Selected 3,3'-dihydroxybenzidine based azo dyes: Human health tier II assessment

08 March 2019

Chemicals in this assessment

Chemical Name in the Inventory	CAS Number
Cuprate(4-), [.mu.3-[7-[[6-[[4'-[(4,5-dihydro-3-methyl-5-oxo-1-phenyl-1H-pyrazol-4-yl)azo]-3,3'-dihydroxy[1,1'-biphenyl]-4-yl]azo]-1,5-dihydroxy-7-sulfo-2-naphthalenyl]azo]-8-hydroxy-1,3,6-naphthalenetrisulfonato(10-)]]tri-, tetrahydrogen	71735-54-1
Cuprate(4-), [.mu.-[7-[[3,3'-dihydroxy-4'-[[1-hydroxy-6-(phenylamino)-3-sulfo-2-naphthalenyl]azo][1,1'-biphenyl]-4-yl]azo]-8-hydroxy-1,3,6-naphthalenetrisulfonato(8-)]]di-, tetrasodium	72927-72-1
Cuprate(3-), [.mu.-[7-[[4'-[[6-(benzoylamino)-1-hydroxy-3-sulfo-2-naphthalenyl]azo]-3,3'-dihydroxy[1,1'-biphenyl]-4-yl]azo]-8-hydroxy-1,6-naphthalenedisulfonato(7-)]]di-, trisodium	75214-64-1
Cuprate(3-), [.mu.-[7-[[4'-[[8-(acetylamino)-1-hydroxy-3-sulfo-2-naphthalenyl]azo]-3,3'-dihydroxy[1,1'-biphenyl]-4-yl]azo]-8-hydroxy-1,6-naphthalenedisulfonato(7-)]]di-, trisodium	75268-77-8

Chemical Name in the Inventory	CAS Number
Cuprate(3-), [.mu.-[3-[[4'-[[6-(benzoylamino)-1-hydroxy-3-sulfo-2-naphthalenyl]azo]-3,3'-dihydroxy[1,1'-biphenyl]-4-yl]azo]-4,5-dihydroxy-2,7-naphthalenedisulfonato(7-)]]di-, trisodium	75284-35-4
Cuprate(6-), [.mu.-[[3,3'-[[3,3'-dihydroxy[1,1'-biphenyl]-4,4'-diyl]bis[azo[8-hydroxy-3,6-disulfo-7,1-naphthalenediyl]imino[6-[(3-methylphenyl)amino]-1,3,5-triazine-4,2-diyl]imino]]bis(6-hydroxybenzoato)](10-)]]di-, hexasodium	86437-45-8

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

NICNAS has made every effort to assure the quality of information available in this report. However, before relying on it for a specific purpose, users should obtain advice relevant to their particular circumstances. This report has been prepared by NICNAS using a range of sources, including information from databases maintained by third parties, which include data supplied by industry. NICNAS has not verified and cannot guarantee the correctness of all information obtained from those databases.

ACRONYMS & ABBREVIATIONS

Grouping Rationale

The critical concern for this group of chemicals and focus of this assessment relates to potential carcinogenic effects following exposure and metabolism to the constituent benzidine congener.

All the chemicals in this group are metallised 3,3-disubstituted benzidine-congener-based dyes (with the characteristic diazotised 3,3'-benzidine-congener structure) and have potential to be metabolised in vivo to the benzidine congener, 3,3'-dihydroxybenzidine (3,3'-DHB) (CAS No. 2373-98-0). Given that the dye synthesis commences with the carcinogenic 3,3'-DMOB, the chemicals in this group are likely to contain significant levels of impurities that are reduced to this benzidine congener.

Structurally similar chemicals have been included in previous Human Health Tier II assessment of 'Selected benzidine-congener-based dyes'. Therefore, this report should be read in conjunction with the report at:

https://www.nicnas.gov.au/chemical-information/imap-assessments/imap-group-assessment-report?assessment_id=1022

Import, Manufacture and Use

Australian

No data are available for the chemicals.

International

The following international uses for the chemical with CAS No. 72927-72-1 have been identified through the European Union (EU) Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) dossier.

The chemical has reported commercial uses as a dye in:

- inks and toners for printing;
- coloured paper products;
- polymer preparations and compounds; and
- textile and impregnating products.

Restrictions

Australian

These chemicals are listed in the Poisons Standard—*the Standard for the Uniform Scheduling of Medicines and Poisons* (SUSMP) in Schedule 7.

BENZIDINE-CONGENER (3,3'-disubstituted) AZO DYES.

Schedule 7 chemicals are described as ‘Dangerous Poison – Substances with a high potential for causing harm at low exposure and which require special precautions during manufacture, handling or use. These poisons should be available only to specialised or authorised users who have the skills necessary to handle them safely. Special regulations restricting their availability, possession, storage or use may apply’ (SUSMP, 2019).

International

No known restrictions have been identified.

Existing Worker Health and Safety Controls

Hazard Classification

The chemicals are not listed on the Hazardous Chemicals Information System (HCIS) (Safe Work Australia).

Exposure Standards

Australian

No specific exposure standards are available.

International

No specific exposure standards are available.

Health Hazard Information

The critical concern for this group of chemicals and focus of this assessment relates to the potential carcinogenic effects following exposure to the constituent benzidine congener. Local effects are considered a secondary concern for this group of chemicals and, as such, have not been considered as part of this assessment.

There are no data available regarding the toxicity of these chemicals. However, the toxic effects of these chemicals can largely be attributed to the benzidine congener that is released when the parent chemical is metabolised. The chemicals in this assessment have potential to be metabolised to the benzidine congener, 3,3’-DHB (CAS No. 2373-98-0; not listed in the Australian Inventory of Chemical substances (AICS)). Data for the potential metabolite 3,3-DHB are included when available.

Data are available for structurally related metallised 3,3’-DHB derivative, C.I. Direct Blue 218 (CAS No. 28407-37-6) (NICNASa; REACHa). Data from this chemical are considered representative for all chemicals in this assessment.

The synthetic route for C.I. Direct Blue 218 consists of coupling 3,3'-dimethoxybenzidine (DMOB—CAS No. 119-90-4) to 4-amino-5-hydroxy-2,7-napthalene disulfonic acid followed by metallizing and elimination of methyl groups from the methoxy groups to form the copper complex (Morgan et al., 1994).

Whilst metal chelation may reduce the carcinogenic potential of the chemicals – by slowing metabolism to the free benzidine congener – based on data for C.I. Direct Blue 218, chelation does not completely eliminate the carcinogenic potential (US EPA, 2010).

Toxicokinetics

Limited data are available. Azo bond reduction and cleavage occurs by an enzyme-mediated metabolism in the liver, skin and intestines. In the liver, cytosolic and microsomal enzymes (Platzek et al., 1999), including NADH cytochrome P450 reductase, NAD(P)H quinone oxidoreductase and cytochrome P450s (OEHHA, 2012), facilitate metabolism. Bacterial strains in human faeces have been shown to cleave azo dyes, suggesting that intestinal microflora play an important role in azo reduction (Platzek et al., 1999).

Although azo bond reduction occurs favourably in anaerobic conditions, several in vitro and in vivo studies indicated that this process could also occur aerobically when azo dyes are applied to the skin (SCCP, 2005). In vitro, the skin microflora of mice, guinea pigs and humans caused reductive cleavage of the azo dyes, followed by percutaneous absorption of the resulting aromatic amine (SCCNFP, 2002).

Chelation with copper of the hydroxyl groups of the benzidine congener is considered to inhibit metabolism of the dye. Whilst the metabolic pathway for the metallised dyes is not certain, azo linkages in C.I. Direct Blue 218 appear to be reduced in the presence of flavin mononucleotide or rat caecal bacteria. The metabolites were not identified but could include 3,3-DHB (NICNASb; Morgan et al., 1994).

Given that the dye synthesis commences with the carcinogenic 3,3'-DMOB, any residual of this chemical or non-metallised impurities in the dye could give rise to DMOB exposure.

Given the high molecular weight of the dye molecule, absorption by any route is expected to be minimal. However, any benzidine congener produced by bacterial metabolism on the skin or in the intestines may be readily absorbed.

Acute Toxicity

Oral

Due to the expected low absorption of the chemicals, acute oral toxicity is expected to be low.

Dermal

Due to the expected low absorption of the chemicals, acute dermal toxicity is expected to be low.

Inhalation

Due to the expected low absorption of the chemicals, acute inhalational toxicity is expected to be low.

Repeated Dose Toxicity

Oral

Based on the available information for C.I. Direct Blue 218, the chemicals may cause adverse effects at high doses. In general, effects observed in animals were associated with cancer (see **Carcinogenicity** section).

The toxic effects of C.I. Direct Blue 218 from repeated exposure were investigated in the NTP-sponsored 2-week, 13-week, and 2-year feeding studies (NTP, 1994). Only minor effects apart from carcinogenicity were seen in any of the studies.

The longer exposure period (2 years) led to a significant number of neoplasms detected in the animals that survived in the mid to high dosed groups (see **Carcinogenicity** section).

Dermal

No data are available for the chemicals.

Inhalation

No data are available for the chemicals.

Genotoxicity

No data are available for the chemicals. Overall data for C.I. Direct Blue 218 indicate that the chemicals would not be genotoxic. Limited information is available for the potential metabolite of the chemicals, 3,3'-DHB. While the (quantitative) structure activity relationship ((Q)SAR) analysis suggests that the potential metabolite 3,3'-DHB is not genotoxic, in vitro mutagenic potential has been reported for the 3,3'-DHB (Ames test), with similar profile to the known genotoxic substance 3,3'-DMOB (NICNASb). In addition, the chemicals are likely to contain impurities that would be reduced to 3,3'-DMOB. The information is not sufficient for classification.

C.I. Direct Blue 218

The chemical C.I. Direct Blue 218 did not induce mutations in *Salmonella typhimurium* strains TA98, TA100, TA1535, and TA1537 in the standard NTP assay (NTP, 1994). C.I. Direct Blue 218 was also negative in strain TA1538 in a modified *Salmonella* test protocol which employed reductive metabolism supplied by flavin mononucleotide or rat caecal bacteria, followed by oxidative metabolism (NTP, 1994). Non-metallised dyes based on 3,3-DMOB were positive in this strain when tested under similar conditions (NICNASa).

In cytogenetic tests with CHO cells, C.I. Direct Blue 218 induced a small but significant increase in sister chromatid exchange (SCE) at the highest dose tested (200 µg/mL) in the second of two trials conducted without S9. No increase in SCEs was observed in either of two trials conducted with S9. No increase in chromosomal aberrations was seen in CHO cells treated with C.I. Direct Blue 218, at concentrations up to 500 µg/mL, with and without S9.

No increase in the frequency of sex-linked recessive lethal mutations was observed in the offspring of male *Drosophila melanogaster* administered C.I. Direct Blue 218 by feeding (l0000 ppm) or by injection (1000 ppm) (NTP, 1994).

Potential metabolite 3,3’-DHB

In vitro mutagenicity

The potential metabolite 3,3’-DHB was

- positive in *S. typhimurium* strain TA98 in the presence of metabolic activation at doses above 1.5 µmole/plate (Morgan et al., 1994);
- positive in *S. typhimurium* strain TA98 and weakly positive in TA100 in the presence of metabolic activation at does up to 10000 µg/plate (NTP);
- weakly positive in *S. typhimurium* strain TA100 at doses up to 2500 µg/plate with or without metabolic activation; and
- negative in *S. typhimurium* strains TA1537, TA 1535 and TA98 with or without metabolic activation (CCRIS).

The chemical 3,3'-DMOB and/or the hydrochloride salts (NICNASb):

- was positive in *S. typhimurium* in strains TA98, TA100 and/or TA1535 in the presence of metabolic activation;
- was positive in *S. typhimurium* in strains TA98 in the absence of metabolic activation;
- was positive in vitro for SCE;
- was positive in vitro in the Chromosomal Aberration (CA) tests in Chinese Hamster Ovary (CHO); and
- produced DNA fragmentation in rat hepatocytes and urinary bladder cells of humans.

Strains TA98 and TA100 are the standard strains used in the Ames assay for detection of frameshift and base substitution mutations, respectively. These strains are considered most specific to aromatic amines (NICNASb-j). In a recent study, 95% of mutagenic primary aromatic amines were positive in at least *Salmonella* TA98 and TA100 (Ahlberg et al., 2016).

(Q)SAR predictions - potential metabolites

The OECD (Q)SAR Toolbox (version 4.2) indicated general mechanistic and endpoint specific genotoxicity structural alerts for the potential metabolite of the dyes, 3,3'-DHB. However, the metabolic simulation (rat liver S9) of 3,3'-DHB did not result in metabolites with genotoxic alerts. This suggests that the active hydroxyl group next to the amine group may influence the metabolism and the ability to generate genotoxic nitroso metabolites.

Weak of lack of genotoxicity potential was supported by the Derek Nexus (KB 2018 1.1; Lhasa Limited) prediction 'Inactive' for bacterial mutagenicity in vitro. No misclassified or unclassified features were reported.

Carcinogenicity

Based on the available data for C.I. Direct Blue 218, the chemicals may be carcinogenic. C.I. Direct Blue 218 is classified as Category 1B carcinogen with a hazard statement 'May cause cancer' (HCIS). Similar to the C.I Direct Blue 218, the chemicals may be metabolised in vivo to the benzidine congener, 3,3'-DHB (CAS No. 2373-98-0), which may be mutagenic (see **Genotoxicity** section) and which has some evidence of carcinogenicity. In addition the chemicals are likely to contain impurities that would be reduced to 3,3'-DMOB. In the absence of data for the individual dyes, classification is considered warranted (see **Recommendation** section).

Overall the existing data provide evidence of the carcinogenic effects of the chemical C.I. Direct Blue 218. Evidence of the carcinogenicity of C.I. Direct Blue 218 (60 % purity) was reported in 2-year NTP-sponsored carcinogenicity studies (drinking and feeding) in F344 rats and in B6C3F1 mice (see **Repeated dose toxicity** section). There was some evidence of carcinogenic activity in male rats and clear evidence in male and female mice (NTP, 1994).

A significantly greater incidence of neoplasms of the oral mucosa was noted in male F344 rats fed with a diet containing 10000 ppm (approximately 1520 mg/kg bw/day) of C.I. Direct Blue 218. These neoplasms were considered potentially treatment related. No similar neoplasms were noted in female rats. A significantly increased incidence of fore-stomach basal cell hyperplasia were noted in male rats receiving 3000 or 10000 ppm, and female rats receiving 10000 ppm. Squamous papillomas and carcinomas of the stomach were also observed in some rats, but the significance of this was not certain. Due to the uncommon occurrence of forestomach neoplasms in untreated male rats, and the slight increase in the incidence of focal hyperplasia, these neoplasms may have been treatment related (NTP, 1994).

In mice, there were increased incidences of hepatocellular foci, adenomas and carcinomas that were considered treatment related. Male mice receiving 10000 ppm had a significantly increased incidence of hepatocellular adenoma and hepatocellular carcinoma. Female mice receiving 3000 or 10000 ppm had a significantly increased incidence of hepatocellular adenoma. Females receiving 10000 ppm had marginally increased incidence of hepatocellular carcinoma. Consistent with this finding, the incidence of hepatocellular foci of cytologic alteration (a preneoplastic lesion) was also increased in mice of both sexes in the 10000 ppm groups. Uncommon renal tubule neoplasms, potentially treatment related, occurred at low incidences in treated male mice. Renal tubule adenomas occurred in two males receiving 1000 ppm, one male receiving 3000 ppm and one male receiving 10000 ppm. Renal tubule carcinoma was seen in one male that received 1000 ppm. Carcinomas of the small intestine occurred in 4 male mice receiving 10000 ppm. Due to the rare occurrence of small intestine neoplasms in control male mice, the slightly higher incidence observed in treated male mice was potentially treatment related (NTP, 1994).

Inconsistent information is available for the potential metabolite 3,3'-DHB. Liver neoplasms were reported in mice receiving 300 mg of 3,3'-DHB three times a week for 45 weeks. However, based on the melting point (136-138°C for tested substance vs 292 °C for 3'3'-dihydroxybenzidine), the chemical used was not pure (Baker, 1953; NTP, 1994). In the follow-up study in rats treated with estimated daily intake of up to 1000 mg of 3,3'-DHB per day (up to 8 g of diet containing the chemical at 0.125% by weight), hepatoma, adenocarcinoma of the colon, carcinoma of the fore-stomach, bladder carcinoma and sebaceous gland tumours were reported (Baker et al., 1953). In another study, treatment-related neoplasms were reported in skin and liver of rats treated with 3,3'-DHB. However, no information was available on the purity of the chemicals or details on the doses used (NTP, 1994).

In contrast, subcutaneous injection with 6 mg/kg bw of 3,3'-DHB twice a week for 52 weeks with the animals remaining untreated thereafter, did not induce neoplasms in mice (NTP, 1994).

The chemical 3,3'-DMOB is reasonably anticipated to be human carcinogen (NICNASb).

Reproductive and Developmental Toxicity

No data are available for the chemicals.

Risk Characterisation

Critical Health Effects

The critical health effect for risk characterisation is the systemic long-term effect of carcinogenicity.

Public Risk Characterisation

The chemicals are currently listed on Schedule 7 of the *Standard for the Uniform Scheduling of Medicines and Poisons* (SUSMP, 2019). This precludes the introduction of these dyes for home use.

However, dermal exposure to the chemicals could occur though prolonged contact with dyed textiles and leather. Bacteria on the skin have been shown to possess azoreductase activity, and bioavailability of benzidine derivatives has been demonstrated in animals following dermal exposure to related dyes (Government of Canada, 2014; NICNASa). Oral ingestion could also occur in infants through the sucking or chewing of textiles and paper.

Whilst the metabolic pathway for the metallised dyes is not certain, metal chelation does not completely eliminate the carcinogenic effects of metallised dyes derived from benzidine congeners (US EPA, 2010). C.I. Direct Blue 218 (which is structurally similar to the chemicals in this assessment) is a known carcinogen (see Carcinogenicity section) and the potential metabolite 3,3'-DHB has some evidence for mutagenicity and carcinogenicity. In addition the dyes in this assessment are expected to contain impurities that would be reduced to 3,3'-DMOB, one of the EU 22 amines (see below).

An international assessment of the risk of cancer caused by textiles and leather goods coloured with certain azo dyes concluded that, while consumer exposure is likely to be 'very low', the associated cancer risks give cause for concern. Although this assessment was not publicly available, the European Scientific Committee on Toxicity, Ecotoxicity and Environment (CSTEE) considers that the report adequately reviews the situation regarding the risk of cancer for consumers from fabrics dyed with azo compounds, and that its conclusions are, in general, acceptable (CSTEE, 1999). The CSTEE also supported the recommendation that using azo dyes with the potential to give rise to the 22 aromatic amines classified as Category 1 or 2 carcinogens according to Directive 76/769/EEC, should be restricted to the lowest possible levels or completely eliminated.

The Australian Competition and Consumer Commission (ACCC) has published safety guidance on concentrations of particular aromatic amines in clothing, textiles and leather articles in direct and prolonged contact with the human skin or oral cavity (ACCC, 2014). 3,3'-DHB is not listed in this guidance. As 3,3-DHB is not included in the list of amines in the EU, routine testing of textiles for this chemical is not expected and test results for 3,3'-DHB are not likely to be available. However, limits for 3,3'-DMOB are in place and suppliers should have systems to manage levels of this chemical. Given that the dyes are likely to contain significant levels of impurities that are reduced to 3,3'-DMOB, the controls in place for 3,3'-DMOB levels in textiles are considered adequate to protect against exposure to 3,3'-DHB.

Limited data are available to assess exposure to azo dyes through use in the manufacture of paper. Overall exposure is not expected to be prolonged and is limited by the fastness requirements of colourants in paper. Widespread use of dyes based on carcinogenic amines in paper is not indicated (personal communication, European Commission, 2000).

Further evaluation could be required if further information become available on

- the carcinogenicity of the dyes or 3,3'-DHB; or
- information on impurities in these dyes; or

- presence of the dyes and/or the aromatic amines in textile or paper products in Australia.

Occupational Risk Characterisation

During product formulation, dermal exposure may occur, particularly where manual or open processes are used. These could include transfer and blending activities, quality control analysis, and cleaning and maintaining equipment. Worker exposure to the chemical at lower concentrations could 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 main routes of exposure are expected to be dermal and inhalation.

Given the critical systemic long-term health effect and other effects described above, the chemical could pose an unreasonable risk to workers unless adequate control measures to minimise dermal and inhalation exposure are implemented. The chemical should be appropriately classified and labelled to ensure that a person conducting a business or undertaking (PCBU) at a workplace (such as an employer) has adequate information to determine the appropriate controls.

The available data support an amendment to the hazard classification in HCIS (see **Recommendation** section).

NICNAS Recommendation

Further risk management is required. Sufficient information is available to recommend that risks for workplace health and safety be managed through changes to classification and labelling.

Further evaluation could be required if further information become available on

- the carcinogenicity of the dyes or 3,3'-DHB; or
- information on impurities in these dyes; or
- presence of the dyes and/or the aromatic amines in textile or paper products in Australia.

Regulatory Control

Public Health

Products containing the chemicals should be labelled in accordance with state and territory legislation (SUSMP, 2019).

Work Health and Safety

The chemical is recommended for classification and labelling aligned with the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) as below. This does not consider classification of physical hazards and environmental hazards.

Hazard	Approved Criteria (HSIS)[a]	GHS Classification (HCIS)[b]
Carcinogenicity	Not Applicable	May cause cancer - Cat. 1B (H350)

[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 consumers

Products containing the chemical should be used according to the instructions on the label.

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 chemicals are is used. Examples of control measures that 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 chemicals, 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 chemicals.

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 chemicals 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 these chemicals has not been undertaken as part of this assessment.

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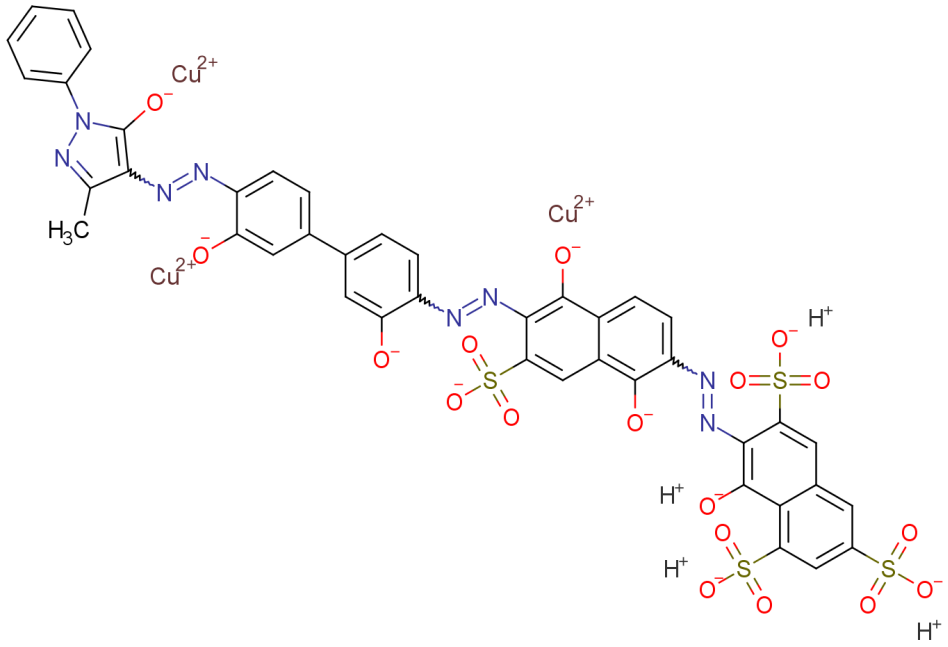
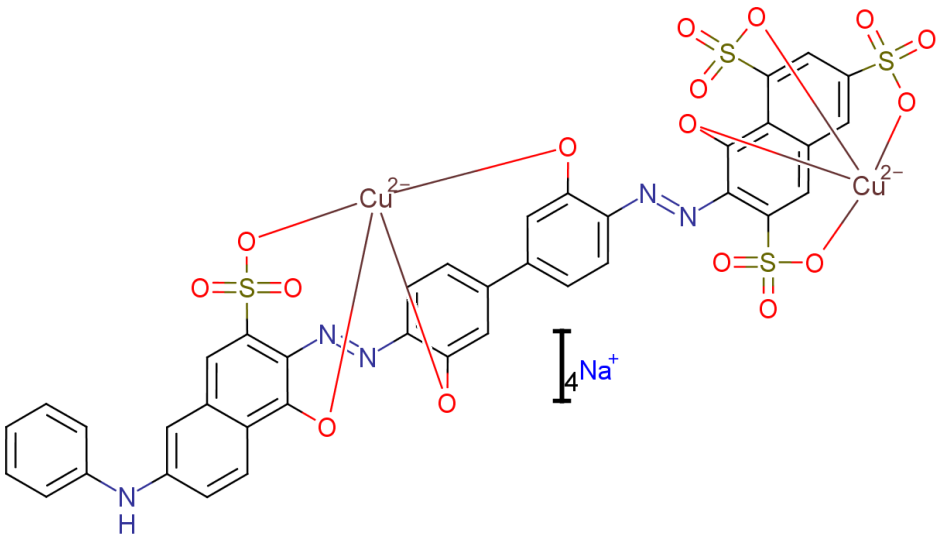
Last Update 08 March 2019

Chemical Identities

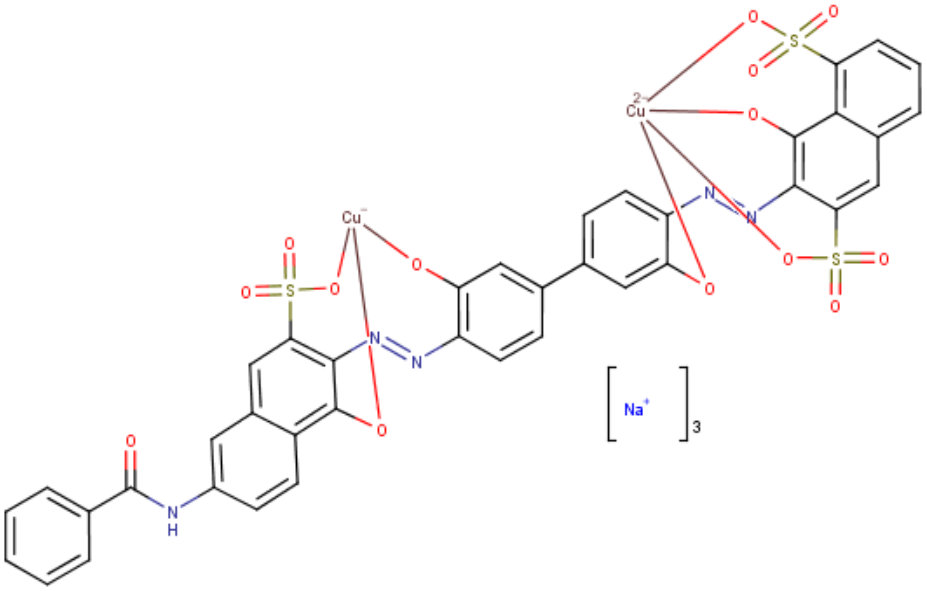
Chemical Name in the Inventory and Synonyms	**Cuprate(4-), [.mu.3-[7-[[6-[[4'-[(4,5-dihydro-3-methyl-5-oxo-1-phenyl-1H-pyrazol-4-yl)azo]-3,3'-dihydroxy[1,1'-biphenyl]-4-yl]azo]-1,5-dihydroxy-7-sulfo-2-naphthalenyl]azo]-8-hydroxy-1,3,6-naphthalenetrisulfonato(10-)]]tri-, tetrahydrogen** cuprate(4-), (μ3-(7-(2-(6-(2-(4'-(2-(4,5-dihydro-3-methyl-5-(oxo-?O)-1-phenyl-1H-pyrazol-4-yl)diazenyl-?N1)-3,3'-di(hydroxy-?O)(1,1'-biphenyl)-4-yl)diazenyl-?N1)-1,5-di(hydroxy-?O)-7-sulfo-2-naphthalenyl)diazenyl-?N1)-8-(hydroxy-?O)-1,3,6-naphthalenetrisulfonato(10-)))tri-, hydrogen (1:4) cuprate(4-), [μ3-[7-[[6-[[4'-[(4,5-dihydro-3-methyl-5-oxo-1-phenyl-1H-pyrazol-4-yl)azo]-3,3'-dihydroxy[1,1'-biphenyl]-4-yl]azo]-1,5-dihydroxy-7-sulfo-2-naphthalenyl]azo]-8-hydroxy-1,3,6-naphthalenetrisulfonato(10-)]]tri-, tetrahydrogen cuprate(4-), [μ3-[7-[[6-[[4'-[[4,5-dihydro-3-methyl-5-(oxo-?O)-1-phenyl-1H-pyrazol-4-yl]azo-?N1]-3,3'-di(hydroxy-?O)[1,1'-biphenyl]-4-yl]azo-?N1]-1,5-di(hydroxy-?O)-7-sulfo-2-naphthalenyl]azo-?N1]-8-(hydroxy-?O)-1,3,6-naphthalenetrisulfonato(10-)]]tri-, tetrahydrogen (9CI) 1,3,6-naphthalenetrisulfonic acid, 7-[[6-[[4'-[(4,5-dihydro-3-methyl-5-oxo-1-phenyl-1H-pyrazol-4-yl)azo]-3,3'-dihydroxy[1,1'-biphenyl]-4-yl]azo]-1,5-dihydroxy-7-sulfo-2-naphthalenyl]azo]-8-hydroxy-, copper complex
CAS Number	71735-54-1

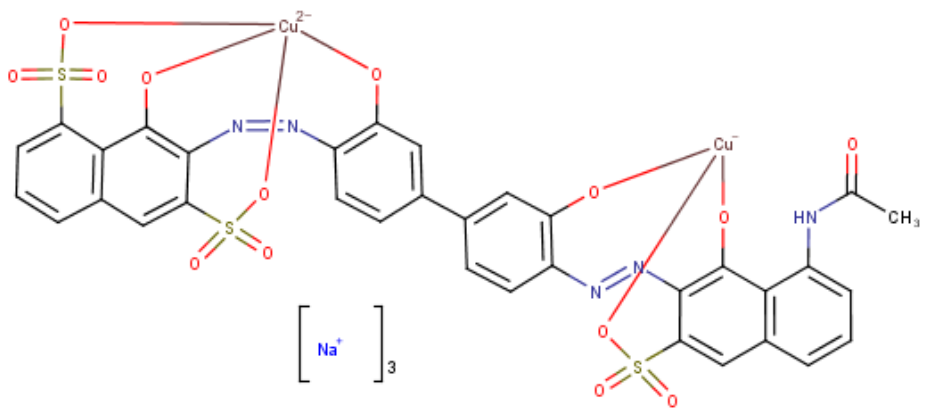
Structural Formula	
Molecular Formula	C42H20Cu3N8O18S4.4H
Molecular Weight	1247.59

Chemical Name in the Inventory and Synonyms	**Cuprate(4-), [.mu.-[7-[[3,3'-dihydroxy-4'-[[1-hydroxy-6-(phenylamino)-3-sulfo-2-naphthalenyl]azo][1,1'-biphenyl]-4-yl]azo]-8-hydroxy-1,3,6-naphthalenetrisulfonato(8-)]]di-, tetrasodium** cuprate(4-), [μ-[7-[2-[3,3'-di(hydroxy-?O)-4'-[2-[1-(hydroxy-?O)-6-(phenylamino)-3-sulfo-2-naphthalenyl]diazenyl-?N1][1,1'-biphenyl]-4-yl]diazenyl-?N1]-8-hydroxy-1,3,6-naphthalenetrisulfonato(8-)]]di-, sodium (1:4) cuprate(4-), [μ-[7-[[3,3'-di(hydroxy-?O)-4'-[[1-(hydroxy-?O)-6-(phenylamino)-3-sulfo-2-naphthalenyl]azo-?N1][1,1'-biphenyl]-4-yl]azo-?N1]-8-hydroxy-1,3,6-naphthalenetrisulfonato(8-)]]di-, tetrasodium (9CI) cuprate(4-), [μ-[7-[[3,3'-dihydroxy-4'-[[1-hydroxy-6-(phenylamino)-3-sulfo-2-naphthalenyl]azo][1,1'-biphenyl]-4-yl]azo]-8-hydroxy-1,3,6-naphthalenetrisulfonato(8-)]]di-, tetrasodium 1,3,6-naphthalenetrisulfonic acid, 7-[[3,3'-dihydroxy-4'-[[1-hydroxy-6-(phenylamino)-3-sulfo-2-naphthalenyl]azo][1,1'-biphenyl]-4-yl]azo]-8-hydroxy-, copper complex
CAS Number	72927-72-1
Structural Formula	

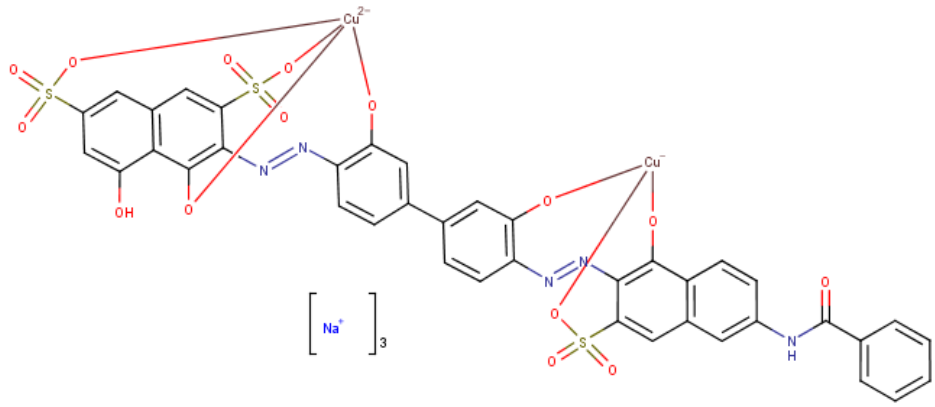
	
Molecular Formula	C38H19Cu2N5O16S4.4Na
Molecular Weight	1148.90

Chemical Name in the Inventory and Synonyms	**Cuprate(3-), [.mu.-[7-[[4'-[[6-(benzoylamino)-1-hydroxy-3-sulfo-2-naphthalenyl]azo]-3,3'-dihydroxy[1,1'-biphenyl]-4-yl]azo]-8-hydroxy-1,6-naphthalenedisulfonato(7-)]]di-, trisodium** cuprate(3-), [μ-[7-[2-[4'-[2-[6-(benzoylamino)-1-(hydroxy-?O)-3-sulfo-2-naphthalenyl]diazenyl-?N1]-3,3'-di(hydroxy-?O)[1,1'-biphenyl]-4-yl]diazenyl-?N1]-8-(hydroxy-?O)-1,6-naphthalenedisulfonato(7-)]]di-, sodium (1:3) cuprate(3-), [μ-[7-[[4'-[[6-(benzoylamino)-1-(hydroxy-?O)-3-sulfo-2-naphthalenyl]azo-?N1]-3,3'-di(hydroxy-?O)[1,1'-biphenyl]-4-yl]azo-?N1]-8-(hydroxy-?O)-1,6-naphthalenedisulfonato(7-)]]di-, trisodium (9CI) cuprate(3-), [μ-[7-[[4'-[[6-(benzoylamino)-1-hydroxy-3-sulfo-2-naphthalenyl]azo]-3,3'-dihydroxy[1,1'-biphenyl]-4-yl]azo]-8-hydroxy-1,6-naphthalenedisulfonato(7-)]]di-, trisodium 1,6-naphthalenedisulfonic acid, 7-[[4'-[[6-(benzoylamino)-1-hydroxy-3-sulfo-2-naphthalenyl]azo]-3,3'-dihydroxy[1,1'-biphenyl]-4-yl]azo]-8-hydroxy-, copper complex
CAS Number	75214-64-1
Structural Formula	

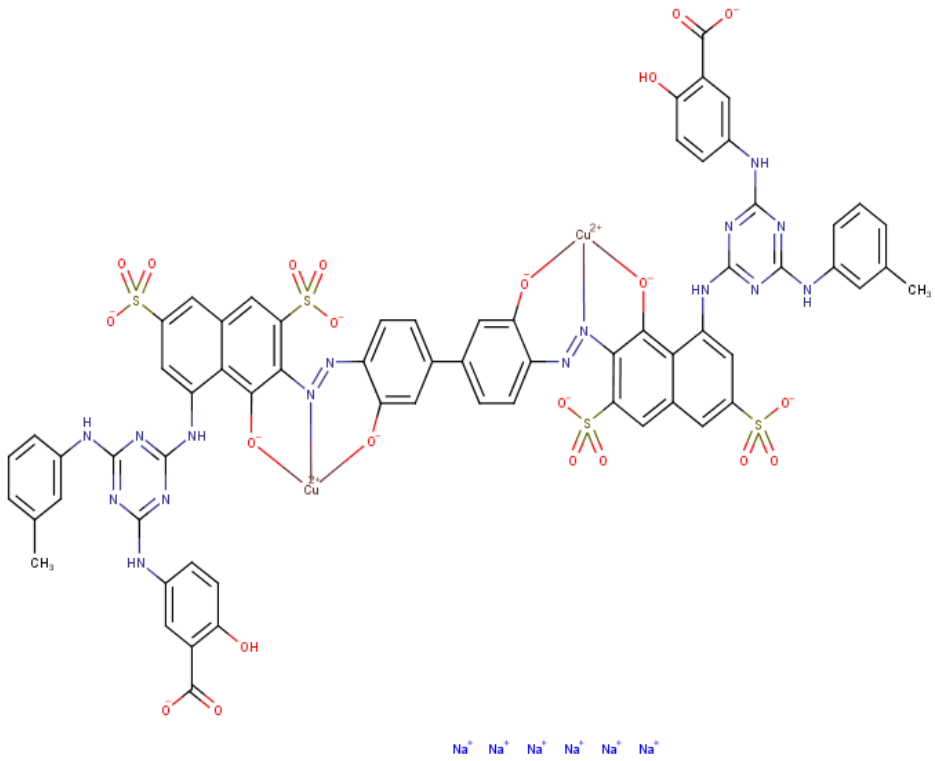
	
Molecular Formula	C39H20Cu2N5O14S3.3Na
Molecular Weight	1074.89

Chemical Name in the Inventory and Synonyms	**Cuprate(3-), [.mu.-[7-[[4'-[[8-(acetylamino)-1-hydroxy-3-sulfo-2-naphthalenyl]azo]-3,3'-dihydroxy[1,1'-biphenyl]-4-yl]azo]-8-hydroxy-1,6-naphthalenedisulfonato(7-)]]di-, trisodium** cuprate(3-), [μ-[7-[2- [4'-[2-[8-(acetylamino)-1-(hydroxy-?O)-3-sulfo-2-naphthalenyl]diazenyl-?N1]-3,3'-di(hydroxy-?O)[1,1'-biphenyl]-4-yl]diazenyl-?N1]-8-(hydroxy-?O)-1,6-naphthalenedisulfonato(7-)]]di-, sodium (1:3) cuprate(3-), [μ-[7-[[4'-[[8-(acetylamino)-1-(hydroxy-?O)-3-sulfo-2-naphthalenyl]azo-?N1]-3,3'-di(hydroxy-?O)[1,1'-biphenyl]-4-yl]azo-?N1]-8-(hydroxy-?O)-1,6-naphthalenedisulfonato(7-)]]di-, trisodium (9CI) cuprate(3-), [μ-[7-[[4'-[[8-(acetylamino)-1-hydroxy-3-sulfo-2-naphthalenyl]azo]-3,3'-dihydroxy[1,1'-biphenyl]-4-yl]azo]-8-hydroxy-1,6-naphthalenedisulfonato(7-)]]di-, trisodium 1,6-naphthalenedisulfonic acid, 7-[[4'-[[8-(acetylamino)-1-hydroxy-3-sulfo-2-naphthalenyl]azo]-3,3'-dihydroxy[1,1'-biphenyl]-4-yl]azo]-8-hydroxy-, copper complex
CAS Number	75268-77-8
Structural Formula	

Molecular Formula	C34H18Cu2N5O14S3.3Na
Molecular Weight	1012.80

Chemical Name in the Inventory and Synonyms	**Cuprate(3-), [.mu.-[3-[[4'-[[6-(benzoylamino)-1-hydroxy-3-sulfo-2-naphthalenyl]azo]-3,3'-dihydroxy[1,1'-biphenyl]-4-yl]azo]-4,5-dihydroxy-2,7-naphthalenedisulfonato(7-)]]di-, trisodium** cuprate(3-), [μ-[3-[2-[4'-[2-[6-(benzoylamino)-1-(hydroxy-?O)-3-sulfo-2-naphthalenyl]diazenyl-?N1]-3,3'-di(hydroxy-?O)[1,1'-biphenyl]-4-yl]diazenyl-?N1]-4-(hydroxy-?O)-5-hydroxy-2,7-naphthalenedisulfonato(7-)]]di-, sodium (1:3) cuprate(3-), [μ-[3-[[4'-[[6-(benzoylamino)-1-(hydroxy-?O)-3-sulfo-2-naphthalenyl]azo-?N1]-3,3'-di(hydroxy-?O)[1,1'-biphenyl]-4-yl]azo-?N1]-4-(hydroxy-?O)-5-hydroxy-2,7-naphthalenedisulfonato(7-)]]di-, trisodium (9CI) cuprate(3-), [μ-[3-[[4'-[[6-(benzoylamino)-1-hydroxy-3-sulfo-2-naphthalenyl]azo]-3,3'-dihydroxy[1,1'-biphenyl]-4-yl]azo]-4,5-dihydroxy-2,7-naphthalenedisulfonato(7-)]]di-, trisodium 2,7-naphthalenedisulfonic acid, 3-[[4'-[[6-(benzoylamino)-1-hydroxy-3-sulfo-2-naphthalenyl]azo]-3,3'-dihydroxy[1,1'-biphenyl]-4-yl]azo]-4,5-dihydroxy-, copper complex C.I. Direct Blue 94
CAS Number	75284-35-4
Structural Formula	
Molecular Formula	C39H20Cu2N5O15S3.3Na
Molecular Weight	1090.87

Chemical Name in the Inventory and Synonyms	**Cuprate(6-), [.mu.-[[3,3'-[[3,3'-dihydroxy[1,1'-biphenyl]-4,4'-diyl]bis[azo[8-hydroxy-3,6-disulfo-7,1-naphthalenediyl]imino[6-[(3-methylphenyl)amino]-1,3,5-triazine-4,2-diyl]imino]]bis(6-hydroxybenzoato)](10-)]]di-, hexasodium** benzoic acid, 3,3'-[(3,3'-dihydroxy[1,1'-biphenyl]-4,4'-diyl)bis[azo(8-hydroxy-3,6-disulfo-7,1-naphthalenediyl)imino[6-[(3-methylphenyl)amino]-1,3,5-triazine-4,2-diyl]imino]]bis[6-hydroxy-, copper complex cuprate(6-),[μ-[[3,3'-[(3,3'-dihydroxy[1,1'-biphenyl]-4,4'-diyl)bis[azo(8-hydroxy-3,6-disulfo-7,1-naphthalenediyl)imino[6-[(3-methylphenyl)amino]-1,3,5-triazine-4,2-diyl]imino]]bis[6-hydroxybenzoato]](10-)]]di-, hexasodium (9CI)

CAS Number	86437-45-8
Structural Formula	
Molecular Formula	C66H40Cu2N16O22S4.6Na
Molecular Weight	Unspecified

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