-methyl-9,10-anthracenedione 2-methyl-1-anthraquinonylamine
CAS Number	82-28-0
Structural Formula	
Molecular Formula	C15H11NO2
Molecular Weight	237.25

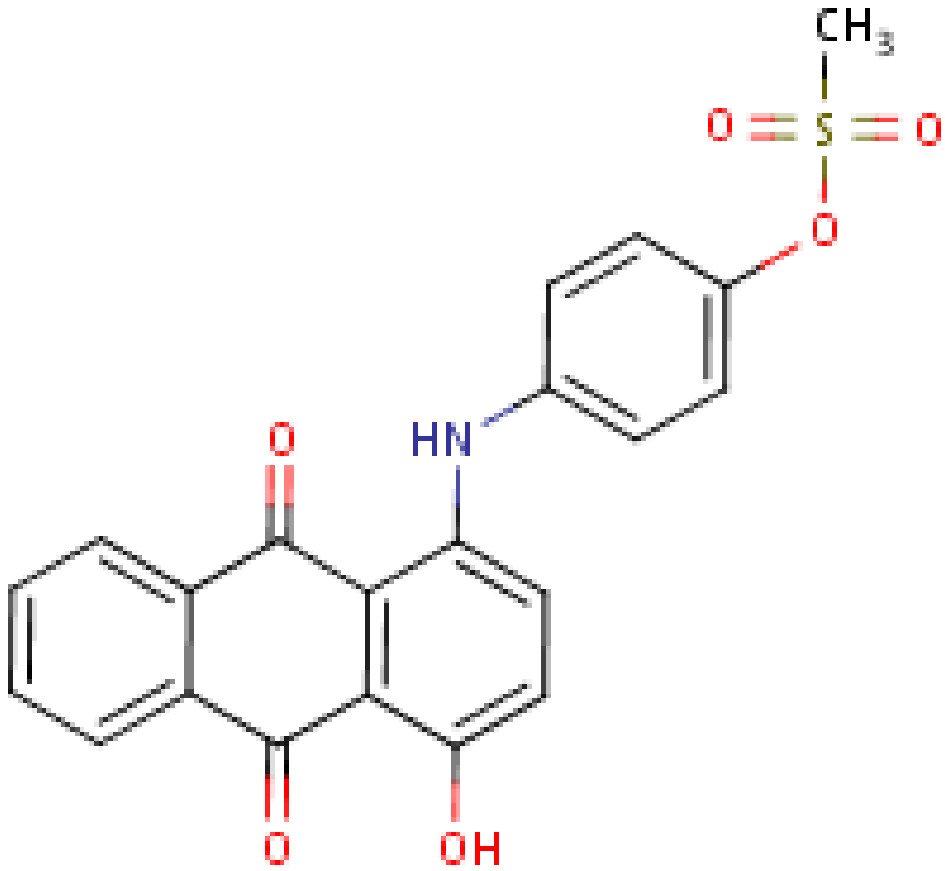
Chemical Name in the Inventory and Synonyms	**9,10-Anthracenedione, 1-amino-4-hydroxy-** 1-amino-4-hydroxy-9,10-anthracenedione C.I. Disperse Red 15 C.I. Solvent Red 53 1-amino-4-hydroxyanthraquinone Acetate Fast Red 2B
CAS Number	116-85-8
Structural Formula	

	
Molecular Formula	C14H9NO3
Molecular Weight	239.23

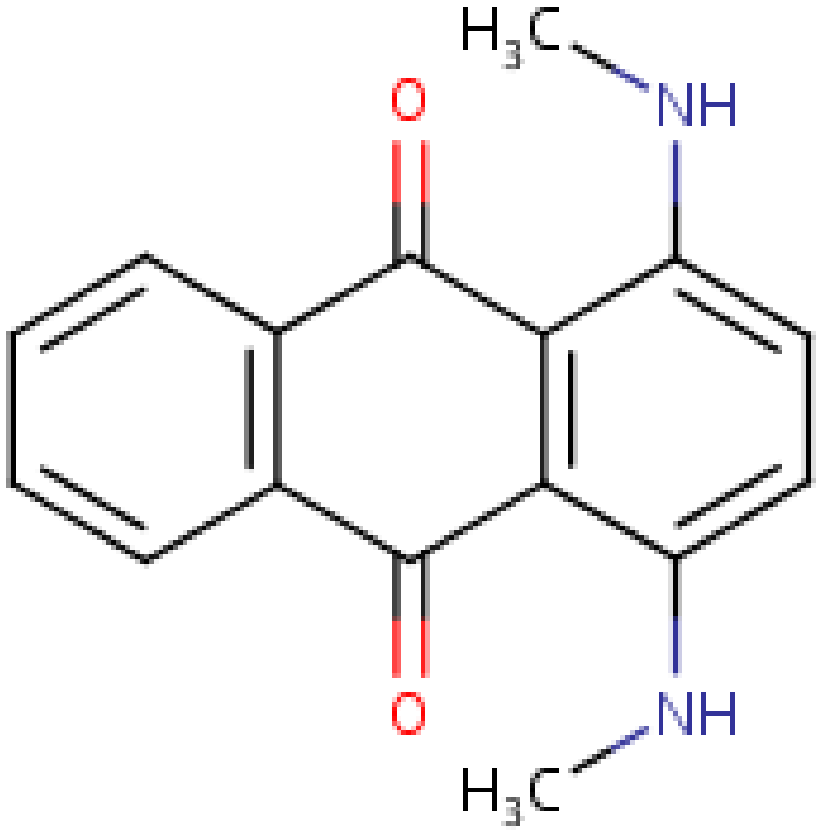
Chemical Name in the Inventory and Synonyms	**9,10-Anthracenedione, 1-amino-4-(methylamino)-** 1-amino-4-(methylamino)-9,10-anthracenedione C.I. Disperse Violet 4 C.I. Solvent Violet 12 anthraquinone, 1-amino-4-methylamino- Acetoquinone Light Violet N
CAS Number	1220-94-6
Structural Formula	

	
Molecular Formula	C15H12N2O2
Molecular Weight	252.27

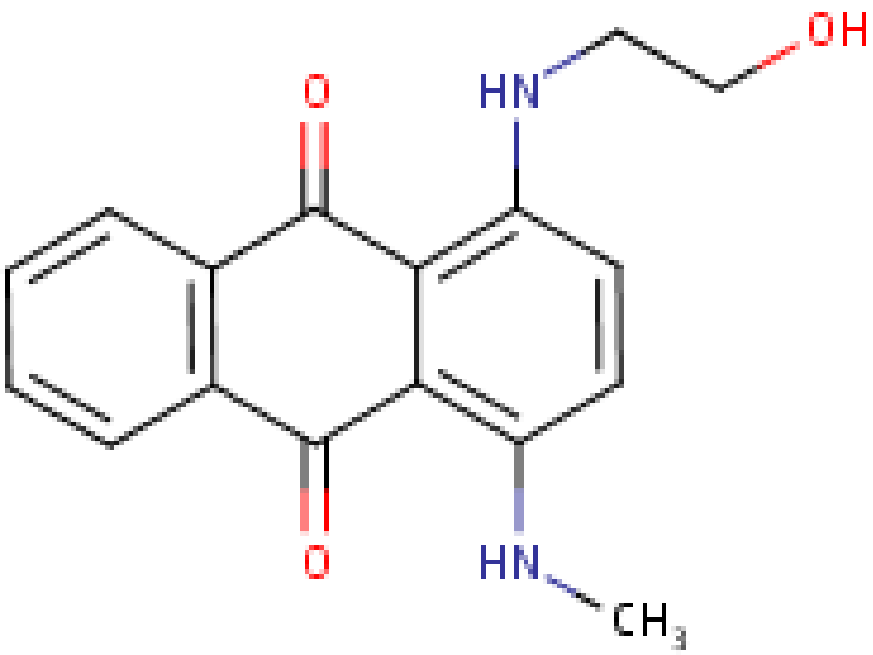
Chemical Name in the Inventory and Synonyms	**9,10-Anthracenedione, 1-hydroxy-4-[[4-[(methylsulfonyl)oxy]phenyl]amino]-** anthraquinone, 1-hydroxy-4-(p-hydroxyanilino)-, 4-methanesulfonate (ester) C.I. Disperse Violet 57 1-hydroxy-4-((4-((methylsulphonyl)oxy)phenyl)amino)anthraquinone
CAS Number	1594-08-7
Structural Formula	

	
Molecular Formula	C21H15NO6S
Molecular Weight	409.42

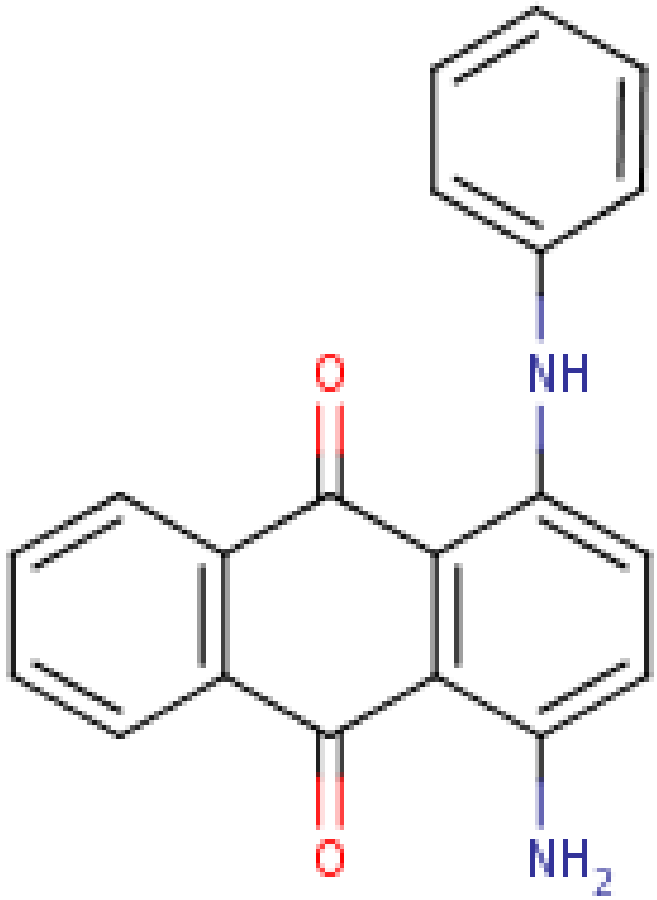
Chemical Name in the Inventory and Synonyms	**9,10-Anthracenedione, 1,4-bis(methylamino)-** 1,4-bis(N-methylamino)anthraquinone 1,4-di(methylamino)anthraquinone C.I. Disperse Blue 14 anthraquinone,1,4-bis(methylamino)- Acetate Blue B
CAS Number	2475-44-7
Structural Formula	

	
Molecular Formula	C16H14N2O2
Molecular Weight	266.30

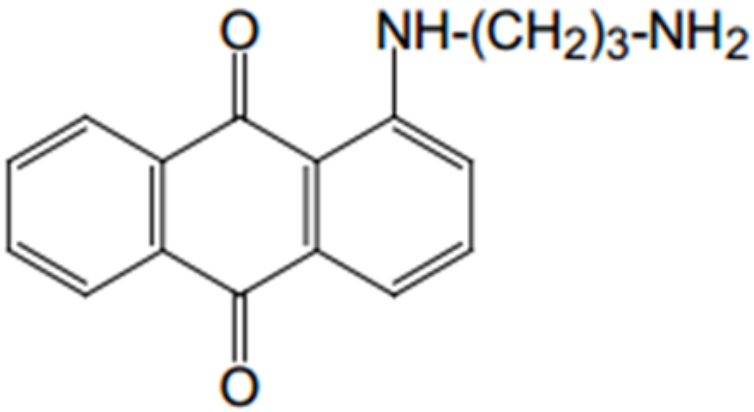
Chemical Name in the Inventory and Synonyms	**C. I. Disperse Blue 3** 9,10-anthracenedione, 1-((2-hydroxyethyl)amino)-4-(methylamino)- 1-methylamino-4-oxyethylaminoanthraquinone 9,10-anthracenedione, 1,4-diamino-, N,N'-mixed 2-hydroxyethyl and Me derivs. Acetate Brilliant Blue 4B Celanthrene Brilliant Blue
CAS Number	2475-46-9
Structural Formula	

	
Molecular Formula	Unspecified
Molecular Weight	296.32

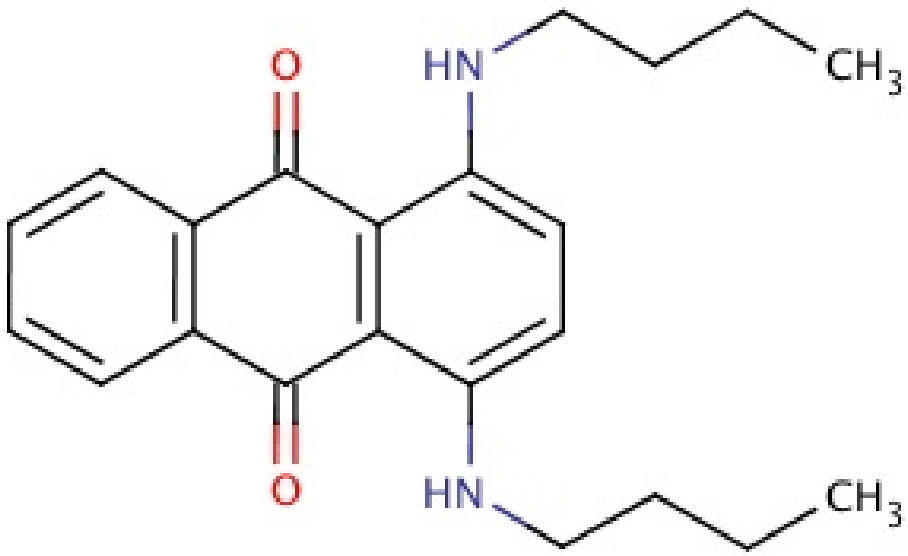
Chemical Name in the Inventory and Synonyms	**9,10-Anthracenedione, 1-amino-4-(phenylamino)-** 1-amino-4-p-toluidinoanthraquinone C.I. Disperse Blue 19 1-amino-4-(phenylamino)anthraquinone 9,10-anthracenedione, 1-amino-4-(phenylamino)- C.I. Solvent Blue 68
CAS Number	4395-65-7
Structural Formula	

	
Molecular Formula	C20H14N2O2
Molecular Weight	314.343

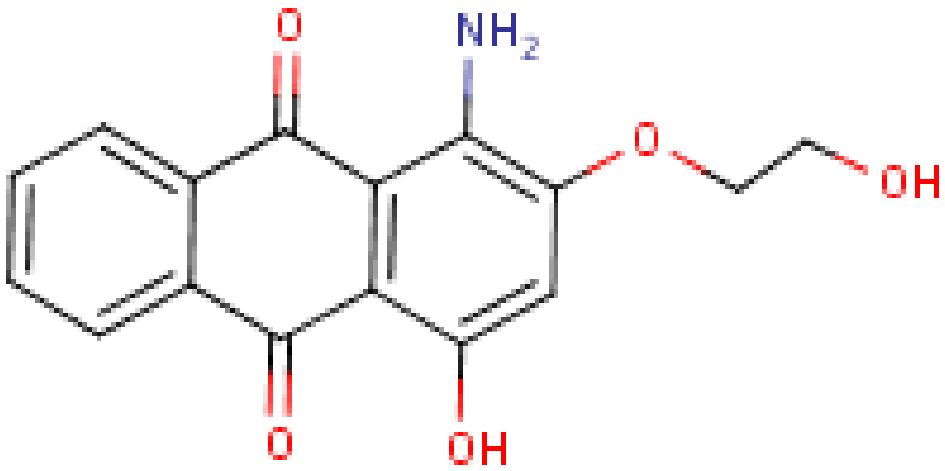
Chemical Name in the Inventory and Synonyms	**9,10-Anthracenedione, 1-[(3-aminopropyl)amino]-** 1-(aminopropylamino)anthraquinone HC Red No. 8 1-(3-aminopropylamino)anthraquinone
CAS Number	13556-29-1
Structural Formula	

	
Molecular Formula	C17H16N2O2
Molecular Weight	316.79

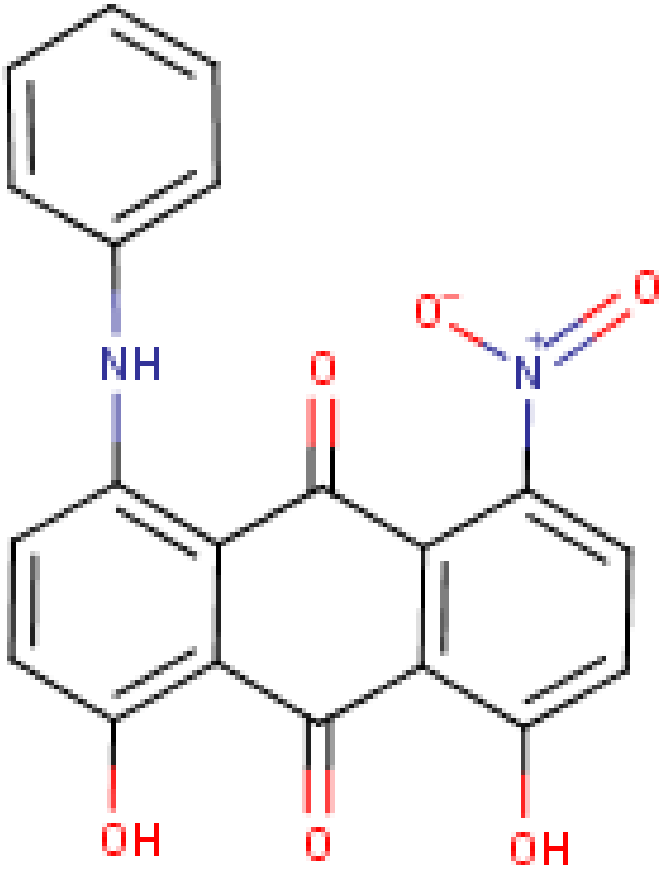
Chemical Name in the Inventory and Synonyms	**9,10-Anthracenedione, 1,4-bis(butylamino)-** 1,4-bis(n-butylamino)-9,10-anthracenedione 1,4-dibutylaminoanthraquinone C.I. Solvent Blue 35
CAS Number	17354-14-2
Structural Formula	

	
Molecular Formula	C22H26N2O2
Molecular Weight	350.45

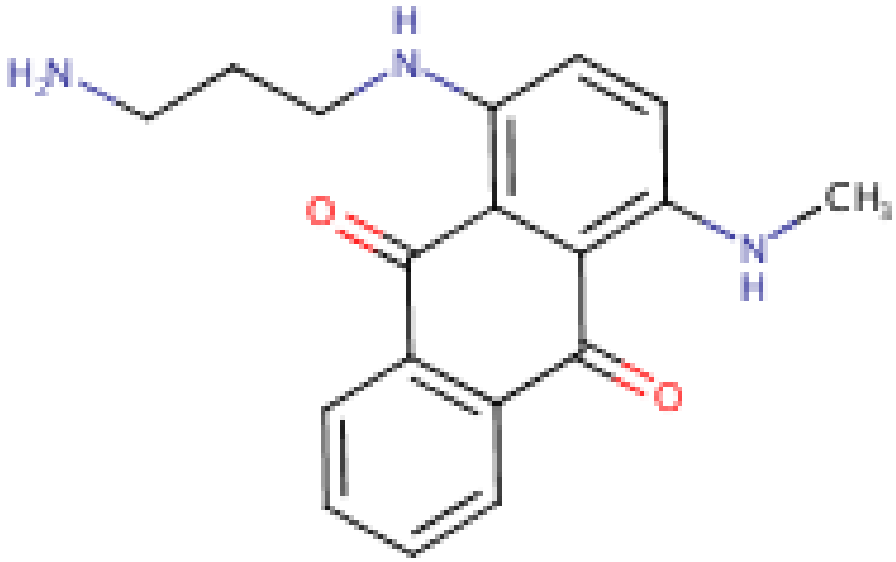
Chemical Name in the Inventory and Synonyms	**9,10-Anthracenedione, 1-amino-4-hydroxy-2-(2-hydroxyethoxy)-** 1-amino-4-hydroxy-2-(2-hydroxyethoxy)-9,10-anthracenedione 1-amino-4-hydroxy-2-(2-hydroxyethyl)oxyanthraquinone
CAS Number	17869-07-7
Structural Formula	

	
Molecular Formula	C16H13NO5
Molecular Weight	299.28

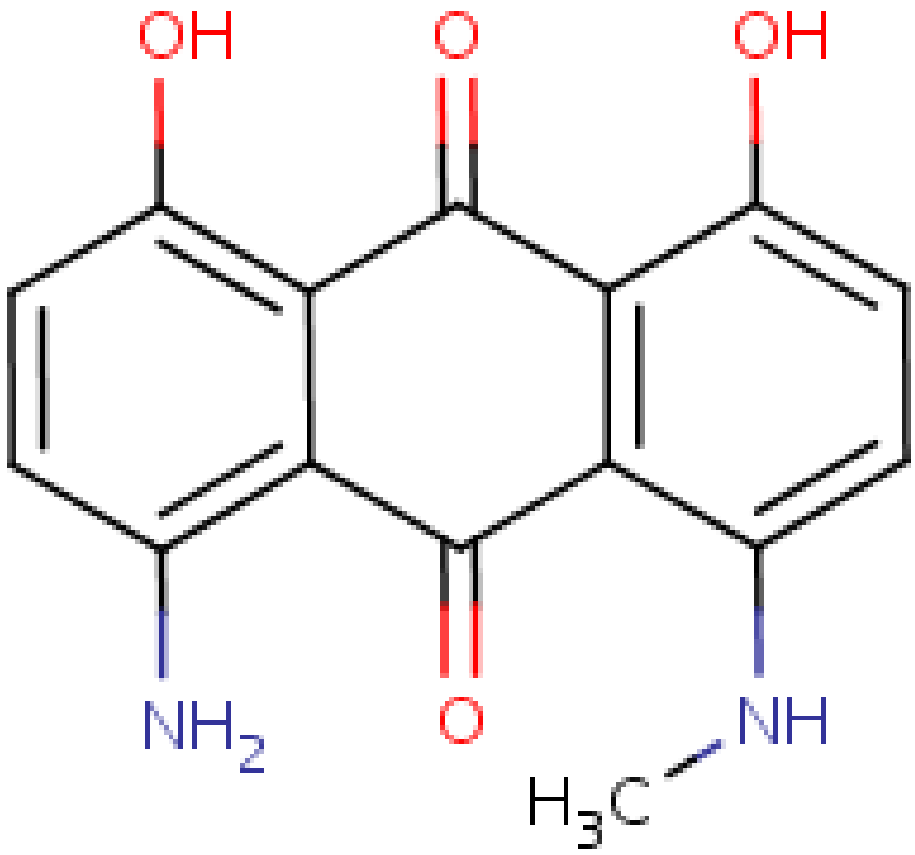
Chemical Name in the Inventory and Synonyms	**9,10-Anthracenedione, 1,8-dihydroxy-4-nitro-5-(phenylamino)-** anthraquinone, 1-anilino-4,5-dihydroxy-8-nitro- C.I. Disperse Blue 77 1-anilino-4,5-dihydroxy-8-nitroanthraquinone 4-anilino-5-nitrochrysazin
CAS Number	20241-76-3
Structural Formula	

	
Molecular Formula	C20H12N2O6
Molecular Weight	376.32

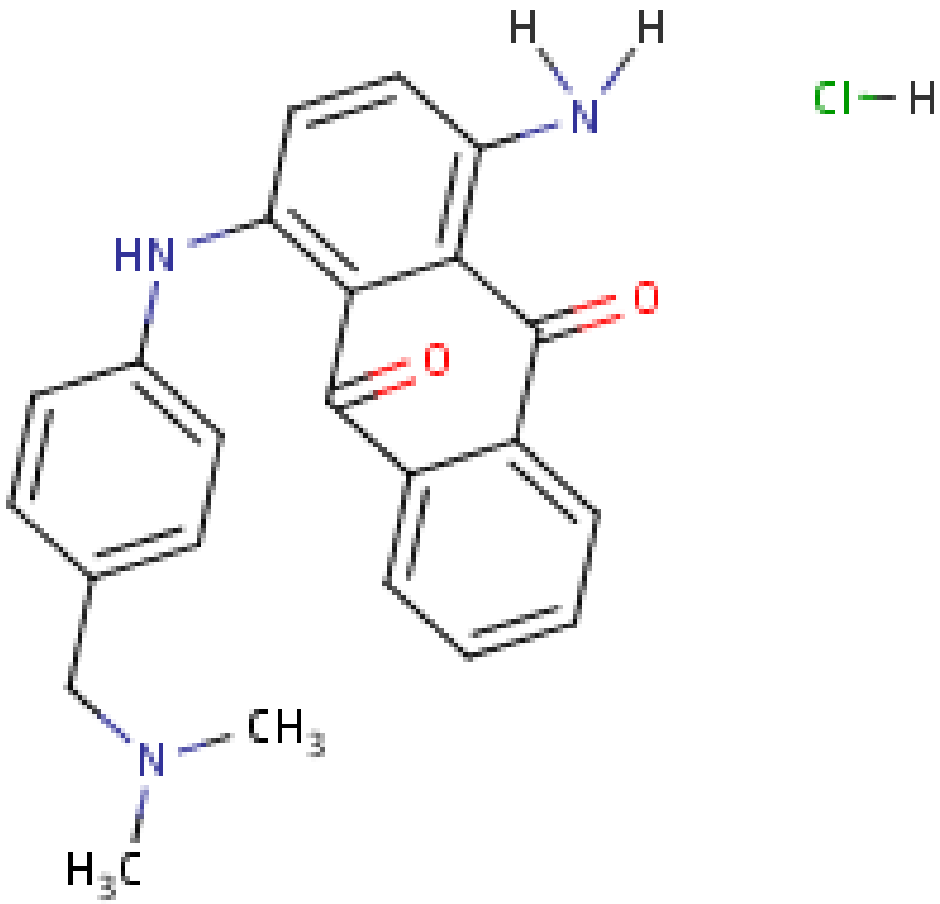
Chemical Name in the Inventory and Synonyms	**9,10-Anthracenedione, 1-[(3-aminopropyl)amino]-4-(methylamino)-** 1-((3-aminopropyl)amino)-4-(methylamino)-9,10-anthracenedione 1-methylamino-4(gamma-aminopropylamino)anthraquinone, hydrochloride HC Blue No. 8
CAS Number	22366-99-0
Structural Formula	

	
Molecular Formula	C18H19N3O2
Molecular Weight	309.38

Chemical Name in the Inventory and Synonyms	**9,10-Anthracenedione, 1-amino-4,5-dihydroxy-8-(methylamino)-** 1-amino-4,5-dihydroxy-8-(N-methylamino)anthraquinone
CAS Number	56524-77-7
Structural Formula	

	
Molecular Formula	C15H12N2O4
Molecular Weight	284.27

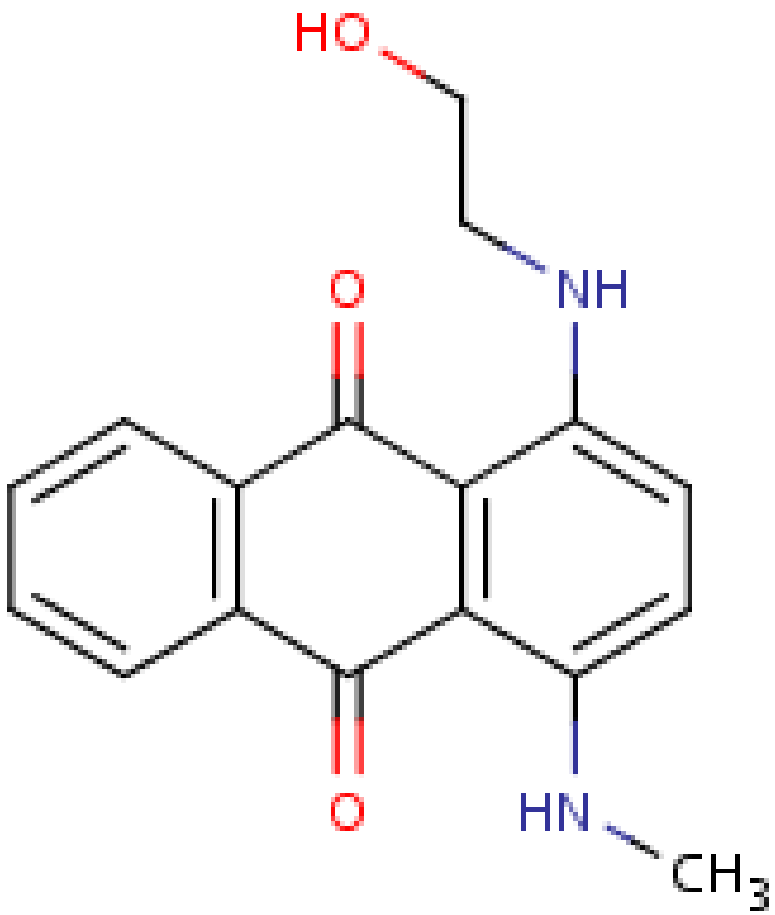
Chemical Name in the Inventory and Synonyms	**9,10-Anthracenedione, 1-amino-4-[[4-[(dimethylamino)methyl]phenyl]amino]-, monohydrochloride** 1-amino-4-(4-(alpha-(dimethylammonium)methyl)phenyl)aminoanthraquinone, chloride 9,10-anthracenedione, 1-amino-4-((4-((dimethylamino)methyl)phenyl)amino)-,hydrochloride (1:1)
CAS Number	67905-56-0
Structural Formula	



Molecular Formula	C23H21N3O2.ClH
Molecular Weight	407.90

Chemical Name in the Inventory and Synonyms	**9,10-Anthracenedione, 1,8-dihydroxy-4-[[4-[2-hydroxy-1-(hydroxymethyl)ethyl]phenyl]amino]-5-nitro-**
CAS Number	114565-66-1
Structural Formula	**No Structural Diagram Available**

Molecular Formula	C23H18N2O8
Molecular Weight	450.40

Chemical Name in the Inventory and Synonyms	**9,10-Anthracenedione, 1-[(2-hydroxyethyl)amino]-4-(methylamino)-** 1-(beta-hydroxyethylamino)-4-(methylamino)anthraquinone 1-((2-hydroxyethyl)amino)-4-(methylamino)anthraquinone anthraquinone, 1-((2-hydroxyethyl)amino)-4-(methylamino)- (8CI) Toray blue Serisol Brilliant Blue BGN 300
CAS Number	86722-66-9
Structural Formula	
Molecular Formula	C17H16N2O3
Molecular Weight	296.32

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